Northern Goshawk Status Review

June 1998

USDI Fish and Wildlife Service. 1998
Status Review of the northern goshawk in the forested west
Office of Technical Support - Forest Resources
Portland, OR
Unpublished Report
250 pages

Corrections to original document:
Added citation to title page 4/27/99
Updated Literature Cited Section 4/27/99
Corrected Table of Contents 4/28/99
Corrected incomplete sentence, Ch. 3, Pg. 107, under the heading Goshawk Population Distribution in Status Review Area, The sentence begins "Our analysis of the ..." 1/21/00

Note: The pagination and appearance of this electronic version of the Northern Goshawk Status Review may vary slightly from the original printed document. However, the content of this version is the same as the printed version.

Northern Goshawk Status Review

June 1998

Team Members

Catrina Martin, Team Leader, USFWS, Office of Technical Support
Cay Ogden, USFWS, Office of Technical Support
George Mayfield, USFWS, Office of Technical Support
Steve Spangle, USFWS, Region 2
Marilet Zablan, USFWS, Region 6

Charlie Bruce, Oregon Department of Fish and Wildlife
Susan MacVean, Arizona Game & Fish Department
Richard Reynolds, USFS, Rocky Mountain Research Station
Brian Woodbridge, USFS, Klamath National Forest

With assistance from
Sandy Boyce, USFS, Region 3
Loyal Mehrhoff, USFWS, Office of Technical Support
Barry Mulder, USFWS, Office of Technical Support

Monty Knudsen, Project Manager, USFWS, Office of Technical Support
333 SW First Avenue, Portland, Oregon 97204

Northern Goshawk Status Review - June 1998
Table of Contents

Chapter 1 - Introduction and Approach

Chapter 2 - Life History and Ecology

Chapter 3 - Distribution and Status

Chapter 4 - Conservation and Management

Chapter 5 - Summary and Conclusions

Chapter 6 - Recommendations

Literature Cited

Appendix A - Silvicultural Prescriptions Reported in Forest Service Annual Reports, and Their Effect on Goshawk Habitat

Chapter 1 - Introduction and Approach

Approach to the Status Review (Methods)

The purpose of this Goshawk Status Review is to assemble information pertinent to the question of whether listing under the Endangered Species Act is warranted for the northern goshawk population(s) in the Review Area. Pertinent information includes, but is not limited to: goshawk research results, goshawk locations and associated demographic data, forest habitat information, land management planning decisions, regulations for the management of raptor and goshawk nests, and regulations on removal of goshawks from the wild. The information presented in this Status Review was obtained from a variety of sources to meet this purpose. Among the sources of information were:

- A complete review of the published scientific literature, supplemented with unpublished material, when available.
- Habitat and goshawk location information obtained from landowners and managers throughout the Review Area.
- Habitat information available from agency internet websites
- Land management planning analysis and decision documents
- Timber harvest records from the Forest Service

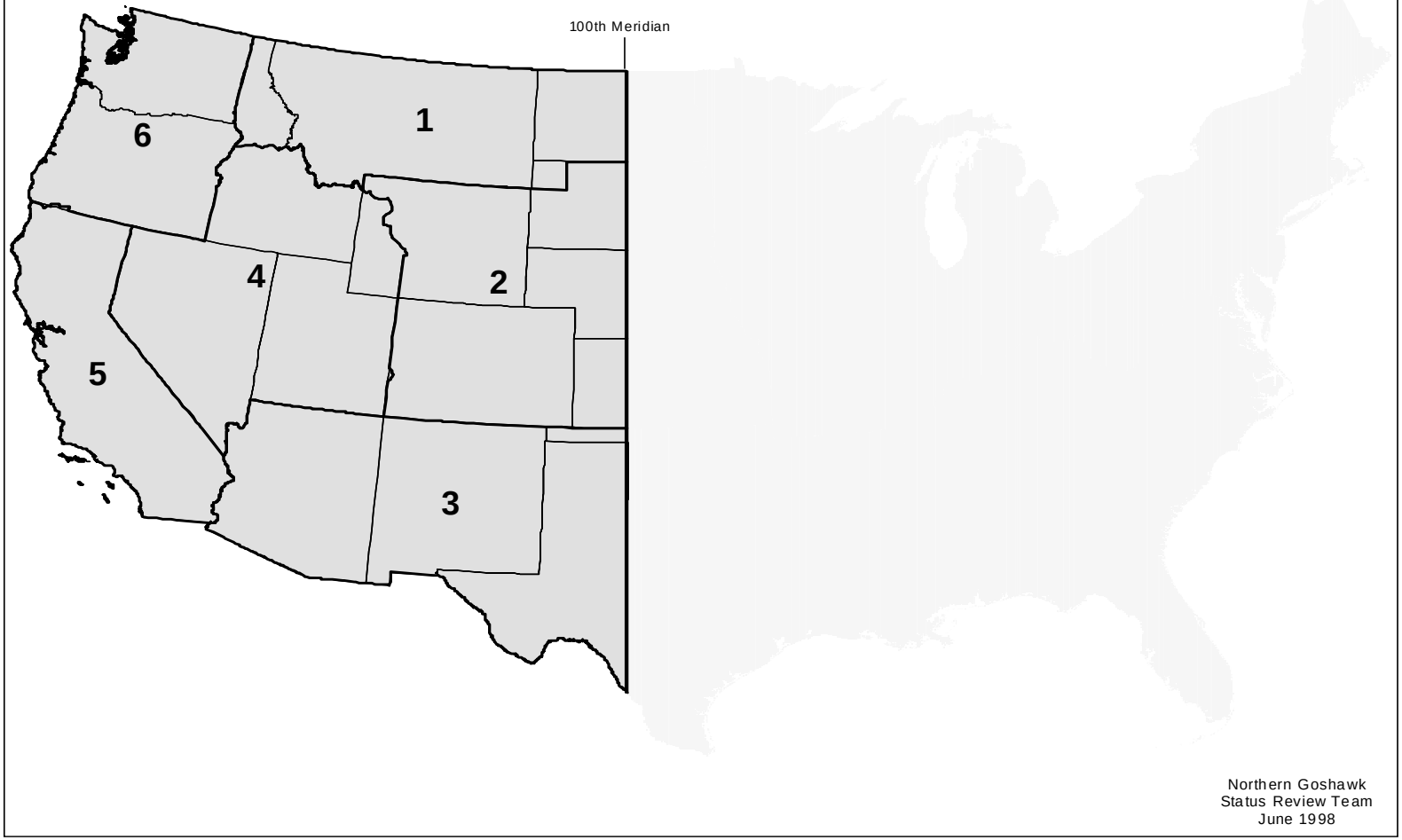
Five types of information were specifically requested for the Status Review: 1.) Goshawk location and occupancy information, 2.) Forest habitat, 3) Land management planning documents, 4) State and Tribal wildlife regulations, and 5) State and Tribal forestry regulations.

Geographic Scope and Land Management of the Status Review Area

The geographic extent of this Status Review - forest lands in the United States, west of the 100th Meridian - was defined by members of the public who petitioned that the species be listed under ESA (Figure 1.1).

Figure 1.1 Northern Goshawk Status Review Area

with Assessment Area boundaries



In addition to non-biological reasons for the area of the Status Review, the 100th Meridian also generally matches an ecological break in the forest vegetation cover across the United States, creating somewhat of an ecological barrier between western and eastern forests in the conterminous States. Goshawk life history and habitat use necessitates analysis that emphases forested habitats within the Review Area (i.e. large areas of nonforested habitat do not provide important goshawk habitat for analysis and consideration).

Review of the scientific literature and the Review Team's experience lead to the conclusion that most forest vegetation types should be considered as potential goshawk habitat, since the species has been documented to use a wide variety of forest vegetation types and forest stand conditions. An overview of the distribution of forested habitat in the West provided the Review Team with an understanding of which land managers currently have management control of potential nesting and foraging habitat for this species (Table 1.1).

Table 1.1 Forested Lands* in the United States, West of the 100th Meridian

Land Ownership/Management	Acres	Percent of Review Area
Forest Service	123,012,000	55%
State and private	43,344,000	20%
Bureau of Land Management	34,605,000	16%
Indian Lands	12,034,000	5%
National Park Service	7,607,000	3%
Department of Defense	897,000	<1%
U.S. Fish and Wildlife Service	352,000	<1%
	221,851,000	

* "Forested lands" in this table are taken from an EPA website which is based upon the Forest Inventory and Analysis data maintained by the Forest Service. Much of this forested land is not currently goshawk habitat due to timber harvest and other factors which are discussed elsewhere in this document. A portion of this acreage is considered incapable of supporting goshawks because the ecological capability of the site is inadequate to support particular tree species and growth forms. Thus, this table is a first approximation of the distribution and relative amount of potential goshawk habitat, but is an overestimation.

This summary revealed that the Federal government manages 166,473,000 acres, or 80% of the forested acres in the Review Area. It was apparent that Federal land managers, particularly the Forest Service, should be a focus in our attempt to acquire habitat and goshawk location information. While Federal agencies were an important information source, we did not want to

overlook the management of the remaining 20% of the forested West. Therefore, requests for information were sent to over 821 managers of resources (both forestland managers and wildlife managers), including Federal offices (N=662), organizations (N=26), timber industry (N=35), State (N=38) and Tribal (N=57) resource managers (Figure 1.2). We believe the scope of the request represents managers of 80 to 90% of the potential goshawk habitat in the Review Area.

Many land management units which do not have forested lands received the requests, meaning that many National Wildlife Refuges, BLM offices and Tribal governments received the request even though they do not manage forestlands. This affected the response to the requests by lowering the overall response rate, since managers who do not have forestlands often did not respond at all. Conversely, the request is known to 'under report' private land management since the request to private land managers was sent to a specific list of industrial forestland owners who were known by the Review Team to have large acreage of forested habitat, rather than all private landowners.

Subdivision of the Review Area

There are 17 states which are wholly or partially in the Review Area. To facilitate the analysis, the overall Status Review Area was subdivided into "Assessment Areas". The subdivision was generally based upon State boundaries and Forest Service Regional boundaries, because data was expected to best fit these lines. There are some discrepancies between these Assessment Area boundaries and data assembled, but these discrepancies should not affect the conclusions of the analyses because the acres involved were relatively minor or the issue did not require direct linkage to acreage. For example, there was some difficulty in addressing State-specific issues because only a portion of some states are in the Review Area and Idaho is bisected by the Assessment Areas (Figure 1.1). In this case, the Review Team aggregated their State-specific discussions of falconry, etc. to match as closely as possible to the Forest Service Regional boundaries (Table 1.2) and explains this in the Management Chapter. Another potential for small acreage discrepancy occurred where nonfederal landowners and managers with a majority of their land in one State were assigned to that State and their data was linked to the appropriate Assessment Area. In addition to the small acreage involved, the lack of response from these landowners minimizes the implications of this discrepancy.

Table 1.2 Subdivisions of the Goshawk Status Review Area		
Assessment Area Defined by Status Review Team	States included in Chapter 4 Discussions	Forest Service Region
Assessment Area 1 North Dakota, Montana, South Dakota (small portion) and Idaho (northern portion)	North Dakota, Montana, and Idaho	Northern Region
Assessment Area 2 Colorado, Wyoming (majority portion), Nebraska, South Dakota (majority portion) and Kansas	Colorado, Wyoming, Nebraska, South Dakota and Kansas	Rocky Mountain Region
Assessment Area 3 Arizona, New Mexico, Texas and Oklahoma	Arizona, New Mexico, Texas and Oklahoma	Southwest Region
Assessment Area 4 Utah, Nevada, Wyoming (western portion) and Idaho (southern portion)	Utah, Nevada and Idaho	Intermountain Region
Assessment Area 5 California	California	Pacific Southwest Region
Assessment Area 6 Oregon and Washington	Oregon and Washington	Pacific Northwest Region

Time Period for the Requested Information

To create an appropriate data source to understand population and habitat trend, and to gather a more consistent set of information, it was necessary to identify time periods for the Review request.

The habitat information requested from land managers was for the approximate time periods of 1988, 1998 and projected to the year 2028. This 40 year period was selected by the Review Team for three reasons:
1) our understanding that the current Forest Service planning documents, and the data assembled to support them, began around 1988;
2) we wanted to understand the range of timber harvest pressure on the western forests over a time period which would be meaningful to the goshawk population (i.e. a short period of time would not capture the possible responses of a long-lived species to the habitat change); and

3) our need to estimate the "foreseeable" future to present information for a listing decision, for which we chose 30 years into the future, which is should generally encompass three Forest Service land management planning cycles, or 3 to 4 goshawk generations.

The goshawk territory information was requested for the time period of 1970 to the present. The date of 1970 was selected because the Review Team felt it was the earliest date that land managers were likely to have maintained reliable wildlife observation records.

First Approximation of Goshawk Nest Habitat

Other chapters of this document include discussions of the complexity of defining and describing goshawk habitat, which affect any conclusions made in this Status Review. Despite these complexities, it was necessary for the Review Team to identify the forest stand descriptors which would include the bulk of goshawk nesting habitat, to attempt to assess trends in that type of habitat. We identified a series of forest types and their stand descriptors as a first approximation. This list was sent to many goshawk researchers for input, and was modified slightly to incorporate their opinions of what forest stands should be considered goshawk habitat. This final table became the primary piece of the Habitat Information Request which is discussed later in this section. While it was intended to capture the mature and older forest stands which are believed to be the predominant forests used for goshawk nesting in the Review Area, it should not be extrapolated to imply that goshawks only use these older forest types. Goshawk nesting has been documented in younger forest types as well, and their foraging occurs in a wider variety of habitat conditions (see Habitat Characteristics section, Chapter 2).

General Assumptions Behind the Status Review

The Review Team agreed upon two general assumptions to frame the goshawk Status Review:
1. Some studies have recorded goshawk territories are evenly distributed within their habitat. Therefore, when habitat is evenly distributed, we expect the goshawk population to also be evenly distributed, given their life history/territoriality and the local habitat conditions.
2. Goshawk use of an area is generally limited by habitat, prey and territoriality. Therefore we assume goshawk populations will respond to the amount and distribution of their habitat, but are also influenced by their prey's habitat, distribution and abundance.

Response to the Information Request

A request for information was sent to resource managers on January 21st and 22nd, 1998, with a request that replies be returned to us by February 20th, 1998. This short period of time for recipients to assemble data resulted in many responding by saying the inadequate time affected their ability to answer completely. Others did not reply at all, presumably for a variety of reasons.

Our definition of "usable information" varied for the different information requests. Habitat

information which allowed us to extract some understanding of habitat trend was initially thought to be "usable", while territory information was "usable" for initial analysis when the information included a site location and documentation of goshawk presence.

Other information received often contained valuable information, but was in a form which could not be assimilated into this Review at this time because it required analysis and translation in order to enter it into the data bases. Such analysis and translation would be very time consuming and has the potential for misinterpretation because the Team is not fully aware of the background for the data. Future analyses could possibly include this information, if conducted. In the present Review, the effect is to reduce the information available for any analyses.

There was a large discrepancy between the information requested and received from some Federal agencies (other than the Forest Service). As mentioned previously, this is because requests were sent to many Fish and Wildlife Service National Refuges and BLM offices that do not have significant (or any) forested acreage, and chose to not respond. The BLM replies were further complicated by a recent reorganization of the agency in several states but not all. In order to parallel our mailing to other Federal offices, we would have sent the request to offices previously known as "Districts". Our requests were sent to all BLM Field Offices, which are analogous to Forest Service Ranger Districts. Our conclusion is that despite the appearance of these discrepancies for responses from BLM and 'other Federal agencies' do not reflect a large gap in information for the Status Review because of the relatively small acreage of forested habitat they manage.

However, unlike the BLM and 'other Federal agency' responses, the lack of response by the Forest Service in several Assessment Areas did affect our ability to draw consistent and well-founded conclusions for the Status Review. Forest Service overall response to the territory request varied from 55% to 84% of Forests among the Assessment Areas, with most of those responses providing "usable information". For the habitat information request, the National Forest response ranged from 36% to 100% of offices in an Assessment Area, and gave us 27% to 78% "usable information". Our land management planning request ranged between 45% to 92% of National Forests in the Assessment Areas. In the case of land management planning requests, the Forest Service offices sometimes attached copies of the planning documents for us to interpret, but did not complete the actual form to allow the data to be directly entered into databases for analysis in a timely manner.

Each form of information requested (territory, habitat and planning) is discussed below in more detail, including an elaboration on the limitations of each and the basis for a determination of "usable information" which has implications for any conclusions on information gaps.

Goshawk Location Information Requested

The goshawk territory information request was intended to provide an array of information to the Review Team:

- The locations of documented goshawk territories would allow the Review Team to better document the geographic distribution of the species in the Review Area.
- Landownership of the nest core provides knowledge of which land managers are making decisions which affect the persistence of these sites, and the future of the goshawk population .
- The year discovered and records of territory activity through time allowed assessment and discussion of the stability or persistence of goshawk territories.
- Habitat information for the nest core and the surrounding territory was requested to understand more about goshawk selection of territories within broader forest landscapes.
- The accounting of the known land management within the territory (when combined with the territory activity through time) provides information for an analysis of the land management effects upon goshawk use of territories.

While potentially valuable, each of these pieces of information have inherent biases which must be acknowledged and discussed prior to use of the data; these biases are discussed below. The Review Team recognized that responses to this request did not reflect all the landowners that have goshawks on their land. Rather, it reflects those who have searched for and documented goshawks, and reported that information.

The territory location request was sent to the all addresses on the mailing list because all resource managers were considered a potential source of information on goshawks nesting.

Goshawk territory information was the most widely received in a usable form. A total of 91 replies contained goshawk location data directly entered into the databases.

Substance of the Response, Limitations and General Conclusions

The response generated an initial data set of 2,777 goshawk territories which were entered into our database Version 1 for preliminary analyses. It included 2,650 territories with some 'activity codes', including 2,394 territories with activity or 'occupancy' for one or more years which allowed us to perform analyses of documented history of the territory. The Version 1 data set was reduced as quality control procedures identified entries which were not legitimate for the analyses; generally, these were incomplete information. The data set was subsequently enlarged as additional goshawk sites were translated into the data set, creating Version 2. These additional locations were received in formats not readily entered into the database, requiring additional translation work. They include data from the Natural Heritage Databases for Washington, Montana, Oregon, Wyoming, South Dakota, New Mexico, Idaho, Colorado, Arizona, and Nevada. These data points provided additional goshawk locations, primarily on non-Federal lands. They also provided partial information in the area of National Forests which had not provided goshawk location information directly to us. However, Natural Heritage Databases often did not provide sufficient information for our analyses of territory history. This resulted in different numbers of territories being used for different analyses.

The enlarged Version 2 data set consists of 3,242 territories. In this set, 2,916 territories have activity codes reported, and 2,657 of them have activity or occupancy reported one or more years which illustrates the longevity and stability of the territory. Absent the Natural Heritage Database territories, there would be 2,847 territories, 2,720 territories with some activity codes, and 2,463 with activity or occupancy reported in one or more years.

Because some location reports contained no 'activity' codes, and some contained 'activity' codes but did not indicate that goshawks had ever been sighted in the "territories" being reported, the Review Team was unable to determine why these reports were considered territories by the respondents. As described above, this sort of quality control screening reduced the usable data set.

The most complete use of the goshawk territory information is in the display and discussion of goshawk distribution. For this illustration of the distribution, the number of territories considered is 2,916, which is all of the locations where goshawk presence had been recorded for at least one year.

For the purposes of the Status Review, most discussions from the territory records will be based upon the 2,916 in the database. The goshawk locations resulted in maps presented in the Chapter 3 Assessment Area discussions, which show forested acreage, Forest Service lands and total goshawks reported in a general area. As discussed later, this generalized distribution of goshawks throughout the Review Area corroborated the Review Team's expectation of goshawk distribution over the large area and did not reveal any territories in completely unexpected areas. Conversely, the resulting distribution of goshawk territory locations did not support a decision to eliminate whole forested areas from further consideration as goshawk nesting habitat. However, in combination with other information, it contributed to distribution discussions in the Assessment Area discussions of Chapter 3.

To use the territory information for a view of population trend, it was necessary for us to screen the data in a further step. Because of the difficulty in surveying for goshawks, we could not readily accept that a site was not occupied by goshawks if the level of search effort was inadequate. We concluded that only a 'Level IV' effort was adequate to conclude that the previously documented territory was now vacant. Level IV search effort is defined as an intensive search of the entire 1 mile radius around the previous nest site.

Limitations of the Status Review Data for Population Conclusions

The available information and the methods used by the Status Review to gather goshawk territory information result in several limitations in how the information can be used. In making conclusions regarding the goshawk population, some of these limitations result from the means by which the goshawk nests (territories) were first located. Goshawk nests are usually located by biologists or foresters during visits to areas that are scheduled for some management activity, typically timber harvests. Because timber harvests are not placed randomly within landscapes--

(not all forest age-classes are harvested equally, some forest types receive little or no timber harvests, steep slopes are harvested less-often, etc.)--the reported samples of territories are not representative of the actual use of forest age-classes or forest types by goshawks.

Limitations in determining total population size:
For two general reasons the goshawk territory information received for the Status Review does not, and cannot be interpreted to reflect true goshawk populations across the West. First, many landowners/managers in large portions of the Review Area did not respond to the Status Review request creating geographic gaps in the data. Second, there are incomplete records for most goshawk sites reported: 1) with only one or two years of survey and occupancy data recorded over many years; 2) there is an inconsistent level of search effort from one general area to the next; 3) there is inconsistent level of search effort from one year to the next at the same site; and 4) there is inconsistent level of documentation between sites and among years. For example, some reports represent multiple counting of the same territory because alternate nests within territories may be as far as 1.8 miles distant. When a pair is discovered in an alternate nest at this distance it is likely to be recorded as a different territory, which has the effect of inflating the numbers. Therefore, the relationship between the number of territories reported and the actual number of territories in a reporting unit remains unknown.

Limitations in determining goshawk density and fine scale distribution:
To determine the goshawk population density in an area, a consistent intensive census (or legitimate sampling) must be made of the goshawks in a large (>100 square mile) area. This goshawk data would then be compared against a well-developed understanding of the habitat in an area. Some localized areas have survey effort which can be used to calculate an estimate of density (see discussions of Assessment Areas 3 and 5). For the most part, however, the data gathered for the Status Review does not meet criteria to determine population density.

As discussed above, the placement of timber sales is not random because it typically occurs where timber is larger and older. This results in a bias in the discovery of goshawk territories in the older forest stands and also creates a bias in the understanding of distribution of goshawks on a particular land management unit.

Limitations in determining population trend:
There is an unequal level of effort spent monitoring individual goshawk territories. This variable effort among nests/territories within or among reporting units limits the ability to determine population trend. Though occupancy/reproductive status is reported, some territories receive little or no monitoring after initial discovery, while others receive more intensive monitoring during some years but not all. Few territories receive the actual level of effort required to search entire territories for pairs that have moved to alternate nests (Reynolds and Joy 1998).

Limitations of the Status Review Data for Conclusions Regarding Habitat Use

There is a potential for misinterpretation of the data from the habitat portions of the goshawk

territory forms. First, the goshawk nest stand data received from the request cannot be extrapolated or assumed to reflect habitat use outside the nest stand because goshawks do not select nest sites based solely upon the conditions of a particular stand of trees (see Chapter 2). Nest or territory selection appears to also be influenced by the abundance and availability of prey in some areas, which is a factor independent of forest stand conditions.

Further, the goshawk nest stand data received from the request cannot be interpreted to reflect the full array of nest site habitat used by the bird, since it reflects the bias of where people have looked for and documented goshawk nests, rather than a random sampling of all potential forest cover types where goshawks may nest. The proportion of reported territories in a particular forest type is not necessarily a measure of preference or avoidance of that type by nesting goshawks. Despite these limitations, the information received is consistent with goshawk habitat use described in the literature and we believe the data reasonably reflect the bulk of goshawk nest selection for general discussions.

Summary of Population and Habitat Use Limitations of the Location Information:

The following Chapters discuss in more detail results and conclusions for the Status Review. The limitations of the population and habitat data from the territory forms made it inappropriate to perform use-availability analyses or calculations of population trend for the Status Review. This is not to say the data is useless. The compilation of raw data for thousands of goshawk territories provides valuable support for some general conclusions about the documented goshawk population, such as:

- The vast majority of goshawk territories have been recorded in the last ten years, presumably in response to heightened management, legal and scientific interest in the species. There is no reason to assume the data reflects a recent goshawk population increase.
- Even when data is 'spotty' for a particular territory it is reasonable to conclude that some territories have continued to be occupied for periods of ten years, or more.

In completing the territory forms, very few respondents provided information on the overall territory condition and land management history. Those who did, such as the Shasta-Trinity National Forest, provided a valuable source of information which could be analyzed further to understand management effects on territory occupancy.

Forested Habitat Information Requested

This request was intended to assemble habitat information which could be used in combination with the other requests to provide:

- Identification of goshawk nesting outside of the initial habitat parameters which the Status Review Team was using; i.e. are there nest stands or forest types being used which we had not considered?
- Estimation of the proportion of the land unit which had been surveyed for goshawks and

methods used.

- Identification of State Forestry regulations which protect goshawks and their habitat.
- Quantification of potential goshawk habitat on the land unit at three points in time; past, current, and future.
- Identification of the various forest types that occur on the land unit and which may be potential goshawk habitat.

This habitat request was expected to have widely varying replies due to the fact that vegetation and timber inventories throughout the Review Area are not standardized. Variation occurs in the measurement and categorization of tree size, canopy closure, tree density, tree species, time periods, and others. The instructions in the data request asked respondents to provide data in categories as close as possible to the requested categories, and to provide a description of the actual measures used.

The habitat request was sent to all land managers on the mailing list. A reply to the habitat information request was received from 164 of the 634 Federal offices (26% response rate). Forty seven of those replies reported that they did not manage any goshawk habitat. Of the 117 which provided habitat acreage estimates, 105 (90%) were in a form that could be entered into the database to assess goshawk habitat trends.

Substance of the Response, Limitations and General Conclusions

There was variable response to this request from Federal offices, resulting in information gaps. These gaps were further compounded when the Review Team began to screen the replies to determine what analyses could be made. The screening methods for habitat data consisted of a series of steps. The Review Team first sorted all the possible situations in the following manner:

Step 1. Categorized the habitat data by quality/usability based on the Review Team's categories:

Category 1 - Provided past, current and future habitat estimates (N=49)
Category 2 - Provided past and current habitat estimates (N=19)
Category 3 - Provided current and future habitat estimates (N=1)
Category 4 - Provided past and future habitat estimates (N=1)
Category 5 - Provided habitat estimates in a format which couldn't be entered into databases (N=35)
Category 6 - Did not submit habitat estimates of any type (N=51)
Category 7 - Did not answer the data request at all (N=419)

Step 2. Numeric values reported were checked to determine whether the data could be used for past-to-current trends, current-to-future trends, etc. This screen identified data entries which were not logical, such as: 1) "Capable" acreage is larger than "total", 2) "Current" acreage is larger than "capable" or "total". In these cases, we confirmed whether we had entered the data correctly. If we had, and the unit had simply provided data which did not make sense, it was removed from the data set.

Step 3. For reporting units where Step 2 had indicated a discrepancy, additional review was made of the background documentation for a sample of Category 1 reports. Based on this review, it became apparent that variability in the methods used by field units to generate the data made it impossible to credibly compare across geographic areas . For example, despite the instructions we gave:
1) At least one unit used steep slopes as a factor to eliminate some acreage from the report.
2) Some units included wilderness acreage while others did not, depending on the vegetation inventory they had available.
3) Some incorporated a correction factor for their modeling of catastrophic events for a projection of future habitat.
4) Some incorporated a correction for expected timber harvest and other adjustments reflective of their land management plans.
5) At least one unit used elevation as a factor to eliminate some acreage from the report.

These variations further compounded the inherent variation in vegetation databases which was expected by the Review Team. For example, some used stand exams as a data source, others used satellite imagery, some used aerial photo interpretation. Also as expected, units changed the query criteria because of their database limitations.

Ultimately, the accumulation of biases and limitations lead the Team to conclude that the habitat information received for the Status Review was inappropriate and inadequate for use in determining habitat trend for the Review Area. Subsets of the data did have value, and these are discussed in the Assessment Area discussions of Chapter 3.

Request for Information on Assessment of Land Management Planning Documents

The Status Review Team needed information on the land management planning decisions which are providing primary or incidental benefits to goshawks. Some land management decisions are directed at protecting goshawk nests and territories, while other decisions are directed at other resource values, but provide secondary benefits to goshawks by directing resource management which retains forested acreage in older age classes and/or dense stands which can be used by goshawks for nesting and/or foraging.

Federal land managers and others were asked to provide a subjective assessment of how their current planning documents would affect goshawk habitat through time. This assessment included quantitative measures (acres in 'reserve' status) which were identified in a subjective manner.

This request was sent to all land managers in the mailing list; Federal land managers were the predominant respondents. The lack of response from other land managers (private, Tribal and State) result in very incomplete information for these land units.

Substance of the Response, Limitations and General Conclusions

As expected, there were a wide range of management actions and decisions which were judged by field units to provide goshawk benefits. Also as expected, there was a wide range of judgements of land allocations which would provide goshawk habitat through time. Within the timeframes of the Status Review, the Team found no realistic way to determine the legitimacy of these judgements. The information was summarized in tables in the draft Status Review, but was removed from the final Status Review because the information was too incomplete and contained judgements which the Review Team could not substantiate. Further analysis of these data may yield a more valid and complete view of land management plan effects on goshawk habitat, but could not be used for drawing conclusions for the entire Review Area in the time allowed.

Request for Information on State and Tribal Wildlife Regulations

Wild goshawk populations are a source of birds for falconers and removal of birds from the wild has the potential to affect population persistence. State and Tribal wildlife managers were requested to provide information about the extent of this removal of birds from the wild.

The request was sent to all State wildlife management agencies in the Review Area (17 total) and to 57 Tribal councils which have the authority to regulate wildlife populations. With the additional effort of follow-up phones calls, data was received from all 17 states regarding their management of take of goshawks from the wild and the species' status. No data were received from Tribal governments.

Substance of the Response and General Conclusions Drawn

Chapter 4, Conservation and Management, discusses the results of this data request.

Request for Information on State and Tribal Forestry Regulations

Management of Tribal, private and State forestlands plays a role in the management of the goshawk population (Table 1.1 illustrates 20% of the forested West is in State and private landownerships, 5% is in Tribal management). Though the importance of non-Federal timberland management varies by Assessment Area. This request was intended to acquire documentation of the extent of State and Tribal regulation of timber harvest from private and State-owned lands and Indian lands.

The request was sent to all State land management agencies and forestry departments in the Review Area (17 States) and 57 Tribal governments. Initial replies were supplemented with follow-up phone calls to acquire information from all 17 states regarding their management of State lands and regulation of timber harvest. Two Tribal governments provided responses.

Substance of the Response and General Conclusions Drawn

Chapter 4, Conservation and Management, discusses the results of this data request.

<u>Forest Inventory and Analysis and Timber Harvest Records</u>

When it became apparent that the responses to the information request were not producing the form of information which could be used for even a generalized analysis of forest habitat trends, the Review Team looked for other sources of information.

We discussed the national Forest Inventory and Analysis (FIA) data base with staff from the Forest Service and were told this data base could not answer the questions we were asking. Differences in data collection methods, both spatially and temporally, makes renders the FIA data useless as a sample of trends in large tree cover. Also, some of the older data has not been entered into data bases and therefore could not be queried.

Next we acquired silviculture reports of the Forest Service which are prepared annually using somewhat consistent methods. This data, and our discussion of it, is presented in Appendix A.

Chapter 2 - Life History and Ecology

Description

The northern goshawk is the largest of the three accipiters of North America, possessing short, broad wings and a long, rounded tail. Females are larger than males, with total average length for females about 61 cm (24 in) and 55 cm (22 in) for males. Wingspan for females is 105-115 cm (46 in) and for males is 98-104 cm (42 in) (Wood 1938, Squires and Reynolds 1997). Adults are gray above, blackish on the crown and side of head, with a bold, whitish streak over the eye. The underparts are light gray with fine horizontal vermiculations and fine vertical streaks. The tail is dark gray above, with several blackish bands; the tail tip is rounded and usually tipped with a white terminal band. Tail below is lighter gray with fluffy white undertail coverts (Squires and Reynolds 1997). Immatures (Palmer 1988, Johnsgard 1990, and Squires and Reynolds 1997) are a dark brown to brownish-black above with buffy white and cinnamon streaks. The underparts are a buff white, with cinnamon to brown streaking on the throat. The head is brown and usually has a narrow whitish streak over the eye. The dark brown tail has wavy dark brown bands with thin whitish borders that form a zigzag pattern. Undertail coverts are usually streaked, and not fluffy.

Taxonomy

The northern goshawk (*Accipiter gentilis*) was originally described by Linneaus. The northern goshawk is circumpolar in distribution, with two groups recognized worldwide: the palearctic *gentilis* group, consisting of several subspecies (*A. g. gentilis*, Europe to central Russia; *A. g. buteoides*, northern Europe and Asia; *A. g. albidus*, northeastern Siberia to Kamchatka; *A. g. arrigoni*, Sardinia and Corsica: *A. g. schvedowi*, southern Siberia, northern Japan, Chinese Mountains; and *A. g. fujiamae*, Honshu Island), and the nearctic *atricapillus* group consisting of *A. g. atricapillus* (Wilson 1812, type locality Philadelphia, Pennsylvania). The *atricapillus* group occurs over much of Alaska, Canada, and the mountains of western and eastern United States. In addition to the main *A. g. atricapillus* subspecies, at least two other subspecies are currently, but variously, accepted--*A. g. laingi* (Taverner 1940, type locality Queen Charlotte Islands, British Columbia), which occurs on islands off the Canadian Pacific coast, and *A. g. apache* van Rossem (van Rossem 1938, type locality Chiricahua Mountains, Arizona), which occurs in the mountains of southeastern Arizona and northern Mexico (Wattel 1973).

In addition to *apache* and *laingi*, two other subspecies have been described but are no longer recognized. In 1874, Ridgeway (Baird et al. 1874) described a western goshawk (*A. g. striatulus*) on differences in plumages of hawks in the western United States from the more eastern *atricapillus* form. In 1884, Nelson (1884) described *A. g. henshawi* from Lake County, Oregon and Calaveras County, California, on the basis of darker plumages than *atricapillus*.

Taverner, 1940, showed the plumage differences of *striatulus* were associated with age of hawks and that *striatulus* was indistinguishable from *atricapillus*. He described *A. g. laingi* from the

coastal islands of British Columbia on the basis of darker plumages, a characteristic of both the adult and juvenile plumages. Taverner (1940) also reported a gradient in plumage darkness from the lighter-colored mainland hawks to intermediate forms on Vancouver Island to the darkest hawks on the Queen Charlotte Islands.

Van Rossem (1938) described the subspecies *A. g. apache* on the basis of longer wing chords and darker colors of six hawks collected in southern Arizona and Sonora and Jalisco in Mexico. The distinguishing characters of *apache*, as defined by van Rossem (1938), are "darker and more blackish (less bluish) dorsally even than *Accipiter gentilis striatulus* (Ridgeway) of the Pacific Northwest, the darkest of two previously described North American races; young with ventral streaking broader and darker than the young of *striatulus* (= *atricapillus*). Size largest among the North American races." Van Rossem (1938) gives the range of *apache* as "extreme southeastern Arizona (Chiricahua Mountains), south through Sonora (Yecora) to Jalisco (Sierra de Nayarit)."

Recognition of the *apache* subspecies is variable and a subject of current debate. It is recognized by Brown and Amadon (1968), Wattel (1973) and Snyder and Snyder (1991). However, *apache* was excluded from the American Ornithologists' Union's (AOU) Check-list of North American Birds 5th edition (1957). The American Ornithologists' Union's Check-list of North American Birds (Sixth Edition 1983) did not address any subspecies, and specifically deferred to the 5th edition (1957) for subspecies. Because van Rossem (1938) originally descibed *apache* based on only 3 specimens, the validity of the subspecies has not accepted by most taxonomists. Hubbard (1992) presented further evidence for retaining *apache*, however, the AOU still does not recognize it as a valid subspecies (AOU 1983). The U.S. Fish and Wildlife Service acknowledged the existence of *apache* as a subspecies in its 1992 administrative finding relative to the petition to list the northern goshawk. This was based, in part, on erroneous information indicating that *apache* had been recognized by the AOU. The 7th edition of the Checklist of North American Birds is due out in mid-1998, and it will not address subspecies, therefore resolution of this issue by AOU will not be forthcoming. The Status Review team considers the issue of recognition of *apache* as a legitimate subspecies to be unresolved, and does not consider it a separate subspecies for purposes of this Status Review. The team further believes ongoing additional work needs to be completed before a conclusion regarding the legitimacy of *apache* can be reached.

Adequate studies of the taxonomy of goshawks occupying Pacific Northwest coastal forests have not been conducted. The American Ornithologist's Union recognizes *A. g. laingi* as a relatively smaller, darker subspecies occurring on the Queen Charlotte Islands and Vancouver Island, British Columbia (AOU 1957). Based on comparisons of small numbers of specimens from throughout the region, several subsequent authors have variously described the range of this subspecies as extending northward to Baranof Island (Webster 1988) and southward into the Olympic Peninsula (Beebe 1974) and coastal Oregon and Washington (Jewett et al. 1953). Based on an assessment of all published accounts, the U.S. Fish and Wildlife Service (USDI 1997) defined the probable range of *A. g. laingi* as Vancouver Island northward through insular British Columbia, insular and adjacent mainland Alaska, to Icy Strait and Lynn Canal (USDI

1997). Whaley and White (1994) concluded that more study is needed to determine the taxonomic status of insular and mainland goshawks in the Pacific Northwest. This subspecies is currently the subject of litigation under a separate petition for listing under the Endangered Species Act and is not further addressed in this status review.

Distribution

General

Northern goshawks are holarctic in distribution, occupying a wide variety of boreal and montane forest habitats throughout the Nearctic and Palearctic (Johnsgard 1990). They breed in North America from western and central Alaska, northern Yukon, eastern and southern Mackenzie, southern Keewatin, northeastern Manitoba, northern Ontario, central and northeastern Quebec, Labrador, and Newfoundland south to southern Alaska, central California, southern Nevada, southeastern Arizona, southern New Mexico, the eastern foothills of the Rockies and the Black Hills, central Alberta, central Saskatchewan, southern Manitoba, northern Minnesota, central Michigan, Pennsylvania, central New York, northwestern Connecticut, and locally south in the montane habitats at least to West Virginia; possibly eastern Tennessee and western North Carolina. Goshawks are local residents in the mountains of northwestern and western Mexico, and are widely distributed in Eurasia (Squires in prep).

The winter range of goshawks includes all of the breeding range in North America, and extends south as far as southern California, northern Mexico and Texas, and occasionally to northern portions of Gulf States, rarely including Florida (Squires in prep).

Available evidence suggests the distribution of goshawks in the northern and western portions of its range is relatively unchanged since settlement by Europeans, but it may have been more extensive in the eastern United States before the extinction of the passenger pigeon (Jones 1979). Extensive forest cutting in the eastern U. S. may also have reduced goshawk populations; these populations appear to be recovering as forests in the East recover and mature (Speiser and Bosakowski 1984).

Migration

The existence and extent of migratory behavior is geographically and temporally variable, and appears to be closely tied to food availability. Migration routes are poorly delineated. Information on migration patterns comes primarily from counts at migration stations, band returns, and radio-telemetry. Table 2.1 summarizes numbers of goshawks seen at seven counting stations in the U.S. (Leslie in prep).

Table 2.1. Numbers of goshawks sighted at the Goshute Moutains, NV; Wellsville Mountains, UT; Manzano Mountains, NM; Sandia Mountains, NM; Hawk Mountain, PA; Hawk Ridge, MN and Cape May, NJ, during fall migration. (From Squires and Reynolds 1997 and S. Hoffman unpubl. data.)

Year	Goshute Mountains[1]	Wellsville Mountains[1]	Manzano Mountains[1]	Sandia Mountains[1]	Hawk Mountain[2]	Hawk Ridge[3]	Cape May[4]
1972					347	5,382	
1973					307	3,566	
1974					61	1,400	
1975					136	312	
1976					62	308	17
1977		31			85	110	22
1978		30			58	166	19
1979		29			68	326	16
1980					83	250	25
1981					138	981	34
1982					140	5,819	35
1983	108				129	1,999	40
1984	122				59	934	25
1985	112		20	19	50	584	75
1986	63		20	14	106	354	24
1987	54	10	6	14	57	203	20
1988	68	14	6	4	50	177	14
1989	74	14	13	6	27	106	9
1990	115	17	3	10	88	626	34
1991	132	12	7	7	54	1,007	55
1992	222	53	16	12	43	2,247	30
1993	107	15	27	24	109	1,393	80
1994	100	15	29	12	31	305	37

[1] S. Hoffman, Unpublished data submitted for Status Review, HawkWatch International
[2] Hawk Mountain Sanctuary Association, unpublished data
[3] David L. Evans unpublished data, Hawk Ridge Nature Reserve
[4] Cape May Bird Observatory unpublished data

Goshawks in northern areas of their range are known as “irruptive” migrants. Irruptive goshawk

migrations occur in the more northern populations and are in response to rapid decreases in snowshoe hare populations. Mueller and Berger (1968, 1977) reported 2 population irruptions based on counts of migrating hawks in Wisconsin. Irruptions occurred at approximately 10-year intervals and coincided with declines in indices of snowshoe hare and ruffed grouse abundance in breeding areas. Similarly, Doyle and Smith (1994) reported that goshawks in southwest Yukon, Canada were year-round residents during years of high snowshoe hare abundance, but left the area during years of low hare abundance. The numbers presented in Table 1 demonstrate the occurrence of migration irruptions, although a portion of goshawks may be locally derived, and counts may therefore partially reflect annual variations in local reproduction (Hoffman 1992). Migration counts at Hawk Mountain suggest northeastern goshawk populations "irrupt" on a 4-year cycle (Nagy 1975). Migrations generally occur between 17 September and 16 December, and adult males and females migrate simultaneously during irruption years (Mueller and Berger 1968, 1977, Nagy 1975).

Juveniles are more mobile than adults (McGowan 1975), and fledglings are believed to migrate first. Adults tend to stay on or near nesting areas except in times of food shortages, while juveniles tend to leave nest territories in late summer or fall (Palmer 1988).

Mueller and Berger (1967) summarized band return data from North America through 1965. Sample sizes were too small to draw meaningful conclusions concerning migration patterns. However, only 4 of 35 recoveries of adult birds were more than 2 degrees latitude from their place of banding, which may indicate relatively short distance movements.

Band return data from the European subspecies are considerably more extensive. Bugler and Klaus (1987) summarized band return data from Switzerland that suggested short distance movements or "wandering" during the nonfreezing season. Highland (1964) found evidence from band return data for both short and long-distance migrations for goshawks in Fennoskandia and concluded that populations from northern latitudes are more migratory than those from southern latitudes. The majority of recoveries for birds banded as adults were from near the place of initial capture. However, distances between place of capture and recovery of 210 and 280 km (130 - 174 mi) were noted.

Radio-telemetry studies provide information on migration patterns but studies conducted to date have sampled too few years to establish long term patterns. A radio-tagged female in Alaska exhibited fidelity during winter to an area no larger than a typical summer home range (McGowan 1975). A similar observation was made by Kennedy (unpublished data) in New Mexico. Goshawks in Wyoming exhibited short distance migration (range 65 - 185 km)(40 - 115 mi) during the winter of 1992 (Squires and Ruggiero 1995), while limited data from northern Arizona indicate altitudinal migrations of very short distances (< 20 km)(<12.4 mi), (Reynolds et al. 1994). Radio-tagged goshawks in Arizona south of the Grand Canyon appeared to be year-round residents (P. Hall, unpublished data).

In summary, the data indicate that goshawks are not migratory, except in the northern part of

their range where they irrupt irregularly in response to declines in prey populations. Southern populations are more sedentary. Most southern populations are resident year-round in years of moderate to high food availability, but may "wander", irrupt or exhibit altitudinal migrations when prey populations decline.

Home Range

Goshawks are highly mobile and have large home ranges. In North America, few telemetry studies of goshawk movements and habitat-use patterns have been conducted (Austin 1993, Bright-Smith and Mannan 1994, Hargis et al. 1994, Kennedy et al. 1994, Titus et al. 1994). Thus, current understanding of the ranging patterns of goshawks is limited. The difficulty in monitoring goshawk movements via radio telemetry often results in studies having small sample sizes which reduce the statistical power of habitat-use analyses. Small samples may also underestimate home range size and variation in habitat use exhibited by individuals within populations. Nevertheless, radio-telemetry has provided valuable insights into the foraging and spatial-use patterns of goshawks. Techniques that have been used other than radio telemetry to estimate goshawk home ranges include: 1) repeatedly observing the direction and distance traveled by male goshawks above the forest canopy (Reynolds 1979); 2) assuming the home ranges are circular and assuming one-half the mean distance between nests as the radius of the home range (Reynolds 1983); 3) plotting the locations of marked prey whose remains were found in a goshawk nest (Eng and Gullion 1962); and 4) plotting the locations of molted feathers (Brüll 1964).

Size

In North America, home ranges of nesting goshawks usually range from approximately 500 to 4,000 ha (1,200 - 10,000 acres) depending on sex, habitat characteristics, and field procedures. Size comparisons among studies are difficult and may not be meaningful due to differences in methodology. Home ranges of males tend to be larger than those of females (Hargis et al. 1994, Kennedy et al. 1994), but there are exceptions (Austin 1993). Home ranges of adjacent pairs may overlap, especially in areas where nesting populations are at or near saturation (Reynolds and Joy 1998).

In Alaska, nesting home ranges (minimum convex polygon) of males were large, averaging 5847 ha (14,450 acres)(Titus et al. 1994). Breeding home ranges of adult females ranged from 273 to 111,407 ha (675 - 275,300 acres), because two females abandoned their nests during the post fledgling dependency period. Thus, the mean, 19,215 ha (47,500 acres), and median, 2,737 ha (6,800 acres), estimates of home range size differed substantially. Some home ranges of males and females included large areas of ocean; considering these extensive movements as home ranges may be questionable. A goshawk pair nesting on Prince of Wales Island, Alaska, had a combined (male and female) home range of 157,850 ha (390,000 acres), of which 78,924 ha^2 (193,500 ac) as dry land (Alaska Department of Fish and Game 1993).

On the Shasta-Trinity and Klamath National Forests in the southern Cascades, Austin (1993)

found an average home range of 2,425 ha (5,990 ac) for 5 males and 3,774 ha (9,322 ac) for 5 females using radio-telemetry (100% minimum convex polygon method).

Little is known about the size of winter home ranges of goshawks in North America. In the Lake Tahoe region of the Sierra Nevada, California, Keane and Morrison (1994) found ninety-five percent minimum convex polygon home ranges averaged 8,360 ha (12,289 ac) during the nonfreezing season for males and 3,180 ha (4,675 ac) for females. In Sweden, winter home range sizes for 6 male and 8 female goshawks averaged 5,700 ha (14,100 acres) (Widén 1989). There was no significant difference between the home range size of males and females. Home ranges were smallest where prey densities were greatest, and largest when the home range contained the least woodland edge (Kenward and Widén 1989).

Habitat Characteristics

Nest Habitat

Vegetation and landform characteristics associated with nest site, or nest area, habitat are one of the best understood aspects of goshawk biology. These characteristics have been described for hawks nesting in the Great Basin (York and Bechard 1994), interior ranges of Oregon (Reynolds et al. 1982, Moore and Henny 1983) and Cascade Range of California (Saunders 1982), Modoc Plateau and Sierra Nevada of California (McCarthy 1986), Inner Coast Ranges of California (Hall 1984), Cascade Range of north-central California (Allison 1996), eastern Oregon (Daw 1996, Desimone 1997, McGrath 1997), Washington (Fleming 1987, McGrath 1997), northeastern Arizona (Crocker-Bedford and Chaney 1988, Ingraldi and MacVean 1995), New Mexico (Siders and Kennedy 1994), Rocky Mountains of Montana, Idaho (Hayward and Escano 1989), Colorado (Shuster 1980), Wyoming (Squires and Ruggiero 1996), Utah (Hennessy 1978), South Dakota (Bartelt 1977), Pennsylvania (Kimmel and Yahner 1993), New Jersey and New York (Speiser and Bosakowski 1987) and Alaska (McGowan 1975a**).**

Forest raptors typically have a wide choice of locations, forest types and forest structures in which to nest. For territorial species like goshawks that prefer a certain forest structure, choice of nest sites may be limited to portions of a landscape not already occupied by other pairs, but that also contain the landscape structure and pattern comprising suitable with nest habitat. Given that forest raptors typically have habitat needs that extend beyond their nest areas, their choice of territory may depend on larger scales that provide suitable habitat for foraging and prey.

Although goshawk nest habitat has been widely studied, a number of potential biases in studies should be addressed. In some studies, nests were located during preparation of timber-sales which typically occur in older-aged forest stands. In others, observers only searched areas that met their preconceived notion of "suitable" goshawk nest habitat; typically, these areas only included mature and old-growth forests. Thus, knowledge of goshawk choice of nest sites may be biased toward older habitat types (Squires in prep). However, Daw et al. (in press) compared habitat characteristics in 0.4 ha areas around 27 nests found systematically and around 22 nests

found opportunistically on three national forests in eastern Oregon and found that both density of large trees and canopy closure were similar for nests found with either search method. However, these results do not preclude the fact that bias can be reduced by conducting nest searches in a systematic fashion across all habitats within landscapes.

Comparing habitats "used" by goshawks to those "available" can identify habitat preferences with careful interpretation (McCallum 1994). Individual hawks may exhibit a "preference" among habitats even if all choices are sub-optimal and they have little choice. Few goshawk studies compared habitat characteristics at nest sites to those available habitats within home ranges or landscapes (Hall 1984, Speiser and Bosakowski 1987, Bosakowski and Speiser 1994, Ingraldi and MacVean 1995, Squires and Ruggiero 1996, Allison 1996), which limits our understanding of habitat preferences. Most studies of goshawk nest site habitat were limited to small spatial scales. Typically, nest habitat is characterized at the nest tree to the nest stand/nest area scale, and few studies have investigated nest habitat at a landscape scale (Johansson et al. 1994, Hargis et al. 1994). Thus, the effects of changes in forest landscapes on habitat choice by nesting goshawks are unknown. Additional research is needed at larger spatial scales.

Goshawks nest in either conifer or deciduous trees, depending on availability (Bent 1937, Reynolds et al. 1982). Apfelbaum and Seelbach (1983), summarized nest habitat data from the North American Nest Record Card Program (Cornell University). They found that goshawks nested in 20 tree species or species groups. Deciduous trees were used twice as often as conifers throughout North America, and nine to one over conifers in the Midwest. The most important deciduous tree for nesting was beech, followed by maple, aspen, and yellow birch. Eastern white pine was the most frequently used North American conifer followed by spruce, fir, western pines, and eastern hemlock. However, most nest record cards in this data base were filed by amateur ornithologists and lay persons and might be subject to search biases (e.g. differing detectibility of nests in conifers versus deciduous trees, greater human population densities, and higher frequency of incidental discovery of nests in eastern versus western U.S. forests).

In the intermountain west, goshawks nest in both deciduous trees such as cottonwoods near stream bottoms (Call 1974) and in either aspens or conifers at upland sites (Shuster 1980, Hayward and Escano 1989, Bokich 1991, Squires and Ruggiero 1996). In Wyoming, 38 percent of nests were in aspen (n = 39), 59 percent in lodgepole pine, and 3 percent in subalpine fir; aspen and lodgepole pine were used in proportion to their availability while subalpine fir was avoided (Squires and Ruggiero 1996). In the southwestern U.S. and the Black Hills of South Dakota, goshawks frequently place nests in ponderosa pines (Crocker-Bedford and Chaney 1988, Kennedy 1988, Reynolds et al. 1992, Ingraldi and MacVean 1995).

Goshawks in the Pacific coastal states typically nest in conifers. In eastern Oregon, 41 nests were located in ponderosa pine, 14 in Douglas-fir, and 6 in white fir; the remaining 8 nests were in either lodgepole pine, western larch, quaking aspen, or western hemlock (Reynolds et al. 1982). Douglas-fir, lodgepole pine, Jeffrey pine, red fir, and western larch were used by goshawks in

other Pacific coastal populations (Saunders 1982, Moore and Henny 1983, Hall 1984, Hargis et al. 1994, Daw 1996, McGrath 1997). In interior Alaska, paper birch was used in 94 percent of nest stands where two or more tree species were present (McGowan 1975a). Birch trees were favored over aspens because birch had large forks that provide stable nest foundations.

Goshawks often nest in one of the largest trees in the stand (Reynolds et al. 1982, Saunders 1982, Erickson 1987, Hargis et al. 1994, Ingraldi and MacVean 1995, Squires and Ruggiero 1996); height and diameter of nest trees are highly variable depending on forest type and geographic location. In Wyoming, goshawks chose nest trees that had larger diameter than trees at the nest site or in the nest stand (Squires and Ruggiero 1996). Likewise, in California, Saunders (1982) found that mean diameter of nest trees was 74.2 cm (29 in) (range 43.7 - 121.9 cm)(17.2 - 48 in), more than twice the mean diameter for trees in the immediate nest sites (33.2 cm)(13 in) or nest stands (27.1 cm)(10.7 in). However, in eastern forests, only 4 of 32 nests were built in the largest tree of the nest site (Speiser and Bosakowski 1989). In general, goshawks appear to choose nest trees based on size and structure more than the species of tree.

Goshawks usually construct their nests in the lower one-third of the nest tree, just below the forest canopy (Shuster 1980, Reynolds et al. 1982, Moore and Henny 1983, Speiser and Boskowski 1987). However, goshawks in interior Alaska placed their nests in the middle to upper canopy probably because of the relatively higher branching pattern of paper birch, the preferred nest tree (McGowan 1975a). As a consequence of the consistent pattern of nest placement within trees, heights of goshawk nests are significantly correlated with nest-tree heights (Kennedy 1988, Speiser and Bosakowski 1989). Nest heights vary according to the species of nest tree and regional differences in tree heights. The average height of North American nests was 11.8 m (38.6 ft) (range = 6.1-25.7 m; 20 - 84 ft) (Apfelbaum and Seelbach 1983).

Rare records indicate that goshawks have nested on the ground in Europe and sometimes on rocky cliffs in Alaska (Schweigman 1941, Turner 1886; cited in Palmer 1988). Olendorff (1980, cited in Palmer 1988) listed four references (none in North America) where goshawks nested on man-made nest bases.

Typical territories often contain several alternate nests that are used by pairs over several years (Reynolds and Wight 1978, Speiser and Bosakowski 1987, Reynolds et al. 1994, Woodbridge and Detrich 1994, Reynolds and Joy 1998). During a 9 year period in northern California, the mean number of nests used by goshawk pairs was 2.6 (range = 1-5) and only 44 percent of nesting attempts were in nests used the previous year (Woodbridge and Detrich 1994). The spacing and distribution of alternate nests varied among territories; most nests were clumped in 2-3 adjacent stands whereas others were scattered up to 2.1 km (1.3 mi) apart. The mean spacing between alternate nests was 273 m (892 ft) (range = 30-2,066 m; 100 ft - 1.3 mi) (Woodbridge and Detrich 1994) in California, and on 59 territories in Arizona that contained alternate nests, the mean spacing was 489 m (1,604 ft) (range = 21- 3,410 m; 69 ft - 2.1 mi)(median = 285 m; 935 ft) (Reynolds and Joy 1998).

Nest Areas and Nest Stands

Dominant Forest Types. Forest types associated with nest areas vary geographically. In New York, sugar maple, yellow birch, beech, and hemlock were dominant in most nest areas (Allen 1978). Forest types in western goshawk nest areas include pinyon/juniper, riparian cottonwood, ponderosa pine, Douglas fir, pines, various species of spruce mixed with true fir, and aspen (White et al. 1965, Bartelt 1977, Reynolds et al. 1982, Saunders 1982, Hall 1984, Reynolds et al. 1990, Squires and Ruggiero 1996, Allison 1996, Desimone 1997). In interior Alaska, paper birch was the dominant tree species in nest areas; pure stands of paper birch were used more commonly than any other forest type (McGowan 1975a). Although approximately half of Alaskan nests occurred in mixed conifer and deciduous forest, paper birch was still a significant member of the forest community in 78 percent of nest areas. In southeast Alaska, there was significantly more hemlock (81 percent) at goshawk nest sites than randomly available (75 percent) (Iverson et al. 1996). The difference may be due to goshawk nest areas being associated with productive old-growth forests and hemlock-spruce cover types as compared to random locations that contained more cedar or spruce only.

Forest Structure. Goshawk nest habitat is often characterized as mature to old-growth forests composed primarily of relatively large trees with relatively high canopy closure (60-80 percent), near the bottom of moderate slopes, on north exposures and in areas with sparse ground cover (Reynolds et al. 1982, Moore and Henny 1983, Speiser and Bosakowski 1987, Hayward and Escano 1989, Ingraldi and MacVean 1995, Squires and Ruggiero 1996). The goshawk's inclination to nest in habitats relatively denser than surrounding forests may reduce predation and, when combined with north slopes may provide relatively cool environments (Reynolds et al. 1982). In Oregon, goshawks nest in dense, mature or old-growth conifers with a mean tree density of 482 trees/ha (range 273- 750 trees/ha) (195 trees/ac; range 110 - 304 trees/ac) (Reynolds et al. 1982). Nest areas ranged from those with a few mature trees, but with dense understory trees, to those with closed mature canopies and sparse understory trees. Most nest areas were in old forests, but 5 percent were in second growth forests, and 4 percent were either in mature lodgepole pine or mixed stands of mature lodgepole and ponderosa pine; the lodgepole nest areas had relatively open, single-layered canopies (166 trees/ha; 67 trees/ac, 38 percent canopy closure). In southeast Alaska, goshawks generally nested in stands with complex structure associated with multiple canopy layers (Iverson et al. 1996). However, goshawks in southcentral Wyoming nested in stands that were in even-aged, single storied, mature forests with high canopy closure and clear forest floors (Squires and Ruggiero 1996).

Forest stands containing nest areas are often relatively small (Woodbridge and Detrich 1994). In northern California, goshawk territories contained 1-5 alternate nests in different nest stands (Woodbridge and Detrich 1994). The maximum distance recorded between nest stands was 1.8 km (1.1 mi), but approximately 85 percent of stands containing alternate nests were less than 0.7 km (0.4 mi) apart . Woodbridge and Detrich (1994) defined nest-stand clusters as the aggregate area of all nest stands within a territory. In their area, nest-stand clusters ranged from 10.5 ha to 114 ha (26 - 282 ac) in size. The occupancy rate of nest stands was positively correlated with stand size (Woodbridge and Detrich 1994). Smaller stands (<10 ha)(<25 ac) typically contained

1-2 nests that were occasionally occupied, whereas large stands (>20 ha)(>50 ac) were more consistently occupied. Woodbridge and Detrich also found that the annual occupancy of nest-stand clusters (clusters with at least 5 years of monitoring) was positively correlated with aggregate cluster size. Clusters less than 20 ha (50 ac) in size were occupied less than 50 percent of years, 75 to 80 percent of years for clusters approximately 40 ha (100 ac) and approximately 100 percent of years for clusters totaling greater than 61 ha (150 ac).

In eastern U. S. forests, goshawks seem to prefer nesting in contiguous forest stands: 16 territories were in mature or old-growth mixed hardwood and hemlock stands, 2 were in submature hardwood stands containing few old trees, 2 were in groves of mature white and red pine surrounded by mature forest, and one was in a dense cedar swamp surrounded by mature mixed species forest (Speiser and Bosakowski 1987). In general, eastern goshawks preferred extensive forest areas (Bosakowski and Speiser 1994) that contained significantly more mature trees than was randomly available (Speiser and Bosakowski 1987).

Although goshawks appear to favor mature forests for nesting, there are exceptions. In California, goshawk nest habitat consisted of young and even-aged forests with sparsely distributed mature and old-growth trees (Farber et al. 1998). Goshawks also nest in tall willow communities along major drainages in the arctic tundra (Swem and Adams 1992) and in riparian cottonwood stands (White et al. 1965).

Canopy Closure and Tree Basal Area. Goshawk nests are usually in forests with high canopy closure. In northern California, canopy closure at nests ranged from 53 to 92 percent (Saunders 1982). In northern Arizona, goshawks preferred nest areas that had the greatest canopy closure available (Crocker-Bedford and Chaney 1988). The average canopy closure in nest areas used by this Arizona population was 76 percent, 18 percent greater than in 360 control areas.

In northern Idaho and western Montana, forest vegetation at nest sites (0.04 ha surrounding nest) (0.1 ac) in the mesic Columbia Highlands west of the Continental Divide were different from those in the drier Rocky Mountain zone to the east (Hayward and Escano 1989). Despite differences in some habitat characteristics, high canopy closure at nest sites was the most uniform habitat characteristic in either geographic area. Tree basal area was the second most consistent habitat variable for the two populations, ranging from 29 to 54 m^2/ha (126 to 235 ft^2/ac); most (60 percent) nest stands were between 39 to 46 m^2/ha (170 to 201 ft^2/ac) (Hayward and Escano 1989). Goshawks nesting in the eastern United States, preferred mature forests (Speiser and Bosakowski 1987) and nest stands had greater total tree basal area compared to random sites.

Although goshawks apparently favor closed-canopy forests, birds will nest in more open forests. In Oregon, Reynolds et al. (1982) reported that seven nest areas had an average canopy closure of 59.8 percent, but three nests were located in pure stands of mature lodgepole pine that were relatively open (166 trees/ha; 67 trees/ac 38 percent canopy coverage). In eastern California, canopy closure in nest stands was 31 percent, quite low compared to other goshawk studies

(Hargis et al. 1994).

Aspect, Slope, Elevation. In the more southerly portions of their range, goshawk nest areas typically have northerly aspects and are located near the bottom of moderate slopes. In Oregon, 61 percent of nests were on northwest to northeast-facing slopes while only 8 percent had southerly exposures (Reynolds et al. 1982); slopes in nest areas averaged 9 percent (range = 0 - 75 percent). In northeastern Oregon, the average slope at nests was 14 percent (Moore and Henny 1983). In Idaho and Montana, goshawks used northern aspects on moderate slopes (<50 percent slope); over 40 percent of these nests had aspects between 31.5º and 45º (Hayward and Escano 1989). Most Idaho and Montana nests were located on the lower third of the slope -- 12 percent were upper 1/3 slope, 18 percent mid-slope, 29 percent lower slope, and 41 percent at toe slope or bottom (Hayward and Escano 1989). In eastern forests, goshawks avoided nesting on southerly aspects as compared to random points throughout the study area (Bosakowski and Speiser 1994). Goshawks nesting in New Mexico did not choose a given nest aspect, but most pairs (55 percent) used moderate (10%) (Kennedy 1988). In Wyoming, goshawks also nested on aspects that were similar to those randomly available (Squires and Ruggiero 1996), but preferred nesting on more moderate slopes (11 percent), compared to those randomly available (16 percent). In northwestern California, goshawks used some of the most precipitous slopes recorded for the species, averaging 42 percent (Hall 1984).

In interior Alaska, most (64 percent) goshawk nests were on southern aspects; 16 percent were on the upper portion of the slope, 46 percent were on the middle portion, and 38 percent were on the lower portion of the slope (McGowan 1975a,b).

Plucking Perches. Goshawks use the same logs, stumps, old nests, and low, bent-over trees or saplings repeatedly for plucking prey in nest areas (Schnell 1958, Palmer 1988). Although nests are usually placed under mature canopies, plucking perches are usually located in denser portions of the secondary canopy and up slope from the nest (Reynolds 1982, Hall 1984). Apfelbaum and Haney (1984) found three plucking perches, all within 100 m of the nest tree on gently sloping or level fallen logs that were approximately 0.5 to 0.75 m (1.6 to 2.45 ft) above the ground. In Oregon, Reynolds et al. (1982) found the mean distance from nests to plucking perches was 45 m (147 ft) (range 27-74 m; 88 - 242 ft) from the nest tree. In California, an average of 2 plucking perches were present per nest site (range =1-3, Hall 1984). Schnell (1958) found the mean distance from 10 plucking perches to a nest was 69 m (226 ft) (range 30 - 130 m; 98 - 425 ft).

Water. While goshawks often nest near water (Bond 1942, Beebe 1974, Shuster 1980, Reynolds et al. 1982, Hargis et al. 1994), distances of water from nests differs regionally according to landscape physiography. In British Columbia, Canada, goshawks consistently nested within 120 to 360 m (395 - 1190 ft) of permanent water (Beebe 1974). The water source varied from a forest pond or small stream to a major river or large lake. In Colorado, Shuster (1980) found that all aspen nest stands were near running water, but the distance to water in pine stands varied from 10 to 450 m (33 to 1485 ft). Cataracts in loud-rushing streams appear to be avoided by nesting goshawks (Shuster 1980, Reynolds et al. 1982, Speiser and Bosakowski 1987). In

California, permanent water sources (springs and small streams) were on average closer to nests than to random points (Hargis 1994); shapes of home ranges suggest that goshawks incorporated water sources as far as 3.5 km (2.2 mi) from their nests. Young goshawks may bathe or wade in water for extended periods (Brown and Amadon 1968). The function that water provides during nesting is unknown but Hennessy (1978) speculated that frequent bathing by brooding goshawks may help maintain proper humidity during incubation.

Although free water may be favored, it is not a habitat requirement in nest areas. On the Kaibab Plateau in Arizona, only 8 of 43 nest sites occurred within 1 km of permanent water (Crocker-Bedford and Chaney 1988); bodies of water averaged 3.6 km apart in this region. In New York and New Jersey, Speiser and Bosakowski 1987 found no difference in distance to water between nest sites and random points.

Forest Openings. Goshawks often nest close to forest openings such as meadows, forest clearings, logging trails, dirt roads and fallen trees (Gromme 1935, Reynolds et al. 1982, Hall 1984, Erickson 1987, Hayward and Escano 1989). In California, an average of one forest opening was present within 15 m (49.5 ft) of goshawk nests and averaged 113 m^2 (1,208 ft^2) in size (Hall 1984). In South Dakota, canopy openings accounted for approximately 10 percent of the nest territory (area defended against observer, Bartelt 1977); only two sites were not associated with an opening. Another South Dakota study found that all goshawk nests were near either old logging roads (78.6 percent) or forest openings (21.4 percent, Erickson 1987); the mean distance from the nest tree to either type of opening was 73.9 m (242 ft) (range 16.9 - 215 m; 55 - 703 ft).

Goshawks in New York and New Jersey nested closer to lightly traveled roads and trails as compared to random points; this result was obtained despite extensive off-road searching (Speiser and Bosakowski 1987). Small roads represented the only break in a contiguous forest patch. In California, goshawks nested an average of 85.3 m (279 ft) from medium-use roads (Saunders 1982).

The function of forest openings near nests is unclear. They may serve to increase access to the nest or to aid in locating nests. Erickson (1987) observed male goshawks on several occasions returning high over the forest canopy with food, and then dropping into an opening or trail to deliver the prey to the female; he believed that openings and trails were used as access corridors to the nest. In eastern forests, goshawk fly, perch, and pluck prey along small roads, using them opportunistically as travel corridors (Speiser and Bosakowski 1987). In Colorado, Shuster (1980) found that each of 20 goshawk nests were within 350 m (1,145 ft) of a 0.4 ha (1 ac) or larger opening. These were natural meadows that supported populations of ground squirrel prey.

Nest Area Forest Types as Reported to Status Review Team

The following is a summary of the data for nest area forest types reported to the Status Review Team through the information request discussed in the Methods section of this document (Tables 3.2 - 3.7). As previously stated, there are biases and limitations associated with these data

relative to how the data were collected and reported. Further, for analysis purposes, the list of specific tree species reported was reduced to a more refined list of forest types corresponding to FIA/SAF forest cover type data as discussed in the Methods Section. These data provide an example of forest types for known goshawk nests throughout the status review area. The Status Review Team views these data as a sample of forest types currently known to be used, and not a complete list of forest types used by goshawks.

Table 2.2. Forest Types reported from Assessment Area 1 for a total of 316 nest areas.

Forest Type	Number of Occurences	Percent of Total
Douglas Fir	189	60
Lodgepole Pine	50	16
Ponderosa Pine	45	14
Hemlock-Sitka Spruce	14	4
Aspen-birch	6	2
Fir-spruce	6	2
Western Hardwoods	2	.6
Larch	1	.3

Table 2.3. Forest Types reported from Assessment Area 2 for a total of 328 nest areas.

Forest Type	Number of Occurences	Percent of Total
Ponderosa Pine	161	49
Lodgepole Pine	82	25
Aspen-birch	52	16
Douglas fir	16	5
Fir-spruce	17	5

Table 2.4. Forest Types reported from Assessment Area 3 for a total of 246 nest areas.

Forest Type	Number of Occurences	Percent of Total
Ponderosa Pine	188	76
Douglas Fir	51	21
Aspen-birch	5	2
Western Hardwoods	1	.5
Pinyon-juniper	1	.5

Table 2.5. Forest Types reported from Assessment Area 4 for a total of 721 nest areas.

Forest Type	Number of Occurences	Percent of Total
Aspen-birch	247	34
Douglas fir	213	30
Lodgepole Pine	122	17
Ponderosa Pine	87	12
Fir-spruce	42	6
Western Hardwoods	7	1
Larch	2	.3
Pinyon-juniper	1	.1

Table 2.6. Forest Types reported from Assessment Area 5 for a total of 2,544 nest areas.

Forest Type	Number of Occurences	Percent of Total
Douglas Fir	1,684	66
Ponderosa Pine	520	21
Fir-spruce	253	10
Western Hardwoods	57	2
Lodgepole Pine	24	1
Aspen-birch	6	.2

Table 2.7. Forest Types reported from Assessment Area 6 for 886 nest areas.

Forest Type	Number of Occurences	Percent of Total
Douglas Fir	618	70
Ponderosa Pine	129	14
Lodgepole Pine	78	9
Fir-spruce	43	5
Larch	9	1
Hemlock-Sitka Spruce	4	.5
Aspen-birch	2	.2
Mixed conifer	2	.2
Pinyon-juniper	1	.1

Post-Fledging Area (PFA)

The PFA surrounds the nest area and includes the area used by the family group from fledging until young are no longer dependent on the adults for food (Kennedy 1989, Reynolds et al. 1992, Kennedy et al. 1994). In New Mexico, PFAs averaged 170 ha (420 ac) in size and may correspond to the defended area (territory) of a goshawk pair (Kennedy et al. 1994). Post-fledging areas may be important to fledglings by providing hiding cover and prey on which to develop hunting skills.

During the post-fledging dependency period the activities of young are centered around their nests, but distances that fledglings move from the nest increased with time (Kennedy et al. 1994). In New Mexico, the average distance fledglings moved from nests increased from 11.8 m (39 ft) in week 1 to 1955.6 m (1.2 mi) in week 8 (Kennedy et al. 1994). During the first 4 weeks following fledging, 88.1 percent of 193 locations were within 200 m (654 ft) of the nest and 99.5 percent were within 800 m (0.5 mi) of the nest. During the last 4 weeks of the fledgling-dependency period, only 34.3 percent of 108 locations were within 200 m (654 ft) of the nest and only 75.9 percent of locations occurred within 800 m (0.5 mi) of the nest.

Kenward et al. (1993a) found that European goshawks usually fledged between 39 - 43 days of age. Only 2 percent of observations were more than 300 m (0.2 mi) from the nest 1 - 25 days after fledging compared to 26 percent of observations in the 25 - 50 days after fledging. Dispersal from nest areas was abrupt. Most fledglings (90 percent) dispersed by 65-90 days of age; females dispersed approximately a week later than males.

Foraging Habitat

Goshawks have been observed hunting in habitats as diverse as open steppes and dense forests. However, limited evidence suggests that goshawks preferentially forage in mature forests.

In the southwestern U.S., Reynolds et al. (1992) conducted in a literature review of the habitats of important goshawk prey and found that while some goshawk prey preferred forest openings, the majority were in mature and old forests. Beier and Drennan (1997) believed that when goshawks selected foraging sites, prey abundance was not as important as was the accessibility of prey, which is influenced by forest structure (i.e., high canopy closure, high tree density) that make prey easier to locate and capture.

In Utah, a single radio-tagged male selected foraging in mature Douglas-fir/white fir stands compared to the availability of this habitat type (Fischer 1986). In southwest Yukon, Canada, 33 percent of goshawk kills were in dense forest cover while only 18 percent of the valley was this cover-type (Doyle and Smith 1994). Hargis et al. (1994) found that radio telemetry locations (assumed to occur during foraging) were in forest stands with significantly higher basal area, more canopy cover, and more trees in large diameter classes than were randomly available. In the southern Cascades, goshawks preferred the oldest, densest vegetation type available and avoided the youngest, most open vegetation (Austin 1993).

In Colorado, Shuster (1980) observed goshawks hunting in openings and clearcuts. In Nevada, three males foraged in open sagebrush away from trees (based on 13 visual locations prior to transmitter loss), or along aspen groves to hunt Belding's ground squirrels in the surrounding sagebrush (Younk and Bechard 1992). These studies suggest that goshawks hunt in open and edge habitats but visual observations are subject to visibility bias.

Foraging habitat in forested environments can be partitioned into several layers from the forest floor to above the forest canopy. Reynolds and Meslow (1984) assigned bird and mammal prey

species to four height zones (ground-shrub, shrub-canopy, canopy, aerial) on the basis of where each spends most of its time and found that approximately 40 percent of prey in goshawk diets were zone generalists and approximately 35 percent were most often in the ground/shrub layer. The remaining prey were evenly distributed between shrub-canopy and canopy layers. Large-bodied prey, which may be more important to breeding goshawks than smaller prey (Reynolds et al. 1992), were primarily associated with the lower forest strata or were zone generalists.

In Arizona, Boal and Mannan found that more prey was captured from the ground/shrub zone (62 percent) than all other zones combined. About 25 percent of prey were zone generalists, whereas prey from the shrub/canopy and canopy zones only accounted for 13.0 percent of prey. Highly aerial prey, such as swallows, were not observed in goshawk diets.

In the Coast Ranges of Oregon, where goshawks are rare, the forests contain high understory stem densities and dense undergrowth. Even though prey species in the Oregon Coast Ranges are varied and abundant, these forest conditions may make prey species difficult capture. DeStephano and McCloskey (1997) state that if a relationship between vegetation structure and the availability of prey does exist, then the forest conditions described above may limit prey availability to goshawks, potentially depressing or preventing reproductive activity.

Winter Habitat

Winter habitat use of northern goshawks is among the least understood aspects of their biology. Few goshawk studies in North America have investigated their migration and winter biology (Doerr and Enderson 1965, Alaska Dept. of Fish and Game 1993, Squires and Ruggiero 1995, Beier 1997). Our understanding of goshawk biology during the winter comes primarily from Europe (Opdam et al 1977, Kenward et al. 1981, Marcström and Kenward 1981, Widén 1985, 1987, 1989, Kostrzewa and Kostrzewa 1991). The applicability of these results to goshawks in North America is unknown.

Wintering goshawks use forests, woodlands, shrublands, and riparian-strip forests in search of prey (Squires and Ruggiero 1995, Beier 1997). In the Rocky Mountains of the U.S., wintering goshawks use cottonwood riparian areas (Squires and Ruggiero 1995), aspen, spruce/fir, logepole pine, ponderosa pine and open habitats (Squires and Reynolds 1997).

In northern Arizona, 13 adult goshawks used ponderosa pine and pinyon-juniper woodlands during two winters. In general, female goshawks (n=6) remained in the ponderosa pine vegetation type in the general vicinity of their nest stands throughout both winters. Most male goshawks moved 5-10 miles from the nest area and generally into the closest pinyon-juniper woodlands (Beier 1997).

In Sweden, Widén (1989) radio-tracked goshawks (n = 23 males, 20 females) that wintered in highly fragmented forests interspersed with clear cuts, wetlands and agricultural lands. Young and middle-aged forests were used by goshawks in proportion to availability, whereas large patches >40 ha (100 ac) of mature forests (70 yrs old) were used significantly more than

available. Mature forests seemed to provide goshawks with cover to move from hunting perch to hunting perch undetected by prey, yet were open enough for birds to maneuver when attacking prey (Widén 1989). Wintering goshawks killed more than half their prey in mature forests.

In England, Kenward (1982) reported that four goshawks tracked by radio spent 50% of their time in woodland, even though only 12% of their home range was wooded, and 70% of prey was taken in or from woodlands. Kenward and Widén (1989) reported that wintering goshawks in England used edge habitats in agricultural parts of the country. Differences in habitat use in England compared to Sweden were attributed to different prey distributions. In boreal forests, goshawks fed primarily on squirrels, a species that was distributed throughout the forest whereas in agricultural areas prey are more abundant near forest edges. Goshawk home ranges were smallest in agricultural areas where prey densities were greatest, and were largest in areas that contained the least woodland edge. These results suggest that prey distribution rather than the amount of woodland habitat was the factor that determined the distribution of goshawks during winter.

Food Habits

Like other raptors, the food habits of goshawks have been determined by : 1) examination of stomach contents, 2) removing food from crops of nestlings, 3) direct observation of nests, 4) prey remains, and 5) regurgitated pellets (Sherrod 1978). Analysis of pellet/food remains and direct observation of nesting birds are the primary techniques used to determine goshawk food habits. Younk and Bechard (1994) found that goshawks only plucked birds at plucking perches, whereas ground squirrels were taken directly to the nest. Thus, in some areas, quantifying prey remains at plucking perches may be biased toward avian and large-bodied prey. However, Kennedy (1991) compared three techniques (remains analysis, pellet analysis, and direct observation) for studying the food habits of Cooper's hawks and goshawks and found that all yielded similar rankings of prey taxo. She concluded that periodic samples of prey remains at nests adequately characterized diet composition of nesting goshawks. Collopy (1983) found similar results for golden eagles.

Although diet composition has been studied for many populations, additional local studies will be needed as resource agencies develop management strategies for different populations. Very little is known about the winter diets of North American goshawk populations. Beier (1997) made 27 observations of birds with freshly-killed prey during the winter and suggested that individual goshawks specialized in taking cottontails and Abert's squirrels, but not both. Wintertime prey base was dissimilar to summertime prey (e.g., golden-mantled ground squirrels, chipmunks and other hibernators) suggesting predation efficiency was based on prey availability and opportunism.

<u>Prey Taxa and Abundance in Diets</u>
North American (Schnell 1958, Meng 1959, Reynolds and Meslow 1984, Boal and Mannan 1994, Bull and Hohmann 1994, Reynolds et al. 1994, Younk and Bechard 1994) and European

goshawks (Cramp and Simmons 1980) prey on a variety of birds and mammals. In summarizing the diets of various North American goshawk populations, Sherrod (1978) found mammals numerically comprised 21 to 59 percent of diet whereas avian prey represented 18 to 69 percent. In Arizona, mammals accounted for 94 percent and birds 6 percent of prey biomass delivered to goshawk nests (Boal and Mannan 1994). In five North American studies, the average composition was 33.8 percent mammalian and 64.4 percent avian prey (Jones 1979). Herptiles and invertebrates were occasionally taken. Table 2.8 shows the proportion of mammalian and avian prey in the diets of northern goshawks during the nesting season as reported by various researchers.

Goshawks, like most predators, are opportunists. Diets differ among populations as prey availability changes regionally and seasonally. More than 30 species of mammalian and 53 species of avian prey have been identified in diets from goshawk populations in North America. However, a few prey taxa are particularly important to most goshawk populations: chipmunks (*Eutamias* sp), cottontail (*Sylvilagus* sp), snowshoe hare (*Lepus arcticus*), Douglas squirrel (*Tamiasciurus douglasi*), red squirrel (*Tamiasciurus hudsonicus*), golden-mantled ground squirrel (*Citellus lateralis*), gray squirrel (*Sciurus* sp), northern flying squirrel (*Glaucomys sabrinus*), American robin (*Turdus migratorius*), blue jay (*Cyanocitta cristata*), Steller's jay (*Cyanocitta stelleri*), ruffed (*Bonasa umbellus*) and blue grouse (*Dendragapus obscurus*), common crow (*Corvus* sp), domestic pigeons (*Columba livia*), and northern flicker (*Colaptes auratus*).

Gallinaceous birds (primarily grouse and pheasants) are important prey for both North American (Mendall 1944, McGowan 1975, Gullion 1981a, b, Gullion and Alm 1983, Apfelbaum and Haney 1984) and European goshawks (Kenward 1979, Sollien 1979, Kenward et al. 1981, Linden and Wikman 1980, 1983). Fluctuations in grouse populations affect goshawk productivity. In Finland, Lindén and Wikman (1983) studied the relationship between grouse and goshawks. In 1974, their study area contained 25 breeding goshawk pairs. From 1976 to 1977, the grouse population (mainly hazel grouse) declined sharply, causing the population of nesting goshawks to decline to 10 pairs. When grouse abundance was low, the proportion of non-breeding goshawk pairs varied from 35 to 52 percent. Clutch sizes remained relatively constant during the decline in grouse abundance, but the reproductive output of nesting hawks declined from 2.4 young/active nest in 1974 during a good grouse year to 0.5 young/active nest in 1977 when grouse were scarce. Goshawk predation on grouse was not linearly related to abundance. They killed more grouse than was expected based on abundance, suggesting that goshawks developed a search image for this prey item. Grouse may be particularly important to nesting goshawks during the spring when alternative prey are scarce and migratory prey have not yet returned to the hawk's nesting territory. Sollien (1979) also found that fluctuations in European goshawk populations were related to fluctuations in forest grouse populations.

Sciurids (squirrels) including chipmunks, tree and ground squirrels also represent an important group of prey. Squirrels occur in most goshawk diets due to their high abundance and broad distribution. In California, Woodbridge et al. (1988) found that sciurids were present in 55.0

percent of diets and contributed 59.1 percent to the food biomass, whereas total mammals (9 spp.) provided 81.5 percent of prey biomass. Important sciurids in terms of biomass included golden-mantled ground squirrels (15.6 percent), Douglas squirrels (14.7 percent), and western gray squirrels (9.3 percent, Woodbridge et al. 1988). Several studies have documented that red squirrels are particularly important prey (Mendall 1944, Meng 1959, Reynolds et al. 1994). Red squirrels are distributed from Alaska, throughout hardwood and coniferous forests, east to Appalachian states. They may be especially important during the winter when other prey are unavailable (Widén 1987).

Rabbits and hares are another class of large-bodied prey that are used extensively by goshawks (Reynolds and Meslow 1984, Kennedy 1991). Cottontail rabbits are abundant in most habitats and are distributed throughout the goshawk's range. Boal and Mannan (1994) found that cottontails contributed the greatest proportion of prey biomass (26 percent) taken by goshawks, and together with golden-mantled ground squirrels accounted for 41 percent of all identified prey. Snowshoe hares are also important prey, particularly in northern and boreal forests (Mendall 1944, McGowan 1975a, Doyle and Smith 1994). In the Yukon, snowshoe hare density rose six-fold from spring 1987 to 1990 (Doyle and Smith 1994). Hare densities remained high in 1991, then declined 15-fold by spring 1993. During this period, goshawks increased sharply in numbers and peaked in 1991, the year following the peak in hare density. During this same period, numbers of goshawks observed declined five-fold from 1990 to 1992. Goshawk breeding success peaked in 1990 with 3.9 young per successful pair when hares were abundant, and then declined until 1992 when no goshawks successfully fledged young.

Robins are moderate-sized thrushes that are widely distributed throughout the geographic range of nesting goshawks and are present in most goshawk diets. Robins constituted 6.6 percent of the diet of goshawks in eastern Oregon (Reynolds and Meslow 1984) and 2.6 percent in New York (Grzybowski and Eaton 1976).

Steller's jays and other corvids (crows and jays) are common residents of conifer and mixed-species forests. Steller's jays, along with northern flickers, were the most common avian prey species (16 percent) of goshawks nesting in Arizona (Boal and Mannan 1994). In California, Steller's jays were present in 12 percent of remains (Bloom et al. 1986) whereas in New Mexico, they comprised 17 percent of total birds in goshawk diets (Kennedy 1989). On the Shasta-Trinity and Klamath National Forests in California, Steller's jays comprised 16.6 percent of numbers of prey and 6.3 percent of biomass (Woodbridge et al. 1988). The Queen Charlotte goshawk (*A. g. laingi*) fed extensively on Steller's jay and varied thrush (Beebe 1974). Blue jays formed 6 percent of the diet of northeastern goshawks (Bosakowski et al. 1992)

American crows commonly occur in the diets of some goshawk populations (Meng 1959, Eng and Gullion 1962, Gullion 1981b, Fleming 1987). In New York, Grzybowski and Eaton (1976) found that crows comprised 5.2 percent of prey in New York. However, crows contributed only 1.4 percent of the diet of goshawks nesting in New York, New Jersey, and Connecticut (Bosakowski et al. 1992). Northwestern crows are important prey of goshawks nesting on the

Queen Charlotte Islands (Beebe 1974).

Woodpeckers, including Williamson's sapsucker (Reynolds et al. 1994, Schnell 1958), northern flicker (Eng and Gullion 1962, Erickson 1987), pileated woodpecker (Allen 1978, Eng and Gullion 1962, Reynolds and Meslow 1984), black-backed woodpecker (Erickson 1987), three-toed woodpecker (Erickson 1987, Gullion 1981b) and hairy woodpecker (Fleming 1987), collectively are important goshawk prey. In California, woodpeckers comprised 3.1 percent of total prey biomass (Woodbridge et al. 1988). Northern flickers are particularly important in many goshawk diets (Grzybowski and Eaton 1976, Reynolds and Meslow 1984, Bloom et al. 1986, Boal and Mannan 1994). Flickers are large birds that often forage on the ground, have conspicuous markings and behavioral displays, and are widely distributed (Reynolds et al. 1992) . In New Mexico, northern flickers comprised 26.4 percent of total birds present in the diet of nesting goshawks (Kennedy 1989).

Table 2.8. Proportion of mammalian and avian prey in diets of northern goshawk during the breeding season (from Squires and Reynolds 1997).

Location	Percentage of Mammalian Prey (biomass)	Percentage of Avian Prey (biomass)	Study
United States			
Alaska	78 (90)	21 (10)	Zachel 1985[1]
Arizona	76 (94)	24(6)	Boal and Mannan 1994[3]
Arizona	62	38	Reynolds et al. 1994[1,2]
California	32	68	Bloom et al. 1986[2]
Nevada	67	32	Younk and Bechard 1994[3]
New Mexico	49	51	Kennedy 1991[1]
New York	39	61	Grzybowski and Eaton 1976[2]
Oregon	42	59	Bull and Hohmann 1994
Oregon	45	55	Reynolds and Meslow 1984[1,2]
Utah	82	18	Lee 1981[1,2]
Canada			
Yukon	---(86)	---(13)	Doyle and Smith 1994[2]
Sweden	21.3 (15.2)	78.6 (84.8)	Widen 1982[2]

[1] Pellet analysis
[2] Prey remains
[3] Direct observation

Prey Species Habitat Needs

Reynolds et al. (1992), recognizing that goshawk populations are often food limited, included key elements of the habitats of their important prey species into the habitat "gestalt" of goshawks in southwestern pine forests. Because species on which goshawk prey vary among forest types, the habitat gestalt of goshawks varies by forest type. In southwestern pine forests, snags provide critical resources for many species of birds, mammals, invertebrates, and plants. All woodpeckers in goshawks diets use snags for feeding, nesting, or both, and several bird species use snags for perches and roosts. Several mammalian prey species, such as red squirrels, ground squirrels and chipmunks, use snags for nesting (when cavities are available) and cone caching (Reynolds et al. 1992). The density of many chipmunk species is positively correlated with large snags in mature forest (Rosenberg and Anthony 1993), and with snag density (Doyle 1990).

Downed logs (>12 inches in diameter and 8 feet long) provide cover, feeding and nest sites for a great variety of species. Among goshawk prey, downed logs are important feeding sites for several woodpeckers and as den sites for chipmunks, golden mantled ground squirrels, and cottontail rabbits. Downed wood and woody debris are also important as a substrate for fungi, an important food for chipmunks and ground squirrels. Downed logs are an important element in red squirrel cache sites and in blue grouse courtship sites (Reynolds et al. 1992).

Woody debris is woody material larger than 3 inches in diameter on the ground. Woody debris provides cover and feeding sites for a variety of vertebrates. The character, amount, and distribution of woody debris may affect the diversity and abundance of animals in an area (Dimock 1974).

Openings, and associated herbaceous and shrubby vegetation, provide important food and cover for a number of goshawk prey species. Openings are particularly valuable for band-tailed pigeon, mourning dove, and blue grouse; blue grouse for nesting and brood-rearing, and the pigeon and dove for feeding. Because pigeons and doves typically travel long distances to feed in agricultural or other large non-forested areas, large openings in the forest are not required for them. Therefore, a forest containing small to medium (<4 acres) openings would benefit the blue grouse, chipmunks, mantled ground squirrels and cottontails while minimizing the effects on other interior forest prey species (Reynolds et al. 1992).

Large trees (>18 inches in diameter) provide important nesting, denning, feeding, and roosting sites for goshawk prey such as tree squirrels, large woodpeckers, and blue grouse. Large trees also are good cone producers, providing a source of seed for many species of goshawk prey. Because large trees are the source for large snags and downed logs, they are as important to woodpeckers as are large snags. Large trees also provide hunting perches and nest trees for goshawks (Reynolds et al. 1992).

Herbaceous and shrubby understories provide important foods (seeds and berries), and cover for many of the selected prey. Well developed understories occur in forests with canopy sufficiently open to allow the necessary light to reach the forest floor; closed canopied forests are often

limited in the quantity of these plant foods (Reynolds et al. 1992).

Interspersion measures the degree of intermixing of vegetation structural stages. The red squirrel responds negatively to a high level of interspersion of structural stages; its populations reach a maximum in unbroken old forests. Other goshawk prey populations either respond positively to high interspersion (e.g., blue grouse), or are little affected by high levels of interspersion (e.g., chipmunks) (Reynolds et al. 1992).

Several species (such as American robin and mourning dove) are generalists and occur at medium populations in most structural stages, while others, including the red squirrel are specialists and occur in a limited number of structural stages. The blue grouse requires both openings and older forests, interspersed with one another, to attain high populations during all seasons (Reynolds et al. 1992).

Canopy cover influences population levels of goshawk prey in different ways. For example, species of goshawk prey such as the blue grouse, chipmunks, cottontails, and northern flicker, occur at greater densities in open forests (<40% cover). The hairy woodpecker, northern flicker red-naped sapsucker, and tassel eared squirrel, occur at high populations in closed forests (>60% cover), but the red squirrel, requires closed older forests to attain high populations. Others attain high populations in 40-60% canopy cover as well (Reynolds et al. 1992).

Many small mammals, and the majority of birds, in goshawk diets in southwestern pine forests are either granivores or herbivores--feeding on seeds, berries, and foliage of plants that occur in openings in forests and in forest understories. Many of these prey also depend heavily on seeds of conifers; for example, tree squirrels climb trees for cones and chipmunks and ground squirrels scavenge cones or seeds from the ground or steal cones from caches of others.

All mammalian prey species in southwestern pine forests, except cottontails, depend heavily on fungi during summer and fall, and the physiological condition in which tree squirrels and chipmunks begin the winter may be dependent on the amount of fungi eaten (Smith 1968, Maser et al. 1978). Fungi are best produced in conifer stands with canopy cover greater than 60%. In ponderosa pine forests the best fungi-producing stands are mid-aged with high canopy cover (States 1985, States et al. 1988, Uphoff 1990).

In summary, goshawk foraging habitat in southwestern pine forests consists of relatively open understories and large trees. Large trees are required for hunting perches, and openness provides opportunity for detection and capture of prey by goshawks. These forests have small to medium openings (<4 acres) and patches of dense mid-aged forests. Openings are scattered to enhance the availability of food and habitat resources of prey that use them, and limit the effect of large openings on the distribution and abundance of prey species that use interior forests.

For the most part, southwestern pine forests ideal for goshawks and their prey consist of older age classes that are relatively open (40-60% canopy cover). These forests have well-developed

herbaceous and shrubby understories. Large tree components (live trees, snags, and downed logs) are scattered throughout the foraging area. The large tree component, often occurring in clumps with interlocking crowns, provides a myriad of unique hiding, feeding, denning, and nesting sites used during some part of the annual cycle of all selected goshawk prey species.

Seasonal Dietary Shifts

Most of our knowledge regarding seasonal changes in the diets of goshawks is based on European studies. Marquiss and Newton (1982) found that goshawks in Britain ate game birds (red grouse and gray partridge) in the spring (March to May) and in August. Rabbits were taken from spring through July, and hares mainly in June. Doves and pigeons were present in the diet throughout the nesting season. Diet diversity was greatest in August when large birds, particularly crows and other passerines, were also taken. In northern Finland, Tornberg and Sulkava (1990) noted a similar shift from galliformes in the spring to other prey during the summer; grouse constituted approximately 60 percent of the diet during nest-building and incubation, but only 35 percent when nestlings were present. In southern Finland, grouse and pheasants were also primary prey of nesting goshawks (Lindén and Wikman 1983). As summer progressed, the proportion of grouse and pheasants in the diet decreased while the proportion of corvids increased, especially after the young fledged.

Wikman and Tarsa (1980) studied goshawk diets in Finland from 1966 to 1977 in areas of poor grouse habitat. A total of 1,300 prey animals were cataloged, including 46 species of birds and 7 species of mammals. They found that goshawk diets had a higher species diversity during the nestling stage than during incubation. Prey diversity reached a peak in May when migrant birds returned. Prey diversity decreased slightly in early June when young thrushes, jays, and other passerines fledged their nests. For the remainder of the summer, juvenile birds formed the main portion of their diets.

In Swedish boreal forests, Widén (1987) studied food habits of goshawks during the winter by radio-tracking goshawks and during the breeding season by examining remains at nests. Birds dominated diets during the breeding season, accounting for 86 percent of prey numbers and 91 percent of biomass. Wood pigeon, black grouse, hooded crow, and jay provided more than 50 percent of prey individuals, whereas capercaillie and black grouse accounted for more than 50 percent of prey biomass. However, during the winter, squirrel dominated both the numbers (79 percent) and biomass (56 percent) of prey. The proportion of squirrel in the diet was high in both winters of high and low squirrel abundance.

In Nevada, goshawks shifted their diets to include more birds such as American robins and northern flickers when Belding's ground squirrels began to estivate (Younk and Bechard (1994). However, on the Kaibab Plateau in Arizona, there was no difference through the nesting season in the proportions of the three most frequent goshawk prey (golden-mantled ground squirrel, cottontail rabbits, chipmunks; Boal and Mannan 1994).

Foraging Behavior

Goshawks, like other accipiters, have evolved morphological and behavioral adaptations for hunting in forests. Relative to open country hawks and falcons, goshawks have short wings and long tails for maneuvering in and below a forest canopy. Goshawks have robust feet and bill that are adapted for capturing and eating a wide variety of comparatively large prey (Wattel 1973).

As in most raptors, male goshawks provide the female with food during incubation and nesting, while the female primarily guards the nest (Reynolds 1972, Newton 1974, Allen 1978). For example, Schnell (1958) observed that of 88 prey items brought to the nest, 73 (85 percent) were brought by the male and 13 (15 percent) by the female. Of the total 5,866 g (13 lbs) of prey brought to the nest, the male secured 4838 g (10.71bs) (82.5 percent) and the female 1028 g (2.38bs) (17.5 percent).

Hunting Tactics

Goshawks are short duration-sit-and-wait predators; this hunting style is suited to foraging in forests where visibility is limited (Reynolds et al. 1992). Hunting Goshawks typically make short flights to perches from which they briefly search an area for prey before flying a short distance to the next perch. Thus, foraging goshawks move rapidly through the forest, perch to perch, punctuated with brief periods of prey searching. In Britain, goshawks changed perches every 2 to 6 minutes, with flights averaging 100 m in length in woodlands and 200 m in open country (Kenward 1979). Goshawks occasionally hunt by flying rapidly along forest edges, across openings, and through dense vegetation in an effort to surprise prey. Only three percent of goshawk attacks on prey were from hawks already in flight (Kenward 1982).

In Sweden, goshawk flight activity increased with increasing time since last feeding (Widén 1984). On the day that goshawks successfully killed prey, flight activity was 3 percent of their daily time (3 birds monitored for 16 kills). If unsuccessful, flight activity increased to 5.7 percent the day following a kill and was 9.1 percent the second day after a kill. In order to increase flight activity, goshawks perched for shorter periods between flights (Widen 1984). In all cases except one, goshawks killed again within two days.

Hunting goshawks readily use trees, shrubs, and topographic features as cover for approaching prey. Backstrom (1991) observed a goshawk using a weed and vegetation “path” along a stream for cover during its attack on a sharp-tailed grouse. Goshawks may at times stalk prey. In Colorado, a goshawk was seen standing in a wet meadow stalking a blue-winged teal on a pond (Bergstrom 1985). The goshawk crouched low and ran 4 or 5 times on the ground, using a row of willows as hiding cover for approaching the teal.

Goshawks may capture quarry through dogged persistence rather than using surprise attacks. In Arizona, Westcott (1964) observed two similar instances where adult goshawks pursued Abert’s squirrels. The attacks involved hawks hopping from tree branch to tree branch, chasing the squirrels through a tree, while always remaining below their prey. The hawks captured the squirrels after 10 to 15 minute chases. Both attacks were unhurried though persistent, with

continual vocalizations by the hawks. Likewise, Brace (1983) observed a goshawk hunting a snowshoe hare in a 10 m wide hedge that was too thick for the hawk to enter. The goshawk flew above the hare as it ran back and forth under the hedgerow. After 45 to 60 minutes, the hare was captured while crossing a small clearing.

Hunting tactics of goshawks vary depending on prey type and behavior. If the hawk is undetected by the prey, its attack may consist of a smooth, silent, accelerating glide that ends in a strike without so much as a wing beat (Beebe 1974). However, if the hawk is spotted during its approach, it immediately begins rapidly flapping attempting to increase its speed toward its quarry. Attacks on birds rarely last longer than a kilometer before the goshawk's full-speed strike ends the chase. Goshawks will readily crash through shrubs and other vegetation when pursuing prey. The vigorous and often reckless nature of goshawks when attacking prey is legendary among falconers (Beebe 1976). Goshawks will even enter water when chasing prey. Fulton (1983) observed a goshawk in Georgia attack a crow that had fallen into the water at a trout hatchery. The goshawk landed directly on its prey in the water and after 5 seconds jumped from the water with the live crow. Schnell (1958) observed a female goshawk return to her nest with mallard ducklings; her wet breast suggested she waded in shallow water to capture her prey.

Foraging Success and Prey Delivery Rates

Foraging success and prey delivery rates vary according to prey type, hunting experience, and habitat characteristics. The average number of prey items delivered to nests by goshawks in the Adirondacks was 1.84 and 2.69 deliveries per observation day (Allen 1978); most prey were delivered during mid-morning or late afternoon. In Arizona, Boal and Mannan (1994) observed 385 prey deliveries to nests at the rate of 0.25 items/hr. During 19 days of observation, Schnell (1958) observed a male goshawk deliver 75 food items at the rate of 3.9 items per day. The male delivered food to the nest during all daylight hours, but more prey was delivered in the early morning (6:00-7:00 am) and in the afternoon and evening (4:00 - 8:00 pm). Kenward (1982) found that only 6 percent of the attacks during the winter were successful, and that wintering hawks hunted an average of 262 minutes per kill. In Oxfordshire, England, four radio-tagged goshawks (3 falconry birds, 1 removed from nest) were monitored for 87 days during the winter and killed an average of twice every three days (Kenward 1979).

Prey Caching

Caching surplus food has been recorded in small falcons to large eagles (Newton 1979). Food caching occurs most frequently during the breeding season, but some raptors cache throughout the year. This behavior saves food for future use during periods of low food availability. Goshawks cache food when nestlings are small and unable to consume entire prey (Schnell 1958). In Schnell's study, the female ceased caching prey when nestlings were approximately one month old.

Foraging Distance from Nest

Although not well documented, the distance that males hunt from their nests probably vary by habitat type, nesting phenology, prey density, and the number of observations the study

documented. Kennedy (1988) found (preliminary data) that radio-tracked goshawks did not hunt immediately adjacent to the nest, but foraged mostly between 0.8 km to 8 km (0.5 to 5 mi) of the nest. Of 11 prey items the female brought to the nest, five were caught in the nest vicinity and six were captured outside a 91 to 122 m (300 - 400 ft) radius from the nest (Schnell 1958). The female's capture of prey appeared to be fortuitous and was dependent on prey abundance in the nest area. In Minnesota, all but 5 of 37 kills of banded ruffed grouse (whose bands were recovered at a goshawk nest) were made within 2 km (1.2 mi) radius of the goshawk's nest; 26 of the kills were within a 1.6 km (1 mi) radius (Eng and Gullion 1962). Nine banded male ruffed grouse were killed approximately 1,097 to 2,515 m (0.7 - 1.6 mi) from the nest.

.

Population Ecology

Changes in the number of animals in a population over time are a function of four demographic parameters: reproduction, survival, immigration, and emigration. Population ecology is concerned with determining how factors such as population density, distribution, age structure, resource availability, habitat distribution, competition, and climate influence these population parameters. Thus, population ecology studies provide information critical for formulating management plans for a species (Leslie in prep).

Annual Cycle

Activities and behaviors associated with breeding typically occur between late March and mid to late August (Leslie in prep). Throughout the breeding season there is a marked division of duties between the sexes. Males do most of the foraging while females incubate, brood and feed the young, and defend the nest. These behavioral attributes are reflected in morphology. Females average 1.4 times heavier than males, enabling them to better defend the nest, incubate eggs, and withstand periods of resource limitation. Males have larger pectoral muscles and a lower wing loading relative to females, enabling them to carry prey longer distances (Marcstrom and Kenward 1981). Female accipiters may occasionally forage during the nestling period, with this tendency becoming more pronounced during years of low prey availability (Newton 1986, Ward and Kennedy 1996).

Pre-Laying Period

Goshawks have been observed near their nesting areas as early as late February (Lee 1981), but are typically observed for the first time in early to late March (Zirrer 1947, Reynolds and Wight 1978, Widen 1984, Beier 1997). However, in some areas goshawks may occupy their nesting areas throughout the winter (Leslie in prep).

Females apparently do most of the nest building, with males contributing only occasionally (Zirrer 1947, Lee 1981). Females may aggressively defend the nesting area during this period (Zirrer 1947). As in many raptors, the female becomes sedentary as egg laying approaches, presumably to acquire the energy reserves necessary for egg formation (Reynolds 1972, Newton 1979, Lee 1981). The male delivers prey directly to the female during this time.

Incubation Period

Timing of clutch completion varies considerably among pairs, geographic areas, and years - the dates ranging from 10 April to 2 June (Reynolds and Wight 1978, Henny et al. 1985, Reynolds et al. 1994). On average, clutches are completed between late April and early May. Replacement clutches and clutches laid by 1-year-old hawks are often completed later than the average. In Oregon, the mean date of clutch completion for birds at lower elevations was 12 days earlier than those of birds at higher elevations (Henny et al. 1985).

The incubation period has been estimated at 30 to 32 days by Reynolds and Wight (1982), 36 to 38 days by Brown and Amadon (1968) and Snyder and Wiley (1976), and an average of 43.7 days by Lee (1981). Differences among estimates may be due to individual, geographic, or annual variation in the length of incubation, or may be attributed to measurement error. Eggs are laid at 2-3 day intervals (Holstein 1942) which could result in differences of several days for different clutch sizes. The female is generally reluctant to leave the nest during this period.

Nestling Period

Hatching generally occurs between late May and early June (McGowan 1975, Reynolds and Wight 1978, Lee 1981, Reynolds et al. 1993) although variation in hatch date is considerable. The nestling period varies from 37 to 45 days (Dixon and Dixon 1938, Brown and Amadon 1968, McGowan 1975, Reynolds and Wight 1978, Newton 1979, Kenward et al. 1993, Boal 1994). Variation, at least in part, is due to males developing faster and fledging sooner than females (Reynolds and Wight 1978, Kenward et al. 1993, Boal 1994). Young generally fledge between early and late July (Reynolds and Wight 1978, Reynolds et al. 1994).

Females will brood for up to 3 hours at a time, and may spend up to an hour perched near the nest (Siewart 1933, in Schnell 1958). Females do most of the brooding, but males may brood for up to 2 hours after a prey delivery while the female feeds (Siewart 1933, in Schnell 1958). Apparently, only the female directly feeds the young (Lee 1981) prior to fledging. Females may occasionally forage in and around the nest stand during the nestling period, but males probably provide a minimum of 85 percent of the prey items delivered to the nest (Siewart 1933, in Schnell 1958, Boal and Mannan 1994). Live prey are occasionally brought to the nest (Siewart 1933, in Schnell 1958). For the first few days post-hatching, the female broods the young and only rarely attacks intruders entering the nest stand. Although individual and geographical variation in nest defense behavior is considerable, adult females can be aggressive toward human intruders later in the nestling period (Boal and Mannan 1994). In addition, response rates to broadcasts of conspecific calls are high during this period, facilitating detection of nests (Kennedy and Stahlecker 1993, Joy et al. 1994).

In Europe, where the proportion of birds in the diet is greater than in North America, the average number of prey deliveries is 3.9 per day (Siewart 1933, in Schnell 1958). In North America, the corresponding figure has been estimated at 3.5 deliveries per day (Boal and Mannan 1994).

Post-Fledging Period

This period begins when the young leave the nest and continues until they are no longer dependent on the adults for food. The post-fledging period has been estimated at a minimum of 6 weeks for the North American subspecies (Zirrer 1947, Reynolds and Wight 1978). However, Kenward (1993) estimated a mean post-fledgling dependency period of 32 and 36 days for males and females of the European subspecies, respectively.

The fledgling-dependency period is an important period of transition during which the young learn to hunt and fend for themselves. Feather growth is not yet complete (Bond 1942) and young, at least initially, are incapable of sustained flight. As a result, fledglings may have special habitat requirements during this period (Bartelt 1977, Kennedy 1989, Kennedy et al. 1994, Reynolds et al. 1994).

For the first 3 weeks after fledging, juveniles tend to remain within 300 meters of the nest, after which they gradually venture farther away (Kennedy et al. 1994). Dispersal is abrupt, with males dispersing approximately 7 days earlier than females (Kenward et al. 1993).

Nonbreeding Period

This period begins when juveniles are no longer being fed by adults. The end of this period coincides with the beginning of courtship, which typically begins in late March (Leslie in prep).

Movements

Movements of birds beyond home range boundaries have been classified in several ways. Typically, 3 types of movement are distinguished: migration (previously discussed), natal dispersal, and breeding dispersal. Natal dispersal is defined as movements between a bird's place of birth and the area where it subsequently breeds (Greenwood 1980). Breeding dispersal is defined as movements between years among breeding sites (Greenwood 1980). Dispersal (both breeding and natal) is an important component of population dynamics. The impact of dispersal on avian population dynamics has only recently been fully appreciated, and is the least studied component of avian population dynamics (Lebreton and Clobert 1991, Newton 1991).

Natal Dispersal

Successful dispersal is essential to the genetic and demographic viability of populations. Habitats used during dispersal, dispersal direction, and dispersal distances have been little studied in the goshawk. The information available comes from recapture of marked birds, band returns, radio-telemetry and satellite telemetry (Beier 1997, Leslie in prep).

Two records of band recoveries are available from the southwestern United States. Both occurred in the year of banding at distances of 160 and 176 km (100 and 109 mi) (P. Kennedy, unpublished data, Reynolds et al. 1994). Distances from natal nest sites of 16 juveniles radio-tagged in New Mexico ranged from 5.5 to 176 km (3.4 - 109 mi) (P. Kennedy, unpublished data).

Six instances of natal dispersal were reported on the Kaibab Plateau; three males first nested from 10.3 km (5.4 mi) to 23.0 km (14.3 mi) from their natal site, and three females first nested from 15.0 km (9.3 mi) to 32.0 km (19.9 mi) from their natal site (Reynolds and Joy 1998). These distances are most likely biased low by constraints imposed by the size of the study area; some natal dispersal off the study area may have occurred but were not detected.

Breeding Dispersal

Movements between years by adult goshawks from one breeding-site to another include movement between alternate nests within a territory, and movements of individuals from one territory to another. While movements of the first type are not important demographically, they confound detection and interpretation of the latter. The two types of movement can be distinguished only by the study of marked individuals. Breeding dispersal could result from death of a mate, or may represent an attempt to acquire a better territory or mate. In northern Arizona, three birds that moved from one territory to another between years all produced more young the year following the move (Reynolds et al. 1994).

Movement within territories between years may occur between alternate nests within the same forest stand or in different stands (Reynolds and Wight 1978, Woodbridge and Detrich 1994), with some nest areas used for decades (Reynolds and Wight 1978, Gullion 1981, Reynolds et al. 1992). In Oregon, Reynolds and Wight (1978) reported that alternate nests were usually 60 to 90 meters (200 - 300 ft) apart, but some were up to 400 meters apart. Reynolds et al. (1994) reported a mean distance between alternate nests in northern Arizona of 266 m (1,320 ft). The mean distance for 4 cases where both members of the pair were known was 485 m (1,600 ft). The maximum distances moved between alternate nests by a pair of known birds was 1,316 m (4,316 ft) (Reynolds et al., unpublished data) in northern Arizona and 966 m (3,188 ft) in north - central New Mexico (P. Kennedy, unpublished data). Woodbridge and Detrich (1994) reported a mean distance between alternate nests in northern California of 273 m (893 ft). They considered this estimate to be conservative because long distance movements were more difficult to detect under their sampling protocol. However, because not all birds were marked, movements between territories could have been confounded with movements between alternate nests.

In about 320 opportunities (years in which hawks were recaptured/resighted on territories subsequent to 1st year of banding), seven instances of breeding dispersal (2 males, 5 females) were recorded in Northern Arizona (Reynolds and Joy 1998). Mean male breeding dispersal distance was 2.8 km (1.7 mi) (SD= 1.06 km [0.66 mi], range = 2.0-3.5 km [1.2-2.2 mi]) and 5.2 km (3.2 mi) (SD = 2.66 km [1.65 mi], range = 2.4-8.6 km [1.5-5.3 mi]) for females. These distances were equivalent to moving to an adjacent territory for males and about two territories for females (Reynolds and Joy 1998). The consistent shortness of these breeding dispersal distances reduces the likelihood that biases imposed by size of study area (about 700 mi^2) are as great as in natal dispersal distances (see above) (Reynolds and Joy 1998). Detrich and Woodbridge (1994) reported higher rates of breeding dispersal in northern California. Four of 22 females (18.2 percent) and 3 of 13 males (23.1 percent) were found breeding in more than 1 territory over 9 years. Dispersal distances averaged 9.8 km (6 mi) (range = 5.5 to 12.9 km; 3.4 -

8.1 mi) for females and 6.5 km (4 mi)(range = 4.2 to 10.3 km; 2.6 - 6.4 mi) for males. Recent discovery of a female breeding 60 miles from her natal area demonstrates a larger maximum dispersal distance (P. Detrich pers. comm). As with natal dispersal distances based on recaptures, maximum breeding dispersal distances are constrained by study area size and thus may not be representative of the true distribution of dispersal distances.

Territory and Mate Fidelity

Fidelity to mates is difficult to assess in goshawks because the fate of previous mates is often unknown. Thus, mate fidelity can be confounded with mate replacement due to mortality. For example, Detrich and Woodbridge (1994) reported that breeding adults in northern California retained the same mate on average 72 percent of the time. However, the 28 percent of cases in which adults were subsequently found to be paired with new mates could have been due to death of the previous mate. Detrich (pers. comm.) noted that in a few cases, new pairing was not due to death, citing a recent example of a female who returned to a previous mate after a two year absence during which she bred with another male at least one year. Reynolds et al. (1994) reported a replacement rate of 23 percent between 1991 and 1992 in northern Arizona (7 replacements in 30 opportunities to detect it where opportunity = a bird of the same sex captured or recaptured on the same territory). However, in only one case out of 70 recaptures from 1992 to 1994 could divorce be established (i.e. previous mate known to be alive, Reynolds et al., unpublished data). However, Detrich and Woodbridge (1994) reported that in 3 territories observed for 5 years, 2 males and 2 females bred in three different combinations. Patterns of mate fidelity may be dissimilar in the 2 populations (Leslie in prep).

Territory fidelity is confounded in a manner similar to that of mate fidelity. In New Mexico, 5 of 7 adults banded on their nesting areas in 1990 were re-sighted in the same nesting area in 1992 (P. Kennedy, unpublished data). In northern Arizona, 6 of 10 territories where both sexes were captured in two consecutive years remained on the same territory with the same mate. Of the four remaining territories, two had both members replaced and two had one member of the pair replaced (Reynolds et al. 1994). None of the replaced individuals have been subsequently resighted. In 6 years of capture-recapture study of marked goshawks during 478 territory-years in northern Arizona, Reynolds and Joy (1998), found that males annually remained faithful to their territories 91.3 percent of the time and females 77.8 percent of the time. Conversely, adult males and females in northern California occupied the same territory in consecutive years 76.5 and 71.4 percent of the time. Males were significantly more likely than females to remain on the same territory in consecutive years (Detrich and Woodbridge 1994).

Spatial Structure

Spatial structure refers to the pattern in which birds distribute themselves over the landscape in relation to food, nest sites, habitat, other resources, and each other. Spatial patterns are scale dependent. The emphasis here is on the local distribution of nesting pairs during the breeding season (Leslie in prep).

Dispersion

A consistent characteristic of goshawk populations from both North America and Europe is the regular spacing of breeding pairs (McGowan 1975, Schuster 1976, Reynolds and Wight 1978, Widen 1985, Buhler and Oggier 1987, Kennedy 1988, Reynolds et al. 1994, Reynolds and Joy 1998). Widen (1985) and Buhler and Oggier (1987) quantified the dispersion of goshawk territories using nearest-neighbor distances in Sweden and eleven study areas in Switzerland, respectively. The mean nearest neighbot distance among 103 territory centers on a 700 mi^2 study area in northern Arizona was 3.9 kn (2.5 mi) (disallowing duplicate measurements) (Reynolds and Joy 1998). In all cases, the distribution of territories was significantly regular. Mean nearest neighbor distances in Europe range from 2.5 to 6.3 km (1.5 - 4 mi), while those from North America range from 3.0 to 5.6 km(1.8 - 3.5 mi). While nests as close as 0.8 km (0.5 mi) have been reported (Schuster 1976), such close spacing rarely lasts more than 1 to 2 years (Reynolds and Wight 1978).

A regular distribution of nesting pairs could result from the distribution of suitable habitat and/or territorial behavior. The size of goshawk home ranges makes defense of the entire area unlikely. The regular spacing of pairs documented in numerous studies throughout the range of the species makes the distribution of suitable habitat an implausible explanation also. It also seems implausible that the distribution of habitat is regular enough to result in a regular spacing of pairs over the many areas where it has been documented. Thus, mutual avoidance in some form seems likely (Leslie in prep). Newton (1979) has argued that spacing behavior is the mechanism by which raptor populations adjust density to resource abundance.

The mechanism by which goshawks distribute themselves over the landscape is important for management in that density dependence may be a factor regulating goshawk populations (Maguire 1992). Spacing behavior may limit the number of pairs an area can support below that dictated by availability of food or nest sites (Fretwell and Lucas 1972, Bernstein et al. 1991, Smith et al. 1991). If spacing behavior limits the number of breeding pairs in a landscape, provision of additional nest habitat would have no effect on breeding rates (Leslie in prep).

At larger spatial scales encompassing several mountain ranges or forest patches, the distribution of nesting areas becomes clumped. Consideration of the size and distribution of these habitat patches - and the degree to which exchange of individuals between habitat patches is possible - are important considerations in developing conservation strategies (Leslie in prep).

Density

Two primary methods have been used to estimate goshawk densities: (1) estimates based on a census of breeding pairs, and (2) estimation of density from the distribution of nearest neighbor distances. Density calculated from a census can be either crude density (birds per unit area), or ecological density (birds per unit of suitable habitat). Because searches for goshawk nests are often conducted only in "suitable" habitat, many studies actually report ecological density. Each technique relies on a number of assumptions, the most fundamental of which is that counts are complete and accurate. This assumption is problematic in that non-breeding birds often go

undetected. In some cases, the number of traditional nest areas is used in density calculations, while in others only active nests are included. In most cases, only breeding birds in regularly occupied territories have been accounted for in density estimates. In addition, density estimates are sensitive to the size of the area searched due to edge effects, particularly for species such as goshawks that occur at relatively low densities. However it is measured, goshawks occur at low densities relative to many avian species (Leslie in prep).

Density estimates from North American populations range from less than 1 up to 11 pairs per 100 km^2 (Table 2.9). Reynolds and Joy (1998) estimated the total number of nesting pairs of goshawks on the Kaibab Plateau, northern Arizona, by dividing their study area (173,168 km) by an exclusive "area" (circular area with radius equal to half the mean nearest-neighbor distance among territory centers) of 1,182 ha (2,920 ac) per pair of goshawks. The estimated total of 146 pairs maded the 107 goshawk territories already identified by them in 1996 equal to about 73 percent of the estimated population, and resulted in an overall density of 11.9 pairs per 100 km^2 (Reynolds and Joy 1998). Conversely, the low of 0.3 pairs per 100 km^2 from Alaska in 1972 (McGowan 1975) may be indicative of a general breeding failure in the year of the estimate, with non-breeding pairs going undetected, or insufficient survey effort. However, density estimates from Alaska for all 4 years are lower than other estimates from North America and exhibit considerable annual variation.

Table 2.9. Northern goshawk nsting density in North America (Squires and Reynolds 1997).

Location	Year	Density pairs/100km^2	Forest Type	Study
Alaska	1971-1974	0.3-2.4[1]	Aspen/spruce/birch	McGowan 1975
Arizona	1991-97	11.9 [2]	Ponderosa pine/mixed conifer	Reynolds 1998
California	1984-1992	10.7	Sierran montane, upper montane	Woodbridge and Detrich 994
Colorado	1974	5.8	Lodgepole pine/aspen	Shuster 1976
New Mexico	1984-1988	6.4	Ponderosa pine	Kennedy 1989
Oregon	1992-1993	6-7	Mixed conifer	DeStefano et al. 1994
Oregon	1974	3.6	Ponderosa pine	Reynolds and Wight 1978
Pennsylvania	1988-1991	1.17[3]	Northern hardwood/Appalachian oak	Kimmel and Yahner 1991
Yukon Territory	1990	5	Spruce/aspen	Doyle and Smith 1994

[1] Variation across years.
[2] Estimated density based on nearly complete counts over approximately 73 percent of a 1,732 km^2 (669 mi^2) study area.
[3] Variation across study years.

Methodological problems frustrate attempts to assess patterns in density. However, Buhler and Oggier (1987) reported densities from 11 study areas in Switzerland and found them to be significantly correlated with elevation and the proportion of forest in the study area. They concluded that elevation itself was probably correlated with prey abundance.

Demographics

Breeding System

Like most raptors, goshawks are at least serially monogamous (Newton 1979, Reynold 1994). Studies of marked hawks in northern Arizona indicate that most birds remain with the same mate for several years, although at least one instance of "divorce" (a bird mated to a bird other than its mate of the previous year, where the previous mate was known to be alive and breeding) has been documented (Reynolds et al. 1994). Conversely, several cases of "divorce" have been noted in northern California (Detrich and Woodbridge 1994).

Age Structure

Goshawks can be placed into 3 classes during the breeding season based on plumage characteristics (Bond and Stabler 1941, Mueller and Berger 1968, Henny et al. 1985, Reynolds et al. 1994). Recaptures of known age birds supports the hypothesis that these plumage classes correspond to age-classes (Reynolds, unpublished data). The term Subadult refers to birds

between 1 and 2 years of age with primarily juvenile plumage. Young adult refers to birds between 2 and 3 years of age with primarily adult plumage but retaining some juvenile feathers either on the chest, back or scapular region. The term Adult refers to birds greater than 3 years of age with full adult plumage.

Subadult female goshawks have been observed breeding, but no observations of subadult males breeding have been reported. Examination of the testes of males of the European subspecies indicate that subadult males are physiologically incapable of breeding (Hoglund 1964). Frequency with which subadult females breed varies geographically and temporally. In Oregon, Reynolds and Wight (1978) reported 70 observations of breeding females, none of which were subadults, while Henny et al. (1985) reported 2 of 46 (4.3 percent) breeding females in this age-class. In Nevada, 5 of 14 (36 percent) breeding females were subadult in 1991, no subadults were observed to breed in 1992, and 1 of 25 (4 percent) breeding females were subadult in 1993 (Younk 1994). In contrast, no subadults have been observed to breed in 87 and 114 observations of breeding males and females, respectively, in 1991-1994 in a northern Arizona population (Leslie and Reynolds, unpublished data). In addition, only 1 case of a breeding subadult has been observed in banding studies in northern California or New Mexico, both of which have been ongoing for over 11 years (P. Kennedy and B. Woodbridge, unpublished data). In Europe, subadult females lay eggs approximately 10 to 30 days later than full adults in a given year (Huhtala and Sulkava 1981). McGowan (1975) hypothesized that subadults are able to breed only in years of high prey availability based on his observation of 4 subadults breeding in 1 year and none in subsequent years. Breeding subadults in his study used only "non-traditional" nesting territories.

The frequency with which young adults breed is also geographically and temporally variable. Fall and winter trapping in interior Alaska resulted in estimates of 69, 50, 40, and 10 percent of birds trapped during 1971-74, respectively, being in the young adult age-class (McGowan 1975). In Arizona, 6.8 percent of breeding males and 12.2 percent of breeding females trapped during 1991 and 1992 were young adults (Reynolds et al. 1994), while in Nevada, 11 of 22 (50 percent) breeding females observed in 1992 and 1 of 25 females (4 percent) in 1993 were young adults (Younk 1994).

Reproduction

Because fecundity of goshawks is difficult to measure, various indices of reproductive success are utilized depending on the type of study and intensity of data collection. Resolution of a particular measure of reproductive success is proportional to the intensity of data collection, and ranges from the mean number of young fledged per successful nest (least resolution) through fecundity (most resolution)(Leslie in prep).

The use of multiple measures of reproductive success has led to the adoption of various terminologies. An occupied territory is defined as a territory exhibiting evidence of fidelity or regular use by goshawk, and thus represents a potentially breeding bird. Occupancy rate has been generally defined as the proportion of known territories that are occupied (Leslie in prep).

An active territory or nest is defined as a territory or nest in which eggs are laid. A successful territory or nest is one in which at least 1 young is fledged. Nest success is the proportion of active nests that fledge at least one young. This term is occasionally used to refer to the proportion of occupied territories that fledge at least one young. Productivity is defined as the mean number of young fledged per successful nest, but has also been used to represent the mean number of young produced per nest attempt (i.e. per active nest)(Leslie in prep).

Bias in estimates of reproductive parameters arise primarily due to the difficulty associated with locating goshawks. Reproductive success is generally overestimated due to the greater probability of detecting breeding versus non-breeding pairs and successful versus unsuccessful nests. Territorial, non-breeding pairs commonly go undetected, as do pairs in which the nest attempt fails early in the nesting cycle. Difficulty of access to high-elevation sites early in the breeding season may preclude identification of early season nest failures (Detrich and Woodbridge 1994). Because goshawks may use alternate nests up to 1.3 km apart, active nests often go undetected due to insufficient effort in determining occupancy. Thus, the number of active nests under observation during a study decreases in the absence of rigorous searches for alternate nests (Crocker-Bedford and Chaney 1988).

Proportion of pairs breeding

Little information exists concerning the proportion of pairs that attempt to breed annually. Widen (1985) reported 8 of 12 (67 percent) adults radio-tagged during winter in Sweden were subsequently found to be breeding. In a six year study, including 478 territory-years, of goshawks in northern Arizona, Reynolds and Joy (1998) found that the proportion of pairs annually laying eggs declined from highs in 1991-93 (77- 87%) to lows in 1994-96 (22-49 %). Reynolds and Joy (1998) believe that annual variations in proportions of pairs laying eggs was related to annual fluctation in prey populations; in poor prey years more females were probably unable to secure sufficient food to form a clutch of eggs.

Clutch size

Mean clutch size in interior Alaska was 3.2, with estimates from individual years ranging from 3.0 to 3.8 (1971 - 1973). However, no 5 egg clutches were observed (McGowan 1975). Estimates from Utah and Oregon were 3.75 and 3.2, respectively (Reynolds and Wight 1978, Lee 1981).

The only estimates of hatching success are from 5 clutches in Oregon where 81.2 percent of eggs laid hatched (Reynolds and Wight 1978).

Nest Success

All published values of nest success are based on the naive estimator of the ratio of successful to total number of active nests rather than the unbiased estimator proposed by Mayfield (1961, 1975). The bias of the naive estimator has been demonstrated repeatedly and stems from the greater probability of detecting successful nests relative to failed nests (Miller and Johnson 1978, Johnson 1979, Hensler and Nichols 1981, Steenhof and Kochert 1982). This is particularly

relevant for goshawks due to the difficulty associated with locating their nests. Thus, timing and duration of surveys and variation in effort all effect the magnitude of bias in the naive estimator.

Table 2.10 shows some of the published number of young per successful clutch for northern goshawk populations in North America as reported in Squires and Reynolds (1997). Estimates of nest success range as low as 44 percent and as high as 94 percent.

Causes of nest failure include human disturbance (e.g. shooting of adults, tree harvest activities) (Hoglund 1964, Oakleaf 1975, Hennessy 1978, Buhler et al. 1987), great horned owl and goshawk predation (Hennessy 1978, Ward and Kennedy 1996), disease (McGowan 1975, Ward and Kennedy 1996), mammalian predation (McGowan 1975, Hennessy 1978, Doyle and Smith 1994), and inclement weather (Hennessy 1978). Food limitation can result in higher predation rates on nestlings because females must allocate more time to foraging and less time to defense of young (Ward and Kennedy 1996).

Table 2.10. Reproductive performance of northern goshawk populations in North America. Data shown as mean ± SD (n). Asterisk indicated SE, instead of SD. Taken from Squires and Reynolds 1997.

Location	Year	Fledglings per Active Nest[1]	Fledglings per successful nest[2]	Nest Success[4] (%)	Study
Alaska	1971-1973	2.0 (33)	2.7 (33)		McGowan 1975
Arizona	1991	2.0 ± 0.77 (36)	2.2 ± 0.61 (34)	94 [3]	Reynolds et al. 1994
Arizona	1992	1.8 ± 1.05 (59)	2.2 ± 0.72 (49)	83 [3]	Reynolds et al. 1994
Arizona	1990-1992	1.9 ± 1.0 (6-8)	2.2 ± 0.7		Boal and Mannan 1994
California	1981-1983	1.7 (127)		91	Bloom et al. 1986
California	1987-1990	1.39 (23)[3]	1.78 (18)[3]	82.5 (30)[3]	Austin 1993
New Mexico	1984-1988	0.94 (16)	2.14 (16)	44	Kennedy 1989
New York/ New Jersey	1977-1990	1.4 (36)		80	Speiser 1992
Oregon	1992	1.2 (12)	1.4 (10)	83	Bull and Hohmann 1994
Oregon	1969-1974	1.7 (48)		90.4	Reynolds and Wight 1978
Yukon	1989		2.0 ± 0.35* (3)		Doyle and Smith 1994
Yukon	1990		3.9 ± 0.37* (8)		Doyle and Smith 1994
Yukon	1991		2.3 ± 0.25* (7)		Doyle and Smith 1994
Yukon	1992		0 (1)		Doyle and Smith 1994

[1] Nests in which eggs were laid
[2] Nests in which young fledged
[3] Calculated from presented data
[4] Nest success calculated based on naive estimator of ratio of successfuel to total number active nests. Note potential bias because of greater probability of detecting successful nests relative to failed nests.

Productivity

Productivity in North America ranges from 1.4 to 3.9 young per successful nest. Comparable figures from Europe are 1.93 to 3.08 (Table 2.11). Annual variation in productivity was moderate in Switzerland over an 8 year period (Buhler et al. 1987), while variation in southern Finland appeared to be more stable over a 4 year period (Hakila 1968). The highest estimates of productivity in North America are from Yukon, Canada and interior Alaska (McGowan 1975, Doyle and Smith 1994) which may indicate that birds from higher latitudes are capable of laying larger clutches and raising larger broods in years of high prey availability. An analysis of components of variance in productivity (i.e. separation of sampling variance from parameter variance across years) using formula in Burhnam et al. (1987) has been conducted for a population in northern Arizona (Leslie, unpublished data). Parameter variance over a 3 year period was significantly different from 0, indicating that productivity is also an important source of variation in goshawk reproductive success.

Table 2.11. Mean young per active, occupied and per successful nest (± SD) for various goshawk populations in North America and Europe (From Leslie in prep).

Years	Mean Young per Occupied Nest	Mean Young per Active Nest	No. Active Nests	Mean Young per Successful Nest	No. Successful Nests	Location	Source
North American Subspecies							
1972-76				1.77 ± 0.44	13	South Dakota	Bartell 1974
1981-83		1.71	127			California	Bloom et al., 1986
1992		1.20	12	1.40	10	Oregon	Bull and Hohmann 1994
1989	1.3 ± 0.88			2.0 ± 0.35		Yukon, Canada	Doyle and Smith 1994
1990	2.8 ± 0.57			3.9 ± 0.37		Yukon, Canada	Doyle and Smith 1994
1991	1.3 ± 0.47			2.3 ± 0.25		Yukon, Canada	Doyle and Smith 1994
1992	0.0			0.0		Yukon, Canada	Doyle and Smith 1994
1979-85		3.00				Utah	Fischer et al., in Reynolds 1989
1992	1.83			2.36	14	New Mexico	Kennedy pers. comm., 1993
1984-86 & 1988		0.94	16	2.14	?	New Mexico	Kennedy pers. comm., 1993
1993	0.847 ± 1.06	1.00 ±1.08	20	1.82 ± 0.75	11	New Mexico	Kennedy pers. comm., 1993
1979-80		3.75 ± 0.50	4	3.75 ± 0.50	4	Utah	Lee 1981
1971		2.5		3.0		Alaska	McGowan 1975
1972		1.8		2.3		Alaska	McGowan 1975
1973		1.8		2.9		Alaska	McGowan 1975
1992		1.62 ± 1.19	13	2.10 ± 0.88	10	California	Morrison and Keane 1994
1993		0.93 ± 0.92	14	1.63 ± 0.52	8	California	Morrison and Keane 1994
total		1.26 ± 1.10	27	1.89 ± 0.76	18	California	Morrison and Keane 1994
1974				1.50		Nevada	Oakleaf 1975
1975				2.50		Nevada	Oakleaf 1975

Years	Mean Young per Occupied Nest	Mean Young per Active Nest	No. Active Nests	Mean Young per Successful Nest	No. Successful Nests	Location	Source
1969		1.50				Oregon	Reynolds 1975
1970		1.80				Oregon	Reynolds 1975
1971		1.60				Oregon	Reynolds 1975
1972		1.90				Oregon	Reynolds 1975
1973		1.50				Oregon	Reynolds 1975
1974		2.00				Oregon	Reynolds 1975
total		1.70 ± 0.76	48			Oregon	Reynolds 1975
1991	1.97 ± 0.83	2.03 ± 0.77	36	2.15 ± 0.61	34	Arizona	Reynolds et al. 1993
1992	1.74 ± 1.08	1.80 ± 1.05	59	2.16 ± 0.72	49	Arizona	Reynolds et al. 1993
1993	1.54 ± 1.04	1.69 ± 0.97	62	1.94 ± 0.76	54	Arizona	Reynolds et al. 1993
total	1.71 ± 1.02	1.81 ± 0.96	157	2.07 ± 0.71	137	Arizona	Reynolds et al. 1993
1984-92		1.93	84			California	Woodbridge & Detrich 1994
1991		1.29 ± 1.38	14	2.25 ± 1.04	14	Nevada	Younk 1994
1992		2.77 ± 0.92	22	2.90 ± 0.70	21	Nevada	Younk 1994
1993		2.00 ± 1.19	25	2.38 ± 0.86	21	Nevada	Younk 1994
total		2.11 ± 1.27	61	2.58 ± 0.86	50	Nevada	Younk 1994

Years	Mean Young per Occupied Nest	Mean Young per Active Nest	No. Active Nests	Mean Young per Successful Nest	No. Successful Nests	Location	Source
European Subspecies							
1978				2.83	6	Switzerland	Buhler et al. , 1987
1979				2.17	6	Switzerland	Buhler et al. , 1987
1980				2.25	8	Switzerland	Buhler et al. , 1987
1981				3.08	12	Switzerland	Buhler et al. , 1987
1982				2.57	7	Switzerland	Buhler et al. , 1987
1983				1.93	14	Switzerland	Buhler et al. , 1987
1984				2.70	20	Switzerland	Buhler et al. , 1987
total				2.52	73	Switzerland	Buhler et al. , 1987
1965		2.30 ± 1.20	6	2.80 ± 0.45	5	Finland	Hakila 1968
1966		2.75 ± 0.96	4	2.75 ± 0.96	4	Finland	Hakila 1968
1967		1.57 ± 1.81	7	2.75 ± 1.50	4	Finland	Hakila 1968
1968		2.29 ± 1.25	7	2.67 ± 0.82	6	Finland	Hakila 1968
total		2.17 ± 1.37	24	2.74 ± 0.87	19	Finland	Hakila 1968
1969	2.80					Southern Finland	Wikman & Linden 1981
1970	1.40					Southern Finland	Wikman & Linden 1981
1971	0.70					Southern Finland	Wikman & Linden 1981
1972	2.00					Southern Finland	Wikman & Linden 1981
1973	2.20					Southern Finland	Wikman & Linden 1981
1974	2.40					Southern Finland	Wikman & Linden 1981
1975	1.90					Southern Finland	Wikman & Linden 1981
1976	1.60					Southern Finland	Wikman & Linden 1981
1977	0.90					Southern Finland	Wikman & Linden 1981
1978	1.10					Southern Finland	Wikman & Linden 1981
1979	1.80					Southern Finland	Wikman & Linden 1981
1980	2.50					Southern Finland	Wikman & Linden 1981
1981	2.20					Southern Finland	Wikman & Linden 1981

Nestling mortality rates have been estimated in two studies in North America. Kennedy (1988, 1993) reported nestling mortality rates

in New Mexico of 25 and 15.6 percent for 1989 and 1993, respectively. Reynolds and Wight (1978) reported an average nestling mortality rate of 28 percent for birds in Oregon, and Hoglund (1964) reported 20 percent mortality from egg laying to fledging. He attributed most mortality to egg loss rather than nestling mortality.

A sex ratio at fledging of 1:1 has been reported by Kenward (1993b) for the European subspecies and by Reynolds et al. (1994) for northern Arizona. However, Kenward (1993b) reported that in years of marked brood reduction, the sex ratio was biased toward females. Ingraldi (unpublished data) has documented a skewed sex ratio in favor of males in east-central Arizona.

Correlates of reproduction

Productivity has been correlated with both extrinsic and intrinsic factors. Extrinsic factors include human disturbance (Hennessy 1978), timber harvest (Crocker-Bedford 1990), and food availability (McGowan 1975, Huhtala and Sulkava 1981, Linden and Wikman 1981, Sulkava 1981). Sample size in Hennessy (1978) were too small to draw meaningful conclusions about the effects of human disturbance on reproduction. Crocker-Bedford (1990) reported that timber harvest caused over a 90 percent reduction in reproduction of goshawks in northern Arizona, but his conclusions are contradicted by more recent data from the same population (Reynolds et al. 1994, Reynolds and Joy 1998). For the same study area, Reynolds and Joy (1998) found productivity to be relatively constant among years, ranging from 1.2 to 2.0 young per nest per year.

In North America, the number of breeding pairs and productivity have been related to the number of snowshoe hares for populations in northern latitudes (McGowan 1975, Doyle and Smith 1994). Wikman and Linden (1981) and Linden and Wikman (1983) reported declines in goshawk populations and reproductive success coinciding with declines in grouse abundance. However, when prey populations increased, goshawk numbers remained low. Declines in reproductive success were attributed primarily to non-breeding or early nest failure, while brood sizes remained fairly constant.

Intrinsic factors include the age and condition of breeding birds. Condition was estimated by the amount of fat present on the keel for birds in northern Arizona (Reynolds et al. 1994). Although differences in productivity were not significant, the trend was in the direction expected. Age, however, was significantly related to productivity. Reynolds et al. (1994) showed that pairs in which at least one member was a young adult produced significantly fewer young than pairs from which both members were known to be full adults. The difference was due primarily to the higher failure rate of pairs composed of young adults.

Survival

Adult survival estimates are available from two studies in North America and two in Europe. Reynold and Joy (1988) estimated adult survival for goshawks in northern Arizona using capture-recapture methodology and model selection procedures outlined in Lebreton et al. (1992). Estimates of apparent survival were 0.688 (SE= 0.0618) and 0.866 (SE= 0.0514) for

males and females, respectively.

DeStefano et al. (1994) calculated adult survival rates for goshawks in northern California using the same methodology, which yielded point estimates of apparent survival of 0.61 (SE= 0.05) for males and 0.69 (SE= 0.09) for females. However, the authors point out that these estimates are imprecise due to the small sample of marked birds and low resighting values. They further point out that the estimates produced were likely biased low because some marked birds emigrated off the study area and only birds that were associated with successful nests were resighted.

Buhler et al. (1987), using molted feathers to identify individuals, estimated that 80 percent of breeding areas in Switzerland regularly occupied by goshawks were reoccupied by the same female the following year, while 20 percent were either deserted or occupied by a new female. They considered this rate high for the European subspecies. Haukioja and Haukioja (1970) estimated survival rates of Fennoskandian birds based on band returns using the approach of Haldane (1955). Their point estimates were 0.37, 0.67, and 0.89 for juvenile, subadult, and full adult birds, respectively (young adult and full adult birds were not distinguished). The estimates are based on the same records used by Hoglund (1964). They were considered maximum values, and no estimates of precision were provided. When comparing these rates with data from North America it should be noted that approximately 75 percent of the returns on which the estimates are based were birds shot by humans.

Marcstrom and Kenward (1981) reported that juvenile weight was significantly related to the probability of being recaptured after 60 days for juvenile females, but not males. They thus concluded that fall/winter weight is positively related to survival for juvenile females.

The large differences between sexes in point estimates of adult survival rate would be evolutionarily unstable without some method of compensation. One would expect adult males to become limiting given their lower survival rate, resulting in a selective advantage for those birds producing primarily male offspring. Given the 1:1 sex ratio at fledging observed in most studies, this scenario seems unlikely. A higher survival rate for males than females during the first few years of life could result in a more even sex ratio among adults, but also seems unlikely. Mark-recapture methods cannot distinguish between mortality and emigration. Point estimates derived from these methods are of apparent survival (i.e. 1-mortality-emigration). Thus, it is possible that differences in adult survival between sexes actually represent differences in breeding dispersal rates.

Longevity

One record of a captive bird living 19 years was reported by Bailey and Niedrach (1965). Age records for wild birds include a 6-year-old bird from Alaska (McGowan 1975), a 9-year-old bird from New Mexico (P. Kennedy, pers. comm.), and 5 and 7 year-old-birds from northern California (Detrich and Woodbridge 1994).

Rates of population change

Insufficient information exists to estimate rates of population change (lambda) for any goshawk population in North America (DeStefano et al. 1994, Kennedy 1997, Reynolds and Joy 1998). However, a general assessment might prove useful in highlighting research needs.

Chapter 3 - Distribution and Status

Goshawk Habitat Distribution and Status in the Review Area

Introduction

The area of this goshawk Status Review includes 920 million acres, of which 222 million acres (24%) are covered by forest vegetation which could be considered potential goshawk habitat (Figure 3.1). This map serves as a consistent baseline for the Status Review habitat discussions. This forested habitat occurs in a variety of landownerships (Table 1.1), and is managed for an array of management objectives. The forested habitat in the Status Review area includes a diversity of forest types and potential goshawk habitat.

For the purposes of this Status Review, "potential goshawk habitat" is the acreage which is reported as growing species of trees which have been documented as goshawk nest habitat. This does not mean the acreage is currently covered by trees of sufficient size, structure, etc. to be goshawk nest habitat at this time. It only represents the acreage potentially capable of growing the trees species which may support goshawk nesting. Therefore, this acreage will always be an overestimate of the acreage which may be "suitable" goshawk habitat, because a portion will have been harvested for timber and another portion will be ecologically incapable of supporting sufficient tree size and canopy closure for nesting. This data serves as a basis for general percentages of various forest cover types, rather than estimates of acres of goshawk habitat.

The habitat discussions in this Status Review emphasize goshawk nesting habitat because this habitat is more completely described in the literature and more readily analyzed in vegetation change. Further, the role of nesting habitat to successful reproduction of the goshawk population is a key factor in any overall conclusions about the species status. Other goshawk habitat parameters, such as foraging habitat and winter habitat, are less clearly defined and therefore more difficult to analyze and discuss. These other habitat parameters are also documented in more diverse habitat conditions and considered by some to not be a limiting factor for goshawks.

Habitat Management

The broad ecological range of forest conditions, from Pacific Northwest coastal forests to Pinyon-juniper woodlands of Arizona, makes this a very diverse area. Correspondingly, there is a diversity of land management issues which have the potential to influence the condition of forested habitat. Throughout the Review Area timber harvest has, and will continue, to result in effects to goshawk habitat. In areas where regeneration harvest practices occur, the effect is removal of nesting habitat resulting in loss of habitat for several decades. In areas of selective tree removal, the result is a more subtle effect on stand conditions, with varying effect on goshawk use of the area (Appendix A). In drier forest types, the emerging issues of 'forest health', the effects of decades of wildfire suppression, and urban-forest interface are actively being discussed (Everett and Baumgartner, 1995) and have important effects on goshawk habitat.

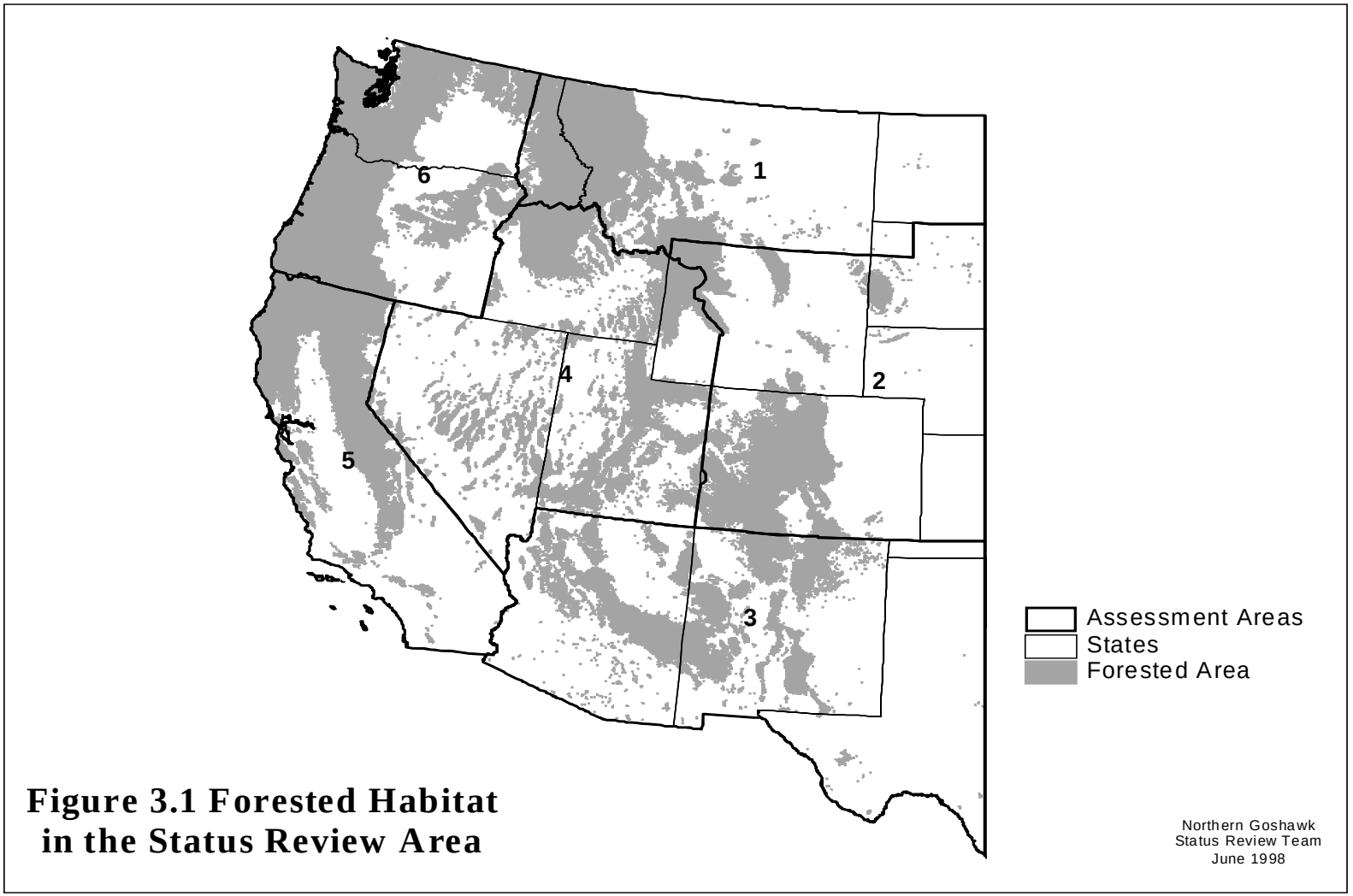


Figure 3.1 Forested Habitat in the Status Review Area

The federal land management offices in the Status Review Area are 84 National Forests, 137 BLM offices, and 78 National Park offices. Among the federal lands with potential goshawk habitat, the National Parks and Monuments are expected to be managed in a manner that will continue to provide goshawk habitat because of their legal charter and management emphasis (acknowledging that some loss of habitat will occur from natural events such as fire and windthrow). Forest Service and BLM lands are expected to managed for multiple-use purposes, including timber harvest which would remove goshawk habitat.

Nonfederal lands in the Status Review area are managed for a variety of objectives. For the purposes of this analysis, it is assumed that these lands, including industrial forestlands, Indian lands and state forestlands, would continue to be managed as they have in the past decade.

Approach to Habitat Information

The Status Review Team pursued several sources of information about goshawk habitat status and trends. First, we requested information directly from land managers. Second, we reviewed the scientific literature and habitat analyses. And third, we gathered timber harvest data from the Forest Service.

The Team believes that general population biology theories indicate there should be a relationship between change in forest habitat and a change in goshawk population. However, there is no documentation in research which has demonstrated the nature of this presumed relationship across the entire Status Review Area. Some studies have reported local areas where a correlation between habitat abundance and goshawk populations was found (Desimone 1997; Crocker-Bedford 1990). These localized studies lend support to the Team's general assumption, despite the lack of documentation for the Review Area as a whole.

This lack of documentation of a relationship between habitat and goshawk populations for the Review Area, when combined with the species known use of a variety of forest types and dependence on prey availability (which may be independent of forest cover altogether), reinforces the caution needed in drawing conclusions about changes in forest habitat and goshawk population change. While caution is appropriate, it should not be concluded that forest habitat change is irrelevant to the goshawk population situation.

Habitat Information Requested in the Status Review

To gain an understanding of the distribution and trend in goshawk habitat conditions across this area, the Status Review requested information from land and resource managers. Ultimately, we were unable to conduct objective, numeric analyses with this data because of variation in the methods which were used to generate the information.

Additionally, these data illustrate the need for caution in using generalized forest information from maps to assess the status of goshawks. As described in earlier sections: 1) the inconsistent response to the request created geographic gaps in data to analyze; 2) the inconsistent methods used to generate habitat data makes comparisons difficult; and 3) the habitat maps do not

illustrate the complexities of on-the-ground management and situations which affect the ability of forests to support goshawks.

Literature and Large-scale Assessments

The results of our review of the literature is presented in Chapter 2 of this document.

Large-scale science and planning documents serve as additional sources of information on goshawk habitat condition and trends. The geographic extent of some of these documents are illustrated in Figure 3.2. Because these documents address areas which overlap from one Assessment Area to another, it is appropriate to also discuss them in this general overview and introduction of goshawk habitat. Additional discussion of these documents occurs in the following Assessment Area discussion, as well.

Northwest Forest Plan

This plan was based upon science work reported in the Forest Ecosystem Management Assessment Team report. It covers an area of 57 million acres (6% of the total Status Review area), but prescribes management for only the Forest Service and BLM lands within that area (3% of the total Status Review area and 12% of the forested land in the Review area). As illustrated in Figure 3.2, the Plan overlaps between Assessment Areas 5 and 6 of this Status Review. The Northwest Forest Plan incorporates habitat information from the other federal lands (National Parks, FWS refuges, etc) and expected management of those lands into the design of a reserve and management strategy for late-successional species (Table 3.1).

The Plan has the effect of creating large habitat reserves throughout the range of the northern spotted owl which would also serve as secure goshawk habitat. The science work to prepare the plan included an 'expert panel' which was asked to judge the effectiveness of the plan to provide goshawk habitat to support a well distributed population on the federal lands. The result of this panel assessment was a conclusion of 100% likelihood that the goshawk population would achieve the 'well-distributed' objective. Independent Implementation monitoring of this Plan has recorded greater than 95% compliance with the standards and guidelines of the Plan.

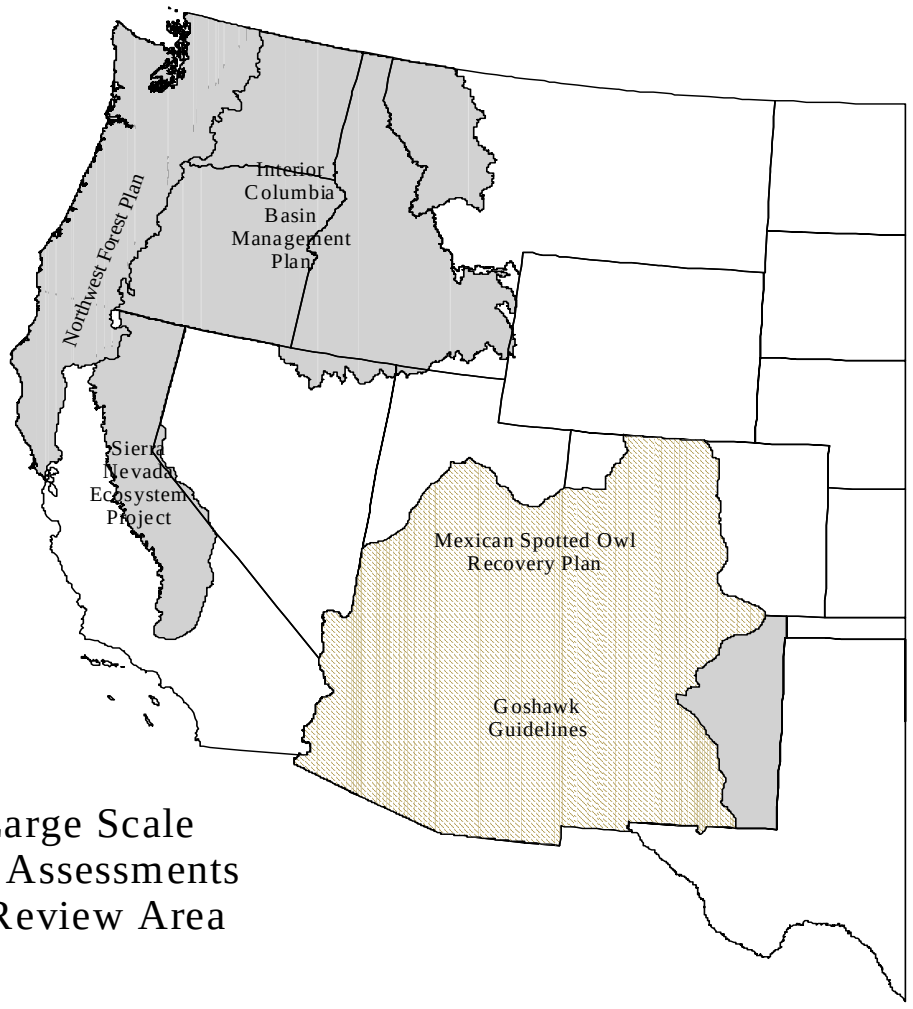


Figure 3.2 Large Scale Forest Habitat Assessments in the Status Review Area

Northern Goshawk
Status Review Team
June 1998

Table 3.1. Estimated Acres of Federal Lands by Land Allocation for the Northwest Forest Plan.

State/ Physiographic Province	Total Acres Federal Land	Congressional Reserved Areas	Late-Successional Reserves	Adaptive Mngmt. Areas	Managed Late-Successional Areas	Administrative Withdrawn Areas	Riparian Reserves	Matrix
Washington								
Eastern Cascades	3,470,400	1,479,400	874,700	100,100	92,100	221,100	247,000	455,900
Western Cascades	3,719,400	1,753,500	1,094,900	167,100	0	193,600	218,100	292,100
Western Lowlands	126,300	126,300	0	0	0	0	0	0
Olympic Peninsula	1,530,000	989,300	413,900	124,500	0	300	1,000	1,000
Total	8,846,100	4,348,500	2,383,500	391,700	92,100	415,000	466,100	749,000
Oregon								
Klamath	2,118,900	261,300	858,700	249,500	0	60,000	267,000	422,400
Eastern Cascades	1,573,600	427,700	378,400	0	0	194,700	159,000	413,800
Western Cascades	4,488,100	723,700	1,303,600	236,100	0	275,900	767,300	1,181,500
Coast Range	1,411,900	23,800	924,200	78,900	0	35,800	161,700	187,500
Willamette Valley	26,200	8,700	1,100	100	0	100	7,500	8,700
Total	9,618,700	1,445,200	3,466,000	564,600	0	566,500	1,362,500	2,213,900
Assessment Area 6 Total	18,464,800	5,793,700	5,849,500	5,849,500	194,300	981,500	1,828,600	2,962,900
California								
Coast Range	471,300	189,500	118,300	0	0	42,600	44,500	76,400
Klamath	4,511,700	1,291,200	1,227,800	398,700	0	356,900	564,700	672,400
Cascades	1,007,500	46,200	235,200	166,800	10,100	96,100	189,700	263,600
Assessment Area 5 Total	5,990,500	1,526,900	1,581,300	565,500	10,100	495,600	798,900	1,012,400
Assessment Areas 5 & 6 Total	24,455,300	7,320,600	7,430,800	1,521,800	102,200	1,477,100	2,627,500	3,975,300

Interior Columbia Basin Ecosystem Assessment

This Assessment has not yet been completed, but has compiled and reported information for a variety of resource management concerns in this large area. The Columbia Basin project covers a total 140 million acres (15% of the Status Review area) and has scientific analysis of the entire acreage, though it will ultimately address management decisions for only the Forest Service and BLM lands within that area. Within the Columbia Basin area, 58 million acres is forested, with 45 million of those forested acres in Forest Service and BLM management (20% of the forested acreage in the Status Review). Thus, it serves as a source of information for a significant portion of the forested habitat in the Review area. The results of this Assessment are discussed further for Assessment Areas 1, 4 and 6.

The Columbia Basin project has developed two analyses which are pertinent to the Goshawk Status Review Area. First is evaluations of the goshawk habitat conditions for the total area and for the BLM/Forest Service lands within the total area (Quigley et al. 1997). Both types of evaluation assess historic conditions, the current situation, and the expected conditions under the Alternatives being considered in the Draft EIS. Separate evaluations were made for the two large areas within the Basin - Eastside Ecosystem and Upper Columbia. These ratings by panel experts concluded there is a 70% likelihood that Forest Service/BLM lands had historic habitat conditions in the Upper Columbia and Eastside which provided for a broadly distributed goshawk population which functioned as a metapopulation (total of Outcomes 1 and 2). In comparison, for the current habitat situation, they concluded a 47-54% likelihood of a functioning metapopulation, but also placed 11-14% likelihood that habitat conditions would result in isolated populations and may have areas of local extirpation (Outcome 4). For goshawks, the panelists did not feel that any of the situations would result in "Outcome 5 - habitat very scarce, little possibility of interactions of local populations, strong potential for extirpation and little likelihood of recolonization," meaning that they did not foresee any situation where the current range of the species would not be maintained. The assessment of the current situation on Forest Service/BLM lands contributes to the Alternatives being considered in the EIS, most of which were rated as creating an improved situation by reducing the likelihood of isolated populations and areas of local extirpation. It is worth noting that the standard deviations for many of the raptor ratings (including the goshawk) were higher than those for other avians, reflecting a degree of uncertainty which panelists had regarding the possible habitat conditions/situations and how the raptor populations may respond to those conditions. Generally, the assessments which considered the total area (non-Federal lands in addition to the Federal lands) showed slightly higher ratings than Federal lands only.

The second analysis being prepared by the Columbia Basin Science Team is documentation of "source habitats" throughout the Basin (Wisdom et al. in prep). For the Basin as a whole and for each Ecological Reporting Unit they report the historic and current percentage of the landscape which was/is "source habitat" for summer and winter. The definition of "source habitat" is acreage with characteristics of macro vegetation (trees and shrubs) that contribute to stable or positive population change. For goshawks, this could be considered forested vegetation which supports successful nesting and foraging. The habitat is measured with square pixels of 1

kilometer in size. Their analysis includes the absolute percentage of change of source habitat from historic to the present situation. It also presents the relative change; that is, "Of the XX percent of the landscape in source habitat 100 years ago, what percentage now occurs?." Finally, they present a rating of the trend in change of this habitat. As in the earlier analyses, they present conclusions for the Forest Service/BLM lands only and for the Basin as a whole.

Their conclusion is that 69% of the Ecological Reporting Units show a decline in goshawk summer habitat, 15% show a neutral status and 15% show an increase. For goshawk winter habitat, they report 54% of the Ecological Reporting Units declining, 8% neutral and 38% increasing. The spatial array of these results is important, and is discussed further in the Assessment Area discussions, particularly in Assessment Areas 1 and 6.

Southwest Regional Goshawk Guidelines

The intention of this amendment to National Forest Plans in Arizona and New Mexico is to incorporate specific direction for the identification and management of goshawk territories in this Forest Service Region. The guidelines have generally been implemented since 1992, but they were not formally adopted until 1996. Considering their implementation since 1992, it is premature to know whether these Guidelines are resulting in the desired forest conditions. Neither implementation monitoring nor effectiveness monitoring have been initiated for these Guidelines.

Mexican Spotted Owl Recovery Plan

This plan provided a framework for land management decisions in the four-state area of Figure 3.2 shown with crosshatching, which overlaps between Assessment Areas 2, 3 and 4. In Arizona and New Mexico, the National Forests have formally adopted these measures as Forest Plan amendments; National Forests in Utah and Colorado have not amended their plans to adopt the measures. The effect of this Plan is to prescribe protection and management of spotted owl home ranges and to guide management outside the homes ranges to develop and maintain habitat suitable for spotted owls. The result of this Plan is management of forest habitat which would provide benefits to goshawks as well.

Sierra Nevada Ecosystem Project

The Sierra Nevada Ecosystem Project (SNEP) is an interagency study conducted to support land management decisions in a large portion of California and a smaller portion of Nevada. The report of the SNEP provided specific conclusions and critical findings relating to environmental policy and management of the Sierra Nevada (UC Davis, 1996) but no action has been taken to implement the findings

Forest Service Timber Harvest Data

Our third view of goshawk habitat trends came from Forest Service silviculture reports which provided acres of land harvested with various silvicultural prescriptions. Appendix A provides a detailed discussion of the results. For the Status Review Area, we documented a decline in the acreage affected by timber harvest in the past ten years (Figures 3.3 and 3.4 Summary of Forest

Service Timber Harvest between 1984 and 1997.), which has the general effect of slowing the loss of goshawk habitat from these public lands.

Figure 3.3 Sumary of Harvest Rates, Forest Service Region 1 - 6, between 1984 and 1997

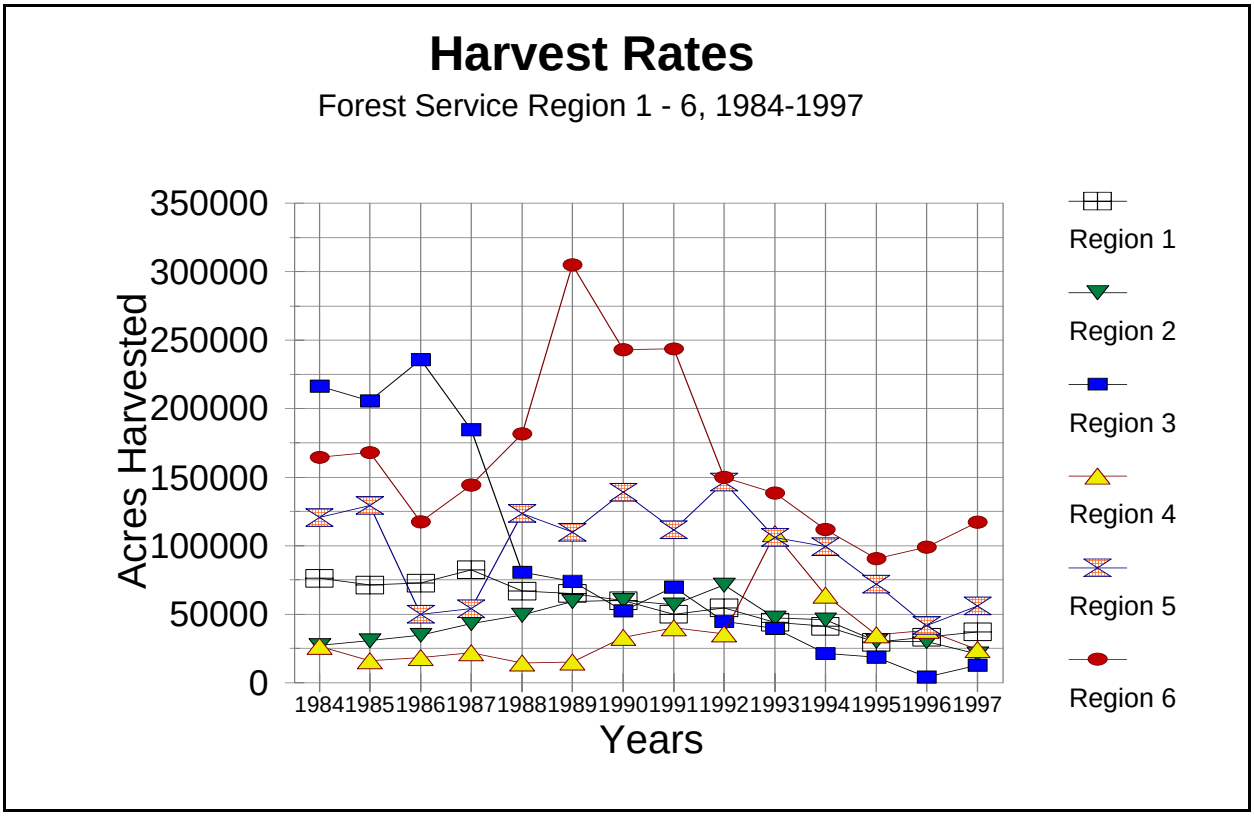
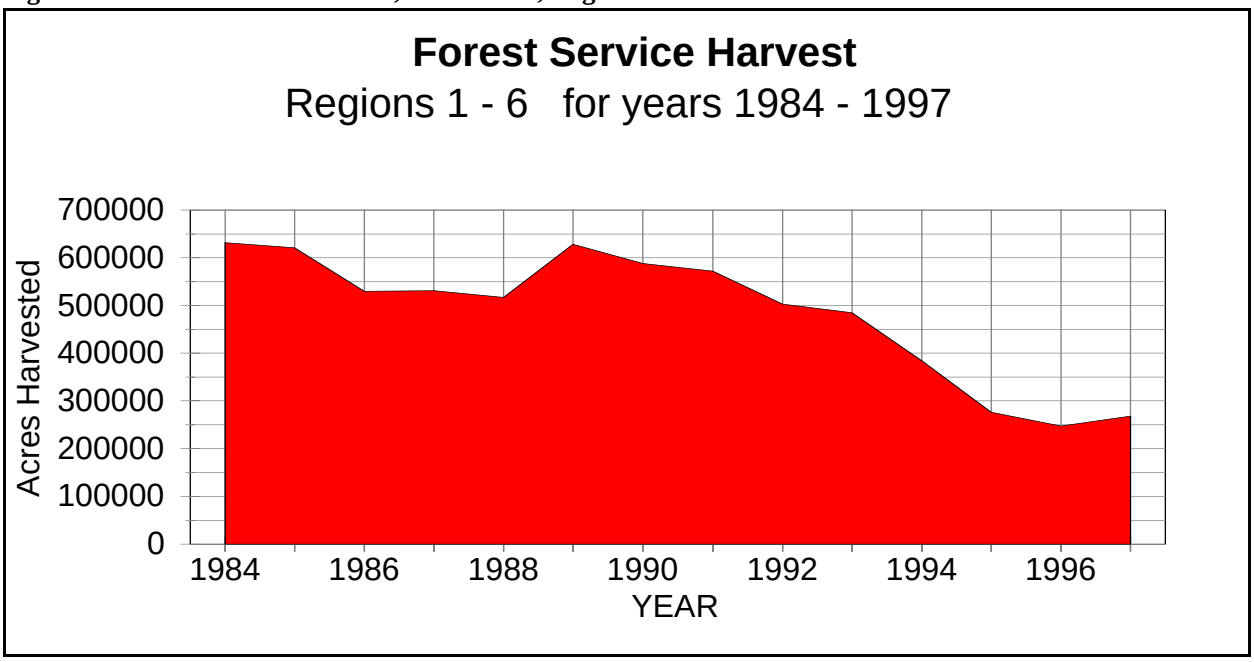


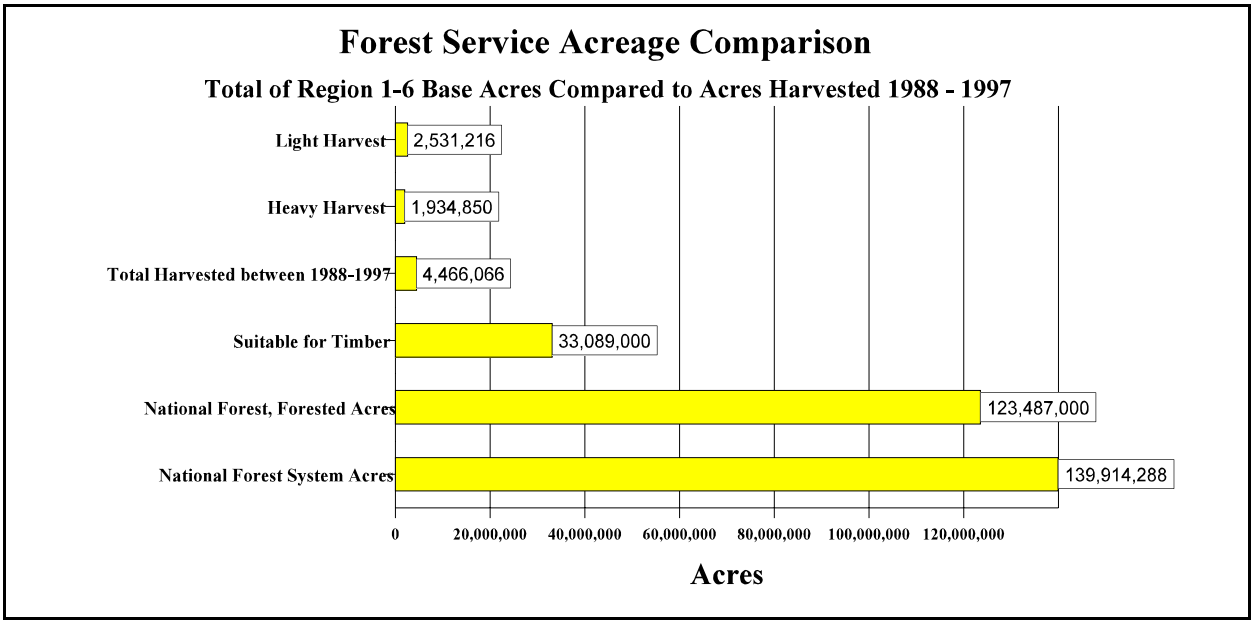
Figure 3.4 Forest Service Harvest, 1984 - 1997, Region 1 - 6



In large areas these declines are the result of recent adoption of management strategies to manage and protect more acres of habitat, which reduces the acreage available for timber harvest. But there are other subtleties within the data which require further attention. In each Assessment Area discussion (following this section) we have more detailed information, sometimes for a longer period of time, which shows a change in the types of silvicultural prescriptions which were used. All but one Assessment Area (Area 4) show a decline in acres affected by "heavy harvest" (see Appendix A for definitions) and increases in "light harvest". This change in harvest pattern has a general effect of slowing the loss of goshawk nest habitat, and reducing the period of time before harvested acres provide goshawk habitat structure and function (see discussion in Chapter 4, Conservation and Management, Habitat Alteration section). If the harvest patterns and rates of the 1980s had continued into the current time, it likely would have affected conclusions of this Status Review, as the current acres of goshawk nest habitat would be much lower.

To understand the effect of this loss of forested habitat, it is necessary to look at the context in which the harvest occurs. Figure 3.5 displays the total National Forest System acreage in the Review Area and the portion of that acreage that is allocated as "Suitable for timber" as of 1995. In comparison, the figure shows the acreage harvested between 1988 and 1997. (Note: In considering these comparisons of acreage, the reader must remember that the 'suitable for timber' acreage is modified with Forest Plan revisions and amendments. Many of these Forest Plan changes have occurred during the time periods displayed here, making a direct comparison more difficult. All of the Forest Plan changes we are aware of had the effect of reducing the 'suitable for timber' acreage. Despite the complexity, we believe this information can contribute to a broad view of the proportion of National Forest lands affected by timber harvest.)

Figure 3.5 Displays the total National Forest System acreage in the Review Area and the portion of that acreage that is allocated as "Suitable for timber" as of 1995



The remainder of this section will discuss in more detail each Assessment Area of the Status Review. Each Area will be introduced with forest habitat information generated from Figure 3.1., followed by the information received for the Status Review. Then we present summary and discussion of habitat information which was obtained from other sources. This is followed with a discussion of what is known about the goshawk population status and trends in the Assessment Area. Finally, for each Area we provide some conclusion regarding goshawk habitat and populations.

Assessment Area 1

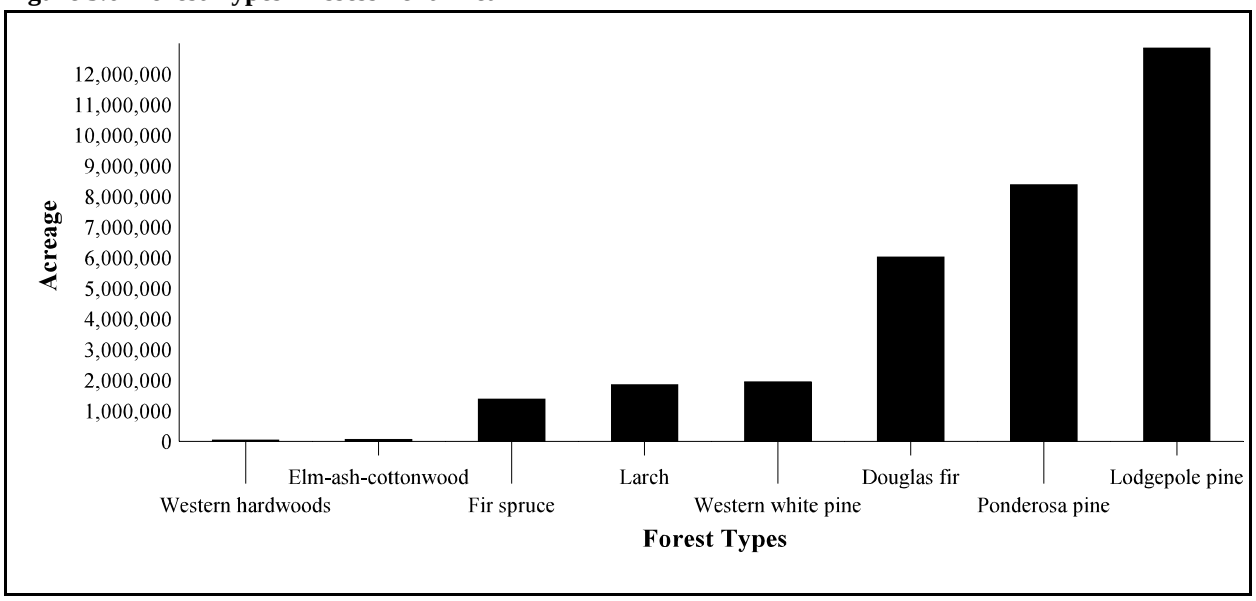
Introduction and Current Habitat as Modeled from FIA data

Assessment Area 1 consists generally of the State of Montana, northern Idaho and the portion of North Dakota which is in the Review Area and a small portion of South Dakota (Figure 1.1) Table 3.2 provides an initial view of the potential forest vegetation, by ownership, in the Area; a portion of these acreages would be considered capable of supporting goshawk habitat. Figure 3.6 illustrates the relative proportions of these forest types in the Area.

Table 3.2. Forest Cover Types, by Land Manager/Owner - Assessment Area 1.

Forest Type	Indian Lands	National Forests	Bureau of Land Management	National Park Service	Fish and Wildlife Service	Other Lands*	Total
Douglas fir	174,000	3,984,000	605,000	184,000	6,000	1,065,000	6,018,000
Elm-ash-cottonwood					1,000	61,000	62,000
Fir-spruce	9,000	1,237,000	37,000	12,000	2,000	81,000	1,378,000
Larch	27,000	1,216,000	3,000	84,000	1,000	521,000	1,852,000
Lodgepole pine	383,000	10,835,000	308,000	553,000	6,000	770,000	12,855,000
Ponderosa pine	665,000	4,635,000	338,000	168,000	2,000	2,582,000	8,390,000
Western hardwoods	2,000	26,000	1,000	4,000		9,000	42,000
Western white pine	91,000	1,168,000	15,000			674,000	1,948,000
Total	1,351,000	23,101,000	1,307,000	1,005,000	18,000	5,763,000	32,545,000

Figure 3.6 Forest Types - Assessment Area 1

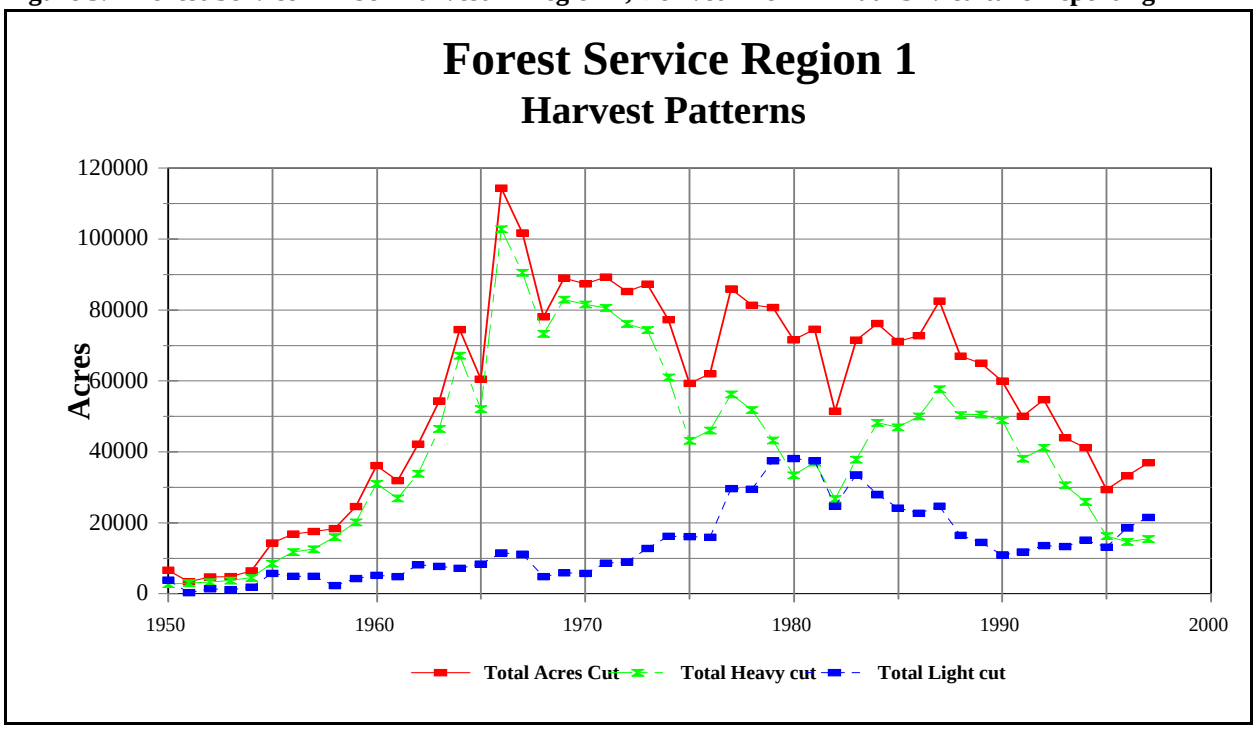


Habitat Trends

The Forest Service provided a draft of documentation of their conclusions regarding goshawk habitat management on the National Forests in Region 1, which is within Assessment Area 1 (Maj 1996). The following discussion includes interpretations based upon the documentation.

The Forest Service concludes that goshawks use a variety of forest cover types in this Assessment Area and identified the following principle forest types used as goshawk habitat: mixed conifer, Douglas fir, lodgepole pine, ponderosa pine, aspen, and cedar-hemlock (Maj 1996). Lack of research in the Assessment Area and the absence of well-designed surveys prohibits confirmation of this conclusion, but the list is consistent with literature from throughout the Status Review Area. The Forest Service estimates these forest types total approximately 10 million acres in this Assessment Area. An unknown percentage of these forests were in seral stages suitable for goshawk use (i.e., mature and old-growth forests). Spruce-fir forests are considered to be important goshawk habitat in very few areas. Of the goshawk nest stands reported to the Status Review, 60% were in Douglas fir types, 16% in lodgepole, 14% in Ponderosa pine and 9% in other types (Chapter 1, this document). (As cautioned in earlier sections of this document, these proportions should not be compared against the percentages of these cover types because survey effort to identify these nests sites was not randomly placed in the habitat, nor rigorous enough to determine absence of birds.)

Figure 3.7 Forest Service Timber Harvest in Region 1, Derived From Annual Silviculture Reporting



The current abundance and distribution of goshawk habitat differs from pre-settlement conditions A combination of wildfire, fire suppression, mining, grazing, urbanization, and timber harvest is attributed to changes in the amount of some forest types and seral stages. These changes have resulted in a decrease in some goshawk habitat types and an increase in other habitat types. In particular, mature and old-growth seral stages in the ponderosa pine and cedar-hemlock forest types are less abundant than in pre-settlement conditions.

Timber harvest data for the last 45 years from the Forest Service in Region 1 (Figure 3.7) illustrates a harvest of 1,970,834 acres (8% of the National Forests, based upon figures in Appendix A) of forested habitat which we assume was goshawk habitat, using silvicultural methods which caused long-term (greater than 100 years) loss of goshawk nesting habitat (See Appendix A for discussion of "heavy" and "light" harvest effects). In their support of prey habitat and populations, these acres are generally currently providing foraging habitat for goshawks. In the same time period, another 600,000 acres (2% of the National Forests) were harvested with methods resulting in degradation, though not complete loss of goshawk nesting structure and cover. This total of 2,570,834 acres of forested habitat represents 11% of the National Forest acreage, and 30% of the land currently classified in the timber base (as of 1995). It includes acreage which was salvage logged and therefore could be assumed already lost as goshawk habitat prior to the logging. As elsewhere in the western Forest Service Regions, there is a recent pattern in Region 1 which shows reduced proportions of "heavy" cut acreage and increased proportions of "light" cut acreage.

Current land management plans on National Forests in Assessment Area 1 are expected to result in both increases and decreases in the amount of seral stages suitable for goshawk habitat (maj 1996). Table 3.3 provides information on how individual National Forests are managing for old-growth forests and what the Forests' expectations are with respect to future goshawk habitat. In a Regional summary by Maj (1996) many Forests describe their expectation that habitat will provide for long term goshawk viability, but do not provide data or analysis to illustrate a basis for these conclusions.

Table 3.3. Summary of Forest Service Judgements of Future Expectation of Old-Growth Forests and Goshawk Habitat on National Forests in Assessment Area 1. Derived from USDA Forest Service, M. Maj, 1996.

National Forest	Targets for Retention of Old-Growth in Forest Plans		Statements Regarding Future Changes to Goshawk Habitat
	As % of Landscape	As % of Timber Base	
Helena NF	5%		Increase
Deerlodge NF		5%	Stable
Beaverhead NF		10%	?
Gallatin NF		30%	?
Lewis and Clark NF		5%	Decrease
Custer NF		Not Specified	?
Lolo NF	8%		?
Bitterroot NF		No Provision	?
Kootenai NF		Not Specified	?
Flathead NF		Not Specified	?
Nez Perce NF	10%	5%	Stable
Clearwater NF	10%	5%	Decrease
Idaho Panhandle NF		No Provision	?

The Columbia Basin Science Assessment includes Ecological Reporting Units (ERUs) which cover the westernmost quarter of Assessment Area 1. As reported in Quigley et al. (1997) the goshawk viability panel concluded with rating a 70% likelihood that Forest Service/BLM lands had historic habitat conditions in the Upper Columbia which provided for a broadly distributed goshawk population which functioned as a metapopulation (total of Outcomes 1 and 2). In comparison, for the current habitat situation, they concluded a 47% likelihood of a functioning metapopulation, but also placed 17% likelihood that habitat conditions would result in isolated populations and may have areas of local extirpation (Outcome 4). Importantly, the panelists did not feel that any of the situations (historic, current or the alternatives) would result in 'Outcome 5 - habitat very scarce, little possibility of interactions of local populations, strong potential for extirpation and little likelihood of recolonization'. This means the panelists did not foresee any situation where the current range of the species would not be maintained.

The assessment in Quigley et al. (1997) also projected goshawk habitat under the Alternatives being considered in the EIS, most of which were rated as creating an improved situation, reducing the likelihood of isolated populations and areas of local extirpation.

It is worth noting that the standard deviations for many of the raptor ratings (Quigley et al. 1996) (including the goshawk) were higher than those for other avians, reflecting a higher degree of uncertainty which panelists had regarding the possible habitat conditions/situations and how the raptor populations may respond to those conditions. Generally, the assessments which considered the total area (non-Federal lands in addition to the Federal lands) showed slightly higher ratings than Federal lands only.

Another analysis being prepared by the Columbia Basin Science Team is documentation of "source habitats" throughout the Basin (Wisdom et al. in prep). All of ERUs 8 and 9, and portions of ERUs 5, 7, and 13 are in the Assessment Area (Quigley et al. 1997). For the Basin as a whole, and for each ERU, they report the historic (circa 1850) and current (circa 1990) percentage of the landscape which was/is "source habitat" for summer and winter goshawk use. The definition of "source habitat" is acreage with characteristics of macro vegetation (trees and shrubs) that contribute to stable or positive population change. For goshawks, this could be considered forested vegetation which supports successful nesting and foraging. The habitat is measured with square pixels of 1 kilometer in size. Their analysis includes the absolute percentage of change of source habitat from historic to the present situation. It also presents the relative change; that is, "Of the XX percent of the landscape in source habitat in 1850 years ago, what percentage now occurs?." Finally, they present a rating of the trend in change of this habitat. As in the earlier analyses, they present conclusions for the Forest Service/BLM lands only and for the Basin as a whole.

For the ERUs entirely or partially in Assessment Area 1, they conclude all ERUs show a decline in goshawk summer habitat (Table 3.4). For goshawk winter habitat, all but one have declined. We believe the dramatic declines in overall habitat in this analysis stem principally from the combination of large fires which occurred in the early 1900s and timber harvest on Federal lands (Figure 3.7) and non-Federal lands. Hann et al. (1997) also discuss the occurrence of extensive loss and poor regeneration of white pine as a result of white pine blister rust which would account for some of the habitat loss.

These conclusions about source habitat require further explanation. An average loss of 95% of the goshawk summer source habitat would tend to indicate the species should be rare in the area. Yet the recent goshawk surveys continue to find new territories (Figure 3.9) and greater than 51% of the reported sites were documented as active in the last 7 years. Discussions with the report authors suggest the fire patterns in these areas, often mixed-severity fires which killed 20 to 70 percent of the overstory trees (Hann et al 1997), created patches of unburned old-growth which would likely be smaller than the pixel size of the source habitat analysis (1 kilometer square). While too small to be counted in the source habitat analysis, these patches, surrounded with burned mid-seral habitat (which was generally not salvage logged) create a mosaic of vegetation which is apparently sufficient to support the existing goshawk population.

Table 3.4. Goshawk Summer and Winter Source Habitat Conclusions for All Lands in Ecological Reporting Units which Occur in Assessment Area 1 (adapted from Wisdom et al, in prep).

ERU	Summer - Historic Percentage	Summer - Current Percentage	Summer - Absolute change in Percentage	Summer - Relative change from historic to current	Winter - Historic Percentage	Winter - Current Percentage	Winter - Absolute change in Percentage	Winter - Relative change from historic to current
5	17.77	8.37	-9.41	**-52.92**	16.14	19.73	3.59	**22.27**
7	28.63	1.54	-27.09	**-94.62**	28.43	2.94	-25.50	**-89.66**
8	25.04	1.69	-23.35	**-93.24**	25.07	1.69	-23.38	**-93.25**
9	15.61	0.54	-15.07	**-96.66**	18.05	.87	-17.18	**-95.19**
13	15.46	14.39	-1.07	**-6.92**	17.75	14.08	-8.68	**-20.63**

Wisdom et al. (In prep) discuss management implications of the overall habitat changes and for the declines in old-forest structural changes, they discuss the potential management actions of: 1) conservation of existing habitats in watersheds where the decline in old forest has been strongest; 2) use of silvicultural manipulations in mid-seral forests to accelerate the development of late-seral stages; and 3) long-term silvicultural manipulations and long-term accommodation of fire and other disturbance regimes in all forested structural stages to hasten development and improvement in the amount, quality and distribution of old-forest stages. This science report, along many others, is contributing to the analysis of management alternatives for the entire Columbia Basin. The future trend in goshawk habitat for Forest Service and BLM lands in the Basin will depend upon the alternative selected. These data indicate there is a need to address this decline in goshawk habitat and the authors' presentation of potential management actions are reasonable avenues to consider.

Conclusions regarding goshawk habitat trends in Assessment Area 1

The data received in response to the Status Review request are inconclusive as to trend in goshawk habitat. The results were difficult to use because of lack of response from some administrative units, inconsistent methods to respond, and incomplete responses. Ultimately, the Status Review Team chose to delete these data from any analysis for this Status Review.

Information from the Forest Service, reported separately (Maj 1996), lead the agency to conclude that current levels of goshawk habitat are probably below historic levels for the cedar-hemlock and ponderosa pine habitat types. They estimate that other habitats are probably similar to historic levels. There is insufficient information in the report to determine the basis for the conclusions, and future levels of mature and old-growth forests which they expect. The explicit Forest Plan standards intended to retain old-growth on the Forests are inconsistent (ranging from 5% to 30% of an area), and do not facilitate an understanding of the future of goshawk habitat since the species uses a wider array of habitat conditions than "old-growth".

The Columbia Basin Science work reinforces the conclusion that goshawk habitat has declined,

and the viability panel conclusions reflect professional judgement that a decline has occurred as well. The panel ratings of the historic situation indicate that goshawk habitat was not considered evenly distributed even 100 years ago, prior to land management effects (rating values were assigned to Outcome 3 - habitat distribution included some patches and isolated populations). The standard error calculations for the panel ratings for raptors are a further indication of uncertainty about habitat conditions in the past, currently and under the Alternatives.

The 'source habitat' analysis presents a clearer picture of magnitude and nature of the decline, but the pixel size may result in an underestimation of current habitat. Additional analysis would be helpful to understand the large declines. The authors state their work is broad-scale, requiring further validation and finer-scale evaluations. They also discuss the difficulties in comparing the habitat change conclusions against any measures of species population change. The difficulty which seems most applicable to this situation is the lack of intensive species monitoring to validate the habitat assumptions.

Current timber harvest rates are substantially below those of a decade ago and reflect a trend away from silvicultural prescriptions which eliminate habitat and toward prescriptions which have less disruptive effects and shorter term effects to forest cover. Nevertheless, habitat changes due to a variety of forest management issues and practices continue. It is reasonable to assume that large scale habitat changes will occur due to forest health and catastrophic events, and management actions designed to address these issues.

Status of goshawk populations in Assessment Area 1

The goshawk population in Assessment Area 1 is poorly represented in the published research, with only one research study found in the Area (Table 3.5).

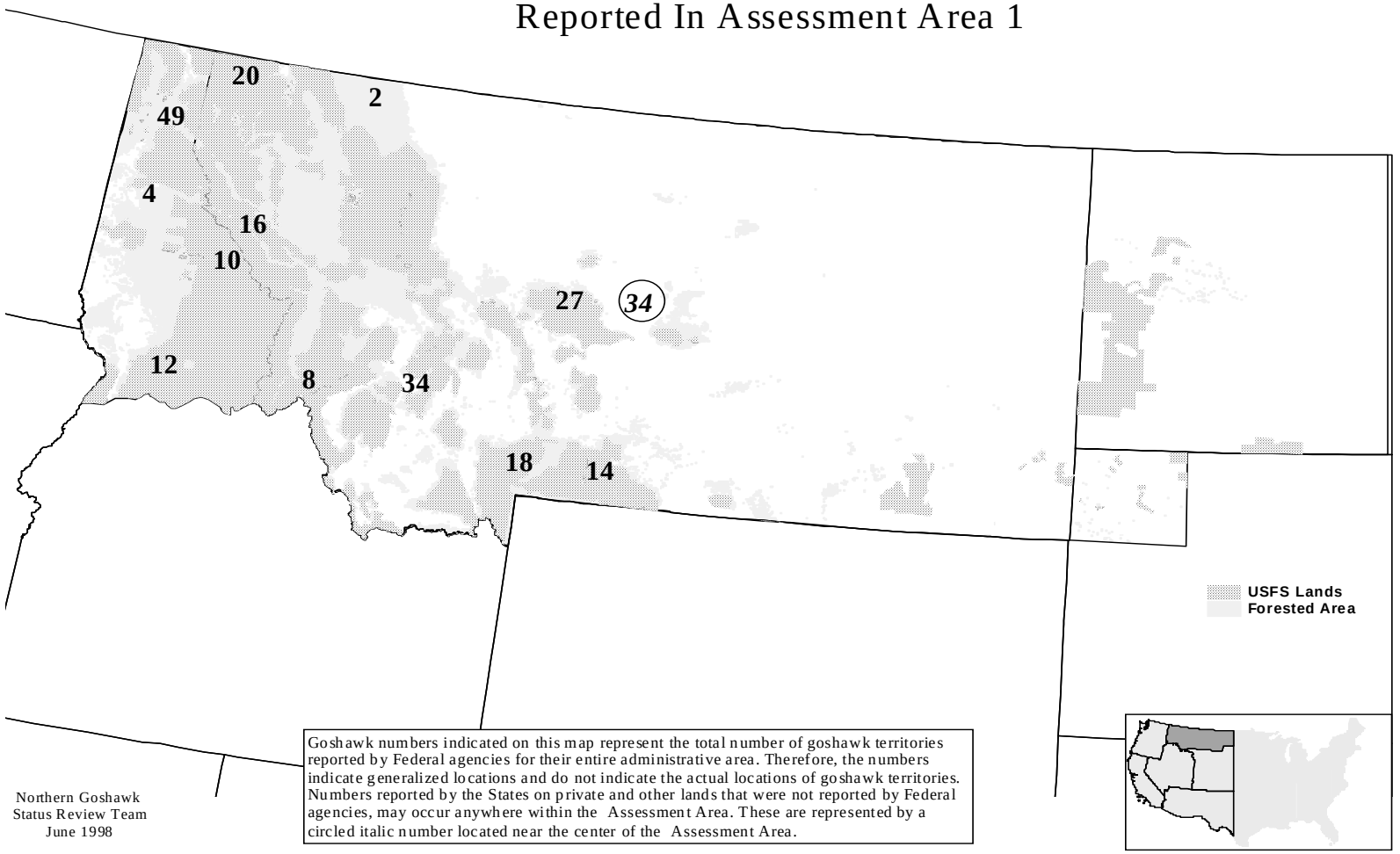
Table 3.5. Published and unpublished goshawk field studies conducted, or in progress, in Assessment Area 1.

Source	Type	Location	Topic(s)
Hayward and Escano 1989	published paper	northern Idaho, western Montana	nest tree and nest stand characteristics

Distribution and Reported Numbers

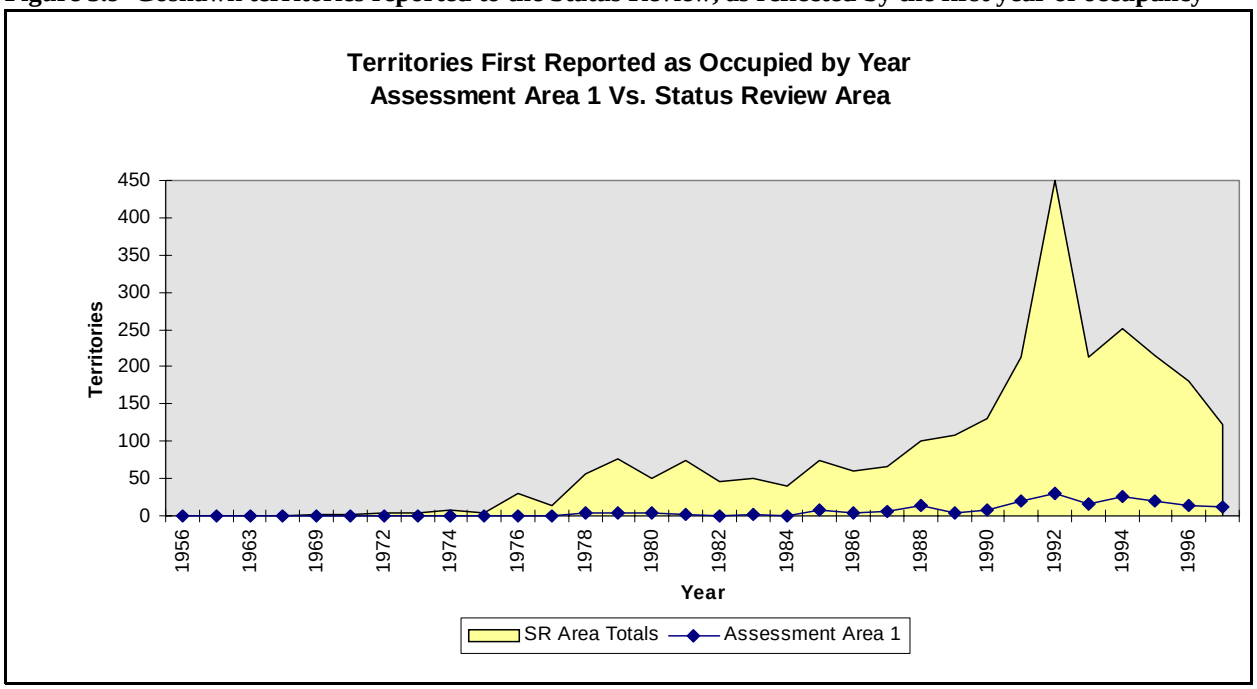
Goshawks are widely distributed across the forested habitat of this Assessment Area (Figure 3.8) and we believe this distribution is similar to the historic range of the species.

Figure 3.8 Numbers of Northern Goshawk Territories Reported In Assessment Area 1



Unlike other Assessment Areas, there was not a dramatic spike in survey effort in 1992-93 (Figure 3.9). Most reported goshawk surveys in the Assessment Area have been conducted on Forest Service lands (84% of the reported territories, managing 71% of the potential goshawk

Figure 3.9 Goshawk territories reported to the Status Review, as reflected by the first year of occupancy



habitat). The

BLM reported 9% of the territories, as did private and other landowner categories (Table 3.6). This 18% of the reported goshawks on non-Forest Service lands contributes to the conclusion that these other lands are important to the long term management of the species.

Of the five land management units which reported survey summary information to the Status Review, two gave estimates of the proportion of their unit which had been surveyed. The Lolo Forest estimated 20% of the Forest had been surveyed between 1992 and 1997 using the 'Kennedy protocol', resulting in the location of as many as 9 territories. The Clearwater Forest estimated that 300 miles of road routes (roughly equivalent to 10% of the Forest), had been surveyed in 1993 using the 'Kennedy protocol', resulting the location of as many as 3 territories. Other Forests did not report an estimate of their survey effort, but did report goshawk territory locations (Table 3.6).

Table 3.6. Goshawk territories reported to the Status Review Team by land management agencies and state natural heritage programs in Assessment Area 1.

State	Landowner	No. Territories[1]
Idaho	Clearwater National Forest	10
	Idaho Panhandle National Forests	49
	Nez Perce National Forest	12
	Nez Perce National Historical Park	1
	Bureau of Land Management, Coeur d'Alene Field Office	4
	Subtotal:	**76**
Montana	Beaverhead-Deerlodge National Forests	34
	Bitterroot National Forest	8
	Custer National Forest	14
	Gallatin National Forest	18
	Kootenai National Forest	20
	Lewis and Clark National Forest	27
	Lolo National Forest	16
	Glacier National Park	2
	Montana State Dept of Natural Resources	6
	Various, including private lands	16
	Bureau of Land Management, Garnet Field Office	7
	Bureau of Land Management, Dillon Field Office	4
	Subtotal:	**172**
	TOTAL:	**248**

Population Status

There is no information available to directly assess historical goshawk population trends in the Assessment Area. However, based on the assessment of historical habitat changes, it is reasonable to conclude that goshawk populations have been reduced from historical levels. The magnitude of any population change is unknown. Goshawks are probably less abundant in areas that have been more heavily logged or other habitat loss, but we have no survey results or research to document this conclusion. While abundance of goshawks has likely changed, goshawk distribution in Assessment Area is probably similar to pre-settlement times and we have no evidence of areas where the species has been extirpated.

The northern goshawk is afforded special recognition in the Assessment Area. It is used by ten of the thirteen National Forests Service as a Management Indicator Species (MIS) to serve as an ecological indicator of old growth forests. At least one Forest has concluded that goshawk, "may not be a good choice as a MIS status since it appears across the landscape at low density and is difficult to monitor or detect even when present." An additional argument against the goshawk as a MIS for old growth is the species' use of a wider array of habitat ages than is typically considered "old-growth".

The goshawk is a Species of Special Concern in both Idaho and Montana.

Forest Service Region 1 evaluated the goshawk for listing as a sensitive species in 1988 and 1991. In both of these evaluations the agency concluded the goshawk did not meet the criteria which would support listing the species as sensitive.

Thus, there are mixed indications of the level of concern for goshawk in Assessment Area 1. Despite the agency designations which would indicate some concern, there has not been widespread alarm that the species is declining in this Area.

Conclusion

It is reasonable to conclude that there have been declines in goshawk populations in the Assessment Area when looking at habitat changes since pre-settlement times. Information to determine the magnitude of presumed decline or the stability of current populations is currently lacking. The lack of scientific research, and/or agency monitoring of goshawk territories, contributes to the dearth of information on goshawk population status and trends in this Assessment Area.

Assessment Area 2

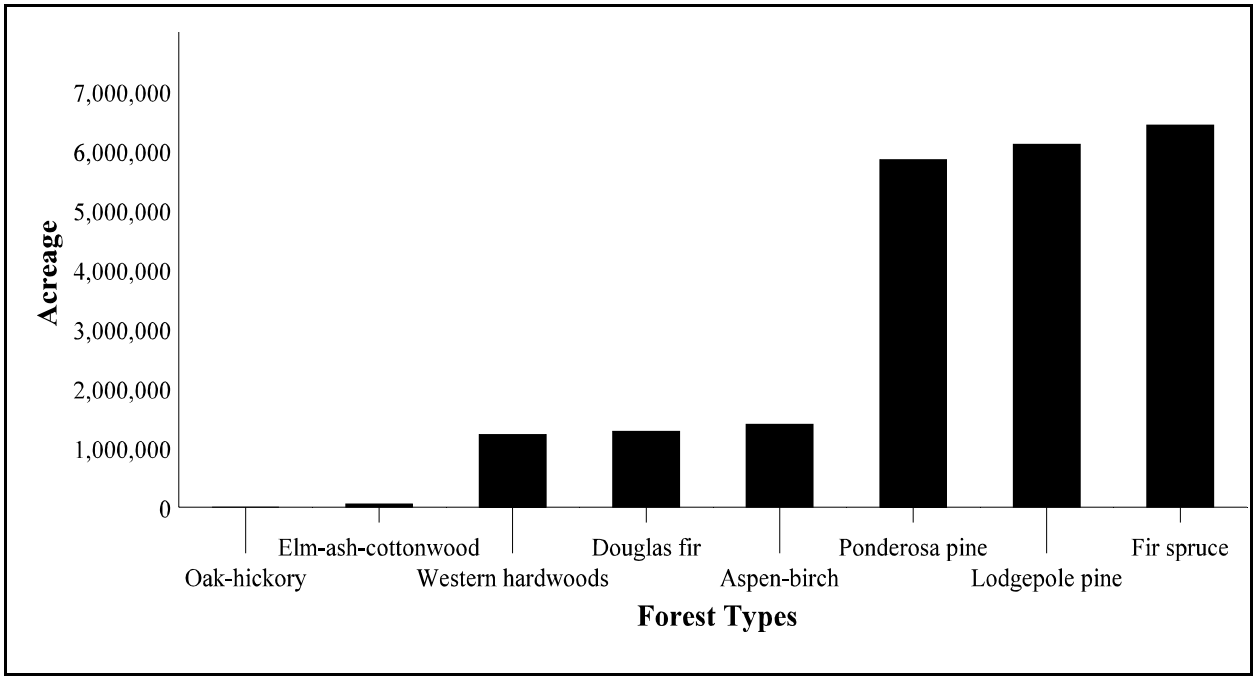
Introduction and Current Habitat as Modeled from FIA data

Assessment Area 2 consists generally of the States of Colorado and Wyoming and portions of South Dakota, Nebraska and Kansas which are in the Review Area (Figure 1.1) Table 3.7 provides an initial view of the potential forest vegetation, by ownership, in the Area; a portion of these acreages would be considered capable of supporting goshawk habitat. Figure 3.10 illustrates the relative proportions of these forest types in the Area.

Table 3.7. Forest Cover Types, by Land Manager/Owner - Assessment Area 2.

Forest Type	Indian Lands	National Forests	Bureau of Land Management	National Park Service	Fish and Wildlife Service	Other Lands*	Total
Aspen-birch	2,000	1,077,000	181,000	7,000		129,000	1,396,000
Douglas fir	18,000	592,000	239,000	180,000		248,000	1,277,000
Elm-ash-cottonwood		5,000				50,000	55,000
Fir-spruce	208,000	5,576,000	244,000	215,000		189,000	6,432,000
Lodgepole pine	136,000	3,990,000	539,000	1,047,000		395,000	6,107,000
Oak-hickory						3,000	3,000
Pinyon-juniper	342,000	2,311,000	2,594,000	137,000		1,338,000	6,722,000
Ponderosa pine	102,000	3,499,000	689,000	49,000	2,000	1,508,000	5,849,000
Western hardwoods	27,000	698,000	281,000	61,000		157,000	1,224,000
Total	835,000	17,748,000	4,767,000	1,696,000	2,000	4,017,000	29,065,000

Figure 3.10 Forest Types - Assessment Area 2



Habitat Trends

Based upon the total forested acreages figures of Table 3.7, the Forest Service manages 61% of the potential goshawk habitat in Assessment Area 1; BLM 16%; National Park Service 6%; and other landownerships 17%.

Assessment Area 2 is particularly lacking in information regarding goshawk habitat trends. The Status Review request for information did not generate adequate response to support analyses of habitat conditions. And we could not locate any broad scale environmental assessments, such as are available for other Assessment Areas.

The Forest Service Rocky Mountain Regional Office provided a draft Biological Evaluation (BE) regarding management of habitat for goshawk. It included a brief summary of habitat management considerations and conclusions for four of the ten National Forest units in the Area. It also discussed some broad scale conclusions for the Region.

The Forest Service BE reports goshawks use a variety of forest cover types in this Assessment Area. Table 3.8 provides their estimates of acres of forest types which they judge to be used by goshawks on Forest Service lands in Assessment Area 2. The Friedlander (in lit.) identified four forest types as being the primary habitat for goshawk; lodgepole pine, ponderosa pine, aspen, and Douglas fir (mixed conifer). An unknown percentage of these forests were in seral stages suitable for goshawk use (i.e., mature and old-growth forests). The report judges spruce-fir

forests to be less important goshawk habitat.

Table. 3.8. Historic Abundance of Forest Types used by the Goshawk - Assessment Area 2 (Derived from Forest Service Biological Evaluation).

Habitat	Acres (millions)	Abundance of Mature and Old-Growth Forests
Spruce-fir (sub-alpine forest)	4.2	Not Abundant
Douglas fir*	1.3	
Ponderosa pine*	2.1	Not Abundant
Lodgepole pine*	2.8	
Aspen*	2.1	
Pinyon-juniper	0.3	
Gambel oak	0.3	
High elevation riparian	Not Available	
Cottonwood riparian	Not Available	

* Identified as primary goshawk habitat by the Forest Service

The BE reports the current abundance and distribution of suitable goshawk habitat differs from pre-settlement conditions. It states that a combination of fire suppression, mining, grazing, urbanization, and timber harvest has resulted in changes in the amount of some forest types and seral stages. These changes have resulted in a decrease in goshawk habitat for ponderosa pine forests and an increase in lodgepole pine habitats. Table 3.8 provides estimates of late-successional habitat (mature and old-growth) for the most abundant forest types.

Table 3.9. Current and Future Estimates of Mature and Old-Growth Forests - Assessment Area 2 (Derived from Forest Service BE).

Habitat	Mature and Old-Growth Age Class	Current Percentage of Forest Type in Mature and Old-Growth Seral Stages	Expected Future Changes to Abundance of Mature and Old-Growth Seral Stages
Spruce-fir (sub-alpine forest)	>200 yrs	?%	Currently abundant, with a continued increase in amounts
Douglas fir*	>180 yrs	?%	Currently abundant and expected to remain so
Ponderosa pine*	>160 yrs	11.0%	Currently little late-successional forest, but current management is expected to increase older forests
Lodgepole pine*	>140%	11.0%	Historically and currently rare, but expected to increase due to fire suppression
Aspen*	>100 yrs	11.0%	Unknown

* Identified as primary goshawk habitat by the Forest Service

The Forest Service BE concludes that recent planning efforts on National Forests in Assessment Area 2 are expected to result in a stable or increasing amount of seral stages suitable for goshawk habitat. Table 3.9 is a summary of the information in the BE on how these habitats are expected to change as a result of implementation of these plans.

Friedlander (in lit., p. 24) states that timber harvests are declining throughout Assessment Area 2, and data collected by the Status Review Team corroborates this statement (Figures 3.11 and 3.12).

Figure 3.11 Total, Heavy and Light Harvest Acres in Forest Service Region 2, 1987 through 1997.

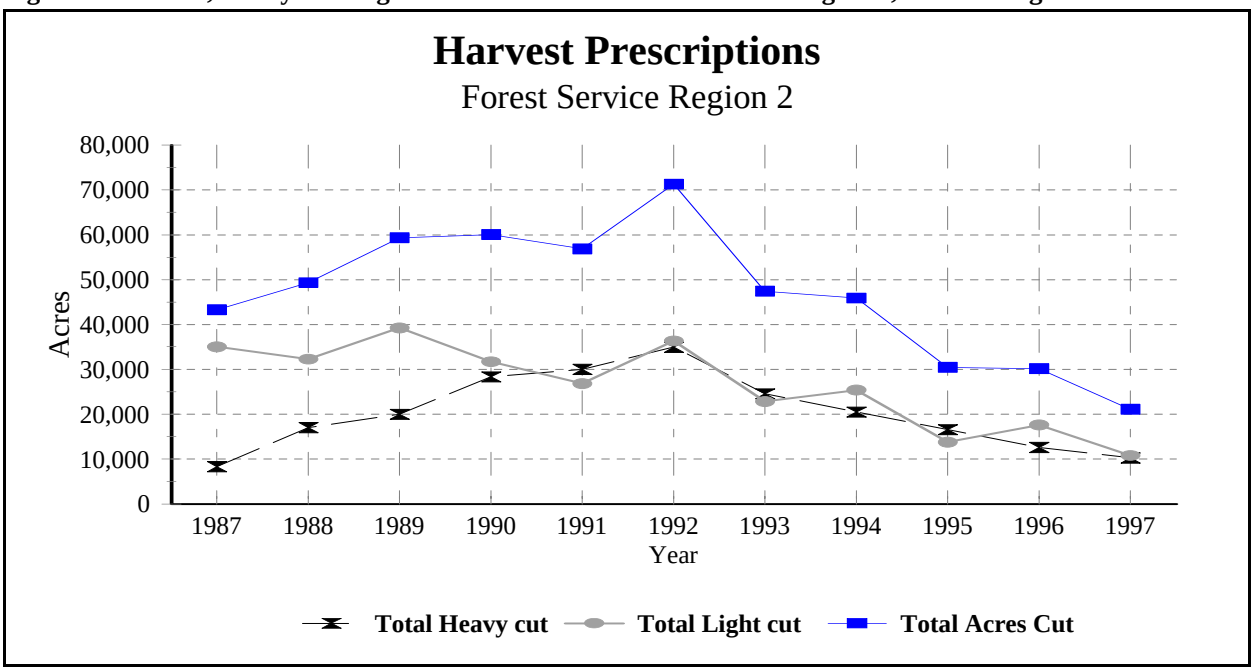
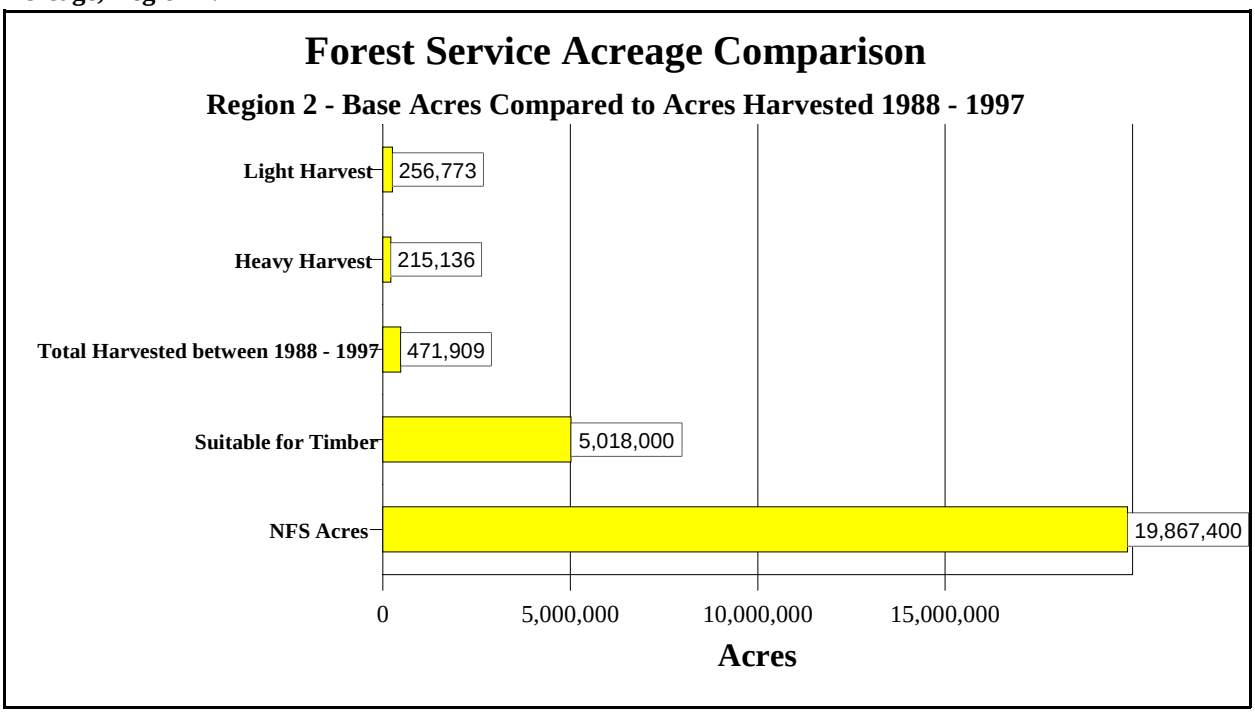


Figure 3.12 Comparison for Forest Service Harvest Acreage 1988 - 1997 Against Total and Suitable for Timber Acreage, Region 2.



The Forest Service BE concludes that widespread fire suppression activities have significantly modified natural fire regimes. And continued exclusion of fire is expected to increase both the short-term value of forests to goshawks and to increase the risks of large, catastrophic stand-replacing fires. They conclude that aggressive fuels reduction or forest-health treatments may reduce the risk of catastrophic events, but may (or may not) also decrease the value of forests to goshawks.

Conclusions regarding goshawk habitat trends in Assessment Area 2

The Assessment Area 2 data received from the Status Review request are inconclusive as to trend in goshawk habitat.

Information from the Forest Service, reported separately, lead the Forest Service to conclude that with the exception of the ponderosa pine forest type, Assessment Area 2 currently has an abundance of mature and old-growth forests available as goshawk habitat. Again, with the exception of the ponderosa pine forests, the current amount of mature and old-growth forests is "probably at the high end of what was present prior to settlement." Anticipated future management on National Forests is expected to increase the total amount of suitable seral stages.

Status of goshawk populations in Assessment Area 2

The goshawk population in Assessment Area 2 is represented in the published research with five published reports found in the Area (Table 3.10).

Table 3.10. Published goshawk field studies conducted in Assessment Area 2.

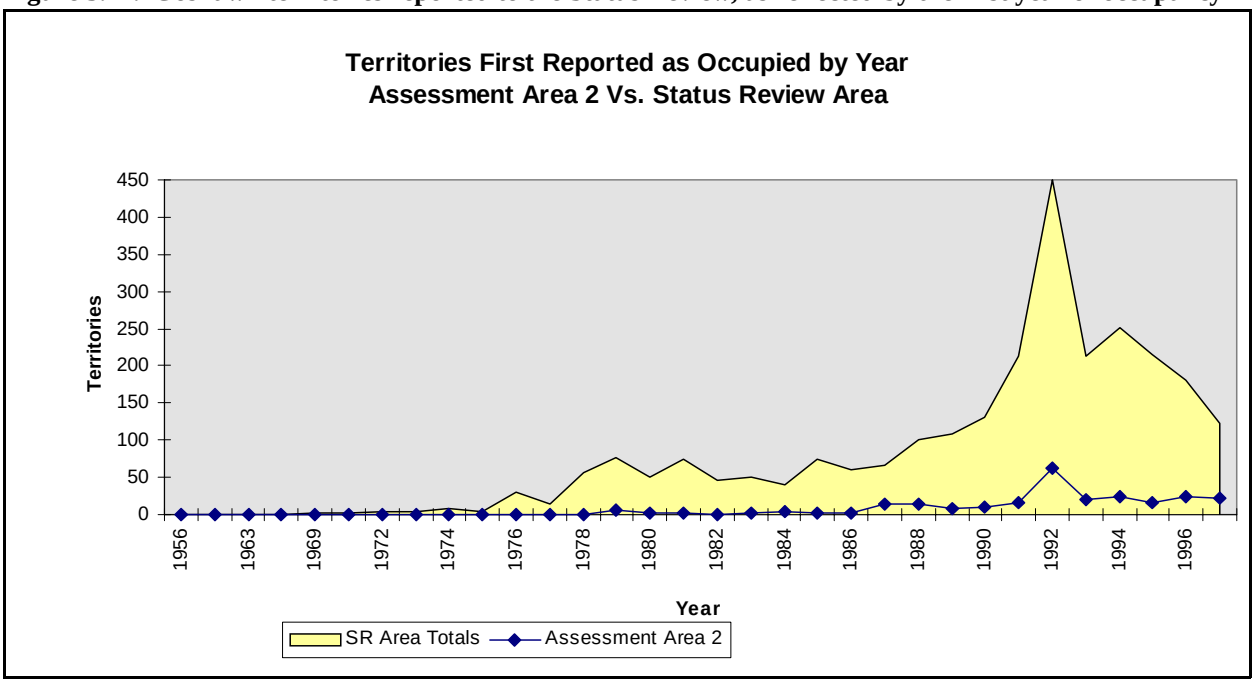
Source	Type	Location	Topic(s)
White, Lloyd and Richards 1965	published paper	near Dinosaur NP	nest site in Upper Sonoran vegetation zone
Doerr and Enderson 1965	published paper	Colorado Springs	winter abundance index
Shuster 1980	published paper	Arapaho and Roosevelt NFs and Rocky Mtn. NP	nest-site habitat characteristics
Squires and Ruggiero 1995	published paper	Southcentral Wyoming and Colorado	winter movements, migration
Squires and Ruggiero 1996	published paper	Medicine Bow NF	nest-site habitat characteristics

Distribution and Reported Numbers

Goshawks are widely distributed across the forested habitat of this Assessment Area (Figure 3.13) and we believe this distribution is similar to the historic range of the species.

Like other Assessment Areas, there was a temporary increase in survey effort in 1992-93 (Figure 3.14). Most reported goshawk surveys in the Assessment Area have been conducted on Forest Service lands (84% of the reported territories, managing 61% of the forested acres). The BLM reported 4% of the territories. Private and other landowner categories reported 11% of the sites (Table 3.11). This 15% of the reported goshawks on non-Forest Service lands contributes to the

Figure 3.14. Goshawk territories reported to the Status Review, as reflected by the first year of occupancy



conclusion that these other lands are relevant to the long term management of the species.

Review of the history of the reported territories shows that 72% have been documented in the past seven years as a result of increased survey effort.

Table 3.11. Goshawk territories reported to the Status Review Team by land management agencies and state natural heritage programs in Assessment Area 2.

State	Landowner	No. Territories
Colorado	Arapaho and Roosevelt National Forest	4
	Grand Mesa, Uncompahgre, and Gunnison National Forest	22
	San Juan-Rio Grande National Forest	5
	White River National Forest	26
	Florissant Fossil Beds National Monument National Park Service	1
	Mesa Verde National Monument National Park	2
	Rocky Mountain National Park	5
	Bureau of Land Management: Glenwood Springs Field Office	9
	Bureau of Land Management: Grand Junction Field Office	1
	Colorado State: Forest Service	8
	Subtotal:	83
South Dakota	Black Hills National Forest	80
	Subtotal:	80
Wyoming	Medicine Bow-Routt National Forest	127
	Devils Tower National Monument National Park Service	1
	Bureau of Land Management: Buffalo Field Office	2
	Bureau of Land Management: Newcastle Field Office	1
	Bureau of Land Management: Worland District Office	1
	Monarch Wildlife Consultants	6
	Wyoming Natural Heritage Diversity Database	6
	Wyoming State: Forestry Division	4
	Wyoming State: Game and Fish Department	12
	Subtotal:	**160**
	TOTAL	**323**

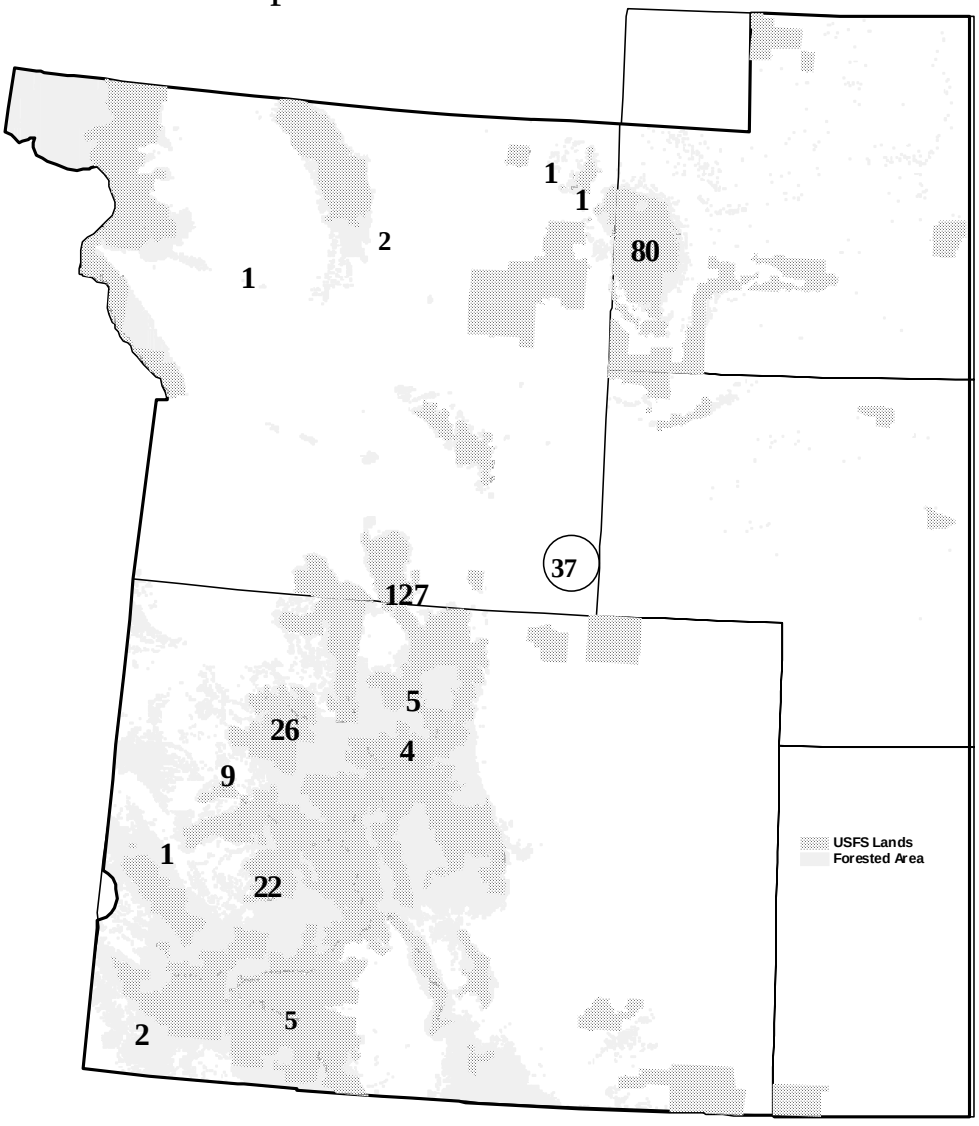
Population Status

There is no information available to directly assess historical goshawk population trends in the Assessment Area. There is very little information on historical habitat changes to derive conclusions for goshawk populations. Goshawks are probably less abundant in areas that have been more heavily logged or affected by wildfires, but we have no survey results or research to document this conclusion. While abundance of goshawks may have changed, goshawk distribution in Assessment Area 2 is probably similar to pre-settlement times and we have no evidence of areas where the species has been extirpated.

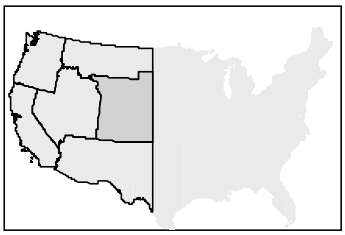
Conclusion

It is reasonable to conclude that there have been declines in goshawk populations in the Assessment Area when looking at habitat changes since pre-settlement times. Information to determine the magnitude of presumed decline or the stability of current populations is currently lacking. The lack of scientific research, and/or agency monitoring of goshawk territories, contributes to the dearth of information on goshawk population status and trends in this Assessment Area.

Figure 3.13 Numbers of Northern Goshawk Territories Reported In Assessment Area 2



Goshawk numbers indicated on this map represent the total number of goshawk territories reported by Federal agencies for their entire administrative area. Therefore, the numbers indicate generalized locations and do not indicate the actual locations of goshawk territories. Numbers reported by the States on private and other lands that were not reported by Federal agencies, may occur anywhere within the Assessment Area. These are represented by a circled italic number located near the center of the Assessment Area.



Northern Goshawk
Status Review Team
June 1998

Assessment Area 3

Introduction and Current Habitat as Modeled from FIA data

Assessment Area 3 consists of the States of Arizona and New Mexico, western Texas and the Oklahoma panhandle (Figure 1.1) Table 3.12 provides an initial view of the potential forest vegetation, by ownership, in this Assessment Area; a portion of these acreages would be considered capable of supporting goshawk habitat. Figure 3.15 illustrates the relative proportions of these forest types in this Assessment Area. In Assessment Area 3 the Forest Service is the dominate land manager of forested vegetation which is capable of supporting goshawk habitat.

Table 3.12. Forest Cover Types, by Land Manager/Owner - Assessment Area 3.

Forest Type	Indian Lands	National Forests	Bureau of Land Management	National Park Service	Fish and Wildlife Service	Other Lands*	Total
Aspen-birch	7,000	61,000	5,000	1,000		119,000	193,000
Douglas fir	33,000	302,000	4,000			140,000	479,000
Fir-spruce	93,000	385,000				166,000	644,000
Pinyon-juniper	4,192,000	7,711,000	3,524,000	737,000	74,000	5,347,000	21,585,000
Ponderosa pine	2,116,000	5,838,000	350,000	86,000	11,000	1,124,000	9,525,000
Western hardwoods	109,000	112,000	68,000	5,000	7,000	287,000	588,000
Total	6,550,000	14,409,000	3,951,000	829,000	92,000	7,183,000	33,014,000

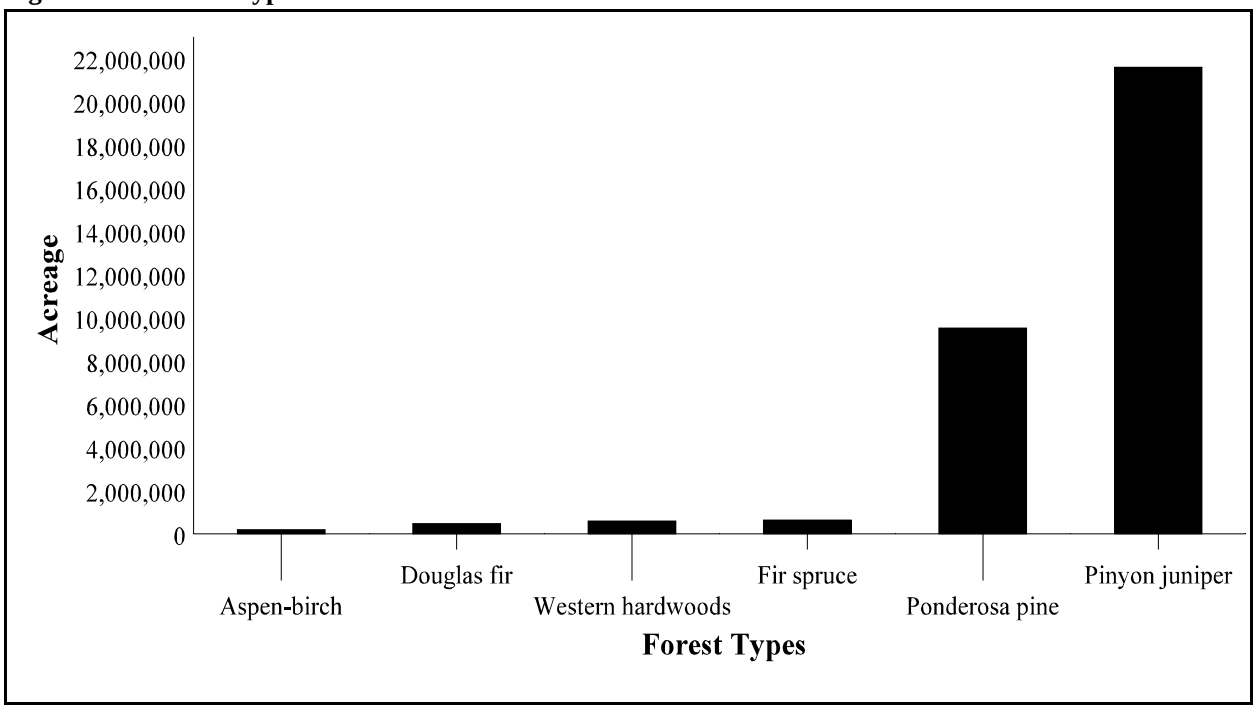
Habitat Trends

Historical Changes

With the arrival of European settlers in the 1870s, southwestern forests were subjected to many new influences. Three primary factors played an important role in shaping current forest conditions: 1) disruption of natural disturbance regimes (i.e., fire control), 2) livestock grazing, and 3) commercial timber harvest (Cooper 1960; Covington and Moore 1992, 1994; Harrington and Sackett 1992).

Aggressive fire suppression began after European settlement (Cooper 1960) and remains current policy in many areas. The absence of frequent, low-intensity fire, coupled with widespread overgrazing by livestock in the late 1800s, reduced competition between herbaceous vegetation and tree seedlings. These effects generally resulted in increased tree densities on forested lands

Figure 3.15. Forest Types - Assessment Area 3



(e.g., Covington and Moore 1992, 1994; Harrington and Sackett 1992). Increased tree densities alter the stand structure and can also cause changes in stand species composition by favoring shade-tolerant tree species and driving succession from one forest type to another (e.g., many ponderosa pine and aspen stands appear to be converting to mixed-conifer stands).

Timber harvest began with the arrival of European settlers and attained commercial scale during the 1880s (Schubert 1974). Timber harvest also has altered stand structure and in some cases species composition. In many cases, the net effect of timber harvest has been a decrease in old trees and at least a short-term decrease in tree density and basal area, thus having the opposite effect of fire suppression, especially when coupled with overgrazing. Where timber harvest has targeted the removal of shade-intolerant species (e.g., ponderosa pine), it can cause the stand to trend towards shade-tolerant species (e.g., white fir, Douglas-fir).

Recent Habitat Trends

Limited sources of data are available to quantify habitat trends in southwestern forests. Forest inventories conducted in New Mexico and Arizona in the 1960s (Choate 1966, Spencer 1966) and 1980s (Conner et al. 1990, Van Hooser et al. 1992) can provide insight into changes over an approximate 25 year period. However, differences in definitions and data collection methods make comparisons between the 1960s and 1980s data difficult, and results must be interpreted with great caution. These differences include: 1) changes in definitions of vegetation types, 2) changes in the landbase being sampled (e.g., due to changes in wilderness designation), and 3)

differences in sampling intensity.

The following comparisons are limited to commercial forest lands in Arizona and New Mexico. Some comparisons of the 1960s and 1980s data sets (Johnson 1994, USDA Forest Service 1995) have extrapolated these data to unsampled forested lands such as wilderness areas. Our comparisons, like those of the Mexican Spotted Owl Recovery Team (USDI Fish and Wildlife Service 1995), focused on changes on commercial forest lands for which data exist. Due to changes in land designations (i.e., commercial timber land becoming wilderness) between the two sampling periods, comparisons of raw values are potentially misleading. Comparisons of proportions are more appropriate.

Total forested land increased by approximately 5% from the 1960s to the 1980s while the commercial forest landbase decreased by approximately 15% (Table 3.13). It appears the proportion of several forest types also changed from the 1960s to the 1980s. Mixed-conifer forests appear to have increased, spruce-fir remained approximately the same, and the proportion of ponderosa pine and aspen forests declined (Table 3.14). Explanations for the changes in proportions of forest types include: 1) invasion and succession of mixed-conifer species into other types (meadows, aspen) in the absence of fire, 2) selective harvest of ponderosa pine in mixed-conifer, and 3) changes in forest type definitions.

Table 3.13. Changes in Total Forested Land and Commercial Forest Landbase from the 1960s to the 1980s in Arizona and New Mexico. Sources of Data: Choate (1966), Spencer (1966), Conner et al. (1990) and Van Hooser et al. (1992).

	1960s	1980s	% Change
Total Forest Land	11,160,000	11,738,000	+5
Commercial Forest Land	10,246,000	8,701,000	-15

Table 3.14. Changes in Area and Distribution of Forest Types from the 1960s to the 1980s on Commercial Forest Lands in Arizona and New Mexico. Adapted from USDI Fish and Wildlife Service (1995). Sources of data: Choate (1966), Spencer (1966), Conner et al. (1990) and Van Hooser et al. (1992).

Forest Type	Area in 1960s	Proportion of 1960s Area	Area in 1980s	Proportion of 1980s Area	Change in Proportion
Ponderosa Pine	7,992,000	78	6,252,000	72	-6
Mixed Conifer	1,173,000	12	1,752,000	20	+8
Spruce-Fir	635,000	6	496,000	6	0
Quaking Aspen	446,000	4	201,000	2	-2
TOTAL	10,246,000	100	8,701,000	100	

Changes also occurred in size-class distribution of trees on commercial lands in Arizona and New Mexico from the 1960s to the 1980s (Table 3.15). Sapling-sized trees (1-4.9 in dbh) decreased in absolute density and relative contribution to the size-class distribution. In the next size class (5-12.9 in dbh), trees increased in density by 40% and in relative proportion of the size class distribution by approximately 9%. Mid-sized trees (13-18.9 in dbh) increased in absolute density (7.5%) but the proportion of this size of trees did not change. Large trees (>19 in dbh) decreased from 2.2 to 1.7 trees per acre, a >20% decline in absolute density. This last decrease is due to the harvest of large trees during this period. Possible explanations for the increase in smaller stems (5-12.9 in dbh) include fire suppression, pre-commercial thinning, planting of harvested acreage and lack of harvest of this size class.

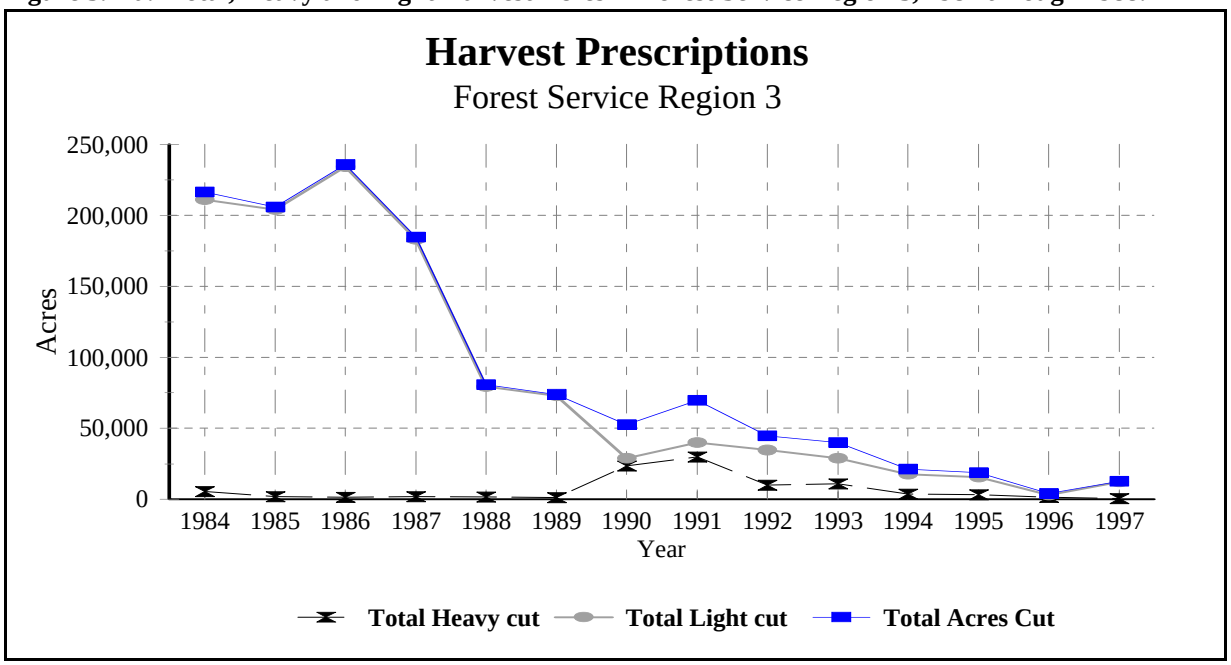
Table 3.15. Changes in Density (trees per acre) and Distribution of Tree Size Classes from the 1960s to the 1980s on Commercial Forest Lands in Arizona and New Mexico. Adapted from USDI Fish and Wildlife Service (1995). Sources of data: Choate (1966), Spencer (1966), Conner et al. (1990) and Van Hooser et al. (1992).

Tree Size Class (dbh in inches)	1960s Density (trees/ac)	1960s Proportion (% of total stems)	1980s Density (trees/ac)	1980s Proportion (% of total stems)	Change in Proportion	Density Change
1-4.9	59.2	62.5	54.3	53.7	-8.8	-8.3
5-12.9	28.5	30.0	39.9	39.4	+9.4	+40.2
13-18.9	4.9	5.2	5.3	5.2	0	+7.5
> 19	2.2	2.3	1.7	1.7	-0.6	-20.4

In summary, from the 1960s to the 1980s, 1) total forested acres increased, 2) mixed-conifer apparently covered more of the landbase, while ponderosa pine and aspen covered less (but note cautions above regarding this conclusion), and 3) densities of large trees declined. The 20% decline in large trees over the 25 year period is probably the most significant trend with respect to an important northern goshawk habitat components.

In the 1980s and into the early 1990s, timber harvest levels from National Forests in the Assessment Area were higher than recent years. It is our assumption that this harvest is the larger size classes of trees. Harvest rates for these Forests were available from 1984 to 1997 (P. Jackson, USDA Forest Service Region 3, Albuquerque, pers. comm.). These showed a peak in total acres harvested in 1986 followed by a reduction beginning in 1988 (Figure 3.14a; also see Appendix A). Total "heavy harvest," which consists of prescriptions that removed most or all of the large trees (i.e., seed, removal and clear cuts), peaked in 1991 and has been declining since 1992 (Figure 3.14a) as a result of Forest Plan amendments.

Figure 3.14a. Total, Heavy and Light Harvest Acres in Forest Service Region 3, 1984 through 1988.



A recent Final Environmental Impact Statement amending Forest Plans for the Southwestern Region (FEIS) (USDA Forest Service 1995) described existing forest structure on National Forest lands (Table 3.16). The percentages reported in the FEIS for current acres of young, mid-aged and mature age classes are difficult to interpret in comparison to earlier documents; documents from the early 1980s reported proportions of size classes on all commercial forests, which may or may not be comparable to age classes (see Table 3.15). In our attempt to interpret the data, we assume there is a general relationship between age and size of trees. The FEIS data seem inconsistent with National Forest harvest reports discussed above and on-the-ground observations (R. Miller, Arizona Game and Fish Department, Flagstaff, pers. comm.). The differences between the FEIS and other sources with regard to proportions of young, mid-aged, and mature forest contributes to our inability to make definitive conclusions about habitat trend in Assessment Area 3.

Table 3.16. Existing and Predicted Long-term (200+ years) Forest Structure Under Current Management Direction on National Forest Lands in Arizona and New Mexico. Adapted from USDA Forest Service (1995).

Tree Age/Size Class (dbh in inches)	Existing Conditions (%)	Predicted Conditions (%)
Seedling (0-1)	3	8
Sapling (1-5)	4	9
Young (5-12)	36	16
Mid-aged (12-18)	23	17
Mature (18+)	30	25
Old[1]	4	25

[1] Meets Regional standard for old growth (dbh varies by site and forest type).

In the recent past, large acreages of forested habitats have also been lost to catastrophic fires (USDA Forest Service 1995). From 1989 to 1994, approximately 251,100 forested acres on National Forests were impacted by fire. Approximately 30% of these acres were burned with a severity to kill the tree canopy (Table 3.17). Once a site has been severely impacted by fire, re-establishment of northern goshawk habitat could take over 200 years and in some cases, suitable habitat may be lost indefinitely (USDA Forest Service 1995).

Table 3.17. Large Fire Effects to Forested Habitats (1989-1994) and Predicted Decadal Impacts (1994-2005). Adapted from USDA Forest Service (1995).

Cover Type	Fire Effects		
	Acres Impacted (1989-1994)	Percentage with Complete Canopy Loss	% Predicted to Burn (1994-2005)
Ponderosa Pine	174,500	38%	18
Mixed Conifer	55,200	16%	6
Spruce Fir	21,400	4%	12
TOTAL	251,100	30%	15

Habitat Projections for National Forests in Assessment Area 3

The following discussions are limited to National Forest lands in Arizona and New Mexico and are based on quantitative and qualitative analyses provided in the FEIS for the Southwestern Region (USDA Forest Service 1995). The purpose of these amendments was to incorporate the *Mexican Spotted Owl Recovery Plan* (USDI Fish and Wildlife Service 1995) and the regional goshawk guidelines (Reynolds et al.1992) into all Forest Plans in the Region. The Record of Decision (ROD) (USDA Forest Service 1996) implemented the preferred alternative in 1996.

This decision will have a short-term effect (5-10 years) because each of the Region's Forest Plans are scheduled for revision beginning in 1996.

Under the ROD, prescribed fire and thinning of small trees (< 9 in dbh) are promoted to reduce the risk and extent of stand-replacing fires. Seasonal and area restrictions for owls and goshawks, and air quality issues, may prevent widespread application of these management tools, leaving some important habitats vulnerable to catastrophic events. The FEIS evaluated these short-term habitat losses due to catastrophic fire. From 1994 to 2005, the Forest Service estimated approximately 15% of ponderosa pine, mixed-conifer and spruce-fir forests will burn (Table 3.17); a portion of the predicted burn area is expected to be stand-replacing fires. More recent information (R. Fletcher, USDA Forest Service Region 3, Albuquerque, pers. comm.) indicates that future fuels reduction budgets for the Southwestern Region, beginning in 1999, are expected to increase substantially, in recognition of the unnaturally high level of risk for catastrophic fire in owl and goshawk habitat. Overall implementation of the ROD includes the necessary balancing of short-term risk to currently occupied owl and goshawk habitat against long-term goals for the landscape.

Implementation of the ROD will affect forest structure, primarily on lands classified as suitable for timber harvest. According to the FEIS, over the short-term (10-15 years), managed events are not expected to have profound effects on forest structure. While in the long-term (200+ years), the significant changes to forest structure are expected, most notably the increase in old trees (see Table 3.16).

The FEIS clarified that the projected forest structure of old trees (Table 3.16) cannot be attained and sustained across large areas at tree densities for owl and goshawk nest/roost site conditions because of the ecological limitations (primarily soil moisture). While large, contiguous areas of dense forest are not necessary for goshawk nest areas, patches of these forest conditions must occur, and must be well-distributed across the landscape (see Chapter 2, Life History and Ecology). According to the FEIS, the projected high levels of mature and old forest arose primarily from thinning from below, either with fire or tree cutting, while retaining larger trees. In densely stocked stands, the FEIS stated that large fires, and insect and disease effects would be expected to intervene long before the projected conditions were approached. However, if lower densities of trees (relative to present densities) are managed for, the projected size-class distribution could probably be sustained across the landscape over the long-term.

Conclusions regarding goshawk habitat trends in Assessment Area 3

Historical and current trends of northern goshawk habitat are not well understood in this Assessment Area. Many factors contribute to this lack of knowledge, but the paucity of reliable vegetation data is the most obvious explanation. While it is clear that changes have occurred in forests of Assessment Area 3, the net effect of these changes on amount and quality of northern goshawk habitat is difficult to quantify. Similar to conclusions reached by the Mexican Spotted Owl Recovery Team (USDI Fish and Wildlife Service 1995), our inability to evaluate habitat

trends strongly emphasizes the need for accurate and consistent inventory and monitoring of forest resources to assess future changes in forest habitats (see Chapter 6).

Data received from land management units for the Status Review were not useful in ascertaining trend in goshawk habitat in Assessment Area 3. Data obtained from other sources were more useful but presented difficulties as well. Information in the forest inventories, Forest Service harvest reports, and personal knowledge of the ground were not consistent with interpretations of the FEIS data on current distribution of tree size classes. Despite lack of definitive information, we conclude there has been a reduction in the proportion of large, mature and old trees in the Assessment Area.

Implementation of the goshawk guidelines (Reynolds et al. 1992) in Forest Service Region 3 cannot yet allow us to predict effects on goshawk habitat. Interpretation and implementation of the goshawk guidelines has been asserted to vary widely across Forests and Ranger Districts (Arizona Game and Fish Department 1993, Braun et al.1996). Whether the intent of the guidelines is being met continues to be a subject of debate. Regardless of this controversy, the effectiveness of the guidelines could not yet be demonstrated in even the best of applications. It is simply premature to evaluate whether these guidelines will provide adequate protection for goshawks and their habitat, because they have been in effect for only two years. Even considering that informal application of the guidelines began in the early 1990s, the time period of application is too short to determine their effectiveness. Long-term effectiveness monitoring will be necessary to make that determination.

Fire, insects and disease will undoubtedly reduce goshawk habitat in the near future. Recent forest health status reports and initiatives (e.g., Moody et al. 1992, USDA Forest Service 1994) and forest restoration proposals (e.g., Covington 1996, Covington et al. 1997, Greco 1998, Taylor 1998) are aimed to prevent large-scale habitat losses due to catastrophic events. These new management paradigms propose more open forest conditions at a landscape scale across the Southwest. If implemented in stands with tree density and canopy considered goshawk nest habitat, these treatments would degrade the habitat and reduce the likelihood that the stands would be selected for nest areas (see Chapter 2, Habitat Characteristics and Chapter 4, Vulnerability and Threats). These new management paradigms would also affect foraging habitat. More open forest conditions would be expected to benefit some goshawk prey (e.g., golden-mantled ground squirrels) but degrade habitat for others (e.g., Abert's squirrel) (Reynolds et al. 1992). However, some authors assert that more open forest structure may not favor goshawk foraging and prey availability (Beier and Drennan 1997). Therefore, while forest health prescriptions would have more predictable results in goshawk nest habitat, it is difficult to predict an overall effect on goshawk foraging habitat.

In conclusion, goshawk habitat in southwestern forests has been affected by the loss of mature and old forest, primarily to timber harvest. The bulk of goshawk habitat occurs on federal lands (Forest Service) where dramatic reductions in timber harvest in recent years have occurred. The rate of loss of goshawk habitat from these lands has been greatly reduced. Concurrently,

management attention has turned to restoration of the natural processes (fire) and vegetation structure (open stands of large trees with patches of more dense vegetation). Implementation and effectiveness of the Forest Service Regional goshawk guidelines and the Mexican spotted owl recovery plan are premature to draw conclusions regarding goshawk habitat and populations. However, these management guidelines, along with a greater understanding of southwestern forest ecosystem functions, should result in improved forest management strategies (R. Fletcher, USDA Forest Service Region 3, Albuquerque, pers. comm.). Monitoring of the goshawk guidelines should be is initiated, and adaptive management should be used to adjust the guidelines and their implementation in response to the monitoring results.

Status of goshawk populations in Assessment Area 3

Over the last 20 years, numerous goshawk studies have been conducted in the Assessment Area. These studies have addressed a wide array of topics, ranging from describing habitat characteristics to measuring demographic parameters (Table 3.18). Although all of these studies have addressed important aspects of goshawk ecology, only two (Ingraldi 1998, Reynolds and Joy 1998) directly contribute to assessing goshawk population status and trends. Both studies are in progress.

Table 3.18. Published and unpublished goshawk field studies conducted, or in progress, in Arizona and New Mexico. In some cases, multiple papers or reports have resulted from the same study. Since the intent is to display an overview of the number of different studies (vs. number of publications), generally only the most complete or most recent publication or report is cited.

Source	Type	Location	Topic(s)
Beier 1997a	report	Coconino NF, AZ	winter foraging habitat
Beier 1997b	report	Coconino NF, AZ	fledgling survival and movements
Beier and Drennan 1997	published paper	Coconino NF, AZ	summer foraging habitat
Boal and Mannan 1994	published paper	Kaibab NF, AZ	diet, productivity
Bright-Smith and Mannan 1994	published paper	Kaibab NF, AZ	home range, habitat use
Crocker-Bedford and Chaney 1988	published paper	Kaibab NF, AZ	habitat characteristics
Crocker-Bedford 1990	published paper	Kaibab NF, AZ	effects of timber harvest on occupancy and productivity, density
Gavin and May 1996	report	AZ	genetics, taxonomy
P. Hall, pers. comm.	unpublished data	Coconino NF, AZ	home range
Hubbard 1992	report	Southwest	taxonomy
Ingraldi 1998	draft report	Sitgreaves NF, AZ	demography, ecology
Ingraldi and MacVean 1995	report	Sitgreaves NF, AZ	habitat selection
Kennedy 1989	report	Santa Fe NF, NM	reproductive success, density, habitat characteristics, food habits
Kennedy et al. 1994	published paper	Santa Fe NF, NM	dispersal, post-fledging areas, home range
Luckett 1978	report	AZ	habitat characteristics
Reynolds and Joy 1998	report	Kaibab NF, AZ	demography, ecology
Snyder 1995	report	Coronado NF, AZ	distribution, productivity, habitat characteristics, diet
Siders and Kennedy 1996	published paper	Santa Fe NF, NM	habitat characteristics
Ward and Kennedy 1996	published paper	Santa Fe NF, NM	juvenile survivorship
Ward et al. 1992	report	Kaibab NF, AZ	habitat changes and reproduction

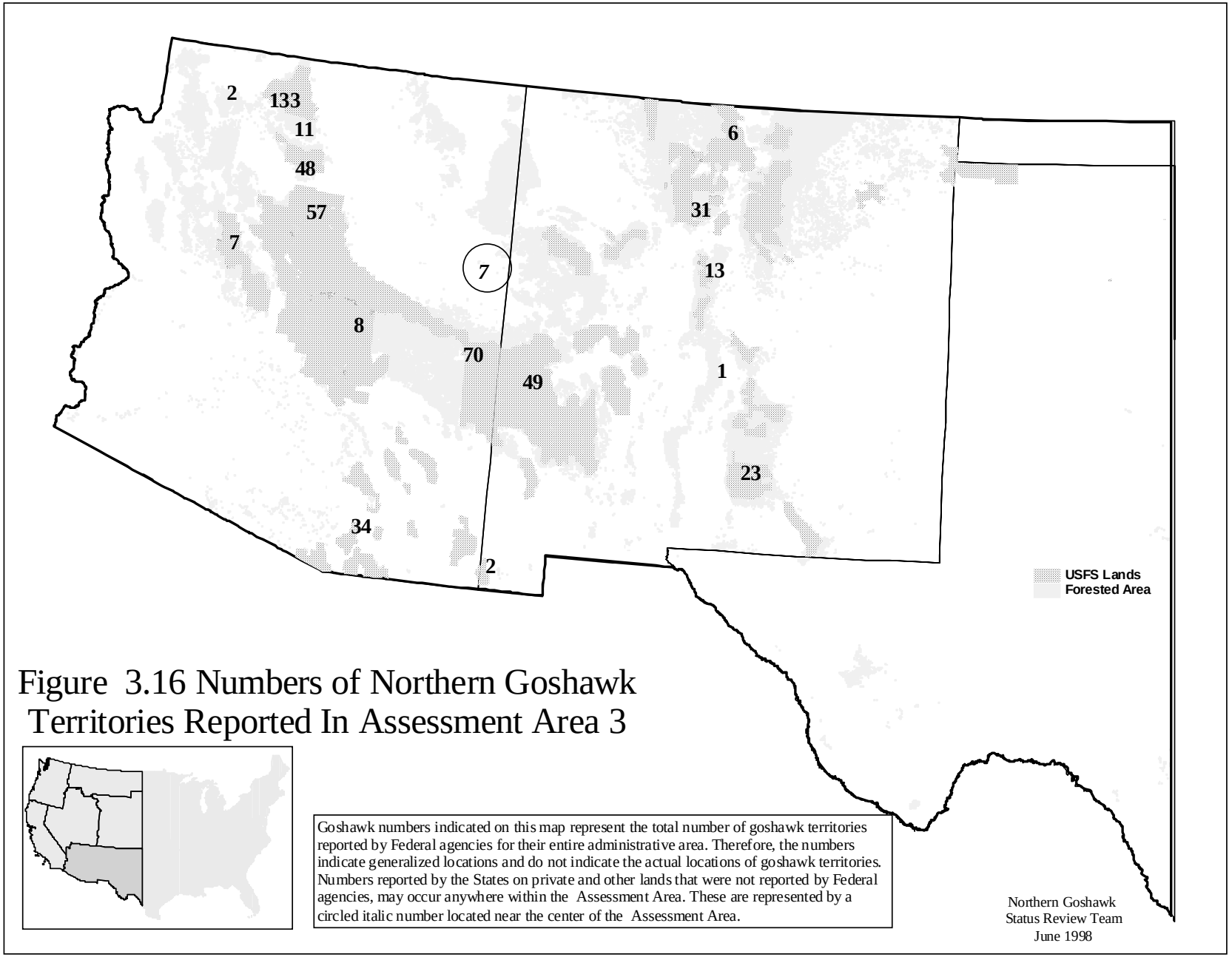


Figure 3.16 Numbers of Northern Goshawk Territories Reported In Assessment Area 3

Distribution and Reported Numbers

Goshawks are widely distributed across the Southwest (Fig. 3.16). There are breeding records from all major mountain ranges, as well as smaller sky islands, generally above 6,000 feet in elevation (Snyder and Snyder 1998). In the Southwest, the goshawk's winter range is believed to be similar to its breeding range, although there is some irregular movement of individuals, particularly immature birds, and generally to lower elevations (P. Hall, unpubl. data; Beier 1997a; Ingraldi 1998).

Most goshawk surveys in the Southwest have been conducted on Forest Service lands (e.g., Russo 1976 and 1977, Todd 1978, Luckett and Todd 1982, Tibbitts et al. 1988, Tibbitts and Zinn 1989, Zinn and Tibbitts 1990, Dargan 1991, Beatty 1992, McGuinn-Robbins and Ward 1992, Heslin et al. 1993, Driscoll and MacVean 1994, Lutch 1996) beginning in the 1970s, but with most occurring since 1991 when the Forest Service first issued regional goshawk guidelines (Fletcher and Sheppard 1994, USDA Forest Service 1995). Surveys have followed a standard inventory protocol based on Kennedy and Stahlecker (1991, 1993) and Joy et al. (1994). A disproportionate number of these surveys have occurred on a single Ranger District (North Kaibab Ranger District) in northern Arizona, which is now the focus of the largest goshawk demography study (Reynolds and Joy 1998) in the species' range. A few surveys have also been conducted on other lands (e.g., NPS, Berner and Mannan 1992, Driscoll and MacVean 1994; BLM, Driscoll and MacVean 1994; tribal lands, Moors 1996).

Goshawks are difficult to survey and detect (Joy et al. 1994, Reynolds and Joy 1998) and goshawk numbers reported to the Status Review Team (Figure 3.16, Table 3.19) must be interpreted cautiously (Chapter 1). First, surveys tend to focus on project areas (e.g., timber sale areas) and thus rarely achieve complete coverage of a given administrative unit. Even for surveyed areas, the data are confounded by two primary and opposing factors: 1) because goshawks build multiple alternate nests, the number of pairs is often overestimated; and, conversely, 2) because goshawks can be difficult to detect and many are never located, the number of pairs can be underestimated. Thus, it is difficult and expensive to reliably estimate populations because hawks must be marked and considerable time and effort expended, as described by Reynolds and Joy (1998). To further confound territory numbers, it is important to note that the numbers reported to the Team (Table 3.19) are based on agency databases that include historical sites which may no longer exist (e.g., burned, logged, no recent occupancy), may not be complete and up-to-date, may include locations which have not been verified (e.g., territories with no documented goshawk activity, only assumed to be goshawk), and may include duplicate records.

Table 3.19. Management agencies and state natural heritage programs in Assessment Area 3.

State	Landowner	No. Territories[1]
Arizona	Kaibab National Forest: North Kaibab	133
	Kaibab National Forest: South Kaibab	48
	Apache-Sitgreaves National Forests	70
	Coconino National Forest	57
	Coronado National Forest	34
	Grand Canyon National Park	11
	Tonto National Forest	8
	Prescott National Forest	7
	Bureau of Land Management: AZ Strip Field Office	2
	various, including private lands	7
	Subtotal:	**377**
New Mexico	Gila National Forest	49
	Santa Fe National Forest	31
	Lincoln National Forest	23
	Cibola National Forest	13
	Carson National Forest	6
	Coronado National Forest	2
	Bureau of Land Management: Socorro Field Office	1
	Subtotal:	**125**
	TOTAL:	**502**

[1]Territory numbers reported in this table may not match numbers reported elsewhere in the document. This table includes territories reported directly by landowners supplemented with state natural heritage program database information to fill in gaps. Also, these territories have not been screened for territory validity. See text for any such adjustments.

In February 1997, in an attempt to more reliably estimate the number of known goshawk pairs in Arizona, the Arizona Game and Fish Department surveyed land management agency biologists (M. Ingraldi, pers. comm.). Biologists were asked to provide the number of northern goshawk territories which had been active (i.e., laid eggs) at least once since 1990. The total number of

territories reported for Arizona in this survey (292) was substantially lower than that reported to the Team (377, Table 3.19) and may be a better representation of the number of known goshawk territories. Biologists were also asked to estimate the proportion of ponderosa pine and higher elevation forest that had been surveyed for goshawks. This estimate ranged from 50-75%. Thus, this estimated number of goshawk territories (292) should be viewed as a minimum number of goshawk pairs in the state.

In May 1998, the Status Review Team received additional information from New Mexico Department of Game and Fish (A. Sandoval, Santa Fe, pers. comm.) including the Department's tally of goshawk territories in New Mexico through 1997. Their estimate was 145 (vs. 125, Table 3.19), however, it was not qualified in any way so the Team could not determine whether this estimate had screened out historical and unverified territories. Also, we have no estimate for what proportion of New Mexico's forested habitat has been surveyed for goshawks but we suspect it is lower than for Arizona. Thus, the Arizona and New Mexico state agency estimates combined indicate there are 437 (vs. 502, Table 3.19) known goshawk territories, and should be viewed as a minimum number of goshawk pairs in the Southwest.

Population Status

Historical Trends

There is no information available to directly assess historical goshawk population trends in the Southwest. However, based on assessment of historical habitat changes (see section on Habitat Trends for Assessment Area 3), it seems reasonable to conclude that goshawk populations have been reduced from historical levels, although the magnitude of population change is unknown. Goshawks are probably less abundant in areas that were historically railroad logged (e.g., Apache-Sitgreaves and Coconino National Forests), but may occur at similar densities elsewhere in the Southwest (e.g., Coronado National Forest). While abundance has likely changed, goshawk distribution in the Southwest is probably similar to pre-settlement times.

Current Status

The northern goshawk is afforded special status in the Southwest. It has been a Forest Service sensitive species since 1982 (USDA Forest Service 1991) and an Arizona Game and Fish Department species of special concern since 1988 (AZ Game and Fish Dept. 1988 and 1996). Over the last decade, concerns over changes in forest habitats in the Southwest, and the viability of northern goshawk populations, have been expressed by wildlife professionals and the public (e.g., Kennedy 1989, Crocker-Bedford 1990, Zinn and Tibbitts 1990, Reiser 1991, Silver et al. 1991). In 1990, in response to growing concerns, the Regional Forester conducted an internal status review on the goshawk and later formed the Goshawk Scientific Committee (GSC). The GSC's charge was to develop a credible management strategy to conserve the goshawk in the Southwest. In

their management recommendations (Reynolds et al. 1992), the GSC acknowledged that past forest management practices (primarily harvest of mature and old growth forest stands) had altered goshawk nest area habitat and implied that goshawk populations had been reduced.

Several recent reviews of available information have discussed, and in a few cases attempted to assess, the status or viability of goshawk populations, including those in the Southwest (e.g., Maguire and Call 1993, Block et al. 1994, White 1994, Braun et al. 1996, Kennedy 1997). These reviews have generally pointed out that there is no evidence to indicate a decline in goshawk populations. However, it is important to note that there is also no evidence to support an increase, nor to support that goshawk populations are stable in the Southwest. Ongoing demography studies aim to answer this question for two Arizona goshawk populations (Ingraldi 1998 and Reynolds and Joy 1998). However, neither study has collected data for a sufficient number of years to adequately assess goshawk population trends at this time.

The Forest Service study (Reynolds and Joy 1998) began in 1991 on the Kaibab Plateau in northern Arizona. This study is the largest goshawk demography study, both in terms of population size as well as total effort expended (see Intensive Studies section for a detailed description of this study). A few salient points, based on data collected to date, include: 1) the breeding density estimate for the Kaibab Plateau population (11.9/100 sq km) is the highest reported for the species, 2) the habitat appears saturated, and 3) the population appears relatively stable (Reynolds and Joy 1998). However, as mentioned before, several more years of study are needed to reliably estimate population trend.

In 1993, the Arizona Game and Fish Department (Ingraldi 1998) initiated a second study in response to one of Maguire and Call's (1993) recommendations. Maguire and Call (1993) failed to find sufficient demographic data to conduct a population viability analysis for the Kaibab Plateau population and recommended that a similar study be carried out in at least one other area. The Sitgreaves National Forest was selected because surveys had identified a relatively high number of breeding territories and the habitat was more representative of the current Arizona ponderosa pine forests. Unlike most ponderosa pine forests in the Southwest, the Kaibab Plateau was not railroad logged and is still largely dominated by mature trees. This makes the Kaibab Plateau unique in Arizona and in the Southwest. The Kaibab Plateau is judged by some to provide the best goshawk habitat in ponderosa pine across the pine's range (R. Reynolds, USDA Forest Service, Fort Collins, pers. comm.).

Ingraldi's (1998) study area on the Sitgreaves National Forest is almost twice as large as the Kaibab's (1276 sq mi vs. 669 sq mi), but has less than half the goshawk population. On the Sitgreaves 42 territories are known, with 50 estimated; on the Kaibab 108 are known and 146 estimated. This is not surprising given the forest management history of ponderosa pine forests on the Sitgreaves study area. Demographic data have been

collected for five years (1993-1997). At this time, the precision of demographic parameter (e.g., adult survivorship) estimates is too low to adequately measure the rate of population change. This is due primarily to the fact that too few marked hawks have been resighted. Also, the last five years are not expected to encompass the full range of variation in these parameters. Several more years of data collection will improve the precision of demographic parameter estimates.

For the draft report Ingraldi (1998) performed a sensitivity analysis which revealed that adult survivorship, and not fecundity or juvenile survivorship, is the key parameter to the viability of this central Arizona population. This is similar to findings for other raptors (e.g., peregrine falcons, Wooten and Bell 1992; northern spotted owl, Noon and Biles 1993).

Based on data collected to date on the Sitgreaves, Ingraldi (1998) noted that the number of fledglings per active nest was lower and the failure rate higher than averages reported for other western goshawk populations. When similar years of study for the Sitgreaves and Kaibab are compared (1993-1996), activity rate patterns have been similar (e.g., lows and highs have occurred in the same years), but the absolute values for activity rates have been lower on the Sitgreaves. Ingraldi also noted a bias in the male fledgling sex ratio of 1.74:1 (n=93), which was different than 1:1 (p=0.053). A skewed sex ratio such as this has not been reported for other North American goshawk populations, and may suggest a stressed population (Clark 1978, Silk 1983, Clutton-Brock and Iason 1986, McGinley 1984). These preliminary data from Ingraldi (1998) suggest that the Sitgreaves population is unstable and if current trends continue, could be declining.

Raptor migration studies by Hawkwatch International have collected long-term data across the West, including at three sites in the Southwest: Grand Canyon, Manzano Mountains and Sandia Mountains (Hoffman et al. 1992, Thomas and Smith 1997, Smith and Hoffman 1997). While Smith and Hoffman (1997) described trends in goshawk populations from these data, few goshawks were observed at southwestern count locations. Furthermore, the origin of the migrant birds was not known and southwestern goshawks are not believed to migrate. Therefore, migration data do not contribute to our knowledge of goshawk status in the Assessment Area.

Conclusions regarding goshawk populations in Assessment Area 3

It is reasonable to conclude that there have been local declines in goshawk populations in the Southwest when compared to pre-settlement times. We do not have adequate information to determine the stability of current populations. Despite five and seven years of intensive demographic study, it is premature to draw any conclusions about the status and trends of the two Arizona populations. Furthermore, results of these studies are site-specific, and while they may provide insight into goshawk population status in similar habitats, they should not be extrapolated to assess population performance across the Southwest.

Today, timber harvest rates are well below those of even a decade ago in the Assessment Area. Nevertheless, habitat changes due to a variety of forest management practices continue. Also, although large scale habitat changes are still occurring (e.g., due to catastrophic events), generally the magnitude of habitat change is lower. Thus, the effects of current management practices seem more subtle and are difficult to evaluate.

As discussed in the Habitat Trends section, recent amendments to Forest Plans are aimed at managing southwestern National Forest lands to maintain and enhance spotted owl and goshawk habitat. This is significant since National Forests comprise most of the goshawk habitat in the Southwest. Implementation and effectiveness monitoring is necessary, and adaptive management should be used to evaluate and make appropriate adjustments to the goshawk provisions in the current Forest Plans. The goshawk guidelines are intended to provide relatively stable goshawk habitat on the Forest Service lands in the Assessment Area, with an expected goshawk population response. Given their recent implementation, we have not yet seen evidence of effectiveness of the guidelines to achieve these expectations. Concurrent with the monitoring of the guidelines, goshawk populations in the Assessment Area must be monitored at intensive enough levels to be able to periodically assess their status, and again apply adaptive management to ensure that viable populations are maintained.

Assessment Area 4

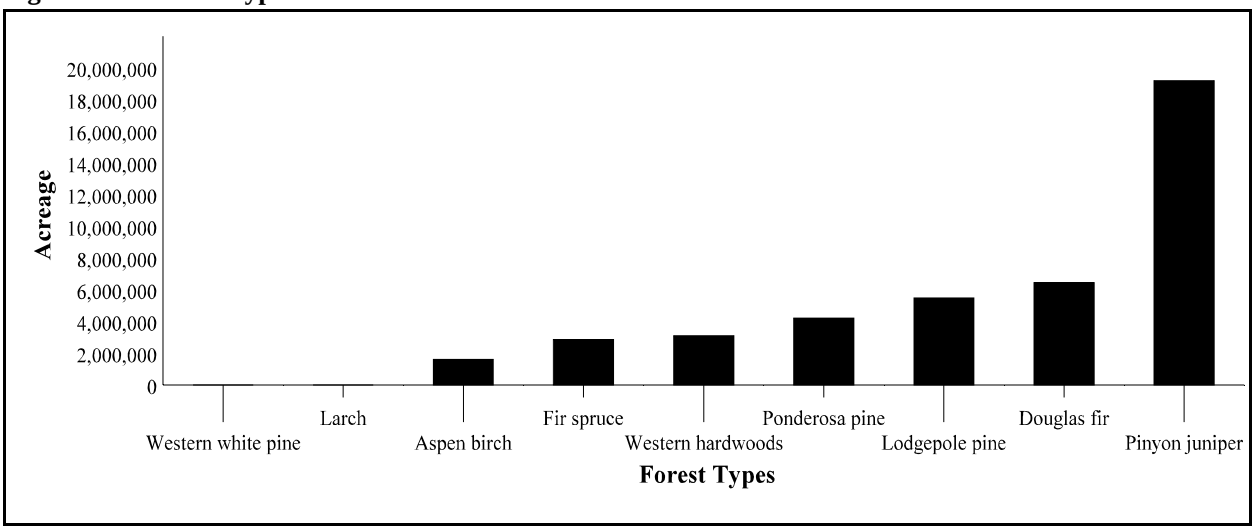
Introduction and Current Habitat as Modeled from FIA data

Assessment Area 4 consists generally of southern Idaho, Nevada, Utah, and western Wyoming (Figure 1.1) This Assessment Area includes 41,475,993 acres of varying forest type administered by the U.S. Forest Service in 19 national forests, U.S. Bureau of Land Management, non-Federal entities, U.S. Bureau of Indian Affairs, National Park Service, and U.S. Fish and Wildlife Service (U.S. Forest Service 1998). Table 3.20 provides an initial view of the potential forest vegetation, by ownership, in this Assessment Area; a portion of these acreages would be considered capable of supporting goshawk habitat. Figure 3.17 illustrates the relative proportions of these forest types in this Assessment Area.

Table 3.20. Forest Cover Types, by Land Manager/Owner - Assessment Area 4.

Forest Type	Indian Lands	National Forests	Bureau of Land Management	National Park Service	Fish and Wildlife Service	Other Lands*	Total
Aspen-birch	76,000	1,088,000	247,000			201,000	1,612,000
Douglas fir	48,000	5,496,000	445,000	158,000	7,000	318,000	6,472,000
Fir-spruce	46,000	2,622,000	89,000	95,000		21,000	2,873,000
Larch		1,000				1,000	2,000
Lodgepole pine	3,000	4,708,000	243,000	368,000	3,000	165,000	5,490,000
Pinyon-juniper	693,000	5,674,000	10,545,000	288,000	99,000	1,901,000	19,200,000
Ponderosa pine	18,000	3,406,000	272,000	34,000		488,000	4,218,000
Western hardwoods	175,000	1,642,000	247,000	24,000	1,000	1,021,000	3,110,000
Western white pine						1,000	1,000
Total	1,059,000	24,637,000	12,088,000	967,000	110,000	4,117,000	42,978,000

Figure 3.17 Forest Types - Assessment Area 4



Habitat Trends

Five forest types make up most of the forested portion of Assessment Area 4: pinyon-juniper, ponderosa pine, Douglas-fir, lodgepole pine, and fir-spruce (Figure 3.17). The major hardwood (deciduous) type is aspen. Forested land, and thereby goshawk habitat, in Assessment Area 4 is widely, yet unevenly, distributed. High elevation areas of the interior West that receive ample precipitation are forested. Fir-spruce occupies areas at higher elevations where temperatures are cool and moisture abundant. In Wyoming and Utah, the fir-spruce type is the highest elevation forest cover, occurring at timberline.

Although the goshawk may require specialized habitat conditions for nesting, it is a forest habitat generalist in terms of forest types it occupies. The following information is taken from various sources including agency reports, and is intended to supplement the limited amount of data on forest type trend, status, and projection received by the Service through responses to its data request entitled “Goshawk Data Summary” . No published data or agency reports are available from the Forest Service that provide this northern goshawk habitat information on a regional scale in the format requested (J. Amundson, USDA Forest Service, Region 4, pers. commun.).

Southern Idaho

This portion of Idaho includes about 13,800,000 acres of forest lands. However, not all forest types are necessarily potential goshawk habitat in this area (e.g., pinyon-juniper, hardwoods [cottonwoods]). Primary forest types include Douglas fir, ponderosa pine and lodgepole pine based on FIA stand data (Table 3.21).

Table 3.21. Area of Forest Land by Forest Type Group, Southern Idaho.

Forest Type Group	Total (acres)
Douglas-fir	5,273, 783
Lodgepole pine	3,025,451
Ponderosa pine	2,588,831
Pinyon-Juniper	1,734,371
Western hardwoods	666,420
Fir-spruce	508,525
Aspen-birch	13,096
Larch	1,977
Western white pine	741
Total	13,813,195

Forest land ownership in southern Idaho is primarily Forest Service and smaller amounts of BLM**.** As a result of a 1993 Presidential directive, the Forest Service and BLM have been developing what is proposed to become an ecosystem-based strategy for all Columbia River basin forests and rangelands. All federal lands in the entire Columbia River basin have been undergoing intensive study and analysis for the past 4 years as part of the Interior Columbia Basin Ecosystem Management Project (ICBEMP) (Quigley et al. 1997). An extensive assessment was made of all resources including forest lands. The assessments compared historical to current conditions and it was determined that: 1) ponderosa pine has decreased across the Basin with a significant decrease in single-story structure and large trees have decreased within roaded and harvested areas; and 2) mid-seral forest structures have increased in dry and moist potential forest vegetation along with an increase in the density of smaller diameter shade-tolerant trees (e.g., white-fir). In short, timber harvest selectively removed old-forests and fire exclusion promoted the transition of early seral stands to mid-seral forest structures (USDA and USDI 1996 and 1997).

The ICBEMP has resulted in the development of the Upper Columbia Basin Draft EIS for Forest Service and BLM lands in Idaho, northern Nevada and Utah, western Montana and a small portion of western Wyoming (USDA and USDI 1997). Selection of a preferred alternative is expected in 1999. The proposed preferred alternative is designed to restore ecosystem health and move forest communities back into the range of historical variability in 100 years. The preferred alternative is also predicted to provide a high likelihood of species persistence and viability over the next 100 years. An expert panel reviewing potential impacts of all alternatives rated the preferred alternative as having a

significant likelihood of improving the viability of goshawk populations across the project area.

Nevada

The U.S. Forest Service resource bulletin, “Nevada Forest Resources” summarized the results of the first State-wide forest inventory (Born et al. 1992) (Tables 3.22 and 3.24). Information is included about the extent and condition of the forest resources and recent forest product outputs as of 1989. The area of reserved and non-reserved timberland and woodland by ownership class is shown in Table 3.23. Timberland is defined as forest land where timber species make up at least 10 percent of growing space. Timber species are defined as tree species traditionally used for industrial wood products. In the Rocky Mountain States, these include aspen and cottonwood hardwood species and all softwood species except pinyon and juniper. Woodland is defined as forest land where timber species make up less than 10 percent of the extent of growing space, or stocking. Woodland species are tree species not usually used for industrial wood products and include areas used for fuelwood, fenceposts, and Christmas trees (Born et al.1992). In Nevada most of the woodland area consists of pinyon-juniper or juniper.

Table 3.22. Total Area (millions of acres) by Land Class and Owner Group, Nevada, 1989 (Born et al. 1992).

Ownership	Non-Forest	Forest
National Forest	3.0	2.8
Other Public	47.3	6.2
Private	10.2	0.8
Total	60.5	9.8

Table 3.23. Area of Reserved and Non-Reserved Timberland and Woodland by Ownership Class in Nevada (based on Born et al. 1992).

Land Ownership	Timberland	Woodland
Bureau of Land Management	106,505	6,024,047
Indian Lands	5,436	37,066
National Forest	435,406	2,354,217
National Park	38,055	19,769
Other public (including State and County)	3,460	30,147
Private	168,529	544,383
Total	757,391	9,009,629

Born et al. (1992) reported that of Nevada's 757,000 acres of timberland, about 65,000 acres are in reserved status, meaning that tree utilization is precluded by statute or administrative designation. This reserved acreage figure may underrepresent wilderness, National Park Service (including Great Basin National Park) lands, and scattered, inaccessible stands. Also, because timberlands were not field sampled in Nevada, the inventory data are limited to area information, and the available data are not adequate to compile forest inventory estimates for the State. With the exception of the Lake Tahoe area, the greatest concentration of forest land is in the northeast and east-central portions of Nevada. Scattered remnant trees indicate that some timberland likely occurred at more accessible lower elevations in the past but was cut to support earlier settlement, mining, and railroad activities (Born et al. 1992).

Table 3.24. Area of Forest Land by Forest Type Group, Nevada, 1989 (Born et al. 1992).

Forest Type Group	Total (acres)
Sierra conifer	128,992
Other conifer	275,775
Aspen	330,139
Cottonwood	21,251
Pinyon-Juniper	6,337,878
Juniper	2,009,004
Riparian	30,147
Other Woodland	292,579
Non-stocked	341,259
Total	9,767,024

Utah

The U.S. Forest Service resource bulletin, “Forest Resources of Northern Utah Ecoregions” presented condition and extent of forest resources of the Forest Service’s northern Utah ecoregion, with emphasis placed on species diversity, forest health, and land use issues (Table 3.25) (O’Brien 1996). This approach differed from traditional timber summaries. Similar information is not yet available for the Forest Service’s southern Utah ecoregion.

Table 3.25. Percent of Timberland Area in Each Province that is Accounted for by Each Habitat Type Series in Northern Utah, 1993 (O'Brien 1997).

Habitat Type Series	Province			
	Desert	Southern Rockies	Semi-Desert	Nevada-Utah Mountains
White fir	30	5	-	12
Sub-alpine fir	8	35	67	3
Engelmann spruce	-	7	-	-
Blue spruce	-	<1	-	-
Lodgepole pine	-	7	-	-
Limber pine	7	1	-	-
Ponderosa pine	-	2	-	-
Douglas-fir	35	13	33	63
Aspen	20	30	-	22
Total	100	100	100	100

Western Wyoming

No supplementary information on habitat condition and trend specifically for this sub-area was available in Service files. Discussion of habitat condition in the western Wyoming portion of Assessment Area 4 is included primarily in the discussion below of the Forest Service Region 4's assessment process for upland conditions.

Forest Type Trend, Current Status and Projection

Region 4 of the Forest Service compiled a draft report entitled "Properly Functioning Condition: Rapid Assessment Process" (USDA Forest Service 1997), based on adaptation of the original site-specific riparian assessment process to larger scales and to upland vegetation. The purpose of the report is to assess upland conditions at large scales, including Intermountain Regional, sub-regional, and landscape. The report applies the assessment of Proper Functioning Condition (PFC), described originally by the Bureau of Land Management (USDI Bureau of Land Management 1993) for use in riparian areas, to the Forest Service Intermountain Regional (millions to tens of thousands of square miles), sub-regional (thousands to tens of square miles), and landscape (thousands to hundreds of acres) scales. While this report does not quantify trend or projection, nor does it document commitments from the Forest Service regarding habitat management to ensure PFC, it provides the most recent qualitative information on current forest

functioning condition. The results of this analysis are an assessment of whether or not subject areas are within PFC with regard to structure, composition, disturbance regime, and patterns; and if not, an estimate of the degree of departure from PFC. These results are summarized for selected geographic and temporal scales, and a relative risk is estimated in terms of subject area or combinations of subject areas.

A summary of the relative risk to PFC at the Intermountain Regional scale is shown in Table 3.26. The relative risk rating of low, moderate, and high is an indication of how much departure there may be below the PFC.

Table 3.26. Regional Summary of Relative Risk of Departure from Properly Functioning Condition for All Reported Subject Areas (USDA Forest Service 1997).

Subject Area	High Risk	Moderate Risk	Low Risk
Riparian/Wetland	x		
Quaking Aspen	x		
Big Sagebrush/Grassland	x		
Pinyon-Juniper	x		
Tall Forb	x		
Engelmann Spruce-Subalpine Fir	x		
Grand Fir/White Fir complex	x		
Ponderosa Pine/Jeffrey Pine complex		x	
Ponderosa Pine (Southern Utah) type		x	
Douglas-Fir		x	
Lodgepole Pine		x	
Mountain Mahogany		x	
Subalpine Timberline Forests and Woodlands		x	
Mountain Brush complex			x
Gambel Oak			x
Alpine Lodgepole Pine			x

The following overview of the PFC approach of Region 4 of the Forest Service is taken from the draft report (USDA Forest Service 1997). It is important to understand that the PFC assessment process is a “coarse filter approach,” with the assumption that if vegetative communities and their processes are similar today to those occurring historically, then conditions will approximate those under which species evolved. It is important to note that the entire PFC assessment

methodology is not included in this document, but is summarized from the draft report (USDA Forest Service 1997). Four basic characteristics of ecosystems were evaluated: structure, composition, processes, and patterns. A matrix with these four characteristics as criteria and at three scales was developed to assess PFC. The matrix was used to describe each subject area. At the scale of the Intermountain Region the subject areas included 16 vegetation types, a hydrologic regime, a soil quality description, and an aquatic and terrestrial animal description. Indicators of a properly functioning condition were developed for each subject area, by criteria, and at each scale mentioned above.

As mentioned above, vegetation structure was one of the four criteria evaluated. Structure was intended to represent the balance of age and size classes for included subject areas related to vegetation types. A defined balance of size classes was estimated to reflect one that would sustain the type in the long-term. This means that there must be adequate recruitment in the type to sustain a range of age classes. For many of the conifer types the selected range of classes included approximately: 10 percent grass/forb, 10 percent seedling/sapling; 20 percent young forest, 20 percent mid-aged forest, 20 percent mature forest, and 20 percent old forest. The basis for using these vegetative structural stages was the work done by the Northern Goshawk Scientific Committee in 1990-1992. This committee recommended this mixture of classes because it sustained both forest cover types and a large suite of wildlife species. One assumption of the draft PFC report is that if these proportions are sought after by management most of the wildlife and social needs in forested landscapes can be met (USDA Forest Service 1997). For other subject areas such as non-conifers, non-forest types, riparian/wetlands, soil quality, hydrologic regime, and aquatic and terrestrial animals, structure was expected to reflect a balance not exceeding the sustainable biological and physical capabilities of the resource, and the indicators for these subject areas were based on scientific studies and the experience and education of the Forest Service Intermountain Region 4 interdisciplinary team members, charged with determining, and assessing risk of departure from, PFC.

The significance of relative risk of departure from PFC may be most meaningful for evaluation of potential goshawk habitat when one considers nine of the subject areas. Areas used by northern goshawk that are at a high risk of departure from PFC include: quaking aspen, Engelmann spruce-subalpine fir, and grand fir/white fir complex. Those areas used by goshawks that are at a moderate risk of departure from PFC include: ponderosa pine/Jeffrey pine complex, ponderosa pine (southern Utah) type, Douglas-fir, lodgepole pine, and subalpine timberline forests and woodlands. The subject area used by goshawks that is identified at a low risk of departure from PFC is alpine lodgepole pine. The following conclusion and discussion are excerpted from the draft report (USDA Forest Service 1997). Because the PFC assessment is specific to National Forest lands within Assessment Area 4, reference below is made to Forest Service “Region 4,” rather than to the more broad Assessment Area 4 of this Status Review. Data such as those included in the draft report were not available for all potential goshawk habitat within the Assessment Area.

Quaking Aspen (High Risk)

Quaking aspen is distributed throughout Forest Service Region 4, with the largest concentration in eastern Idaho, western Wyoming, and Utah. Fire is the most important influence on structural stages and composition, and minimizing dominance by conifer species. The fire return interval is less frequent today compared to historical averages. Many areas in this region are being dominated by conifers through plant succession. In one watershed on the Targhee National Forest, 95 percent of the quaking aspen type has succeeded to other vegetative types compared to conditions in 1910, and similar decreases in quaking aspen are occurring Region-wide. The lack of successful regeneration over large areas, combined with continuing heavy grazing pressure by ungulates is projected to result in degradation of this type.

Engelmann Spruce-Subalpine Fir (High Risk)

Engelmann spruce-subalpine fir is found primarily in southern Idaho, northwestern Wyoming, and Utah, with lesser amounts in Nevada. Structural stages are not balanced throughout Region 4 in this type, with the majority of the type in mature to old age classes. There is a dynamic cycle between spruce and subalpine fir dominance depending on stand conditions and insect activities. Current and recent Engelmann spruce beetle epidemics have affected extensive landscapes, favoring a shift to more dominance by subalpine fir as mature spruces have been killed. On the Payette, Dixie, and Manti-LaSal National Forests, spruce beetle outbreaks have resulted in spruce mortality exceeding 80 percent in many areas. Much of the affected area on the Payette National forest burned as a result of wildfires in 1994. Historically, fire regimes of mixed severity occurred on a 50- to 80-year cycle, with lethal fires every 100 to 300 years. Because of increased mortality in these older age class forests, the potential for stand-replacing fires has increased. While current conditions within the Region are within the historical range of variation for the type, potential major changes in stand structure and composition are high for this type. Changes will eventually occur as a result of large, stand-replacing fires, insect epidemics, or a combination of the two throughout much of the spruce/fir range. Closed canopies will be affected as structures change to early-seral conditions.

Grand Fir/White Fir Complex (High Risk)

This complex is found Region-wide except for eastern Idaho and northwestern Wyoming. Site conditions vary from very dry white fir sites in southern Utah to very moist grand fir types in Idaho. Within the region, they are the potential climax tree species on most sites where they are found. These species regenerate readily in the shade of most other trees and grow well under very dense conditions. The historical pattern was one where these true firs dominated relatively few stands. Currently the typical stand structure and composition is multi-layered, composed primarily of true firs and dominated by mature and overmature age/size classes. This is a result of fire exclusion, selective harvest of large seral species, and natural succession processes. In the absence of low-intensity fires, grand fir and white fir increase in amount and density, leading to eventual dominance. The risk to grand fir/white fir complex is high regionally for stand-replacing wildfires

with an associated loss of wildlife habitat for some species.

Ponderosa Pine/Jeffrey Pine Complex (Moderate Risk)
The Ponderosa pine/ Jeffrey pine complex is found mainly in southern Idaho on the Boise, Payette, Challis, and Salmon National Forests. Jeffrey pine in Region 4 is limited to the Sierra Mountains in western Nevada (Reno/Tahoe). Historical structures were predominantly multi-canopy, lightly to moderately stocked, and dominated by ponderosa pine/Jeffrey pine. Current structural conditions are mainly mid- to mature-aged classes, with small amounts of old growth and seedling/sapling size classes. It is thought that some of the best goshawk habitat in the Region was in these savannah forests. Past management in the 1960s through 1980s simplified many of the structural conditions, resulting in a more even-aged single canopy structure. On the Boise National forest, extensive stands of pure ponderosa pine are common in areas planted after the wildfires of the last four decades. A high risk exists for losing significant acreage of the type to catastrophic wildfires similar to those during the last few years. This actual and potential loss decreases habitat for late-seral vegetation-dependent wildlife species. Loss of ponderosa/Jeffrey pine to late seral species such as Douglas-fir and white fir results in a net loss of ponderosa/Jeffrey pine habitat, and such unbalance provides poor habitat for the suite of animal and plant species which have historically inhabited this ecosystem, and this impact could be great on the goshawk.

Ponderosa Pine (Southern Utah) Type (Moderate Risk)
The ponderosa pine (southern Utah) type is found on Utah's Ashley, Dixie, Manti-LaSal, and Fishlake National Forests within Region 4. Tree species composition and the complex of associated insects differ from the ponderosa pine in southern Idaho. Structures are normally multi-layered with a range of tree sizes. Historical fire regimes include non-lethal fires at intervals of five to 25 years. It is thought that some of the best goshawk, flammulated owl, and wild turkey habitat in the region occurred in these savannah forests, and Mexican spotted owls are known to use this type for foraging. Exclusion of frequent non-lethal fires has allowed much of this cover type to progress to latter successional stages, and early seral species such as aspen are poorly represented. The effects of harvesting in the 1960s to 1970s, which created open-stand conditions, are now declining, particularly in the Monticello unit of the Manti-LaSal National Forest in Utah. Overly dense stands create conditions leading to a major mountain pine beetle epidemic. Fires have not been active in these areas for the last 100 years, adding to the density and ingrowth of late-seral tree species (e.g., Douglas-fir and white fir). Ladder fuels and a build-up of forest litter are well-developed and contribute to wildfires outside the historical range in intensity and size. The risk is high in this cover type for losing significant acreage to catastrophic wildfires similar to recent fire activity on the Dixie and Manti-LaSal National Forests. This actual and potential loss is predicted to cause a reduction in habitat conditions suitable for late-seral-dependent wildlife species. Replacement of ponderosa pine by more competitive late seral species such as Douglas-fir and white fir results in a net loss of ponderosa pine forest, and such conditions outside

historical range provide poorer habitat for the suite of animal and plant species which historically inhabited such ponderosa pine forest, including the northern goshawk.

Douglas-fir (Moderate Risk)

Douglas-fir is widespread throughout Utah, southern Idaho, and northwestern Wyoming, with lesser amounts in Nevada. The species is adapted to a wide variation of site, climate, and soil conditions. Current structures are typified y mid- to mature age/size classes, with limited amounts of old growth trees. This small proportion of old growth is due to insect and disease epidemics and past harvest practices. Because Douglas-fir often grows on steep terrain; management activities may be limited. Douglas-fir beetle is currently at epidemic levels on some sites in south-central Idaho and in central Utah, but remains at endemic levels throughout most of the rest of the Region. The most significant risk in this type is associated with fire, particularly where ladder fuels exist of are developing. Stand replacement fires, outside historical ranges of intensity and size, are likely. Sites become more susceptible to Douglas-fir tussock moth defoliation as stand densities and proportion of grand fir increase through time. Approximately one-third of the Douglas-fir type within the Region is affected by dwarf mistletoe and in some areas, levels of infection are moderate to high, affecting viability of the trees. Potential loss or reduction of habitat conditions for late-seral-dependent wildlife species is high. The historical balance of patterns and structures will be compromised by large stand-replacing fires, or continued exclusion of frequent non-lethal fires. Such unbalanced patterns provide poor habitat for the suite of animal and plant species which historically inhabited this forest type.

Lodgepole Pine (Moderate Risk)

Lodgepole pine is typically an early seral tree species ranging over extensive areas of the Region. It is abundant in south-central and southeastern Idaho, northwestern Wyoming, northern Utah, and on the Bridgeport Ranger District of the Toiyabe National Forest. Lodgepole pine readily regenerates naturally after a fire and is often found in pure stands. This type has a history of extensive management, mostly by clearcutting in areas adjacent to Yellowstone national park and in northern Utah. Lodgepole pine has a history of extensive mountain pine beetle epidemics at elevations generally below 9600 feet, and dwarf mistletoe is the most common disease, affecting about 45 percent of this type within the Region. Most lodgepole pine forests in the Region are in the mature and old age classes, except for recently harvested and wildfire-burned area. Currently there is very little balance of structural stages in the lodgepole pine type in the Region. Mature lodgepole pine forests in the Region have been affected significantly by mountain pine beetle epidemics. The extensive areas of lodgepole pine forests on the North Slope of the Uinta Mountains are an example of a high risk landscape. The primary sort-term risk is related to structural changes in the mature age class. Long-term risks are related to large swings from mature-aged forests to grass/seedling classes. Rate changes in time and space determine the amount of risk associated with a particular landscape.

Subalpine Timberline Forests and Woodlands (Moderate Risk)
This high elevation type occurs throughout the Region, but is most important in southwestern Idaho and within the greater Yellowstone Area. Mountain pine beetle and white pine blister rust are significant agents of change affecting tree and seed viability. Most whitebark pine trees are older aged, and its species viability is affected by competition with other tree species (e.g., subalpine fir), seed loss, and tree mortality caused by mountain pine beetle and white pine blister rust. Because these species occupy limited habitat, the risk of departure from PFC associated with a continuing decline is high.

Alpine Lodgepole Pine (Low Risk)
Alpine areas occupy a relatively small area within Region 4. Alpine is located at high elevations above treeline and is most common in the Wind River, Uinta, and Sawtooth mountain ranges. Improper grazing and human traffic impacts are causing the greatest damage to vegetation of these areas, and one-half of alpine areas in the Region are considered to be in PFC. Regionally, the risk associated with this type is low.

This “coarse filter approach” to assessing the status of Forest Service Region 4 lands may offer a measure of the current condition of vegetation, but it does not offer information on past or projected trend in vegetation status. It is important to note that the draft document makes implication or commitment with regard to management prescriptions to maintain or lower the relative risk of departure from PFC. The draft report (USDA Forest Service 1997) summarizes the relative risk of departure from PFC, but caution must be exercised in linking these conclusions directly to pattern or trend in goshawk populations. Again, although the goshawk may require specialized habitat conditions for nesting, it is a forest habitat generalist in terms of forest types it occupies.

Catastrophic Loss of Habitat within Assessment Area 4

Factors contributing to catastrophic loss of forest vegetation within Assessment Area 4 include pine beetle infestation and fire. For example, in the Uinta Mountains of northeastern Utah, the pine beetle proliferated in great numbers in the 1980s, and there is a large landscape of dead overstory lodgepole pine on the east side of the Uintas now, with decaying trees and blowdown (K. Paulin, Forest Service, Ashley National Forest, pers. commun.). Assessment Area 4 includes several areas that have been infested by pine beetle. Wildfire has played a major role in forest succession in parts of Region 4, including Utah (Bradley et al. 1992). Lodgepole pine, for example, owes much of its widespread occurrence to past fire. Decadent aspen stands are rejuvenated by periodic fire. There are a few areas within this Assessment Area where wildfire has played a major role, but there remain large areas showing no evidence of burning, for example 80% of the forested area in northern Utah (O’Brien 1996). There is evidence to support the likelihood of high intensity fire increasing, at least in some areas (Beschta et al. 1995, O’Brien 1996).

Conclusions regarding goshawk habitat trends in Assessment Area 4

The data received and available for the Status Review indicate that several vegetation types, with the exception of alpine lodgepole pine, in some areas within the Assessment Area are suspected to be currently at moderate to high risk of departure from proper functioning condition (USDA Forest Service 1997). The draft report provides some examples of specific areas at risk within the Assessment Area. While the draft report (USDA Forest Service 1997) documents changes that have occurred in forest types within Assessment Area 4, the net effect of these changes on amount and quality of northern goshawk habitat specifically is difficult to quantify. Northern goshawks utilize a wide variety of forest types for various life history requisites, and it is difficult to translate these relative risks of departure from PFC to trend in goshawk habitat. The draft report (USDA Forest Service 1997) on relative risk of departure from PFC of Forest Service lands within Assessment Area 4 is the only report available that compares current condition to natural variation, yet it does not allow inference to effect on goshawk habitat trends or projection. Further, the PFC risk rankings only apply to biological and physical attributes and do not reflect management priorities, which are essential in determining trend.

Status of Goshawk Populations in Assessment Area 4

Assessment of goshawk populations in Assessment Area 4 was attempted based on review of available literature and ongoing studies, and analysis of goshawk data provided by land management agencies and others. A number of agency reports, master's theses, doctoral dissertations, and research publications incorporate northern goshawk data obtained within Assessment Area 4. Although these studies addressed a number of topics, ranging from effects of human disturbance to large-scale habitat modelling, none directly assess goshawk population and trends throughout the Assessment Area.

Table 3.27. Representative subset of published and unpublished goshawk field studies conducted in Assessment Area 4. In some cases, multiple papers or reports have resulted from the same study.

Source	Type	Topic(s)	Title [State]
Dewey 1996	report	movements, survival, juvenile dispersal, home range	Ashley National Forest Northern Goshawk Inventory and Monitoring Report, 1991-1996. [Utah]
Fischer 1986	dissertation	habitat	Daily activity patterns and habitat use of coexisting Accipiter hawks in Utah.
Hennessy 1978	thesis	habitat, human influences	Ecological relationships of accipiters in northern Utah, with special emphasis on the effects of human disturbance.
Herron et al. 1981	report	counts, distribution	Population surveys, species distribution, and key habitats of selected nongame species. [Nevada]
Hoffman et al. 1992	report	counts, population trends	Patterns and recent trends in counts of migrant hawks in western North America.
Jewell and Smith 1998	report	counts	Fall 1997 raptor migration study in the Goshute Mountains of northeastern Nevada.
Johansson et al. 1994	published paper	habitat characteristics	Large-area goshawk habitat modelling in Dixie National Forest using vegetation and elevation data. [Utah]
Kaltenecker et al. 1995	report	counts	Monitoring of fall raptor migration in southwestern Idaho.
Lee 1981	published paper	human influences	Habituation to human disturbance in nesting accipiters. [Utah]
Shipman et al. 1997	report	dispersal, demography, habitat, home range size, reproductive biology, post-fledging behavior	Ecology of northern goshawks (Accipiter gentilis) in the shrubsteppe habitat of northeastern Nevada: a six-year summary.
Smith and Hoffman 1997	report	counts, population trends	Population trends of northern goshawks assessed from migratory counts at four sites in the western United States.
White 1994	published paper	population trends	Population trends and current status of selected western raptors.
White et al. 1965	published paper	range and distribution	Goshawk nesting in the upper Sonoran in Colorado and Utah.
Whitfield et al. 1995	report	counts	Inventory and monitoring of bald eagles and other raptorial birds of the Snake River, Idaho.
Whitfield and Maj 1998	report	counts	Inventory and monitoring of bald eagles and other raptorial birds of the Snake River, Idaho: 1996-97 progress report.
Younk and Bechard 1994	published paper	habitat, feeding ecology, reproductive biology	Breeding ecology of the northern goshawk in high-elevation aspen forests of northern Nevada.
Younk 1996	thesis	demography, habitat, home range size, feeding ecology, human influences, reproductive biology, density	Breeding ecology of the northern goshawk in relation to surface gold mining in naturally fragmented aspen forests of northern Nevada.

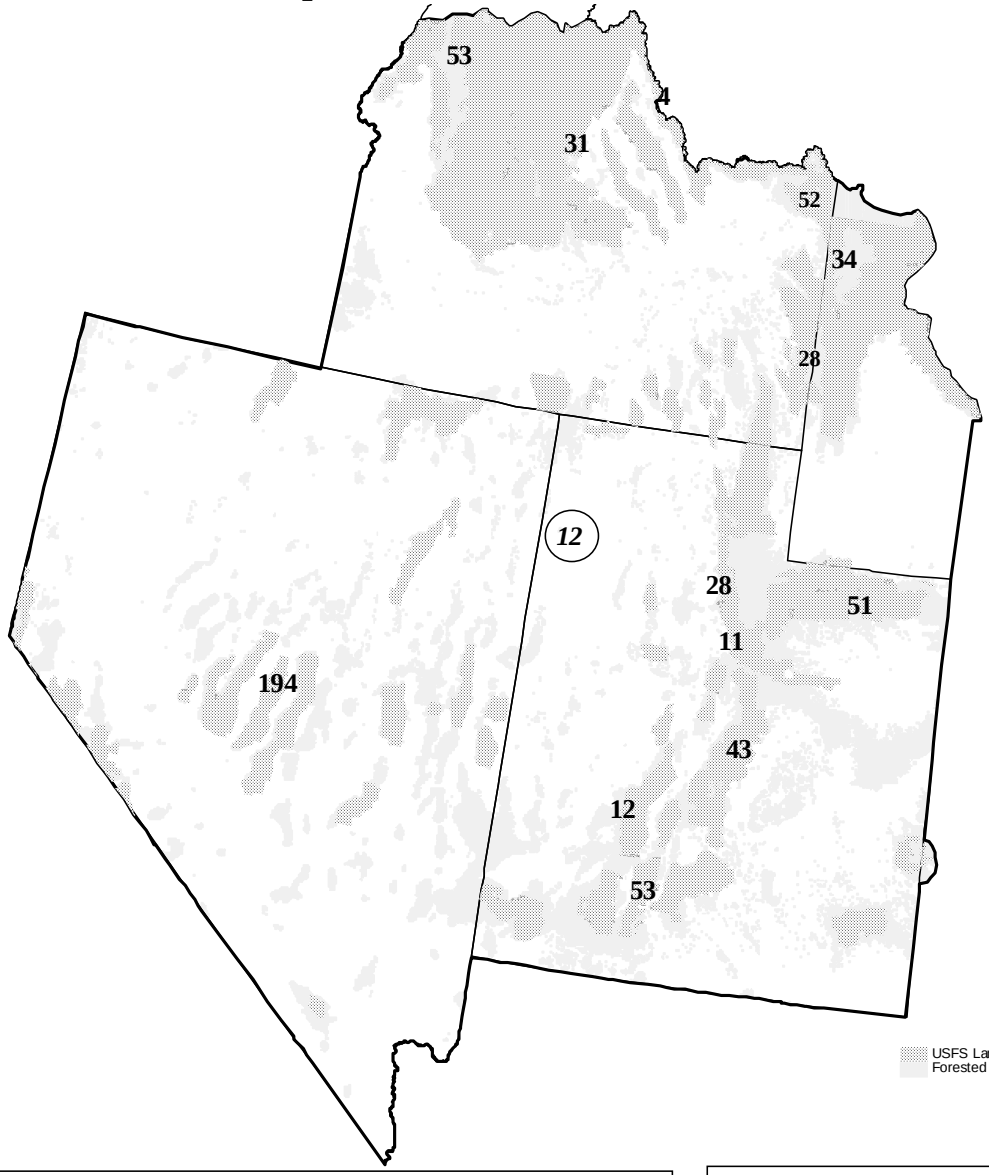
Distribution and Reported Numbers

Systematic surveys for goshawks have not been conducted at a large scale within the Assessment Area, and the majority of territories were discovered during timber sale surveys, Mexican spotted owl surveys, or incidentally to other activities. Because no large areas within Assessment Area 4 receive systematic goshawk surveys, numbers of territories reported here should be considered a cumulative minimum. Surveys tend to focus on proposed project areas (e.g., timber sale areas) and thus rarely achieve complete coverage of a given administrative unit. Even for surveyed areas, the data are confounded by two primary and opposing factors: 1) goshawks have been known to build multiple and alternate nests, and conversely, 2) because goshawks can be difficult to detect and many are never located, the number of pairs can be underestimated. It is difficult and expensive to reliably estimate populations because birds must be marked and considerable time and effort expended (Reynolds and Joy 1998). Further confounding reported territory numbers is the fact that agency databases include historical sites which may no longer exist (e.g., burned, logged, no recent occupancy), may not be complete and up-to-date, may include locations that have not been verified (e.g., assumed goshawk territories without documented goshawk activity), and may include duplicate records due to reporting and data entry errors. Despite these concerns, the total of 602 goshawk territories reported in Table 3.28 and Figure 3.18 provides the best currently available estimate of the general distribution and relative abundance of goshawk pairs within the Assessment Area.

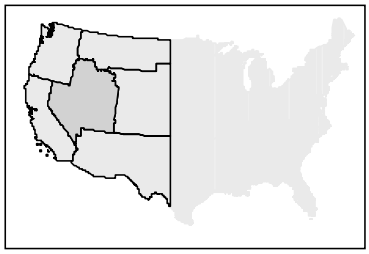
Table 3.28. Number of northern goshawk territories reported in Assessment Area 4, by reporting unit.

Reporting Unit	Number of Territories Reported
Bureau of Land Management	
Malad Field Office	1
Owyhee Field Office	1
Snake River Field Office	1
Vernal Field Office	2
National Park Service	
Bryce Canyon National Park	5
Grand Teton National Park	34
Great Basin National Park	2
US Forest Service	
Ashley	51
Caribou	28
Dixie	53
Fishlake	12
Humbolt-Toiyabe	194
Manti-La Sal	43
Payette	53
Salmon-Challis	31
Targhee	52
Uinta	11
Wasatch-Cache	28
Total Reporting Units	**602**

Figure 3.18 Numbers of Northern Goshawk Territories Reported In Assessment Area 4



Goshawk numbers indicated on this map represent the total number of goshawk territories reported by Federal agencies for their entire administrative area. Therefore, the numbers indicate generalized locations and do not indicate the actual locations of goshawk territories. Numbers reported by the States on private and other lands that were not reported by Federal agencies, may occur anywhere within the Assessment Area. These are represented by a circled italic number located near the center of the Assessment Area.



Northern Goshawk
Status Review Team
June 1998

Population Status

Historical Trends

There is no information available to directly assess historical northern goshawk population trends in the Assessment Area 4. However, based on assessment of habitat changes leading to current estimated risk of departure from proper (historical) functioning condition (see section on Habitat Trends for Assessment Area 4, especially discussion of ponderosa pine/Jeffrey pine complex and ponderosa pine (southern Utah) type), it is tempting to conclude that goshawk populations have been reduced from historical levels. Caution must be exercised, however, in the direct application of trends in forest type to trends in goshawk population. While abundance may have changed in parts of the Assessment Area due to major landscape changes due to various factors (e.g., catastrophic fire, insect outbreak, as discussed above), it is likely that goshawk distribution in the Assessment Area is similar to pre-settlement times, as the species is currently widespread in the Assessment Area.

Current Status

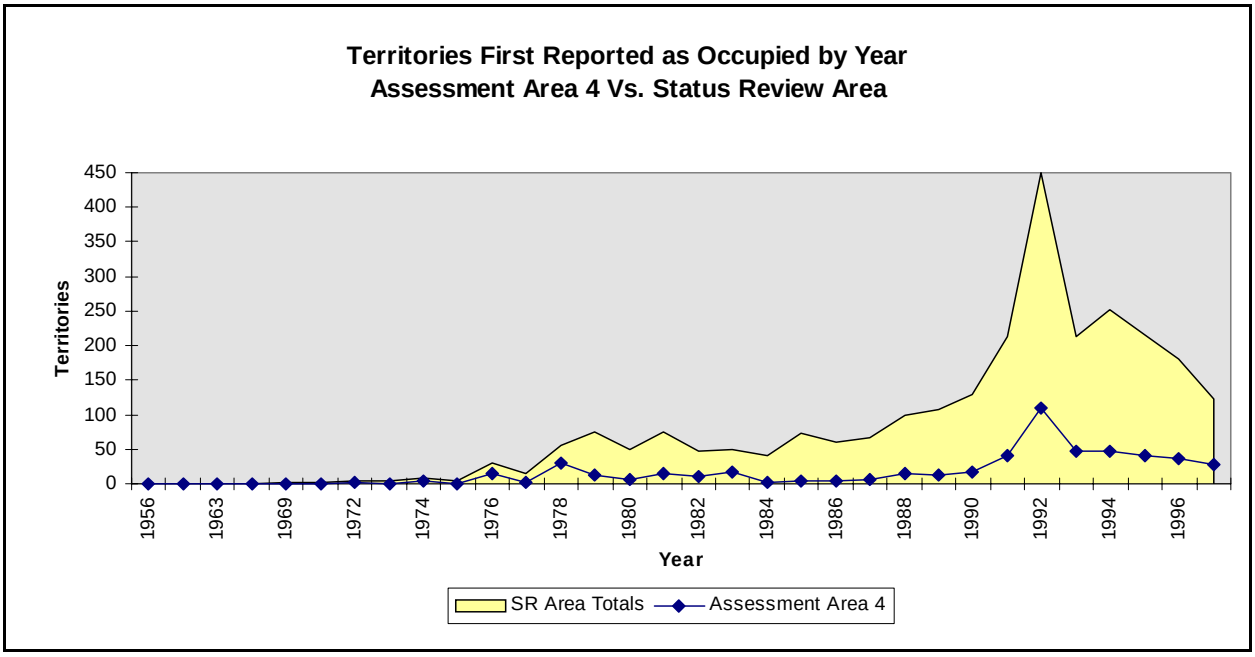
In 1991, the northern goshawk was designated as a sensitive species within the Forest Service Region 4. The management recommendations developed by the Goshawk Scientific Committee (Reynolds et al. 1992) for the Southwest Region of the Forest Service were also adopted by Region 4 of the Forest Service in 1992.

Population data available for this Status Review are inadequate to allow determination of any current trends in goshawk populations in Assessment Area 4. The information collected to date has been generated primarily from timber sale surveys and smaller-scale monitoring efforts over short period of time. These types of data collection do not allow for determination of population declines or stability. Further, our understanding of the relationships between goshawks and amounts of mature forest habitat is inadequate to infer goshawk population trends from current habitat trends (refer to population status discussion for Assessment Area 5).

Examination of the number of territories first reported as occupied, by year, reveals an interesting trend both for the Assessment Area and for the entire Status Review Area (Figure 3.19). This figure shows the number of newly discovered goshawk territories, by Assessment Area 4 and by Status Review Area, as a function of time. It appears that in 1992, the year of Forest Service Region 4's decision to adopt and implement the Management Guidelines for the southwest (Reynolds et al. 1992), and the year following the Region's determination of the goshawk as a sensitive species, there was a spike in the number of newly discovered territories. This observation is consistent with the spike in territories first reported in 1992 in the entire Status Review Area. Unfortunately, there is no data available regarding level of effort expended to find goshawk territories by year, or

possible random effects of weather. These population data may be confounded by these factors.

Figure 3.19 Territories first reported as occupied by year: Assessment Area 4 versus Status Review Area



Raptor migration studies by HawkWatch International have collected long-term data across the West, including at two sites in Assessment Area 4: Wellsville Mountains in northern Utah, and Goshute Mountains along the Utah-Nevada border (Smith and Hoffman 1997, Jewell and Smith 1998). With one exception, the HawkWatch data failed to indicate any significant trends in population indices for northern goshawks at either of these sites. Smith and Hoffman (1997) presented an apparent decline of 40% since the late 1970s in the mean passage rate of immature goshawks observed at their Wellsville site. They concluded that there may have been a decline of goshawk reproduction in that area during the 1980s, but also note that there has been an absence of a significant trend during the past 11 years. Smith and Hoffman (1997) further state that data from all their sites show that the number of hawks they observe varies greatly from year to year, presumably due to annual variations in breeding success, as well as the irruptive tendencies of adults tied to prey population changes. Smith and Hoffman (1997) concede that only additional years of data spanning multiple decades will clarify the true nature of any patterns, and that annual weather patterns randomly affect their raptor counts.

Conclusions Regarding Goshawk Populations in Assessment Area 4

Although historical population data are not available, it is reasonable to conclude that there have been local declines in goshawk populations within the Assessment Area when compared to pre-

settlement times. This conclusion is not unique to northern goshawks, but is common when inferring wildlife population changes since pre-settlement times. This conclusion of likely local declines is based primarily on inferred effects of local catastrophic changes in habitat due to factors including fire and insect outbreaks, as detailed above for various forest types of the Assessment Area. This conclusion of possible local decline does not extend to the Assessment Area, as no evaluation of population trend exists, and as northern goshawk pairs appear widespread throughout forest types in the Assessment Area. Further, it appears that territory detection is related to effort expended, which confounds numbers reported to this status review. More systematic collection of population data, across larger scales and longer periods of time, are required for any meaningful inference beyond very local changes in habitat and goshawk numbers.

Assessment Area 5

The Pacific Southwest Assessment Area includes the state of California (Figure 1.1). Forest habitats within the state are managed by a variety of agencies, as well as large industrial timberland holdings. Among federal land management agencies, the majority of forested lands are administered by the Forest Service (17 National Forests: 56.5%), followed by BLM Districts (15%), and National Parks (4.2%). Private timberlands comprise 23.5% of California's forested area. It is important to recognize that ownership patterns vary widely among the different forest cover types (table 4.5.1). Over 83% of redwood forests, and 71% of western hardwoods are owned by industrial timber companies. Conversely, the Forest Service administers 83% of lodgepole pine and 75% of ponderosa pine forest area (California Dept. of Forestry 1988).

Habitat Trends

The Pacific Southwest Assessment Area 5 supports approximately 34 million acres of forest habitat, of which about 19 million acres are considered productive timberlands capable of producing 20 cubic feet of wood per acre annually (EPA data, California Dept. Forestry 1988). Natural variation in forest structure and composition among forest cover types, as well as the effects of forest management practices, affect the ability of these lands to provide habitat for northern goshawks. For example, oak woodland and juniper woodland typically do not exhibit the structural attributes of goshawk nesting habitat, and do not appear to be occupied by goshawks during the breeding season. Timber harvest has had a variable effect on goshawk habitat, generally resulting in the reduction of older seral stages. Forest Service estimates show a 26% decrease in standing volume of large sawtimber (20+ inch dbh) from 1952 to 1992 (Powell et al. 1992), while smaller size classes have increased. The effects of timber harvest has been disproportionate in some forest types such as redwood, where less than 6% of historical late-successional habitat remains (USDI 1992).

Forest ecosystems in California are diverse, ranging from temperate coastal rainforest to xeric eastside pine habitats (Table 3.29) . The dominant forest cover types tend to be distributed among distinct physiographic regions within the state. Habitat suitability for goshawks, land management issues and habitat trends also vary widely among these physiographic regions and forest types. To some extent, large-scale ecosystem studies and planning efforts are separated along these physiographic boundaries. For the purposes of this assessment, habitat status and trends will be described separately for each major region, permitting a more detailed evaluation.

Table 3.29. Area (acres x 1000) of forest cover types, by data source.

Forest Cover Type	RM-234*	FRRAP**	EPA***
Douglas-fir	1,532 (1,179)	1,772	4,867
Ponderosa Pine	5,029 (4,246)	3,351	11,032
Fir-Spruce	5,875 (5,102)	2,134	2,907
Redwood/Sitka	1,162 (1,056)	1,570	1487
Lodgepole Pine	199 (199)	752	1,888
Mixed Conifer	N/A	10,652	N/A
Montane Riparian	N/A	86	N/A
Western Hardwoods	2,375	9,547	6,738
Pinyon-Juniper	0	1,463	4,900
California Total	13,797 (11,782)	18,544	33,819

Note: Acreage figures given in Powell et al. (1992) and Cal. Dept. Of Forestry (1988) are of "productive timberlands", capable of growing more than 20 cubic feet of wood per year, and exclude forested areas that do not support sustainable timber yields. These figures are lower than EPA estimates that include total land base occupied by a given tree species group.

Sierra Nevada and Cascade Range Province

These interior mountain ranges constitute a band of similar forest types from the Oregon border into the southern 1/3 of California. Precipitation in this band is low to moderate, falling mostly as snow; and elevation ranges from 3,000 to 8,000 feet. The dominant forest cover types within this region include mixed conifer, true firs (red fir and white fir), yellow pines (ponderosa and Jeffrey), and, at lower elevation, oak woodland. Virtually all of California's lodgepole pine and montane riparian forest are within this province.

Land Ownership

The Lassen, Plumas, Tahoe, Eldorado, Stanislaus, Inyo, Sierra, and Seqouia National Forests are the primary public landowners in the Sierra Nevada, with a total land base of 6.98 million acres, about 73% of which is forested (USDA 1995). Lassen Volcanic National Park, Sequoia/Kings Canyon National Parks, and Yosemite National Park have a total land base of 1,719,039 acres. The BLM administers scattered parcels within this region, largely lower elevation woodland or nonforest habitats. About 68,500 acres of BLM lands are considered potential goshawk habitat (USDA 1995). Private timberlands occupy 2.4 million acres (1.45 industrial, 0.96 other private) occurring both as "checkerboard" holdings and large contiguous blocks.

Within the Cascade Range, the Klamath (Goosenest RD), Shasta-Trinity (McCloud and Mt. Shasta RDs), and Modoc (Doublehead RD) National Forests are the primary Federal landholders. Only portions of each Forest fall within the Cascade region, however, and much of the forested land base is interspersed with private industrial holdings. The Warner Mountains are almost entirely within the Warner Mountain RD of the Modoc National Forest.

Historical Habitat Status

Historically, forest conditions within the Sierran-Cascade Province were strongly influenced by climate, elevation, and wildfire. At mid-to lower elevations, mixed conifer and ponderosa pine forests dominated and were maintained in an open, "fine-grained" condition by frequent low-intensity fire. Late-successional forest stands typically had canopy closures <40%, with denser stands largely limited to north-facing slopes, riparian areas and other mesic sites. Higher elevations were dominated by true firs and lodgepole pine. Cooler conditions and late snowpacks acted to reduce the effects of fire in these forest types, resulting in larger, denser stands (Franklin and Fites 1996, Verner et al. 1992). Because of intensive early (1848-1920) logging of lower elevation areas, little is known about the abundance or distribution of late-successional habitats in the Sierran-Cascade Province.

Current Habitat Condition

Forest conditions within the Sierran-Cascade Province have changed dramatically following Euro-American settlement. Logging, grazing, mining, introduction of exotic plant species, and fires caused large-scale disturbances to the natural communities, the effects of which continue today (Verner et al. 1992, USDA 1992). By the 1940's, virtually all of the mid-to lower elevation mixed conifer and ponderosa pine stands in this region had been logged to varying degrees (Verner et al. 1992). Removal of the mature overstory, in concert with suppression of natural wildfire, resulted in regeneration of dense stands, now 80+ years old and moving into a mature forest state. High tree density and accumulations of woody fuels in these stands have resulted in an increase of high-severity (stand-replacing) fires. The effects of logging and fire suppression have been less noticeable in higher-elevation true fir forests, where access for harvesting was limited until the 1950's. In general, the proportion of the Sierran-Cascade Province occupied by dense mid-mature forest has likely increased over pre-settlement times; however the structure, composition and susceptibility of these stands to disturbance differs markedly from natural ranges (Franklin and Fites 1996, Verner et al. 1992).

Future Habitat

Current Land Management Plans for National Forests within the Sierran-Cascade Province emphasize reduction of fire risk and other "forest health" issues as well as

production of wood products. Under the 1995 California Spotted Owl Interim Standards and Guidelines (CASPO), harvest of mature forest habitat has been dramatically curtailed. Management practices under CASPO include protection of 980 "Protected Activity Centers" (300 acres each) for spotted owls, totaling 294,000 acres. In addition, management guidelines focused on improving or creating late-successional characteristics of forest stands have been incorporated into Land Management Plans for the Sierran National Forests. Data showing predicted trends in forested acres or suitable goshawk habitat on Federal Lands were not available for this Assessment**.**

Assessment of future trends in potential goshawk habitat in the Sierra Nevada cannot be made based on current Federal planning documents, nor on the probability of implementation future management strategies. Increasing public debate over management of these National Forests, coupled with concerns over the viability of California spotted owl populations, has resulted in proposals of several management strategies, currently being assessed in the Draft EIS for *Managing California Spotted Owl Habitat in the Sierra Nevada National Forests of California* (USDA 1995). Challenges to this EIS have lead to further assessment of ecological conditions and proposed management strategies (Sierra Nevada Ecosystem Project).

In the Cascade portion of this province (Klamath NF;Goosenest RD, Modoc NF; Doublehead RD, Shasta-Trinity NF; McCloud and Mt. Shasta RDs), habitat management is guided by the provisions of the Northwest Forest Plan (NFP) (USDA, USDI 1994). Under the NFP, the 1,007,500 acres of National Forest and Bureau of Land Management lands in the province are divided into several land allocation categories, including extensive late-successional reserves (LSR), managed late-successional areas, adaptive management areas, riparian reserves, and general forest matrix, as well as Congressionally withdrawn lands such as wilderness areas (USDA, USDI 1994). Large LSRs, in particular, are intended to provide long-term habitat for species associated with late-successional forests. Reserved land allocations intended to provide long-term habitat for species associated with late-successional forests account for 647,100 acres (64%) of the Federal land base within the province. Late-successional Reserves account for 235,325 acres of the Reserved Lands, and support 51,556 acres (21%) of late-successional habitat (USDA, USDI 1994). Because this province lies on the eastern margin of the range of the northern spotted owl, Reserved Areas are small and widely scattered, and much of the potential and occupied goshawk habitat in open pine-dominated habitat is within matrix or adaptive management area lands where timber production is emphasized. Under the NFP, no additional management for goshawks is required. The proportion of mature forest habitat (and potential goshawk habitat) within Reserved Areas within the California Cascades province is likely to increase as second-growth stands mature. This prediction will be dependant on implementation of prescribed burning and other treatments intended to maintain sustainable stand densities and reduce risk of catastrophic disturbance events.

On private industrial timberlands, Habitat Conservation Plans are being developed in conjunction with the US Fish and Wildlife Service. These plans contain management strategies to conserve forest-associated wildlife species, particularly northern spotted owls (Cascades) and California spotted owls (Sierra Nevada), as well as mesocarnivores and snag-dependant species. The HCPs are anticipated to provide additional long-term habitat for an undetermined number of northern goshawk territories.

Modoc Plateau Province

This province consists of the relatively flat volcanic upland extending from the California Cascades east to the Warner Mountains, and from the Oregon border south to the Pit River drainage and into the lowlands of the Lassen National Forest. The dominant forest cover type in this province is ponderosa pine, with pine/white fir and mixed conifer on uplands. Forest habitats are interspersed with large areas of juniper woodland and sage-steppe habitat.

Land Ownership

The 1.6 million-acre Modoc National Forest administers the majority of forested lands within this province. The Klamath National Forest (Goosenest RD) manages (32,680 acres) of Eastside ponderosa pine habitat on the western margin of the Plateau.

Historical Habitat

Prior to euro-American settlement, ponderosa pine forests dominated the Modoc Plateau in the 4,000-6,500 foot elevation range. Presettlement ponderosa pine stands were highly variable in structure and composition, ranging from open stands of scattered mature trees to dense, continuous stands on better sites. Frequent low-intensity wildfire played an important role in maintaining open stand conditions and grassy understories (Laudenslayer et al. 1989). Estimates of historic acreage of potential goshawk habitat are not available, but current patterns of goshawk occupancy of remaining stands suggest that a large proportion of the area was suitable habitat.

Current Habitat

The high value of ponderosa pine for building materials, combined with easy access to stands on relatively level terrain, resulted in significant reduction in the area of mature pine forest. By 1950, approximately 2.7 million acres (20%) of the historic mature forest area had been harvested, much which was on the Plateau and northern Sierra (Laudenslayer and Darr 1990). Perhaps as important as removal of mature timber has been the effects of fire suppression in this forest type. Large areas of second-growth ponderosa pine exhibit high densities of small trees, high canopy closure, and ingrowth by white fir (Laudenslayer et al. 1989). Currently, less than 5% of the Eastside pine area

of the Klamath NF (Goosenest RD) is in late-successional condition. On the Modoc NF, approximately 6% of Eastside pine forest is in mature or old-growth condition (USDA 1991). Overall, the area of nesting and foraging habitat for goshawks has declined dramatically from historical levels.

Future Habitat

Increased protection of forest habitats within the ranges of the marbled murrelet, northern spotted owl and California spotted owl has resulted in more emphasis on timber production in Eastside pine forest. The Land and Resource Management Plan for the Modoc National Forest (1991) predicts further reduction in area of mature ponderosa pine, from the current 6% to 2% during the first decade of the plan. Approximately 18.2 million board feet of pine are scheduled to be harvested annually. By the 5th decade of this Plan, an estimated 70% of suitable timberlands will be in plantations and sapling - small tree seral stages (USDA 1991.) The proportion of this area that will provide suitable goshawk habitat is unknown, but it is likely that the amount of mature forest habitat preferred by nesting and foraging goshawks in pine forests will decline significantly. Eastside pine habitats on the Klamath National Forest lie within the Goosenest Adaptive Management Area (AMA), a land allocation under the Northwest Forest Plan. Although a Management Plan for the AMA has not been completed, the guiding emphasis for the AMA is development of natural mature ponderosa pine habitat. As the existing large acreage of younger pine and pine/white fir stands mature over time, it is likely that the area of potentially suitable goshawk habitat will increase.

California Klamath Province

This province consists of the Klamath, Siskiyou, and Salmon Mountains, extending from the Oregon border south to the Clear Lake Basin in the Inner Coast Ranges. The area is mountainous and steeply dissected, with elevation ranging from 800 to 7,000 feet. Mixed Douglas-fir forests dominate the area, varying from dense Douglas-fir/tanoak forests in the mesic western portion of the province, to Douglas-fir/ponderosa pine and Douglas-fir/oak associations in drier eastern sites. At higher elevations, white and red firs mix with Douglas-fir. In the southern portion of the province, Douglas-fir occupies canyons and north slopes, with chaparral, oak woodlands and canyon live-oak in the uplands.

Land Ownership

The majority of the 6-million-acre province is administered by the US Forest Service (72%) including the Klamath, Six Rivers, Shasta-Trinity, and Mendocino National Forests. Less than 5% is in other Federal ownership. Private industrial landowners manage about 24%, largely in the eastern portion of the province.

Historic Habitat

Under presettlement conditions, a large proportion (>70%) of the Klamath Province supported forest cover (USDA 1992). Stand density and species composition were strongly affected by site conditions (slope, aspect, soil type) and by frequent fire. Denser stands of mixed Douglas-fir and hardwoods occupied lower slopes and riparian areas, whereas upper slopes and ridges supported more open stand conditions.

Current Habitat Conditions

Steep terrain and lack of nearby markets limited timber harvesting in the Klamath Province until the mid-1940's, when improved transportation and logging technology enabled harvests on steep slopes. Since that time, from 25 to 40% of historic dense mature forest habitat has been removed from the 4 National Forests in the province. In more recent years, average annual harvests on the Six Rivers NF was 158.6 million board feet (1960-1984), 80.2 million board feet on the Mendocino NF(pre-1984) and 248 million board feet on the Shasta-Trinity NF (1974-1984) (USDI 1992). Between 1986 and 1990, lower elevation mixed conifer forests on private timberlands were harvested at the rate of 103,000 acres per year. Harvest levels dropped dramatically in the late 1980's, and have remained low in the 1990's, largely due to Federal restrictions relating to northern spotted owl management. Despite extensive past logging, potentially suitable habitat for goshawks remains abundant and well-distributed in most of the Klamath Province. Potentially suitable goshawk habitat occupies 2,406,600 acres of Federal lands (USDI 1992).

Future Habitat

The Klamath Province lies entirely within the range of the northern spotted owl, and is managed under the provisions of the Northwest Forest Plan. Reserved Areas account for approximately 80% (3,622,600 acres) of the Federal lands in this province. These areas include LSRs (1,200,535 acres), as well as riparian reserves, and managed LSRs, as well as Congressionally Reserved and Administratively Withdrawn Areas such as Wilderness (USDA, USDI 1994). As younger stands within these protected land allocations mature, the amount of potentially suitable habitat for goshawks is likely to increase. The primary future threat to this habitat is catastrophic wildfire in large areas currently exhibiting high fuel levels and fire risk (USDI 1992). Therefore, fuels reduction and prescribed fire are important aspects of implementation of the NFP.

On private industrial timberlands, management of forest habitats for goshawks and other forest-associated wildlife will be guided by Habitat Conservation Plans developed in conjunction with the U.S Fish and Wildlife Service. HCPs currently under development in the Klamath Province cover approximately 300,800 acres and will include measures for managing goshawk territories.

North Coast Range Province

The California Coast Province extends from the Oregon border to San Francisco Bay, and from the ocean to the western boundaries of National Forest lands. This province is composed of the coastal plain and outer Coast Ranges, and is characterized by low topography and elevation, and mild climate with abundant year-round precipitation. The dominant forest cover types are redwood, sitka spruce/western hemlock, and Douglas-fir.

Land Ownership

Land ownership in the 5.7-million acre California Coast Province is dominated by industrial and nonindustrial private ownership, which account for 87% of the land base. Federal ownership comprises a small fraction of the Province, largely within National Parks (3%), Bureau of Land Management (5%) and Forest Service (Six Rivers and Mendocino NFs) (1%). State Parks administer an additional 4%. Management of goshawk habitat within this province is therefore strongly affected by State Timber Harvest Practice Rules and Federal (USFWS) Habitat Conservation Plans (HCP) for northern spotted owls and marbled murrelets (USDI 1992).

Historical Habitat Status

Within the California Coastal Province, abundant rainfall and mild climatic conditions foster the development of dense late-successional forest stands on a high proportion of the forested land base. Greater than 75% of the 1.95 million acres of redwood forest was historically in old-growth condition (USDI 1992). Douglas-fir and Douglas-fir/hardwood cover types dominated inland from the redwood belt. Forest structure within all coniferous forest types in this province was relatively dense, typically with multilayered canopies and understory vegetation such as salal and swordfern. Structure and composition of both redwood and Douglas-fir types were affected by infrequent moderate-intensity fires which acted to reduce the number of small-diameter trees, and particularly in the southern portion of this province, create interspersion of forested stands with oak woodlands, chaparral and grasslands (USDI 1992).

Current Habitat Status

Early logging of forests in the Coastal Province, particularly valuable redwood forests, was facilitated by a number of factors, including gentle terrain and ease of access, and close proximity to coastal ports. The decline of late-successional redwood was rapid and nearly complete, and continues today. In coastal floodplain areas, conversion of forest to agricultural and residential uses also resulted in fragmentation of redwood and sitka spruce/ hemlock forests. Of the 1.4 million acres of late-successional redwood stands estimated to exist historically, only 6% remained in 1992 (USDI 1992). Abundant moisture and rapid regeneration by stump-sprouting redwoods, however, permitted development of large acreage of mid-to large diameter second growth redwood stands. Inland from the redwood belt, harvest of Douglas-fir stands for lumber and of tanoak (an

understory associate of Douglas-fir) for tanbark also occurred at the turn of the century. Coniferous forest habitats within the southern portion of the Province are naturally fragmented, with hardwoods, chaparral and grasslands occupying upland areas and Douglas-fir stands limited to canyons (USDI 1992).

Federal lands currently constitute about 471,000 acres within the Coastal Province, of which 4,700 acres (1%) are classified as small conifer (9-20.9 inches dbh) and 35,400 acres (7.5%) are medium/large conifer (>21 inches dbh). Little information is available to permit estimation of current amounts of potential goshawk habitat on private lands within the Coastal Province. Data developed in HCPs for larger industrial timberlands may allow more complete estimation in the future.

Future Habitat

The dominance of private ownership in the Coastal Province makes prediction of future trends in potential goshawk habitat difficult. Future management of forests within the province will be determined by State of California Forest Practice Rules see Chapter 5), and by HCP agreements between private landowners and USFWS. Federal lands account for only 471,300 acres within this province, 84% of which are in National Parks, late-successional reserves, and other reserved land allocations under the Northwest Forest Plan. Only 13% of these reserved lands are currently in late-successional condition; an unknown proportion of these acres may provide habitat for northern goshawks.

Habitat Conservation Plans under development on private industrial forestlands will provide management guidelines for northern spotted owls, goshawks and other forest-associated wildlife. In the North Coast Ranges Province, HCPs affect approximately 1,171,200 acres of forest.

Southern California/Central Coast Ranges Province

This province lies within the southern half of California, and includes the Southern Transverse Ranges (San Gabriel, San Bernadino, San Jacinto and Clark Mountains) and the Central Coast Ranges (Santa Cruz, Santa Lucia and Santa Ynez Mountains) as well as scattered smaller ranges. These ranges are somewhat isolated from the Sierra Nevada and other major mountain ranges. Forest cover types within the province include riparian hardwood forest, live oak/bigcone Douglas-fir forest, mixed conifer forest, and redwood/California-laurel forest (Verner et al. 1992). Well-developed coniferous forest structure typically associated with goshawk occupancy in the western U.S. is very limited in distribution, found largely at higher elevations in Jeffrey pine and lodgepole pine stands.

Land Ownership

Four National Forests (Los Padres, Angeles, San Bernadino, and Cleveland NFs) administer 1,301,800 acres of forested land; the majority of forested Federal lands within the Southern California province. Bureau of Land Management, Indian Lands, and State lands constitute a small percentage of potential goshawk habitat area.

Historical Habitat

The distribution and species composition of coniferous forest habitats in the Southern California province appear to be similar to those seen today (Verner et al. 1992).

Current Habitat Conditions

Early logging in southern California forests was limited in extent, but large fires associated with mining may have removed significant amounts of lower-elevation bigcone Douglas-fir forest (Verner et al. 1992). From 1947 to 1990, about 362.3 million board feet of timber were removed from San Bernadino and Los Angeles counties. Estimates of existing area of conifer forest suitable for goshawk habitat were unavailable.

Future Habitat

Data were not available to estimate future amounts of potentially suitable goshawk habitat. Logging intensity in Los Angeles and San Bernadino counties declined dramatically between the period from 1955 to 1977 (10-25 million board annually) and post-1980 (0-3 million board feet) (Verner et al. 1992). Current Land Management Plans for the 4 southern California National Forests emphasize recreation and habitat maintenance, and subsequent low timber volume targets. Potential goshawk habitat in higher elevation coniferous forest in this province is likely to remain stable over time.

Conclusions regarding goshawk habitat trends in Assessment Area 5

Changes between historical and current habitat:
It is clear that dramatic changes have occurred in the distribution, amount, and structural characteristics of mature forests throughout much of California. These changes have been described in detail for the Sierra Nevada and Cascade Ranges, Modoc Plateau, and North Coast Ranges, and to a lesser extent in the California Klamath Province. In general, the primary change has been reduction of mature forest cover by logging, although other factors such as catastrophic fire have also been implicated. Although the extent to which goshawk populations are correlated with amounts of mature forest cover is unknown, there has clearly been a significant reduction in the amount of habitat typically associated with goshawk nest sites. Other changes such as grazing and suppression of wildfire have had an important, but more subtle effect on the structural characteristics and ecological processes of California's forests. At the landscape level, these changes may effect foraging habitat structure, prey abundance, and development of future nesting

habitat.

Changes between current and future habitat:
Throughout much of California, the nature and magnitude of change in mature forest habitats has declined significantly during the past two decades. Public debate over management of forest resources has resulted in regional forest management strategies such as the Northwest Forest Plan and CASPO interim standards and guidelines, which focus on retention and restoration of mature forest habitats. These changes are reflected in the declines in timber volume sold on National Forest Lands in California (Appendix A, Figure A.10). However, in some areas not covered by regional plans, (e.g Modoc Plateau and parts of the Cascades), mature forest habitat continues to be harvested extensively.

Despite a general reduction in rate of harvest of mature timber on public forestlands, it is difficult to project future habitat trends for goshawks in California. Data allowing assessment of future amount and distribution of mature forest habitat were not available to this Status Review. There is little certainty as to how regional ecosystem plans will be implemented with regard to nesting and foraging habitat requirements of goshawks. In drier habitats in the eastern Klamath, Sierra Nevada, Cascade and Modoc Provinces, factors such as fire management and it's effects on stand structure may be important to long-term habitat quality.

Status of goshawk populations in the Pacific Southwest Assessment Area

Assessment of goshawk populations in the Pacific Southwest Assessment Area was made based on review of available literature and ongoing studies, and analysis of goshawk data provided by land managers and the State of California. A number of studies and inventories of goshawks have been or currently are being conducted within this Assessment Area. Table 3.30 displays a summary of these studies by author, topic and location.

All of these studies provide valuable information on the ecological relationships of goshawks in various forest types in California, however, few address population estimates such as density, or annual reproductive performance, and none evaluate population trends. Seven of the studies were conducted within a single study area (Goosenest/ McCloud RDs)

Table 3.30. Selected goshawk studies conducted within the Pacific Southwest Assessment Area, by author, publication type, location, and topic.

Author (s)	type*	location	topic
Hargis et al. 1994	MS,P	Sierra Nev.	Home range and habitat selection: telemetry
Austin, K.K. 1993	MS	Cascades*	Home range and habitat selection: telemetry
Saunders, L. B. 1982	MS	Cascades*	Nest area habitat
Allison, B. 1996	MS	Cascades*	Nest area, landscape level habitat, density, GIS
Rissler, L.J. 1995	MS	Cascades*	Nest area habitat structure
Keane, Morrison 1994	PhD,P	Sierra Nev.	Habitat selection, preybase relationships, telemetry
Keane, J. 1997	PhD	Sierra Nev.	Ecological relationships, prey, home range: telemetry
Hall, P.A. 1984	MS	Klamath	Nest area habitat
McCoy, R. 1998	MS	Cascades*	Prey selection, energetics
Woodbridge, Detrich 1994	P	Cascades*	Occupancy patterns, nest area habitat fragmentation
Detrich, Woodbridge 1994	P	Cascades*	Fidelity to mate & nest site; breeding, natal dispersal
Schnell, J.H 1957	P	Sierra Nev.	Prey selection
Farber et al. 1998	R	Statewide	Nest area, PFA habitat, managed forestlands
DeStefano et al. 1994	P	Cascades*	Demographics, population parameters
Bloom, Stewart 1986	R	Statewide	Status, distribution, historical records, gen. ecology

*type: MS=Master's Thesis, PhD=Doctoral Dissertation, P=journal publication, R=unpublished report

Distribution and Reported Numbers:

Systematic surveys for goshawks have not been conducted at a large scale within the Pacific Southwest Region, and the majority of territories reported were discovered during timber sale surveys, spotted owl surveys, or other activities. In recent years, intensive surveys for spotted owls (all provinces), and marbled murrelets (N. Coast and west Klamath provinces) have resulted in searches of large areas of potentially suitable goshawk habitat by wildlife biologists; and subsequent discovery of many goshawk territories. Because large areas do not receive systematic goshawk surveys, numbers of territories reported here should be considered minimums: on the other hand, some territories reported as active may have been abandoned over time. Nonetheless, the overall number and distribution of territories provides the best currently available estimate of the general distribution and relative abundance of goshawks within the various Provinces (Table 3.31). A total of 816 goshawk territories were reported within the Pacific Southwest Assessment Area.

The "reported density" figures given in Tables 3.31 and 3.32 represent the numbers of territories reported per 100 km^2 of suitable forest habitat (trees >11dbh, >40% canopy closure). This habitat definition excludes very young forest stands and nonforest habitats which may be used for foraging, but serves as a reference point for comparing densities reported among different areas. The numbers of goshawk territories reported reflect a wide range of survey and monitoring efforts and should not be interpreted as complete census.

Goshawk territory data reported for the Sierra Nevada and Cascade Ranges, and the Modoc Plateau, suggest that the species is well-distributed throughout these Provinces. Despite high variability in survey effort, densities reported by National Forests and National Parks are remarkably similar, generally from one territory per 5,000 to 7,000 acres of forested habitat (Table 3.31). Only the Sierra NF reported relatively low densities; it is unknown whether this density results from low survey effort or scarcity of goshawk territories. More intensive survey and monitoring efforts on 7 National Forest Ranger Districts distributed throughout these Provinces provide adequate data to at least roughly estimate territory density (Table 3.32).

Land managers in the Klamath Province reported intermediate numbers of territories, and suggested that extremely steep terrain often tends to limit survey effort there. In the mesic western portion (Douglas-fir/ Hardwood Zone) of the Klamath Province (Six Rivers and western Klamath NFs), intensive goshawk surveys in large tracts of late-successional forest detected very few territories, suggesting that the species is relatively scarce there. Numbers of territories reported were much higher in the drier eastern portion of the province.

Very few territories were reported for the North Coast Range, where in recent years, intensive surveys for northern spotted owls and marbled murrelets would be expected to detect additional territories. Most of the territories reported in this Province are older records of territories discovered during preparation of timber sales on private timberlands; nearly all of the territories reported have subsequently been logged. Since 1992, only two active territories have been

reported in the North Coast Range Province, one on private timberlands and the other in late-successional redwood in a State Park.

Goshawks appear to be rare and poorly distributed in the Southern California/ Central Coast Range Provinces. Despite intensive surveys and demographic study of California spotted owls in mature forests throughout this province, no active territories have been detected in over a decade. Nesting has been observed in Ventura County (Mt. Abel and Mt. Pinos) in 1904, 1989 and 1990; and a set of eggs was collected in San Diego County (Cuyamaca Mts.) in 1937 (Kiff and Paulson 1997. These reports and scattered observations of adult goshawks (including defensive behavior and juvenile birds) suggest that the species is present at very low densities (Lentz 1993). It is unknown whether goshawks nesting in southern California are colonists from a larger metapopulation in the Sierra Nevada, or if a small self-sustaining population persists in the scattered "islands" of higher-elevation conifer habitat.

Table 3.31. Numbers and reported density of goshawk territories reported by agencies and private landowners in California.

Reporting Unit	# Terrs. Reported	Reported Density
Sierra Nevada/ Cascade Province		
Eldorado NF	57	1/ 5,329 ac. (4.64/ 100km^2)
Inyo NF	30	1/ 3,307 ac. (7.47/ 100km^2)
Klamath NF (eastside)*	35	1/ 2,123 ac. (12/ 100km^2)
Lassen NF	86	1/ 5,975 ac. (4.13/ 100km^2)
Modoc NF (Warner Mts)	60	1/ 2,242 ac. (11/100km^2)
Plumas NF	66	1/ 4,875 ac. (5.07/ 100km^2)
Sequoia NF	16	1/ 5,993 ac. (4.21/ 100km^2)
Shasta-Trinity NF (eastside)*	31	1/ 2,241 ac. (11/ 100km^2)
Sierra NF	11	1/ 30,133 ac. (0.82/ 100km^2)
Stanislaus NF	43	1/ 6,183 ac. (4.64/ 100km^2)
Tahoe NF	39	1/ 7,182 ac. (3.44/ 100km^2)
Lake Tahoe Basin	11	1/ 6,820 ac. (3.04/ 100km^2)
State Parks	2	unk.
Yosemite NP	22	1/ 5,818 ac. (4.25/ 100km^2)
Private Timberlands	49	unk.
Modoc Plateau Province		
Modoc NF (excl. Warner Mts)	59	1/ 3,563 ac. (6.93/ 100km^2)
Private / State Timberlands	5	unk.
California Klamath Province		
Six Rivers NF	48	1/ 10,138 ac. (2.44/ 100km^2)
Mendocino NF	17	1/ 14,782 ac. (1.67/ 100km^2)
Shasta-Trinity NF (west-side)	26	1/ 25,553 ac.(0.97/ 100km^2)
Klamath NF (west-side)	39	1/ 11,789 ac.(0.48/ 100km^2)
Private / State Timberlands	9	unk.
North Coast Range Province		
Private / State Timberlands	7	unk.
National Parks	0	
Southern California Province		
Los Padres NF	2	unk.
Angeles, Cleveland, San Bern. NF	0	

Density = # territories reported per area of "forested" habitat. ***= intensive survey area**

Population Status

Historical Trends

Based on assessment of historical habitat changes in many areas of the Pacific Southwest Assessment Area, it is reasonable to conclude that goshawk populations have been reduced from historical levels, but the magnitude of population change is unknown**.** Extensive areas of lower elevation mixed conifer and ponderosa pine forest of the Sierra Nevada and Cascade Ranges, and the Modoc Plateau were logged earlier this century and do not currently support mature conifer forest in significant amounts. In some of these areas, goshawk territories are centered on remaining fragments of mature forest, and landscapes lacking such fragments are not occupied (Allison 1996). Despite widespread changes in the amount and distribution of mature forest habitat throughout the Sierra Nevada and Cascade Ranges and Modoc Plateau, however, goshawk territories remain well-distributed and (in areas with intensive inventories) at densities comparable to studies elsewhere in North America (Table 3.32). Mature forest cover remains abundant and well-distributed in the Klamath Province, where goshawk populations likely resemble historical levels. In the North Coast Ranges Province, dramatic reduction of the amount of late-successional forest, increased vegetation density in managed forests, and short harvest rotation schedules in managed forests have likely resulted in reduction of goshawk populations. However, several authors have suggested that under natural conditions, high vegetation density in mesic coastal forests provides poor quality habitat for goshawks, and that the species may naturally be rare in coastal habitats (Reynolds and Wight 1978, DeStefano and McCloskey 1997). There is a lack of recent nesting records in Southern California, where intensive inventories for California spotted owls would expected to detect nesting goshawks in areas where historical nesting areas were reported.

Current Status

Population data available to this status review are inadequate to allow determination of any current trends in goshawk populations in the Pacific Southwest Assessment Area. Territory data provided to this Status Review represent an accumulation of territory locations over time, and only small subsets of these territories have been monitored adequately to assess long-term occupancy (Figure 3.20).

Population studies on the Klamath National Forest; Goosenest Ranger District (Woodbridge and Detrich 1994, Detrich and Woodbridge 1995), and other monitoring efforts on National Forest lands (Lassen NF, Modoc NF), suggest that, while annual occupancy and reproductive success are highly variable, most known territories continue to be used by goshawks over a period of many years. Many of these territories exhibiting long-term occupancy are in areas with long histories of extensive timber harvest. In addition, occupancy and habitat data for 68 territories on privately-owned industrial forestlands in California demonstrate that some goshawks persist in intensively-managed

forest landscapes (Farber et al. 1998). Reports from Forest Service biologists often correlated local timber harvests with abandonment of known goshawk territories, however the level of survey typically was adequate only to assess occupancy of a specific nest grove, not the entire territory. These cases must be corroborated by landscape-level surveys to assess whether territory abandonment has in fact occurred. This information does not allow determination of population declines or stability, and indicates that our understanding of the relationships between goshawks and amounts of mature forest habitat is inadequate to infer goshawk population trends from current habitat trends.

Reported densities of territories were much higher in 7 units (in this case Ranger Districts) where relatively high levels of survey effort were expended by Forest Service biologists (Table 3.32). These densities are based on territories reported as occupied at least once from 1990 to 1996.

Table 3.32. Densities of goshawk territories reported for Forest Service units with intensive goshawk inventory programs.

Reporting Unit	**territories total**	**territories post-1990**	**% territories post-1990**	**Reported density***
Sierra Nevada/Cascades				
Lassen NF, Almanor RD	42	40	95%	1/ 2,709ac.(9.12/100km2)
Modoc NF, Warner Mt. RD	60	33	55%	1/ 4,077ac. (6.06/100km^2)
Klamath NF, Goosenest RD	35	34	97%	1/ 2,185ac. (11.3/100km^2)
Shasta-Trinity NF, McCloud	31	24	77%	1/ 2,894ac. (8.54/100km^2)
Plumas NF, Beckwourth RD	25	22	88%	1/ 3,822ac. (6.47/100km^2)
Modoc Plateau				
Devil's Garden/Big Valley RDs	55	47	85%	1/ 4,473ac. (5.52/100km^2)
Other N. American studies			**Study Area(ha)**	
Kennedy 1989 (New Mexico)	7	7		6.36/ 100km^2
Reynolds and Joy 1998	107	107	173,200 ha.	6.17/ 100km^2
Woodbridge and Detrich 1994	11	11	10,230 ha	10.7/ 100km2
Woodbridge and Detrich 1994	6	6	10,440 ha.	5.75/ 100km2
DeStefano et al. 1994	9	9	10,519 ha.	8.6/ 100km2
DeStefano et al. 1994	3	3	11,396 ha.	2.6/ 100km2

* reported density: number of recently active territories per area of forested habitat.

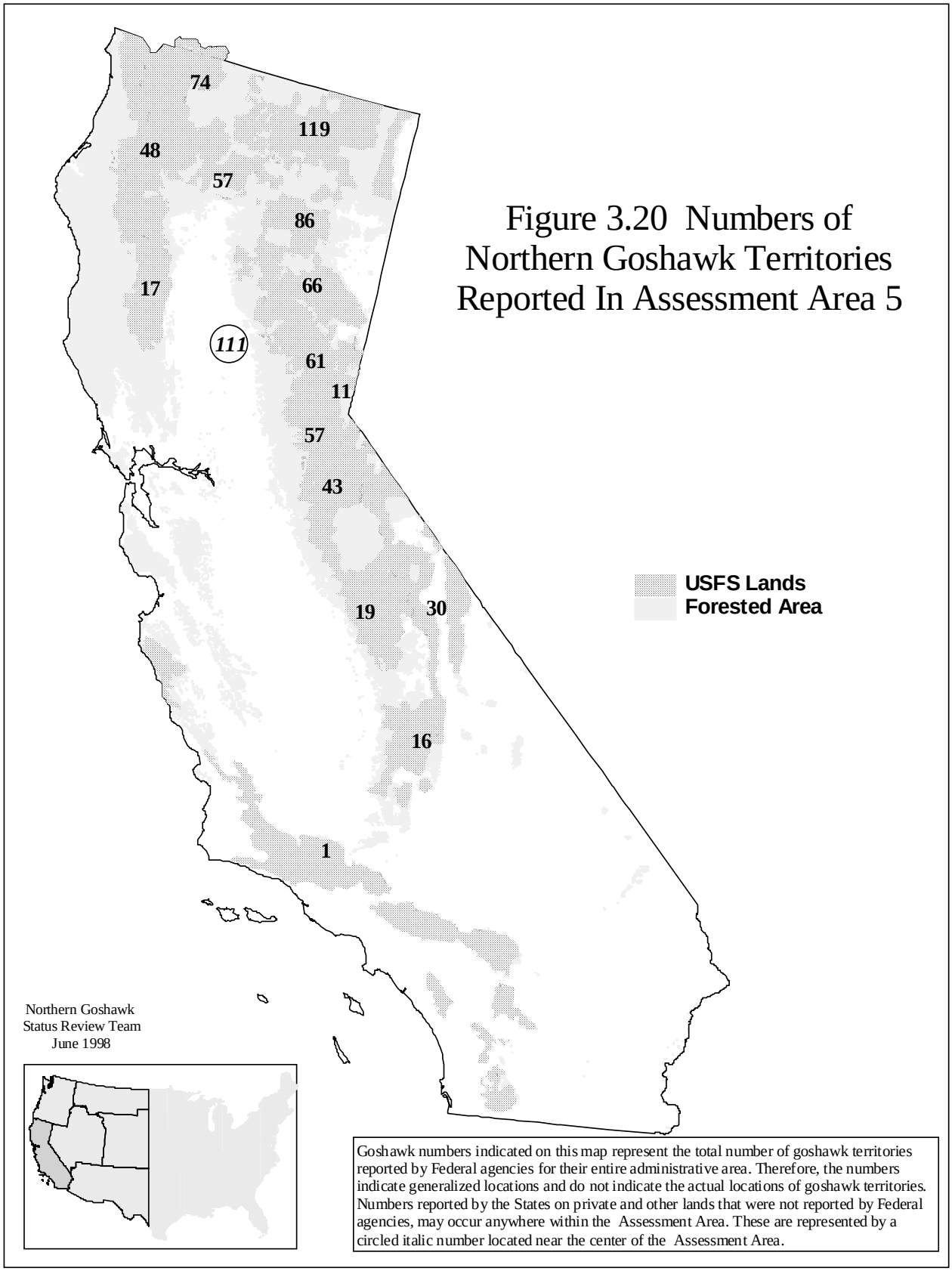


Figure 3.20 Numbers of Northern Goshawk Territories Reported In Assessment Area 5

Conclusions regarding goshawk population status in Assessment Area 5

1) Goshawks are well-distributed and relatively abundant in most forested areas of the Sierra Nevada, Cascades, and Modoc Plateau in California.

2) Goshawks appear to be of limited distribution and rare in the North Coast and Southern California Provinces, and have not been reported to nest in the Central Coast Ranges.

3) Some reduction in historical goshawk populations likely resulted from large-scale changes in amounts of mature forest habitat occurring from roughly 1850-1980.

4) Goshawk population data and habitat trend data available for this Status Review are not adequate to allow determination of current (post-1988) trends in goshawk populations in California.

5) Broad-scale forest management planning efforts (Northwest Forest Plan, California Spotted Owl Interim Guidelines) and recent significant declines in timber harvests on Forest Service lands greatly increase the probability that future trends in mature forest habitat will be favorable for the goshawk over a significant portion of it's range in California.

6) Although broad-scale planning and land management efforts are likely to increase the overall abundance of mature forest habitat, current management guidelines aimed at maintaining goshawk territories are inadequate, often focused on management of 5-50 acres surrounding the nest tree. Under current management practices, timber harvests may render many goshawk territories unsuitable for long-term occupancy. If selection of nest areas by goshawks is based partially on physiographic location or landscape features, this may have a negative impact on goshawk populations.

Assessment Area 6

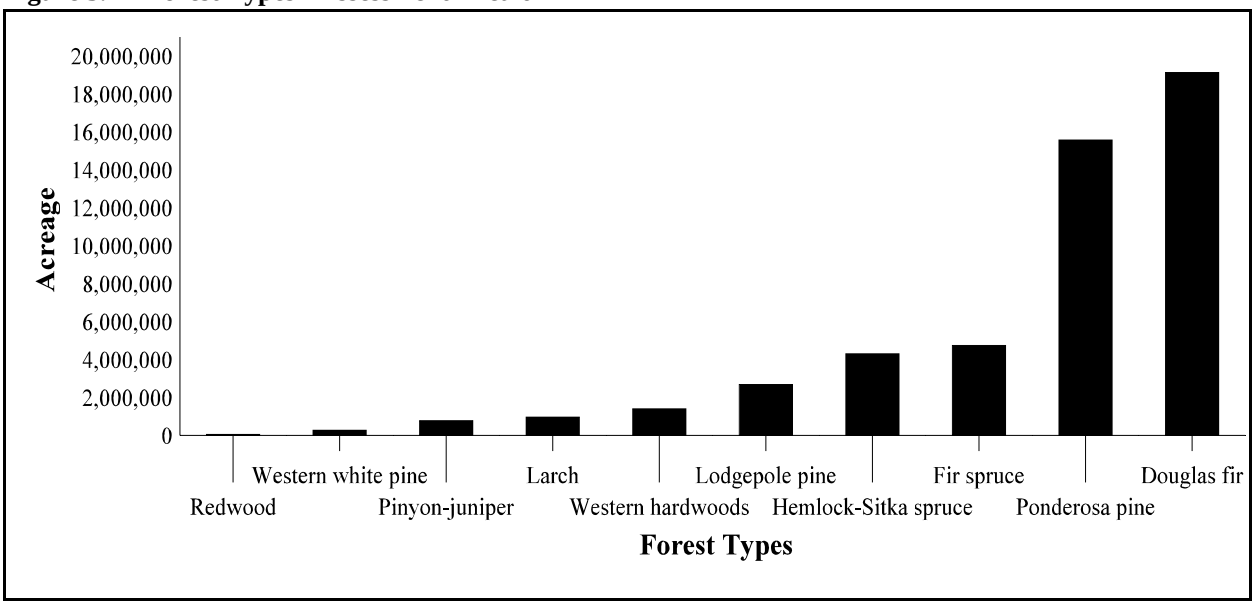
Introduction and Current Habitat as Modeled by FIA data

Assessment Area 6 includes the states of Washington and Oregon (Figure 1.1). Table 3.33 provides an initial view of the potential forest vegetation, by ownership, in this Assessment Area; a portion of these acreages would be considered capable of supporting goshawk habitat. Figure 3.21 illustrates the relative proportions of these forest types in this Assessment Area.

Table 3.33. Forest Cover Types, by Land Manager/Owner - Assessment Area 6.

Forest Type	Indian Lands	National Forests	Bureau of Land Management	National Park Service	Fish and Wildlife Service	Other Lands*	Total
Douglas fir	173,000	7,221,000	4,632,000	371,000	3,000	6,720,000	19,120,000
Fir-spruce	90,000	3,588,000	22,000	912,000	1,000	125,000	4,738,000
Hemlock-Sitkaspruce	149,000	456,000	373,000	144,000	4,000	3,177,000	4,303,000
Larch	144,000	496,000	113,000	1,000	26,000	172,000	952,000
Lodgepole pine	170,000	2,049,000	167,000	21,000	12,000	261,000	2,680,000
Pinyon-juniper	15,000	254,000	377,000		22,000	112,000	780,000
Ponderosa pine	1,189,000	9,970,000	1,589,000	151,000	45,000	2,625,000	15,569,000
Redwood		35,000	2,000			11,000	48,000
Western hardwoods	17,000	243,000	198,000	58,000	1,000	882,000	1,399,000
Western white pine	18,000	167,000	43,000		3,000	36,000	267,000
Total	1,965,000	24,479,000	7,516,000	1,658,000	117,000	14,121,000	49,856,000

Figure 3.21 Forest Types - Assessment Area 6



Habitat Trends

Overview of Forest Lands in the Area

Washington

Washington forests cover about 21,000,000 acres or 50 % of the state (see Map 2.6). About 18 million acres are considered productive timberlands capable of producing 20 cubic feet per acre of commercial forest. Forest ownerships are split among National Forest (29%), forest industry (29%), miscellaneous private owners (19%), other public of which most is state (15%), and Native American (8%) (Bolsinger et al. 1997). Over 85% of the timberlands are conifer forests dominated by Douglas-fir with lesser amounts of ponderosa pine, western hemlock, coastal Sitka spruce, true firs, and lodgepole pine. Dominant hardwoods including red alder, bigleaf maple and black cottonwood covered about 12% of timberlands during the period 1988-1991 (Bolsinger et al. 1997).

Oregon

Oregon forest lands cover about 28,000,000 acres or about 46% of the land area (Map 2.6). About 22 million acres are considered productive timberlands (Lettman 1988). Forest ownerships are split among National Forests (48%), Bureau of Land Management (10%), forest industry (20%), non-industrial forests (16%), other public of which most is state (4%), and Native American (2%). Forest composition is similar to Washington with larger amounts of lodgepole pine and western larch in eastern Oregon.

Forest Habitat Status in Assessment Area 6

The Pacific Northwest Assessment Area is characterized by a diversity of ecological forest conditions ranging from rain-forest like landscapes on the Olympic Peninsula to sparsely forested high desert aspen and juniper groves of southeast Oregon (Table 3.33). Within the Areas the larger federal land management categories include 24 National Forests, 10 BLM Districts, four National Parks, and 5 larger tribal reservations.

The broad range of ecological conditions corresponds to a diversity of land management issues that are influencing the status of goshawk habitat and populations. Throughout the Assessment Area timber harvest and forest management activities has, and will continue, to likely result in both positive and negative effects on goshawk habitat. In areas where regeneration harvest practices are common, the effect is removal of nesting habitat and reduced foraging opportunities for a period of time. In areas of selective tree removal, the effect is likely more subtle. In drier forest types of southwest Oregon and eastern Washington and Oregon, the emerging issues of forest health, decades of wildfire suppression, and urban-forest interface conflicts are actively being discussed in planning efforts, such as the Columbia Basin science investigations (USDA and USDI 1997).

For analysis purposes, western and eastern Washington and Oregon are treated separately because of differences in plant communities, resulting from climate and geological history. These same differences have lead to their separation in most studies and large scale planning efforts. In many cases the data between different studies are not comparable because of different management unit boundaries, management assumptions and time frames addressed leading to further analysis concerns.

Historical Habitat Status

Western Washington and Oregon

Significant changes on forested lands have occurred in the western portions of both states since settlement of the northwest by early pioneers in the 1840's (Jackson and Kimmerling 1993). As populations expanded lowland areas were logged and then cleared for settlement and farming. Bolsinger et al. (1997) estimated over 2,000,000 acres of forested lands have been lost to road construction and urban expansion in Washington alone, the majority of which has occurred in the Puget Sound area.

Booth (1991) estimated the amount of prelogging old-growth in western Oregon and Washington for all ownerships using 1933 data from the first forest surveys conducted by the U.S. Forest Service, and adjusted forest type information based on fire probabilities. These estimates were compared to 1986 forest inventory data by Haynes (1986). For western Oregon and Washington prelogging old-growth (forests >200 years old) was estimated at 10.5 and 9.1 million acres, respectively, compared to 1.8 and 1.7 million in

the 1980's. Overall this represents an 83-84% decrease in older forests due to logging, fires and land conversions (e.g., urbanization, roads) during this 50 year time frame. Most private industrial lands have been logged one or more times and little mature or older forest remains (Thomas et al. 1990, USDI 1992). The primary approach to forest management during this period for all ownerships was clear-cut logging and intensive reforestation with one or more species, predominantly Douglas-fir. Forest industry lands in both state are now mostly covered with early seral stand conditions and generally are managed on short rotations (Bolsinger et al. 1997, Lettman 1988).

Eastern Washington and Oregon

Similar forest changes have occurred on federal forest lands in eastern Washington and Oregon. Productive timberlands total approximately 2.5 and 5.5 million acres respectively out of a total of 15,000,000 acres of federal forest lands.. Most are National Forest lands but included are about 182,000 acres of forested BLM lands primarily in south central Oregon. As a result of a 1993 Presidential directive, the Forest Service and BLM have been developing an ecosystem-based strategy for east side forests and rangelands (Quigley et al. 1997). All federal lands east of the Cascades in Washington and Oregon as well as portions of all other states in the entire Columbia River basin, have been undergoing intensive study and analysis for the past 4 years as part of the Interior Columbia Basin Ecosystem Management Project (ICBEMP) (Quigley et al. 1997).

As a part of the scientific assessment for the basin, dominant vegetation was mapped and analyzed by potential vegetation group (PVG) (Quigley et al. 1996). Five of 14 terrestrial PVGs were classified as forested including alpine, cold (higher elevations), dry, moist, riparian, and woodland. These six groups cover about 25% of eastern Oregon and Washington. Forested communities, excluding riparian and woodland, were further divided into early, mid-, or late seral forests. Of the 12 possible seral combinations, 8 showed what was considered ecologically significant change from historical vegetation across the basin. Upland woodlands also showed significant change. The average amount of change was about 55% among the various forest and woodland combinations. The largest changes included significant decreases in both early and late-seral lower montane forest and a corresponding increase in mid-seral lower montane forest (Quigley et al. 1996).

Current Habitat Status

Western Washington and Oregon

More comprehensive estimates of current forest stand conditions were developed for federal land management planning within the range of the northern spotted owl (USDA

and USDI 1994). For single and multi-story stands 21 inches in diameter or larger on federal lands in western Washington and western Oregon respectively, about 1,650,000 acres and 2,985,000 acres remained. This constitutes about 42% of the total federal land base, the majority of which are located in the Cascade Mts. of both states. Of approximately 8.2 million acres of forest industry lands within the entire range of the northern spotted owl (including California), about 90% of the acreage are in stands under 80 years old and most are under 60 (USDA and USDI 1994). On state forest lands in western Oregon about 87% of all forests are under 80 years of age (Oregon Dept. of Forestry 1995, 1998), and on State Dept. of Natural Resources lands in Washington within the range of the northern spotted owl about 75% of existing forests are under 80 years of age (Wash. Dept. of Natural Resources 1997).

In summary, federal, state and private lands have been heavily logged and fragmented with road systems since the early 1900's. Most remaining mature and older forests are found on federal lands in the Cascades, Olympics and southern Oregon Klamath Mountains (USDI 1992, USDA and USDI 1994).

Eastern Washington and Oregon

Eastern Washington and Oregon forests have undergone similar and extensive forest changes. As part of the Interior Columbia Basin project, an assessment was made of all resources including forest and range lands (Quigley et al. 1996). In comparing historical to current conditions the assessments determined that: 1) since the early 1800's there has been a 27% decline in multi-layered and 60% decline in single-layer old forest, particularly in ponderosa pine and Douglas-fir forest types; 2) mid-seral multi-layered stands increased as much as 12-55% in potential vegetation groups; and 3) disease and fire susceptibility have increased by 60%. In short, timber harvest selectively removed old-forests and fire exclusion promoted the transition of early stands to mid-seral forest structures (Quigley et al. 1996 and 1997). Except in reserved land, extensive road systems now bisect all forested lands. As noted under future conditions below, considerable efforts have been initiated to reverse these unnatural changes and begin restoring ecological structure and processes to the region.

Future Habitat

Western Washington and Oregon

As a result of decades of debate over the decline of old-growth forests and associated flora and fauna, particularly the northern spotted owl, the Northwest Forest Plan was adopted by the U.S. Forest Service and U.S. Bureau of Land Management for National Forest and BLM lands within the range of the northern spotted owl in Washington, Oregon and northwestern California (USDA and USDI 1994). The plan includes

extensive late-successional reserves, Congressionally reserved areas (e.g., national Parks and wilderness), riparian reserves, managed late-successional areas, adaptive management areas, administratively withdrawn areas, and general forest matrix (Table 3.1). Between Washington and Oregon about 13,500,000 acres or 73% of federal lands will be managed as Congressional reserves, late-successional reserves and riparian reserves. These reserves further connect with an additional 3.8 million acres of similar reserves in northern California. Further, 100 acres of late-successional forest habitat is to be maintained within forest matrix lands around all spotted owl activity centers known prior to 1994, and managed late-successional areas are to maintained around 12 activity centers on the eastside of the Washington Cascades. Managed late-successional areas are located in areas of high fire frequency and are designed utilizing median home range size for that physiographic province.

Eastern Washington and Oregon

The large scale assessment of the interior Columbia Basin has resulted in the development of the Eastside Draft EIS for the entire Columbia Basin (USDA and USDI 1997). For eastside forests within the range of the spotted owl (e.g., Wenatchee, Deschutes, Winema) that overlap with the ICBEMP, the Northwest Forest Plan would continue to provide current direction. Until a preferred alternative is selected later this year, interim management strategies (also known as "eastside screens") have been implemented to initiate ecosystem-based management with new timber sales. This includes specific efforts to accelerate restoration of both terrestrial and riparian ecosystems (USDA 1994) and protection of known goshawk nest site and post-fledging areas.

Conclusions regarding goshawk habitat trends in Assessment Area 6

As a result of the adoption of the Northwest Forest Plan, timber harvests on federal lands within the range of the northern spotted owl in both western and eastern portions of the Assessment Area are expected to drop from an average of 4.5 billion board feet (bbf) per year in the 1980's to 1.1 bbf per year over the 10 year life of the plan (Tuchmann 1996). This represents a 76% drop in the federal land timber harvest from the 1980's within the range of the northern spotted owl. Future scheduled timber harvests are directed to the "matrix" lands and forest stands outside of reserves and administratively withdrawn areas. The matrix lands covers only 16% of the federal lands within the Northwest Forest Plan area. Matrix lands also includes provisions for maintaining blocks of late-successional forest distributed throughout the landscape to provide for spotted owl dispersal and connectivity. Silvicultural treatments will be allowed in some reserved and adaptive management area lands but only to accelerate restoration of functional late-successional forests.

The Northwest Forest Plan teams evaluated impacts of plan implementation on many plant and animal species associated with late-successional forests within the plan area. For the alternative

adopted and that is being implemented on federal lands in the range of the spotted owl, the northern goshawk was rated as having a 100% likelihood of having sufficient quality, distribution, and abundance of habitat to allow the species population to stabilize well-distributed across federal lands regardless of current population status (USDA and USDI 1994). This rating, conducted by a panel of scientists, reflects a high degree of confidence that the network of large reserves together with management direction between those reserves will improve and sustain goshawk populations in this area. The panelists were directed to incorporate factors and issues of any "bottle-neck" periods they would expect as previously-harvested areas in the reserves were developing into more suitable goshawk habitat, while habitat was being cut for timber production in the surrounding matrix. The Northwest Forest Plan superceded and amended prior National Forest or BLM District plans, some of which had earlier provisions for protection of goshawk nests (Schommer and Silovsky 1994).

For eastern Oregon and Washington, similar to the Northwest Forest Plan, an expert panel rated species outcomes according to their viability likelihood under historic, current and future management scenarios. The goshawk rated near the median on federal lands under several likely alternatives that included active management, habitat restoration and adaptive management but showed a significant decline was predicted under current management plans (Quigley et al. 1997). Caution was expressed that species respond to habitat changes at finer scales then the above evaluation. However, as indicated earlier, federal forest management has already moved to a more ecologically based direction on all eastside spotted owl forests and interim direction is in place on remaining federal forest lands. Since 1993 under the eastside screens which are applied outside of the Northwest Forest Plan area (USDA and USDI 1997), all known and historical goshawk nests are to be protected with a 30 acre buffer and 400 acre post-fledging area. These requirements are to be incorporated into forest plans until the Eastside EIS is completed sometime in the next year.

Status of goshawk populations in the Pacific Northwest Assessment Area

Assessment of goshawk populations in the Pacific Northwest Assessment Area was made using the same approach as other Assessment Areas including review of available literature, agency and nonagency reports, analysis of goshawk data and information provided during the public comment periods, and personal communications. A significant number of studies and surveys have occurred in both Washington and Oregon dating from the 1970's with most conducted since 1990 (Schommer and Silovsky 1994, Hayes and Desimone *in review* 1998)(Table 3.34). Additional studies or surveys continue on both public and private lands including the Olympic Peninsula and other parts of western Washington (Finn et al. 1998) (Jim Michaels, pers. comm).

Table 3.34. Published and unpublished goshawk field studies, summary and progress reports for Washington and Oregon.

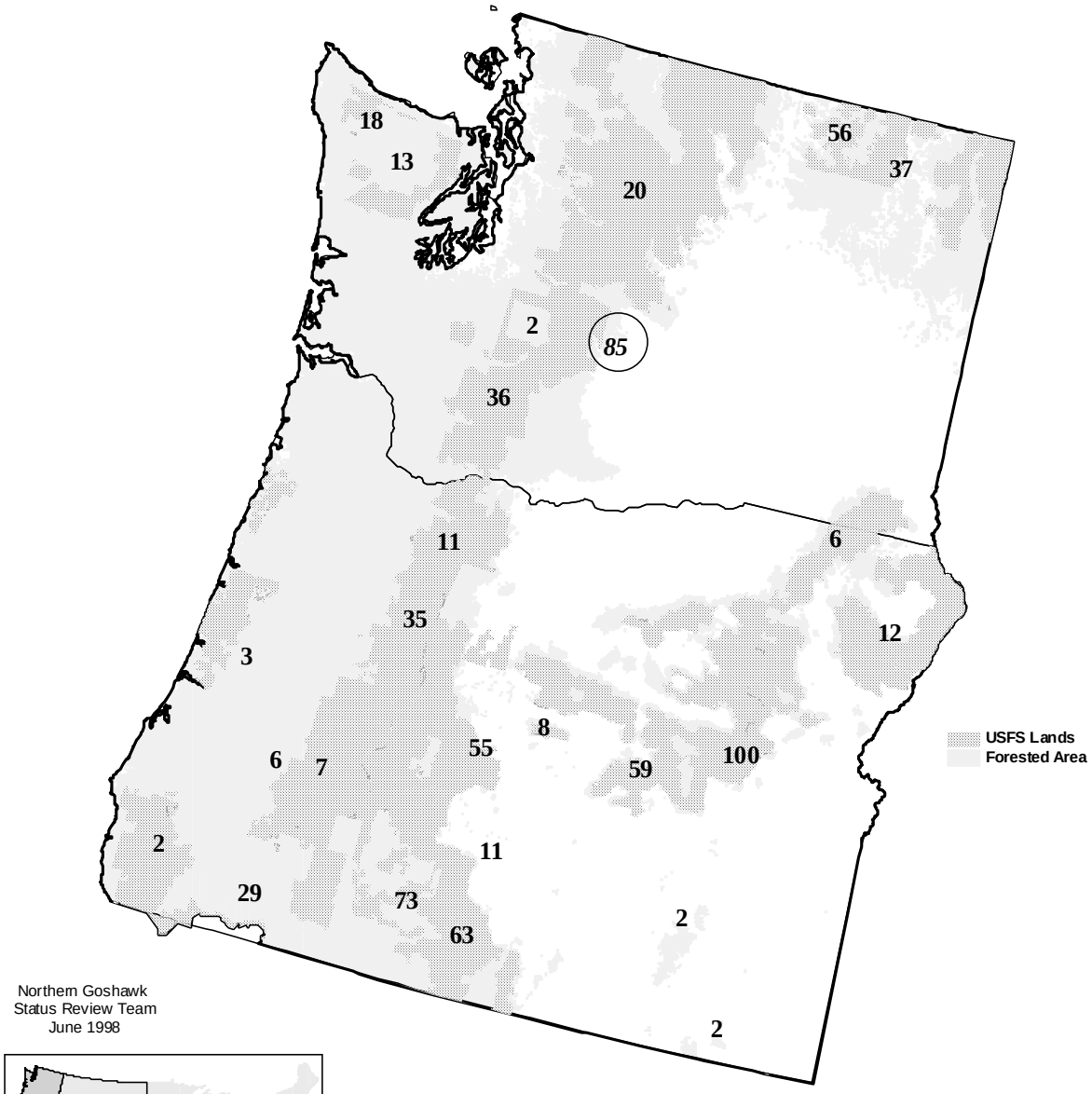
Author(s)	Type	Location	Topic(s)
Washington			
Fleming 1987	Report	western Wash., Olympics	status, habitat
Buchanan & Irwin 1993	Publication	eastern Wash.	nest sites
Scommer & Silovsky 1994	Report	Oregon, Washington	status, monitoring, management, research
Bosakowski & Vaughn 1996	Publication	western Wash. Cascades	survey methods
McGrath 1997	MS (Thesis)	eastern Or. & Wash.	nesting habitat
Smith et al. 1997	Publication	statewide	distribution, status
Watson et al. 1998	Publication, in Review	statewide	survey methods, nest success
Wagenknecht et al. 1998	Report	eastern Wash.	breeding ecology
Finn et al. 1998	Report	western Wash.	habitat, productivity, demographics
Hayes & Desimone 1998	Report, in review	statewide	status, ecology
Oregon			
Reynolds 1975	MS.	Or. Coast, Cascades. Eastern OR.	distribution, density, productivity
Reynolds 1978	Ph.D.	Or. Coast, Cascades. Eastern OR.	food and habitat partitioning
Reynolds & Wight, 1978	Publication	Or. Coast, Cascades. Eastern OR.	distribution, density, productivity
Anderson 1980	Report	northeast Oregon	nesting habitat
Reynolds et al. 1982	Publication	northeast Oregon	nesting habitat
Reynolds & Meslow 1984	Publication	Coast range, southcentral Or.	food habits and competition
Moore & Henny 1983	Publication	Northeast Or.	nest site characteristics
Henny et al. 1985	Publication	Northeast Or.	breeding chronology, molt, measurements
Marshall 1992	Report	Or, Wash	status, distribution, ecology
Schommer & Silovsky 1994	Report	Or, Wash	status, monitoring, mngmnt, research
Bull & Hohmann 1994	Publication	northeast Or.	breeding biology
DeStefano et al. 1994	Publication	eastern Or.	density, productivity
Haines 1995	MS	northeast Or.	breeding habitat
Rissler 1995	MS	southern Cascades Or. and Calif.	habitat structure,
Daw 1996	MS	eastern Or.	nest site, habitat
Desimone 1997	MS	southcentral Or.	nesting habitat, occupancy
Thrailkill & Andrews 1997	Publication	Coast Range	nesting habitat
McGrath 1997	MS	eastern Or. & Wash.	nesting habitat
DeStefano & McCloskey 1997	Publication	Coast Range	habitat, distribution, foraging

Distribution and Reported Numbers

Northern goshawks territories have been documented throughout Assessment Area 6 in most forested regions except the north Coast Range of Oregon and juniper woodlands of southeast Oregon (Reynolds and Wight 1978, Marshall 1992, Destefano and McCloskey 1997, Hayes and Desimone *in review* 1998). Relative goshawk densities appear to increase as you move from the Coast Ranges of Washington and Oregon into eastern portions of both states (DeStefano and McCloskey 1997, Watson et al. 1998). Goshawk territories have been located through a combination of random and systematic surveys within more intensive study areas (e.g., Reynolds 1975, Haines 1995, Desimone 1997, Wagenknecht et al. 1998), timber sale surveys (Schommer and Silovsky 1994), or general field surveys for other species such as northern spotted owls (Buchanan and Irwin 1993). For this review, at least 267 territories have been documented in Washington and 484 in Oregon (Figure 3.22), primarily on federal lands (Table 3.35). These numbers should also be viewed with caution as not all federal land management units responded to data request, some territories may no longer exist due to past forest management activities (e.g., regeneration harvest), extensive fires or insect epidemics subsequent to their discovery. Although some studies or surveys in Table 3.34 include private forest company lands, limited data are available in general from private and tribal lands. These ownerships constitute about 54% of commercial forest lands in Washington and 38% in Oregon and extend throughout the Assessment Area. Active territories are known to exist on some nonfederal lands and surveys are being conducted by some ownerships (Jim Michaels [Wash.] and Rick Gearhart [Or.], pers. comm.).

The distribution and abundance of northern goshawks in the Coast Range mountains of Washington and Oregon are the least known of the entire Assessment Area. Only 4 territories are reported to date for the entire coastal physiographic province south of the Olympic Peninsula, 2 in each state (DeStefano and McCloskey 1997, Hays and Desimone *in review* 1998, Watson et al. *in review* 1998). Factors likely responsible for the low numbers of goshawks reported include lack of adequate surveys, natural unsuitability of dense temperate rainforest habitats, intensive timber harvests and large scale fires (Reynolds et al. 1982, DeStefano and McCloskey 1997). An additional issue regarding goshawks in the coastal region is the suggestion that the goshawk subspecies present may be *Accipiter gentilis laingi*, the Queen Charlotte goshawk subspecies (Jewett 1953). This hypothesis is further discussed in Chapter 2 but data is lacking to support the claim.

Figure 3.22 Numbers of Northern Goshawk Territories Reported In Assessment Area 6



Goshawk numbers indicated on this map represent the total number of goshawk territories reported by Federal agencies for their entire administrative area. Therefore, the numbers indicate generalized locations and do not indicate the actual locations of goshawk territories. Numbers reported by the States on private and other lands that were not reported by Federal agencies, may occur anywhere within the Assessment Area. These are represented by a circled italic number located near the center of the Assessment Area.

Conclusions Regarding Goshawk Populations

Goshawk populations appear to remain fairly widely distributed throughout the Assessment Area based on the studies and surveys reviewed above. Populations densities appear to be naturally lower in portions of western Washington and Oregon however survey effort has been limited, particularly in the Coast Range province. Recent discoveries of nesting goshawks in younger forests of western Oregon (Thrailkill and Andrews 1997, Mike Blow [Eugene BLM] pers. comm.) confound the issue. The higher numbers of nesting territories located on the Olympic Peninsula presents a unique situation and requires further study and explanation. None of the studies conducted in the northwest have been of sufficient duration, scale and intensity to determine population trend.

Based on studies in the Pacific Northwest identified above and elsewhere (Chapter 2), it is likely that populations have decreased in some areas, particularly western Washington and Oregon, from pre-settlement periods given the extensive timber harvest that has occurred on both public and private lands and land conversion to non-forest uses throughout both states. Desimone (1997) seemed to document a significant decline in historical territories due to timber management activities in southcentral Oregon although the short-term nature of the study unfortunately limits the value of the results.

As discussed in the Habitat Conclusions above the combination of implementing the Northwest Forest Plan in both western and eastern Oregon, the Interior Columbia Basin ecosystem program and interim "eastside screens", provide both short-term and long-term optimism for both currently occupied and future goshawk habitat on federal lands. In spite of this optimism, large scale and long-term habitat changes will likely continue due to both natural and anthropogenic forest management, fires and insect epidemics, particularly in eastern portions of the Assessment Area. The combined effects these variables will remain to be seem. Only an effective long-term research and monitoring program will help clarify the status of the species.

Table 3.35. Goshawk territories reported to the Status Review Team by land management agencies and state natural heritage programs in Assessment Area 6.

State	Landowner or Data Source	No. Territories
Washington	Washington Dept. of Fish and Wildlife, Wildlife Information System	84
	Okanogan National Forest	56
	Colville National Forest	37
	Gifford Pinchot National Forest	36
	Mt. Baker-Snoqualmie National Forest	20
	Olympic National Forest	18
	Olympic National Park	13
	Mount Rainier National Park	2
	Bureau of Land Management: Spokane District Office	1
	Subtotal:	**267**
Oregon	Malheur National Forest	100
	Winema National Forest	73
	Fremont National Forest	63
	Ochoco National Forest	59
	Deschutes National Forest	55
	Willamette National Forest	35
	Bureau of Land Management: Medford District Office	29
	Bureau of Land Management: Lakeview District Office	11
	Mt. Hood National Forest	11
	Wallowa-Whitman National Forest	12
	Bureau of Land Management: Prineville District Office	9
	Umpqua National Forest	7
	Bureau of Land Management: Roseburg District Office	6
	Umatilla National Forest	6
	Bureau of Land Management: Eugene District Office	3
	Siskiyou National Forest	2
	Bureau of Land Management: Burns District Office	2
	Hart Mt. National Antelope Refuge	1
	Sheldon National Wildlife Refuge	1
	Subtotal:	**484**
	TOTAL:	**751**

Goshawk Population Distribution and Status in the Review Area

The previous sections of this Chapter included Assessment Area discussions of what is known of the goshawk populations in each Area. The following summary discussion builds upon those previous pieces, yet is more directed at the entire Status Review Area. Much of the following summarizes and discusses the goshawk territory data received by the Status Review Team in response to the information request. The nature of the information request (recipients and respondents) and some potential problems and limitations of the data are presented in the Chapter 1, Approach section.

The following will discuss three measures of the goshawk population: total population size, population distribution, and population trend.

Total Goshawk Population Size in the Review Area

The best available view of the total goshawk population in the Status Review Area is the data which was gathered as a part of this Review. Goshawk territory information was received from many land and resource managers in the Review Area, representing a total accumulation of 3,242 territories. This number cannot be considered the true total population because several factors would adjust the number both upward and downward.

The 3,242 territories would be considered an underestimate of the population because not all land managers responded to the information request. We know that a portion of these land managers who did not respond have goshawk territories (for example, 20 National Forests did not submit goshawk territory locations). Despite our use of the Natural Heritage data bases to fill in those areas of non-reporting, we know that additional sites could be reported by the land managers. We also know that managers who did provide territory data have not surveyed all the of the goshawk habitat they manage. For example, the Clearwater National Forest estimated 10% of the Forest had been surveyed using the standard protocol, all other territories were located incidentally. This lack of survey leads to a significant underestimation of the goshawk population (see discussion under Intensive Studies). These two obvious factors contribute to the uncertainty of the estimate, resulting in a strong trend toward underestimation of the population.

Conversely, the number would be considered an overestimate because it includes sites which were located a decade or more in the past, and have not been verified in recent years. In our analysis subset of 2,729 territories there are 354 territories which were recorded prior to 1988 but did not have records after 1988 (13% of the subset). These territories may or may not be vacant at this time, we simply don't have records to know. Also, there are some situations where the same territory is reported with two or more records because the nest site moved from one year to the next, and the data collector or reporter did not correct these duplicate records of the same territory. In some areas, such as National Forests in California, the data has been reviewed and these duplicate situations have been eliminated. In many areas, this review of the data has not occurred. Thus, we have at least two factors which indicate the number of 3,242 may be

considered an overestimate of the goshawk population in the Status Review Area.

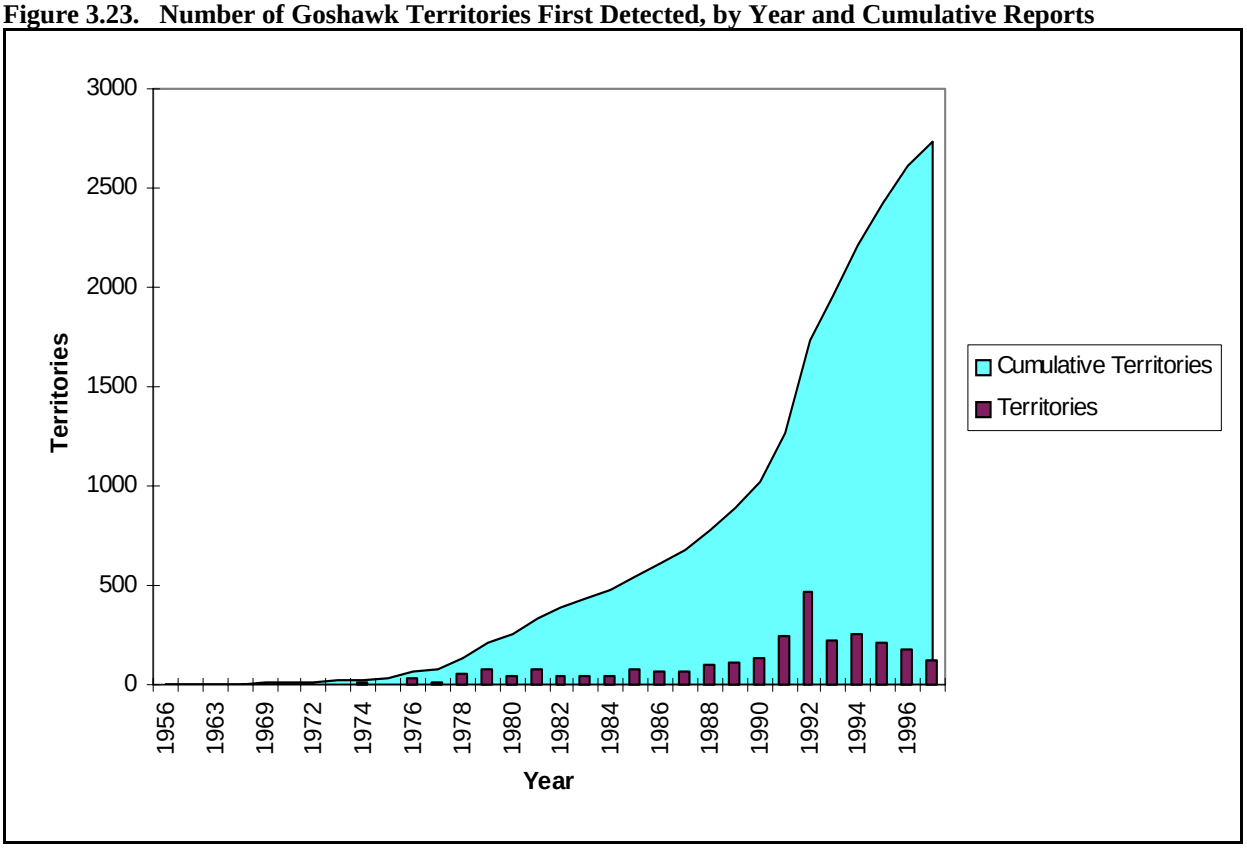
Our estimate of the total count of the population is but one consideration of species status, and the first approximation of that answer is: there are approximately 3,200 goshawk territories on record with the Status Review Team. This is likely an underestimate of the population because the factors which would cause an underestimation (lack of surveys and non-reporting of known territories) are more prevalent than the factors which would cause an overestimation. Ultimately, we believe the estimate of total goshawk population is less meaningful to our Status Review than measures of the population health (demographic parameters).

Table 3.36 and Figure 3.23 illustrate the accumulation of goshawk territory data, using a subset of the total reported number of goshawks. The subset (2,729 territories) was based upon the territories which met particular criteria of quality and completeness of data, which allowed such an analysis. To the subset, the Review Team selected those territories for which goshawk 'activity' (nesting or young documented) or 'occupancy' (adult birds seen at the site) had been recorded, or sufficient survey effort had been reported to support a conclusion of "non-occupancy" (Table 3.37).

Table 3.36. Cumulative Number of Territories, by Year First Documented.

Year First Documented	Number of Territories	Year First Documented	Number of Territories	Year First Documented	Number of Territories
1956	1	1977	14	1988	100
1961	1	1978	58	1989	110
1963	1	1979	76	1990	132
1965	1	1980	50	1991	250
1969	2	1981	75	1992	464
1971	2	1982	48	1993	221
1972	5	1983	50	1994	255
1973	5	1984	41	1995	215
1974	9	1985	74	1996	181
1975	5	1986	62	1997	122
1976	31	1987	68		

Figure 3.23. Number of Goshawk Territories First Detected, by Year and Cumulative Reports



The rate of accumulation of territory information (Table 3.36 and Figure 3.23) should not be confused with the population trend discussion below. This non-linear accumulation, especially the apparent marked increase in territory discovery since 1991, is the result of increased search effort and not a sudden increase in the goshawk population. Seventy-five percent of the recorded goshawk territories have been first located in the past 10 years. Clearly, goshawks existed in these areas prior to surveys. These data indicate that for goshawks the level of search effort is significant to making confident estimations of goshawk numbers. The higher search effort, the more birds are found (up until total area survey is accomplished), and the more confident our estimate of territories.

Goshawk Population Distribution in the Status Review Area

The distribution the goshawk and its habitat, in comparison to its historic range, is important to address in this Status Review. Maps of all reported territories (presented as figures earlier in Chapter 3) show goshawks well-distributed within the forested habitat of each Assessment Area. Any interpretation of the distribution should consider that some of these locations have not been confirmed in the past ten years (approximately 13%). If all of the "old" territories (those not documented in the past 10 years) were concentrated in a portion of the geographic area, we would have indications of the goshawk being eliminated from a portion of its range. Our analysis of the "old" territories compared against the current documented goshawk populations

showed no large areas where goshawks occurred in the past, but were now absent.

Thus, we found no evidence or reports of goshawks being eliminated from a large landscape which could be interpreted as contraction of the species range. There are localized reports of goshawks being disappearing from individual territories, but the general distribution appears to be correlated with the forested west. The exception to this statement are the portions of the forested west where goshawks have not been reported in abundance either in the past or recently (coastal northern California, Oregon, and Washington and southern California). The discussions of Assessment Areas 5 and 6 address these situations.

Comparing the estimated current distribution against a historic distribution is difficult because of the lack of data on historic populations and habitat. However, we can draw some general conclusions about the historic distribution of forested habitat in the west. Few areas of forest have been permanently changed from forested habitat; notable areas are the Puget Trough in Washington and the Willamette Valley of Oregon. In these areas we would not expect to find appreciable numbers of goshawks today. We also have indications of increased acreage of forest in portions of the west, principally from the expansion of pinyon-juniper forests in the absence of fire. But in general, looking at the scale of the Review Area, we believe the current distribution of forested habitat (Figure 3.1) approximates the historic distribution of potential goshawk habitat.

Based on our analysis of the subset of 2,729 reported territories, we conclude that the distribution of goshawks shown in the series of Assessment Area maps represents a good sample of the near recent and current goshawk distribution. We further conclude that the current distribution of known territories probably approximates the likely historical distribution of nesting goshawks. We feel this conclusion regarding the current distribution is well-founded, despite the fact that "historic" territories are included in the figures, because the bulk of reported goshawk territories have been first recorded within the past 10 years.

Goshawk Population Trend

The critical aspect of determining the trend of the goshawk population in the Status Review Area is following the individual goshawk territories through time (or a representative sample of the territories in the population). The ability to determine the trend depends upon the frequency of visits to the territory (at least annually) and the intensity if the survey effort when visits occur.

As described above, the data set for use analysis of goshawk population trend consists of those territories for which goshawk 'activity' (nesting or young documented) or 'occupancy' (adult birds seen at the site) had been recorded. A total of 2,729 goshawk territories met this criteria (Table 3.37) in the Status Review data base and are amenable to analysis. Assessment Area 5 reported the most (773 territories), while Assessment Area 1 reported the least (207 territories) (Table 3.37). In the Table, the number of territory-years is presented for the review period, 1971 through 1997. A "territory-year" is defined as a year in which a territory location was on

record, and may have been under observation. The number of territory years for a given territory was calculated by counting the number of years since, and including, the year the territory was discovered (e.g., a territory discovered in 1992 would have (1997-1992 = 6 “territory-years”). It is important to note that territory-years do not equate to territories; rather, they reflect the available pool of annual territory observation opportunities, over time.

Table 3.37 also shows, by Assessment Area, the number and percentage of reported territory-years when active/occupied status was documented; the number and percentage of territory-years that were sufficiently surveyed and no birds were found; the number and percentage of territory-years in which there was an insufficient level of monitoring; and the number and percentage of territory-years in which territories were not known to be surveyed. This sorting of the data allows a greater understanding of the confidence we may have in the results. For example, 16,341 of the reported 23,343 territory-years (70%) were situations where territories were either not surveyed, or survey effort was not adequate to reliably determine occupancy status. This represents an important limitation in our ability to confidently document the goshawk population in the Review Area. The remaining 30% of the records provide a sample of goshawk territory activity or occupancy, though not a statistically sound sample.

Table 3.37. Territory Activity Reported, by Assessment Area.

Assessment Area	Number of Territories	Territory-Years	Territory-Years							
			Surveyed						Not Surveyed	
			Active/Occupied		Not Occupied		Insufficiently			
			Count	Percent	Count	Percent	Count	Percent	Count	Percent
1	207	1,464	352	24%	28	2%	862	59%	222	15%
2	263	1,804	508	28%	24	1%	984	55%	288	16%
3	416	3,894	1,562	40%	61	2%	1,159	30%	1,112	29%
4	530	4,608	1,209	26%	77	2%	3,096	67%	232	5%
5	773	8,043	2,066	26%	168	2%	1,893	24%	3,916	49%
6	540	3,530	924	26%	29	1%	1,639	46%	938	27%
Total	2,729	23,343	6,621	28%	387	2%	9,633	41%	6,708	29%

Knowledge of the continued occupancy of territories is essential to any understanding of the stability of the goshawk population. As stated elsewhere in this Status Review and illustrated in our data, it is not uncommon for a goshawk territory to be located, recorded and never visited again. In these instances, the continued occupancy of the territory is unknown and its contribution to the stability of the population is unknown. Table 3.37 summarizes the recorded occupancy history of reported territories, illustrating this point. The majority (2,182 or 80%) of the 2,729 reported territories were known to be occupied for 3 or fewer years between 1970 and 1997. The years when occupancy was documented are often interspersed with years when non-occupancy may be incorrectly interpreted. The absence of information for the other years cannot necessarily be interpreted that goshawks weren't there, but often reflects the site was not adequately surveyed to record goshawk presence.

Table 3.37. Number of Goshawk Territories Where Occupancy and Nest Activity Were Documented, by Assessment Area.

Assessment Area	Number of Territories with at least one year of occupancy	Number of Years of Known Occupancy						Number of Years of Known Nest Activity					
		10+ years	5 - 9 years	4 years	3 years	2 years	1 year	10+ years	5 - 9 years	4 years	3 years	2 years	1 year
1	207	0	8	7	23	40	129	0	3	2	11	24	79
2	263	3	13	16	25	52	154	0	3	0	5	24	82
3	416	16	118	41	78	79	84	1	28	25	38	70	131
4	530	2	65	27	58	125	253	0	20	23	27	57	137
5	773	8	117	64	112	182	290	6	83	47	72	162	308
6	540	0	21	21	68	92	338	0	5	13	23	54	200
Total	2,729	29	342	176	364	570	1,248	7	142	110	176	391	937
Percentage of Total		1.1%	12.5%	6.4%	13.3%	20.9%	45.7%	0.3%	5.2%	4.0%	6.4%	14.3%	34.3%

Importantly, 547 of the territories (20%) were documented as occupied for 4 or more years and all Assessment Areas are represented. Fully 342 territories (13%) were documented as occupied five to nine years, and again all Assessment Areas are included. Areas 3 and 5 have higher proportions of repeated years of occupancy because of the long-term studies in these Areas. There were 29 territories (1%) where goshawk occupancy had been recorded for ten or more years, which would be a very good indication of territory stability. Assessment Areas 1 and 6 are not represented in this summary. All of these calculations of continued occupancy of goshawk territories indicate that goshawk territories in the Status Review Area are demonstrating some stability, though the statistical validity of the sample has not been determined. The small sample size in this summary gives little confidence in drawing conclusions about goshawk population stability from these data. They are useful only as anecdotal indications of population trend.

A further refinement of this analysis is to look at territories where goshawk nesting has been documented. Records of nesting at a particular territory for several years would provide some assurance that the site is stable and contributing young to the next generation. As Table 3.38 indicates, 937 of the territories (76%) had nesting reported only once. This does not reflect an overall lack of goshawk nesting; many of these sites were recorded only one year, making it impossible for the data to contribute to an understanding of population trend. More valuable are the data for sites where nesting was recorded 4 or more years. These data indicate 259 territories (9%) where goshawk nesting was reported had nesting records for many years.

This sample of goshawk territory occupancy and recorded nesting that has persisted through time must be weighed against the territories which have not persisted. Further analysis should be done

to explore this context. Unfortunately, negative survey data is much more difficult to obtain with confidence, and requires large expenditures of fieldwork.

Given that we know the sample data is skewed towards the recent years, and our knowledge of the difficulty in finding goshawks, these analyses give reason to believe the goshawk population is relatively stable at the broadest scale (the Review Area). Further analysis of these data would provide a more refined understanding and could investigate the situation for the smaller geographic scale of the Assessment Areas. Granted, this analysis is very crude. But given the lack of information available for the Review Area prior to this Status Review, we feel it is a significant improvement in our knowledge of the goshawk population.

The salient point of this series of analyses of the data is that it is not possible to calculate population trends from these reported data. The data illustrate areas of relative stability in goshawk presence and reproduction at a few of the territories which had been adequately monitored. While these few could not be interpreted as a statistically valid sample of the total goshawk population in the Status Review Area, they do contribute to our understanding.

Kennedy (1997) conducted a review of the literature to investigate whether there was scientific evidence to supporting assertions that goshawk populations in North American were declining. Her review looked at the documented species range, population demographics (density, fecundity, and survival) and population trends. Based on a variety of evidence for northern goshawk across North America, Kennedy concludes that there is no strong evidence to support a conclusion that goshawk populations are changing (either increasing or decreasing). She emphasizes two possible conclusions based on her analysis: 1) either the goshawk is not changing, or 2) current sampling techniques are insufficient to detect population trends. She suggests that a more detailed meta-analysis is required to definitively address this question. Data collection to support such a meta-analysis would likely take ten years and require establishment of long-term study areas throughout the continent.

After our attempt to supplement the published literature with additional information (our information request), the conclusion of this Status Review is similar to that of Kennedy (1997). Recent management attention for the goshawk generated increased survey data, which we analyzed and present here. We cannot provide definitive evidence of the stability or instability of the goshawk population from this data. We can demonstrate that goshawk territories have persisted as active sites for years. And a portion of sites have been documented to continue to support goshawk nesting. In comparison, we were able to gather evidence of broad scale habitat declines, but were not able to link this to any decline in the goshawk population in the Review Area.

Population Data from Intensive Studies

Within the Status Review Area, there are several longer-term studies, including areas in the following Forest Service reporting units: Ashley National Forest, Utah (5 years); Santa Fe

National Forest, New Mexico (12 years); Kaibab National Forest, Arizona (7 years); Klamath, Shasta-Trinity and Modoc National Forests, California (14 years); Medicine Bow National Forest, Wyoming (5 years); and Targhee National Forest, Wyoming (7 years).

These studies have not generated data sets adequate to calculate the rate of population change (known as 'lambda'). But they have provided valuable information, which is summarized in Chapter 2. They have also provided us with a greater understanding of the considerations which are necessary when reviewing goshawk population data.

Comparing the data from these long-term study areas against the surrounding Assessment Area in which they occur, we find a greater number of territories were reported per acre, and proportionally more active nests are found in the study areas. This observation is consistent with the our conclusion that more territories are documented in areas where more search effort is expended, up to the point at which the entire area has been fully searched. From this it is reasonable to infer that if a commensurate amount of effort were expended in forested areas outside of the long-term study areas, we likely would see an increase in records of goshawk territories and an increase in documented goshawk nesting. This is important in light of the high percentage (70%) of territory-years where insufficient or no survey effort was reported to the Status Review Team, and contributes to an overall conclusion that the total data set of goshawk records (3,242 territories) is an underestimate of the total goshawk population (see discussion above).

In addition, these intensive study areas report higher annual occupancy rates compared to the overall occupancy reported to the Status Review Team. In these study areas, field personnel experienced in searching for goshawks are able to do so full-time, and thus expend considerably more effort than agency personnel for whom goshawk inventory is but one of many demands on their time. For example, in the study on the Kaibab Plateau, Reynolds and Joy (1998) found that between 53 and 73% of nesting pairs of goshawks annually move to alternate nests within their territory, and that a total of 7 person-days are required to sufficiently search a territory for a pair that has moved (Reynolds pers. com.). Such a search effort would be unlikely in an average Ranger District, and the territory would simply be recorded as unoccupied.

Reynolds and Joy (1998) reported that the proportion of pairs laying eggs on the Kaibab Plateau annually varied from 22 - 86% (mean = 55%). If these rates are typical of goshawks throughout the Status Review Area, then only 15 - 25% of pairs would be expected to be nesting in a previously used nest in a given year; they surveyors would have a 15 - 25% likelihood of visiting a nest site where actual nesting was occuring. This knowledge assists us in interpretating the reports of non-nesting, since we now have an estimate of the likelihood of finding an active nest in a previously known nest site.

The 44% of territory-years in which territories were occupied reported in Assessment Area 3, when compared to the 24-29% reported for the other Assessment Areas, likely reflects the high rate of territory occupancy found in intensive research on 108 goshawk territories (one-third of territories reported for Assessment Area 3) on the Kaibab Plateau in Northern Arizona (Reynolds et al., 1994, Reynolds and Joy 1998). The Southwest reported that 55% of the territory-years received no or insufficient monitoring, compared to the 70-74% reported for the other Assessment Areas, further illustrating the results of intensive search effort in a portion of the Area.

Goshawk Population Trend Data from Other Counts and Surveys

The Status Review Team investigated nation-wide monitoring conducted for a variety of avian species to learn whether these sources had information which would contribute to our assessment of goshawk population trend. This investigation found no credible trend information, primarily because of the methods used and the the goshawk's life history and behavior patterns.

As discussed in Chapter 2 and shown in Table 2.1, migration counts from long-term counting sites shows high variability in goshawks recorded. Kennedy (1997) cites Bednarz et al. (1990) and Titus and Fuller (1990), who suggest that fluctuations in goshawk populations may not be adequately assessed through migration counts because goshawk migrations are characterized by irruptive invasions which can mask population trends. Based upon our experience and review of literature, the Status Review Team agrees with this conclusion.

The Breeding Bird Census (BBC) is another potential source of information about population status and trend. The BBC program is based on individual study plots established within a single habitat type. Standardized methods are followed to collect data on the avian and vegetative communities. Over a period of years, these data may provide insight into the changes occurring in breeding avifauna within these communities. Limitations of BBC data include: biased selection of study plot locations, the plots are an inadequate sampling of the habitats and avian communities in an area, inability to represent temporal changes in bird communities over a larger area, and inability to distinguish differences in bird communities between plots due to differences in plot size, geography, and vegetation structure and composition. Johnson (1990) detailed additional factors to consider when examining data from individual plots, including aperiodicity of data from some plots, annual variation in census effort, and changes in observer competency over time. Due to all of these limitations, the Status Review Team did not utilize data from the BBC for the purposes of this Status Review.

The Breeding Bird Survey (BBS) is a potential source of information to estimate long-term population trends of avian species. The BBS is based on a fixed route that is usually driven by automobile, with fixed observation points over years. At the observation point, the observer records all birds heard and seen. Because of the ecology and natural history of the northern goshawks, the BBS methodology is unlikely to detect this species. From this bias, Saab and Rich (1997) concluded that BBS data are insufficient to monitor goshawks and it is unlikely that

increasing the number of BBS routes would increase the sample size of goshawks encountered.

Finally, the Christmas Bird Count (CBC) is another potential source of data. The CBC is an entire-day bird census occurring within a 15-mile circle, conducted in late December of every year. In the late 1950s, the National Audubon Society implemented uniform standards for conducting the CBC. With nearly a century of data in some cases, the CBC is a valuable source of information on in the abundance and distribution of birds during the early winter period in the United States and Canada. Unfortunately, the absence of standardization of many aspects of the CBC complicates any analyses of these data. CBCs also tend to be concentrated near cities, and tend to be located near areas where large numbers of birds are concentrated during the winter. The inherent biases reduce its utility to infer any changes in goshawk status and distribution from CBC data to overall populations, as the habitats surveyed on CBCs are not be representative of a region or continent as a whole and are not located in areas where goshawks would be expected to occur. Also, the fact that goshawks generally do not migrate and congregate in winter reduces the utility of the CBC to monitor this species. Butcher (1990) provided several considerations regarding bias and limitation of inference based on CBC data. As with the other national standardized avian monitoring methods, the Status Review Team concluded that it would be inappropriate to interpret and infer goshawk population trends from the CBC data.

Though we could not use the results of these monitoring efforts, the Status Review Team acknowledges that the alternative data sources we've discussed above are valid avian monitoring methods. They provide data valuable to answer questions other than our primary task - the assessment of west-wide population status and trend of northern goshawk.

Conclusion

- The Status Review Team assembled goshawk location data for the first time for this very large area and determined that the current goshawk population is probably over 3,200 territories.

- Examination of the goshawk distribution reported in the Status Review Area shows that the northern goshawk population is well-distributed in the forested west, and that its current distribution appears to be similar to what we judge was its historical distribution. The Status Review Team was unable to find significant forested areas where goshawks had been known but are now absent, and found no evidence of extirpation of populations.

- The data collected for the Status Review which could be used for an approximate analysis of population trend (a crude analysis of the rate of continued occupancy of territories), indicates that more than 20% of the territories were occupied for 4 or more years in the past 10 years.

- The literature indicates that goshawk population trends among areas and over time are poorly understood (Squires and Reynolds 1997) (Kennedy 1997), and migration or Christmas bird counts are inappropriate to use for this species because of low numbers observed, biases inherent in the methodology, and irruptive goshawk migrations (Titus and Fuller 1990).
-

Chapter 4 - Conservation and Management

Vulnerability and Threats

Habitat Alteration

General effects of timber harvest on goshawk "habitat"

Very few studies of goshawk habitat have had sufficient survey effort, sample size, or statistical rigor to demonstrate changes in goshawk behavior or nest success resulting from a particular timber harvest activity. Crocker-Bedford (1990) reported declines in the number or density of goshawk territories in areas that had been selectively harvested, however this result has been disputed by continuing studies in the same area (Reynolds and Joy 1998). This Status Review received reports of goshawks abandoning nest sites subsequent to timber harvest activity in nearby stands; often the nest sites remained unoccupied for several years following treatment. Goshawks are very mobile nesters, and in many cases a local timber harvest may have resulted in a 0.2 to 1.0-mile shift in nest site, or a shift in foraging area; these cases are typically classified as "abandoned" based on inadequate survey of the previous nest stand. On the other hand, some of these reports described extensive removal of the overstory at the nest site and in much of the surrounding landscape. Clearly there is some level of habitat change that will render a landscape unsuitable for occupancy and reproduction by goshawks.

The spatial relationships among different functional levels of habitat use by goshawks (nest site, nest area, post-fledging area, foraging areas) are important considerations in assessing effects of timber harvest on goshawk habitat. Depending on the ecosystem or forest type, a landscape may only need to provide small amounts of nest area habitat, if adequate foraging habitat is provided in the 'matrix' of other habitats (example aspen/shrubsteppe, eastside ponderosa pine). In other systems, large areas of mature forest ("nest habitat") may be required to provide adequate prey resources (example Douglas-fir/hardwood forest). Any assessment of effects of timber harvest on goshawk populations should be based on careful evaluation of local forest conditions, important goshawk prey species and their habitat requirements, and natural forest processes and disturbance regimes at the local scale.

Nest Habitat- structure

Goshawk nest habitat is often characterized as mature to old-growth forest composed primarily of relatively large trees with relatively high canopy closure (60-80 percent) (Reynolds et al 1982, Moore and Henny 1983, Mannan and Meslow 1984, Speiser and Bosakowski 1987, Woodbridge 1988, Marshall 1992, Crocker-Bedford 1990, 1994, Patla 1991, Reynolds et al. 1992, Ward et al.

1992, Squires and Ruggiero 1996). Most studies of nest site or nest area habitats used by goshawks in the western U.S demonstrate an association with denser stands of larger trees, relative to what is available in the landscape. The basic structural attributes of these suitable nest stands are easily quantified, and local or regional standards based on existing nest sites are available for many forest types or localities. While silvicultural prescriptions may be employed to maintain stand structure within the range of stand density, tree size and canopy closure associated with goshawk nest areas, this is rarely the objective of commercial timber sales. In practice, economic and logistical considerations of commercial timber operations typically require that timber harvests remove a significant proportion of the trees from a sale unit. Therefore, to estimate "losses" of potential nest habitat, comparison of expected post-harvest stand density and canopy closure to local definitions of 'mean' structural attributes of nest area habitat is necessary.

The effect of timber harvests on goshawk nest habitat (usually generalized to 'goshawks') can be described as the number of acres of potentially suitable forest (meeting local definitions from nest habitat studies) that are modified to a condition no longer meeting the definition. In forest types where goshawk nest areas are characterized as having very high canopy closure, most harvests will reduce canopies to below definition. In more open forest types (ponderosa pine, Jeffrey pine) light thinning of smaller trees (thinning from below) may occur without significantly altering the canopy; maintaining suitability for nest area habitat. Desimone (1997) found that goshawks in Oregon were more likely to persist in territories having a high percentage of mature and older forests (about 50%) in closed-canopies conditions within 52 ha (128 ac) around the territory center. He suggests that little or no habitat alteration within aggregate nest stands is important to the persistence of nesting goshawks. Bright-Smith and Mannan (1994) state that tree harvest methods which create large areas with reduced canopy cover (<35-40%) may be particularly detrimental. Reynolds (1989) states that practices such as selective overstory removal or patch and clear-cut harvesting, that result in either a complete removal of trees or in a reduction of the stem density and canopy volume throughout management units, lower the quality of goshawk nesting habitat. Reduction of canopy closure may have several effects on goshawk nesting success, including increased solar radiation and subsequent heat stress, reduced buffering from adverse weather, and increased visibility to predators.

Another potential effect of timber harvest is removal of larger trees that may provide nest platforms. Farber et al. (1998) report that in managed stands where larger trees were lacking, nesting often occurred in deformities such as "fork tops" or mistletoe clumps. Harvest practices that eliminate these structures from stands may be expected to reduce nesting opportunities for goshawks, even if much of the forest canopy is retained.

Nesting Habitat - amount and patch size

While much is known about structural attributes of forest stands used for nesting by goshawks, relatively few studies have addressed the amount or patch size that the hawks may be selecting, and whether this habitat represents selection of a buffer of "nest site habitat" larger than what is actually used at the nest, or simply the forested area that happens to surround the nest site. Based

on observations of feathers, whitewash, and prey remains, Reynolds (1988) defined an area (approximately 30 acres) of intensified use surrounding the nest as the "nest area"; this area has often been interpreted by land managers as the total area of nest habitat needed by reproducing goshawks. In studies by Woodbridge and Detrich (1994), occupancy rates of forest stands used for nesting decreased as stand size decreased, suggesting that the hawks were selecting larger (85-200 acres) stands. However, in many cases small (30 - 60 acres) stands were used successfully. The larger area (approximately 420 acres) of relatively denser forest surrounding nest areas that is used by the newly-fledged young during the "post-fledging dependency period" (Kennedy et al.1994) further illustrates that larger patches of mature forest surrounding goshawk nests can be important.

The extent (spatial scale and treatment intensity) of timber harvest within a given landscape will affect the availability of suitable habitat patches for occupancy by nesting goshawks. This effect will depend on the forest type, and pre-harvest condition of the landscape. For example, two 50-acre clearcuts within a goshawk home range may only slightly affect the availability of nest habitat, whereas two 200-acre thinnings may degrade all of the available stands to conditions below structural characteristics of typical goshawk nest area habitat.

Nesting Habitat: Physiographic Location

Assessment of habitat availability for goshawk nest areas is often made at broad scales, following an assumption that presence of forest habitat meeting certain structural criteria will meet the needs of goshawks. However, there is evidence to suggest that location of goshawk nest sites is affected by landscape features such as slope, aspect, riparian vegetation, meadows, drainages, water, and other features. In northern California, nest sites were located on gentle north-east slopes, near streams, and closer to meadows than random sites (Allison 1996, Laacke and Flores, unpub); these associations have been reported by numerous other authors as well. If selection of nest sites by goshawks is at least partially dependant on certain physiographic features, then harvest of timber within these features will have a disproportionate effect on habitat suitability.

Foraging Habitat

Habitats used for foraging by goshawks are poorly known. With the exception of a small number of telemetry studies, much of our knowledge is limited to extrapolation of the habitat requirements of important prey species (Reynolds et al. 1992). It may be reasonable to assume that timber management practices known to impact the quantity and quality of habitats associated with goshawk prey species are likely to impact goshawk foraging (Reynolds et al. in press). There is evidence to suggest that goshawks, as large-bodied, visual predators, avoid overly dense habitats where physical or visual access to prey is limited. Habitat management practices, particularly fire suppression activities, that allow forests to become too dense for flight below or within the canopy may also be detrimental (Reynolds 1989). Such overly dense forest structures would limit goshawk detection of and access to prey. Harvest practices such as light thinning may, in these cases, actually improve or create foraging habitat for goshawks.

Telemetry studies (Beier and Drennan 1997, Austin 1993) suggest that goshawks select mature

forest stands with open understories for foraging; however, it is likely that actual foraging habitat selection occurs at spatial and temporal scales difficult to investigate using radio telemetry. Small openings, treefall gaps, edges, riparian zones, and rock outcrops are examples of small-scale landscape elements that are used by foraging goshawks (Squires and Reynolds 1997), the use of which is difficult to detect through radio telemetry. Analyses of prey used in naturally open habitats demonstrate that goshawks will forage away from forest cover if suitable prey are available (Younk 1996, Woodbridge and Detrich 1994, McCoy 1998) . However, it cannot be assumed that adequate prey will necessarily be available in openings created by timber harvests. In mesic habitats, removal of forest cover often results in dense regrowth where goshawks would be unlikely to detect or capture prey. In most forest habitats, silvicultural prescriptions that maintain some overstory structure would be expected to also maintain populations of forest-associated prey species. However, populations of many prey species are linked to structural attributes such as snags, large logs, large trees (cone crops, mistletoe, etc.), soil organic horizon depth (fungi) and hardwoods (mast) which may not be maintained under various silvicultural prescriptions, unless the prescription is specifically designed to maintain them.

Much of the current literature suggests that goshawks are food limited (Reynolds et al., in prep). However, current understanding of how foraging habitat may limit goshawk populations is not clear (Reynolds et al. in press). In low quality habitats, prey populations may be low or unavailable, resulting in poorer goshawk health (greater predisposition for disease) and reproduction, greater interspecific competition for food, and greater susceptibility to predators (Reynolds et al. in press). In interior Alaska, where diets of nesting goshawks are dominated by snowshoe hare, McGowan (1975) showed that fluctuations in the density of hares over a 10-year period coincided with changes in the number of active goshawk nests and the production of fledglings. Food availability may affect the distribution and abundance of raptors, their territory or home range sizes, the proportion of pairs breeding, nesting success and fecundity (Schoener 1968, Southern 1970, Galushin 1974, Baker and Brooks 1981, Smith et al. 1981). Low food abundance during winter may cause goshawks to leave their breeding home ranges and preferred foraging habitats, for areas where they might be exposed to greater mortality. If food availability remains low in early spring, adults may enter the breeding season in poor condition, males may not be able to find adequate prey, and egg laying may not occur, may be delayed or clutches may be abandoned. Shortages of food during the nestling period can result in females leaving their broods unattended to help males forage (Reynolds 1972, Ward and Kennedy 1997).

Other Habitat Alteration

In addition to habitat loss due to timber management activities, livestock grazing has been identified as a cause of habitat loss and degradation in Nevada (Lucas and Oakleaf 1975), where goshawks nest in mature aspen. Aspen stands are vulnerable to grazing because characteristics associated with nest stands - shade, water and level ground along creeks and in swales - also tend to concentrate livestock (Reynolds 1989). In areas subjected to long-term, concentrated grazing, aspen sprouts are unable to survive, and replacement of mature overstory trees does not occur. Grazing also can affect the habitat used by goshawk prey species; long-term grazing can reduce or eliminate the herbaceous and shrubby understories that provide important food and cover for

prey species (Reynolds et al. in prep).

Conclusions

Habitat quality can be reflected in physical condition (body mass), nesting success and productivity, degree of fidelity to territory and mate, size of home range and population densities of both goshawks and prey species (Reynolds et al. 1994). The structure, function and quality of both nesting and foraging habitat can be impacted by timber harvests that destroy nests and nest trees, modify or remove entire nest stands, remove overstory and older, mature trees, and remove or decrease the number of snags and the amount of down wood available to goshawk prey. Timber management has been suspected of affecting goshawks at least at local levels (Reynolds 1989, Crocker-Bedford 1990, Bright-Smith and Mannon 1994, Woodbridge and Detrich 1994, Beier and Drennan 1997, Desimone 1997, McGrath 1997). Reduction and fragmentation of habitat of mature forest may favor early successional competitor and predators such as red-tailed hawks (*Buteo jamaicensis*) and great horned owls (*Bubo virginianus*) (Woodbridge and Detrich 1994). However, forest management practices, such as the use of controlled fire and selective thinning, may make habitats more suitable to goshawks by opening up dense understory vegetation, creating snags, down logs, woody and debris, and creating conditions conducive to goshawks and their prey (Reynold et al. 1992, Graham et al. 1997).

Disturbance

Human disturbance is another factor that may affect goshawks. Disturbances associated with timber practices can cause nest failure, especially during incubation (Anonymous 1989, Boal and Mannan 1994, Squires and Reynolds 1997). Camping has also been determined to cause nest failure (Speiser 1992). Disturbances associated with research are usually of short duration, and apparently have little impact on nesting birds. Observations of nests for short periods of time following hatching of young is not documented to cause desertion, and nor does trapping of adults for banding or attaching radio transmitters during nesting (Austin 1993, Squires and Reynolds 1997). Based on the information available to the team, disturbance, in general, does not appear to be a significant factor affecting the long-term survival of any North American goshawk populations.

Predation and Competition

Evidence of predation on young and adults has been reported in nearly all studies of goshawks, although, in none of these studies do the authors suggest that predation limits these populations.

Whether goshawks occupy a particular habitat might depend in part on the presence of competitors and predators. Differential use of habitats among different raptors has been widely noted and is often assumed to be the result of competition (Janes 1985). Competition is expressed through interspecific territoriality and can result in greater distance between nests of interspecifics. A species may be excluded from a habitat by agonistic interactions with other species, especially species that are larger (Crannell and DeStephano 1996, Kenward 1996). Goshawks are among the largest raptors in North American forests and are, therefore, more likely to be a dominant species in agonistic, and predator-prey, interactions. In spite of the above, it is

not clear to what extent competition or predation affects occupancy of forests by goshawks. Open habitats, such as shrublands, typically contain larger raptor species capable of displacing or killing goshawks. Predation may more often limit the use of open versus forest habitats by goshawks. Great horned owls sometimes prey on goshawks (Rohner and Doyle 1992), but it is not known if owls exclude goshawks from any habitat.

Two potential competitors of the goshawk for nest habitat are the sharp-shinned hawk and Cooper's hawk. However, there is some partitioning of habitat, mostly on the basis tree size and density within nest areas, by these species (Reynolds et al. 1982, Moore and Henny 1983, Siders and Kennedy 1994). However, because the goshawk is the largest of these species, it is more likely to exclude the smaller species from nest habitat (Reynolds et al. 1982, Moore and Henny 1983, Siders and Kennedy 1994, 1996).

Predation

Goshawks are occasionally killed by large raptors (e.g., eagles, Squires and Ruggerio 1995; great horned owls, Rohner and Doyle 1992) and mammals (Doyle 1995, Paragi and Wholecheese 1994, Reynolds et al. 1997). Zachel (1985), Rohner and Doyle (1992), and Squires and Reynolds (1997) indicate that predation may increase during periods of low food availability. The great horned owl is a perhaps the most important potential predator because of its wide distribution within the goshawk's geographic range, and its size, abundance, and its capacity for preying on large raptors (Orians and Kuhlman 1956, Hagar 1957, Houston 1975, Luttich et al. 1971, McInvaille and Keith 1974). Although goshawks aggressively defend their nests against predators during the day, they are less capable of doing so at night. Thus, most reports of predation on goshawks by great horned owls are losses of nestlings, but adults are occasionally taken (Rohner and Doyle 1992). The effect of great horned owl predation on goshawk populations is unknown, but the owl's potential to affect the fecundity of large raptors is suggested by predation rates as high as 49 percent on nestling red-tailed hawks (Luttich et al. 1971). Because juvenile goshawks are inexperienced predator avoiders, predation is likely to be more important in this age class than in adults (Reynolds et al. 1997, in prep). Kennedy (1997) notes that no data are available to determine long-term temporal trends in nestling mortality.

Great horned owls begin nesting earlier than goshawks and, on occasion, lay eggs on goshawk nests, forcing goshawks to construct or use alternate nest sites. Because alternate goshawk nests are often close together (Reynolds et al. 1994, Woodbridge and Detrich 1994), goshawks and owls occasionally nest in close proximity. This proximity increases the potential for reciprocal predation on adults and young of goshawks and the owl (Gilmer et al. 1983, Rohner and Doyle 1992).

Even less is known about the extent of predation on goshawks during winter. Squires and Reynolds (1997) review reports of predation on goshawks, including instances by eagle during winter (Squires and Ruggiero 1995), by marten (*Martes americana*) in winter (Paragi and Wholecheese 1994), wolverine (*Gulo gulo*), and other predators (McGowan 1975, Ward and Kennedy 1996). Capture-recapture (1991-1996) estimates of annual survival of banded adult

goshawks on the Kaibab Plateau, Arizona were 87 and 69 percent for adult females and males, respectively (Reynolds and Joy 1998). In view of combined losses to various sources of mortality (starvation, accidents, disease, predation), these survival rates suggest that predation on adult goshawks during winter in this population are not extreme.

Competition

The extent to which goshawk habitat use is affected by interspecific competition for habitat is not known. Pairs of goshawks may be excluded from nest sites by other raptors, in which case goshawks may move to an alternate nest or, if other suitable nest habitat is not available, might be excluded from the area (Reynolds et al. 1997 in prep). It is not uncommon for goshawks and other raptors to nest close to one another (Reynolds and Wight 1978). A co-occurring species that has a similar preference for nest habitat is the Cooper's hawk (Reynolds et al. 1982, Moore and Henney 1983, Siders and Kennedy 1994). However, Cooper's hawks are smaller than goshawks and begin nesting later (Reynolds and Wight 1975). The Cooper's hawk, therefore, is more likely to be displaced from an area by goshawks. Great horned owls, spotted owls, and great gray owls often use nests of goshawks (Forsman et al. 1984, Bryan and Forsman 1987, Buchanan et al. 1993). However, the intraspecific territorial behavior of these owls results in a dispersion of their nests (McInvaille and Keith 1974) making it unlikely that goshawks would be excluded from entire forest tracts unless other suitable nest habitat was not available.

Red-tailed hawks often nest in wooded habitats and are potential competitors for nests with goshawks. However, nests of red-tail hawks tend to be close to forest openings (Spieser and Bosakowski 1988, Titus and Mosher 1981), high on ridges (Spieser and Bosakowski 1988, Titus and Mosher 1981), and in relatively open sites (Titus and Mosher 1981). Because goshawks typically nests lower on slopes and in sites where trees are relatively dense (Reynolds et al. 1982), competition between goshawks and red-tail hawks for nest sites is likely to be low except, perhaps, in naturally open forests such as ponderosa pine or forests fragmented by meadows, burns or clearcuts. During six years of studying goshawks on more than 100 territories in relatively open ponderosa pine and mixed-conifer forests on the Kaibab Plateau in Arizona, competition over nests between this species and goshawk was not observed (Reynolds pers.obs.).

Several species of hawks and owls, and numerous mammalian predators are potential competitors with goshawks for food. The Cooper's hawk forages in the same habitat and feeds on many of the same prey (Storer 1966, Reynolds and Meslow 1984, Bosakowski et al. 1992). The red-tailed hawk and great horned owl also prey on the same species eaten by goshawks, although neither has the same degree of dietary overlap with goshawks as does the Cooper's hawk (Fitch et al. 1946, Luttich et al. 1970, Smith and Murphy 1979, Janes 1984, Bosakowski and Smith 1992). Because both the red-tailed hawk and great horned owl are more abundant in open habitats (meadows, edge, forest openings, woodlands, Howell et al. 1978, Spieser and Bosakowski 1988), the extent to which they coexist and compete for food with goshawks probably varies by the openness of forest types and extent of natural and anthropogenic fragmentation of a forest.

In most North American forests, a variety of mammalian carnivores including foxes, coyotes, bobcats and lynx, weasels, and martens, co-occurs with goshawks. These species feed on some of the same prey as goshawks such as rabbits, tree and ground squirrels, grouse, and other birds. In years when prey populations are naturally low, the cumulative effects of predation by these carnivores on the abundance and distribution of goshawks are unknown. Erlinge et al. (1982) has shown, for example, that numerous co-occurring species of carnivores, owls, and hawks in Sweden consumed large numbers of small vertebrate prey, and their combined consumption resulted in food limitations.

Conclusions

In general, goshawks have few natural predators, and predation does not appear to be a significant mortality factor particularly in adults. As noted above, nestling and juvenile goshawks are incapable of or inexperienced at predator avoidance. Predation, therefore, is likely to be a more important mortality factor for these age classes than in adults (Reynolds et al. 1997 in prep). The magnitude of effects on goshawks of interspecific competition is not well understood. Fragmentation of forested habitats can make the affected areas more accessible and attractive to competing species such as red-tailed hawks and great horned owls, potentially decreasing habitat available to goshawks.

Disease

Disease has not been documented as a major factor in the long-term health and survival of North American goshawk populations. Newton (1986) found that disease was practically non-existent in a population of sparrowhawks (*Accipiter nisus*) he studied for 14 years in Scotland. Squires and Reynolds (1997) summarize information on diseases and parasites affecting goshawks. Their summary includes citations on tuberculosis (Lumeij et al. 1981), erysipelas (Schroder 1981), heart failure caused by *Chlamydia tsittaci* and *E. coli* (Ward and Kennedy 1996), and *Aspergillus* (Redig et al. 1980). Squires and Reynolds (1997), state that stress resulting from reduced prey abundance, migration during invasion years, and agonistic interactions may increase susceptibility to *Aspergillus*. Snyder and Snyder (1998) documented trichomoniasis as a cause of goshawk fledgling mortality in goshawks in southeastern Arizona.

Reynolds et al. (in prep.) found only one report of an epizootic in wild goshawks. Redig et al. (1980) reported aspergillosus (*Aspergillus fumigatus*) in 53 percent of 49 hawks and 7 percent of 45 goshawks trapped in Minnesota in 1972 and 1973, respectively. The authors believed that the trapped goshawks were birds emigrating from more northern forests due to low prey abundance there, and that the epizootic was the result of increased stress on the hawks related to increased agonistic interactions, reduced prey availability, and migration (Redig et al. 1980).

Squires and Reynolds (1997), also note that internal parasites are common and, citing Keymer (1972), that heavy infestations of ectoparasites like lice (Degeeriella nisus vagrans) usually occur in weakened birds. Greiner et al. (1975), cited in Squires and Reynolds (1997), found that approximately 56% of North American birds had blood parasites including Leucocytozoon,

Haemoproteus, *Trypanosoma*, and *microfilariae*. Beebe (1974), cited in Squires and Reynolds (1997), suggested that "frounce", a disease contracted by feeding on fresh pigeons, may threaten some goshawk populations in British Columbia, but data are lacking.

In conclusion, the Team believes that, while disease has been documented in the wild, there are no data to show that this factor has a significant effect on the likelihood of long-term goshawk persistence in the review area.

Pesticides and Other Contaminants

In the early 1970's, pesticide levels in goshawks in the U.S. were low (Snyder et al. 1973), but were high in other raptors such a peregrine falcons, osprey and sharp-shinned hawks. Eggshell thinning has not been a problem for most populations, although California eggshells from pre-1947 (pre-DDT) to 1947-1964 (DDT in use) declined 8-12 percent in weight and thickness (Anderson and Hickey 1972). In Illinois, wintering goshawks during the 1972-73 invasion year contained less organochlorine and PCB residues than did other raptors (Havera and Duzan 1986). These birds were probably from nonagricultural northern forests. In general, it appears that pesticides and other contaminants have not significantly affected goshawks in the review area.

In conclusion, the information reviewed for this status review does not present evidence that pesticides and other contaminants significantly affect goshawks in the review area.

Take of Individuals

Take of goshawks through shooting, trapping, poisoning or other means is generally illegal. The specific regulatory mechanisms protecting goshawks will be discussed in a later section.

Falconry is one means by which live goshawks can be legally taken. Specific falconry regulations are discussed by State in a later section, but as Table 4.1 shows, up to 60 goshawks per year are estimated to be taken throughout the western U.S. While there may be some localized impacts to nesting goshawks, falconry take at this rate is not expected to have significant, negative rangewide effects on goshawk populations.

In a Final Environmental Assessment on falconry and raptor propagation regulations (EA), the Service (1988) concluded that falconry is a small scale activity that has little or no impact on raptor populations. The Service based its findings, at least in part, on Brohn (1986) who reported that 1) falconry is practiced by a small number of persons (<3,000 nationally), a number that appears to be stable, and 2) the number of raptors taken from the wild for falconry is low, generally fewer than 1,000 nationally. From 1976 to 1986, permit holders varied from a high of 2,783 to a low of 2,676. Most birds taken were of abundant, widely-distributed species. For example, in 1984 and 1985, 624 and 731 total raptors, respectively, were legally taken from the wild by falconers. Red-tailed hawks constituted 36-38 percent of the birds taken, while northern goshawks comprised 9-14 percent. Mosher (1997) found that almost 56 percent of all raptors taken for falconry were red-tailed hawks or prairie falcons. Regionally, California reported the

highest take of falconry birds. For this status review, California also reported the highest take of northern goshawks (Table 4.1). The Service's EA (1988) also stated that the known illegal take was less than legal take and did not alter the conclusion that falconry has no impact on the raptor resources.

In its EA, the Service assumed that a bird taken from the wild is permanently removed from the population and is thereby treated as a type of mortality. This is a prudent and conservative approach. Many raptors taken for falconry are subsequently returned to the wild (Brohn 1986, Kenward 1974, Newton 1979), and there is evidence that some returned birds become viable members of wild populations (Kenward et al. 1981, Marquiss 1981, Kenward 1997). Also, birds taken by falconers are generally nestlings or juveniles (it is illegal to take adult goshawks whose probability of surviving to breeding age is low.

In its EA, the Service explained that it made inferences about the impact of take to species' populations as a whole, and for most species, including the northern goshawk, it was not possible to reduce the assessment to regional or state levels. The EA assumed that the take of raptors is spread geographically. However, it also acknowledged that there may be local populations that are disproportionately affected, i.e., "hot spots." Although there may ve anecdotal information suggesting such areas exist, the status review team received no documented evidence to support this.

The Service, in its EA, acknowledged that there was not sufficient population data for northern goshawks to determine the species' status. However, the EA concluded that there was no indication that goshawk populations were not at a satisfactory level and that take by falconers was likely of no consequence to goshawk populations.

Mosher (1997) examined data reported by Brohn (1986) as well as falconers' annual reports and concurred with the conclusions reached by the Service in its EA, that the harvest of wild raptors by falconers has no significant biological impact on the resource.

Conclusions

Based on information reviewed, the Team does not believe falconry to be a significant factor affecting the long-term trend of goshawks within the petitioned area. The overall take allowed is minimal and well regulated by the states.

Regulatory Mechanisms

Federal Laws

Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) provides the only Federal protection for the northern goshawk. Raptors, with the exception of eagles, did not receive any Federal protection prior to 1972, when the treaty with Mexico was amended. At that time, regulations for raptors became

the responsibility of the Service under the authority of the MBTA. The MBTA makes it unlawful to pursue, hunt, take, capture, or kill in any manner any migratory bird. Protection under the MBTA includes prohibition of destruction of nests or eggs. The MBTA provides no protection to habitat, other than the actual tree or nest that the species is using during the breeding season.

National Forest Management Act

The National Forest Management Act (NFMA) governs management of National Forest System lands. Section 219.19 (Fish and wildlife resources) states:

> "Fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired nonnative vertebrate species in the planning area. For planning purposes, a viable population shall be regarded as one which has the estimated numbers and distribution of reproductive individuals to ensure its continued existence is well distributed in the planning area. In order to ensure that viable populations will be maintained, habitat must be provided to support, at least, a minimum number of reproductive individuals and that habitat must be well distributed so that those individuals can interact with others in the planning area."

The requirements of the NFMA are intended to eliminate the need to list any vertebrates occurring to a large extent on National Forest lands. However, some believe full implementation of NFMA provisions would require funding and personnel levels far in excess of current resources. For northern goshawks, assurance of maintenance of "viable populations", as defined above, would require knowledge of habitat requirements currently not well understood, and an inventory and monitoring program beyond the capacity of current budgets. Considering that the goshawk is but one of thousands of vertebrate species on National Forest lands, meeting NFMA mandates presents a considerable challenge.

Nonetheless, some National Forests provide meaningful protection for northern goshawks. In four of the six Forest Service Administrative Regions in the review area, goshawks are considered "sensitive species", which are recognized by the Forest Service as needing special management to prevent being places on Federal or State lists. Such designation requires biological evaluations to consider potential impacts to the species of any proposed management actions. Forest Service Region 3 has amended the forest plans for its 11 National Forests to incorporate the Management Recommendations for Northern Goshawks (Reynolds et al. 1992). Interim guidelines for goshawks have been in place since 1992, and the Record of Decision implementing the final guidelines was signed in 1996. At this point, the Review Team believes that these management recommendations, if properly implemented, may provide a level of habitat protection to necessary maintain goshawks on the landscape over time in the Southwest. The Team notes, however, that results from implementation monitoring and effectiveness monitoring programs will be needed to actually assess how consistently and effectively the guidelines are being implemented and if the goshawks are responding to the guidelines as scientists expected.

State Laws and Regulations Including Falconry

Falconry is the sport of taking game with trained raptors and is a centuries old tradition. In the U.S., falconry became well established by the early part of this century. In 1976, the Service promulgated regulations governing falconry. The regulations allowed for the development of state falconry programs to operate within rigorous Federal guidelines and requirements for entry into the sport, for facility and equipment standards, and for reporting and marking birds. About 60 species of raptors are protected by Federal regulations; 18 are of importance to falconry, including the northern goshawk (USDI 1988).

General Status

No state in the review area affords legal protection to the northern goshawk beyond protection provided by federal laws (e.g., Migratory Bird Treaty Act). Eight of the 17 states in the review area recognize the goshawk as a sensitive, protected, priority or species of special concern in state policy. Of the nine states which do not recognize the goshawk as a sensitive species, five have no breeding records for the species.

Overview of Falconry Regulations in Review Area

Of the 17 states in the review area, 10 states reported estimated goshawk take for falconry, over the last 10 years, of 1-11 birds per year, with the highest take in California and the lowest in Oregon and South Dakota. One state (NM) reported no take of goshawks since 1991 due to a moratorium on take of nestlings, and prior to 1991 approximately one bird was taken per year. Arizona had a moratorium on take of goshawks from 1991-1995 but since 1995 has allowed take of three birds per year. The remaining five states reported no goshawk take for falconry over the last 10 years because goshawks do not breed and are rare migrants in these states. Seven of the 17 states in the review area have a falconry quota for northern goshawks ranging from three to 70 birds per year. In these states, actual take has been well below allowed take. The maximum annual take across the review area has been approximately 60 birds.

Northern Assessment Area - Area 1

Status

In the Northern Assessment Area the northern goshawk is not afforded state legal protection beyond that provided by federal laws (e.g., Migratory Bird Treaty Act). No breeding records exist for North Dakota, however, both Montana and Idaho consider it a Species of Special Concern (Table 4.1). For Montana this classification is used to highlight species for special consideration in land use planning.

Falconry Regulations

Legal take of northern goshawks is limited to licensed falconers in all states, however, only Idaho

allows take by nonresidents under a limited quota that began in 1997 (Table 4.1). No nonresident permits have been issued to date.

Rocky Mountain Assessment Area - Area 2

Status
In this Area, northern goshawks are not afforded special state legal protection, and only Wyoming recognizes the species as a Species of Special Concern (Table 4.1). This classification is used to recognize that a species has restricted habitat needs and that additional information on its status needs to be obtained. No specific protection requirements are conferred.

Falconry Regulations
Legal take of northern goshawks is limited to licensed falconers in all states. Although it is legal to take this species in Kansas and Nebraska (in Nebraska, take is limited to immature birds only), no confirmed goshawk breeding records exist in these states and over the past 10 years there has been no take of the species in either state (Table 4.1). In Colorado, there is no information to indicate that actual take is significantly different than reported take. Non-resident take is not allowed in any state in this Area.

Southwest Assessment Area - Area 3

Status
In the Southwest, individual states do not afford legal protection to the northern goshawk beyond that provided by federal laws (e.g., Migratory Bird Treaty Act) (Table 4.1). In Arizona, the northern goshawk is included on the Arizona Game and Fish Department's *Wildlife of Special Concern* (AGFD, October 1996 draft). This list, however, only serves as a policy guide. Species on the list are those whose occurrence in the state is or may be in jeopardy, or species with known or perceived threats or population declines.

Falconry Regulations
Legal take of northern goshawks is limited to licensed falconers in all four states. In Texas, the northern goshawk is accidental or a winter visitor only. Falconers may practice falconry with this species in Texas but these birds are procured in other states. In the two states with breeding populations, Arizona and New Mexico, there is a quota on annual take (Table 4.1). In Arizona, there was a moratorium on falconry take of goshawks from 1991-1995. This moratorium was established because at that time known goshawk nests were relatively few in number and largely restricted to the North Kaibab Ranger District in northern Arizona. Prior to 1991, eyas and passage goshawks could be taken by Arizona falconers. Take was restricted to north of the Gila River (to avoid the putative subspecies, *A. g. apache*), but no take quota existed. One or two goshawks were taken per year. Greatly increased goshawk survey efforts between 1991 and 1995 revealed a larger population fairly well distributed across Arizona's montane conifer forests. In the early 1990s two demography studies were initiated in Arizona but results regarding the

stability of these populations will not be available for several years. In 1996, with many more breeding pairs known to occur in the state but population performance unknown, the moratorium was lifted but a quota was placed on take of both nestlings and immature birds. As before, take continued to be restricted to north of the Gila River. In New Mexico, concern for goshawk populations prompted a moratorium on take of nestling goshawks only (immature birds are still legal for take) in 1991 which continues today. This moratorium has effectively reduced take from an annual average of 1.3 birds (maximum take was 5 birds in 1982) prior to 1991, to zero since 1991. In New Mexico, as in Arizona, take is also restricted to avoid the range of the putative subspecies, *A. g. apache*. No state the Southwest allows non-residents to take northern goshawks. There is no information indicting that actual take is significantly different than allowable take for this species.

Intermountain Assessment Area - Area 4

Status

In the Intermountain Assessment Area, states do not afford legal protection to the northern goshawk beyond that provided by federal laws (e.g., Migratory Bird Treaty Act) (Table 4.1). Utah lists the goshawk as a Species of Special Concern on the Division of Wildlife Resource's *Utah Sensitive Species List.* The purpose of the *List* is to identify species in the state that are most vulnerable to population or habitat loss and is intended to stimulate management actions (e.g. development and implementation of a conservation strategy) to preclude federal listing.

Falconry Regulations

Legal take of northern goshawks is limited to licensed falconers in both states. Both states have quotas on take but the quotas apply only to take of nestlings; there are no quotas on immature birds (Table 4.1). Nevada allows non-resident take. There is no information indicating that actual take is significantly different than allowable take for this species but in Nevada some illegal take is suspected.

Pacific Southwest Assessment Areas - Area 5

Status

In the Pacific Southwest Assessment Area, the northern goshawk is not afforded state legal protection beyond that provided by federal laws (e.g., Migratory Bird Treaty Act) (Table 4.1). The species is classified as a Species of Special Concern by California Department of Fish and Game, however, this classification does not confer any special protection. Some habitat protection considerations are required under other state rules (i.e., forest practices).

Falconry Regulations

In California, northern goshawks may be taken under permit by both resident and nonresident licensed falconers. Under state falconry regulations goshawks take is prohibited in the Lake Tahoe Basin (Table 4.1).

Pacific Northwest Assessment Area - Area 6

Status

In the Pacific Northwest Assessment Area the northern goshawk is not afforded state legal protection beyond that provided by federal laws (e.g., Migratory Bird Treaty Act) (Table 4.1). In Washington the species is classed as a State Candidate for review for potential listing and a Priority Species under the Washington Department of Fish and Wildlife's Priority Habitats and Species Program. These classifications are used to draw emphasis to the species and suggest that protective measures or management guidelines are needed. For Oregon the species is classified as State Sensitive- Critical, a species for "which listing may be appropriate if immediate conservation measures are not taken" (Oregon Administrative Rule 635-100-040).

Falconry Regulations

Legal take of northern goshawks is limited to licensed falconers in both states and an annual take of 12 birds is allowed in Oregon (6 nestlings and 6 immature birds) (Table 4.1).

Table 4.1. Northern goshawk state status, annual falconry quota and estimated annual take for falconry over the last 10 years in the Status Review Area, by Assessment Area and State.

Assessment Area	State	State Status[1]			Falconry Quota[2]	Falconry Estimated Annual Take	Comments
		Legal	Policy	None			
Area 1	ID		x		none- R, 10-NR	6	No quota for resident take; quota of 10 birds for non-resident take.
	MT		x		none	5	
	ND			x	none	0	No breeding records for state.
Area 2	CO			x	none	6-10	
	KS			x	none	0	No breeding records for state. Infrequent winter visitor.
	NE			x	none	0	No confirmed breeding records; fall and spring migrant. No quota but take limited to immature birds.
	SD			x	none	1-2	
	WY		x		70	8	
Area 3	AZ		x		3	1-2	Moratorium on take 1991-1995.
	NM			x	6	0	Moratorium on take of nestlings 1991-present. Prior to 1991 annual take was 1.3 birds
	OK			x	none	0	No breeding records for state. Rare winter visitor.
	TX			x	none	0	No breeding records for state. Winter visitor only.
Area 4	NV			x	10- R, 3-NR	5	Falconry quota applies only to nestlings; no quota on immature birds. Annual take has ranged from 1-7 birds.
	UT		x		20	4	Falconry quota applies only to nestlings
Area 5	CA		x		none	11	Take prohibited in Tahoe Basin.
Area 6	OR		x		12	1	
	WA		x		none	6	

[1] State Status: Legal- listed as a threatened or endangered species under state legislation
Policy- recognized in policy as a sensitive, protected, priority or species of concern
None- not listed under state legislation and not recognized as a sensitive, protected, priority or species of concern in state policy

[2] Falconry Quota: R- resident, NR- nonresident

State Forest Practice Rules and Management Policies for Private and State-Administered Lands

Overview

Of the 17 states in the review area, 12 states manage forested lands, ranging from 13,300 acres (ND) to 2,100,000 acres (WA). Ten of these states administer, or believe they likely administer, some goshawk breeding habitat. Available estimates ranged from approximately 6000 acres (AZ) to 1,150,000 acres (WA), however most states could not estimate the proportion of forested lands that might provide goshawk habitat. Only two states (OR, CA) currently have policies or regulations that apply specifically to management of goshawk habitat. A third state (CO) is developing a management plan for one state forest that will include management guidelines for goshawk habitat. Only these three states (OR, CA, CO) have conducted at lease partial surveys for goshawks on state-administered lands. A fourth state (NM) is preparing a plan to inventory resources on state lands and proposes to survey for goshawks.

Northern Assessment Area - Area 1

Idaho
The Idaho Department of Lands manages approximately 780,000 acres of commercial forest lands (Table 4.2). Goshawks are known to be present on state lands however, no systematic surveys have been conducted. The goshawk is designated as a "species of special concern" by the Idaho Department of Fish and Game however, no specific protection is provided under this classification. No rules or optional management guidelines address northern goshawk habitat on state lands. Idaho's Forest Practices Act does require that "special consideration [be given] to preserving any critical wildlife or aquatic habitat" (rule 030.08.b). Idaho Department of Lands internal policy recommends that Idaho Fish and Game and the U.S. Fish and Wildlife Service be contacted before management activities occur within habitat of species of special concern.

Montana
The Montana Department of Natural Resources and Conservation manages approximately 622,000 acres of forested trust land. A few goshawk nest sites have been documented on state lands however no systematic inventories have been conducted. Known nest sites have been located during timber sale field work. Statewide, breeding goshawks have been documented in 50% of the state's 47 latilong blocks (degree blocks) with others suspected.

No regulatory mechanisms or optional management guidelines have been established to protect northern goshawk habitat on state-managed lands. A 1996 State Forest Land Management Plan governs current forest management operations. No specific guidance is provided for goshawk habitat, however, state lands are being managed for a "desired future condition characterized by the proportion and distribution of forest types and structures historically present on the landscape." The exception is that old-growth forests would be maintained at no less than one-half the historical proportion of any given forest type. A "fine filter" species-specific approach would address habitat needs for threatened, endangered and sensitive species should they inhabit state lands.

North Dakota
The North Dakota Forest Service manages approximately 13,300 acres of forest lands distributed

among five forests, three of which are located west of the 100th meridian. There are no records of goshawks nesting in the state and no surveys have been conducted. However, potential habitat may be present in the north central portion of the state.

Rocky Mountain Assessment Area - Area 2

Colorado
The Colorado State Forest Service manages approximately 300,000 acres of forested state trust lands (Table 4.2). Goshawk surveys were conducted 1995-1997 on one administrative unit, the 71,000 acre Colorado State Forest and Park. Seven breeding pairs were located (R. Cavallaro, independent contractor, pers. comm.). A 10 year management plan for this area is currently under revision and will include Best Management Practices for northern goshawk habitat (based on Reynolds et al. 1992).

Kansas
No information was received from the Kansas State Forest Service. However, Kansas Department of Fish and Game biologist Jerry Horak (pers. comm.) indicated goshawks are infrequent visitors to the state and no nests have been recorded in Kansas.

Nebraska
No information was received from the Nebraska Forest Service. The Nebraska Game and Parks Commission (M. Fritz, pers. comm.) indicated the goshawk is a fall and spring migrant nearly statewide. There are no confirmed breeding records in the state, however, there have been several breeding season sightings reported from one locale on the Nebraska National Forest (Pine Ridge Ranger District). Nebraska state lands are not expected to provide goshawk breeding habitat and therefore regulations would not apply.

South Dakota
The South Dakota Department of Agriculture, Division of Resource Conservation and Forestry does not manage any state forest lands. Most state lands were consolidated into Custer State Park (76,000 acres) and managed by the Department of Game, Fish and Parks. One active territory was located in 1997 on the boundary between the Park and the Black Hills National Forest. No surveys have been conducted on state park lands and no special regulations protecting goshawk habitat on non-federal lands exist.

Wyoming
The Wyoming Office of State Lands and Investments, Forestry Division, manages 200,000 acres of forested lands. Approximately 160,000 acres are considered commercial lands and 90,000 are actively managed. No surveys have been conducted on state lands although one inactive goshawk nest was reported. No specific rules exist for protection of goshawk habitat.

Southwest Assessment Area - Area 3

Arizona
The Arizona State Land Department manages approximately 35,000 acres of forested lands (Table 4.2). State lands in Arizona are generally part of a checkerboard pattern of state and private sections. Approximately 6000 acres (discontinuous) located in northern Arizona include

late successional ponderosa pine forests and are suitable or capable of providing goshawk nesting habitat. No surveys are conducted for northern goshawks and no nests have been located. However, based on incidental sightings, up to three breeding pairs may occur on state lands.

No regulatory mechanisms or management guidelines are in place to protect northern goshawk habitat on state-managed lands. A forest management plan sets objectives for multiple use and uneven-aged management on state lands. The plan indicates federally listed species and state species of special concern will be considered in project planning. Surveys for federally listed species (e.g., Mexican spotted owl) are conducted on state lands and habitat is protected in consultation with the USFWS (K. Pajkos, AZ State Land Department, pers. comm).

New Mexico
The New Mexico Land Office manages approximately 90,000 acres of forested lands which may provide goshawk nesting habitat. No surveys are conducted for northern goshawks and no nests have been located.

No regulatory mechanisms or management guidelines are in place to protect northern goshawk habitat on state-managed lands. The New Mexico Land Office is currently developing a plan to inventory resources on state lands. This plan will propose surveys for federally listed and proposed for listing wildlife species and sensitive wildlife such as the northern goshawk (B. Jenks, NM Land Office, pers. comm.). The New Mexico Forestry Division works with private landowners to develop Woodland and Forest Stewardship Management Plans. These plans, however, do not directly address northern goshawks and their habitat and there is no information on the amount of available habitat on private lands (K. Paul, NM Energy, Minerals & Natural Resources Department, pers. comm.).

Oklahoma
The Oklahoma Department of Agriculture, Forestry Division manages approximately 40 acres of ponderosa pine forest mixed with upland oak, pinyon and juniper, as well as 35,000 acres of pinyon-juniper woodland in western Oklahoma. Ponderosa pine tree size is small and crowns are open. This area is not expected to support goshawks. Due to low rainfall, adverse growing conditions and land use, the woodland sites probably do not currently meet goshawk habitat standards and are not considered capable of supporting goshawk habitat. Therefore, no surveys have been conducted and no regulations apply to the protection of goshawk habitat on state lands (K. Atkinson, OK Forestry Division, pers. comm.).

Texas
No information was received from the Texas Forest Service, however, Texas Parks and Wildlife Department (C. Farquhar, pers. comm.) indicated that the only goshawk records for the state are from winter months. State-administered lands do not provide goshawk breeding habitat and therefore no regulations apply to the protection of goshawk habitat.

Intermountain Assessment Area - Area 4

Nevada
Nevada has no state forests and state lands are comprised of lower elevation habitats not likely to provide goshawk nesting habitat (Table 4.2). Therefore, no surveys have been conducted and no

regulations apply to the protection of goshawk habitat on state lands.

Utah
The Utah Division of Lands and Forestry (Ed Storey, pers. comm.) only manages lower elevation riparian and desert habitats. Therefore, no surveys have been conducted and no regulations apply to the protection of goshawk habitat on state lands.

Pacific Southwest Assessment Area - Area 5

California
California Department of Forestry manages approximately 70,000 acres of forest lands in five state forests. Several of the forests have been partially surveyed for goshawks, and a few goshawk nests have been located. California Forest Practices Rules (Title 14, California Code of Regulations, Chapters 4 and 4.5, Section 919.3) apply to all Timber Harvest Plans on State and private forest lands. For active goshawk nest sites (not inactive or alternates), a minimum buffer zone of 5 acres is established. This buffer may be increased up to 20 acres with written justification. Thinning, salvage and selective harvest is allowed in the buffer outside of a "critical" (nesting) period of March 15 through August 15.

Pacific Northwest Assessment Area - Area 6

Oregon
State forest lands in Oregon are managed by several agencies including the Division of State Lands, Department of Forestry, Parks and Recreation Department and Oregon Department of Fish and Wildlife. While forested state lands are scattered throughout the state, most are located in western Oregon and managed by the Oregon Dept. of Forestry (approximately 779,000 acres). Significant blocks of state forest lands are located on the Oregon Coast Range, west slope of the Cascade Mountains and the southeast slope of the Cascades.

Based on historical records and extensive raptor surveys conducted over the past 25 years, the Oregon Coast Range is generally considered unsuitable for goshawks. However, state lands in western Oregon have not been surveyed specifically for goshawks. The Oregon Department of Forestry and Division of State Lands have completed a Habitat Conservation Plan (HCP) for spotted owls on the Elliott State Forest (93,000 ac) in the southern coast range, however, goshawks are not known to be present. New forest plans and an HCP are being developed for all western Oregon state forests (634,000 ac) and have the goals of maintaining older-forest conditions across the landscape. Less then 1% of state forest lands within the HCP area are currently considered mature or old-growth forest.

The Oregon Department of Forestry has completed a Forest Plan for the Sun Pass Forest on the southeast slopes of the Oregon Cascades (approximately 48,000 acres). Habitat is being managed to maintain several potential nesting areas and mature forest conditions in areas between adjacent Forest Service lands and Crater Lake National Park. Goshawk surveys detected one pair in 1997. Additional surveys will be conducted in 1998 (C. Smith, pers. comm.).

No regulatory mechanisms or management guidelines exist in Oregon except those for the Sun Pass Forest referenced above. Oregon has a state Forest Practices Act that applies to all state and private forest lands. Special rules have been developed for protecting site specific habitat for

sensitive species (e.g., spotted owls, bald eagles) however none exist for the goshawk.

Washington

The Washington Department of Natural Resources (DNR) manages approximately 2.1 million acres of forested state lands in western and eastern Washington. Under a 1997 spotted owl HCP for western Washington state lands, DNR manages an estimated 1,150,000 acres of forest lands capable of supporting goshawk nesting habitat. Currently about 512,000 acres of those lands may provide goshawk nesting habitat and little change is expected to occur in the overall amount within the next 30 years. An additional 72,000 acres of uninventoried lands in western Washington are considered likely goshawk habitat. The HCP does not cover eastern Washington state lands however, other land and species management plans (e.g., Loomis Landscape Plan and Lynx Management Plan) provide direction such that an estimated 19,000 acres of forest lands will be managed consistent with potential goshawk nesting habitat. Other uninventoried state forest lands are also considered likely goshawk habitat. There are currently no forest practice rules in Washington that apply specifically to the goshawk.

Table 4.2. Northern goshawk habitat status and protection on state-administered forested lands in the Status Review Area, by Assessment Area and State.

Assessment Area	State	Estimated Forested Acres	Breeding goshawks or nesting habitat?	Goshawk Habitat Protection?
Area 1	ID	780,000	yes	no
	MT	622,000	yes	no
	ND	13,300	unknown	no
Area 2	CO	300,000	yes	no
	KS	0	no	n/a
	NE	0	no	n/a
	SD	76,000	yes	no
	WY	200,000	yes	no
Area 3	AZ	35,000	yes	no
	NM	90,000	likely	no
	OK	35,040	unlikely	no
	TX	0	no	n/a
Area 4	NV	0	no	n/a
	UT	0	no	n/a
Area 5	CA	70,000	yes	yes
Area 6	OR	779,000	likely	yes
	WA	2,100,000	yes	some

Conclusions

Based on information reviewed, the Team finds that for most states in the review area, state lands constitute a relatively small amount of overall goshawk habitat. While only two of the states within the review area have regulations that specifically address goshawk management, others are beginning to give the goshawk additional attention. Additionally, goshawks may benefit from regulations and management implemented by the states for the northern spotted owl, California spotted owl, and Mexican spotted owl. At this time, the Team does not find information that would indicate state regulatory mechanisms, or lack thereof, are significantly affecting goshawk populations within the review area.

Chapter 5 - Summary and Conclusions

In view of the preceding chapters, it is evident that there is inadequate data available which could be used to determine the population trend for northen goshawks throughout the review area. Furthermore, our knowledge of the factors that affect the size of goshawk populations at local and regional levels, or in the entire review area is incomplete; a clearer understanding of population size and factors affecting goshawk populations is needed. Much of what is known is currently applicable only to local populations and localized habitat conditions and effects, and should not be extrapolated to the larger range of the species.

Some factors the Review Team identified as critical in the assessing the status of the goshawk population in the review area include:

- the species' distribution,
- its abundance, survival and reproduction,
- status and trends in the amount and distribution of breeding and wintering habitats, and
- regulatory mechanisms that protect or enhance goshawk habitat.

The Team attempted to gather data concerning these topics. Unfortunately, while numerous studies have taken place on goshawks within the review area, very few have focused on population dynamics over a sufficient period of time to provide much demographic information for this status review. The Team was aware of the likelihood that these kinds of data were limited at the outset. This realization led the Team, in view of existing but still limited knowledge of the types and structures of habitats used by goshawks, to identify trends in the habitat. The Team also knew at the outset, however, that we could not directly tie changes in goshawk populations to changes in their habitats over time; there is just too little information concerning the kinds of habitats that goshawks use during the breeding and winter seasons to be confident about goshawk population responses to changes in their habitats.

In spite of these limitations, the Team queried Federal and State resource management agencies, Tribes, and private organizations for the numbers of known goshawk nests/pairs on their lands, the annual frequency with which these goshawks occupied their territories or laid eggs, and the extent to which their known territories/nests were monitored in the years between initial discovery and 1998. The Team hoped that this information would provide insight into the current distribution of breeding goshawks in the review area. At the same time, the Team understood that the reported annual frequency of occupancy/nesting by goshawks on known territories, both within and among assessment areas, contained considerable bias; it is unlikely that the same effort was spent by each management agency in first searching for, and then monitoring pairs and nests of goshawks. Varying search and monitoring efforts resulted in an inability to compare the distribution and abundance of goshawk and their rates of occupancy/ nesting through time within a particular land ownership, let alone among ownerships and assessment areas.

The Team also queried resource management agencies, Tribes and private organizations for the expected trends in the amount of mature and old forests on their lands. Because most existing data on habitat use by goshawks suggests that mature and old forests are important habitat elements, the Team hoped to gain an understanding of the trends of these forest age classes. We were aware that goshawks used more than just mature and old forests; they forage in openings along forest edges, they occasionally nest in young and mid-aged forest, and some populations breed in mountain-shrub or tundra communities. It was also indicated that at least some goshawk populations appear to be sustaining themselves in managed forests (Reynolds and Joy 1998). As discussed in Chapter 1, the Team was unable to use much of the data received. While historical changes in habitat are clear, the Team found that current and future trends in goshawk habitat are equivocal.

Information on the ecology, demographics and habitats of goshawks that the Team gathered and analyzed lead the Team to conclude that 1) there appears to have been little change from the historical distribution of breeding goshawks, and 2) that there is insufficient demographic evidence to judge whether goshawk population numbers in the review area are either decreasing, increasing or remaining stable. In the Team's view, there have been too few intensive demographic studies to accurately estimate local population sizes, birth and death rates, and population change (see DeStephano et al. 1994, Kennedy 1997, Reynolds and Joy 1998). All long-term demographic studies conducted to date have included either too few years and/or too few goshawks to detect local population changes. The Team, therefore, was unable to specify the status (increasing, decreasing, stable) of the goshawk anywhere in the review area.

Change in forest habitat in some parts of the western United States (e.g., ponderosa pine, mixed-conifer) has been considerable since the European settlement, whereas in some western areas forests appear to have changed little (e.g., Rocky Mountain spruce-fir). Because of uncertainties in our understanding of the relationship between goshawk demographics and forest changes, it is currently difficult to judge the effects of the forest change on goshawk populations.

Overutilization for Commercial, Recreational, Scientific or Educational Purposes

Falconry is one means by which live goshawks can be legally taken. However, legal take through falconry is only estimated to be up to 60 goshawks per year throughout the western United States. While there may be some localized impacts to nesting goshawks, falconry take at this rate is not expected to have significant, negative rangewide effects on goshawk populations.

The magnitude of the effects of recreational and educational activities regarding the goshawk are little known, and not widely discussed in the literature. While camping was documented to be a cause of at least one nest failure (Speiser 1992), little else appears in the literature. Disturbances associated with research, which are usually of short duration, apparently have little impact on nesting birds (Austin 1993, Squires and Reynolds 1997).

Disease and Predation and Competition

Disease has not been documented as a major factor in the long-term health and survival of North American goshawk populations. Only one epizootic affecting wild goshawks was reported in the literature, and it was believed to be the result of increased stress on the goshawks related to increased agonistic interactions, reduced prey availability, and migration during invasion years (Redig et al. 1980).

Information reviewed for this status review indicate that goshawks have few natural predators, and predation does not appear to be a significant mortality factor particularly in adults. Predation, particularly by great horned owls, does increase during times of low prey availability, and may particularly impact nestlings. However, there is no evidence to indicate this is having a significant effects on overall goshawk populations.

Competition between goshawks red-tailed hawks and great horned owls is documented in the literature. Fragmentation of mature forested habitats can make the affected areas more accessible and attractive to competing species such as red-tailed hawks and great horned owls, potentially decreasing habitat available to goshawks. However, the Team finds no evidence that this is a major factor affecting the overall health of goshawk populations in the review area.

In conclusion, the Team believes that, while disease, predation, and competition have all been documented in the wild, there are no data to show that these factors have a significant effect on the likelihood of long-term goshawk persistence in the review area.

Existing Regulatory Mechanisms

Federal Statutes and Regulations

The Migratory Bird Treaty Act (MBTA) currently provides the only Federal protection for the northern goshawk. The MBTA protects only the individual bird and its nests or eggs. It does not protect its habitat.

The National Forest Management Act (NFMA) governs management of National Forest System lands. The requirements of the NFMA are intended to eliminate the need to list any vertebrates occurring to a large extent on National Forest lands. However, some believe full implementation of NFMA provisions would require funding and personnel levels far in excess of current resources. For northern goshawks, assurance of maintenance of “viable populations”, as defined above, would require knowledge of habitat requirements currently not well understood, and an inventory and monitoring program beyond the capacity of current budgets. Considering that the goshawk is but one of thousands of vertebrate species on National Forest lands, meeting NFMA mandates presents a considerable challenge.

Nonetheless, some National Forests provide meaningful protection for northern goshawks. In four of the six Forest Service Administrative Regions in the review area, goshawks are

considered “sensitive species”, which are recognized by the Forest Service as needing special management to prevent being places on Federal or State lists. Such designation requires biological evaluations to consider potential impacts to the species of any proposed management actions. Forest Service Region 3 has amended the forest plans for its 11 National Forests to incorporate the Management Recommendations for Northern Goshawks (Reynolds et al. 1992). Interim guidelines for goshawks have been in place since 1992, and the Record of Decision implementing the final guidelines was signed in 1996. At this point, the Team finds that these management recommendations, if properly implemented, can provide a level of habitat protection necessary to maintain goshawks on the landscape over time in the Southwest. Goshawks remain widespread despite past management practices, and should increase in numbers with improved management plans.

State Falconry Regulations

About 60 species of raptors are protected by Federal law; 18 are of importance to falconry, including the northern goshawk (USDI 1988). No state in the review area affords legal protection to the northern goshawk beyond protection provided by Federal laws (e.g., Migratory Bird Treaty Act). Eight of the 17 states in the review area recognize the goshawk as a sensitive, protected, priority or species of special concern in state policy. Of the nine states that do not recognize the goshawk as a sensitive species, five have no breeding records for the species.

Of the 17 states in the review area, 10 states reported estimated goshawk take for falconry, over the last 10 years, of 1-11 birds per year, with the highest take in California and the lowest in Oregon and South Dakota. One state (NM) reported no take of goshawks since 1991 due to a moratorium on take of nestlings, and prior to 1991 approximately one bird was taken per year. Arizona had a moratorium on take of goshawks from 1991-1995 but since 1995 has allowed take of three birds per year. The remaining five states reported no goshawk take for falconry over the last 10 years because goshawks do not breed and are rare migrants in these states. Seven of the 17 states in the review area have a falconry quota for northern goshawks ranging from three to 70 birds per year. In these states, actual take has been well below allowed take. The maximum annual take across the review area has been approximately 60 birds.

Conclusions

Based on information reviewed, the Team does not believe falconry to be a significant factor affecting the long-term trend of goshawks within the petitioned area. The overall take allowed is minimal and well regulated by the states.

State Forest Practice Rules and Management Policies for Private and State-Administered Lands

Of the 17 states in the review area, 12 states manage forested lands, ranging from 13,300 acres (ND) to 2,100,000 acres (WA). Ten of these states administer, or believe they likely administer, some goshawk breeding habitat. Available estimates ranged from approximately 6,000 acres (AZ) to 512,000 acres (WA); however, most states could not estimate the proportion of forested lands that might provide goshawk habitat. Only two states (OR, CA) currently have policies or regulations that apply specifically to management of goshawk habitat. A third state (CO) is

developing a management plan for one state forest that will include management guidelines for goshawk habitat. Only these three states (OR, CA, CO) have conducted at least partial surveys for goshawks on state-administered lands. A fourth state (NM) is preparing a plan to inventory resources on state lands and proposes to survey for goshawks.

Conclusions

Based on information reviewed, the Team does not believe falconry to be a significant factor affecting the long-term trend of goshawks within the petitioned area. The overall take allowed is minimal and well regulated by the states. Based on information reviewed, the Team finds that for most states in the review area, state lands constitute a relatively small amount of overall goshawk habitat. While only two of the states within the review area have regulations that specifically address goshawk management, others are beginning to give the goshawk additional attention. Additionally, goshawks may benefit from regulations and management implemented by the states for the northern spotted owl, California spotted owl, and Mexican spotted owl. At this time, the Team does not find information that would indicate state regulatory mechanisms, or lack thereof, are significantly affecting goshawk populations within the review area.

Other Natural or Man-Made Factors Affecting the Goshawk's Continued Existence

Pesticides and Other Contaminants

Information reviewed for this status review does not present evidence that pesticides and other contaminants significantly affect goshawks in the review area.

Take of Individuals

Take of goshawks through shooting, trapping, poisoning or other means is generally illegal throughout the review area, and does not appear to be a significant factor affecting goshawk populations in general.

Chapter 6 - Recommendations

Our charge in this Status Review was to collect and analyze information which would allow FWS to make a determination of whether listing of the northern goshawk is warranted. We found that data limitations precluded much of the analysis we had hoped to conduct. Therefore, many of our recommendations are directed at this lack of cohesive information.

- Our inability to adequately evaluate habitat trends in this Status Review strongly emphasized the need for accurate and consistent inventory and monitoring of forest resources to assess changes in forest habitats. Habitat data collection should be standardized to allow an initial assessment of trends and monitoring of habitat amount and distribution through time.

- We had hoped that the Forest Inventory and Analysis Data Base maintained by the Forest Service would answer the relatively simple questions we posed. We were greatly disappointed to learn that inconsistent data collection methods (temporally and spatially) prevented any use of this inventory. We also learned that data has not been entered into data bases, and is therefore useless to resource managers. We recommend the Forest Service address the failings of this inventory.

- Based upon the evidence we've gathered in this Status Review, it is apparent that land managers should improve inventory and monitoring of goshawk populations. Improvements should include a standardized protocol to conduct goshawk surveys.

- There is also a need to develop long-term, well-distributed, and well-designed demographic studies to gather the population in a manner that will answer the questions which were posed in this Status Review.

- Genetic analysis of goshawk populations in the area of the purported *apache* subspecies is needed.

- Any consideration of the long-term management of goshawk populations which are purported to be the *apache* subspecies must include a thorough review of the habitat and population of the species in Mexico.

- Much of the data and information which we collected as part of this Status Review has not been fully analyzed. As suggested by our Peer Reviewers, we recommend that FWS continue analysis of the data we acquired and explore its possible use. Further, FWS should continue to gather information on this species and acquire the information which is currently shown as gaps

- Regional-level goshawk specific Standards & Guidelines should be developed within the Forest Service. Once implemented, these measures should be the subject of implementation and effectiveness monitoring.

- We suggest that the northern goshawk is not an appropriate species for use as a Management Indicator for the Forest Service. The species is difficult to locate through surveys, making it less amenable to monitoring and its habitat use is not restricted to old-growth, making it less appropriate for use as an old-growth indicator.

References Cited in 12-month Finding on
Petition to List the Northern Goshawk (Accipiter gentilis)
In the United States West of the 100th Meridian
(63 FR: 35183)

Corrected: April 27, 1999

Alaska Dept. of Fish and Game Division of Wildlife Conservation. 1993. Ketchikan forest raptor study final report: A summary of survey, radio-telemetry, and other results regarding goshawk field studies in southeast Alaska. USDA Forest Service, Ketchikan Area and Wildlife, Fisheries and Subsistence Management, Regional Office. Juneau, AK. 37 pp.

Alerstam, T. 1987. Radar observation of the stoop of the peregrine falcon *Falco peregrinus* and the goshawk *Accipiter gentilis*. Ibis. 129: 267-273.

Allen, B. A. 1978. Nesting ecology of the goshawk in the Adirondacks. Syracuse, NY. State University of New York. M.S. Thesis. 71 pp. (3 pp. - partial)

Allison, B. 1996. A landscape characterization of nesting goshawk habitat in northern California using remote sensing and GIS. Edwardsville, Illinois. Southern Illinois University. M.S. Thesis. 87 pp.

American Ornithologists' Union. 1957. Checklist of North American birds, 5th edition. American Ornithologists' Union. Baltimore, MD. (1 p. - partial)

American Ornithologists' Union. 1983. Checklist of North American birds, 6th edition. American Ornithologists' Union. Lawrence, KS.

Amundson, J. 1998. U.S. Forest Service, Region 4 silviculturist. Telephone conversation with M. A. Zablan. March 20, 1998.

Anderson, R.A. 1980. Forest management and goshawks in northeastern Oregon. Unpubl. Rep. U.S. Forest Service, Wallowa-Whitman National Forest. Wallowa, OR. 22 pp. (1 p. - partial)

Anonymous. 1989. Goshawk breeding habitat in lowland Britain. British Birds. 82:56-57.

Apfelbaum, S. and A. Haney. 1984. Note on foraging and nesting habitats of goshawks. Loon. 56: 132-133.

Apfelbaum, S. I. and P. Seelbach. 1983. Nest tree, habitat selection, and productivity of seven

North American raptor species based on the Cornell University nest record card program. Journal of Raptor Research. 17: 97-113.

Arizona Game and Fish Dept. 1988. Threatened native wildlife in Arizona. Phoenix, AZ. 32 pp.

Arizona Game and Fish Dept. 1993a. Review of U.S. Forest Service strategy for managing northern goshawk habitat in the southwestern United States. May 1993. 173 pp.

Arizona Game and Fish Dept. 1993b. Internal review of northern goshawk take under commission order 25. 12 pp.

Arizona Game and Fish Dept. 1996. Wildlife of special concern. Draft. Phoenix, AZ. 40 pp.

Austin, K. 1993. Habitat use by breeding goshawks in the southern Cascades. Corvallis, OR. Oregon State University. M.S. Thesis. 69 pp.

Babbitt, C., Galvin, P., Hitt, S. M., Hoffman, S. W., MacFarlane, A., Rait, K., Sandell, C. I., Sauber, M., Schulke, M. T. and G. Wardwell. 1991. Letter to the US Dept. of the Interior, requesting to amend a petition to list the northern goshawk. Maricopa Audubon Society. Phoenix, Arizona. September 26, 1991. 5 pp.

Backstrom, P. 1991. Northern goshawk predation on sharp-tailed grouse. Loon. 63: 74.

Bailey, A. M. and R. J. Niedrach. 1965. Birds of Colorado. Denver Mus. Nat. Hist. Denver, Colorado. Vol. 1. 895 pp. (6 pp. - partial)

Baird, Brewer, and Ridgway. 1874. History of North American Birds. Vol. 3. 238-240.

Baker, J. A.; Brooks, R. J. 1981. Distribution patterns of raptors in relation to density of meadow voles. The Condor. 83: 42-47.

Bartelt, P. E. 1977. Management of the American goshawk in the Black Hills National Forest. Springfield, SD. University of South Dakota. M.S. Thesis. 107 pp.

Beatty, G.L. 1992. Goshawk nesting survey. North Kaibab Ranger District, Kaibab National Forest, Arizona. Final Report #07-90-02. Nongame and Endangered Wildlife Program. Arizona Game and Fish Dept. Phoenix, AZ. 44 pp.

Bednarz, J. C. et al. 1990. Migration counts of raptors at Hawk Mountain, Pennsylvania, as indicators of population trends, 1934-1986. The Auk. 107: 96-109.

Beebe, F. L. 1974. Goshawk. In: Field studies of the Falconiformes of British Columbia. British Columbia Provincial Museum Occasional Papers. Series No. 17. 54-62 pp.

Beebe, F. L. 1976. The Goshawk. In: F. L. Beebe, and H. M. Webster, [eds.] North American Falconry and Hunting Hawks. Fourth Edition. North American Falconry and Hunting Hawks. Denver, CO: 185-195. 313 pp. (7 pp. - partial)

Beier, P. and J. E. Drennan. 1997. Forest structure and prey abundance in foraging areas of northern goshawks. Ecological Applications. 7: 564-571.

Bent, A. C. 1937. Life histories of North American birds of prey. U.S. National Museum Bulletin 167. New York: Dover Publications, Inc. 409 pp. (15 pp. - partial)

Bergstrom, B. J. 1985. Unusual prey-stalking behavior by a goshawk. Journal of Field Ornithology. 56: 415.

Berner, L.R. and R.W. Mannan. 1992. Survey for sensitive raptors in the Rincon Mountains of Saguaro National Monument, Arizona. Final Report. Cooperative Agreement No. 8000-2-9001. National Park Service. 18 pp.

Bernstein, C., Krebs, J.R. and A. Kacelnik. 1991. Distribution of birds amongst habitats: theory and relevance to conservation. In: Perrins, C.M.; Lebreton, J.D.; Hirons, G.J., [eds.] Bird population studies: relevance to conservation and management. Oxford University Press. Oxford, England. 317-345.

Beschta, R.L. et al. 1995. Wildfire and salvage logging: recommendations for ecologically sound post-fire salvage logging and other post-fire treatments on federal lands in the west. Salem, Oregon. Oregon State University. 14 pp.

Block, W.M., Morrison, M.L. and M.H. Reiser, [eds.] 1994. The northern goshawk: ecology and management. Studies in Avian Biology. 16: 1-136.

Bloom, P. H., Morrison, M. L. and M. H. Reiser, [eds.] 1994. The status of the northern goshawk in California, 1981-1983. Administrative report. Sacramento, CA. State of California, Dept. of Fish and Game.

Bloom, P. H., Stewart, G. R. and B. J. Walton. 1986. The status of the northern goshawk in California, 1981-1983. Admin. Rep. 85-1. State of California, Dept. of Fish and Game, Wildlife Management Branch. 29 pp.

Boal, C.W. 1994. A photographic and behavioral guide to aging nestling northern goshawks. (Proceedings of a symposium of the Cooper Ornithological Society, Sacramento, CA. 14-15 April 1993: The northern goshawk: Ecology and management. Cooper

Ornithological Society. Camarillo, CA.) Studies in Avian Biology. 16: 32-40.

Boal, C. W. and R. W. Mannan. 1994. Northern goshawk diets in ponderosa pine forests on the Kaibab Plateau. Studies in Avian Biology. 16: 97-102.

Bolsinger, C. L. et al. 1997. Washington's Public and Private Forests. USDA Forest Service Resource Bull. PNW-RB-218. 144 pp.

Bond, R. M. 1940. A goshawk nest in the upper Sonoran life zone. The Condor. 62: 100-103.

Bond, R. M. 1942. Development of young goshawks. Wilson Bulletin. 54: 81-88.

Bond, R. M. and R. M. Stabler. 1941. Second-year plumage of the goshawk. The Auk. 58: 346-349.

Booth, D. E. 1991. Estimating prelogging old-growth in the Pacific Northwest. J. of Forestry. 89: 25-29.

Born, J. D., Tymcio, R. P. and O. E. Casey. 1992. Nevada Forest Resources. USDA Forest Service Resource Bull. INT-76. 65 pp.

Bosakowski, T. and D. G. Smith. 1992. Comparative diets of sympatric nesting raptors in the eastern deciduous forest biome. Canadian Journal of Zoology. 70: 984-992.

Bosakowski, T., Smith, D. G. and R. Speiser. 1992. Niche overlap of two sympatric-nesting hawks Accipiter spp. in the New Jersey-New York highlands. Ecography. 15: 358-372.

Bosakowski, T.; Vaughn, M.E. 1996. Developing a practical method for surveying northern goshawks in managed forests of the western Washington Cascades. West. J. Applied For. 11(4): 109-113.

Bosakowski, T. and R. Speiser. 1994. Macrohabitat selection by nesting northern goshawks: implications for managing eastern forests. Studies in Avian Biology. 16: 46-49.

Boulanger, J. G. and G. C. White. 1990. A comparison of home-range estimators using Monte Carlo simulation. J. Wildlife Management. 54(2): 310-315.

Brace, K. 1983. Goshawk-showshoe hare encounter. Blue Jay. 41: 120.

Bradley, A. F., Noste, N. V. and W. C. Fischer. 1992. Fire ecology of forests and woodlands in Utah. U.S. Forest Service Gen. Tech. Rep.. INT-287. 128 pp.

Braun, C. E. et al. 1996. Northern goshawk and forest management in the southwestern United

States. The Wildlife Society and American Ornithologists' Union Technical Review Team on Northern Goshawks. 96-2, March, 1996. 22 pp.

Bright-Smith, D. J. and R. W. Mannan. 1994. Habitat use by breeding male northern goshawks in northern Arizona. (Proceedings of a symposium of the Cooper Ornithological Society, Sacramento, CA. 14-15 April 1993: The northern goshawk: Ecology and management; Cooper Ornithological Society; Camarillo, CA). Studies in Avian Biology. 16: 58-65.

Brohn, A. 1986. Report of the subcommittee on falconry rules. International Association of Fish and Wildlife Agencies. Washington DC.

Brown, L. H. and D. Amadon. 1968. Eagles, hawks, and falcons of the world. Country Life Books. London, England. 932 pp. (4 pp. - partial)

Brüll, H. 1964. A study of the importance of goshawk *Accipiter gentilis* and sparrow hawk *Accipiter nisus* in their ecosystem. In: International Council for Bird Preservation, Working Conference on Birds of Prey and Owls. 1964 April 10. Caen, France. 24-41 pp.

Bryan, T. and E. D. Forsman. 1987. Distribution, abundance, and habitat of great gray owls in southcentral Oregon. Murrelet. 68: 45-49.

Buchanan, J. B., Irwin, L. L. and E. L. McCutchen. 1993. Characteristics of spotted owl nest trees in the Wenatchee National Forest. Journal of Raptor Research. 27:1-7.

Buhler, U., Klaus, R. and W. Schlosser. 1987. Brutbestand und Jungenproduktion des Habichts *Accipiter gentilis* in der Nordostschweiz 1979-1984. Der Ornithologische Beobachter. 84: 95-110.

Buhler, U. and P. Oggier. 1987. Bestand und Bestandsentwicklung des Habichts *Accipiter gentilis* in der Schweiz. Der Ornithologische Beobachter. 84: 71-94.

Bull, E. L. and J.E. Hohmann. 1994. Breeding biology of northern goshawks in northeastern Oregon. Studies in Avian Biology. 16: 103-105.

Burnham, K.P. et al. 1987. Design and analysis of methods for fish survival experiments based on release-recapture. Am. Fish. Soc. Monogr. 5 pp.

Butcher, G.S. 1990. Audubon Christmas Bird Counts. In: J.R. Sauer and S. Droege, [eds.] Survey designs and statistical methods for the estimation of avian populations trends. U.S. Fish and Wildlife Service Biological Report. No. 90(1). 5-13 pp.

Call, M. W. 1974. Goshawk. Nesting habitats and surveying techniques for common western raptors. In: Technical Note TN-316. USDI, Bureau of Land Management. Denver, CO.

115 pp. (6 pp. - partial)

Centers for Water and Wildland Resources. 1996. Summary of the Sierra Nevada Ecosystem Project Report, Report 39. University of California, Davis. 24 pp.

Choate, G.A. 1966. New Mexico's Forest Resource. USDA Forest Service Resource Bull. INT-5. Intermountain Research Station. Ogden, Utah. 61 pp.

Clark, A.B. 1978. Sex ratio and local resource competition in prosimian primates. Science 201: 163-165.

Clutton-Brock, T.H. and G.R. Iason. 1986. Sex ratio variation in mammals. Quarterly Rev. of Biology. 61: 339-374.

Collopy, M. W. 1983. A comparison of direct observations and collections of prey remains in determining the diet of golden eagles. J. Wildl. Manage. 47: 360-368.

Conner, R.C. et al. 1990. Forest Resources of Arizona. USDA Forest Service Resource Bull. INT-69. Intermountain Research Station. Ogden, Utah. 92 pp.

Cooper, C.F. 1960. Changes in vegetation, structure and growth of southwestern pine forests since white settlement. Ecol. Monogr. 30: 129-164.

Covington, W.W. 1996. Implementing adaptive ecosystem restoration in western long-needled pine forests. In: W.W. Covington and P.K. Wagner, [technical coordinators.] Conference on adaptive ecosystem restoration and management: restoration of Cordilleran conifer landscapes of North America. RM-GTR-278. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO. 5 pp.

Covington, W.W. and M.M. Moore. 1992. Postsettlement changes in natural fire regimes: implications for restoration of old-growth ponderosa pine forests. In: [technical coordinators.] Old-growth forests in the Southwest and Rocky Mountain regions: proceedings of a workshop. U.S. Forest Service GTR RM-213. Fort Collins, CO. 19 pp.

Covington, W.W. and M.M. Moore. 1994. Southwestern ponderosa forest structure: changes since Euro-American settlement. J. For. 92: 39-47.

Covington, W.W. et al. 1997. Grand Canyon forest ecosystem restoration. Proposal for adaptive ecosystem research and management to the USDI Interior Fire Coordinating Committee. Northern Arizona University. Flagstaff, AZ. 64 pp.

Cramp, S. and K.E.L. Simmons. 1980. Handbook of the birds of Europe, the Middle East, and North Africa, Vol. 2. Oxford University Press. London, England. 148-157. 695 pp.

(8 pp. - partial)

Crannell, D. and S. DeStephano. 1992. An aggressive interaction between a northen goshawk and a red-tailed hawk. Journal of Raptor Research. 26: 269-270.

Crocker-Bedford, D.C. 1990a. Goshawk reproduction and forest management. Wildlife Society Bulletin. 18: 262-269.

Crocker-Bedford, D.C. 1990b. Status of the Queen Charlotte goshawk. Report to U.S. Forest Service, Alaska Region. Ketchikan, Alaska. 16 pp.

Crocker-Bedford, D.C. and B. Chaney. 1988. Characteristics of goshawk nesting stands. In: R.L. Glinski, B.G. Pendleton, M.B. Moss, M.N. LeFranc Jr., B.A. Millsap, and S.W. Hoffman [eds.] Proceedings of the southwest raptor management symposium and workshop, 21-24 May 1986, Univ. of Arizona, Tucson. National Wildlife Federation, Washington, DC, National Wildlife Federation Scientific and Technical Series No. 11. 210-217 pp.

Dargan, C. 1991. Coconino National Forest 1991 northern goshawk surveys. USDA Forest Service, Flagstaff, AZ. 53 pp.

Daw, S.K. 1996. Northern goshawk nest site selection and habitat association at the post-fledging family area scale in Oregon. Oregon State University. MS. Thesis. 63 pp.

Daw, S.K., DeStefano, S. and R. J. Steidl. [in press]. Does Survey Method Bias the Description of Northern Goshawk Nest-site Structure? Arizona Cooperative Fish and Wildlife Research Unit. Tucson, Arizona. 17 pp.

Demet'ev, G.P. et al. 1951. Birds of the Soviet Union. Moscow: Israel Program for Scientific Translation. 704 pp. (20 pp. - partial)

Desimone, S.M. 1997. Occupancy rates and habitat relationships of northern goshawks in historic nesting areas in Oregon. Oregon State University. M.S. Thesis. 87 pp.

DeStefano, S. et al. 1994. Density and productivity of northern goshawks: Implications for monitoring and management. Studies in Avian Biology. 16: 88-91.

DeStefano, S.; McMcloskey. 1997. Does vegetation structure limit the distribution of northern goshawks in the Oregon Coast Ranges? J. Raptor Res. 31(1): 34-39.

DeStefano, S., Woodbridge, B. and P.J. Detrich. 1994. Survival of northern goshawks in the southern Cascades of California. (Proceedings of a symposium of the Cooper Ornithological Society, Sacramento, CA, 14-15 April, 1993.: The northern goshawk:

Ecology and management, Cooper Ornithological Society, Camarillo, CA). Studies in Avian Biology. 16: 133-136.

Detrich, P. and B.Woodbridge. 1994. Territory fidelity, mate fidelity and movements of colormarked northern goshawks in the southern Cascades of California. Studies in Avian Biology. 16: 130-132.

Dewey, S. 1996. Ashley National Forest Northern Goshawk Inventory and Monitoring Report, 1991-1996. US Forest Service, Ashley National Forest. Vernal, UT. 28 pp.

Dimock, E.J. III. 1974. Animal populations and damage. In: Environmental effects of forest residues management in the Pacific Northwest: a state-of-knowledge compendium. Gen. Tech. Rep. PNW-24. Pacific Northwest Forest and Range Experiment Station. Portland, OR. 518 pp.

Dixon, J.B. and R.E. Dixon. 1938. Nesting of the western goshawk in California. The Condor. 40: 3-11.

Doerr, P. D. and J.H. Enderson. 1965. An index of abundance of the goshawk in Colorado in the winter. The Auk. 82: 284-285.

Doyle, A.T. 1990. Use of riparian and upland habitats by small mammals. J. Mamm. 71(1): 14-23.

Doyle, F.I. 1995. Bald eagle (*Haliaeetus leucocephalus*) and northern goshawk *(Accipiter gentilis*), nests apparently preyed upon by a wolverine(s), (*Gulo gulo*), in the southwestern Yukon Territory. Canadian Field-Nat. 109: 115-116.

Doyle, F. I. and J. N. M. Smith. 1994. Population responses of northern goshawks to the 10-year cycle in numbers of snowshoe hares. Studies in Avian Biology. 16: 122-129.

Driscoll, J.T. and S.R. MacVean. 1994. Northern goshawk breeding survey in northwestern Arizona- 1993. Nongame and Endangered Wildlife Program. Tech. Rep. 36, Arizona Game and Fish Dept., Phoenix, AZ. 25 pp.

Eng, R.L.and G.W. Gullion. 1962. The predation of goshawks upon ruffed grouse on the Cloquet Forest Research Center, Minnesota. Wilson Bulletin. 74: 227-242.

Erickson, M.G. 1987. Nest site habitat selection of the goshawk *(Accipiter gentilis*) in the Black Hills National Forest of South Dakota. Springfield, SD. University of South Dakota. M.S. Thesis. 53 pp.

Erlinge, S. et al. 1982. Factors limiting number of vertebrate predators in a predator prey

community. Trans. Intern. Congr. Game Biol. 14: 116-268.

Finn, S.P.; Marzluff, J.M.; Varland, D.E. 1998. Northern goshawks occupancy and productivity in managed forests of western Washington. Ann. Rpt. Boise State University. 52 pp.

Fischer, D.L. 1986. Daily activity patterns and habitat use of coexisting Accipiter hawks in Utah. Provo, UT. Brigham Young University. Ph.D. Dissertation. 32 pp.

Fitch, J.S., Glading, B., and V. House. 1946. Observations on Cooper's hawk nesting and predation. California Fish and Game. 32: 144-154.

Fleming, T.L. 1987. Northern goshawk status and habitat associations in western Washington with special emphasis on the Olympic Peninsula. USDA, Pacific Northwest Forest and Range Experiment Station, Old-Growth Research Laboratory. Olympia, WA. 50 pp.

Fletcher, N. and G. Sheppard. 1994. The northern goshawk in the southwestern region: status report. USDA Forest Service, Southwestern Region. Albuquerque, NM. 22 pp.

Forsman, E.D., Meslow, E.C. and H.M. Wight. 1984. Distribution and biology of the spotted owl in Oregon. Wildlife Monographs. 87: 1-64.

Franklin, J. F. and C. T. Dyrness. 1973. Natural Vegetation of Oregon and Washington. Oregon State University Press. 452 pp.

Franklin, J. F. and J. A. Fites-Kaufmann. 1996. Assessment of Late-Successional Forests of the Sierra Nevada. Sierra Nevada Ecosystem Project: Final report to Congress Vol. II, Assessments and scientific basis for management options. Centers for Water and Wildland Resources, 1996. Davis: University of California. 627-661 pp.

Fretwell and Lucas. 1969. On territorial behavior and other factors influencing habitat selection in birds. 1. Theoretical development. ACTA Bioth. 19: 16-36.

Fulton, J.T. 1983. A northern goshawk in Georgia. The Oriole. 48: 5.

Galushin, V.M. 1974. Synchronous fluctions in populations of some raptors and their prey. The Ibis. 116: 127-134.

Gavin, T.A. and B. May. 1996. Genetic variation and taxonomic status of northern goshawks in Arizona: implications for management. Arizona Game and Fish Dept. Phoenix, AZ.

Gilmer, D.S., Konrad, P.M. and R.E. Stewart. 1983. Nesting ecology of red-tailed hawks and great horned owls in Central North Dakota and their interactions with other large raptors. Prairie Naturalist. 15: 133-143.

Goslow, G.E., Jr. 1971. The attack and strike of some North American raptors. The Auk. 88: 815-827.

Graham, Russel T. et al. 1994. Sustaining forest habitat for the northern goshawk: a question of scale. Studies in Avian Biology. 16: 12-17.

Greco, B. 1998. Proposed Action. Flagstaff urban/wildland interface forest health restoration. USDA Forest Service, Coconino National Forest, Peaks Ranger District. Flagstaff, AZ. 6 pp.

Greenwood, P.J. 1980. Mating systems, philpatry, and dispersal in birds and mammals. Animal Behavior. 28: 1140-1162. 23 pp.

Greiner, E.C. et al. 1975. Distribution of avian haematozoa of North America. Canadian Journal of Zoology. 53: 1762-1787.

Gromme, O.J. 1935. The goshawk (*Astur atricapillus atricapillus*) nesting in Wisconsin. The Auk. 52: 15-20.

Grzybowski, J.A. and S.W. Eaton. 1976. Prey items of goshawks in southwestern New York. Wilson Bulletin. 88: 669-670.

Gullion, G.W. 1981a. The impact of goshawk predation on ruffed grouse. Loon. 53: 82-84.

Gullion, G.W. 1981b. A quarter century of goshawk nesting at cloquet. Loon. 53: 3-5.

Gullion, G.W. and A.A. Alm. 1983. Forest management and ruffed grouse populations in a Minnesota coniferous forest. Journal of American Forestry. 81: 529-532, 536.

Hager, D.C. 1957. Nesting populations of red-tailed hawks and horned owls in central New York state. Wilson Bulletin. 69: 263-272.

Haines K. F. 1995. Northern goshawk breeding habitat in conifer stands with natural tree mortality in eastern Oregon. Boise State University. MS. Thesis. 55 pp.

Hakila, R. 1969. Kanahaukan (*Accipiter gentilis*) pesimabiologiasta satakunnassa. American Reprints of the Ornithological Soc. Pari. 1968. In Finnish-English summary. 52-54 pp.

Hall, P.A. 1984. Characterization of nesting habitat of goshawks (*Accipiter gentilis*) in northwestern California. Arcata, California. Humboldt State University. M.S. Thesis. 79 pp.

Hann et al. 1997. An Assessment of Ecosystem Components in the Interior Columbia Basin and

Portions of the Klamath and Great Basins. Gen. Tech. Rpt. PNW-GTR-405. USDA, Forest Service, Pacific Northwest Research Station. Portland, OR. Chap. 3, Vol. 4. 2,066 pp.

Hargis, C. D., McCarthy, C. and R. D. Perloff. 1994. Home ranges and habitats of northern goshawks in eastern California. Studies in Avian Biology. 16: 66-74.

Harrington, M.G. and S.S. Sackett. 1992. Past and present influences on southwestern ponderosa pine old-growth. In: Kauffman, M.R.,Moir, W.H. and R.L. Bassett, tech. coords. Old-growth forests in the Southwest and Rocky Mountain regions: proceedings of a workshop. USDA Forest Service GTR RM-213. Fort Collins, CO. 44-50 pp.

Haukioja, E., and M. Haukioja. 1970. Mortality rates of Finnish and Swedish goshawks. Finnish Game Research. 31: 13-20.

Havera, S.P. and R. E Duzan. 1986. Organochlorine and PCB residues in tissues of raptors from Illinois, 1966-1981. Bull. Environ. Contan. Toxicol. 36: 23-32.

Haynes, R.W. 1986. Inventory and value of old-growth in the Douglas-fir region. U.S.D.A Forest Service Research Note PNW-437. 20 pp.

Hays, D.W. and Desimone, S.M. 1998. [In review.] Northern goshawk. In: Larsen, E. et al. [eds.]: Priority Habitats and Species. Washington Dept. of Fish and Wildlife. Olympia, WA. 27 pp.

Hayward, G.D., and R.E. Escano. 1989. Goshawk nest-site characteristics in western Montana and northern Idaho. The Condor. 91: 476-479.

Hennessy, S.P. 1978. Ecological relationships of accipiters in northern Utah with special emphasis on the effects of human disturbance. Logan, Utah. Utah State University. M.S. Thesis. 66 pp.

Henny, C.J., Olson, R.A., and T.L. Fleming. 1985. Breeding chronology, molt, and measurements of accipiter hawks in northeastern Oregon. Journal of Field Ornithology. 56: 97-112.

Hensler, G.L. and J.D. Nichols. 1981. Mayfield method of estimating nesting success: model, estimators and simulation results. Wilson Bulletin 93: 42-53.

Herron, G.B., R.J. Turner, and S.J. Stiver. 1981. Population surveys, species distribution, and key habitats of selected nongame species. Job Performance Report, Nevada Dept. of Wildlife. Reno, NV. 2 pp.

Heslin, B.S., J.T. Driscoll and L.Z. Ward. 1993. 1992 northern goshawk nesting survey on the Kaibab Plateau, Arizona. Final Report. Nongame and Endangered Wildlife Program, Arizona Game and Fish Dept. Phoenix, AZ. 79 pp.

Hoffman, S.W., Deragon, W.R. and J.C. Bednarz. 1992. Patterns and recent trends in counts of migrant hawks in western North America. HawkWatch International. Salt Lake City, UT. 161 pp.

Hoglund, N.H. 1964. Der Habicht *Accipiter gentilis* Lenne in Ferroskandia. Viltrevy. 2: 195-269. 76 pp.

Holstein, V. 1942. Duehogen *Astur gentilis dubius* (Sparrman). Kopenhagen: H. Hirschsprung Verlag. 75 pp.

Houston, C.S. 1975. Close proximity of red-tailed hawk and great horned owl nests. The Auk. 92: 612-614.

Howell, J. et al. 1978. Habitat structure and productivity in red-tailed hawks. Bird-Banding. 49: 162-171.

Hubbard, J.P. 1992. A taxonomic assessment of the northern goshawk in southwestern North America. New Mexico Dept. of Game and Fish. Santa Fe, NM. 24 pp.

Huhtala, K. and S. Sulkava. 1981. Environmental influences on goshawk breeding in Finland. In: Kenward, R.E. and I.M. Lindsay [eds.] . Understanding the goshawk. International Association for Falconry and Conservation of Birds of Prey. Oxford, United Kingdom. 89-104 pp.

Ingraldi, M.F. 1998. Ecology of northern goshawks in east-central Arizona. Nongame and Endangered Wildlife Program Draft Tech. Report, Arizona Game and Fish Dept. Phoenix, AZ. 107 pp.

Ingraldi, M.F. and S.R. MacVean. 1995. Nest-site selection by northern goshawks in a ponderosa pine forest in east-central Arizona. Nongame and Endangered Wildlife Program Tech. Report 47. Arizona Game and Fish Dept. Phoenix, AZ. 20 pp.

Iverson, G.C. et al. 1996. Conservation assessment for the northern goshawk in southeast Alaska. C.G. Shaw, III, [technical coordinator] Conservation and resource assessments for the Tongass Land Management Plan revision. U.S.D.A., Forest Serv., Gen. Tech. Rep. PNW-GTR-387. 101 pp.

Jackson and Kimmerling. 1993. Atlas of the Pacific Northwest. Eighth Edition. Oregon State University Press. ISBN 0-87071-416-3. 105-109 pp.

Janes, S.W. 1984. Influences of territory composition and interspecific competition on red-tailed hawk reproductive success. Ecology. 65: 862-870.

Janes, S.W. 1985. Habitat selection in raptorial birds. In: Cody, M.L., [ed.] Habitat selection in birds. Academic Press: 159-188.

Jewell, J., and J.P. Smith. 1998. Fall 1997 raptor migration study in the Goshute Mountains of northeastern Nevada. HawkWatch International, Inc. Salt Lake City, UT. 43 pp.

Jewett, S. G. 1953. The Birds of Washington State. University of Washington Press. Seattle, WA. 767 pp. (2 pp. - partial)

Johansson, C., Hardin, P. and C.M. White. 1994. Large-area goshawk habitat modeling in Dixie National Forest using vegetation and elevation data. Studies in Avian Biology. 16: 50-57.

Johnsgard, P. A. 1990. Goshawk. In: Hawks, eagles and falcons of North America. Smithsonian Institution Press. Washington Press. 176-182 pp.

Johnson, M. 1994. Changes in southwestern forests: stewardship implications. J. Forestry. 92: 16-19.

Johnson, D.H. 1979. Estimating nest success: the Mayfield method and an alternative. The Auk. 96: 651-661.

Johnston, D.W. 1990. Descriptions of surveys: Breeding Bird Census. In: J.R. Sauer and S. Droege, [eds.] Survey designs and statistical methods for the estimation of avian population trends. U.S. Fish and Wildlife Service Biological Report No. 90(1). 33-36 pp. 4 pp.

Jones, S. 1979. The accipiters goshawk, Cooper's hawk, sharp-shinned hawk. USDI, Bureau of Land Management, Habitat Management Series for Unique or Endangered Species. No. 17. 54 pp.

Joy, S. M., Reynolds, R.T., and D. Leslie. 1994. Northern goshawk broadcast surveys: hawk response variables and survey costs. Studies in Avian Biology. 16: 24-31.

Kaltenecker, G.S., K.K. Bates, and M.J. Bechard. 1995. Monitoring of fall raptor migration in southwestern Idaho. USDI Bureau of Land Management Technical Bull. 95-11.

Keane, J. 1997. [Unpublished thesis] Ecology of the northern goshawk in the Sierra Nevada, California. Abstract. 1 p.

Keane, J. and M.L. Morrison. 1994. Northern goshawk ecology: effects of scale and levels of biological organization. In: Proceedings of a symposium of the Cooper Ornithological Society, Sacramento, CA. 14-15 April 1993. The northern goshawk: Ecology and management. Cooper Ornithological Society. Camarillo, CA. Studies in Avian Biology. 16:3-11.

Kennedy, P.L. 1988a. [Unpublished] The nesting ecology of Cooper's hawks and northern goshawks in the Jemez mountains, NM: A summary of results, 1984-1986. Report Contract 516.6-74-15. New Mexico Dept. of Game and Fish. 37 pp.

Kennedy, P. L. 1988b. [Preliminary data] Habitat Characteristics of Cooper's Hawks and Northern Goshawks Nesting in New Mexico. In: R.L. Glinski, B.G. Pendleton, M.B. Moss, M.N. LeFranc Jr., B.A. Millsap, and S.W. Hoffman [eds.] Proceedings of the southwest raptor management symposium and workshop, 21-24 May 1986. Univ. of Arizona, Tucson. National Wildlife Federation, Washington, DC. National Wildlife Federation Scientific and Technical Series No. 11. 218-227 pp.

Kennedy, P.L. 1989. The nesting ecology of Cooper's hawks and northern goshawks in the Jemez Mountains, NM: A summary of results, 1984-1988. Report P.O. #43-8379-8-346. USDA, Forest Service. Santa Fe National Forest, NM. 59 pp.

Kennedy, P. L. 1991. Reproductive strategies of northern goshawks and Cooper's hawks during brood-rearing in north-central New Mexico. Utah State University. Logan, Utah. Ph.D. Dissertation. 234 pp.

Kennedy, P.L. 1991. The diet of northern goshawks and Cooper's hawks during the nesting season in north-central New Mexico. Journal of Raptor Research. 25: 156. Abstract.

Kennedy, P.L. 1997. The northern goshawk (*Accipiter gentilis atricapillus*): Is there evidence of a population decline? Journal of Raptor Research. 31: 95-106.

Kennedy, P.L. and D.W. Stahlecker. 1991. Broadcast calls of the northern goshawk: their effectiveness and use in inventory and long-term monitoring programs. PO # 43-8371-0-0583, USDA Forest Service, Southwestern Region. Albuquerque, NM. 25 pp.

Kennedy, P.L. and D.W. Stahlecker. 1993. Responsiveness of nesting northern goshawks to taped broadcasts of three conspecific calls. Journal of Wildlife Management. 57(2): 249-257.

Kennedy, P.L. et al. 1994. 1994 Accipiter inventory and territorial status report. Santa Fe National Forest, NM.

Kennedy, P.L. et al. 1994. Post-fledging areas in northern goshawk home ranges. Studies in

Avian Biology. 16: 57-82.

Kenward, R.E. 1974. Mortality and fate of trained birds of prey. J. Wildlife Management. 38: 751-756.

Kenward, R.E. 1977a. Hawks, doves and phesants: selection in goshawk attacks. 1977, November 11. Raptor Research Foundation Annual Meeting, 14th. Tempe, AZ.

Kenward, R.E. 1977b. Predation on released pheasants (*Phasianus colchicus*) by goshawks (*Accipiter gentilis*) in central Sweden. Viltrevy. 10: 79-112.

Kenward, R.E. 1978a. Hawks and doves: factors affecting success and selection in goshawk attacks on wood pigeons. Journal of Animal Ecology. 47: 449-460.

Kenward, R.E. 1978b. The influence of human and goshawk *Accipiter gentilis* activity on Woodpigeons *Columbia palambus* at brassica feeding sites. Annals of Applied Biology. 89: 277-286.

Kenward, R.E. 1979a. The numbers of birds of prey obtained and possessed by falconers in the United Kingdom. Falconer. 7: 158-163.

Kenward, R.E. 1979b. Winter predation by goshawks in lowland Britain. British Birds. 72: 64-73.

Kenward, R.E. 1982. Goshawk hunting behavior, and range size as a function of food and habitat availability. Journal of Animal Ecology. 51: 69-80.

Kenward, R.E. 1996. Goshawk adaptation to deforestation: Does Europe differ from North America? In: D.M. Bird, D.E. Varland and J.J. Negro [eds.] Raptors in human landscapes. Raptors Research Foundation. Academic Press, Inc. San Diego, California. 233-243 pp.

Kenward, R.E. 1997. Inferring sustainable yields for raptor populations. Journal of Raptor Research. 31: 295-296.

Kenward, R.E., Marcstrom, V. and M. Karlbom. 1993a. Post-nesting behavior in goshawks, *Accipiter gentilis*: I. The causes of dispersal. Animal Behavior. 46: 365-370.

Kenward, R.E., Marcstrom, V. and M. Karlbom. 1993b. Post-nesting behavior in goshawks, *Accipiter gentilis*: II. Sex differences in sociality and nest -switching. Animal Behavior. 46: 371-378.

Kenward, R.E., Marquiss, M., and I. Newton. 1981. What happens to goshawks trained for

falconry. Journal of Wildlife Management. 145: 803-806.

Kenward, R.E., and P. Widen. 1989. Do goshawks *Accipiter gentilis* need forests? Some conservation lessons from radio tracking. In: Meyburg, B.U., and R.D. Chencellor, [eds.]. Raptors in the modern world. World working group on birds of prey. London, United Kingdom. 561-567 pp.

Keymer, I.F. 1972. Diseases of birds of prey. Vet. Rec. 90: 579-594.

Kiff and Paulson. 1997. Northern Goshawk Breeding Records from San Diego County, California. Western Birds. 28: 113-114.

Kimmel, J. T. and R. H. Yahner. 1993. Landscape analysis of northern goshawk habitat in two forest regions of Pennsylvania. J. Raptor Research. 27: 75. Abstract.

Kostrzewa, R. and A. Kostrzewa. 1991. Winter weather, spring and summer density, and subsequent breeding success of Eurasian kestrels, common buzzards, and northern goshawks. The Auk. 108: 342-347.

Laacke and Flores. [unpublished] A GIS model to predict suitable goshawk habitat in landscape level analysis. 12 pp.

Laudenslayer, W.F., Jr., Darr, H.H. and S. Smith. 1989. Historical effects of forest management practices on eastside pine communities in northeastern California. In: Multi-resource Management of Ponderosa Pine Forests. Tecle, A., Covington, W. W. and R. H. Hamre, [Technical Coordinators.] USDA Forest Service, Gen. Tech. Rep. RM-185, Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO. 26-34 pp.

Lebreton, J.D. et al. 1992. Modeling survival and testing biological hypotheses using marked animals: a unified approach with case studies. Ecol. Monogr. 62: 67-118.

Lee, J.A. 1981. Habituation to human disturbance in nesting accipiters. Journal of Raptor Research. 15: 48-52.

Lentz, J.E. 1993. Breeding Birds of Four Isolated Mountains in Southern California. Western Birds. 24: 201-234. (18 pp. - partial)

Leslie, D. G. [In prep.] Population ecology of the northern goshawk. In Northern Goshawk: technical assessment of status, ecology and management. R. T. Reynolds and R. H. Hamre, [Technical editors.] USDA Forest Service, Rocky Mountain Research Station. Gen. Tech. Rep. 21 pp.

Lettman, G. J. 1988. Assessment of Oregon's forest. Oregon Dept. of Forestry. 263 pp.

Linden, H. and M. Wikman. 1981. Brood size of the goshawk in relation to tetranoid densities. Suomen Riista. 27: 63-69.

Linden, H. and M. Wikman. 1983. Goshawk predation on tetraonids: availability of prey and diet of the predator in the breeding season. Journal of Animal Ecology. 52: 953-968.

Lucas, P. and R.J. Oakleaf. 1975. Population surveys, species distribution, and key habitats of selected nongame species. Federal Aid Wildlife Restoration Project W-53-R, Study Jobs 1 and 2. Nevada Dept. of Fish and Game.

Luckett, B. 1978. Characteristics of goshawk nesting sites in Arizona ponderosa pine forests. Appendix III. In: Arizona Game and Fish Dept., Wildlife Surveys and Investigations (Nongame). Spec. Perf. Report, Project W-53-R-28. Phoenix, AZ. 10 pp.

Luckett, W.E. and Todd 1982. Special report on raptor investigations, Project W-53-R-32, Arizona Game and Fish Dept. Phoenix, AZ. 63 pp.

Lumeij, J.T., Dorrestein, G.M. and J.W.E. Stam. 1981. Observations on tuberculosis in raptors. In: Recent advances in the study of raptor diseases: Proceedings of the International Symposium on Diseases of Birds of Prey (Cooper, J.E. and A.G. Greenwood, [eds.]) Chiron Publ. West Yorkshire, England. 137-141 pp.

Lutch, D. 1996. Tonto Rim northern goshawk inventory. Payson and Pleasant Valley Ranger Districts. Final Report. Heritage Grants I93023 and I93024. Arizona Game and Fish Dept. Phoenix, AZ. 20 pp.

Luttich, S.N., Keith, L.B. and J. D. Stephenson . 1971. Population dynamics of the red-tailed hawk (*Buteo jamaicensis*) at Rochester, Alberta. The Auk. 88: 73-87.

Luttich, S.N. et al. 1970. Ecology of red-tailed hawk predation in Alberta. Ecology. 51: 190-203.

Maguire, L. 1992. Population viability analysis of Northern goshawks (*Accipiter gentilis*) on the North Kaibab Ranger District, Arizona. Contract No. G10076-A. Report to Arizona Game and Fish Dept. 38 pp.

Maguire, L. and D. Call. 1993. Population viability analysis of northern goshawks (*Accipiter gentilis*) on the North Kaibab Ranger District, Arizona. Final Report. Contract No. G10076-A, Arizona Game and Fish Dept. Phoenix, AZ. (1 p. - partial)

Maj, M. 1996. Draft summary of goshawk information from the Forest Service Northern Region. 32 pp.

Mannan, R.W. and E.C. Meslow. 1984. "Bird populations and vegetation characteristics in managed and old-growth forests, Northeastern Oregon." J. Wildlife Management. 48: 1219-1238.

Marcstrom, V. and R. Kenward. 1981. Sexual and seasonal variation in condition and survival of Swedish goshawks *Accipiter gentilis*. Ibis. 123: 311-327.

Marquiss, M. 1981. The goshawk in Britain-its provenance and current status. In: R.E. Kenward and I.M. Kindsay, [eds.] Understanding the goshawk. International Association of Falconry and Conservation of Birds of Prey. Oxford, United Kingdom. 43-57 pp.

Marquiss, M. and I. Newton. 1982. The goshawk in Britain. British Birds. 75: 243-260.

Marshall D.B. 1992. Status of the northern goshawk in Oregon and Washington. Audubon Society of Portland. Portland, Oregon. 38 pp.

Maser, C., Trappe, J.M. and R.A. Nussbaum. 1978. Fungal-small mammal interrelationships with emphasis on Oregon coniferous forests. Ecology. 59: 799-809. 9 pp.

Mayfield, H. 1961. Nesting success calculated from exposure. Wilson Bulletin. 73: 255-261.

McAdoo, J. K., and J. C. Bokich. 1991. Goshawk nest site attributes in northern Nevada J. Raptor Research. 25: 157-158. Abstract.

McCallum D.A. 1994. Methods and terminology used with studies of habitat associations. In: Hayward, G.D. and J. Verner, [technical editors.] Flammulated, boreal and great gray owls in the United States: a technical conservation assessment. USDA Forest Service, Rocky Mtn. For. and Range Exp. Station. Gen. Tech. Rep. RM 253. Fort Collins, CO. 5-8 pp.

McCarthy, C. 1986. Goshawk progress report/proposal for nesting habitat analysis on the Inyo National Forest. Draft Report. USDA Forest Service, Inyo National Forest. Bishop, CA.

McCoy, R. 1998. Table containing preliminary information from thesis. Unpublished data on goshawk prey species and energetics. 2 pp.

McGinley, M.A. 1984. The adaptive value of male biased sex ratios among stressed animals. Amer. Natur. 124: 597-599. (2 pp. - partial)

McGowan, J. D. 1975a. Distribution, density and productivity of goshawks in interior Alaska. Federal Aid Wildlife Restoration Project Report W-17-4, W17-5, W-17-6, Job 10.6A. Alaska Dept. of Fish and Game. 57 pp.

McGowan, J.D. 1975b. Nesting habits and reproductive success of goshawks in interior Alaska. Raptor Research. 3: 147-152.

McGrath, M.T. 1997. Northern Goshawk Habitat Analysis in Managed Forest Landscapes, Oregon State University. M.S. Thesis. 142 pp.

McGuinn-Robbins, D.K. and L.Z. Ward. 1992. Goshawk reproductive survey on the Williams, Chalendar and Tusayan Ranger Districts, Kaibab National Forest: 1992. Final Report. Nongame and Endangered Wildlife Program Tech. Report, Arizona Game and Fish Dept. Phoenix, AZ. 22 pp.

McInvaille, M.A. and L.B. Keith. 1974. Predator-prey relations and breeding biology of the great horned owl and red-tailed hawk in central Alberta. Canadian Field Naturalist. 88: 1-20.

Mendall, H.L. 1944. Food of hawks and owls in Maine. Journal of Wildlife Management. 8: 198-208.

Meng, H. 1959. Food habits of nesting Cooper's hawks and goshawks in New York and Pennsylvania. Wilson Bulletin. 71: 169-174.

Miller, H.W. and D.H. Johnson. 1978. Interpreting the results of nesting studies. Journal of Wildlife Management. 42: 471-476.

Modoc National Forest. 1991. Final Environmental Impact Statement. Land and Resource Management Plan. Appendices. USDA Forest Service. Pacific Southwest Region. 3 Vol. plus maps. Land and Resource Management Plan, 324 pp. Appendices, 551 pp. EIS, 435 pp.

Moody, R. et al. 1992. Fire and forest health. USDA Forest Service, Southwestern Region. Albuquerque, NM. 41 pp.

Moore, K.R. and C.J. Henny. 1983. Nest site characteristics of three coexisting accipiter hawks in northeastern Oregon. J. Raptor Research. 17: 65-76.

Moors, A. 1996. San Carlos goshawk inventory project. Final Report. Heritage Grant I94008, Arizona Game and Fish Dept. Phoenix, AZ. 15 pp.

Mosher, J.A. 1997. Falconry harvest in the United States. J. Raptor Research. 31: 294-295. 6 pp.

Mueller, H.C. and D.D. Berger. 1967. Some observations and comments on the periodic invasions of goshawks. The Auk. 84: 183-191.

Mueller, H.C. and D.D. Berger. 1968. Sex ratios and measurements of migrant goshawks. The Auk. 85: 431-436.

Mueller, H.S., Berger, D.D. and G. Allez. 1977. The periodic invasions of goshawks. The Auk. 94: 652-663.

Nagy, A.C. 1975. Population trend indices based on 40 years of autumn counts at Hawk Mountain. In: Proceedings of the ICBP world conference on birds of prey. Vienna. 243-253. (6 pp. - partial)

Nappe, L., and D.A. Klebenow. 1973. Rare and endangered birds of Nevada. Foresta Inst. For Ocean and Mountain Studies. Carson City, NV. 26 pp.

Newton, I. 1979. Population ecology of raptors. Buteo Books. Vermillion, SD. 399 pp. (1 pp. - partial)

Newton, I. 1986. The Sparrowhawk. T and A. D. Poyser, Ltd. Staffordshire, United Kingdom. 396 pp. (1 pp. - partial)

Newton, I. 1991. Population limitation in birds: a comparative approach. In: C.M. Perrins, Peberton, J.D. and G.M. Hirons [eds.] Bird population studies. Oxford University Press. Oxford, United Kingdom. 683 pp. (19 pp. - partial)

Noon, R.B. and C.M. Biles. 1993. Mathematical demography of spotted owls in the Pacific northwest. J. Wildlife Manage. 54: 18-27.

Oakleaf, R.J. 1975. Population surveys, species distribution and key habitats of selected nongame species. Federal Aid in Wildlife Restoration Project W-53-R. Nevada Dept. of Fish and Game. 6-11 pp.

O'Brien, R.A. 1996. Forest resources of northern Utah ecoregions. U.S. Forest Service Resource Bull. INT-RB-87. 34 pp.

Olendorff, R. R., Motroni, R. S. and M. W. Call. 1980. Raptor management, the state of the art in 1980. USDI, Bureau of Land Management. Tech. Note 345. 56 pp.

Opdam, P. et al. 1977. Feeding ecology of a population of goshawks (*Accipiter gentilis*). Journal fuer Ornithologic. 118: 35-51.

Oregon Dept. of Forestry. 1995. Elliott State Forest habitat conservation plan. Salem, Oregon. 269 pp.

Oregon Dept. of Forestry. 1998. Draft western Oregon habitat conservation plan. Salem, Oregon. 426 pp.

Oregon Dept. of Forestry. 1998. Draft northwest Oregon state forests management plan. Salem, Oregon. 570 pp.

Orians, G. and F. Kuhlman. 1956. The red-tailed hawk and great horned owl population in Wisconsin. The Condor. 58: 371-385.

Palmer, R.S. 1988. Handbook of North American birds. Diurnal Raptors (Part 1). Yale University Press. New Haven, CT. 433 pp.

Paragi, T.G. and G.M. Wholecheese. 1994. Marten, *Martes americana*, predation on a northern goshawk, *Accipiter gentilis*. Canadian Field-Nat. 108: 81-82.

Patla, S. 1990. Northern goshawk monitoring report no. 2. 1989. On file with: USDA, Targhee National Forest, P.O. Box 208, St. Anthony, ID 83445. 58 pp.

Patla, S. 1991. Northern goshawk monitoring project - Report #2. Purchase Order No. 43-02S2-0-0184. Targhee National Forest. St. Anthony, Idaho. 52 pp.

Phillips, A.F., Marshall, J. and G. Monson. 1964. The birds of Arizona. Univ. of Arizona Press. Tucson, AZ. 9 pp.

Postupalsky, S. 1974. Raptor reproductive success. Some problems with methods, criteria and terminology. Raptor Res. News. 2: 21-31. (6 pp. - partial)

Powell, D.S. et al. 1992. Forest Resources of the United States, 1992. USDA, Forest Service. Gen. Tech. Rep. RM-234. Fort Collins, CO. 132 pp.

Quigley, T.M. et al. [Tech. eds.] 1996. Integrated scientific assessment for ecosystem management in the Interior Columbia Basin and portions of the Klamath and Great Basins. Gen. Tech. Rep. PNW-GTR-382. USDA, Forest Service, Pacific Northwest Research Station. Portland, OR. 303 pp.

Quigley, T.M. and S.J. Arbelbide, [tech eds.] 1997. An assessment of ecosystem components in the Interior Columbia Basin and portions of the Klamath and Great Basins. Gen. Tech. Rpt. PNW-GTR-405. USDA, Forest Service, Pacific Northwest Research Station. Portland, OR. 4 Vol. 2,066 pp.

Redig, P.T., Fuller, M.R. and D.L. Evanss. 1980. Prevalence of *Aspergillus fumigatus* in free-living goshawks. J. Wildlife Dis. 16: 169-174.

Reiser, H. 1991. Status of the northern goshawk (*Accipiter gentilis*) in the Southwest Region. USDA Forest Service. Albuquerque, NM. 11 pp.

Reynolds, R.T. 1972. Sexual dimorphism in accipiter hawk: a new hypothesis. The Condor. 74: 191-197.

Reynolds, R.T. 1975. Distribution, density, and productivity of three species of accipiter hawks in Oregon. Oregon State University. Corvallis, OR. MS. Thesis. 39 pp.

Reynolds, R.T. 1978. Food and habitat partitioning in two groups of coexisting Accipiter. Oregon State University. Ph. D. Dissertation. 116 pp.

Reynolds, R.T. and H.M. Wight. 1978. Distribution, density, and productivity of accipiter hawks breeding in Oregon. Wilson Bulletin. 90: 182-196.

Reynolds, R. T. 1979. Distribution of nest sites, patterns of use and site requirements of Accipiter in western conifer forests. Presented to the Wildlife Management Workshop, U.S. Forest Service, Region 5. Long Beach, CA. 4 pp.

Reynolds, R.T., Meslow, E.C. and H.M. Wight. 1982. Nesting habitat of coexisting accipiter in Oregon. Journal of Wildlife Management. 46: 124-138. (8 pp. - partial)

Reynolds, R.T. 1983. Management of western coniferous forest habitat for nesting *Accipiter* hawks. Gen. Tech. Rep. RM-102. USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO. 7 pp.

Reynolds, R.T. and E.C. Meslow. 1984. Partitioning of food and niche characteristics of coexisting accipiter during breeding. The Auk. 101: 761-779.

Reynolds, R.T. 1989. Accipiters.. In: B.G. Pendleton [ed.]. Proceedings of the western raptor management symposium and workshop. National Wildlife Federation, Washington, DC. 92-101 pp.

Reynolds, R.T., Joy, S.M. and T.B. Mears. 1990. Predation and observation records of boreal owls in Colorado. Colorado Field Ornithologist. 24: 99-101.

Reynolds, R.T. et al. 1992. Threatened, endangered, and sensitive species: northern goshawk. In: The multiple use of public lands. Proceed. Commission on the Arizona Environ., 5 June 1991. Flagstaff, AZ. 49-57 pp. (5 pp. - partial)

Reynolds, R.T. et al. 1992. Management recommendations for the northern goshawk in the southwestern United States. USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station. Gen. Tech. Rep. RM-217. Fort Collins, CO. 90 pp.

Reynolds, R.T. and B.D. Linkhart. 1992. Flammulated owls in ponderosa pine; evidence of preference for old growth. In: Workshop on old-growth forests in the Southwest and Rocky Mountain region. 1992 March 3-5. Portal, AZ. 166-169.

Reynolds, R.T., Joy, S.M. and D.G. Leslie. 1993. Northern goshawk broadcast survey results on the North Kaibab Plateau: annual report 1992. Report to the North Kaibab Ranger District, Kaibab National Forest. Arizona.

Reynolds, R.T., Joy, S.M. and D.G. Leslie. 1994. Nest productivity, fidelity, and spacing of northern goshawks in northern Arizona. Studies in Avian Biology. 16: 106-113.

Reynolds, R.T. and S.M. Joy. 1998. Distribution, territory occupancy, dispersal and demography of northern goshawks on the Kaiba Plateau, Arizona. Final Report, Heritage Project No. I94045. Arizona Game and Fish Dept. Phoenix, Arizona. 75 pp.

Reynolds, R.T., Graham, R.T. and D.A. Boyce. [In Prep.] A procedure for developing northern goshawk habitat conservation strategies. In: Northern goshawk: technical assessment of status, ecology and management. Richard T, Reynolds and Robert Hamre, [technical eds.] USDA Forest Service, Rocky Mountain Research Station, Gen. Tech. Rep. 61 pp.

Rissler, L.J. 1995. Habitat structure analyses of northern goshawk, *Accipiter gentilis atricapillus,* and northern spotted owl, *Strix occidentalis caurina*, nesting stands in the eastern Cascades. Utah State University. MS. Thesis. 86 pp.

Rohner, C. and F.I. Doyle. 1992. Food-stressed great horned owl kills adult goshawk: exceptional observation or community process? Journal of Raptor Research. 26: 261-263.

Rosenberg, D.K, and R.G. Anthony. 1993. Differences in Townsend's chipmunk populations between second- and old-growth forests in western Oregon. J. Wildlife Management. 57(2): 365-373.

Russo, J.R. 1976. Nongame investigations, Arizona Game and Fish Dept., Spec. Perf. Report, Project W-53-R-26. Phoenix, AZ. 45 pp.

Russo. 1977. Nongame investigations, Arizona Game and Fish Dept., Spec. Perf. Report, Project W-53-R-27. Phoenix, AZ. 47 pp.

Saab, V.A. and T.D. Rich. 1997. Large-scale conservation assessment for Neotropical migratory land birds in the interior Columbia River basin. Gen. Tech. Rep. PNW-GTR-399. USDA, Forest Service, Pacific Northwest Research Station. Portland, OR. 56 pp.

Saunders, L.B. 1982. Essential nesting habitat of the goshawk (*Accipiter gentilis*) on the Shasta-

Trinity National Forest, McCloud District. California State University. Chico, CA. M.S. Thesis. 55 pp.

Schnell, J.H. 1958. Nesting behavior and food habits of goshawks in the Sierra Nevada of California. The Condor. 60: 377-403.

Schoener, T.W. 1968. Sizes of feeding territories among birds. Ecology. 49: 123-149.

Schommer, T. and G. Silovsky. 1994. Goshawk monitoring, management, and research in the Pacific Northwest Region. USDA Forest Service. Portland, OR. 72 pp.

Schroder, H.D. 1981. Diseases of birds of prey with special reference to infectious diseases. In: Recent advances in the study of raptor diseases: Proceedings of the International Symposium on Diseases of Birds of Prey (Cooper, J.E. and A.G. Greenwood, [eds.]). Chiron Publ. West Yorkshire, England. 37 - 40 pp.

Schubert, G.H. 1974. Silviculture of the southwestern ponderosa pine: the status of our knowledge. Res. Pap. RM-123. USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO. 71 pp.

Sherrod, S.K. 1978. Diets of North American falconiformes. J. Raptor Research. 12(3/4): 49-121.

Shipman, M.S., J.V. Younk and M.J. Bechard. 1997. Ecology of northern goshawks (Accipiter gentilis) in the shrubsteppe habitat of northeastern Nevada: a six-year summary. Feb. 27-28, 1997. Spokane, WA. [Paper presented at the Silviculture/Goshawk Workshop] 13 pp.

Shuster, W.C. 1976. Northern goshawk nesting densities in montane Colorado. West. Birds. 7: 105-110.

Shuster, W.C. 1980. Northern goshawk nest site requirements in the Colorado Rockies. Western Birds. 11: 89-96.

Siders, M.S. and P.L. Kennedy. 1994. Nesting habitat of Accipiter hawks: Is body size a consistent predictor of nest habitat characteristics? (Proceedings of a symposium of the Cooper Ornithological Society, Sacramento, CA 14-15 April, 1993. The northern goshawk: Ecology and management, Cooper Ornithological Society, Camarillo, CA). Studies in Avian Biology. 16: 92-96.

Siders, M.S. and P.L. Kennedy. 1996. Forest structural characteristics of accipiter nesting habitat: is there an allometric relationship? The Condor. 98: 123-132.

Silk, J.B. 1983. Local resource competition and facultative adjustment of sex ratios in relation to competitive abilities. Amer. Natur. 121: 56-66. (6 pp. - partial)

Silver, R.D. et al. 1991. Letter to Dept. of the Interior, petitioning to list the northern goshawk (*Accipiter gentilis*) in Utah, Colorado, New Mexico and Arizona, under the Endangered Species Act. Maricopa Audubon Society. Phoenix, Arizona. 61 pp.

Smith, C.C. 1968. The adaptive nature and social organization in the genus of tree squirrels Tamiasciurus. Ecol. Monogr. 38: 31-63.

Smith, D.W. and J.R. Murphy. 1973. Breeding ecology of raptors in the eastern Great Basin of Utah. Brigham Young University Science Bulletin Biological Series. 18: 1-76.

Smith, E.L. et al. 1991. Investigation of goshawk reproduction relative to timber harvest and environmental patterns, on the North Kaibab. 19 pp.

Smith, J.P. and S.W. Hoffman. 1997. Population trends of northern goshawks assessed from migratory counts at four sites in the western United States. HawkWatch International. Salt Lake City, UT. 23 pp.

Smith, M.R., P.W. Mattocks, Jr., and K.M. Cassidy. 1997. Breeding Birds of Washington State. Volume 4. In: Washington Gap Analysis - Final Report (K.M. Cassidy, C.E. Grue, M.R. Smith, and K. M. Dvornich, [eds.]). Seattle Audubon Society Publications in Zoology No. 1. Seattle, WA. 538 pp. (3 pp. - partial)

Snyder, H.A. 1995. Apache goshawk conservation biology in southeast Arizona. Final Report. Heritage Grant I92065. Arizona Game and Fish Dept. Phoenix, AZ. 37 pp.

Snyder, N.F.R. and H.A. Snyder. 1991. Birds of prey. Natural history and conservation of North American raptors. First ed. Voyageur Press, Inc. Stillwater, MN. 224 pp.

Snyder, N.F.R. and H.A. Snyder. 1998. Northern goshawk. In: R.L. Glinski, [ed.] The raptors of Arizona. Univ. of Arizona Press, Tucson and Arizona Game and Fish Dept. Phoenix, AZ. 68-72 pp.

Snyder, N.F.R. et al. 1973. Organochlorides, heavy metals, and the biology of North American accipiters. Bio Science. 23: 300-305.

Snyder, N.F.R. and J.W. Wiley. 1976. Sexual size dimorphism in hawks and owls of North America. Ornithological Monographs. 20: 1-96.

Sollien, A. 1979. Bestandsutviklingen Hos Hønsehauk *Accipiter gentilis*, i norge de site 100 r. [The goshawk population in Norway over the past 100 years]. Vår Fuglefauna. 2: 95-106.

Southern, H.N. 1970. The natural control of a population of tawny owls (*Strix aluco*). Journal of Zoology. London. 162: 197-285.

Speiser, R. 1992. Notes on the natural history of the northern goshawk. Kingbird. 42: 133-137

Speiser, R. and T. Bosakowski. 1984. History, status, and future management of goshawk nesting in New Jersey. Records of New Jersey Birds. 10: 29-33.

Speiser, R. and T. Bosakowski. 1987. Nest site selection by northern goshawks in northern New Jersey and southeast New York. The Condor. 89: 387-394. New Jersey. Records of New Jersey Birds. 10: 29-33.

Speiser, R. and T. Bosakowski. 1989. Nest trees selected by northern goshawks along the New York-New Jersey border. The Kingbird. 39: 132-141.

Spencer, J.S., Jr. 1966. Arizona's Forests. Resource Bull. INT-6. USDA Forest Service, Intermountain Research Station. Ogden, UT. 56 pp.

Squires, J. [in prep]. Ecology of the northern goshawk. In Northern Goshawk: technical assessment of status, ecology and management. R. T. Reynolds and R. H. Hamre, [tech eds.] USDA Forest Service, Rocky Mountain Research Station. Gen. Technical Report. 48 pp.

Squires, J. 1993. Excerpted from U.S. Forest Service notes of 1993 Forest Service Meeting on Northern Goshawk in Jackson, Wyoming.

Squires, J.R. and R.T. Reynolds. 1997. Northern goshawk Accipter gentilis. In: Poole, A. and F. Gill [eds.] Vol. 298 . The Birds of North America. The Academy of Natural Sciences, The American Ornithologists' Union, Washington D.C. 1-32 pp.

Squires, J.R. and L.F. Ruggiero. 1995. Winter movements of adult northern goshawks that nested in southcentral Wyoming. Journal of Raptor Research. 29: 5-9.

Squires, J. R., and L. F. Ruggiero. 1996. Nest-site preference of northern goshawks in southcentral Wyoming. J. Wildlife Management. 60(1): 170-177.

States, J. 1985. Hypogeous, mycorrhizal fungi associated with ponderosa pine: sporocarp phenology. In: Molina, Randy, ed. Proceedings of the 6th North American conference on mycorrhizae, 1984 June 25-29, Bend, OR. Forest Research Laboratory. Corvallis, OR. 271-272. 1 pp.

States, J.S. et al. 1988. Foraging patterns of tassel-eared squirrels in selected ponderosa pine stands. In: Symposium proceedings, management of amphibians, reptiles, and small

mammals in North America. Gen. Tech. Rep. RM-166. U.S. Dept. of Ariculture, Forest Service. Fort Collins, CO. 425-431 pp.

Steenhof, K. and M. N. Kochert. 1982. An evaluation of techniques used to estimate raptor nesting success. J. Wildlife Manage. 46: 885-893.

Storer, R.W. 1966. Sexual dimorphism and food habits in three North American accipiters. The Auk. 83: 423-436.

Swem, T. and M. Adams. 1992. A northern goshawk nest in the tundra biome. J. Raptor Research. 26(2): 102.

Taverner, P.A. 1940. Variation in the American goshawk. The Condor. 42: 157-160.

Taylor, G.J. 1998. Environmental Assessment for Mount Trumbull Resource Conservation Area. Ponderosa pine ecosystem restoration. EA-AZ-010-98-06. USDI Bureau of Land Management, AZ Strip Field Office. St. George, UT. 150 pp.

Thomas, S.M. and J.P. Smith. 1997. Fall 1997 raptor migration study in the Grand Canyon of Arizona. HawkWatch International. Salt Lake City, UT. 74 pp.

Thrailkill, J.A.; Andrews, L.S. 1996. Presence of breeding northern goshawks in the Coast Range of Oregon. J. Raptor Research. 30: 248-249.

Tibbitts, T.J., Glinski, R.L. and J.C. Yarchin. 1988. 1988 goshawk nesting survey on the North Kaibab Ranger District, Kaibab National Forest, Arizona. Arizona Game and Fish Dept. Phoenix, AZ. 15 pp.

Tibbitts, T.J. and L.J. Zinn. 1989. 1989 goshawk nesting survey on the North Kaibab Ranger District, Kaibab National Forest, Arizona. Arizona Game and Fish Dept. Phoenix, AZ. 24 pp.

Titus, K. and M.R. Fuller. 1990. Recent trends in counts of migrant hawks from northeastern North America. J. Wildlife Management. 54: 463-470.

Titus, K. and J.A. Mosher. 1981. Nest-site habitat selected by woodland hawks in the central Appalachians. The Auk. 98: 270-281.

Titus, K., Flatten, C.J. and R. E. Lowell. 1994. Northern goshawk ecology and habitat relationships on the Tongass National Forest. P.O./CA/Contract Number 43-0109-3-0272. Prepared for USDA Forest Service, Alaska Region, Tongass National Forest by Alaska Dept. of Fish and Game. 136 pp.

Todd, R.L. 1978. Nongame investigations, Arizona Game and Fish Dept., Spec. Perf. Report, Project W-53-R-28. Phoenix, AZ. 42 pp.

Tornberg, R. and S. Sulkava. 1990. Kanalintujen kannanvaihtelun vaikutus kanahaukan ravinnonkäyttöön ja pesimistulokseen Oulun alueela vuosina 1965-88 [The effect of fluctuations in tetraonid populations on the nutrition and breeding success of the goshawk in Oulu District in 1965-88]. Suomen Riista. 36: 53-61.

Tuchmann, E. T. et al. 1996. The Northwest Forest Plan: A report to the President and Congress. USDA Forest Service PNW. Portland, OR. 253 pp.

Turner. 1886. Contrib. Nat. Hist. Alaska Arctic Ser. Pub. No. 2, issued in connection with Signal Service, U.S. Army. Washington, DC.

Uphoff, K.C. 1990. Habitat use and reproductive ecology of red squirrels (*Tamiasciurus hudsonicus*) in central Arizona. Arizona State University. Tempe, AZ. M.S. Thesis.

USDA Forest Service. 1991. Threatened, endangered and sensitive plants and animals. Interim Directive No. R3 ID 2670-91-1. Albuquerque, NM. 15 pp.

USDA Forest Service. 1992. The California spotted owl: a technical assessment of its current status. Gen. Tech. Rep. PSW-GTR-133. 285 pp.

USDA Forest Service. 1994. Forest health restoration initiative. Southwestern Region. Albuquerque, NM. 19 pp.

USDA Forest Service. 1994. Goshawk monitoring, management, and research in the Pacific Northwest Region. 1994 Status Report. 72 pp.

USDA Forest Service. 1995. Final environmental impact statement for amendment of forest plans. Southwestern Region. Albuquerque, NM. 262 pp.

USDA Forest Service. 1996. Integrated scientific assessment for ecosystem management in the Interior Columbia Basin and portions of the Klamath and Great Basins. Gen. Tech. Rep. PNW-QTR-382.

USDA Forest Service. 1996. Record of decision for amendment of forest plans. Arizona and New Mexico. Southwestern Region. Albuquerque, NM. 96 pp.

USDA Forest Service. 1997. Properly functioning condition: rapid assessment process. USDA Forest Service, Region 4 draft report. 1998. [*FIA Data Reference*]. 73 pp.

USDA Forest Service and USDI Bureau of Land Management. 1994a. Final supplemental

environmental impact statement on management for late-successional and old-growth forest related species within the range of the northern spotted owl. Vol. I. 489 pp.

USDA Forest Service and USDI Bureau of Land Management. 1994b. Record of decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl. Standards and guidelines for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. 218 pp.

USDA Forest Service and USDI Bureau of Land Management. 1997. As assessment of ecosystem components in the Interior Columbia Basin and the portions of the Klamath and Great Basin. Gen. Tech. Rep.. PNW-GTR-405. 4 Vol. 2,066 pp.

USDA Forest Service and USDI Bureau of Land Management. 1997. Eastside draft environmental impact statement. 2 Vol. 1189 pp.

USDI Bureau of Land Management. 1993. Riparian Area Management: process for assessing proper functioning condition. Tech. Reference No. 1737-9. Denver, Colorado. 52 pp.

USDI Fish and Wildlife Service. 1992. Final draft recovery plan for the northern spotted owl. USDI, Fish and Wildlife Service. Portland, OR. 2 Vol. Vol. 1, 330 pp. Vol. 2, 489 pp.

USDI Fish and Wildlife Service. 1988. Final environmental assessment. Falconry and raptor propagation regulations. Washington, DC.

USDI Fish and Wildlife Service. 1995. Recovery plan for the Mexican spotted owl (*Strix occidentalis lucida*). Albuquerque, NM.

Van Hooser, D.D., O'Brien, R.A. and D.C. Collins. 1992. New Mexico's Forest Resources. Resource Bull. INT-79. USDA Forest Service, Intermountain Research Station. Ogden, UT. 116 pp.

Van Rossem, A.J. 1938. A Mexican race of the goshawk (*Accipiter gentilis*) [Linnaeus]. Proc. Biol. Soc. Wash. 51: 99.

Verner, J. et al. 1992. The California spotted owl: a technical assessment of its current status. USDA, Forest Service. Pacific Southwest Research Station. Gen. Tech. Rep. PSW-GTR-133.

Village, A. 1982. The home range and density of kestrels in relation to vole abundance. Journal of Animal Ecology. 51: 413-428.

Ward, J.M. and P.L. Kennedy. 1996. Effects of supplemental food on size and survival of juvenile northern goshawks. The Auk. 113: 200-208.

Ward, J. M. and P.L. Kennedy. 1994. Approaches to investigating food limitation hypotheses in raptor populations: an example using the northern goshawk. Studies in Avian Biology. 16: 114-118.

Ward, L.Z., Ward, D.K. and T.J. Tibbitts. 1992. Canopy density analysis at goshawk nesting territories on the North Kaibab Ranger District, Kaibab National Forest. Arizona Game and Fish Dept. Phoenix, Arizona. #43-8156-0-0487. Final report. 61 pp.

Washington Dept. of Natural Resources. 1996. Loomis State Forest Final Landscape Plan. Olympia, Washington. 125 pp.

Washington Dept. of Natural Resources. 1996. Lynx Habitat Management Plan for DNR Managed Lands. Olympia, Washington. 198 pp.

Washington Dept. of Natural Resources. 1997. Final habitat conservation plan. Olympia, Washington. 475 pp.

Watson, J.W.; Hays, D.W.; Pierce, D.J. 1998. In review. Efficacy of northern goshawk broadcast surveys in Washington state. 29 pp.

Wattel, J. 1973. Geographic differentiation in the genus *Accipiter*. Publication of the Nuttall Ornithologists Club. 13. 231 pp. (10 pp. - partial)

Westcott, P.W. 1964. Unusual feeding behavior of a goshawk. The Condor. 66: 163.

Whaley, A.S. and C.M. White. 1994. Trends in geographic variation of Cooper's hawk and northern goshawk: a multivariate analysis. Western Foundation of Vertebrate Zoology. 5: 161-209.

White, C., Lloyd, G.D. and G.L. Richards. 1965. Goshawk nesting in the upper Sonoran in Colorado and Utah. The Condor. 67: 269.

White, C.M. 1994. Population trends and current status of selected western raptors. Studies in Avian Biology. 15: 161-172.

White, G.C. and R. A. Garrott. 1990. Analysis of wildlife radio-tracking data. Academic Press. New York. 383 pp.

Whitfield, M.B., M.E. Maj, and P. Munholland. 1995. Inventory and monitoring of bald eagles and other raptorial birds of the Snake River, Idaho. USDI Bureau of Land Management

Tech. Bull. 95-12. 76 pp.

Whitfield, M.B., and M.E. Maj. 1998. Inventory and monitoring of bald eagles and other raptorial birds of the Snake River, Idaho. 1996-97 progress report. Bureau of Land Management. Tech Rep. 98-2. 59 pp.

Widen, P. 1984. Activity patterns and time-budget in the goshawk *Accipiter gentilis* in a boreal forest area in Sweden. Ornis Fennica. 61: 109-112.

Widen, P. 1985. Breeding and movements of goshawks in boreal forests in Sweden. Holarctic Ecology. 8: 273-279.

Widen, P. 1987. Goshawk predation during winter, spring and summer in a boreal forest area of Sweden. Holarctic Ecology. 10: 104-109.

Widén, P. 1989. The hunting habitats of goshawks *Accipiter gentilis* in boreal forests of central Sweden. Ibis. 131: 205-231.

Wikman, M. and V. Tarsa. 1980. Food habits of the goshawk during the breeding season in southwestern Finland 1969-77. Suomen Riista. 28: 86-96.

Wikman, M. and H. Linden. 1981. The influence of food supply on goshawk population size. In: Kenward, R.E. and I. M. Lindsay, [eds.] Understanding the goshawk. The International Association for Falconry and Conservation of Birds of Prey. Oxford, England. 105-113 pp.

Wisdom, M. J., Holthausen, R.S., Wales, B.K. and Others. [in prep]. Source habitats for terrestrial vertebrates of focus in the Interior Columbia Basin: broad-scale trends and management implications. USDA Forest Service Pacific Northwest Research Station. Portland, Oregon. 26 pp.

Wood, M. 1938. Food and measurements of goshawks. The Auk. 55: 123-124.

Woodbridge, B. 1988. The goshawk and forest fragmentation. Unpublished report. On file with: USDA Forest Service, Klamath National Forest, 1312 Fairland Road, Yreka, California 96097.

Woodbridge, Detrich, B.P. and P. H. Bloom. 1988. Territory fidelity and habitat use by nesting northern goshawks: implications for management. Unpublished report. USDA Forest Service, Klamath National Forest, Macdoel, CA 96058. 24 pp.

Woodbridge, B. and P.J. Detrich. 1994. Territory occupancy and habitat patch size of northern goshawks in the southern Cascades of California. In: Block, W.M., Morrison, M.L.;

Reiser, M.J., [eds.] The northern goshawk: ecology and management: Proceedings of a symposium of the Cooper Ornithological Society, 1993 April 14-15, Sacramento, California. Studies in Avian Biology. 16: 83-87.

Wootton, J.T. and D.A. Bell. 1992. A metapopulation model of the peregrine falcon in California: viability and management strategies. Ecol. Applications. 2: 307-321.

Younk, J.V. and M.J. Bechard. 1992. Effects of gold mining activity on northern goshawks breeding in Nevada's Independence and Bull Run mountains. Annual Report. Raptor Research Center. Boise, Idaho: Boise State University. 24 pp.

Younk, J.V. and M.J. Bechard. 1994. Breeding ecology of the northern goshawk in high elevation aspen forests of northern Nevada. Studies in Avian Biology. 16: 119-121.

Younk, J.V. 1996. Breeding ecology of the northern goshawk in relation to surface gold mining in naturally fragmented aspen forests of northern Nevada. Boise State University. Boise, ID. MS Thesis. 90 pp. (1 p. - partial)

Zachel, C.R. 1985. Food habits, hunting activity, and post-fledging behavior of northern gosahwks (*Accipiter gentilis*) in interior Alaska. University of Alaska. Fairbanks, AK. MS Thesis. 81 pp.

Zinn, L.J. and T.J. Tibbitts. 1990. Goshawk nesting survey-1990. North Kaibab Ranger District, Kaibab National Forest, Arizona. CCSA # 07-90-02, Nongame and Endangered Wildlife Program, Arizona Game and Fish Dept. Phoenix, AZ. 36 pp.

Zirrer, F. 1947. The goshawk. Passenger Pigeon. 9: 79-94. (8 pp. - partial)

•

Appendix A - Northern Goshawk Status Review
Silvicultural Prescriptions Reported in Forest Service Annual Reports,
and Their Effect on Goshawk Habitat

Background:

One source of information about trends in goshawk habitat in the Status Review Area is the Forest Service records of timber harvest (sample reports attached). The Review Team acquired these data from the six Forest Service Regions in the Review Area. We were not able to acquire consistent years of data for all Regions (Table A.1), but were able to acquire consistent Regional-level summary reporting for the years 1984 through 1997.

Table A.1 Years of Coverage for Timber Harvest Data Received for Forest Service Regions in Status Review Area

Region Reporting	Data Displayed	Years Covered
Region 1	By-Forest Regional Summary*	1946 through 1997 1984 through 1997
Region 2	By-Forest Regional Summary*	1987 through 1997 1984 through 1997
Region 3	By-Forest Regional Summary*	1990 through 1997 1984 through 1997
Region 4	By-Forest Regional Summary*	1988 through 1997 1984 through 1997
Region 5	By-Forest Regional Summary**	1986 through 1997 1984 through 1997
Region 6	By-Forest Regional Summary*	1988 through 1997 1984 through 1997

* The Regional Summary was generated by summarizing the 'By-Forest' data, when available, and supplementing it with National Summaries provided by the Forest Service Washington Office.

The value of this Forest Service data is that it provides the Review Team with a more consistent portrayal of timber harvest, from which we can assess changes in goshawk habitat through time (Figure A.1).

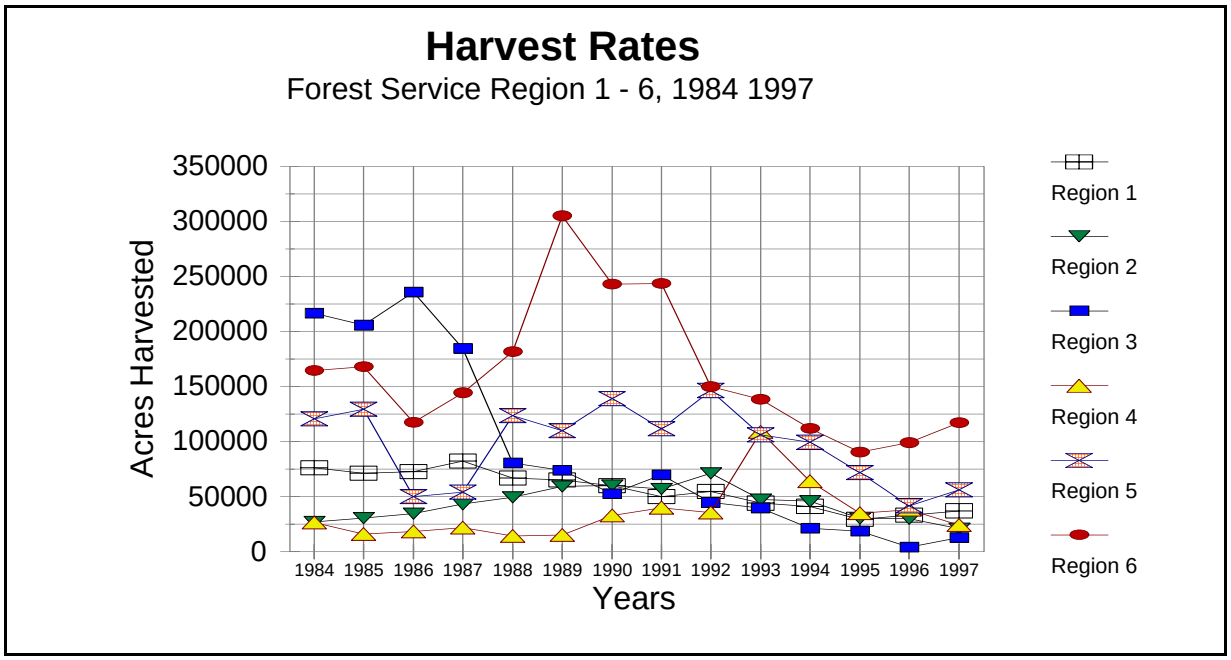


Figure A.1.

The prescription identified for a particular stand of trees is determined by the stand condition and the management objectives. In the case of the two or three-phase prescriptions of preparation cut, seed tree cut, removal cut, some Forest Service Silviculturists report a general impression that fewer stands are receiving the final phases of this treatment than would have been expected a decade ago. The explanation is that Forest staffs are identifying other resource benefits which were not considered when the original prescription was developed, and which could accrue if the final phases were not applied. For example, leaving the seed trees in place has the effect of creating a multi-storied stand much quicker and providing a greater diversity of habitat conditions for wildlife. In the area of the Northwest Forest Plan, this approach is expected on all acres in the reserve network where a seed tree cut or preparation cut had been applied prior to the acreage being transferred to reserve status.

The following section presents each silvicultural prescription in two parts. First, we closely paraphrase the definition of the prescription as defined by the Society of American Foresters (SAF, 1971). Next, we phrase our interpretation of the prescription and provide our general judgement of the effect on goshawk nest and foraging habitat. We conclude a broad discussion of harvest effects on goshawk habitats and our rationale for combining various the prescriptions

into two general categories - “Heavy” harvest effects and “Light” harvest effects.

Clear cutting

SAF definition - 1) strictly, the removal of the entire standing crop, 2) in practice, may refer to exploitation that leaves much unsaleable material standing.
Status Review Team’s Interpretation - removal of all, or nearly all, of the conifers from a site. Result is judged to remove goshawk nesting habitat because the majority of the conifer canopy in large trees will be absent from the site.

Preparatory cutting

SAF definition - Removing trees near the end of a rotation so as permanently to open the canopy and enlarge the crowns of seed bearers, with a view to improving conditions for seed production and natural regeneration before regeneration fellings are begun.
Status Review Team’s Interpretation - the first of a three-phase treatment; in this phase intermediate and suppressed trees are removed with the intention of improving the vigor of the remaining trees. This treatment is judged to not eliminate goshawk habitat because the majority of the conifer canopy is expected to be retained, providing the structure which goshawks can use for nesting and foraging. Though this phase would not remove goshawk habitat, the subsequent entries which would be expected will have that effect.

Seed cutting

SAF definition - Removing trees in a mature stand so as to effect permanent opening of its canopy (if there was no preparatory cutting to do this) and so provide conditions for securing regeneration from the seed of trees retained for that purpose; the first of the shelterwood cuttings under a shelterwood system.
Status Review Team’s Interpretation - the second of the three-phase treatment; in this phase the overall canopy of the stand is appreciably reduced to leave selected trees to serve as seed sources for a next generation of seedlings. This treatment is judged to eliminate goshawk habitat because the majority of the conifer canopy in large trees will be absent from the site, eliminating the structure which goshawks require for nesting.

Removal cutting

SAF definition - Removing trees between the seed cutting and the final cutting under a shelterwood system, so as gradually to reduce the shelter and admit more light to aid the regenerated crop and secure further recruitment.
Status Review Team’s Interpretation - the final phase of the three-phase treatment; the remaining large trees are removed from the stand, leaving the seedlings which have become established underneath. This treatment is judged to eliminate goshawk nesting habitat because the majority of the conifer canopy in large trees will be absent from the site, eliminating the structure which goshawks require for nesting. This prescription is applied to acres which have already been treated (see Seed Tree and Shelterwood discussions), and are judged to not provide sufficient tree canopy to support goshawk nesting conditions either before or after harvest. For the longer period of time of analysis for Region 1 (1950 through 1997) in the Assessment Area section,

these acres are not included in the analysis of harvest impacts. This decision avoids the inappropriate 'double-counting' of acres removed from goshawk nesting conditions**.** However, for the other analysis, which consistently looks at the 1988 through 1997 time period, these acres are included. This is because we feel this shorter time period is less likely to include two entries into the same acreage (i.e. less likely to double-count acres).

Selection cutting

SAF definition - The annual or periodic removal of trees (particularly the mature), individually or in small groups from an uneven-aged forest in order to realize the yield and establish a new crop of irregular constitution. The improvement of the forest is the primary consideration. See also SELECTION SYSTEM.

Selection system

SAF definition - An uneven-aged silvicultural system in which trees are removed individually, hear and there, from a large area each year - ideally over a whole forest or working circle, but from practical considerations almost always over the annual coupes of cutting series; regeneration mainly natural and crop ideally all-aged.

Status Review Team's Interpretation - these prescriptions have variable effects on the forest canopy. For the purposes of the goshawk Status Review, acres treated with these prescriptions are judged to provide continued goshawk foraging habitat, and in some instances, nest habitat, because a majority of the forest canopy is expected to be retained.

Improvement cutting

SAF definition - The elimination or suppression of less valuable in favour of more valuable tree growth, typically in mixed uneven-aged forest.

Status Review Team's Interpretation - a prescription with variable effects on the forest canopy. For the purposes of the goshawk Status Review, acres treated with this prescription is judged to provide continued goshawk habitat benefits because a majority of the forest canopy is expected to be retained.

Thinning cutting

SAF definition - A felling made in an immature crop or stand in order primarily to accelerate diameter increment but also, by suitable selection, to improve the average form of the trees that remain, without - at least according to classical concepts - permanently breaking the canopy....

Status Review Team's Interpretation - a prescription with variable effects on the forest canopy. For the purposes of the goshawk Status Review, acres treated with this prescription are judged to provide continued goshawk habitat. It is most likely to provide foraging habitat, but may also provide nest habitat, depending on the condition of the stand prior to treatment and the extent of thinning applied. In some instances, thinning may open an extremely dense canopy which is impenetrable by goshawks, and make it 'available' to goshawk use.

Salvage cutting

SAF definition - The exploitation of trees that are dead, dying or deteriorating (e.g. because they are overmature or materially damaged by fire, wind, insects, fungi or other injurious agencies)

before their timber becomes worthless. See also SANITATION CUTTING.

Sanitation cutting

SAF definition - The removal of dead, damaged or susceptible trees, essentially to prevent the spread of pests or pathogens and so promote forest hygiene. See also SALVAGE CUTTING.
Status Review Team's Interpretation - prescriptions with variable effects on the forest canopy. For the purposes of the goshawk Status Review analysis of short-term (less than ten year)effects, acres treated with this prescription are judged to provide continued goshawk habitat because it is generally applied selectively, as removal of decadent trees from the site. However, repeated application of these prescriptions would be detrimental to goshawk habitat because the trees removed are often the larger trees in the stand, which provide greater benefits to goshawks than smaller diameter trees. Also, repeated removal of diseased and deformed trees will serve to reduce goshawk nesting structure and the overall habitat diversity and prey species occurrence in these stands.

Special cut

SAF definition - this term is not defined by the Society of American Foresters.
Status Review Team's Interpretation - an extremely variable prescription. For the purposes of the goshawk Status Review, acres treated with this prescription are judged to provide continued goshawk habitat because we believe it consists of specifically designed prescriptions largely targeted at particular trees rather than over entire stands. This prescription accounts for approximately Percent of the Forest Service harvest in the Review Area.

Effects of timber harvest on goshawk "habitat"

Our assessment of timber harvest effects to goshawk habitat is made in a very general manner and reflects our best professional judgement. We acknowledge that within these generalizations it is possible to find situations where a particular harvest prescription did not result in forest conditions that we have generalized. We also acknowledge that goshawk use of harvested stands will vary broadly. However, we felt it was essential to discuss timber harvest in some manner for the entire Status Review Area, and provide some assessment of its effect on goshawk, relying upon our judgement.

This is a difficult topic conceptually, but central to the objectives of this Status Review. Very few studies of goshawk habitat have had sufficient survey effort, sample size, or statistical rigor to demonstrate changes in goshawk behavior or nest success resulting from a particular timber harvest activity. Crocker-Bedford (1990) reported declines in the number or density of goshawk territories in areas that had been selectively harvested, however this result has been disputed by continuing studies in the same area (Reynolds and Joy 1998). This Status Review received many reports of goshawks abandoning nest sites subsequent to timber harvest activity in nearby stands; often the nest sites remained unoccupied for several years following treatment. Goshawks are very mobile nesters, and in many cases a local timber harvest may have resulted in a 0.2 to 1.0-mile shift in nest site, or a shift in foraging area; these cases are typically classified as "abandoned" based on inadequate survey of the previous nest stand. On the other hand, some of

these reports described extensive removal of the overstory at the nest site and in much of the surrounding landscape. Clearly there is some level of habitat change that will render a landscape unsuitable for occupancy and reproduction by goshawks.

The spatial relationships among different functional levels of habitat use by goshawks (nest site, nest area, post-fledging area, foraging areas) are important considerations in assessing effects of timber harvest on goshawk habitat. Depending on the ecosystem or forest type, a landscape may only need to provide small amounts of nest area habitat, if adequate foraging habitat is provided in the 'matrix' of other habitats (example aspen/shrubsteppe, eastside ponderosa pine). In other systems, large areas of mature forest ("nest habitat") may be required to provide adequate prey resources (example Douglas-fir/hardwood forest).

Nest Habitat- structure:
Most studies of nest site or nest area habitats used by goshawks in the Status Review Area demonstrate an association with denser stands of larger trees, relative to what is available in the landscape. The basic structural attributes of these stands are easily quantified, and local or regional standards based on existing nest sites are available for many forest types or localities. While silvicultural prescriptions may be employed to maintain stand structure within the range of stand density, tree size and canopy closure associated with goshawk nest areas, this is rarely the objective of commercial timber sales. In practice, economic and logistical considerations typically require that timber harvests remove a significant proportion of the trees from a sale unit. Comparison of expected post-harvest stand density and canopy closure to local definitions of 'mean' structural attributes of nest area habitat is necessary to estimate "losses" of potential nest habitat.

The effect of timber harvests on goshawk nest habitat (usually generalized to 'goshawks') can be described as the number of acres of potentially suitable forest (meeting local definitions from nest habitat studies) that are modified to a condition no longer meeting the definition. In forest types where goshawk nest areas are characterized as having very high canopy closure, most harvests will reduce canopies to below definition. In more open forest types (ponderosa pine, Jeffrey pine) light thinning of smaller trees (thinning from below) may occur without significantly altering the canopy; maintaining suitability for nest area habitat. Reduction of canopy closure may have several effects on goshawk nesting success; including increased solar radiation and subsequent heat stress, reduced buffering from adverse weather, and increased visibility to predators. Another potential effect of timber harvest is removal of larger trees that may provide nest platforms. Farber et al. (1998) report that in managed stands where larger trees were lacking, nesting often occurred in deformities such as "fork tops" or mistletoe clumps. Harvest practices that eliminate these structures from stands may be expected to reduce nesting opportunities for goshawks, even if much of the forest canopy is retained.

Nesting Habitat- amount and patch size:
While much is known about structural attributes of forest stands used for nesting by goshawks, relatively few studies have addressed the amount or patch size that the hawks may be selecting,

and whether this habitat represents selection of a buffer of "nest site habitat" larger than what is actually used at the nest, or simply the forested area that happens to surround the nest site. Based on observations of feathers, whitewash, and prey remains, Reynolds (1988) defined an area (approximately 30 acres) of intensified use surrounding the nest as the "nest area"; this area has often been interpreted by land managers as the total area of nest habitat needed by reproducing goshawks. In studies by Woodbridge and Detrich (1994), occupancy rates of forest stands used for nesting decreased as stand size decreased, suggesting that the hawks were selecting larger (85-200 acres) stands. However, in many cases small (30 - 60 acres) stands were used successfully. The a larger area (approximately. 420 acres) of relatively denser forest surrounding nest areas that is used by the newly-fledged young during the "post-fledging dependency period" (Kennedy et al.1994) further illustrates the importance of larger patch size of mature forest surrounding goshawk nests.

The extent (spatial scale and treatment intensity) of timber harvest within a given landscape will affect the availability of suitable habitat patches for occupancy by nesting goshawks. This effect will depend on the forest type, and pre-harvest condition of the landscape. For example, two 50-acre clearcuts within a goshawk home range may only slightly affect the availability of nest habitat, whereas two 200-acre thinnings may degrade all of the available stands to conditions below structural characteristics of nest area habitat.

Nesting Habitat - physiographic location:
Assessment of habitat availability for goshawk nest areas is often made at broad scales, following an assumption that presence of forest habitat meeting certain structural criteria will meet the needs of goshawks. However, there is substantial evidence to suggest that location of goshawk nest sites is affected by landscape features such as slope, aspect, riparian vegetation, meadows, drainages, water, and other features. In northern California, nest sites were located on gentle north-east slopes, near streams, and closer to meadows than random sites (Allison 1996, Laacke and Flores, unpub); these associations have been reported by numerous other authors as well. If selection of nest sites by goshawks is at least partially dependant on certain physiographic features, then harvest of timber within these features will have a disproportionate effect on habitat suitability.

Foraging Habitat:
Habitats used for foraging by goshawks are poorly known. With the exception of a small number of telemetry studies, much of our knowledge is limited to extrapolation of the habitat requirements of important prey species (Reynolds et al 1992). There is evidence to suggest that goshawks, as large-bodied, visual predators, avoid overly dense habitats where physical or visual access to prey is limited. Harvest practices such as light thinning may, in these cases, actually improve or create foraging habitat for goshawks. Telemetry studies (Beier and Drennan 1997, Austin 1993) suggest that goshawks select mature forest stands with open understories for foraging, however it is likely that actual foraging habitat selection occurs at spatial and temporal scales difficult to investigate using radio telemetry. Small openings, treefall gaps, edges, riparian zones, and rock outcrops are examples of small-scale landscape elements that are be used by

foraging goshawks (Squires and Reynolds 1997), the use of which is difficult to detect through radio telemetry. Analyses of prey used in naturally open habitats (Younk 1996, Woodbridge and Detrich 1994, McCoy 1998) demonstrate that goshawks will forage away from forest cover if suitable prey are available. However, it cannot be assumed that adequate prey will be available in openings created by timber harvests. In mesic habitats, removal of forest cover often results in dense regrowth where goshawks would be unlikely to detect or capture prey. In most forest habitats, silvicultural prescriptions that maintain some overstory structure would be expected to also maintain populations of forest-associated prey species. However, populations of many prey species are linked to structural attributes such as snags, large logs, large trees (cone crops, mistletoe, etc.), soil organic horizon depth (fungi) and hardwoods (mast) which may not be maintained under various silvicultural prescriptions, unless the prescription is specifically designed to maintain them.

Conclusion:
The Status Review Team felt it was important to assess, in a general manner, the effects of various silvicultural practices on goshawk habitat conditions. And we present a series of analyses and discussions of Forest Service harvest patterns to understand changes to goshawk habitat on the lands which we assume are the major player in management of this species. However, assessment of effects of timber harvest on goshawk populations should be based on careful evaluation of local forest conditions, important goshawk prey species and their habitat requirements, and natural forest processes and disturbance regimes at the local scale. Such an assessment is not available at this time, nor feasible for this broad scale Review.

The use of silvicultural methods to deliberately manage for goshawk habitat has been discussed in at least two published papers. In the lodgepole pine forest type of Wyoming, Squires and Ruggiero (1996) offer suggestions to create goshawk nest stands through silviculture. Lilieholm, Kessler and Merrill (1993) presents theoretical applications of a stand density management regime to Douglas fir stands to the achieve forest structure and tree density documented as goshawk nest sites on the Targhee National Forest. Also, as the concern for forest health and fuels management moves into management action, we anticipate that millions of acres of forest will be considered for treatments which will include silvicultural entries, such as thinning, prior to prescribed burning.

For the following figures, we lumped three harvest prescriptions into a category which we called “Heavy cut” based on the effects of their application. These prescriptions are ‘clear cut’ and ‘seed cut’/‘shelterwood’. In these prescriptions we judge that the post-harvest tree canopy clearly will not provide goshawk nesting conditions and the ‘recovery’ of the acreage into goshawk habitat will take many decades.

The remaining prescriptions which were analyzed were lumped into our “Light cut” category. This category reflects a wide array of post-harvest forest conditions, but has some important aspects in common. In all of these, the post-harvest stand will retain sufficient tree canopy and tree size to provide at least goshawk foraging opportunities and at best nesting conditions. The

removal of trees by these prescriptions is considered to degrade goshawk nest habitat for some period of time, but will generally 'recover' to goshawk nest habitat in one to two decades (versus the many decades of "Heavy cut" prescriptions).

To provide context for the harvest figures, we present additional figures which display the total National Forest System acreage in an Assessment Area, the portion of the acreage which was classified in 1995 as "suitable for timber" harvest, and the harvest figures. These figures illustrate the proportion of National Forest land which is currently subject to harvest, which in some cases is a smaller proportion currently, than when the harvest occured.

Actual timber harvest levels are strongly influenced by market conditions, which can fluctuate widely. For instance, when we look at the long-term Region 1 harvest data we see a noticeable drop in harvest in 1982. At this time the timber market dropped dramatically throughout the West, and purchasers of Federal timber defaulted on their contracts and did not harvest the acreage expected.

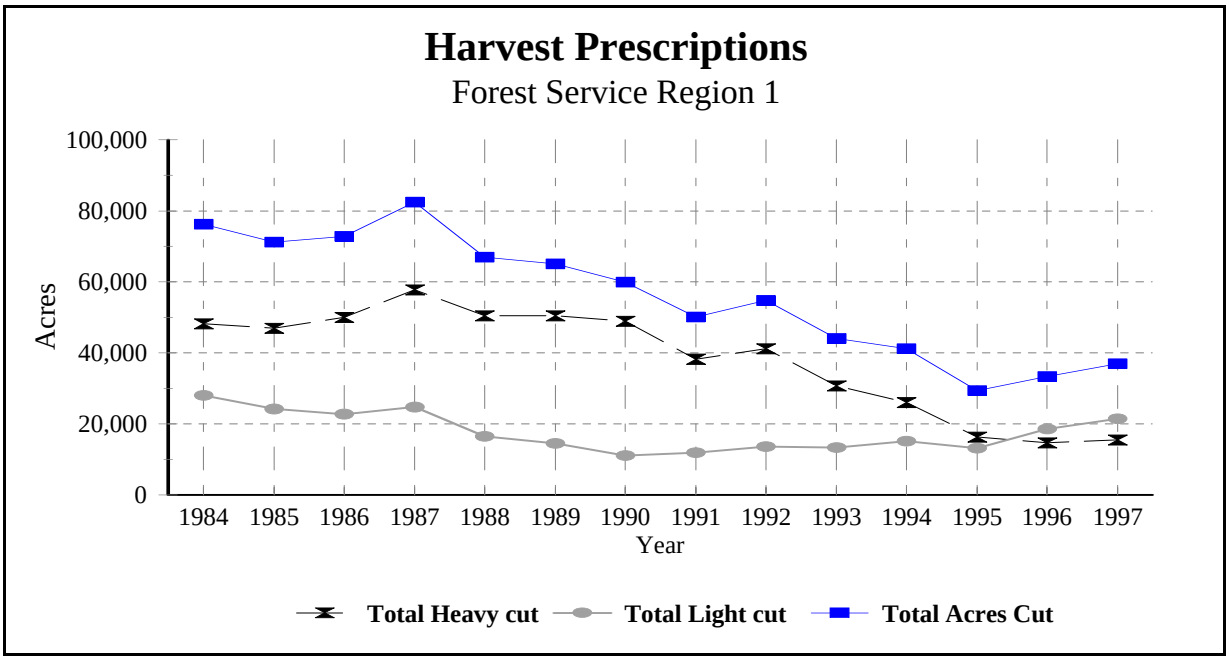


Figure A.2. Total, Heavy and Light Harvest Acres in Forest Service Region 1, 1984 through 1987

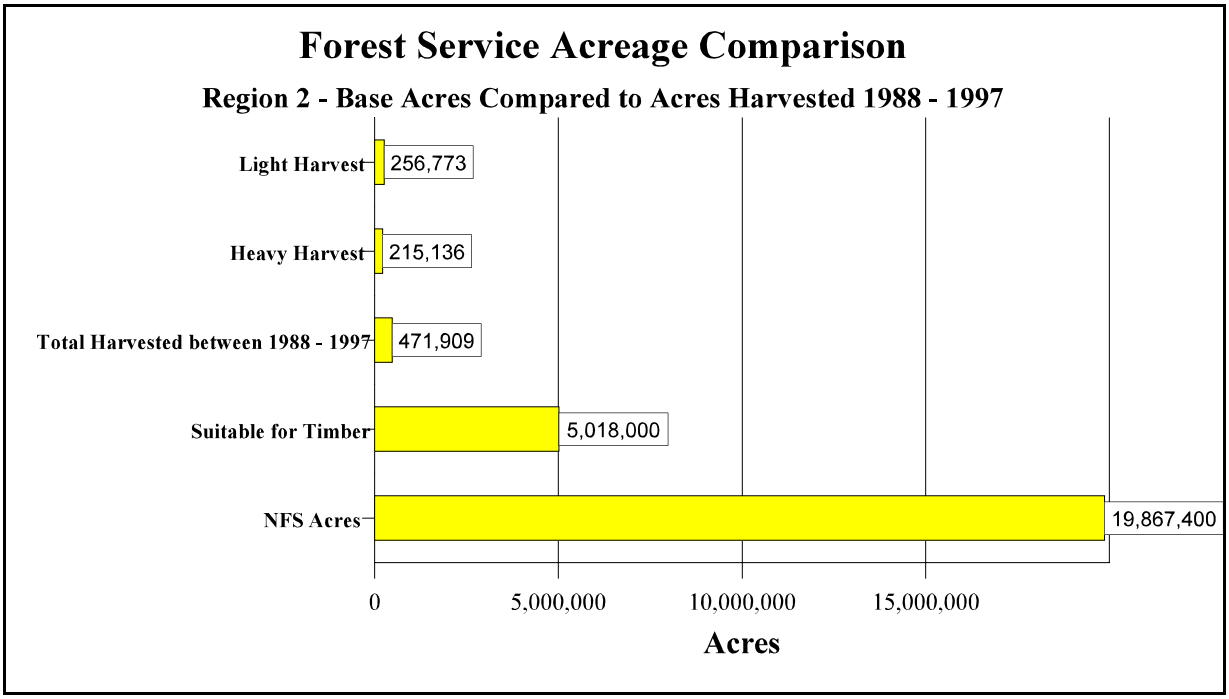


Figure A.5. Comparison for Forest Service Harvest Acreage 1988 - 1997 Against Total and Suitable for Timber Acreage, Region 2.

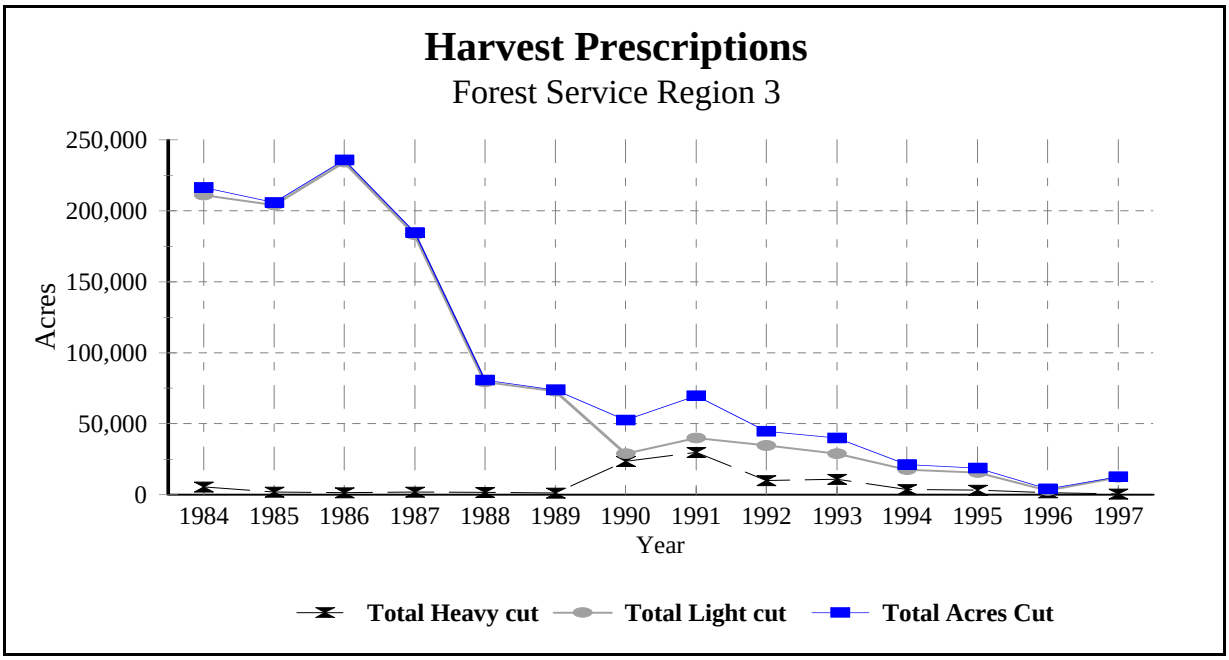


Figure A.6. Total, Heavy and Light Harvest Acres in Forest Service Region 3, 1984 through 1988.

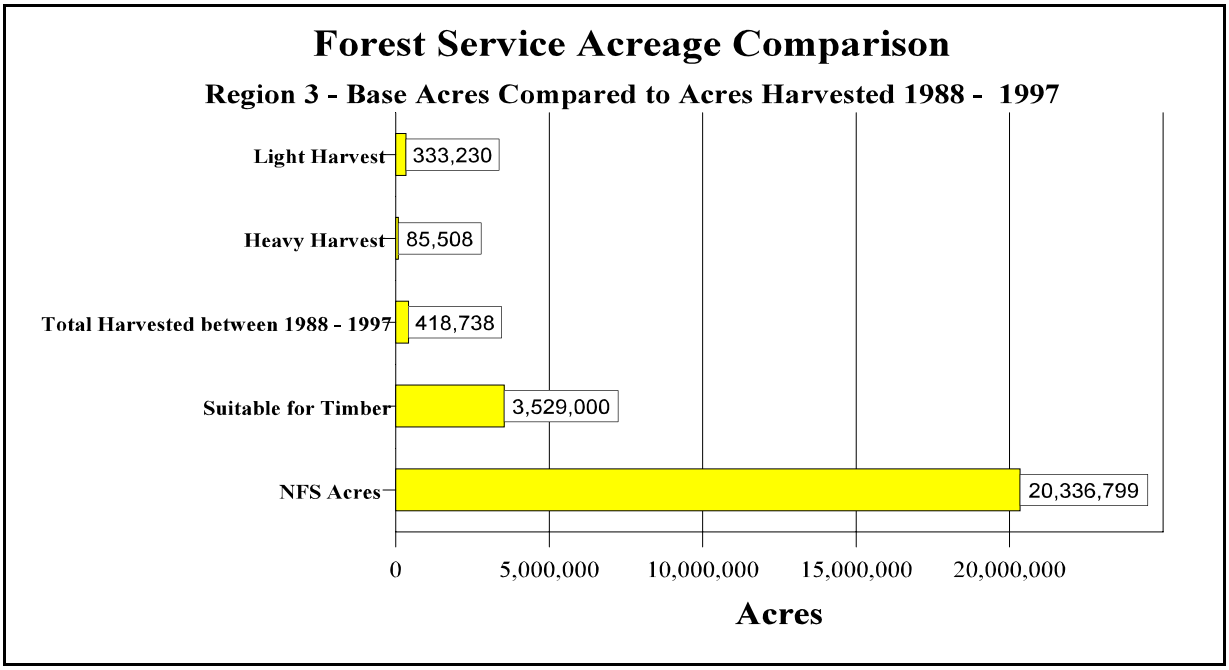


Figure A.7. Comparison of Forest Service Harvest Acreage 1988 - 1997 Against Total and Suitable for Timber Acreage, Region 3.

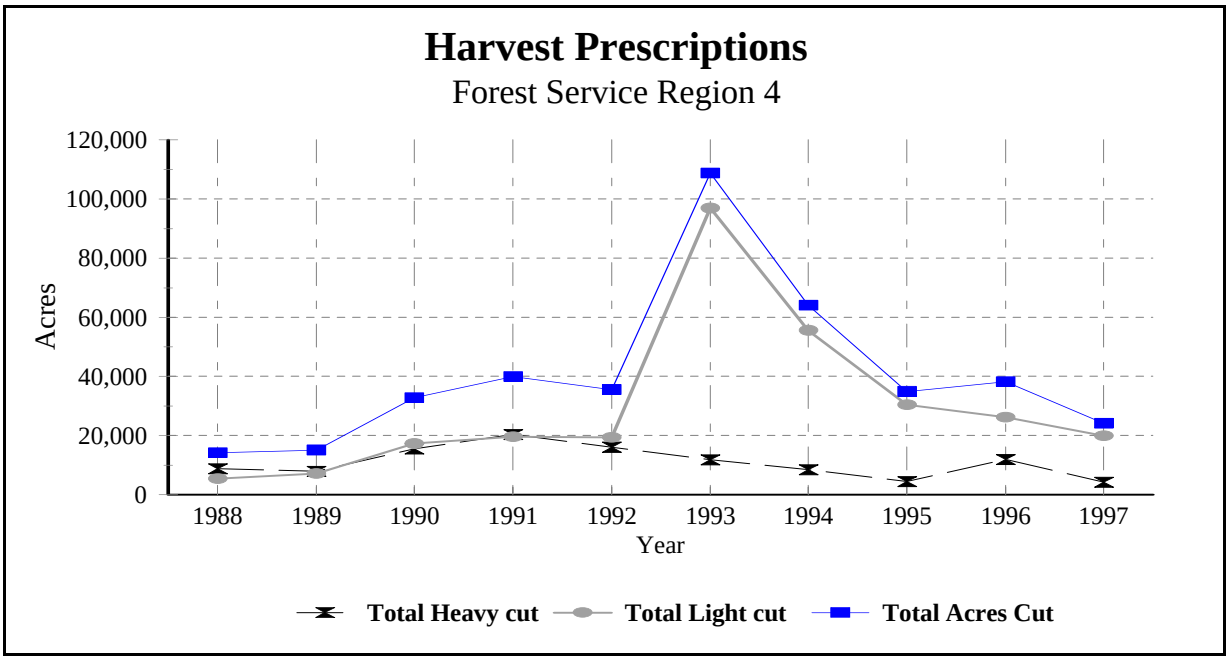


Figure A.8. Total, Heavy and Light Harvest Acres in Forest Service Region 4, 1988 through 1997.

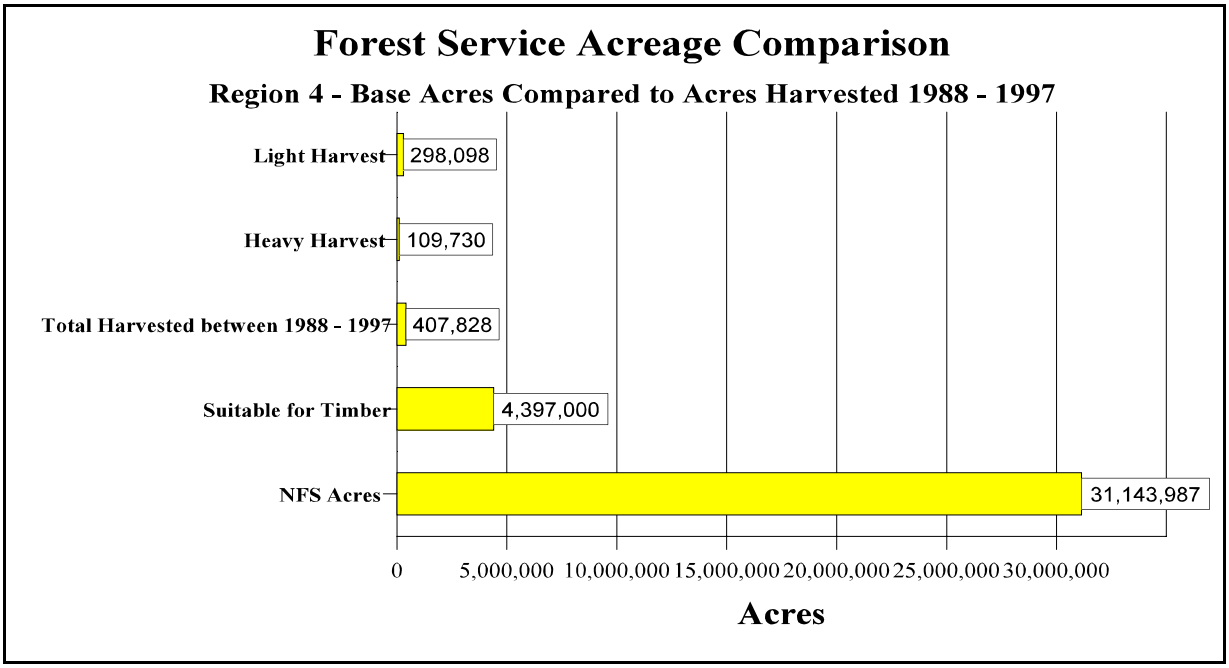


Figure A.9. Comparison of Forest Service Harvest Acreage 1988 - 1997 Against Total and Suitable for Timber Acreage, Region 4.

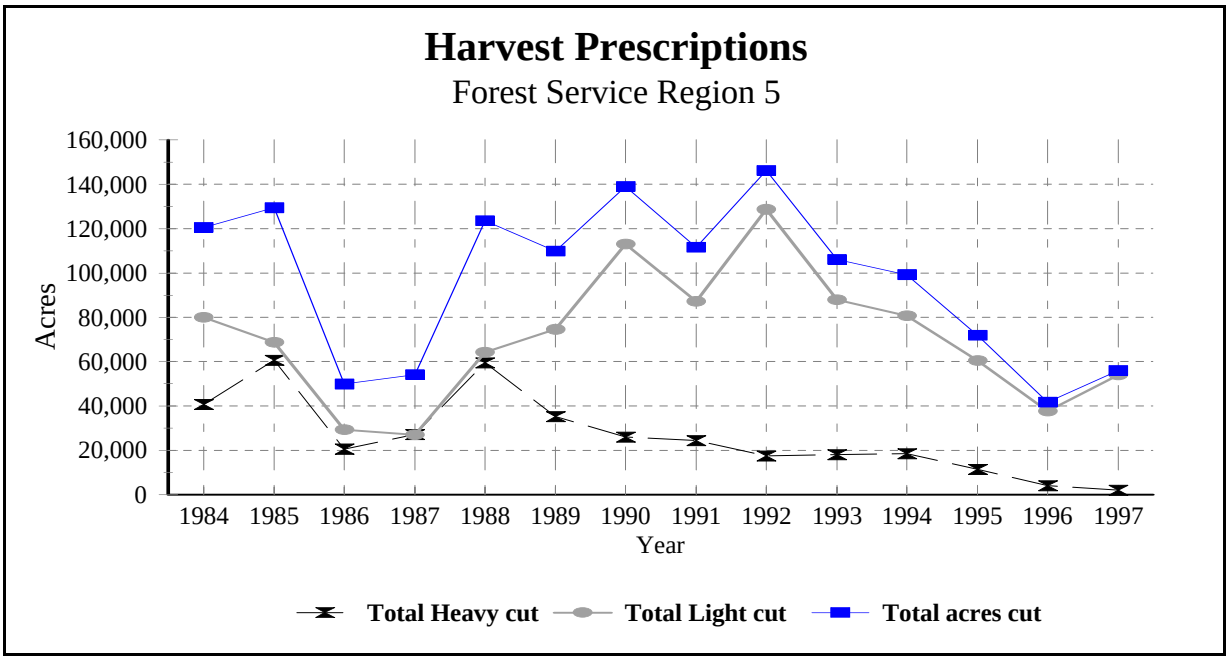


Figure A.10. Total, Heavy and Light Harvest Acres in Forest Service Region 5, 1984 through 1997.

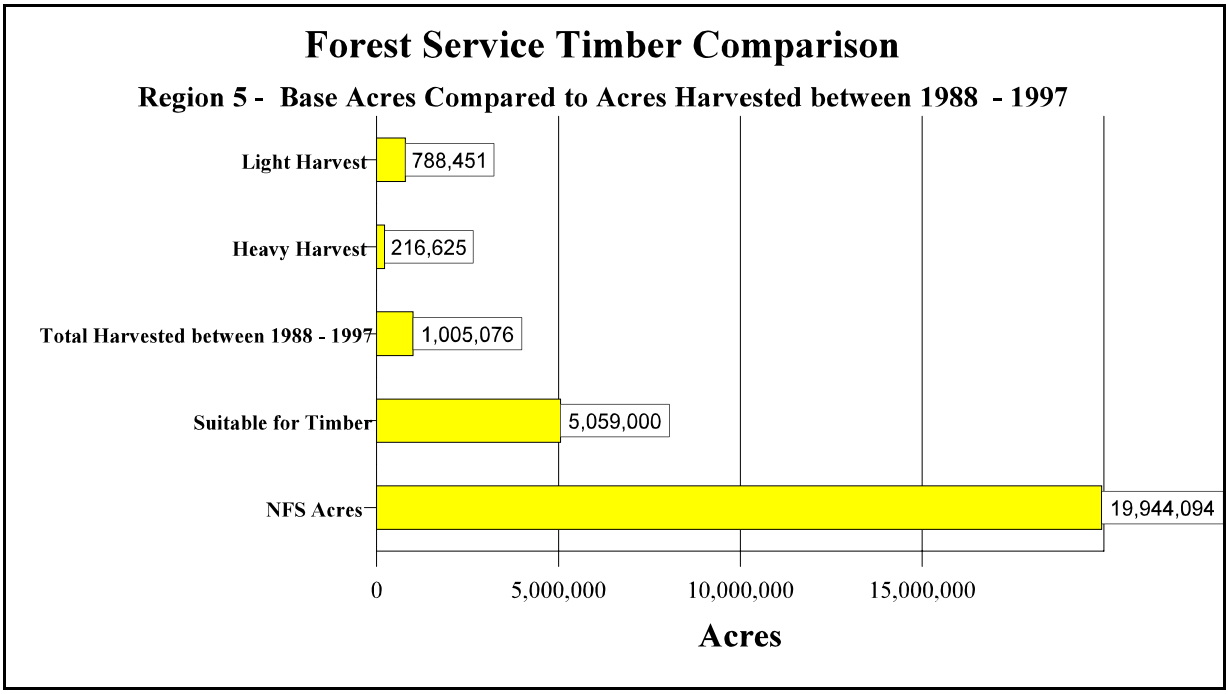


Figure A.11. Comparison of Forest Service Harvest Acreage 1988 - 1997 Against Total and Suitable for Timber Acreage, Region 5.

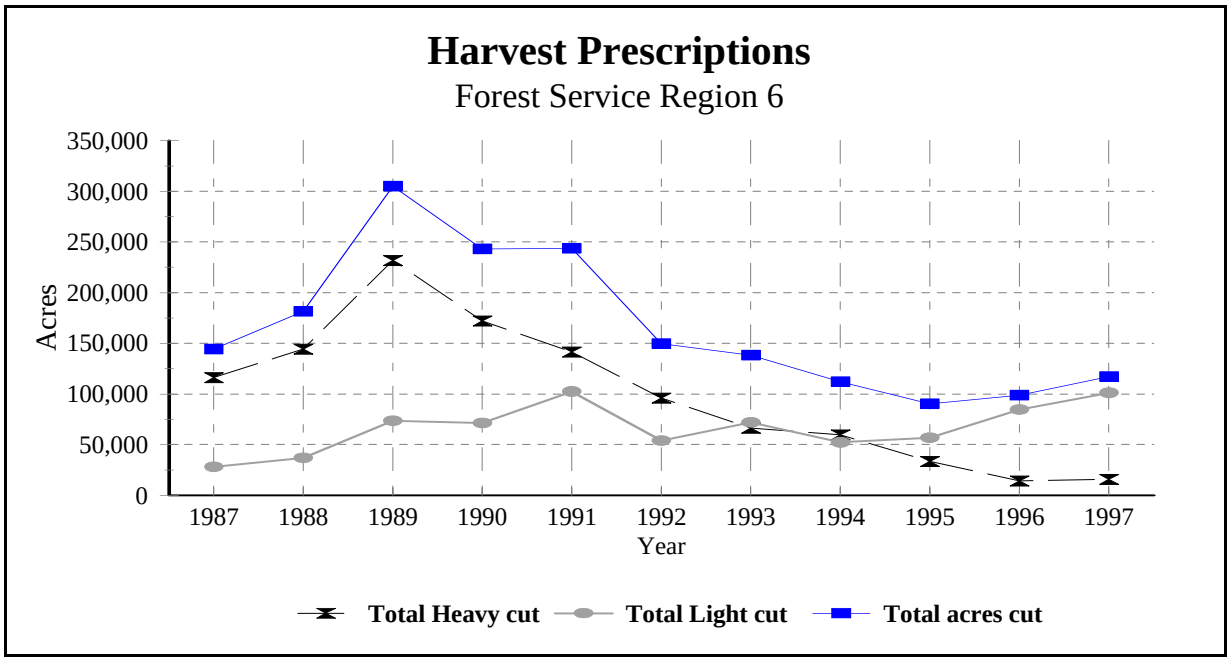


Figure A.12. Total, Heavy and Light Harvest Acres in Forest Service Region 6, 1984 through 1988.

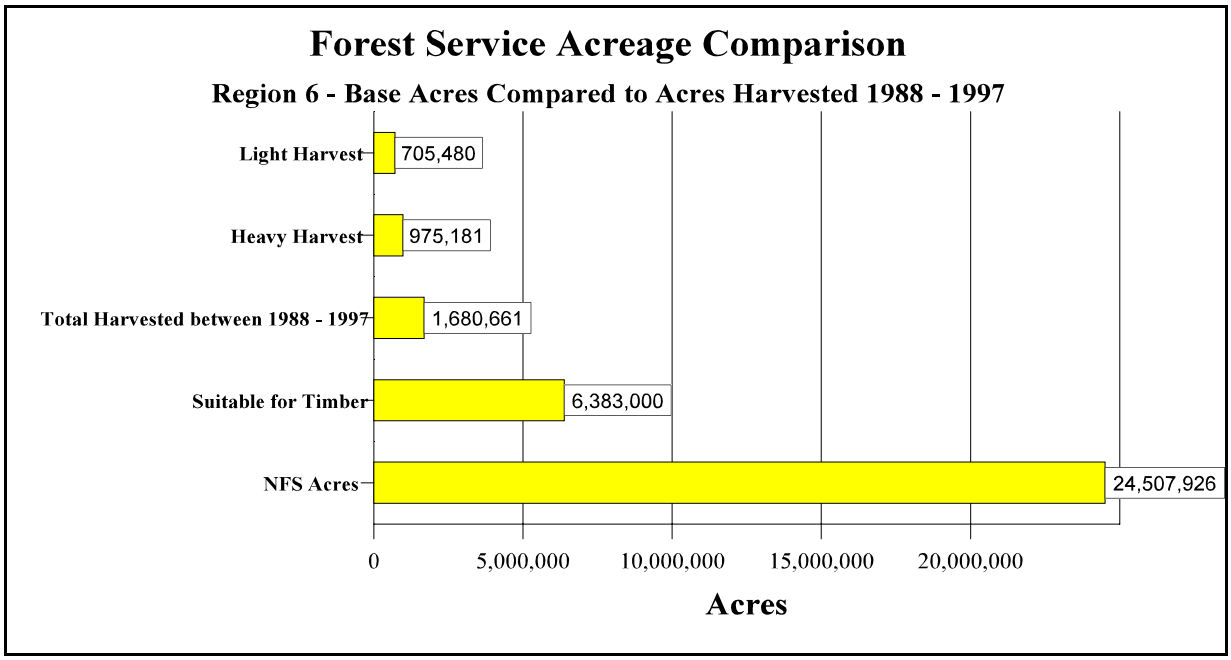
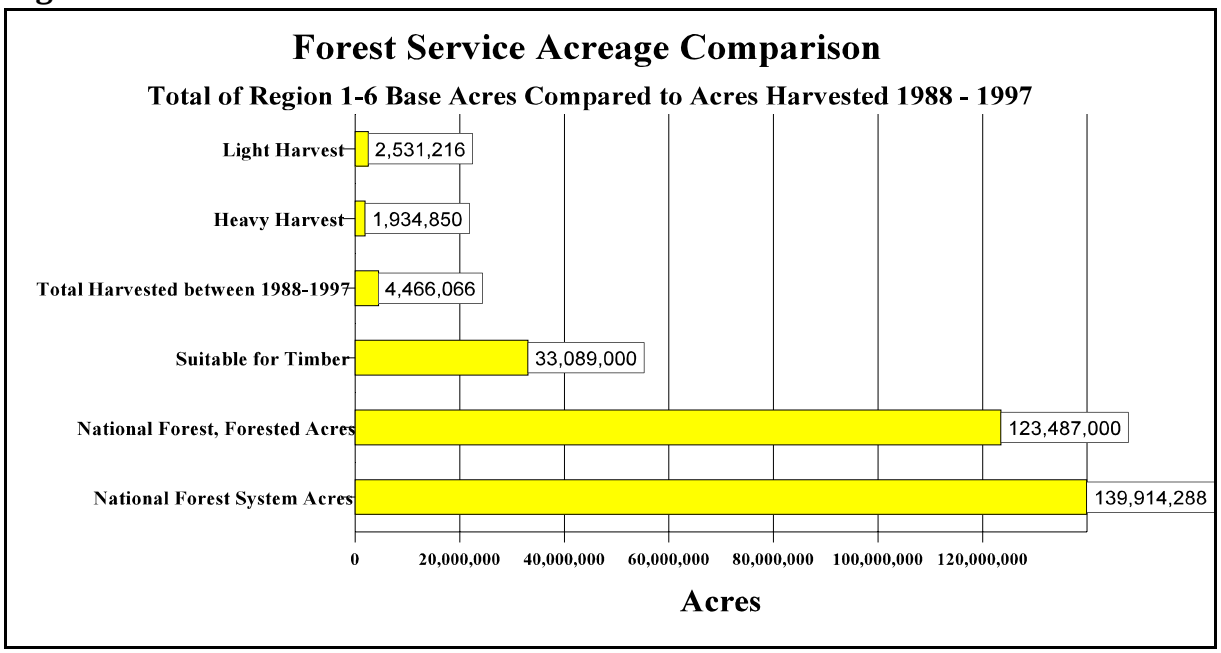


Figure A.13. Comparison of Forest Service Harvest Acreage 1988 - 1997 Against Total and Suitable for Timber Acreage, Region 6.

Figure 13



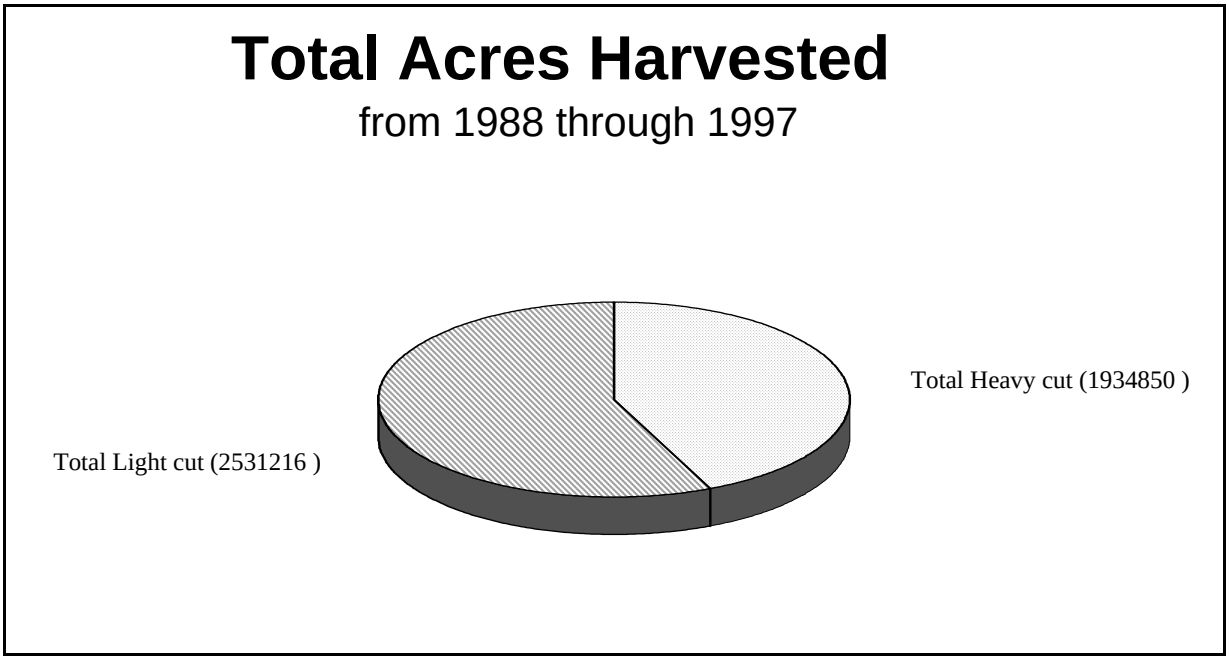


Figure A.14. Proportion of Forest Service Acres in Status Review Categories of “Heavy “ and “Light” Harvest Effects.