# ARIZONA GAME AND FISH DEPARTMENT

# REVIEW OF

# U.S. FOREST SERVICE STRATEGY FOR MANAGING NORTHERN GOSHAWK HABITAT IN THE SOUTHWESTERN UNITED STATES

Arizona Game and Fish Department
2221 West Greenway Road
Phoenix, AZ 85023
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## EXECUTIVE SUMMARY

This document describes the Arizona Game and Fish Department's (Department) concerns related to the U.S. Forest Service management strategy for southwestern forest habitats used by the Northern goshawk (*Accipiter gentilis atricapillus*). Because the Department has management responsibility for all wildlife resources which would be affected by implementation of this habitat management strategy, the concerns presented in this document involve not only the goshawk, but also a broad range of wildlife species.

The Forest Service management strategy is based on interpretation and application of the "Management Recommendations for the Northern Goshawk in the Southwestern United States," (Reynolds et al. 1992) (MRNG) which was developed by the Forest Service's Goshawk Scientific Committee (GSC). Although the Department disagrees with some of the basic assumptions used by the GSC to develop the MRNG, the MRNG represents a significant improvement over previous forest management practices. However, subsequent interpretation and on-the-ground implementation of the MRNG has raised significant concerns about the impacts of this new management strategy on the goshawk, its prey and a wide variety of other wildlife species using southwestern forest habitats.

Many of the concerns identified in this document are reflected in one or more of the following issues:

- **The degree to which the forest structure in goshawk foraging areas should be opened.** Considering the goshawk's morphology, foraging behavior, habitat preference, potential competition from other raptors, and the habitat needs of goshawk prey, the Department believes that the forest should be managed at higher canopy densities than are now proposed in the Forest Service management strategy.

- **Application of the MRNG to lands allocated as old growth and lands designated as unsuitable for timber production.** Because of the unique wildlife habitat values often associated with these lands and the difficulty of recreating these values through silvicultural treatments, the Department believes that application of the Forest Service management strategy to these lands is inappropriate.

- **Cumulative effects of past, present and future timber harvest activities.** The MRNG will be implemented on current forest conditions, which are partly the result of cumulative effects of past timber management activities. The potential impacts of the MRNG on wildlife resources must be evaluated in relation to these past activities, as well as to present and proposed future actions.

- **State agencies with legal mandates to manage wildlife, including the goshawk, were denied membership on the GSC.** Because the GSC recommendations have direct impact on State responsibility and authority to manage wildlife, the Department continues to address concerns with the Forest Service management strategy to fulfill its legal mandate.

- **Current interpretation and application of the MRNG is resulting in management at or below minimum thresholds identified in the MRNG.** Since publication of the MRNG, the Implementation of the MRNG in upcoming timber sales has redefined or reinterpreted minimum thresholds set in the MRNG. These adjustments have moved toward a more open canopy and younger-aged forest.

- **Replacement of Land and Resource Management Plan Standards and Guidelines with the Forest Service management strategy.** The Department believes that wildlife Standards and Guidelines designed for species other than the goshawk can be maintained while still providing appropriate habitat for the goshawk.

- **Proposed application of the MRNG on a landscape scale.** The MRNG embodies a number of untested hypotheses. Until monitoring demonstrates the validity of these assumptions, the Department believes it is not prudent to apply the MRNG across the landscape.

Recommended modifications to the Forest Service habitat management strategy are included in this document to facilitate resolution of the Department's concerns. Modifications include changes to the rotation age, tree density, and number of reserve trees. These modifications are designed to resolve concerns over wildlife habitat components, such as wildlife cover, snags, old growth, and dense canopy. The Department's goal is to work with the Forest Service to achieve a habitat management strategy which will sustain all wildlife populations on Arizona's National Forests.

## INTRODUCTION

This document was compiled to promote a better understanding of the Arizona Game and Fish Department's (Department) concerns relating to management of southwestern forest habitats used by the Northern goshawk (*Accipiter gentilis atricapillus*) and other wildlife. Habitat management decisions made by the Forest Service directly affect the Department's mandate to manage all wildlife in Arizona. The Department is concerned about the health of goshawk populations, but a more significant concern is the health of a broad range of species using mature and old growth forest habitats. The Department's goal is to work with the Forest Service to achieve a habitat management strategy which will sustain all wildlife populations.

Although all positions and concerns identified in this document have previously been discussed, verbally or in writing, with representatives of the Forest Service, they have not been organized into a single document with accompanying explanations and references. The intent of this document is 1) to review the Management Recommendations for the Northern Goshawk in the Southwestern United States (Reynolds et al. 1992) (hereafter referred to as the MRNG), and 2) to stimulate discussion and modification of the Kaibab National Forest's Implementation and Interpretation of Management Recommendations for the Northern Goshawk (Menasco and Higgins 1992) (hereafter referred to as the Implementation Guidelines) and the Interim Goshawk Guidelines for the Southwestern Region of the Forest Service (USDA Forest Service 1992a) (hereafter referred to as the Interim Guidelines), which are based on the MRNG. The Department refers to individual aspects in each of these three documents and also addresses the overall Forest Service goshawk management strategy as an amalgamation of the three documents.

The Department is concerned about application of the Forest Service goshawk management strategy on all Forests. However, the Kaibab National Forest has the highest known goshawk density in the Southwest and is where goshawks have been most studied. Also, management strategy demonstration areas have been established on the Kaibab and Coconino National Forests. Therefore, many examples in this document come from these Forests. Although the examples are specific to certain areas, the Department's concerns pertain to all Forests where the management strategy will be applied.

### Department Overview of the Forest Service Strategy for Managing Northern Goshawk Habitat

Development of the MRNG by the Goshawk Scientific Committee (GSC) was a challenging task. The Department acknowledges this effort as a significant step toward more holistic management of forest habitats and resources. Although the Department disagrees with some of the basic assumptions used by the GSC to develop the MRNG,

the MRNG did address many long-standing concerns regarding management of goshawk habitat. The MRNG called for an extended rotation, consideration of each goshawk pair across 6,000 acre home ranges, silvicultural treatments of small blocks, uneven-aged management, retention of old trees on each acre, maintaining snags and providing downed woody material for wildlife habitat and nutrient cycling. These recommendations represent significant improvements over previous forest management practices and can provide benefits to a wide variety of wildlife.

Unfortunately, subsequent interpretation and application of the MRNG by the Forest Service (e.g., Implementation Guidelines), represent a substantial departure from what the Department believes was the original intent of the MRNG (Fig. 1). Minimum thresholds identified in the MRNG, as necessary to sustain goshawk populations, have become maximums without biological justification. Moreover, the Southwestern Region of the Forest Service has directed that Forest Land and Resource Management Plan (LMP) Standards and Guidelines (S&Gs) may be superseded by the Interim Guidelines when conflicts occur between the two (Appendix 1).

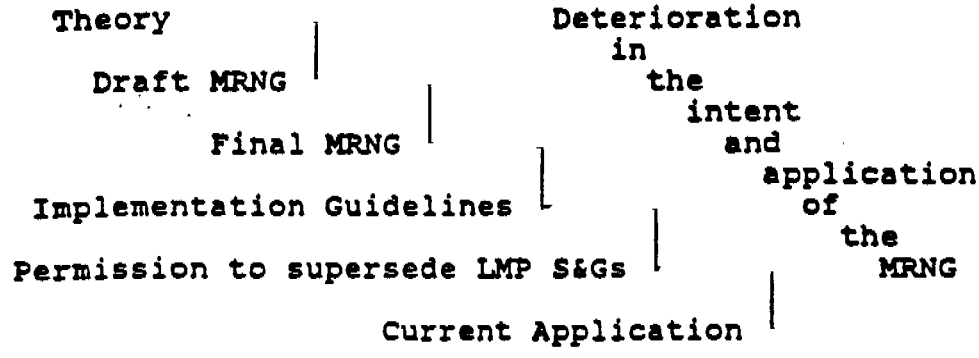


Fig. 1. Department perception of progressive deterioration in the Forest Service approach to goshawk habitat management from the initial efforts of the GSC to current on-the-ground application.

## Content and Organization of the Department's Review

This document presents the Department's perspective on how this departure from the original intent of the MRNG has occurred, and how it is affecting management of forest habitats in Arizona, particularly in ponderosa pine. The Department discusses the relevance of proposed management practices to wildlife and references scientific literature and professional opinions upon which the Department's concerns and positions are based.

The MRNG includes Desired Future Conditions (DFC) for goshawk nest areas, post-fledging family areas (PFA), and foraging areas, in three forest types (ponderosa pine, mixed-species, and spruce-fir). The Department's primary concerns relate to the management of foraging areas in ponderosa pine because 1) most of the known goshawk territories are currently located in this forest type, 2) the foraging area makes up 90% of each goshawk management area (5,400 acres out of 6,000 total acres), 3) the Department believes that application of the Interim Guidelines and Implementation Guidelines for the foraging area will result in forest conditions which do not adequately meet the needs of the goshawk and other wildlife species, and 4) guidelines to implement the MRNG in mixed-species and spruce-fir forests have yet to be developed.

The first section of the document (Background) discusses the distribution, ownership, management and conditions of ponderosa pine habitats in the Southwest. It also provides an historical summary of the goshawk issue from the Department's perspective. The Forest Service's historical perspective is presented in the MRNG and Interim Guidelines.

The second section of the document (Issues Regarding the Assumptions of the Forest Service Management Strategy for the Northern Goshawk), discusses fundamental assumptions of the MRNG and their relevance to the goshawk, its prey and implementation of the MRNG. Discussions address goshawk morphology, foraging behavior, competitors and productivity. The assumption that prey abundance constitutes a limiting factor regulating goshawk populations is addressed and an analysis of prey habitat needs, as defined in the MRNG, is included. An examination of the assumptions in the MRNG and Implementation Guidelines, as they relate to silvicultural practices, follows. This examination is critical to an understanding of the impacts of implementation on other wildlife species, discussed in subsequent sections.

The next section (Issues Requiring Further Consideration) focuses on habitat components required by a wide variety of wildlife species which are inadequately addressed by the Forest Service goshawk management strategy. Species addressed include some of the goshawk prey species selected by the GSC (Reynolds et al. 1992), Forest Service sensitive species, cavity-dependent birds, turkey and bear. These species are only used as examples to demonstrate that the Forest Service goshawk management strategy does not meet all wildlife habitat needs. An analysis of cumulative effects of past timber harvest is included.

The following section (Wildlife Science and its Application to the Forest Service Management Strategy) discusses the Department's concerns regarding the Forest Service's approach to the development and implementation of the MRNG. In the last section (Arizona Game and Fish Department Recommendations), the Department recommends modifications to help resolve concerns with the Interim Guidelines and the Implementation Guidelines.

## Ponderosa Pine Forest Habitats in the Southwest

### Distribution and Ownership

Ponderosa pine forests are widely distributed across the Southwestern United States, occupying approximately 3.4 million hectares (8.5 million acres) of Arizona and New Mexico (Brown 1982). Elevational distribution is typically between 1800-2400 meters (5940-7920 feet), on a variety of soils derived from igneous, metamorphic, and sedimentary rocks (Schubert 1974). In Arizona, the ponderosa pine type is concentrated along the Mogollon Rim, in transition zones between drier pinyon-juniper and oak woodlands, and more mesic Douglas-fir and mixed conifer types. Extensive ponderosa pine forests are also present on high plateaus in the northern portion of the state, such as on the Kaibab Plateau. In Arizona, ponderosa pine occurs as pure stands and in combination with hardwoods or other conifers. Hanks et al. (1983) identified four major habitat types, 12 phases and five community types within the ponderosa pine forests of Arizona.

Arizona has approximately 1.4 million hectares (3.5 million acres) of ponderosa pine forest, the majority of which (66%) are administered by the Forest Service, primarily by the Apache-Sitgreaves, Coconino, and Kaibab National Forests. Thirty-two percent of Arizona's ponderosa pine forests are privately owned and the remaining two percent are held in other public trusts (Conner et al. 1990).

### Forest Management and Conditions

Man's influence on southwestern ponderosa pine forests began well before European settlement. Cooper (1960) cites a number of sources documenting widespread use of fire by Native Americans in Arizona and New Mexico. With the arrival of European settlers in the 1870s, ponderosa pine forests in Arizona were subjected to new influences, including large numbers of exotic ungulates, fire suppression, and timber harvest. These factors have played an important role in shaping current forest conditions.

Historical grazing practices had significant impacts on ponderosa pine forest vegetative community composition and watershed conditions. Overgrazing exposed mineral soil and reduced fine fuels needed to carry surface fires, thus enhancing ponderosa pine seedling establishment and survival (Harrington and Sackett 1992, Covington and Moore 1992). Most private lands in the ponderosa pine type are currently grazed, as are permitted allotments on Forest Service and other public trust lands.

Southwestern ponderosa pine forests are fire-adapted ecosystems. Under presettlement conditions, most were subjected to frequent

surface fires, with a recurrence interval of 2-11 years (Weaver 1951; Harrington and Sackett 1990, 1992). Aggressive fire suppression began after European settlement (Cooper 1960) and remains current policy in most areas. Interruption of "natural" fire regimes significantly affected many ecosystem processes, including nutrient cycling; tree mortality; the abundance and dynamics of tree parasites, diseases and associated insects; and wildfire size and intensity (Covington and Moore 1992).

Timber harvest in Arizona ponderosa pine forests began with the arrival of European settlers, and attained commercial scale during the 1880s (Schubert 1974). Pine forests throughout the state have been managed for wood fiber production, with the majority of the harvest coming from National Forest lands (Conner et al. 1990). A variety of silvicultural treatments have been applied, including thinning, selection harvest, multi-step shelterwood cuts, patch cuts, small clearcuts, mechanical site preparation, planting, and prescribed fire (Schubert 1974, Cassidy 1991).

Ponderosa pine forests have changed considerably from presettlement conditions. Some authors have described presettlement forests as "open" and "park-like" (Cooper 1960, Weaver 1951), and largely composed of small, even-aged groups of trees (Cooper 1961). Contemporary stands typically have much higher stem densities and are dominated by younger age classes (Covington and Moore 1991). However, it should be noted that prevailing notions of presettlement conditions are derived from relatively few studies, of limited geographic extent. There is also disagreement over the degree of openness and variability present in presettlement forests (Dodd 1991). This debate has important management implications because some interpretations of "presettlement conditions" (which are not clearly defined), are being used to justify proposed timber management activities in Southwestern ponderosa pine forests. Drs. Covington and Moore are concerned about misinterpretations and misuse of Covington and Moore (1991, 1992) and have provided a statement of clarification (Appendix 2).

Ponderosa pine forests in Arizona show considerable variation in structure, reflecting the effects of stand age, seedling establishment events, fire history, microclimate, edaphic factors, management by man, and other factors (Brawn and Balda 1988). Small scale patchiness is present in many stands, while others are relatively homogeneous over extensive areas. Vertical structure ranges from simple, single-story young and mid-aged stands to complex, multi-story conditions often associated with remnant old growth. This diversity provides a variety of habitats for a wide array of wildlife. Some species are strongly associated with particular structural attributes of a given age class. For example, flammulated owls nest and forage in old growth pine stands. Other species, such as tassel-eared squirrels, use mid-aged pine stands to meet their foraging needs. Still others, like turkey and deer, use a combination of forest structures and age classes, intermixed with forest openings, to meet their habitat needs. Maintaining this variability creates a mosaic of different

habitats essential to support the wildlife diversity found in Arizona's forests.

Intermediate-scale landscape patterns are difficult to define, due to indistinct and often "fuzzy" patch boundaries. Regional differences in management history are reflected at broad landscape (geographic) scales. For example, the area around Flagstaff was heavily railroad logged during the late 1800s and is now dominated by mid-aged (80 year-old) stands. However, the Kaibab Plateau, north of the Grand Canyon was not commercially harvested until the 1940s and is dominated by older stands of mature "yellow pines." Other ponderosa pine forests in Arizona represent stages of maturity and structural complexity intermediate between these two.

**Historical Summary of the Goshawk Issue in the Southwest**

Over the last two decades, concerns over changes in forest habitats in the Southwest and the viability of goshawk populations, which depend on these habitats, have been expressed by wildlife professionals and the public. These concerns have prompted the Forest Service, the Department and the New Mexico Department of Game and Fish (NMDGF) to gather information on the distribution and status of goshawk populations and to identify the forest habitat conditions necessary to sustain these populations. The Department's activities related to these issues have been ongoing for many years (Appendix 3). In 1982, the Regional Forester classified the goshawk as a sensitive species on all Forest Service lands in Arizona and New Mexico (USFS 1991). In 1988, the Northern goshawk was listed by the Arizona Game and Fish Commission (1988) as a Candidate species in Arizona and has been recommended for listing on New Mexico's state list. Recently, U.S. Fish and Wildlife Service (USFWS) listed the goshawk as a Candidate Category 2 species (species being considered for listing pending more information) (USDI Fish and Wildlife Service 1991:58810).

Goshawk habitat inventory and monitoring activities began on the Kaibab National Forest in the 1970s because of concern over possible population declines (Appendix 3). The Kaibab Plateau was of particular interest because it had, and continues to have, the highest known density of goshawk nests in the Forest Service's Southwestern Region. In 1988, systematic inventory and monitoring activities on the Kaibab Plateau expanded in an effort to establish a data base on goshawk nesting activity and reproductive success. This effort continues under the direction of Dr. Richard Reynolds of the Forest Service Rocky Mountain Forest and Range Experiment Station and the Department. In 1992, the Department began goshawk surveys in other parts of Arizona, including the BLM Arizona Strip District, the Apache-Sitgreaves and Coronado National Forests. Additional information on goshawk home ranges, food habits, and habitat use has come from a variety of completed and ongoing studies in Arizona and New Mexico (Boal and Mannan 1991, 1992; Kennedy 1988a, 1988b, 1989, 1990a, 1990b; Smith and Mannan in review).

As the body of knowledge grew, so did concerns over the status of the goshawk. In March of 1990, in response to a letter from several environmental organizations, the Regional Forester conducted an internal status review on the goshawk. The result of this review was the creation, in August 1990 of the Regional GSC and the Regional Goshawk Task Force (GTF). The GSC began meeting in October 1990 and was charged with developing a credible management strategy to conserve the goshawk in the Southwest (Reynolds et al. 1992). Although representatives from the Department and NMDGF had the opportunity to attend the initial GSC meeting, they were refused membership on the GSC. Subsequent GSC meetings were closed to the State agencies whose legal mandates are to manage wildlife, including the goshawk. Despite state agency membership on the GTF, the final GSC management recommendations did not resolve issues raised by the Department at GTF meetings. In addition, issues raised by the USFWS (which also has responsibilities for migratory birds, including the goshawk) were not resolved.

The function of the GTF was to provide the Regional Forester with possible management options for maintaining viable goshawk populations, while fulfilling other multiple-use responsibilities. The GTF was made up of representatives from the USFWS, Forest Service, Department, NMDGF, the timber industry and concerned citizens. Representatives from environmental groups resigned after the first GTF meeting when Regional Forester David Jolly withdrew his previous commitment to write an Environmental Impact Statement (EIS) to address goshawk management. The environmental groups considered an EIS an essential step to resolve their concerns.

In spring of 1991, the GSC had not yet completed its work. However, the Regional Forester asked the GTF to consider adopting interim goshawk guidelines based on a GSC report, dated March 22, 1991, which was not made available in its entirety to the GTF. Representatives of the three wildlife agencies on the GTF objected to this request. Subsequently, the GSC recommended implementation of interim guidelines which addressed management of nest areas and PFAs (600 acres), but not foraging areas (5,400 acres). The Forest Service issued these interim (one year) guidelines in June 1991 without any other public review process or National Environmental Policy Act (NEPA) documentation by claiming "...the immediate need to protect occupied northern goshawk habitat while gathering additional data..." (USDA Forest Service 1991a:28854). Public comments were invited after the guidelines were published in the Federal Register (USDA Forest Service 1991a).

The Regional Forester's decision to implement the interim guidelines was appealed by a coalition of environmental groups in July 1991. The Chief of the Forest Service dismissed the appeal but directed the Regional Forester to republish the guidelines with any necessary adjustments resulting from public comments. The interim guidelines were republished in October 1991 and did provide some clarification to the June 1991 guidelines. A Biological Evaluation (BE), Environmental Assessment (EA) and Finding of No

Significant Impact were also issued as the NEPA compliance documents for these guidelines in October 1991. After the appeal was dismissed, the coalition of environmental groups filed suit in federal district court to stop implementation of the June 1991 guidelines. However, by the time the case was reviewed in November, the October 1991 revision had been issued, partially rendering the case moot. Upon request of the plaintiffs, the judge dismissed the case without prejudice.

The GSC continued its work on the development of final recommendations. In January 1992, the GSC distributed what was first identified as a draft but later was determined to be the final MRNG. This document included management of nest areas, PFAs and the 5,400 acre foraging area. At the March 1992 GTF meeting, concerns were raised about the MRNG and a consensus recommendation to the Regional Forester could not be achieved. In April 1992, the Department forwarded to the Forest Service a specific set of concerns, as well as suggested changes to the MRNG (Appendix 1). The USFWS also expressed their concerns with the MRNG in a letter to the Regional Forester, dated August 1992 (Appendix 1).

The Regional Forester accepted the GSC's recommendations (MRNG) and used them as the basis for the existing Interim Guidelines. These Interim Guidelines were issued in June 1992 (USDA Forest Service 1992a) and are in effect through December 8, 1993. Also in June 1992, the Forest Service issued a notice of intent to prepare an EIS to amend Forest Land and Resource Management Plans that would incorporate guidelines for management of habitat for the goshawk and Mexican spotted owl (*Strix occidentalis lucida*). To date, the Department is not aware of Forest Service activities relating to preparation of this EIS.

To address growing concerns over the viability of goshawk populations, the Department contracted with Dr. Lynn Maguire of Duke University to conduct a Population Viability Analysis (PVA) of the goshawk population on the North Kaibab Ranger District of the Kaibab National Forest. This PVA was conducted during 1992 and included a workshop in which experts on goshawk biology and management provided estimates for the contractor's population model. Due to the range of variability in population parameter estimates, the PVA failed to reach a conclusion as to whether the goshawk population on the North Kaibab was increasing, decreasing or remaining stable. However, the PVA did identify important information gaps. A final report containing the results of the PVA and recommendations for future research and monitoring was completed in 1993 (Maguire 1993) (Appendix 4).

In summer of 1992, the Kaibab National Forest developed the Implementation Guidelines. The three wildlife agencies expressed concerns that application of these guidelines could harm many wildlife species, including the goshawk. After examining the results of their implementation on specific demonstration projects and timber sales, the Department continues to have serious concerns.

In the Fall of 1992, when questions were raised regarding the public review and NEPA compliance process used for the Interim Guidelines, the Forest Service indicated that a supplemental EA and BE had been prepared in May 1992 to address management activities in the foraging areas. When the Department requested these documents, the Forest Service could not locate them and they were not provided to the Department until January 1993. The BE was dated January 19, 1993.

The Department, NMDGF and the USFWS continue to have concerns regarding the MRNG, the Interim Guidelines and their on-the-ground application. The Department's efforts to resolve these concerns are ongoing and include participation on a Goshawk Implementation Team with the other wildlife agencies and the Forest Service.

## ISSUES REGARDING THE ASSUMPTIONS OF THE FOREST SERVICE MANAGEMENT STRATEGY FOR THE NORTHERN GOSHAWK

### Assumptions Regarding Goshawks

The MRNG argues that the goshawk is a "forest habitat generalist" because goshawks occur in many different forest types (pine, fir, aspen, etc.). However, goshawks have evolved physical characteristics (morphology) that enable them to hunt most efficiently in relatively mature, dense forest structures. Therefore, the Department considers the goshawk a "forest habitat specialist" that is strongly associated with mature, dense forest structure in many forest types. Open forest structures give the competitive advantage to raptors with other hunting styles and morphology. As a habitat specialist, rather than a habitat generalist, loss of nest sites or suitable foraging habitat may limit goshawk population density and distribution.

### Morphology, Foraging Behavior and Competition

Goshawks have relatively long tails and short wings (Bent 1937, Phillips et al. 1964, Mavrogordato 1973, Parry and Putman 1979, Wood and Fyfe 1981, Grossman et al. 1988, Brown and Amadon 1989, Reynolds 1989, Snyder and Snyder 1991). Agility and fast bursts of speed are trademarks of accipiters such as the goshawk. The short wings allow quick maneuvers with the tail balancing these quick movements by functioning as a rudder (May 1935, Bent 1937, Phillips et al. 1964, Mavrogordato 1973, Parry and Putman 1979, Brown and Amadon 1989, Reynolds 1989, Snyder and Snyder 1991). These morphological characteristics allow goshawks to fly easily through a relatively dense forest.

Goshawks are characterized as "short sit-and-wait" predators (Beebe and Webster 1989, Brown and Amadon 1989, Grossman et al. 1988, Johnsgard 1990, May 1935, Palmer 1988, Phillips et al. 1964, Wood and Fyfe 1981), that perch in concealed locations to avoid detection by possible prey before quickly flying a short distance to take the unsuspecting prey (Beebe and Webster 1989, Brown and Amadon 1989, Grossman et al.1988, Johnsgard 1990, May 1935, Phillips et al. 1964). The morphology of the goshawk enables it to move quickly and easily through cover to approach the perch unseen and then gives it the agility to capture prey, even in relatively dense cover (Bent 1937, Brown and Amadon 1989, Grossman et al. 1988, Johnsgard 1990, Mavrogordato 1973, May 1935, Palmer 1988, Parry and Putman 1979, Phillips et al. 1964, Reynolds 1989, Snyder and Snyder 1991, Wood and Fyfe 1981). The goshawk's hunting style of moving quickly from low perch to low perch in the forest, remaining at each spot for only a short time, also allows it to search a large area for prey.

Buteos and falcons have a different morphology; these birds have relatively longer wings and are adapted to hunt in more open

habitat (Brown and Amadon 1989, Cade 1982). The red-tailed hawk hunts by either remaining stationary on a perch for long periods or by soaring at a relatively high altitude. Both strategies allow it to scan large areas for unwary prey. Open vegetation facilitates this search. When prey is spotted, the red-tail can wait until the prey is most vulnerable, then drop from the perch or sky for the capture. The red-tail's morphology and foraging behavior are most efficient in open habitats where large areas can be searched from a few sites.

The Department and the authors of the MRNG agree about the morphological characteristics that give goshawks the necessary maneuverability to hunt in forests (Reynolds et al. 1992:10). However, the Department disagrees with the open forest conditions advocated in the MRNG and Implementation Guidelines for the foraging areas, since these conditions create a forest structure where goshawks cannot use their morphological adaptations most efficiently. This theme is central to the Department's concerns.

Smith and Mannan (in review) used radio telemetry to repeatedly locate male goshawks during the breeding season on the North Kaibab Ranger District. Since males capture prey to feed themselves, the nesting female and their young during this period, the male's use of habitat was assumed to reflect its foraging value. Smith and Mannan (in review) plotted the male's locations on maps showing different forest canopy cover classes (0-15%, 15-40%, 40-55%, and 55+%). They found that goshawk use of areas increased as the canopy cover increased. Smith and Mannan (in review) supported the MRNG's recommendation to leave 60% of the foraging area in stands with high canopy cover, but recommended the minimum canopy cover in these areas be increased from 40% to 55%. Smith and Mannan (pers. commun.) cautioned that final revisions may adjust this recommendation.

Austin (1991) found that goshawks selected the oldest, densest vegetation type available, and avoided the youngest and most open. Kennedy (1989) recommended that no timber harvest occur in a 415 acre area around goshawk nests and that canopy cover in the surrounding 1,185 acres (male core use area) not be reduced below 60%. Kennedy (1989:13) predicted that goshawks nesting in good habitat would have smaller home ranges than those using marginal habitat. "Major vegetation changes such as logging may impact Accipiter home range size by changing good quality hunting habitat to more marginal habitat" (Kennedy 1989:13). Kennedy's (1989) telemetry study found that a male goshawk's home range, in an area managed extensively for timber in recent years, was quite a bit larger than home ranges of males nesting in less managed sites. Kennedy (1989) found the same trend with home ranges of Cooper's hawk (*Accipiter cooperi*) males.

An examination of 38,300 acres of ponderosa pine, centered around goshawk nests on the North Kaibab, Ward et al. (1992) found that, between 1972 and the late 1980s, the percent of this area with less than 40% canopy cover, had increased from 10% to 46% (Fig. 2).

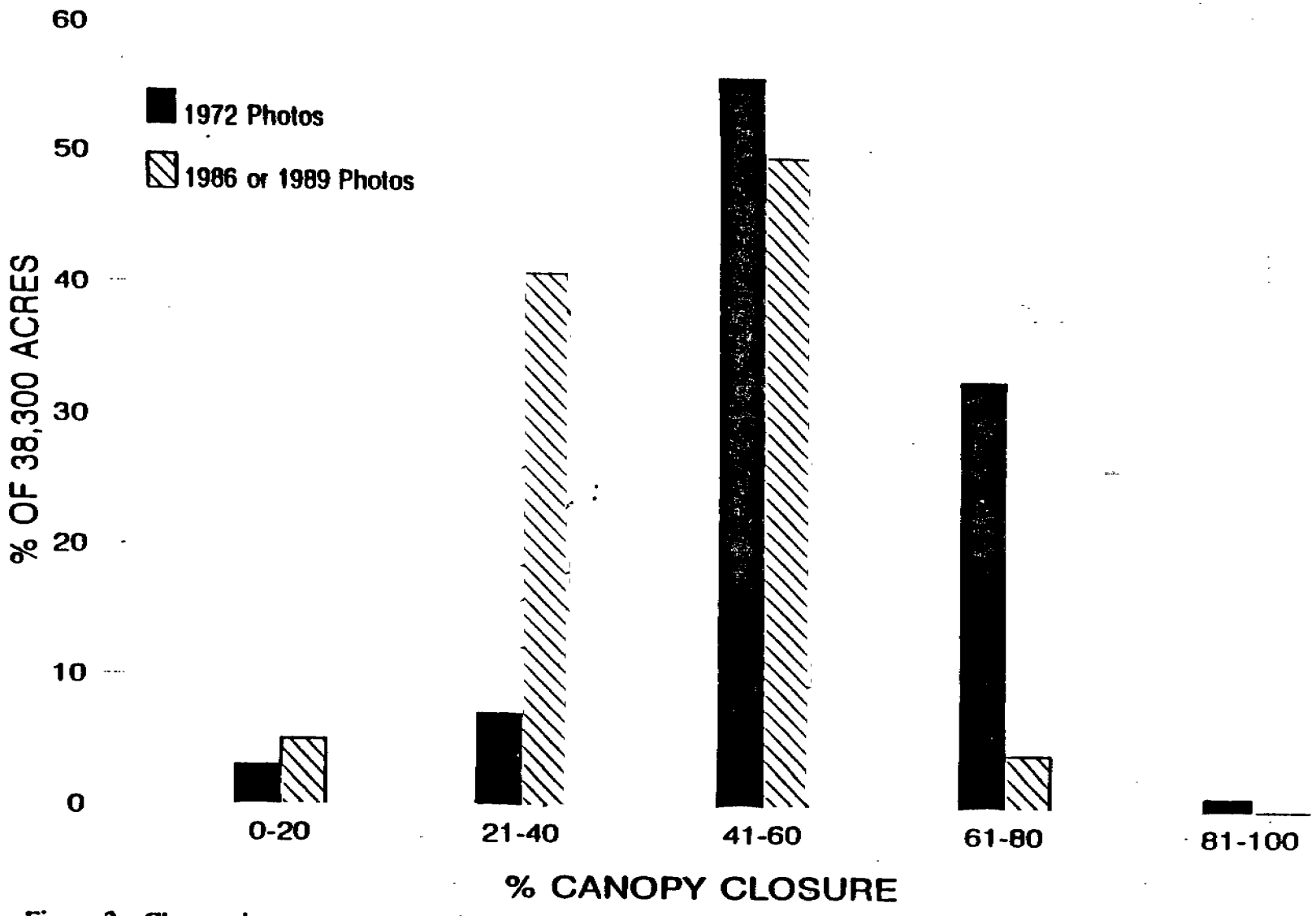


Figure 2. Changes in per cent canopy closure as estimated from aerial photographs on 38,300 acres of ponderosa pine on the North Kaibab Ranger District, 1972 to 1986/1989. From Ward et. al., 1992.

The percent of the area over 60% canopy cover declined from 34% to 4%. Since the late 1980s, more thinning has occurred on the North Kaibab, further reducing the area which, according to Smith and Mannan (in review), is most used by male goshawks.

The MRNG advocates an open foraging area in ponderosa pine (40%+ canopy cover). The Implementation Guidelines propose a harvest scheme that will open the forest even more (approaching 30% canopy cover in the younger stands). Management for a **maximum** canopy cover level of 40%, over large areas, has been proposed in upcoming timber sales on the North Kaibab Ranger District (i.e., Paris and Holy Hollow Timber Sales).

Based on the research discussed above, the Department cannot support the assumption that such open foraging conditions can benefit goshawks. Instead, the Department believes that those conditions will reduce or eliminate goshawk foraging activity.

Another Department concern regarding an open forest is the competitive advantage it gives to other raptors. Forest management practices that create open forest structure usually benefit red-tailed hawks or great horned owls because they have wide ecological tolerances (McCarthy et al. 1989). In Arizona, the red-tailed hawk is a common resident statewide and the great horned owl is found everywhere except in the densest unbroken forests and in chaparral (Phillips et al. 1964). Great-horned owls occupy more diverse habitats than any other species of owl (Peterson 1989). Ganey (pers. commun.) observed that great horned owls increase as the forest canopy is opened. Moore and Henny (1983) stated that logging may benefit these two predators and result in increased competition with, and predation upon, accipiters. Beebe (1992) believed that these two raptors and the Cooper's hawk compete with the goshawk for nest sites. Franzreb and Ohmart (1978) observed an increase in red-tailed hawk and great horned owl abundance after logging on study plots in the Willow Creek watershed on the Apache-Sitgreaves National Forests, Arizona. On the North Kaibab Ranger District, eight instances of goshawk nest sites being taken over by red-tailed hawks or great horned owls were documented from 1985 to 1992 (Zinn and Tibbitts 1990, Heslin and Driscoll in review).

The Department believes that red-tailed hawk and great horned owl abundance will continue to increase in response to the opening of the forest and lead to increased competition with the goshawk. Competition can manifest itself through interspecific aggression, direct predation on goshawks (especially nestlings), as well as through competition for nest sites and prey. Therefore, creating open forest conditions in goshawk foraging habitat, as advocated in the MRNG and Implementation Guidelines, could actually result in a competitive disadvantage for the goshawk.

The Department and the authors of the MRNG differ in the degree to which the forest in foraging areas should be opened. Considering the goshawk's morphology, foraging behavior, habitat preference, and the potential competition from other raptors, the Department recommends most of the forest be managed at higher canopy densities than is now proposed in the Implementation Guidelines. The Department's recommendations are found at the end of this document (Arizona Game and Fish Department Recommendations).

## Comparison of Productivity in Different Habitats

The Grand Canyon separates the Kaibab National Forest into two areas (north and south) which have very different habitat conditions. Despite heavy timber harvest in recent years (Zinn and Tibbitts 1990, Cassidy 1991), the North Kaibab still features an older aged forest structure. The South Kaibab received heavy timber harvest decades ago and is now dominated by a younger forest, much of which has been heavily thinned.

One measure of habitat quality is reproductive success. The Department made a preliminary comparison of goshawk reproduction data between the North Kaibab and South Kaibab. In 1992, on the North Kaibab, 51 goshawk nesting attempts fledged an average of 1.8 young per nest (Reynolds 1992). In the same year, 16 nesting attempts on the South Kaibab produced an average of 1.1 fledglings per nest (McGuinn-Robbins 1992). These reproductive rates were statistically different ($Z = -2.2$, $P > |Z| = 0.03$).

Although this is only a preliminary comparison of the two reproductive rates, it demonstrates the need for further comparisons of goshawk reproductive rates in different forest habitat conditions. In comparing goshawk habitat on the North Kaibab with that in New Mexico, Kennedy (1988b:225) suggested "... if old growth habitat is available, northern goshawks will select this habitat and the population will thrive. Extensive removal of old growth habitat in portions of New Mexico has probably reduced the northern goshawk nesting population and forced it to occupy marginal habitat..." Maguire (1993:23) warned, "Declines in reproductive rates, particularly if they last more than one year, can signal deteriorating habitat. Declines in goshawk numbers, and particularly in territory occupancy, should be viewed with even greater alarm." She recommended region-wide monitoring of goshawk numbers, territory occupancy and reproductive rates.

Differences in forest structure may be a major reason why goshawks on the North Kaibab have a statistically higher reproductive rate per nest than those on the South Kaibab. Until there is a better understanding of the relationship between forest structure and goshawk reproductive rates, the Department considers that managing for more open forest structure is inconsistent with the Forest Service's objective of sustaining goshawk populations (Reynolds et al. 1992:1).

## Assumptions Regarding Goshawk Prey

### Prey Abundance

The MRNG assumes that it is beneficial to manage for open forest conditions in the goshawk foraging area to provide habitat for certain small mammals and birds. The MRNG also assumes that these birds and mammals will be available as prey for goshawks with open forest conditions. The Department disagrees with the assumed need to provide open forest conditions throughout the foraging area. The Department believes that mature, dense forests, where goshawks hunt most effectively, support a diverse prey base, and that goshawks capture prey opportunistically within the structural environment suited to their foraging behavior.

The MRNG states that as many as 50 species of prey are taken by goshawks, with 14 species dominating the goshawk diet in the Southwest (Reynolds et al. 1992:4). Thus, the GSC recognized the broad spectrum of prey available to and used by the goshawk as it hunts through the forest. The Department agrees that many of the prey discussed in the MRNG dominate the goshawk's diet. The MRNG's objective to provide an abundant and diverse prey base for the goshawk is desirable.

However, the MRNG's own analysis of prey habitat needs, shows that a relatively dense, mature forest contributed to maintaining high populations of most of the identified prey during the summer (Fig. 3). During the winter, which may be the most stressful time for goshawks to find prey, six of the 14 targeted prey species have migrated or hibernated, and are thus unavailable. Again, the MRNGs stated that in order to maintain high populations, seven of the remaining eight prey species benefitted from a dense, mature forest structure (Fig. 4), and one, the cottontail, requires cover. Yet,the Implementation Guidelines propose timber management at or below 40% canopy cover, a level which the MRNG shows will not contribute to high populations of most goshawk prey. Furthermore, the MRNG does not recommend that the entire goshawk foraging area be open, only that small openings ($\leq$ 4 acres) are valuable.

Smith and Mannan (in review), Austin (1991), Kennedy (1989), Hargis et al. (in prep.), Crocker-Bedford (1990a), Widen (1989) and Fischer (1986) have described the goshawk's preference for older and/or denser forests. The goshawk's morphological characteristics allow it to hunt efficiently in dense, mature forests. The MRNG, Siegel (1989), Patton (1975, 1984), Patton et al. (1985), Vahle and Patton (1983), and Goodwin and Hungerford (1979) all describe the abundant and/or diverse prey populations found in dense, mature forests. Therefore, the Department believes that managing for a relatively dense, mature forest structure provides the foraging habitat used by goshawks and abundant prey that can be efficiently captured.

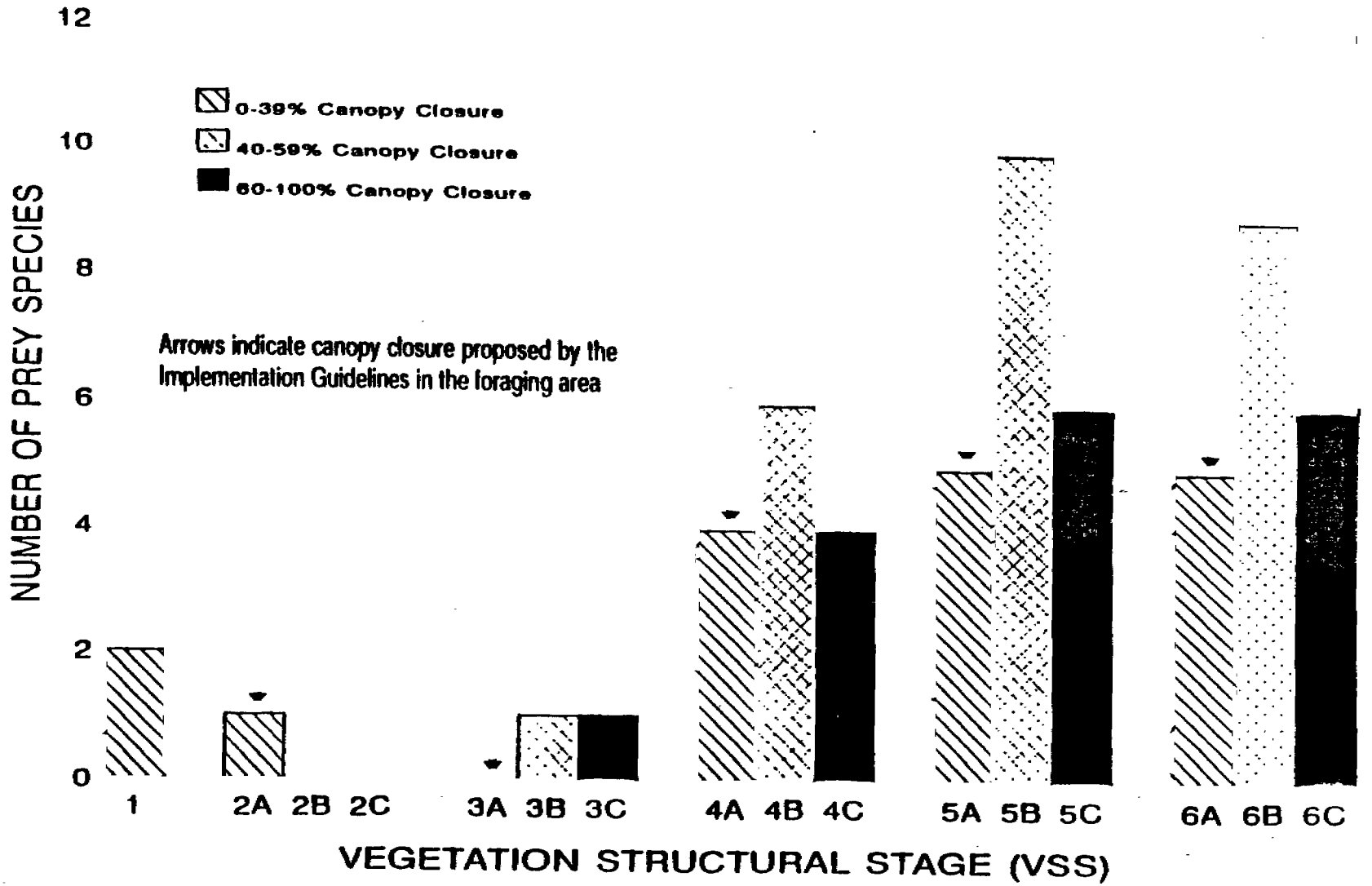


Figure 3. Vegetation Structural Stage (VSS) density classes that contribute to high populations of 14 summer prey species. From Reynolds et. al. 1992.

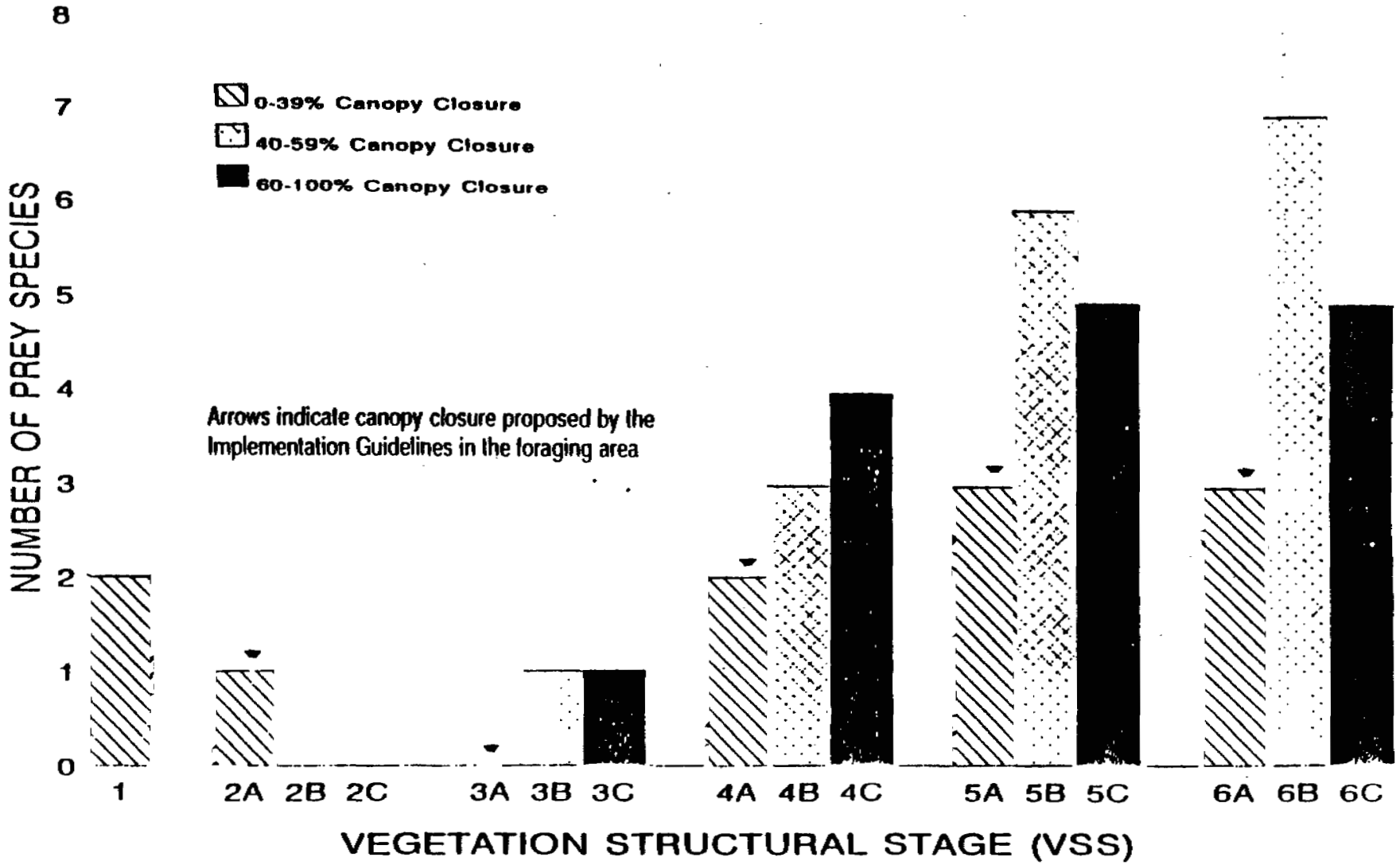


Figure 4. Vegetation Structural Stage (VSS) density classes that contribute to high populations of 8 winter prey species. From Reynolds et. al. 1992.

Another stated objective of the MRNG is to maintain a healthy mycorrhizal fungi community (Reynolds et al. 1992:31). The MRNG describes the importance of fungi as food for small mammals (including for several of the targeted prey species) and as a critical factor for tree nutrient absorption and regeneration. Fungi are the "foundation of a healthy forest ecosystem" (Reynolds et al.1992:32). However, to maintain a healthy fungi community requires a minimum canopy cover of 60% (States 1985, States et al. 1988), which the MRNG and Implementation Guidelines fail to provide in the foraging area.

The Department believes that by managing the foraging area to provide a more dense (i.e., with much of the canopy cover above 60%) mature forest, the Forest Service can maintain the mycorrhizal fungi community, high quality habitat for numerous prey and, most importantly, provide a forest structure where goshawks can effectively and successfully hunt.

## Open Forest Conditions and Forage Utilization Levels

The MRNG attempts to provide food and cover for small mammals and birds by recommending open forest conditions in goshawk foraging areas and by limiting grazing utilization levels on grasses, forbs and shrubs.

*Open Forest Conditions.* The MRNG states that closed canopied forests are often limited in the quantity of plant foods (seeds and berries) (Reynolds et al. 1992:18) important for goshawk prey species. The MRNG thereby justifies the need to create an open canopy, which will allow sunlight to reach the forest floor to grow food and cover for many prey species.

Vegetative species composition and diversity vary with the degree of available sunlight, as indicated in the MRNG, but they also vary with elevation, aspect, moisture, soil and temperature gradients (Peet 1988). Opening the forest may produce more grass and forb growth on some sites, e.g., on north- and east-facing slopes. However, on sites with lower moisture levels and higher temperatures (e.g., south-facing slopes), further opening of the forest could further decrease available moisture and increase ground temperature, leading to species composition changes and decreased production. In fact, a decrease in available moisture and increase in temperature on a given site could result in reduced plant diversity and reduced habitat quality for goshawk prey species. Therefore, although timber harvest does allow more sunlight to reach the forest floor, a blanket assumption that a more open forest will increase forest floor vegetation and prey abundance is not justified.

The MRNG assumes that opening the forest will lead to increased grass and forb production, as well as increased shrub production. Shrub production is necessary to achieve the benefits predicted by the MRNG for goshawk prey species. The MRNG specifically refers to producing berries and providing cover by opening the forest. For some prey species (e.g., cottontails, band-tailed pigeon, blue grouse), an increase in shrubs can be beneficial. In Arizona's ponderosa pine forests, shrub composition, if shrubs are present at all, is determined by soil type, available moisture and elevation gradients. Many shrub species, such as willows and box elder, are specific to higher elevation riparian areas, while others, such as apache plume, cliffrose and mountain mahogany, are associated with drier, lower elevation sites. Still other shrubs are associated with specific soil types. However, much of the ponderosa pine vegetation type in Arizona is largely devoid of shrubs (USDA Forest Service 1991d). In these areas, any gain in understory (herbaceous/shrub) production will likely result from increased grass production and not from increased shrub production.

No evidence could be found in the literature that indicated increased production of grasses would result in increased goshawk prey species populations. Evidence exists (Goodwin and Hungerford 1979, Thomas et al. 1979) that increased populations of mammals can be achieved by increasing the amount of large, dead woody material on the forest floor. Thus, the MRNG provides for these species' cover needs by recommending that slash and dead woody material be left on the ground, but not by recommending an open forest.

As the MRNG and the Implementation Guidelines are applied on the ground, many treatments are not achieving small openings in dense forest, where the MRNG arguments make the most sense. Instead, the majority of treatments have taken place along ridgetops which have been harvested within the last 10 years and are already in a relatively open condition. Thus, the MRNG's recommendations are being used to further open an already open forest. As already discussed earlier in this document, some species, such as red-tailed hawks, may benefit from this open forest but the Department considers such management detrimental to both the goshawk and its prey.

*Forage Utilization Levels.* The Department has consistently advocated and supported sound range management. Benefits include stable and productive soils, healthy watershed conditions and forage for both wildlife and livestock. However, the Department has been unable to find any scientific literature which indicates that an average utilization of 20% on grasses and forbs advocated in the MRNG will significantly benefit any of the goshawk prey species identified. Goodwin and Hungerford (1979) found that abundance of large downed woody material regulated many small mammal populations in ponderosa pine, not herbage production.

The Department has consistently coordinated with Forest Service range conservationists at both programmatic and project levels to promote sound range management which can benefit wildlife. The Department suggests that these are the appropriate forums for developing range management objectives unless the GSC can provide scientific evidence that goshawks are being harmed by current Forest Service grazing practices.

**Assumptions Regarding Implementation of the Forest Service Management Strategy**

Vegetation Structural Stage 6 and Stand Density Index

Vegetation Structural Stage (VSS) is a method of describing a stand of live trees that considers tree size, number of trees and crown canopy cover (Reynolds et al. 1992). The initial VSS system used in the Southwestern Region of the Forest Service described five forest structural stages. The system was developed to help wildlife biologists describe wildlife habitat. At that time, VSS 5 referred to old trees (mature and old growth) which had value primarily in describing habitat for songbirds and raptors. When the Forest Service decided to revise the VSS classes, VSS 6 was added to represent true old growth (dense, old trees plus snags and downed logs).

In order to accommodate VSS classes into existing Forest Service computer data bases, silviculturists inappropriately assumed that tree size, measured as diameter at breast height (DBH), reflected wildlife habitat values which the wildlife biologists associated with the VSS classes. At that point, VSS 5 was defined as trees 18.0-23.9 inches DBH, and VSS 6, trees 24.0 inches DBH and greater. This reinterpretation compromised the original meaning of the classes as descriptions of wildlife habitat. For example, an 18 inch blackjack (a young, dark-barked ponderosa pine tree) was attributed the same wildlife habitat value as an 18 inch yellow pine (mature, yellow-barked ponderosa pine tree). Although these trees are the same DBH, their wildlife habitat attributes are very different. The bark and limb characteristics of the older trees serve different functions for wildlife than those of younger trees. Many songbirds that use ponderosa pine show a strong preference for yellow pines over blackjacks (Keller 1991). The habitat values attributed to VSS 5 and 6 only apply to older trees (150+ years) and do not necessarily apply to all large (greater than 18 inches DBH) trees.

In turn, this reinterpretation of the VSS classes has had a significant impact on modeling, which drives decisions regarding goshawk habitat management. For example, when PROGNOSIS (Forest Service timber growth and yield model) is used to model stand growth, tradeoffs between tree growth and tree density must be

acknowledged. If the objective is to grow big trees quickly, they must not compete with each other. Hence, the model indicates the forest stand will need to be very open.

In order to demonstrate tradeoffs, the Department ran PROGNOSIS using a range of stand density index (SDI) levels (Appendix 5). SDI is most often described as a percentage of the maximum density that a given species of tree can reach. The wildlife equivalent is the idea of carrying capacity. A pond stocked with catfish can only carry a certain biomass of catfish without supplemental feeding. If the carrying capacity of the pond is 500 pounds, you can choose to have 500-one pound catfish or 100-five pound catfish, but not 150-five pound catfish. The nutrients limit what you can grow and simply won't support more than 500 pounds of catfish. SDI is the silvicultural counterpart of carrying capacity.

Maximum SDI represents an estimate of the maximum density of trees that can be grown on an acre. SDI is often described by both numbers and percentages. For ponderosa pine, maximum SDI (100% SDI) equates to the number 450 (Menasco and Higgins 1992, USDA Forest Service 1992c). Long (1985) gives three "key" SDI values which are important thresholds for timber management. The first key SDI value is 25% of maximum SDI, which equates to an SDI of 112. Long identifies this point as the onset of competition. Below this SDI, there is no competition between trees for available nutrients. Above this point, trees begin to compete slightly, but do not significantly inhibit each other's growth. The second key value is 35% of maximum SDI, which approximates an SDI of 160. This is the lower limit of full site occupancy. Above 160, all factors limiting stand growth (light, water, nutrients) are being used by the trees. Management below 160 results in a direct loss of potential wood production because the land has surplus nutrients which are not being used by the trees for growth. The third key value is 60% of maximum SDI, or an SDI of 270. Above this level some trees in the stand begin to die from competition.

Long (1985) suggested managing between 35% and 50% of maximum SDI where a relatively high priority is placed on maximization of timber volume production. For ponderosa pine, these percentages equal SDI 158 and 225, respectively. The Southwestern Region of the Forest Service's stocking chart for ponderosa pine (site index 70+) set the lower and upper management limits at SDI 110 and 348, respectively.

A series of PROGNOSIS runs modeled the effects of managing at different SDI levels in ponderosa pine stands. Four SDI levels were modeled using a site index of 70 and can be compared to the MRNG's Appendix 5 and the Implementation Guidelines' Appendix B. SDI levels of 90, 140, 160, and 220 were chosen to serve as bench marks and represent degrees of stand densities actually used or under consideration for forest management.

The PROGNOSIS model run using an SDI of 90 represents 20% of maximum density. This is the SDI level used in the Implementation Guidelines for the goshawk foraging area . According to PROGNOSIS, this SDI approximates 30% canopy cover; however, the Implementation Guidelines use it to represent the minimum canopy cover of 40% identified in the MRNG for management of goshawk foraging areas.

The PROGNOSIS model run using an SDI of 140 represents 31% of maximum density. PROGNOSIS shows an SDI of 140 provides the 40% canopy cover called for in the MRNG for the goshawk foraging area. The Southwestern Region of the Forest Service (1992c) sets a similar SDI level.

The PROGNOSIS model run using an SDI of 160 approximates 35% of maximum density and is the SDI which the Implementation Guidelines used to manage the goshawk PFAs. The Implementation Guidelines used SDI 160 to represent 60% canopy cover; however PROGNOSIS indicated this SDI produced a canopy cover closer to 45%.

The PROGNOSIS model run using an SDI of 220, 49% of maximum SDI, approaches 60% canopy cover. Again, the Southwestern Region (USDA Forest Service 1992c) uses a similar SDI value (212). Determining SDI levels equal to 40% and 60% canopy cover is important because these are forest management thresholds defined in the MRNG for different portions of the goshawk home range.

Results of SDI comparisons showed canopy cover, foliage biomass, and timber volume outputs all increased as SDI increased (Table 1). Estimated foliage biomass, used as an index to foliage volume, is correlated with songbird densities (Szaro 1976, Szaro and Balda 1979). Higher foliage volumes usually support higher bird densities. Average tree diameter at a given time decreased because higher SDIs produced denser stands of trees. However, all SDIs produced trees that would make quality snags (generally over 18 inch DBH with yellow bark) by 200 years. The Department cautions the reader to remember that these numbers come from a computer model simulation. The trends shown should be real but the numbers should only be considered as approximations.

The Department continues to be concerned that the low canopy cover (i.e., 40% or less) and low tree densities prescribed under the Implementation Guidelines will negatively impact wildlife habitat. This analysis of the effects of increasing SDI values suggests that harvest of timber is higher over time with increased SDIs as well as important wildlife habitat factors such as foliage biomass and canopy cover. Although tree diameters are smaller with increasing SDI values, the difference is not enough to negatively affect the function of these trees as wildlife habitat (see discussion on cavity-dependent birds in section entitled "Issues Requiring Further Consideration").

Table 1. Effects of different SDI levels on several modeling factors using the timber growth and yield model, PROGNOSIS.

**EFFECT OF CHANGING SDI ON PROGNOSIS MODELING RESULTS**

| MODELING FACTORS | STAND DENSITY INDEX 90 | 140 | 160 | 220 |
|---|---|---|---|---|
| PERCENT CANOPY COVER AT 100 YRS. | 27 | 39 | 44 | 58 |
| PERCENT CANOPY COVER AT 200 YRS. [1] | 30 | 41 | 45 | 57 |
| PERCENT CANOPY COVER AT 250 YRS. [2] | 32 | 44 | 48 | 60 |
| FOLIAGE BIOMASS (LB/AC) AT 200 YRS. | 3,764 | 4,539 | 4,852 | 5,381 |
| FOLIAGE BIOMASS (LB/AC) AT 250 YRS. | 3,624 | 4,544 | 4,834 | 4,929 |
| QUADRATIC MEAN DIAMETER (INCHES) AT 200 YRS. [3] | 30.5 | 26.9 | 26.2 | 22.7 |
| QUADRATIC MEAN DIAMETER (INCHES) AT 250 YRS. | 34.0 | 30.1 | 28.9 | 24.9 |
| MERCHANTABLE VOL (BF/AC) AT 200 YRS. | 15,386 | 21,772 | 24,979 | 28,295 |
| MERCHANTABLE VOL (BF/AC) AT 250 YRS. | 15,774 | 23,034 | 25,269 | 30,270 |
| TOTAL VOLUME (BF/AC) FOR 200 YRS.[4] | 28,686 | 33,711 | 36,433 | 39,446 |
| TOTAL VOLUME (BF/AC) TO 250 YRS. | 32,439 | 38,610 | 42,042 | 45,104 |

[1] Implementation Guidelines use a 200 year rotation in the goshawk foraging area.
[2] Rotation age proposed by Arizona Game and Fish Department (see Recommendations section).
[3] Quadratic mean diameter equals the DBH of the tree of average basal area in a given stand (Smith 1986).
[4] Total volume is thinning volume plus all merchantable volume through the end of the rotation.

It is difficult to understand why the Forest Service has chosen such a low SDI level for management of the goshawk foraging area. Not only does this prescription fail to achieve even the minimum canopy cover called for by the MRNG (40% for VSS 4-6 in ponderosa pine foraging areas) but, it yields less timber volume over time.

The Department recommends that the goshawk foraging area be managed for a higher average canopy cover with a wide range of forest densities around that average. Specific recommendations are provided at the end of this document (see Arizona Game and Fish Department Recommendations).

## Snag Recruitment and Longevity Modeling

The importance of snags (standing dead trees) to the forest ecosystem has been well documented. For instance, snags are utilized by 85 species of North American birds (Scott et al. 1977), a minimum of 49 species of mammals, as well as some species of reptiles, amphibians, and invertebrates (Davis 1983). Cavity-nesting bird species also play an important role in the preventing insect outbreaks (Otvos 1979, Kroll and Fleet 1979). At least 41 species of birds are known to use tree cavities in southwestern forest types (Scott and Patton 1989).

The Forest Land Management Plans and the MRNG recognized the need for providing and maintaining snags to support the forest bird community. The MRNGs goal was to have two snags per acre in the PFA and foraging area. However, there was no clear understanding of how many live trees had to be left as "recruitment" trees to become snags in the future. Therefore, the Department, with input from Forest service personnel, developed a computer model to predict how many snags would be created and maintained over time by leaving different densities and ages of live trees. As already cautioned about the PROGNOSIS model, the Department model can be used to reflect trends but numerical outputs are a function of the assumptions driving the model.

The Department's model, a description of the assumptions driving the model, and the research supporting those assumptions is provided in Appendix 6. As a brief summary of factors driving the model, 1) the model used the trees per acre called for in the Implementation Guidelines for each VSS, 2) the model assumed four reserve trees are left per acre when regeneration harvest occurs (MRNG calls for 3-5 reserve trees), 3) the Department modeled rotation lengths similar to the "intensive management" (194 year rotation) and "minimal management" (233 year rotation) scenarios in the MRNG (the intensive management strategy is used in the Implementation Guidelines for the goshawk foraging area), and 4) the Department modeled a rate of 5% tree mortality per decade, which the Department considered an optimistic rate of snag recruitment (research showed that 3% decadal mortality was more realistic) (Appendix 6).

Results of Snag Recruitment Modeling

Under the "intensive management" scenario, the model projected an average of 1.1 - 1.2 snags per acre would be maintained in the foraging area (Fig. 5). The "minimal management" scenario would only maintain about 1.6 - 1.7 snags per acre. Given the assumptions discussed above, the model projected that a rotation length of at least 250 years was needed to maintain two snags per acre. Therefore, based on model projections, none of the management options offered in the MRNG will meet the MRNGs stated DFC of two snags per acre. The objective of two snags per acre is biologically appropriate, but proposed management strategies cannot accomplish the objective.

The Department's modeling process gave the benefit of the doubt to the MRNG and Implementation Guidelines by 1) setting the recruitment tree mortality at 5%, 2) assuming mortality increased at 150 years of age, and 3) assuming that 25% of the snags remained standing for a maximum of 50 years (unlikely where snags are cut for fuelwood). Therefore, it is likely that the Department's model outputs overestimated the number of snags per acre which will be produced and retained. According to the Department's model, the management scenario cited in the Implementation Guidelines for the goshawk foraging area produced approximately half the desired number of snags.

Therefore, the current goshawk management strategy cannot meet its objective of two snags per acre. To accomplish the MRNG snag objective, at least 12 old trees per acre will have to be left as reserve trees (Fig. 6). Three management changes that can increase snag densities include 1) increase rotation lengths so more of the VSS 5 and 6 trees can become snags, 2) manage for a higher density of VSS 5 and 6 trees per acre so more of those trees can become snags, and 3) leave more reserve trees per acre at the time stands are regenerated.

The Department suggests that all three changes be incorporated. Specific recommendations are provided at the end of this document (see Arizona Game and Fish Department Recommendations).

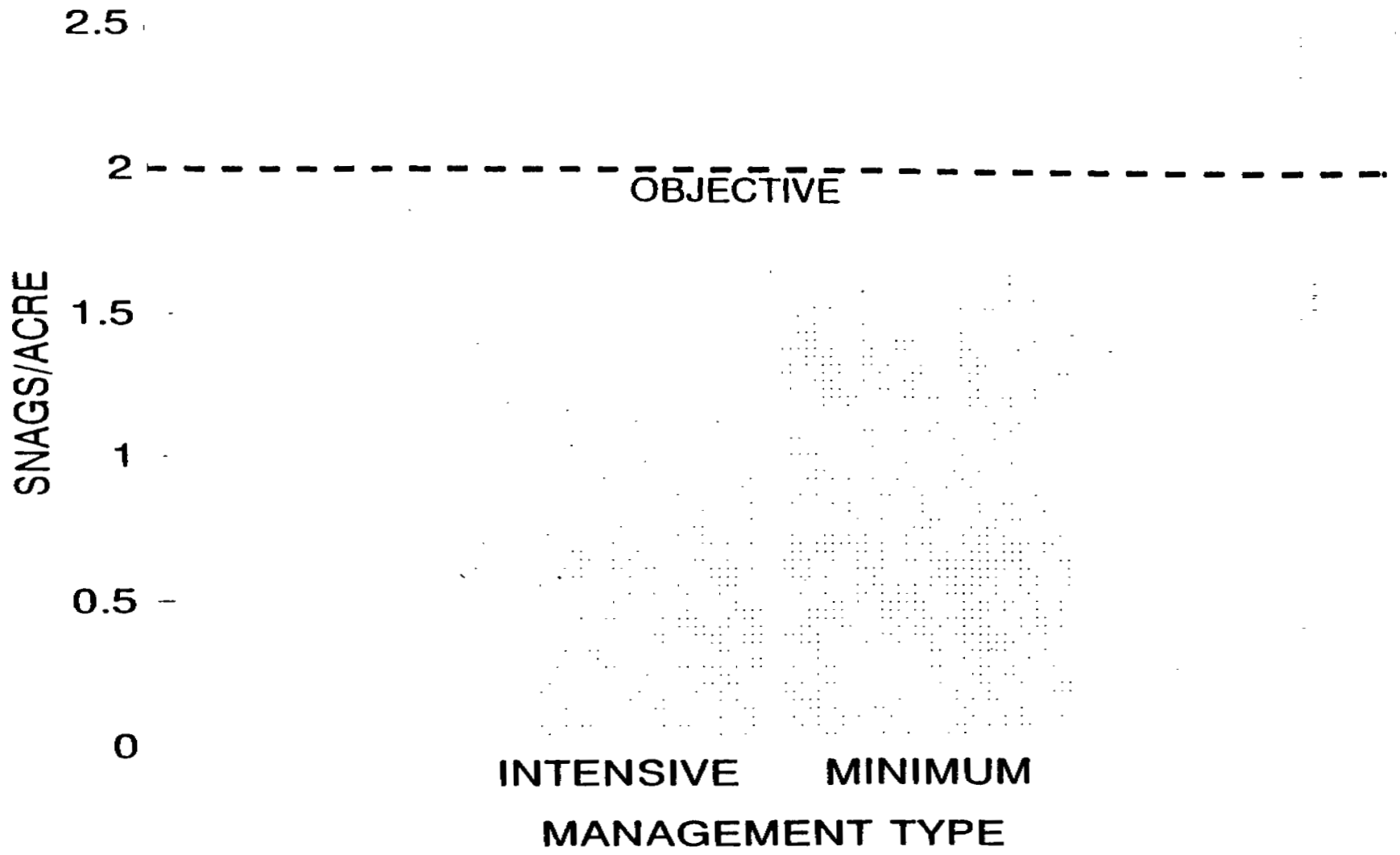


Figure 5. Comparison of snags produced under two Forest Service Management scenarios. "Intensive" management approximates a 190 year rotation. "Minimum" management approximates a 230 year rotation. Both scenarios assume a 5% mortality/decade. From the Arizona Game and Fish Department's Snag Recruitment Model, 1992. See Appendix 6.

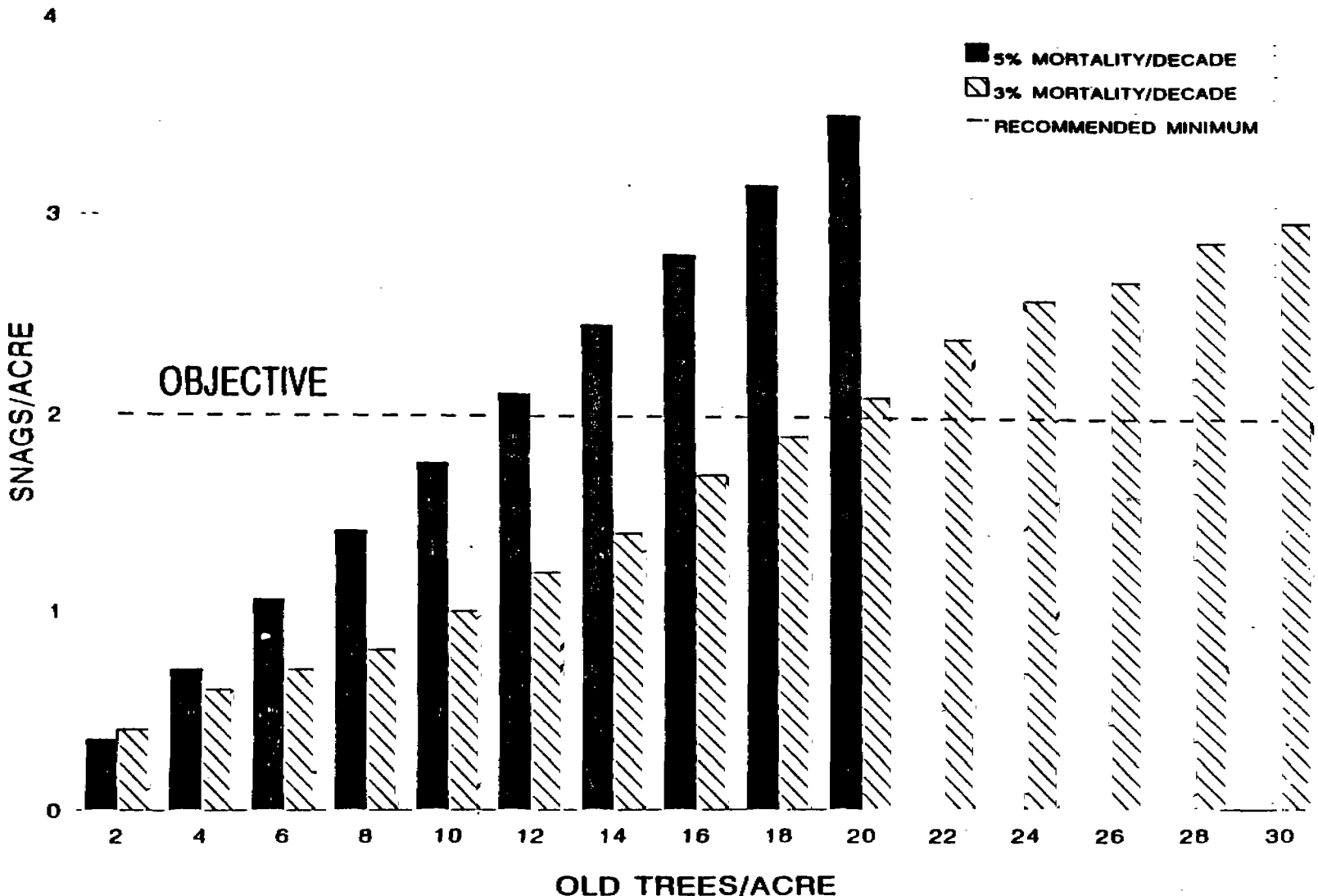


**Figure 6. Comparison of the number of old trees per acre needed to provide two snags per acre at different tree mortality rates. From the Arizona Game and Fish Department's Snag Recruitment Model, 1992. See Appendix 6.**

Management of Goshawk Nest Stands and Post-fledging Family Areas

The Department has two related concerns regarding management of nest areas and PFAs. First, there should be no structural difference between nest areas and PFAs. Second, the MRNG and Implementation Guidelines do not provide for additional PFAs to allow the current goshawk population to maintain itself and to expand into unoccupied habitat.

*Structural Difference.* The MRNG recognized that goshawk nest stands were characterized by "relatively high tree canopy cover and a high density of large trees..."(Reynolds et al. 1992:13). Several studies (Hennessy 1978, Reynolds et al. 1982, Hall 1984) found that goshawks selected nest stands more dense than the surrounding area. Crocker-Bedford and Chaney (1988) found that goshawks nested in the densest stands available on the North Kaibab Ranger District. Goshawks did not nest in stands with less than 60% canopy cover and preferred stands with over 80% canopy cover (Crocker-Bedford and Chaney 1988:213). Minimum canopy cover levels in goshawk nesting habitat were: 79% in good habitat, 72% in suitable habitat, and 60% in marginal habitat (Crocker-Bedford and Chaney 1988:215).

The MRNG cited Kennedy (1989, 1990a) to describe the value and function of the area surrounding the nest. Reynolds et al. (1992:13) stated that although the PFA "...generally includes a variety of forest conditions, the vegetation structure resembles that found within nest stands." The MRNG recommended timber harvest in the PFA to maintain a mix of VSS classes, with the older classes having 50%+ canopy cover.

Kennedy (1989:14,17) did not distinguish between a "nest area" and a "PFA," as in the MRNG, but defined the female goshawk's core area as averaging 415 acres, including the nest. Kennedy (1989) did not describe different forest structures within the core, as done by the MRNG; and furthermore, Kennedy (1989) recommended no silvicultural practices within the female core area which would change the habitat. Kennedy (1989:17) recommended: "Within the zone outside the core area, management should favor treatments that do not reduce canopy coverage below 60%..." This suggests that canopy cover in female core areas was at least 60%.

Therefore, the Department questions the appropriateness of distinguishing between nest stand structure and PFA structure as defined in the MRNG and questions any silvicultural treatments that change current structure.

*Additional Nesting Habitat.* The Department's second concern relates to the failure of the MRNG and Implementation Guidelines to provide suitable habitat into which the known goshawk population can expand. For each pair of goshawks, the MRNG designated a 600 acre block (420 acre PFA and 180 acres of nest area) to be managed for structural attributes quite different from the conditions managed for in the foraging area. If all acres outside established

600 acre blocks are managed as foraging habitat (as has been proposed on the North Kaibab), there will be no 600 acre blocks of unoccupied suitable habitat remaining where new goshawk pairs can nest. Neither the MRNG nor the Implementation Guidelines provide for the recruitment of additional blocks with high quality nesting habitat. As some of the known PFAs are lost to fire or other causes, the goshawk population would be expected to decline. The Department addresses this concern in the recommendations at the end of this document (see Arizona Game and Fish Department Recommendations).

Management of Lands Designated as Old Growth or Unsuitable

Forest managers have expressed interest in applying MRNG prescriptions to areas allocated as old growth and areas designated as "unsuitable" for timber production in Land Management Plans under the provisions of the National Forest Management Act. The impetus for this has been 1) the "landscape ecology approach" proposed by the GSC (Reynolds et al 1992:8), and 2) concerns for forest health (Reynolds et al 1992:79). It has also been stated that implementation of the MRNG will render old growth, snag recruitment, migration corridors, hiding and thermal cover, and other wildlife habitat attributes less meaningful, or of less concern (Menasco and Higgins 1992:6). The implications of this statement and application of the MRNG on acres set aside as old growth or unsuitable for timber production are of serious concern to the Department.

Areas currently exempt from intensive timber management are important habitats for many wildlife species as indicated in the MRNG (Reynolds et al 1992:5, 30, 31). These areas have habitat characteristics that are rare outside of these protected areas (e.g., more snags, larger blocks of habitat, larger trees, critical transitional habitat from summer range to winter range). Old growth and "unsuitable" acres make a valuable contribution to the variation in forest conditions which enhances wildlife diversity.

Old growth habitat attributes are important to a number of Southwestern wildlife species, including snag dependent birds (see "Cavity-Dependent Birds" section under "Issues Requiring Further Consideration), as well as other species of nongame birds (Siegel 1989). Old growth habitats may also be important to other species, such as bats, whose habitat requirements are poorly understood.

The Mexican spotted owl, a subspecies which has recently been listed as Threatened under the Endangered Species Act (USDI Fish and Wildlife Service 1993), shows a preference for habitat characteristics associated with old growth and unsuitable areas, such as steep slopes. Fragmentation of potential and existing spotted owl habitat and habitat loss due to timber harvest were identified as possibly the greatest threats to Mexican spotted owls by the Fish and Wildlife Service (McDonald et al. 1991).

The Department supports forest management practices that retain or attempt to develop old growth forest attributes, such as snags, large trees, and downed woody materials. The MRNG seeks to create and maintain forest conditions associated with old growth (Reynolds et al. 1992:30-31). However, the ability of the management strategy to achieve and sustain these conditions is unknown. Equally uncertain is the degree to which management can mimic "naturally-developed" old growth. A recent review by Thomas et al. (1988) supports this position, proposing that old growth habitat management be based on existing stands, rather than those created by silvicultural practices.

The Society of American Foresters (1984) and The Wildlife Society (1992) have both taken positions advocating retention of existing old growth. The Society of American Foresters' (SAF) position statement begins:

> "...the best way to manage for old growth is to conserve an adequate supply of present stands and leave them alone" (SAF 1984:17).

The SAF (1984:31) later elaborated to say:

> "Through silviculture, foresters can grow big trees and grow them faster than nature unassisted. Yet there is no evidence that old-growth conditions can be reproduced siviculturally. In fact, the question is essentially moot, as it would take 200 years or more to find an answer. Old-growth management, for the foreseeable future, will be predicated on preservation of existing old-growth stands. Further, it does not appear that stands can be manipulated to enhance old-growth attributes or harvest timber and maintain their character. Existing evidence indicates that such efforts would be antithetical to maintaining the old-growth condition."

The Wildlife Society position (1988) is in part:

> - to recognize that old growth forests are rare and unique ecosystems providing critical habitat for some wildlife species, and that maintenance of old growth stands of appropriate size and distribution is essential for maintaining biological diversity.
>
> - to recognize that old growth forests cannot be recreated with current silvicultural practices and that efforts to maintain old growth forests therefore must be initiated with existing old growth stands and include provision for replacing these stands through time.
>
> - sufficient old growth stands should be maintained to permit the widest possible array of management options for the future.

The "Position Statement on National Forest Old-Growth Values" developed by the Forest Service (USDA Forest Service 1989) states that attention should be given to minimizing fragmentation of old growth into small isolated areas and that where appropriate, land management decisions are to maintain future options. Therefore, proposals to silviculturally treat old growth areas contradict the positions advocated by both professional biologists and forest managers.

As defined by the National Forest Management Act, areas classified as unsuitable are protected from reclassification for ten years. The intent of the Act, as defined in the Congressional debate surrounding the definition of unsuitable lands, was to remove from standard forestry practices those lands which were marginally productive or fragile (CEQ 1972). The inclusion of these areas in lands considered for intensive management under the MRNG would violate the intent of Congress. There are provisions in the Act for harvest on unsuitable lands to benefit wildlife. However, in light of the disagreement and doubts presented in this document about the wildlife benefits claimed from implementing the MRNG on suitable timber lands, even more caution should be used on unsuitable lands. Finally, much of the landscape-scale diversity which the MRNG is trying to develop, using silvicultural prescriptions, already exists on unsuitable lands due to their typical location on the boundaries between vegetation types.

Both old growth and "unsuitable" areas play an important role in research and monitoring. In the Pacific Northwest, information derived from unmanaged areas is being used to develop strategies for conserving biodiversity in managed forests (Hansen et al. 1991). This approach is equally relevant to Southwestern forests. Current and future research by the Department and others will provide needed information on the importance (or lack thereof) of old-growth habitats to goshawks, nongame birds, and other wildlife species. Areas not subjected to intensive management will also serve as controls with which to evaluate the effects of the MRNG and other new management prescriptions.

The Department supports the ecosystem management concept. However, the MRNG represents a new and untested approach, which is not yet ready to be applied on a landscape scale. The Department's concerns regarding landscape application of this untested approach are discussed in greater detail later in this document (in the section entitled "Wildlife Science and Its Application to the Management Strategy").

For the reasons described above (and elsewhere in this document), the Department believes application of the MRNG to areas currently allocated as old growth, or identified as unsuitable for timber production, is inappropriate at this time.

## Managing For Minimums

The Forest Land Management Plans described most wildlife Standards and Guidelines (old growth, snags, wildlife cover) in terms of minimum thresholds to accomplish biological objectives. During the planning of timber sales, these minimums have consistently become maximums. Also, many acres allocated to meet the Standards and Guidelines in the Forest Plans do not have the forest attributes needed to fulfill the biological objectives (USDA Forest Service 1990). Therefore, wildlife habitat thresholds are further compromised. This same pattern has occurred with the development of the Forest Service goshawk management strategy.

Since publication of the MRNG, the Implementation Guidelines and proposed alternatives in upcoming timber sales have redefined or reinterpreted minimum thresholds set in the MRNG. These adjustments have moved toward a more open canopy and younger-aged forest. Examples of these adjustments or targeting of minimums are described below for canopy cover, rotation length and number of reserve trees.

*Canopy Cover.* The MRNG calls for managing goshawk foraging areas so that VSS 4, 5 and 6 comprise 60% of the area, with approximately 20% in each VSS class. The remaining 40% is to be comprised of VSS 1-3. The foraging area guidelines in the MRNG stated that all of the acres in VSS 4-6 should be managed for a minimum 40% canopy cover. This would include the "B" (40 to 59% canopy cover) and "C" (60+ % canopy cover) canopy cover classes. The "A" canopy cover class (0-39% canopy cover) did not contribute to the acreage objectives for VSS 4-6.

In the Implementation Guidelines, Menasco and Higgins (1992) redefined the break between the "A" and "B" canopy cover classes based on their desire to produce forage, rather than providing the canopy cover called for in the MRNG. The Implementation Guidelines set the A/B break at 90 SDI which, according to the Forest Service PROGNOSIS computer model, would approximate only 30% canopy cover. The Southwestern Region of the Forest Service (USDA Forest Service 1992c) and the PROGNOSIS model show that 40% canopy cover approximates an SDI of 140. Therefore, application of the Implementation Guidelines creates an on-the-ground condition that does not provide the minimum 40% canopy cover recommended in the MRNG. On the Kaibab National Forest, timber sale planners have used the Implementation Guidelines to represent the 40% minimum canopy cover called for in the MRNG. This discrepancy is not identified in project documents which use the Implementation Guidelines to develop prescriptions for harvest.

Further reduction in prescribed canopy cover has occurred during various project applications. For example, on the Holy Hollow Timber Sale on the North Kaibab Ranger District, the Forest Service's Proposed Action intentionally decreases the canopy cover below the A/B break in the Implementation Guidelines with the expectation that the forest will grow back to the prescribed canopy

cover level in 10 years. This alternative, and others, have treated the minimum canopy cover level in the MRNG as a maximum target, not to be exceeded. As described above, application of the Implementation Guidelines results in about 30% canopy cover in the foraging area. Proposed management, which decreases canopy cover below the level called for in the Implementation Guidelines, may result in canopy cover near 25% over 5400 acres of each 6000 acre goshawk area.

As discussed earlier, Smith and Mannan (in review), Austin (1991) and others identified goshawk preference for areas with higher canopy cover. The Department considers the open forest conditions being proposed for timber sales, and justified by the Implementation Guidelines, harmful to the goshawk and many other wildlife species (examples will be discussed in later sections). As previously shown in Figures 3 and 4, many prey species expected to support goshawks benefit more from the "B" and "C" canopy classes than from the "A" class called for in the Implementation Guidelines. Also shown earlier in Table 1, management at higher SDIs (and canopy cover) produces more timber volume. If the management objective is to benefit goshawks and their prey, it is difficult to understand why the Forest Service has advocated such low canopy cover levels.

*Rotation Age.* In another example of managing for the minimum, the Implementation Guidelines assumed a 20 year re-entry period (the period between timber harvests on an area), with 10% regeneration (or VSS 1) at each re-entry. This results in a 200 year rotation. The MRNG gives 200-250 years for ponderosa pine to reach mid-aged VSS 6 in the foraging area and PFA. Therefore, rotation lengths should be at least this long. However, the Proposed Action for the Paris/Stina and Holy Hollow Timber Sales on the North Kaibab Ranger District, proposed 15% regeneration. With a 20 year re-entry period, 15% regeneration would result in a 140 year rotation. On the same sales, alternatives were considered which proposed 20% regeneration, the equivalent of a 100 year rotation. Since it takes 140-170 years for a ponderosa pine to develop the bark and limb characteristics of a mature tree, these shorter rotations clearly do not produce the wildlife benefits associated with mature and overmature trees. According to the MRNG (Reynolds et al. 1992:19), these mature and old growth structural stages (VSS 5 and 6) support more goshawk prey than any other stages. Thus, it is again very difficult to understand how shortening the rotation age will have any benefit to goshawks or their prey.

*Reserve Trees.* As a third example of managing for the minimum, a draft of the MRNG (dated March 7, 1991) reviewed by the Department, recommended 7-10 reserve trees per acre in ponderosa pine foraging areas. The final MRNG recommends 3-5 reserve trees per acre. The

proposed alternatives on the Paris/Stina and Holy Hollow Timber Sales call for 3 reserve trees per acre. The Department believes that managing for the minimum number of reserve trees will harm many species of wildlife and their habitat (see "Cavity-dependent Birds" in section entitled "Issues Requiring Further Consideration").

## ISSUES REQUIRING FURTHER CONSIDERATION

### Summary of Habitat Component Deficiencies

The Department is concerned with the potential impacts of implementing the MRNG on all forest-dwelling species. Therefore, the Department's evaluation of the Forest Service management strategy goes beyond the goshawk and the 14 prey species identified in the MRNG to include the potential impacts on habitat components required by a broader range of forest wildlife. The Department believes that the Forest Service management strategy is inadequate to meet the habitat needs of all wildlife and should not be implemented across the landscape. The Department recommends modification of the existing Interim Guidelines and Implementation Guidelines to address the following habitat component deficiencies:

canopy cover
interlocking crowns
snag size and density
stand or patch size and distribution
within stand diversity
development of old growth
hiding cover
thermal cover
travel corridors

**The species discussed are not the only ones with which the Department is concerned, but they are used to represent one or more of the habitat components which the Department believes are not adequately addressed in the MRNG and subsequent Implementation Guidelines.**

### Examples of Species-Specific Concerns

#### Cavity-dependent Birds

Sixty to 94% of wintering birds in ponderosa pine forests require snags for roosting (Szaro 1976). For example, large snags are essential to pygmy nuthatches which roost communally to conserve heat energy. As many as 167 birds have been observed to simultaneously use one cavity (Sydeman and Guntert 1983). Hay and Guntert (1983) found the average DBH of snags utilized by pygmy nuthatches during the winter to be 29 inches.

Studies on National Forests in Arizona provided information on the size of snags used by breeding birds (Table 2). On the Coconino National Forest, Cunningham et al. (1980) found that 75% of cavity nests occurred in snags ≥24 inches in DBH. Scott (1978) studied nests on the Apache-Sitgreaves National Forests and found the average DBH of snags used by cavity-nesting birds was 23 inches. Scott and Oldemeyer (1983) determined that snags over 19 inches DBH were more likely to contain cavities.

Table 2. Mean DBH of snags used for nests by birds of the Southwest.

| Species | Diameter at Breast Height (inches) | Source* |
|---|---|---|
| Violet-green swallow | 30 | A |
| Pygmy nuthatch | 27 | A |
| | 18 | B |
| | 15 | C |
| Western bluebird | 27 | A |
| Mountain chickadee | 25 | A |
| Brown creeper | 34 | A |
| | 27 | B |
| Red-breasted nuthatch | 28 | B |
| Hairy woodpecker | 17 | B |
| Norther flicker | 24 | B |
| Lewis woodpecker | 27 | B |
| Williamson's sapsucker | 32 | B |

*A = Cunningham et al 1980
B = Raphael and White 1984
C = Hay and Guntert 1983

There are several reasons why large snags are beneficial to cavity-using species. Clutch size of passerines has been shown to increase with cavity size (Karlsson and Nilsson 1977), and larger snags tend to provide larger cavities. There is greater insulation in larger snags. Presumably, nestlings in larger snags fledge earlier and thus have more time to put on weight to survive the following winter. O'Conner (1978) found that great tits nested earlier in better insulated, warmer nest boxes than in cooler, less insulated nest boxes. Some evidence also exists that large snags may be important as a foraging substrate (Cunningham et al. 1980, Raphael and White 1984, USDA Forest Service 1985). Furthermore, large snags last longer than small snags (Keen 1955, Bull 1983), and this is an important consideration when determining how many snags will be needed over time.

Raphael and White (1984) showed that snags >15 inches DBH were preferentially utilized by cavity-nesting birds. Snags over 27 inches in DBH were more than twice as preferred as those 21-27 inches in DBH, nearly five times as preferred as those 15-21 inches in DBH, and nearly 20 times as preferred as those 9-15 inches in DBH.

In another study, Balda (1975) concluded that the minimum number of snags necessary to maintain natural species diversity and bird densities at average levels was 173 snags per 100 acres, or 1.73 snags per acre. However, Balda (1975) also stated that because of widely fluctuating densities, he believed this figure to be very low and would not recommend its use. Instead, Balda (1975) recommended maintaining a density of 268 snags per 100 acres, or 2.68 snags per acre.

Balda (1975) found that secondary cavity nesters in ponderosa pine comprise 40-55% of the entire breeding bird population of the forest and 33% of all ponderosa pine forest breeding species. Data from the GA Pearson Natural Area (Cunningham et al. 1980) supported this conclusion. When snag densities were reduced, all bird species in the forest declined in density, however, secondary cavity nesters declined more sharply due to the shortage of available cavities.

Scott and Oldemeyer (1983) found that cavity-nesting bird densities declined 53% when conifer snags were removed during a timber harvest on the Apache-Sitgreaves National Forests in Arizona. Birds that nested in ponderosa pine snags were affected most by snag removal. For example, violet-green swallows declined from 41 to 4, per 100 acres, after snags were removed and pygmy nuthatches declined from 32 to 15, per 100 acres.

Miller and Miller (1980:337) studied snag use by birds and stated:

> "Size of nest trees, characteristics of decay and availability of suitable trees all affect cavity nesters. Dead and partly dead trees are important in many other ways. They are used for foraging, drumming, singing posts, food caching, nesting on, nesting under bark, hunting perches, loafing, lookouts, anvils, plucking posts, landing and roosting. Dead, dying, deformed and down trees play a vital role in a complex system."

Other research has also demonstrated the need for and importance of snags. Cavity-nesting birds are primarily insectivorous and play an important role in the prevention of insect epidemics (Otvos 1979, Kroll and Fleet 1979). In a discussion of secondary cavity nesters, Balda (1975) stated that during the winter, insect densities are low and birds are presumably eating hibernating adult insects, larvae, and eggs. It is thus very likely that wintering birds are exerting more control on insect populations during the winter than during other seasons, since potential insect breeders are being harvested by the birds at this time. Hence, the importance of this nesting guild in controlling insect populations. Diem and Zeveloff (1980) noted that although the effects of altering natural assemblages of bird species on forest systems are not known, a reduction in the number of insectivorous birds could result in reduced system stability.

Thomas, et al. (1975) discussed three primary concerns as forest management becomes more intensive: 1) truncated succession, 2) loss of old growth habitats, and 3) removal of snags. Intensive forest management presents a double threat to the availability of snags: 1) the loss of existing snags due to safety requirements imposed by State and Federal regulations, and 2) the lack of replacement snags due to short rotations and the continual removal of potential snags during stand thinnings.

The reliance of cavity nesters on snags renders them vulnerable to certain land use practices (Brawn and Balda 1982). Many aspects of cavity nesting bird biology have been studied, including the types of snags used for nesting (Connor and Adkisson 1977, Cunningham et al. 1980), snag densities needed to support viable populations (Balda 1975, Scott 1978), and the use of snags as foraging substrates (Brawn et al. 1982). These studies have clearly demonstrated the critical importance of snags to cavity nesters. Moreover, Brawn and Balda (1983) stated that virtually all research has shown that intensive silvicultural management of forests is selective against snags, and that density of snags and/or nest holes is a good predictor of cavity nester densities.

## Flammulated Owl

The flammulated owl (*Otus flammeolus*) is a Forest Service sensitive species (USDA Forest Service 1989a). The owl is an obligate cavity

nester, associated with mature and old growth ponderosa pine habitat types as well as ponderosa pine-oak habitat types (Howie and Ritcey 1987; Reynolds and Linkhart 1987, 1992; Reynolds et al. 1989; Johnson and Zwank 1990). The owls are known to nest in cavities in live trees and in snags.

In British Columbia, Howie and Ritcey (1987) found flammulated owls in forest structures with a canopy cover ranging from 35-65%. At least two canopy layers were present, with older firs and pines forming the upper layer and young firs forming the lower layer. A poorly developed shrub layer, but a well developed herbaceous layer were usually present. McCallum and Gehlbach (1988) studied flammulated owl nest-site preferences in the Zuni Mountains of New Mexico. They found that the owls preferred open, mature forest with low shrub cover. Despite the availability of suitable cavities in high density, doghair pine thickets, the owls did not use these sites for nesting. McCallum and Gehlbach (1988) recommended thinning and prescribed burns in doghair stands that also provided cavities.

The flammulated owl is an insectivore and primarily preys on moths. In Colorado, Reynolds and Linkhart (1987) found that the owl foraged in large, high crowns of mature ponderosa pines and associated conifers (e.g., Douglas-fir). Reynolds and Linkhart (1987) reported that moths eaten by the owls are up to four times more abundant in ponderosa pine and Douglas-fir than in other common western conifer habitats. The interior portions of these high crowns expose limbs and trunks that provide perches and access to insect prey. The spaces under these large crowns and between trees provide areas for "hawking" and "hover-gleaning" insects (Reynolds and Linkhart 1987).

Thus, the owl's association with mature and old growth pine habitats involves both food and habitat. First, older forests typically provide abundant snags and live trees with suitable cavities. Second, old ponderosa pines typically have large, open crowns, and form relatively open stands, a habitat structure that favors the owl's foraging strategies. Third, many of the owl's prey species are much more abundant in ponderosa pine and Douglas-fir habitats than in other forest habitats (Reynolds and Linkhart 1987).

Flammulated owls are not normally found in cut-over forests (Phillips et al. 1964, Franzreb and Ohmart 1978, Howie and Ritcey 1987, Scott and Patton 1989). The owls need mature and old growth forest stands for foraging and snags for nesting. These cavity nesters would be detrimentally affected by a reduction in snag recruitment trees, as will occur with implementation of the MRNG (see section entitled "Snag Recruitment and Longevity Modeling" above).

## Mexican Spotted Owl

The Mexican spotted owl subspecies was recently listed as Threatened under the Endangered Species Act (USDI Fish and Wildlife Service 1993). The Mexican Spotted Owl Status Review (Mcdonald et al. 1991) found high tree density, high canopy cover and multi-storied stands to be among the common characteristics of spotted owl habitats across different forest types. Neither of these conditions is compatible with the MRNG. Foraging spotted owls used unlogged habitats more than expected, assuming movements were random, and logged habitats less than expected. Owl use areas had higher basal areas and more snags and downed logs than randomly selected sites (McDonald et al. 1991). The open forest to be created under the Forest Service management strategy will not favor conditions selected by the Mexican spotted owl.

## Sharp-shinned Hawk

The sharp-shinned hawk (*Accipiter striatus*) is another Forest Service sensitive species (USDA Forest Service 1989a). The hawk nests in dense stands composed of mixed conifer or young ponderosa pine (VSS 3). Reynolds (1983) noted that nest sites were located in young conifer stands (25-50 years old) and had high canopy cover and tree density. High tree density created stands with shallow crowns and many dead limbs on the boles below the crowns. Sharp-shinned hawks are the most agile of the forest raptors and are also known to forage in dense vegetation, VSS 3 and 4 stands (Jones 1979).

Reynolds (1983) recommended that nest sites not be isolated by silvicultural treatments. Reynolds (1983) also suggested that precommercial and commercial thinning decrease nesting habitat for sharp-shinned hawks since these practices result in reduced tree densities and deeper crowns.

The MRNG will be implemented on the Lookout Canyon Timber Sale, on the North Kaibab Ranger District. Only 10% of the sale area is considered sharp-shinned hawk nesting habitat and this will be reduced. According to the Biological Evaluation (BE), 84% of the treatable acres will be treated. Based on the figures provided in the BE, it is difficult to determine what proportion of dense ponderosa pine (VSS 3) and mixed conifer is found in the "unsuitable" timber base and in allocated old growth, but the Environmental Assessment calls for treating 10% of the treatable acres now in VSS 3B and 3C. Therefore, it is likely that a large proportion (up to 100%) of the ponderosa pine capable of supporting breeding sharp-shinned hawks will be treated. The thinning called for in the MRNG in VSS 3 and 4 will have negative impacts on the sharp-shinned hawk. A conclusion in the BE of "no effect" on this species is not supported by the Forest Service's own data and analysis thereof.

Merriam's Turkey

Radio telemetry studies of habitat use by Merriam's turkey (*Meleagris gallopavo merriami*) in the western United States have documented that different habitat characteristics are selected for various behavioral activities. The general characteristics of nesting (Petersen and Richardson 1975, Goerndt 1983, Schemnitz et al. 1985, Hengel 1990, Leidlich et al. 1991, Mollohan and Patton 1991, Wakeling 1991), brooding (Mackey 1982, Goerndt 1983, Green 1990, Rumble 1990, Mollohan and Patton 1991), roosting (Hoffman 1968; Boeker and Scott 1969; Phillips 1980, 1982; Jones 1981; Goerndt 1983; Hengel 1990; Mollohan and Patton 1991; Wakeling, unpubl. data), and winter habitat (Wakeling, unpubl. data) are presented in the following sections.

*Nesting habitat.* On the Kaibab National Forest, in north-central Arizona, nest sites typically had more ground cover at the nest than in surrounding areas (Crites 1988). Seventy-five percent of the nests occurred in a combination of conifer, oak thickets, and slash, with half of the nests being located at the base of a tree on the uphill side. Successful nests had significantly more cover at the nest site than did unsuccessful nests, and significantly more slash and dead and down wood.

In mixed conifer forests in the Sacramento Mountains of New Mexico, nests occurred on steep slopes even though more level topography was readily available (Jones 1981, Goerndt 1983, Schemnitz et al. 1985). Overstory canopy cover at nest sites was higher than that of the surrounding area and percent ground cover was high. Cover at the nest site was provided by slash, shrubs, downed logs, or contour effects.

The above literature indicates that when managing for turkey nesting habitat, at least 20% of the stand should be made up of 0.1-2 acre patches of cover with 30-60% ground cover at 0-3 feet of height, made up primarily of large (>12 inches DBH) downed logs and scattered or loosely piled slash, deciduous and conifer regeneration, and herbaceous vegetation. Sites should be multi-storied with >50% overstory cover, the first story ≤10 feet above ground level. The distance to the point where another human being is obscured from vision (human sight distance) should average <75 feet. Stands are generally uneven-aged with the predominant size class 4-12 inches DBH. Under and overstory distributions are generally clumped. Deciduous regeneration is usually abundant. Sites are generally located within 0.5 miles of water and 0.5 miles of acceptable brood habitat.

*Brood habitat.* Brood habitat typically consists of mesic stands in association with a drainage or canyon, including headers and draws. This habitat is generally a landscape mosaic of varied stand characteristics. Stands should have a clumped distribution. Stands with overall basal areas of 90-120 feet$^2$/acre and human sight distances <150 feet are preferred. Small openings (0.5-2 acre)

within dense stands (140 feet$^2$/acre basal area) of VSS 3 with large (>12 inches DBH) downed logs scattered throughout appear to provide excellent brood habitat. Herbaceous cover tends to be high in the openings (>50% ground cover and 10 inches tall) and low within dense stands (<20% ground cover). Approximately 20-50% of the stand should provide feeding habitat and 20-50% should provide loafing and escape habitat.

*Roosting habitat.* Boeker and Scott (1969) found that roosts on the Fort Apache Indian Reservation were typically groups of large, overmature ponderosa pines with flat horizontal branches. Roost sites usually occurred on ridgetops or canyon walls with easy access from above and a forest opening below. Roost sites on the Bill Williams Mountain study area (Phillips 1982) averaged 27 usable roost trees per site and had an average basal area of 94 feet$^2$/acre. A typical roost tree was a large (usually >20 inches DBH), dominant or codominant ponderosa pine with flat horizontal branches.

Stands used for roosting tend to be distinct clumps of ponderosa pine trees situated on the upper edges of canyons and drainages. The minimum DBH for usable roost trees is 16 inches, and an average of >20 inches DBH is typical. Minimum basal area is 90 feet$^2$/acre, but most exceed 110. Summer roosts average about 0.5 acres in size and winter roosts average 2 acres in size. Winter roosts are considered traditional, but are generally used when located in proximity to winter food sources. As winter food sources vary by year, the use of individual roosts also varies. Summer roosts are also reused frequently, sometimes by different groups of birds. All turkey roosts should be considered traditional and receive protection from silvicultural treatment.

*Winter habitat.* Winter range generally occurs at lower elevations than summer range. Habitat needs appear to differ during winter months from those of the summer. Loafing activities are restricted during winter, perhaps as a result of shorter days, increased energy demands, limited or inaccessible food sources, or some combination of these factors. Consequently, most time during the winter is spent feeding. Food sources vary by year, but acorns appear to be the favored food. If acorn crops are poor, juniper berries are generally a staple. Turkeys appear to use more open habitats than during the summer. This may be due to the lack of habitat which provides dense cover as well as adequate food sources. Turkeys undergo a higher mortality rate during the winter than in the summer which may be related to less cover on the winter range. Feeding habitat generally includes Gambel oak, juniper, ponderosa pine, or pinyon pine trees. Stands that exceed 75 feet$^2$/acre basal area are generally preferred for feeding.

Any habitat manipulation designed to improve habitat for one species, may have the effect of degrading habitat for another (Reynolds et al. 1992:8). The MRNG has many features that will improve habitat for turkeys, as well as many that will degrade

existing turkey habitat. The following discussion identifies some of the potential favorable and unfavorable impacts of implementing the MRNG on turkeys.

*Favorable effects of the MRNG.* The management of forest stands and openings on a small scale (≤4 acre) should favor Merriam's turkeys. Throughout the literature, small clumpy stands were identified as those selected by turkeys. The suggested recommendations for lopping and scattering 3-15 tons per acre of slash is consistent with the recommendations for turkey habitat in Arizona (Mollohan and Patton 1991, Wakeling 1991). Group selection harvests have been recommended by Mollohan and Patton (1991) and Wakeling (1991) as a suitable harvest strategy that has favored turkeys in the past. In some instances, Reynolds et al. (1992:25) also favor this treatment for the goshawk. The long-term maintenance of snags and the resulting longevity of downed logs (>12 inches DBH and 8 feet in length) would favor turkey loafing and hiding cover.

*Unfavorable effects of the MRNG.* The MRNG employs a management strategy based on Vegetation Structural Stages that does not reflect turkey habitat selection (Mollohan and Patton 1991) and therefore is not readily comparable to turkey habitat needs. In the goshawk foraging area, the MRNG and the Implementation Guidelines manage against multi-storied stands, dense understories and dense canopy which are forest attributes selected by turkeys in most habitats (Mollohan and Patton 1991, Wakeling 1991). An underlying management objective of the MRNG in calling for relatively open understories is to increase the goshawk's opportunity for detection and capture of prey. Turkeys are prey to many predators and opening the understory may increase turkey mortality rates.

*Conclusions.* Turkeys select habitats that tend to have a large degree of interspersion and landscape mosaics which the MRNG promotes. However, turkeys select multi-storied stands and areas of low horizontal visibility created by a clumpy understory, forest characteristics that the MRNG and Implementation Guidelines manage against. Opening the understory and reducing the amount of available horizontal cover would reduce the quality of turkey habitat until such time as adequate cover could regenerate. Thus, the implementation of the MRNG on a landscape basis would reduce the suitability of many acres across national forests throughout the state for Merriam's turkeys.

## Cottontail

The cottontail (*Sylvilagus* spp.) has been studied for decades across the United States. The common thread throughout the literature is the species' need for cover.

Todd (1927) stated that protection from predators was as important as finding food. Haugen (1942) noted that cottontails would

forsake an abundant food supply for good cover if the two were not found together. Ingles (1941) said the cottontail is very dependent on cover for protection and nest sites. Trippensee (1934) found that as cover became scarce and more open in the fall and winter, cottontails moved to denser vegetation. Bell (1948) observed that cottontails seldom moved more than 30 feet from protective cover when feeding.

In a review of cottontail feeding habits, DeCalesta (1971) noted that the cottontail is ubiquitous, eats a wide variety of foods, cover may be more important to this species than specific foods, and that lack of food does not appear to be an important winter mortality factor. Based on this review of feeding habits, DeCalesta (1971) suggested that management of the species may not require detailed quantitative or qualitative analyses of foods eaten. Kundaeli and Reynolds (1972) studied cottontail use of natural and modified pinon-juniper in New Mexico. They found that cottontail densities were significantly lower on treated areas where all trees were removed (despite more than a doubling of herbaceous vegetation) than on the control. Within the range studied (150-370 lbs/acre), herbaceous vegetation biomass did not seem to affect cottontail habitat use. Turkowski (1975) stated that in most parts of its range, cottontail survival and reproduction are limited more by factors such as the availability of moisture and cover and not by food abundance. In recommending habitat management for cottontails, the Soil Conservation Service (USDA Soil Conservation Service 1978) stated that the most important component of rabbit habitat is cover, and that mature forests with clean understories are generally not good rabbit habitat.

The studies cited above come from across the country and reflect the general body of knowledge on cottontail habitat needs. Costa (1976) studied habitat use by cottontails in different ponderosa pine forest structures on the Coconino and Apache-Sitgreaves National Forests. On the Beaver Creek Study Area, Costa (1976) found that cottontail densities were not affected by strip cuts, shelterwood cuts, patch cuts, or group selection harvesting. This is significant because similar methods are being used to implement the MRNG with the expectation of increasing rabbit densities. Only in a large clearcut (Watershed 12) containing abundant cover, provided by slash piles and numerous thickets of Gambel oak sprouts, did cottontail numbers increase. Although the clearcut produced more herbage, it also retained abundant cover. Goodwin (pers. commun.) collected data similar to Costa's (1976) on nearby Watershed 11. This area too was clearcut, but all brush and downed woody material was removed resulting in abundant herbage production but no cover. Goodwin made no observations of cottontails in Watershed 11 during two years of surveys. He did find cottontail sign along the edge of the treated area, where cover was present.

On the Heber Watershed Area (Watershed 1), Costa (1976) found that cottontail populations were significantly higher only on a 4 acre corner. This area had approximately 45% more stems per acre (933

vs 642), about 4 1/2 feet tall, than the rest of Watershed 1. Costa (1976) concluded that the positive responses of cottontails on Beaver Creek Watershed 12 and on Heber Watershed 1 could be attributed to the increase in yearlong cover and that the absence of sufficient cover in a typically open ponderosa pine forest is the limiting factor.

The MRNG includes the cottontail as one of 14 goshawk prey species. The MRNG acknowledges the value of cover for cottontails (Reynolds et al. 1992:60-62) but then erroneously defines openings and open forest conditions (Reynolds et al. 1992:19) as important for this species. Furthermore, the MRNG's recommendation to increase grasses, forbs, and shrubs in ponderosa pine is problematic. While grasses and forbs will increase as the pine canopy is opened, it's unlikely they will reach densities sufficient to provide hiding cover for cottontails. Similarly, shrubs found on pine sites (*Ceanothus, Ribes, Cercocarpus, Rosa, Rhus*, etc.) do not normally grow in densities adequate to produce hiding cover. Plants that could provide hiding cover (oak, aspen, locust, fir, pine) will not be managed for cover because of the MRNG's objective to maintain an open understory.

Tree Squirrels

Both species of tree squirrels (tassel-eared squirrel, *Sciurus aberti*, and red squirrel, *Tamiasciurus hudsonicus*) are listed as goshawk prey in the MRNG. The MRNG was evaluated to determine its capability to maintain tree squirrel habitat quality and sustain healthy tree squirrel populations to meet the goshawk's foraging needs. Several concerns were identified and are addressed in the following discussions.

Overall, the VSS distributions prescribed in the MRNG for all forest types (i.e., ponderosa pine, mixed species, and spruce-fir) should favor habitat conditions for both squirrel species. However, the desired canopy cover levels (i.e., minimum of 40%) and small patch sizes (i.e., 4 acres or less) which would be created over time, over large areas (e.g., foraging areas), are not likely to provide sufficient quality habitat to sustain healthy squirrel populations.

*Canopy Cover Concerns*. The purpose of the 5,400 acre foraging area, which constitutes 90% of the goshawk territory, is to provide quality habitat for goshawk prey species and to promote desired forest conditions that would provide abundant and sustainable prey populations (Reynolds et al. 1992). Habitat information for both tree squirrel species, from studies conducted in Arizona (Patton 1975 and 1984, Patton and Vahle 1986, Vahle and Patton 1983), was summarized in the MRNG. This information stresses the importance of providing habitat conditions exceeding 60% canopy cover (i.e., through prescribed levels of tree density and basal area). These habitat needs, however, are not fully integrated in the management prescriptions for the foraging area, particularly for the tassel-

eared squirrel. The open stand conditions that are prescribed for ponderosa pine foraging areas, and in some cases mixed species foraging areas, will limit the capability to maintain and develop interlocking canopies that are necessary for good quality habitat for tassel-eared and red squirrels (D.R. Patton and B. Vahle, pers. commun.) over potentially large landscape areas.

Mycorrhizal fungi (e.g., truffles) provide an important food source for both tassel-eared and red squirrels, as well as other mammalian goshawk prey species (e.g., chipmunks, ground squirrels). Furthermore, the fungi function in a critical symbiotic relationship with conifer trees and small mammals in maintaining forest regeneration and forest ecosystem health (States 1985). As summarized in the MRNG (Reynolds et al. 1992), fungi are best produced in conifer stands which exceed 60% canopy cover (States 1985, States et al. 1988, Uphoff 1990). However, healthy fungi populations and tree squirrel habitat will be difficult to maintain in foraging areas, where canopy cover levels will rarely exceed 40% (J.S. States, pers. commun.). Consequently, the availability of fungi to support "abundant" prey populations, such as tree squirrels and other small mammals (e.g., chipmunks, ground squirrels), may be inadequate in goshawk foraging areas.

The DFC for goshawk foraging areas, discussed in the Implementation Guidelines, also raises concern about maintaining and developing quality tree squirrel habitat. This concern is particularly relevant to maintenance of tassel-eared squirrel habitat. As stated previously, the intent of the MRNG in foraging areas was to provide quality habitat for prey species and forest conditions that would provide abundant and sustainable prey populations. The prescribed tree densities and basal areas for VSS 4-6 in pine foraging areas, however, would only provide "poor" habitat (sensu Patton 1984). If the tassel-eared squirrel is an important prey species for the goshawk during the critical winter period, habitat quality for this species needs to be maintained to meet the goshawk's winter foraging needs. This concern is magnified when considering application of the MRNG across the landscape, "...in all our forested ecosystems with minor modifications to fit all species" (Menasco and Higgins 1992:7). Habitat capability for the tassel-eared and red squirrels, as well as cover needs for other species, could be adversely affected if the MRNG and Implementation Guidelines are applied across large landscape areas without significant modification (D.R. Patton, pers. commun.).

*Patch/Stand Size Concerns.* The key to accommodating habitat needs of a variety of forest dwelling species, which may have varying home range sizes, such as tree squirrels, is to provide a diverse arrangement of habitat structural stages and patch/stand sizes (e.g., 1-100 acres or more) (Patton 1992). For example, small habitat patches (e.g., <5 acres) may be important for species of low to moderate mobility which need "edge" habitats to meet their food and cover requirements (Patton 1992). In contrast, some species, such as Northern spotted owls, require larger patches of mature and old growth habitat to meet their needs because of

special conditions provided by "interior" forest stands (Galli et al. 1976). In the Pacific Northwest, minimum stand sizes to maintain maximum bird species diversity, have been estimated at 75-100 acres (Galli et al. 1976, Thomas et al. 1979). There is concern that the current prescriptions in the MRNG will not provide an adequate mosaic of patch size and structure for tassel-eared and red squirrels, as well as other wildlife species, particularly in foraging areas.

As forest stands are reduced in size so that openings and stands become the same size, homogeneity rather than diversity is maximized (Patton 1992). Conforming to a fixed or narrow range of stand sizes will not provide the diversity that is needed to maintain habitat for a large number of wildlife species. Landscape diversity is greatest with a variety of stand sizes ranging from large to small within a management area (Patton 1992). Over time, implementation of the MRNG would fragment forest habitats into patches/stands of 4 acres or less across large landscape areas. On a small scale, these treatments could increase the habitat mosaic and diversity. However, the relative uniformity of the prescribed treatments across large areas and the lack of large patches would ultimately reduce habitat capability for the tassel-eared squirrel, red squirrel and other species, and could reduce overall biological diversity (D.R. Patton and B. Vahle, pers. commun.). Tassel-eared squirrels, for example, need large stands (range = 30-100 acres, average = 50 acres) of relatively similar and contiguous forest in VSS 4-6 to meet many of their food and cover requirements (D.R. Patton, pers. commun).

Historical accounts of "presettlement conditions" describe a wide variety of tree densities and patch/stand sizes across forested lands in Arizona (Beale 1858, Bourke 1874, Dutton 1882, Leiberg 1904, Cooper 1960). Historically, this variability was created and maintained by the occurrence of frequent fires and by insects and disease. It is highly unlikely that historic fires, or other factors affecting stand structure and composition, would have developed a relatively homogenous distribution of small habitat patches of similar size across the landscape, as prescribed in the MRNG (D.R. Patton, pers. commun.).

Finally, both the tassel-eared and red squirrel may be important to goshawks during the winter because they are active during this season and available as prey within ponderosa pine, mixed species, and spruce-fir forest habitats. In contrast, many of the other primary prey species (Reynolds et al. 1992) have either limited distribution in goshawk habitat (e.g., blue grouse), or become unavailable during the winter period. Several species hibernate (e.g., chipmunks, mantled ground squirrel) or migrate (e.g., American robin, mourning dove, band-tailed pigeon). There is evidence that at least some goshawks in the Southwest winter on or near their breeding home range (P. Kennedy, unpubl. data; R. Reynolds, unpubl. data). Preliminary radio telemetry data for six goshawks on the Coconino National Forest, indicated that in the winter, goshawks continue to forage in ponderosa pine areas

centered around their nest sites and not in lower elevational habitats (e.g., pinon-juniper) (P. Beier, pers. commun.). If indeed most goshawks remain at higher elevations throughout the winter, it would be prudent to modify the Forest Service management strategy to better integrate the needs of tree squirrels, particularly those of the tassel-eared squirrel, to ensure development and maintenance of good squirrel habitat over time.

## Black Bear

Implementation of the MRNG will detrimentally affect black bear (*Ursus americanus*) habitat by 1) creating an open understory which will increase horizontal visibility, 2) opening overstory canopy in goshawk foraging areas, and 3) fragmenting suitable habitat.

LeCount and Yarchin (1990) found that black bears in east-central Arizona selected for unlogged, old-growth, mixed-conifer forests, characterized by dense (>60% canopy cover), multi-storied canopies and understory cover with low horizontal visibility (100 feet or less). Such sites usually were located on steep slopes (>20% slope), away from roads, with at least five live trees per acre over 25 inches DBH. These habitat attributes applied to both feeding and bedding sites. Feeding habitat often contained small openings (<0.25 acres), interspersed with suitable cover. Bears avoided meadows and ponderosa pine areas unless the latter structurally resembled mixed-conifer forest. They also avoided logged areas, especially where canopy cover was reduced below 40% and horizontal visibility exceeded 100 feet.

Food and cover are factors strongly influencing black bear habitat selection. However, both Mollohan et al. (1989) and LeCount and Yarchin (1990) found that bears selected habitat on the basis of cover first and food second. Mollohan et al. (1989) observed that logged areas containing abundant food but lacking cover were unused by bears.

LeCount and Yarchin (1990) found that all feeding, bedding, and denning areas must be interconnected by travel corridors at least 600 feet wide, with horizontal visibility not exceeding 100 feet. The best locations for such travelways are along drainages and across ridgetops where heads of drainages occur opposite each other. In ponderosa pine, travel corridors should interconnect mixed conifer and Gamble oak areas (LeCount and Yarchin 1990).

Forest fragmentation has long concerned biologists. As suitable habitat is broken up, small "islands" of usable habitat become isolated in a "sea" of unusable habitat (Harris 1984). For some wildlife species, such as bears, movement between these islands becomes more difficult, and can lead to a reduction in genetic diversity and limit recolonization. Small populations may also undergo higher rates of predation and exploitation due to increased vulnerability in and between islands of suitable habitat (Harris 1984).

Habitat fragmentation requires bears to utilize larger land areas to meet habitat needs, resulting in larger average home ranges. Important seasonal food supplies may become inaccessible if cover in travel corridors is removed. The removal of protective cover or the isolation of food supplies results in decreased habitat value, which affects the total number of bears an area can support. Failure to consider bear population dynamics and habitat needs in the management of this species will inevitably lead to its decline, or even its loss, in fragmented habitats.

Removal of understory cover and lowered canopy cover, as called for in the MRNG, will degrade or render unusable large areas currently used by bears. Furthermore, the MRNG does not provide for travel corridors to connect key bear habitat components. In ponderosa pine forests, bear habitat is inherently fragmented because cover is not uniformly distributed. Widespread application of the MRNG will further reduce cover, which may extirpate black bears from much of Arizona's ponderosa pine forests and islands of mixed conifer interspersed within pine forests.

## Cumulative Effects

Cumulative effects on the environment result from the incremental impact of proposed actions added to past, present and reasonably foreseeable future actions, within and adjacent to a given management area. These spatial and temporal effects can result from individually minor but collectively significant actions. The MRNG is being applied to forest conditions which are, in part, the result of cumulative effects of past and present grazing, timber, fire, recreation, wildlife and other management activities. Although a variety of factors influence forest conditions, the following discussion is limited to the cumulative impacts of timber harvest because of its important role in determining short- and long-term forest conditions. Also, most management activities resulting from implementation of the MRNG will consist of silvicultural treatments.

Significant levels of timber harvest began in Arizona when the railroads arrived in northern Arizona. Cline (1976) stated that in 1882, when the railroad arrived in Flagstaff, there were 600,000 railroad ties lying along the track route. The railroad companies were granted rights to all odd numbered sections for 40 miles on each side of the railroad. The timber rights on these sections were sold to timber companies and the first large scale timber harvests were on railroad lands (USDA Forest Service 1973). In 1902, these odd numbered sections became part of the National Forest Reserve system, today the National Forest system.

Lieberg et al. (1904) reported that 95 to 100% of the timber volume on 75,510 acres of the San Francisco Mountain Forest Reserve (today part of the Coconino National Forest) had been removed. The 1910 Coconino Forest Plan (USDA Forest Service 1910) stated that 91,375 acres were "cut over." By 1911, ponderosa pine cutting methods were becoming standardized across Arizona and New Mexico (Woolsey 1911). The intent at that point was to "capture the mortality" by removing the old growth trees, otherwise seen as a potential waste.

From 1949 to 1958, the Kaibab National Forest reported harvesting timber on 41,670 acres (USDA Forest Service 1962). The Kaibab Forest Plan (1962) reported that the South Kaibab was now largely cut over with the bulk of the virgin timber removed. The Plan showed 22,968 acres of virgin timber remaining out of a total of 298,643 commercial acres. By 1956, most of the mature and old growth timber on the South Kaibab had been removed and harvest was concentrated on younger trees.

By 1965, the Coconino National Forest was exhibiting conditions similar to the South Kaibab. The Coconino Forest Plan (USDA Forest Service 1965) called for completing the initial harvest of commercial virgin timberlands. This Plan called for treating 35,664 acres per year. Over 117,000 acres were to be regenerated by 1972. Regeneration means that most of the trees would be removed to permit young trees to grow. By 1965, approximately 68,000 acres of virgin timber remained on the Coconino and 648,000

acres had been cut over. At this point, wildlife associated with mature and old growth forests with snags had lost a large proportion of their habitat.

The 1973 Coconino Timber Management Plan (USDA Forest Service 1973) reported that 55% of the timber volume was expected to come from trees 29 inches DBH and larger. Today, trees greater than 29 inches DBH are extremely rare on the Coconino. The 1973 plan called for a harvest well in excess of growth (calculated at 41 million board feet per year) by proposing an allowable cut ranging from 50.2-65.2 million board feet per year, from 1933 to 1982. During the same period, the rotation length was reduced from 200 years in 1923-1933, to 150 years in 1943-1953, and to 120 years after 1963. In 1973, the importance of snags was recognized and the Coconino reversed a policy which had called for cutting snags as a fire prevention measure.

As virgin timber was harvested, fewer mature and old growth trees remained. Gradually, stands became dominated by young (VSS 3) and mid-aged (VSS 4) trees. Snags were also greatly reduced. Sound snags were harvested for wood; other snags were cut down as potential hazard trees and removed as firewood. These snags were not replaced because of the reduction in snag recruitment trees. All these changes affected wildlife habitats.

Patton (1984) found that canopy cover above 60% provided good to excellent tassel-earred squirrel habitat. As an example of more recent changes in Arizona's forests, Ward et al. (1992) examined 1972 and late 1980s aerial photos of ponderosa pine forest on the North Kaibab Ranger District. From an analysis of 38,300 acres, Ward et al. (1992) found that stands with over 60% canopy cover comprised 34% of the area in 1972 and only 4% of the area in the late 1980s. This reduction in canopy closure, over an approximately 15 year period, is considered significant by the Department.

In an effort to address cumulative impacts of past, present and future management actions, wildlife biologists have developed models to predict changes in wildlife habitat capabilities over time. The Southwestern Region of the Forest Service has developed a computer model called RO3WILD to predict changes in wildlife habitat quality. In Arizona, only the Apache-Sitgreaves National Forests have consistently used this model.

The Department summarized the cumulative effects analyses for 40 sales on the Apache-Sitgreaves National Forests over a seven year period, from 1986 through early 1993 (Table 3). The summary addresses 278,287 acres on five Ranger Districts. The impacts are expressed in terms of changes in the Habitat Capability Index (HCI), which is an estimate of change in the capability of the habitat to support a given species. These model estimates can be used to obtain relative measures of change in habitat capability under different land management scenarios, such as timber harvest alternatives.

Table 3. Average Habitat Capability Index (HCI) change predicted for seven management indicator species by the RO3WILD model for 40 timber sales on the Apache-Sitgreaves National Forests, from 1986-1993.

| | MANAGEMENT INDICATOR SPECIES | | | | | | |
|---|---|---|---|---|---|---|---|
| | Goshawk | Spotted Owl | Abert's Squirrel | Merriam's Turkey | Black Bear | Pygmy Nuthatch | Red Squirrel |
| Acres Analysed | 246,977 | 112,717 | 158,062 | 191,758 | 126,970 | 146,595 | 105,569 |
| Average HCI Change[1] | -16 | -16 | -20 | -2 | +1 | -23 | -11 |

[1]This is the sum of each sale's HCI change multiplied by the acres analyzed for that sale, divided by the total number of acres.

Recent studies have shown that some wildlife species decline slowly to a habitat/population threshold and then decline precipitously to extinction (Lande 1987, Lamberson et al. 1992). Animals most likely to display this pattern are territorial species where at least one component of their habitat (e.g., nest sites) is fragmented. The population viability analysis (PVA) conducted for the goshawk population on the North Kaibab (Maguire 1993) (Appendix 4) indicated that a declining trend in habitat carrying capacity produces certain extinction in populations whose growth rates are otherwise stable or increasing (Maguire 1993:13). On the Apache-Sitgreaves, the RO3WILD model results suggested that over the last seven years, the capability of the habitat to support goshawks has declined 16% overall, which equates to a 2.3% per year loss in habitat carrying capacity. This rate of loss for the goshawk is roughly paralleled by losses in habitat capability for the spotted owl, Abert's squirrel, pygm. nuthatch and red squirrel (Table 3).

The RO3WILD models are far from perfect, but they do represent a sincere effort, by Forest Service biologists and others, to build a model which displays the impact of timber management. The RO3WILD model estimates declines in habitat quality on the Apache-Sitgreaves for a variety of species caused by timber harvest since 1986 (Table 3). Declines in habitat quality demonstrate the need to reevaluate management direction.

The changes in ponderosa pine habitats since timber harvesting began in Arizona, and RO3WILD model results, indicate there has been a decline in habitat quality for many wildlife species. Current forest conditions provide the setting in which potential additive impacts from implementing the MRNG will be realized. The Department believes that implementation of the MRNG, as currently written, will have adverse cumulative effects on many species (e.g., tree squirrels) whose available habitat has already been degraded or has greatly declined.

**Forest Land and Resource Management Plan Standards and Guidelines**

In a letter to Forest Supervisors in the Southwestern Region dated September 16, 1992, the Deputy Regional Forester directed that the Interim Guidelines will take precedence over existing LMP Standards and Guidelines where conflicts occur between the two (Appendix 1). The justification for this direction was the status of the goshawk as a Forest Service sensitive species. In addition to questioning the anticipated benefits of the Forest Service management strategy for goshawks, the Department also believes that application of the MRNG may harm other sensitive species such as the flammulated owl and sharp-shinned hawk (see section on "Examples of Species-Specific Concerns").

Wildlife Standards and Guidelines in the LMPs were developed with full public involvement under NEPA to ensure that critical wildlife habitat components, such as snags for cavity-dependent birds and thermal and hiding cover for elk and deer are maintained on

National Forest lands. The Department believes that replacement of the Standards and Guidelines with the Interim Guidelines will not adequately address the needs of a variety of wildlife for which the Department has management responsibility.

For example, the number of snags which would be produced under the current Forest Service management strategy (see "Snag recruitment and longevity modeling" section of this document) will not meet the snag requirements of cavity-dependent birds addressed by LMP Standards and Guidelines (see "Cavity-dependent birds" section of this document). Although LMP Standards and Guidelines for thermal and hiding cover were designed primarily for deer and elk, they also satisfy the needs of other species and are an important component of wildlife habitat which is not considered in the MRNG.

The need for forest managers to consider deer and elk cover requirements in their management prescriptions is well recognized (Thill et al. 1983, Wisdom et al. 1986, Thomas et al. 1988, Schuster et al. 1985, Hoover and Wills 1987). While studying elk cover requirements in Arizona, Brown (1987) recommended 70%+ canopy cover for summer thermal cover to maintain high reproductive rates. Haywood et al. (1987) suggested deer selected areas with a high proportion of pine and very low (2.3%) proportion of meadows and recommended managing for 60% cover for deer on the North Kaibab.

Both deer and elk require thermal and hiding cover to ensure survival and high productivity. The Department believes that the thinning in VSS classes 2-6 called for in the Implementation Guidelines, will make it difficult to satisfy LMP Standards and Guidelines for hiding and thermal cover. There is a need to increase the range of densities in the VSS classes to provide this type of cover. In summary, the Department believes that wildlife Standards and Guidelines designed for species other than the goshawk, can be maintained while still providing appropriate protection for the goshawk.

## WILDLIFE SCIENCE AND ITS APPLICATION TO THE FOREST SERVICE MANAGEMENT STRATEGY

This section reviews the MRNG in the context of wildlife science and its application. The MRNG was evaluated from two perspectives: 1) the process of obtaining and using scientific information, and 2) with respect to specific goals, principles, and assumptions involved in development and implementation of the MRNG.

### The MRNG as Wildlife Science

Development and implementation of the MRNG followed an "inductive-deductive" approach (sensu Davis 1985), using pre-existing information to identify, select, and apply biological principles to the management of goshawk habitat. This approach is acceptable where immediate management decisions must be made and testing of an hypothesis is not practical. Since the approach is untested and involves considerable uncertainty, it must be capable of rapidly adjusting to new information and should be limited in the scope of its application to maintain future management options.

Thus far, the process has not involved direct application of the hypothetico-deductive (h-d) scientific method, wherein research hypotheses concerning patterns or processes of interest are identified and then tested with empirical data. Recent reviews of the practice of wildlife science have argued that the h-d method is the best means of obtaining reliable knowledge for use in management (Romesburg 1981, Murphy and Noon 1991). Application of the MRNG has far-reaching ecological implications, affecting forest habitats and wildlife throughout Arizona and New Mexico. Therefore, the MRNG must be based on wildlife science that is not only credible, but defendable and reliable.

The h-d method is typically associated with wildlife research, however, it can also be applied to management. Most management efforts are in reality, experiments based on ecological assumptions. If designed properly, these efforts can test the assumptions and provide valuable information (MacNab 1983). Murphy and Noon (1991:773) noted that many wildlife management situations have two characteristics that argue for the use of h-d methodology: 1) decisions are made with incomplete information, and 2) management plans and conservation strategies have properties that can be stated as hypotheses and tested with empirical data. A recent example of the use of h-d methodology in conservation planning was the development of a conservation strategy for the Northern spotted owl (Murphy and Noon 1991, 1992). A series of hypotheses concerning owl population dynamics and habitat use were formulated and tested with empirical data and simulation models. The end product was a habitat conservation plan that met rigorous scientific standards, specifying the size, forest structure, and distribution of habitat reserves.

The analytical procedures and reserve design criteria used to develop the Northern spotted owl conservation plan may or may not be appropriate to other species (such as the goshawk), however, the general approach is applicable (Murphy and Noon 1991, 1992). The management situation of southwestern goshawks meets the criteria proposed by Murphy and Noon (1991), i.e., available information on many aspects of goshawk biology is limited, as is our understanding of the responses of goshawk habitats to management (Reynolds et al. 1992:1). The MRNG contains a number of assumptions from which testable hypotheses could be developed. For these reasons, the Department feels that h-d methodology should play an important role in the further development, testing, and refinement of management strategies for southwestern goshawk habitats.

**Goals, Principles, and Assumptions Pertinent to Development and Implementation of the MRNG**

The goal of the GSC was "... to develop a credible management strategy to conserve the goshawk in the southwestern United States" (Reynolds et al. 1992:1). The resulting MRNG describes forest conditions which "...in their best estimate, will sustain goshawk populations in the Southwestern Region" (Reynolds et al. 1992:1). The Department believes that the goals of the MRNG need to be stated with greater specificity and accompanied by measurable objectives. The concept of "sustainability" is vague and subject to a variety of interpretations. The wildlife profession has a history of "sloppy terminology," which can complicate the decision-making process and hinder development of defendable conservation plans (Murphy and Noon 1991). Without specific, measurable objectives (such as goshawk breeding distribution, density, territory occupancy, etc.), it will be impossible to objectively evaluate goal achievement. The proposed DFC does provide a set of measurable objectives. However, because there is no known, quantitative correlation between the DFC and goshawk populations, attainment of the DFC is an independent event with uncertain implications.

The Department has several concerns with respect to the assumptions underlying the MRNG. First, the assumptions are untested; second the DFC, which is derived from the assumptions, is untested; and third, the authors of the MRNG identify their assumptions as "...areas where research is needed on goshawk and forest ecology" (Reynolds et al. 1992:1). If one or more of these assumptions are untrue, it could invalidate the entire management approach. As a result, the MRNG embodies considerable uncertainty. This uncertainty is reflected in the tentative language used throughout the document.

The MRNG is described as a suitable design which can be adapted for management of forest habitats at a landscape-scale (Reynolds et al. 1992:8). Among some forest managers, the MRNG have come to be synonymous with "Ecosystem Management," a recent Forest Service initiative (USDA Forest Service 1992b). The Department supports an

ecosystem management approach to forest management, but does not equate the MRNG with ecosystem management. As discussed throughout this document, implementation of the MRNG will not adequately address the needs of many wildlife species. Because the landscape implications of the MRNG are also untested hypotheses, the Department does not feel that they should be applied to forest landscapes across Arizona without further analysis and adjustment.

Monitoring and evaluation were not directly addressed in the MRNG, except for the following statement: "... as our understanding of the goshawk and its habitat use and preferences increase, these management recommendations will be refined" (Reynolds et al. 1992:9). The Department agrees that an adaptive monitoring approach is appropriate, however, a formal framework is essential. Bailey (1982) observed that "... the most widespread failure of wildlife management in the U.S. is the lack of local testing of treatment efficacy." Without the appropriate monitoring, research and refinement called for in the MRNG, the MRNG will remain an untested hypothesis. Development of the MRNG required a tremendous investment in time and resources. This commitment must be carried through the application and evaluation phases. The Department will do all it can to assist in these efforts.

**Conclusions**

The Department believes that conservation and management of the goshawk and its habitats can best be achieved by a more rigorous application of scientific methodology. The MRNG provides a valuable starting point, testable hypotheses which may lead to a viable conservation strategy. The next essential step is a test of these hypotheses in well-designed "management experiments." Because of the uncertainty involved, this should be done on an incremental basis (i.e., on a subset of active goshawk territories). This will allow for modification as needed and also preserve future management options.

## ARIZONA GAME AND FISH DEPARTMENT RECOMMENDATIONS

### Introduction

The Department supports aspects of the MRNG, including longer rotations, more uneven-aged treatment on small areas, 6,000 acre territories for goshawk management and the intent to manage for more acres of large old trees. The Department also supports the continuation of timber harvest as a tool in forest management. However, the MRNG considered only the needs of the goshawk and 14 of its prey species. In this document, the Department has detailed its concerns for the species considered in the MRNG as well as a broad range of other wildlife. Following are the Department's recommendations for modifications to the Interim Guidelines and Implementation Guidelines. The Department believes that these modifications will correct deficiencies in the Forest Service management strategy for the goshawk and will resolve concerns regarding the habitat needs of other wildlife. These recommendations are not intended to provide the best possible habitat for the goshawk but are intended to provide an array of habitat conditions which should maintain the wildlife diversity of the ponderosa pine ecosystem, including the goshawk. The recommendations include 1) changes to the Implementation Guidelines and changes to the Interim Guidelines, and 2) monitoring and research needs.

### Recommended Modifications to Implementation Guidelines and Interim Guidelines

1) Implement a minimum 250 year rotation age in goshawk management areas. Maintain a 20 year period between entries for timber harvest. This recommendation will require a change in the current Implementation Guidelines.

2) Revise the SDIs in the Implementation Guidelines as follows:

   Foraging Area:

   The intent is to maintain high variability. Point sampling may show a range of SDIs from near 0 to over 300. These extremes are both acceptable and desirable. Therefore, the Department recommends managing for a range of SDIs from 110-230, provided the SDIs are determined from an aggregate of points incorporating existing extremes. Manage for an even distribution of SDIs across this range.

   PFA:

   The intent again is to provide high variability but with a higher average SDI. Provide for a range of SDIs from 160-230, provided SDIs are determined from an aggregate of points. Manage for an even distribution of SDIs across this range.

3) Consistent with a 250+ year rotation, manage for a maximum of 8% of the 6,000 acre goshawk management area in regeneration (VSS 1). Manage for a minimum of 20% in VSS 5 and 20% in VSS 6. Where poor growing conditions (low site index) will not produce 20% VSS 6, retain all current trees over 24 inch DBH and substitute additional VSS 5 acres to provide a minimum of 40% in VSS 5 and 6.

4) The Interim Guidelines only replace the original LMP Standards and Guidelines for goshawks. All other wildlife S&Gs should be maintained unless amended pursuant to NEPA.

5) It is unnecessary to treat acres classified as unsuitable for timber harvest in the Forest Plans to benefit the goshawk.

6) Defer treatment of stands with old growth attributes until old growth inventories and allocations required by Forest Plans have been completed, then retain the integrity of those areas allocated to old growth.

7) Return to the original biological intent of VSS 5 and 6 rather than just using a diameter criteria. This requires adjustment in both the Implementation Guidelines and Interim Guidelines to include the biological attributes of older trees.

8) Emphasize uneven-aged management in Arizona's forests. The Department recognizes that control of forest pests and diseases, management of urban interface areas where fire management is important, and maintenance of some site specific wildlife habitat needs may best be accomplished through even-aged management. However, no more than 20% of a goshawk management area should be under even-aged management with maximum stand size of 100 acres.

9) Maintain a minimum of 5 reserve trees per acre to provide future snags and downed logs.

The Department believes that implementation of the Recommendations listed above will help to resolve concerns over snags, canopy cover, old growth, hiding and thermal cover.

**Recommended Scope of Application**

The Department recommendations are limited to the goshawk management areas. Although the Department believes that our recommendations will provide suitable habitat for a broad range of wildlife species, application of any management strategy on a landscape scale is inappropriate without a rigorous analysis of the potential impacts on all resources.

A management issue yet to be resolved is the provision of additional suitable habitat which would allow existing goshawk populations to be maintained or to expand, where appropriate. As

already identified in this document, the Interim Guidelines will not create suitable habitat outside goshawk management areas where goshawks can establish new territories. This is a significant management issue because 1) the state and federal wildlife agencies and the Forest Service have a responsibility to manage for viable wildlife populations, 2) after receiving proposals to list the goshawk under the ESA, the USFWS is conducting a status review, and 3) the Secretary of the Interior has advocated proactive management initiatives to avoid the need for listing under the ESA. Therefore the Department is recommending that the Goshawk Implementation Team develop a strategy to provide for expanding goshawk populations to insure their viability across the southwest.

**Recommended Monitoring and Research**

1) Identify areas in Arizona's forests which reflect the DFC identified in the MRNG. Monitor these areas and recent timber sales to see if goshawks and the 14 targeted prey have responded as expected and whether silvicultural objectives were met.

2) Monitor goshawk populations on at least one other area besides the North Kaibab Ranger District with different habitat attributes than those on the North Kaibab Ranger District. See the goshawk PVA in Appendix 4 for additional research and monitoring recommendations.

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