

# **Appendix AY**

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## HABITAT EFFECTS ON NORTHERN GOSHAWKS

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Goshawk Nest Site. While the term nest site has been variously defined for goshawks, the commonly accepted definition within the USDA Forest Service is that of Reynolds (1983): 20-25 acres that is intensively used by adults and recent fledglings, and which includes most courtship behavior and copulation, most prey plucking and picking areas, and most breeding season roosts. A nest site is shaped like a piece of pie, with the corners nibbled off, and with the outer rim of the pie above the actual nest. There is more distance between the nest and the outer rim than to the tip of the triangle below, because most goshawk activity occurs above the actual nest tree (Reynolds 1983).

Goshawk nest sites include larger trees and denser overstory canopies than most forested stands in the surrounding landscapes (Shuster 1980, Reynolds et al. 1982, Reynolds 1983, Moore and Henny 1983, Speiser and Bosakowski 1987, Crocker-Bedford and Chaney 1988, Hayward and Escano 1989, Warren et al. 1990, Reynolds et al. 1992, Selas 1997, as well as a dozen or more MS theses). Nest sites contain larger amounts of mature productive forest and less opening than random sites (Iverson et al. 1996). On the Kaibab Plateau, goshawks did not nest in stands having less than 60% canopy coverage, nested only 43% as often as expected by random chance in stands estimated to have 60-69% canopy, nested 2.5 times more often than expected in stands having 70-79% canopy, and nested 5.8 times more often than expected by random chance in stands estimated to have 80% or more canopy coverage ( $P < 0.0001$ , Crocker-Bedford and Chaney 1988).

Goshawk territories show strong nest site fidelity within sets of alternate nests (Reynolds 1983, Crocker-Bedford and Chaney 1988, Crocker-Bedford 1990, Woodbridge and Detrich 1994, and several MS Theses), and nest trees may be reused even after as many as four years with no nest remaining in a nest tree (Crocker-Bedford 1990). While reuse of a nest tree is typically by the same individual(s) that last used it (Detrich and Woodbridge 1994), which is not surprising as goshawks are long-lived, other statistics on reuse imply inter-generational use of nest sites (Crocker-Bedford 1990).

Clusters of nest stands that total more area are more likely to be reoccupied by nesting goshawks, as are individual nest stands with more area, while clusters of nest stands in more fragmented landscapes are less likely to be reused (Woodbridge and Detrich 1994). Goshawk nests are farther from openings than are nests of other forest raptors (Falk 1990, Bosakowski and Speiser 1994). If the surrounding landscape does not receive too much timber harvesting, then goshawks may reuse a selectively harvested nest site even though it no longer has a dense overstory canopy (Crocker-Bedford 1991). Nest site fidelity apparently encourages reuse by goshawks accustomed to nesting in a specific stand even if its habitat has been degraded below normal nesting parameters (Crocker-Bedford 1991), but a future generation would seem less likely to nest in the degraded habitat.

Goshawk Habitat Beyond the Nest Site. Radio studies have demonstrated that goshawk habitat selection (percentage of relocations versus percentage of habitat available with their home range) emphasizes stands that have larger trees and denser overstory canopies, even beyond the nest site (Widen 1989, Austin 1993, Bright-Smith and Mannan 1994, Hargis et al. 1994, Iverson et al. 1996, Beier and Drennan 1997, Good 1998, Boal et al. 2001, Stephens 2001). It is generally assumed that such selection is for foraging habitat, though roosting habitat could play a role. A prey capture attempt is more likely to succeed in a mature forest stand than in a young stand or opening (Widen 1989). In most ecosystems somewhat dense, old forests provide the greatest abundance

of most goshawk prey species (Reynolds and Meslow 1984, Crocker-Bedford 1990, Reynolds et al. 1992, Iverson et al. 1996, Keane 1999), though in some ecosystems non-forested areas are heavily used for hunting (Kenward 1982 for farmland adjacent to forest, though goshawks spent most of their time there hunting within woodlands less than 200 m from the farmland; Younk and Bechard 1994, and Patla 1997, for sagebrush areas near forest). In southeast Alaska goshawks selected against stands typed as non-productive forest (19% use versus 28% availability), and their relocations within such stands frequently occurred within inclusions of productive old-growth forest that were too small in area to be delineated separately within the GIS database; hence, the use of non-productive stands "may depend on the amount of inclusions of productive old-growth forest patches within them" (Iverson et al. 1996). [Note, non-productive forests in southeast Alaska have more small trees (and less than 8 thousand board feet per acre), while productive forest have more large trees (and over 8 thousand board feet per acre).]

In a boreal forest in Sweden goshawks selected for mature stands that were larger than 100 acres, ten times more intensively on a per acre basis than mature forest stands smaller than 50 acres (Widen 1989). Widen (1989), R. Kenward (one of the world's foremost goshawk experts, pers. comm.) and Crocker-Bedford (1998) theorize that effective foraging stands must be large enough to encompass the home ranges of prey individuals associated with such habitat. Also, although prey numbers may be self-sustaining in large stands, prey must recolonize small stands after only a few individuals are killed; thus, goshawks may learn that small stands are less likely to provide a meal. Bright-Smith and Mannan (1994) found that some goshawks selected for dense forest more than 200 m from openings.

Beier and Drennan (1997) and Good (1998) found that goshawk hunting selection emphasized forested stands with larger trees, denser overstory canopies, and fewer shrubs and saplings; however, they found no association between foraging locations and the actual density of potential prey. It is thought that the amount of space between the overstory canopy and open understory, or between the overstory canopy and dense saplings and shrubs, is related to the successful pursuit and capture of prey by goshawks (Reynolds 1989, Widen 1989, Gullion 1990, Crocker-Bedford 1990, 1998, Beier and Drennan 1997, DeStephano and McCloskey 1997, Boal et al. 2001). Even in a landscape where trees in most stands were relatively short, goshawks selectively hunted in mature stands with horizontal open spaces of 1.1 to 3.5 m between the bottom of the overstory canopy and the top of the understory trees, and up to 1 m between the bottom of the understory canopy and the top of the shrub layer (Boal et al. 2001). Most kills occur in stands where trees are larger and canopies are denser (Widen 1989, Beier and Drennan 1997, Stephens 2001). An overly dense mid-story canopy may impair goshawk flight, while shrubs, saplings and mid-story canopy all provide escape cover to prey. On the Kaibab Plateau dense understories and midstories, which typify mixed-conifer and spruce-fir forests, apparently limit access to prey and reduce the chance of breeding in an area (Joy 2002). Foraging success may also be impaired if the overstory is so sparse that the hunting goshawk is too visible to its potential prey (Widen 1989, Austin 1993).

The amount of useful foraging habitat in a landscape near a nest site is important for goshawk nesting and productivity, and is likely the limiting factor for goshawks within forests where many potential nesting stands exist (Iverson et al. 1996, DeStephano and McCloskey 1997, Crocker-Bedford 1998). Iverson et al. (1996) found larger percentages of cover in high productivity forest, in moderate productivity forest, and in low productivity commercial forest within 600 acres around the nest, than within 10,000-acre circles. Within landscapes having larger percentages of mature forest or fewer openings, goshawks are more likely to reoccupy historical nest sites (Ward et al. 1992, Arizona G&F 1993, Woodbridge and Detrich 1994, Patla and Trost 1995, Daw 1996, Patla 1997, Desimone 1997, Finn 2000, Joy 2002) and exist at higher densities (Bloom et al. 1985, Crocker-Bedford 1990, 1998, Arizona G&F 1993). On the Kaibab Plateau higher quality territories (1.2-km diameter circles) have less

deciduous-dominated vegetation (< 5% of area) and fewer openings ( $\leq$  3% of area) than random 1.2-km diameter circles (Joy 2002). Other studies have demonstrated reduced chance of territory reoccupancy and egg laying with increasing amounts of timber harvest and fire beyond nest sites (Crocker-Bedford 1987, 1990, 1995, Patla and Trost 1995, Desimone 1997, Patla 1997, Reynolds 1999), or have deduced that sparse or declining goshawk populations were due to timber harvest (Kennedy 1988, Widen 1997 which cited nine studies from northern Europe). In contrast, Kennedy (1997) did not find statistically significant population decline during the period of her studies; however, Desimone (1997) pointed out that few of Kennedy's goshawk home ranges had undergone any anthropogenic habitat modification since Kennedy began her studies.

Iverson et al. (1996:64) stated: "As selected habitat components decline at the landscape scale, home range size may increase (Kenward 1982), and population density may decrease." Based on a review of pertinent literature, and in consideration of selective use of habitats and the large home range of goshawks relative to the amount of prey consumed, Crocker-Bedford (1998:333) suggested:

"[M]ost forest structures and most area within the typical home range provide little or no benefit to goshawks. Consequently, timber operations that miss important habitats may have little or no effect on home range size or breeding density. However, timber harvests in important foraging habitat likely have effects disproportionate to their sizes."

Summary. Goshawks generally emphasize (use versus availability) stands of relatively large trees with relatively dense overstory canopies for both nesting and hunting (many studies). Dense shrubs, dense understory trees, and dense midstory canopies impede the capture of prey (several studies). Up to some point, larger stands of mature forest are better for both nesting and foraging than are smaller stands (a few studies). The probability of goshawks nesting in future years within a home range is higher in landscapes having larger percentages of mature forest (several studies), and the probability of future nesting decreases as the amount of timber harvest and crown fire increases in nesting stands or important foraging stands (several studies). While mature forests and larger stands appear to benefit goshawks, goshawks exist in places without large stands of mature forests. Although individual goshawks are not everywhere obligates of mature forests, such habitat may be important for the survival of the species. Whereas crown fires typically have negative effects on goshawk habitat by reducing the forest overstory and encouraging the eventual regeneration of dense small trees and shrubs, as well as the creation of large amounts of deciduous-dominated stands, ground/understory fires typically benefit goshawks by improving flight space under the overstory and facilitating the capture of prey.

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