Appendix AAG

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HABITAT CONSERVATION OF THE NORTHERN GOSHAWK IN THE SOUTHWESTERN UNITED STATES: RESPONSE TO GREENWALD ET AL. 2005

RICHARD T. REYNOLDS, Rocky Mountain Research Station, 2150 Centre Ave, Bldg. A, Fort Collins CO 80526.

RUSSELL T. GRAHAM, Rocky Mountain Research Station, 1221 South Main, Moscow ID 83843.

DOUGLAS A. BOYCE, Pacific Northwest Research Station, 2770 Sherwood Lane, Suite 2A, Juneau AK 99801.

In their review of the literature on northern goshawk (*Accipiter gentilis*) habitat selection in the home range and implications for forest management, Greenwald et al. (2005) suggested that current management for the northern goshawk, as described in Management Recommendations for the Northern Goshawk in the Southwestern United States (MRNG; Reynolds et al. 1992, Graham et al. 1994, Bassett et al. 1994, Reynolds et al. 1996, Reynolds et al. 2006b) and which have been implemented on National Forests in the Southwestern Region of the USDA Forest Service since 1996 (USDA Forest Service 1996), are inadequate. Greenwald et al. (2005) posited that this inadequacy is evidenced by findings of 12 radio-telemetry studies of goshawk habitat use and 5 studies relating goshawk nest site occupancy and productivity to home range scale habitat characteristics published after the appearance (1992) of the MRNG. Here we show that Greenwald's et al. (2005) conclusion derives from misunderstandings of the desired habitat conditions described in the MRNG, a poor understandings of the ecological factors limiting goshawk populations, a failure to understand goshawk forest habitat as dynamic ecosystems, incomplete reviews of the literature, and inclusion of studies with limited samples of goshawks.

Desired goshawk habitats in MRNG

Here we review the desired goshawk habitats and the process used to identify them in the MRNG (Reynolds et al. 1992). The MRNG specified different sets of desired habitat conditions for three Southwestern forest types (ponderosa pine, mixed conifer, spruce-fir) based on reviews of knowledge of the life history and habitats of goshawks, and the life histories and habitats of their more important prey species (Reynolds et al. 2006b). A synthesis of the life histories and habitats resulted in composites of the habitats of goshawk prey and habitats (nest site and hunting habitat) of goshawks which were then projected into spatial and temporal scales by referencing the natural vegetation composition, structure, and landscape pattern of each of the three Southwestern forest types to assure the desired habitats could be attained and sustained. Reference conditions included vegetation composition, growth characteristics, longevity, age class distribution, and the sizes, structures, distributions, and juxtapositions of plant aggregations that existed in each forest type before the initiation of intensive forest management (tree cutting, cattle grazing, fire suppression). Such spatial and temporal projection verified that the desired habitats, classified into vegetation structural stages (VSS 1, grass/forb/shrub; VSS 2, seedling/sapling; VSS 3, young forest; VSS 4, mid-aged forest; VSS 5, mature forest; VSS 6, old forest up to 290 yrs), were within the bio-physical capabilities of the vegetation comprising each forest type (Reynolds et al. 1994). The literature on prey life histories and habitats indicated that mid-aged to old forests were the most important habitat for most goshawk prey species followed in importance by small open areas (Reynolds et al. 1992). Older forest age classes often provided vegetation structures (sub-canopy flight space, abundant hunting perches) suited to goshawk foraging behavior (Reynolds et al. 1992). Thus, MRNG desired landscapes had as much old forest with small interspersed openings as could be sustained. To sustain goshawk and prey habitats in landscapes, the MRNG described a shifting mosaic of all VSS classes that approximated an area-based balance (about 20% per VSS) of forest age classes (Reynolds et al. 1992). This shifting mosaic was similar to the natural forest patch dynamics of the southwestern forest types, were the interacting consequences of the life spans of trees, tree and stand development characteristics, succession, and the types, intensities, and frequencies of natural disturbances. Each of the three Southwestern forest types had different desired habitats and landscapes because each type has different faunal compositions (potential goshawk prey) with different suites of habitats, different species of dominant vegetation, and different landscape patterns (the result of different natural disturbances).

The desired goshawk and prey habitats in Southwestern ponderosa pine comprised a mosaic of highly interspersed, small patches of different VSS (Reynolds et al. 1992). This mosaic resembled the pattern of pre-settlement ponderosa pine in which trees were strongly aggregated into groups of 3-44 trees occupying 0.2-0.3 ha (Cooper 1961, White 1985). Tree groups, and occasional individual trees, were typically separated by variable-sized, but small, openings into which roots of the grouped trees spread (Pearson 1950). Tree reproduction (seedlings) also occurred in groups where older trees fell or in openings between groups (Pearson 1950, Cooper 1961). Like the MRNG desired habitats, historical ponderosa pine forests were all-aged (coarse scale) made up of small patches of trees of similar age (fine scale), each surrounded by a small opening (Pearson 1950). Tightly-grouped trees in the mid-aged, mature, and old VSS with lifted crowns (subcanopy flight space for goshawks), interlocking branches (for tree squirrel movements), large limbs in and below the live crowns (goshawk hunting perches), and extensive shading (soil protection for mycorrhizal fungi), were important within patch characteristics for goshawks and many of their prey (Reynolds et al. 1992). Small openings around tree groups provided habitat for other important goshawk prey (e.g., rabbits, ground squirrels, some birds), which can be hunted by goshawks from tree groups (Reynolds et al. 1992). A similar landscape pattern was desired for Southwestern mixed-conifer forests but with larger tree groups of mixed species and smaller openings around groups. Desired conditions for spruce-fir forests were more closed forests with scattered small openings (Reynolds et al. 1992). The MRNG also recommended snags, logs, and woody debris for prey habitats and specified the sizes, distributions, and amounts of these habitat elements for each forest type (Reynolds et al. 1992).

Goshawk selection for stand structure

Greenwald et al. (2005) described what they viewed as commonalities in goshawk home range habitat structures among the studies they reviewed. These commonalities were identified as "mature to old-growth forests," which they further characterized as forests having "high canopy cover, large trees for forest type, canopy layering, and abundant course woody debris" (Greenwald et al. 2005, p. 125). Greenwald et al. (2005) argue that these commonalities show that goshawks need forests with high canopy cover, large trees, canopy layering, and abundant woody debris. In our view, instead of demonstrating commonalities in habitat structure, the studies reviewed by Greenwald et al. (2005) demonstrated that habitat structure in areas used by goshawks can be actually quite variable. The level of variation in habitat structure becomes even clearer when other goshawk studies, ignored by Greenwald et al. (2005), are included. First, we point out the extensive structural differences between the dry pinyon-juniper woodlands used by goshawks in Arizona (Drennen and Beier 2003) and Utah (Stephens 2001) and the highly productive coastal temperate rain forest used by goshawks in Alaska and Washington (Titus et al. 1996, Bloxton 2002), both described in studies by Greenwald et al. (2005, Table 1). Pinyon-juniper woodlands are composed of small (typically <12m in height) widely-spaced trees (open canopies) whose dense crowns typically extend to the ground (no canopy layering), and with little large diameter woody debris (Brown 1982). In contrast, coastal temperate rain forests are comprised of some of the largest (40-58m in height and often exceeding 100cm in diameter) conifers found in North America, which form dense and multilayered canopies with considerable woody biomass on the forest floor (Franklin and Dyrness 1973, Alaback and Juday 1989). Similarly, there are few tree size and canopy cover similarities in ponderosa pine forests occupied by goshawks in the Southwest (Crocker-Bedford 1990, Bright-Smith and Mannan 1994, Beier and Drennan 1997, Drennen and Beier 2003) and boreal spruce (*Picea glauca*) forests occupied by goshawks in Canada, described in a goshawk study not reviewed by Greenwald et al. (2005) (Doyle and Smith 1994). Old ponderosa pine forests have large trees (up to 113 cm diameter; Van Hooser and Keegan 1988), canopy heights up to 36 m, canopy cover typically less than 30 percent (Pearson 1923, White 1985, Covington and Sackett 1984), and relatively little woody debris, while the Canadian spruce forests in Doyle and Smith's (1994) study contained two structurally different forest types; stands of old but small (8-13 m) spruce trees with closed canopies and open forests of scattered small spruce trees and occasional clumps of aspen (*Populus tremuloides*) within a dense shrub habitat (Doyle and Smith 1994). Another study cited by Greenwald et al. (2005) but not included their analysis of habitat selection was of goshawks in Nevada (Younk and Bechard 1994, Younk 1996). Younk (1996) use radio-telemetry to determine the movements of breeding goshawks in a shrub-steppe habitat containing small and highly fragmented stands of aspen trees. While goshawks nested in the small aspen stands, between 37-55 percent of radio locations of hunting male goshawks were in the shrub-steppe habitat (no trees) or on the edges of aspen stands from which they initiated hunting forays into the shrub-steppe habitat where Belding's ground squirrels (*Spermophilius beldingi*) was abundant (Younk 1996). Younk's (1996) shrub-steppe habitat was structurally similar to Upper Sonoran Life Zone shrub-steppe habitats surrounding goshawk nests in riparian cottonwood trees (*Populus* spp.) in Colorado and Utah (White and Lloyd 1965) and tundra vegetation around a goshawk nest in a 5-m tall stand of willow (*Salix* spp.) 145 km north of the tree line in Alaska (Swem and Adams 1992).

Such extensive variation in vegetation structure (big trees, little trees, no trees; closed canopy, open canopy, no canopy) leads us to conclude that tree size, canopy cover, canopy layers, and woody debris are not always factors limiting goshawk populations as posited by Greenwald et al. (2005). Reynolds et al. (2006a) found that goshawks appear to be more often limited by food than by other habitat features, and the MRNG review of the life histories and habitat of principle goshawk prey in the focal forest types demonstrated that most species were associated with older, more productive forests (Reynolds et al. 1992). Thus, Southwestern mid-aged to old conifer forests were critically important to the abundance and diversity of species in the goshawk food web. Despite this, the vegetation in these forests typically varied structurally (tree size, canopy cover and layers, woody debris), both within (because of site differences) and among forest types. A more complete view of habitat structural variability is gained when goshawk studies in other geographic locations and forest types are included. In several studies not reviewed by Greenwald et al. (2005), food appeared to be the primary determinant of habitat used by goshawks, leading them in some areas to hunt in non-forested habitats.

Goshawk selection for openings, logged forests, edge

Greenwald's et al. (2005) suggestion of inadequacy of the MRNG is based on their misrepresentations of the desired habitat conditions for goshawks and their prey described in the MRNG (Reynolds et al. 1992). The goshawk habitat studies they choose to review showed that goshawks either avoided or were neutral to openings (whether natural meadows or created by logging), edges, and young ("generally younger than 30 years old") forests, partially logged stands, and stands with <40% canopy closure (Greenwald et al. 2005). In spite of this, Greenwald et al (2005) admit that openings may benefit goshawks by increasing the abundance of ground squirrels (they ignored rabbits), but countered this admission by claiming that "given the history of clearcutting in much of the western United States, we very much doubt that forest clearings are a limiting factor for the species" (p. 126). Equating the desired openings described in the MRNG to historical clear-cuts is misleading. The MRNG recommended nothing more than the restoration of the small openings that have been lost (filled with trees) as a result of decades of fire suppression (see Reynolds et al. 2006b, Figs. 2, 3, 4). MRNG openings are small to medium, and included an upper limit of 0.4-1.6 ha depending on forest type. Upper size limits allowed managers flexibility for treating disease or insects epidemics. Of course, under the MRNG, groups of trees would be reestablished within these openings. Because of the juxtaposition of tree groups and openings in ponderosa pine and mixed conifer forests, the desired conditions would consist of considerable forest-to-open edge. Restoring fine scale edge would restore the diversity of prey habitats and prey species for goshawks. Fine-scale edge and openings are typically missed in radio-telemetry studies of goshawk habitat use; therefore, goshawk responses to large openings and associated edge, as determined in studies cited by Greenwald et al. (2005), are not useful for evaluating goshawk use of fine-scale edge and openings.

Greenwald et al. (2005) claimed that they included all radio-telemetry studies of goshawks that estimated habitat selection at the home range scale. We have already seen that they did not included Younk's (1996, Table 1) study of hunting goshawks using shrub habitats. Further, at least four of the 12 studies Greenwald et al. (2005) reviewed included fewer than 10 radio-tagged goshawks and one included only two goshawks. Fewer than 10 goshawks are unlikely to adequately describe the full range of habitats used even within a local population simply because any one goshawk can only sample the habitats available within its spatially-limited home ranges. This sampling problem was even recognized by Greenwald et al. (2005; p. 124) when they pointed out that shrubland-grassland was not present within the home ranges of the two goshawks in Fischer's (1986) study. Telemetry studies of goshawk habitat use based on larger samples of goshawks typically showed extensive individual variation in habitats used (see Hargis et al. 1994, Beier and Drennan 1997, Drennan and Beier 2003), which is not surprising given the natural spatial (i.e., among home ranges) variation in forest conditions, especially in the more heterogeneous forest types. While Greenwald et al. (2005) included two studies of habitat use by wintering goshawks (Stephens 2001, Drennan and Beier 2003), they failed to consider other studies showing use of extensive pinyon-juniper woodlands, shrub-steppe, lowland riparian, and agricultural lands by wintering goshawks (Reynolds et al. 1994, Squires and Ruggiero 1995, Sonsthagen 2002, Wiens 2004). Greenwald et al. (2005; p. 123) could not ignore the wide diversity of habitats used by the goshawks in the studies they reviewed, but claimed that such data were "inconclusive." We believe this reflects a bias, which is further evidenced by their inclusion of a Beier and Drennan (1997) quote (Greenwald et al. 2005, p. 125): "the range of stem densities, stem sizes and canopy closures at sites used by goshawks was strikingly broad. We suspect that goshawks used all types of forest stands, in part because of the limited availability of denser stands of large trees in our study area."

Goshawk selection for prey abundance

Greenwald et al. (2005) reviewed four studies that attempted to determine whether hunting goshawks selected forests on the basis of prey abundance or forest structure. These studies compared vegetation structure and prey abundance at sites where goshawks were assumed, based on radio-transmitter pulse rates, to have been hunting, or where prey remains were found, or where they were observed feeding, to either randomly located sites (Beier and Drennan 1997, Drennan and Beier 2003), or among kill sites that differed in frequency of revisits by the goshawks (Good 1998). These studies found prey abundance at foraging and random sites to be similar (Beier and Drennan 1997, Drennan and Beier 2003), and that goshawks did not return more often to kill sites with higher prey abundance (Good 1998). However, because foraging sites and more frequently-used kill sites had higher canopy cover, higher tree density, more large trees, or lower shrub cover than random sites, these authors suggested that radio-tagged goshawks selected hunting habitat of the basis of habitat structure and not prey abundance. These findings are contrary to increasing evidence that food is an important factor limiting the survival, reproduction, distribution, density, home range size, proportion of pairs breeding, and nest success of goshawks and other raptors (Southern 1970, Galushin 1974, McGowan 1975, Sollien 1979, Linden and Wikman 1980, Baker and Brooks 1981, Huhtala and Sulkava 1981, Doyle and Smith 1994, Keane 1999, Salafsky et al. 2005, Wiens et al. in press), and that goshawk choice of hunting habitat can be affected by relative differences in prey abundance and availability among habitats (forest type, interior versus edge, non-forest) (Widén 1989, Kenward and Widén 1989, Tornberg and Colpaert 2001, Sunde 2002, and Younk 1996). So, why then do Beier and Drennan (1997), Good (2001), and Drennan and Beier (2003) show that goshawks selected foraging habitat on the basis of vegetation structure and not food abundance? We began by pointing to several potential methodological problems that might consistently bias such foraging/kill site studies (Reynolds et al. 2006a). Potential problems stem from assumptions that the radio-located goshawks were actually hunting when located and not involved in some other activity, that locations of presumed hunting sites were accurate (no systematically biased location errors), and that kill sites were sites where the goshawks first detected their prey. The latter may problematic because the method assumes that killed prey did not attempt an escape, which could be towards denser cover, and that the goshawks had not moved their prey after killing it, which could also be towards denser cover (frequent movement of prey occurs during breeding) (Reynolds et al. 2006a). In spite of these, we do not believe the findings of the authors cited by Greenwald et al. (2005) are necessarily in conflict with the idea that, in areas with similar food abundance, goshawks should use an area with vegetation structures that increase their access to prey because the energetic profitability of different habitats for goshawks, and thus their habitat preference, is determined not only by prey density in a habitat, but by the presence of other habitat features that influence a goshawk's ability to hunt there (Widén 1989, Reynolds et al. 1992). These two factors were the principle concern of the MRNG; to develop a diversity of prey habitats sufficient to support goshawks and to provide interspersed vegetation structures within or adjacent to prey habitats to improve goshawk hunting efficiency (Reynolds et al. 1992, Reynolds et al. 1996, Reynolds et al. 2006b).

Goshawk winter habitat selection

Greenwald et al. (2005) cited Stephens (2001), Drennan and Beier (2003), and Titus et al. (1996) as supporting their view that wintering goshawks continued to occupy ponderosa pine, mixed conifer, and coastal temperate rain forests with "statistically higher canopy closure than random sites." In spite of this, Greenwald et al. (2005) then acknowledged that some of Stephens (2001) and Drennan and Beier (2003) radio-tagged goshawks migrated to lower-elevation pinyon-juniper woodlands. We have already pointed to the extensive structural dissimilarities in the tall conifer forests mentioned above and pinyon-juniper woodlands, dissimilarities that offer counter evidence to Greenwald's et al. (2005) contention that wintering goshawks also need closed forests. Additional counter is available in studies not included in Greenwald's et al. (2005) literature review. These studies also showed goshawks moving into pinyon-juniper woodlands, shrublands, or agricultural areas during winter (Reynolds et al. 1994, Squires and Ruggerio 1995, Stephens 2001, Sonsthagen 2002, Wiens 2004). None of these authors determined why goshawks moved to these woodland and non-forested habitats, but we believe Drennan and Beier (2003) were on the right track when they suggested, despite their finding that goshawks did not select foraging habitat on the basis of prey abundance, that perhaps goshawks moved to pinyon-juniper woodlands "in response to reduced diversity and abundance of prey in ponderosa pine habitats in winter (due to migration and hibernation of most prey species)." Managing for both prey and goshawk habitats, as recommended in the MRNG, is the best strategy for minimizing the need for wintering goshawks to leave breeding habitat for lower elevation woodland or non-forested habitats where they may suffer higher predation rates (Squires and Ruggerio 1995).

Goshawk occupancy and productivity related to landscape features

Greenwald et al. (2005) reviewed five studies suggesting consistent correlations between closed-canopy forests with large trees in landscapes surrounding goshawk nests and goshawk nest occupancy and reproduction. Three of these studies (Ward et al. 1992, Patla 1997, Finn et al. 2002) compared forest structures (canopy closure, proportion of mature forest cover, proportion of forest cover, forest heterogeneity) and territory or nest site occupancy by goshawks, and two studies (Crocker-Bedford 1990, 1995) compared goshawk nest occupancy and reproduction in areas with increased levels of tree harvests. Such studies relating goshawk nest occupancy and reproduction to surrounding habitat features have several potential shortcomings. First, such studies were correlative because use of habitats by goshawks in landscapes surrounding their nests was not actually determined. Thus, only a hypothesized relationship can be developed between habitats and goshawk occupancy or reproduction. Another shortcoming stems from the difficulty of being able to unequivocally determine the status of a breeding territory (goshawk present, eggs laid). The difficulty was demonstrated in a 13-year study of color-banded goshawks (Reynolds et al. 2005) in Arizona, where alternate nests within goshawk territories were as much as 2.4 km apart, where as many as 76% of egg-laying goshawks in a year moved to alternate nests, and where no pair of goshawk laid eggs every year.

As a consequence, a minimum of 10-person-days of annual nest searches, and as many as 8 years of searches, may be required to confidently estimate the presence of nesting goshawks on territories (Reynolds et al. 2004, Reynolds et al. 2005). Others (Woodbridge and Detrich 1994, Siders and Kennedy 1996, Keane et al. 2006) have shown similar temporal variation in breeding and distances of movements of goshawks among alternate nests. In this light, we reviewed the studies cited by Greenwald et al. (2005) for nest sampling efforts. Ward et al. (1992) did not provide information on the extent to which their 12 study territories were searched for nests, and Finn et al. (2002) conducted searched for nests in three years and to about 1 km radius from historical nests. Only Patla (1997, 2005) approached the within- and among-year sampling effort for nests as was recommended by Reynolds et al. (2005). Thus, it is equivocal whether the reproductive status of goshawks in at least two of the three studies reviewed by Greenwald et al. (2005) was adequately determined, and whether the relationship between landscape habitat conditions and goshawk occupancy and productivity, cited by Greenwald et al. (2005), was real.

Greenwald et al. (2005) also missed several studies in their review relating goshawks reproduction to surrounding landscape habitats. La Sorte et al. (2004) compared forest features around goshawk and red-tailed hawk (*Buteo jamaicenis*) at several spatial scales and found that beyond 0.8 km from goshawk nest sites forest structure became increasingly fragmented and resembled patterns found at randomly-located sites. Joy (2002) examined associations between the amount and arrangement of habitat elements surrounding nests in higher and lower quality territories, determined from annual rate of egg laying and fledglings production on 100 territories studied for 10 years on the North Kaibab Ranger District, Arizona. Vegetation differences between high and low quality territories were not detected, but both high and low quality territories differed from random plots in that they had fewer openings within 0.6 km of plot centers. Desimone (1997) revisited 46 historic nest sites in one year (1994) in Oregon to determine the occupancy status by goshawks and to determine the forest age classes and canopy cover in surrounding landscapes. Searches for goshawks were conducted around historic nests at a radius of 1 km (half the distance recommended by Reynolds et al. 2005). Fifteen of the 46 nest sites were occupied and occupied sites had significantly more mid-aged closed forests and late-successional forest than unoccupied sites. Maurer (2000) measured the landscape vegetation around 31 active goshawk nests in Yosemite National Park, California, and reported that nests more often than expected were in areas recently burned by low-severity and moderate-severity fires. Clough (2000) surveyed 70% of extensively managed forests in her Montana study area, and measured vegetation around 18 goshawk nests she found, all of which were on the periphery of her study area within1-5 km of grassland-timber interface. Clough (2000) reported that forested area occupied by goshawks had been heavily influenced by tree harvests, roads, and grazing relative to more interior forests that were not occupied by goshawks. Daw and DeStefano (2001) determined landscape forest structures within nested circular plots of increasing radii around 22 active goshawk nests and 44 randomly-located sites. They found that there was more older forest structure around nests in the inner circles (12 and 24 ha) than around random sites but differences between used and random sites diminished as circle size increased, and that the odds of occupancy by goshawks increased 2.5 times with the presence of dry openings (Daw and DeStefano 2001). McGrath et al. (2003) also determined landscape forest structure within nested circular plots of increasing radii around 28 active goshawk nests and 95 randomly-located sites in Oregon and Washington. While McGrath et al. (2003) found that the presence and arrangement of forest structural types interacted to influence site suitability for goshawk nesting, their ability to distinguish goshawk sites from random sites decreased with increasing area (beyond 83 ha) surrounding nests (McGrath et al. 2003).

Finally, Greenwald et al. (2005) cited Crocker-Bedford's (1990) 3-year study in which he reported significantly lower nest occupancy and productivity of goshawks in areas that had been only lightly harvested versus those in areas that had been more heavily harvests (a second selective harvest). Yet, one of us (RTR) has intensively studied the population of breeding goshawks on the Kaibab Plateau for 15 years (1991-2005) (Joy et al. 1994, Reynolds et al. 1994, LaSorte et al. 2004, Reich et al. 2004, Reynolds et al. 2004, Reynolds et al. 2005, Salafsky et al. 2005, Reynolds and Joy 2006, Wiens and Reynolds 2005, Wiens et al. 2006). This study, which used mark-recapture methods on goshawks in as many as 121 breeding territories (104 in the KNF, 18 in the

GCNP-NR) and includes all the "locales" studied by Crocker-Bedford (1990), has shown considerable temporal and spatial variation in annual frequency of egg-laying and production of young by goshawks (Reynolds et al. 2005, Reynolds and Joy 2006) irrespective of tree-cutting histories on territories. Much of this variation is associated with inter-annual fluctuations in prey populations (Salafsky 2004, Salafsky et al. 2005), high adult fidelity to territories and mates, and variations in the breeding life spans of goshawks (Wiens and Reynolds 2005, Reynolds unpubl. data). In addition to the effects of food abundance and differences in breeding life spans, our research (1991-2005) is showing that vegetation, weather, predators, and competitors, and disease can directly and indirectly affect goshawks, and that these factors often act synergistically on goshawk demography, especially on reproduction (Reynolds et al. 2006a). All of the above significantly confound the detection of tree harvests effects on goshawk reproduction. While Crocker-Bedford (1990) concluded that heavier cutting reduced occupancy and reproduction compared to light cutting, we show below that demonstrating the effects of tree cutting on reproduction is not always straight forward, even with long-term data.

We compared the breeding histories of goshawks on six non-randomly selected territories on the Kaibab Plateau, three in uncut old-growth and three in heavily cut forests. We wish to clarify that this sample of territories did not represent a random sample; we chose the territories simply to make our point. Two of the uncut territories (KG 40, KG78) were adjacent to one another on the NKRD in the last remaining area of uncut old-growth ponderosa pine (access roads had been constructed into the area prior to 1991) and the third territory was in the GCNP, also in uncut old-growth ponderosa pine.

Each of these territories had a minimum of 13 years of intensive study of goshawk (color-banded) occupancy and reproduction (Table 1). Three other territories (KG-5, KG-6, KG-17) were chosen for comparison because they were representative of the more heavily cut territories on the NKRD. Each of these cut territories had 15 years of intensive study of goshawk (color-banded) occupancy and reproduction (Table 1). During the years studied, the uncut old-growth territories had a mean egg laying rate of 0.53 (SD = 9.5), a mean failure rate of 0.267 (SD = 11.0), and a mean production of 0.61 young/nest/year, while the heavily cut territories had an mean yearly egg laying rate of 0.71 (SD = 10.1), a mean failure rate of 2.7 (SD = 4.6), and produced a mean 1.4 young/nest/year. We do not mean to suggest that heavy tree harvests are beneficial to goshawks. Rather, our continuing retrospective studies of goshawk demography and habitat changed by timber harvests, windthrow, and high-intensity fire on the Kaibab Plateau suggest that less heavily changed territories may be more productive on average that more heavily cut territories (Reynolds unpubl. data). Our research is continuing to disentangle the confounding effects of territory fidelity, individual hawk quality, and extensive temporal and spatial variations in prey populations on detecting the effects of forest management.

Conclusions

We disagree with Greenwald's et al. (2005, p. 126) statement that "recommendations focusing on increasing prey abundance at the expense of forest structure ...are not likely to increase goshawk occupancy rates." First, the MRNG do not focus on increasing prey abundance at the expense forest structure suitable for goshawk hunting. Rather, the MRNG focus both on increasing prey abundance and providing the forest structures likely to increase goshawk access to their prey. The multiple species, ecosystem approach of the MRNG addresses the most ubiquitous factors appearing to limit goshawk populations: food abundance, food availability, and suitable nest habitat (Reynolds et al. 2006b). In our view, implementation of the MRNG in Southwestern ponderosa pine, mixed conifer, and spruce-fir forests will increase the likelihood of goshawk occupancy by increasing their density, reproduction, and survival. Advocating management of all vegetation types occupied by goshawk according to the Greenwald et al. (2005) one-size-fits-all criteria (big trees, closed and multilayered canopies, abundant woody debris, etc.) is ecologically unsound because it ignores the full range of vegetation types used by goshawks (forest, non-forest) their criteria cannot be attained or sustained in each of the many and variable-structured forest types occupied by goshawks.

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Table 1. Years studied, egg laying rates (years eggs laid/years territories studied), nest failure (eggs laid, no young fledged) rates (years nest failed/years eggs laid), and total young fledged (mean total fledged = total fledged/years territory studied) in three goshawk territories in uncut old-growth and three territories with heavily cut forests on the Kaibab Plateau, Arizona, 1991-2005. Territories shown were selected to show that goshawks can be more productive in heavily cut forests than goshawks in uncut old-growth.

	Territory number	Years studied	Years eggs laid	Egg laying rate	Years failed	Failure rate	Total young fledged	Mean fledged/yr
	40	14	6	0.43	2	0.33	9	0.64
Uncut old-growth	56	14	7	0.50	1	0.14	10	0.74
	78	13	6	0.46	2	0.33	6	0.46
				0=0.53		0=26.7		0=0.61
				SD=9.5		SD=11.0		SD=0.13
	5	15	11	0.73	0	0	21	1.4
Heavily cut	6	15	12	0.80	1	0.08	23	1.5
	17	15	9	0.60	0	0	18	1.2
				0=0.71		0=2.7		0=1.4
				SD=10.1		SD=4.6		SD=0.2