SHORT COMMUNICATIONS

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NORTHERN GOSHAWKS NESTING ON A PRIVATE INDUSTRIAL FOREST IN WESTERN WASHINGTON

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Very little is known about Northern Goshawk (*Accipiter gentilis*) nesting on private, intensively-managed timberlands in the Pacific Northwest. Previous information about goshawk nesting on the west side of the Cascades (Fleming 1987, U.S. Forest Service 1994) is known primarily from pristine National Parks and Wilderness Areas, as well as National Forest lands which have generally received light to moderate levels of timber harvesting since European settlement.

In 1995, the Murray Pacific Corporation implemented a multi-species Habitat Conservation Plan (HCP) which requires periodic monitoring of goshawk populations on their Mineral Tree Farm in Lewis County, Washington U S.A. (Beak Consultants Incorporated 1995). To meet the requirements of the HCP, we designed and conducted a monitoring plan to determine the occupancy and breeding status of goshawks in all suitable and marginal nesting habitats on the tree farm. Additional information was obtained on goshawk breeding density, productivity, prey, nest sites, and habitat characteristics which are also presented.

STUDY AREA AND METHODS

The study area was the Mineral Tree Farm in Lewis County, WA, an industrial tree farm of about 21 600 ha in size which is owned and operated by the Murray Pacific Corporation. The tree farm is located along the western edge of the Southern Cascade Physiographic Province (Franklin and Dyrness 1984) and ranges in elevation from approximately 300–1640 m. Approximately 19 600 ha of the tree farm are capable of supporting forest, with the remaining area containing rocky ridgetops, alpine meadows, cliff/talus slopes, roads, brush, standing water and gravel pits. The study area falls within the Western Hemlock (*Tsuga heterophylla*) Forest Zone (Franklin and Dyrness 1984), which is dominated by Douglas-fir (*Pseudotsuga menziesii*) and western hemlock. Western red cedar (*Thuja plicata*) is locally abundant while Pacific silver fir (*Abies amabilis*) and noble fir (*A. procera*) are present at higher elevations. Commercial timber production is the dominant land use on the Mineral Tree Farm. In 1994, the landscape was covered by stands of various age classes including: recent clearcuts (0–5 yr old; 12%), saplings (6–26 yr old; 43%), pole forest (27–45 yr old; 28%) and commercially mature forest (>45 yr old; 15%). Scattered patches of remaining old-growth forest (250+ yr old) were lumped into the mature forest category because they were rare (<2%) and most (55%) had experienced partial (<50%) overstory removal within the past 80 yr. The area is characterized by a mild, wet maritime climate. Precipitation occurs mainly in winter and averages 1.8–3.6 m annually (Cummans et al. 1975).

Murray Pacific's Geographic Information System (GIS) timberlands database was queried to identify areas of potentially suitable goshawk nesting habitat on the Mineral Tree Farm. We divided habitat in two categories: (1) *suitable habitat* was considered any conifer-dominated stand ≥45 yr of age and (2) *marginal habitat* was considered any young coniferous stand 27–44 yr old or any stand of alder/hardwoods. Alder stands were dominated by red alder (*Alnus rubra*) and often contained a minor cohort of big-leaf maple (*Acer macrophyllum*) and black cottonwood (*Populus trichocarpa*), especially in riparian areas.

Surveys for nesting goshawks were conducted over the entire tree farm in 1995 and 1996 on all suitable and marginal habitat stands. In addition, we conducted a pilot survey for goshawks on the tree farm in 1994 (Bosakowski and Vaughn 1996) that was limited only to mature conifer habitat (28 cm dbh [diameter at breast height], 24 m height, 250–750 trees/ha, ≥70% conifer composition). The protocol for surveys is described in Bosakowski and Vaughn (1996) and includes several modifications to the current U.S. Forest Service protocol for surveying goshawks in the Pacific Northwest (Appendix B in U.S. Forest Service 1994).

Nest site habitat attributes were measured from 15-m radius circular plots centered on nest trees. All trees and snags (dead trees) ≥10 cm in diameter within the plot were measured for dbh with a diameter tape and were identified to species. Heights of nests and nest trees were measured with a clinometer. Maximum slope through the nest site was measured with a clinometer and slope aspects were recorded. The presence or absence of canopy cover at 20 points was determined with an ocular sighting tube (James and Shugart 1970). The 20 points were systematically positioned with five points along each of the four cardinal directions at 10-m intervals. At each

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Table 1. Characteristics of nest trees and nest sites for three Northern Goshawk territories on the Mineral Tree Farm in the Western Washington Cascades.

PARAMETER	SNOW CREEK	EAST FORK TILTON	MINERAL CREEK	MEAN (SD)
		NEST TREE		
Species	Douglas-fir	Western hemlock	pacific silver fir	
Nest height (m)	13.7	14.7	13.4	13.9 (0.68)
Nest tree height (m)	39.2	30.6	21.0	30.3 (9.10)
Nest tree dbh (cm)	53	73	41	55.7 (16.17)
		NEST SITE[a]		
dbh (cm)	29	32	24	25.5 (2.94)
Canopy cover (%)	80	90	90	86.7 (5.77)
Shrub cover (%)	20	20	45	28.3 (14.43)
Live tree density (≥10 cm) (no./ha)	496	665	1132	764 (329.4)
Snag density (#/ha)	155	298	298	250 (82.56)
Sapling density (5–10 cm) (no./ha)	0	62	170	77.3 (86.0)
Pacific silver fir density (no./ha)	0	298	482	260 (243.2)
Red alder density (no./ha)	58	0	410	156 (221.9)
Western hemlock density (no./ha)	368	352	240	320 (69.74)
Douglas-fir density (no./ha)	70	15	0	28.3 (36.85)
Elevation (m)	600	745	975	773 (189.1)
Slope (%)	46	42	20	36 (14.0)
Slope aspect	N	N	NE	—
Stand age (yr)	40	54	43	45.7 (7.37)
qdbh (cm)	29	34	22	28.3 (4.04)
Patch size (ha)[b]	421	559	210	396.7 (175)

[a] Measurements within a 15-m radius circle.

[b] Nest stands were silvicultural units at least 33 ha as delineated from previous even-aged timber harvests, but all formed a contiguous forest patch mosaic with other closed-canopy stands of various ages ≥27 yr.

point, the presence or absence of shrub/sapling cover within arms' reach was also noted (Collins et al. 1982). Only woody stems ≥0.5 m in height and <10 cm dbh were considered shrub/sapling cover.

Stand-level data were obtained from recent stand inventory records for stand age and stand quadratic mean diameter at breast height (qdbh). Qdbh was calculated using all trees ≥10 cm dbh with the formula: qdbh = square root ((basal area/trees per ha)/0.005454).

A landscape-level spatial analysis with GIS was used to calculate the proportion of closed-canopy forest cover (≥27 yr) and mature forest cover (≥45 yr) within concentric circles at increasing distances (radii) from the nest. The range of distances tested was 0.2–3.2 km from the nests and was inclusive of the 2400-ha home range, 240-ha territory or postfledging family area (PFA) and 12-ha nest site as defined by Reynolds et al. (1992) for the Northern Goshawk in the southwestern U.S.

Prey remains were found under nests or at nearby prey-plucking posts. These were identified and enumerated using standard methods described by Reynolds and Meslow (1984).

RESULTS

During the 1994–96 study period, we found goshawks nesting in three different territories on the Mineral Tree Farm. Only one nest was occupied in 1995 (Mineral Creek), producing at least one fledgling. In 1996, three different occupied nests were monitored, each producing two fledglings for a productivity rate of 2.0 young fledged per nesting attempt. Overall, the nesting results translated into a nesting density ranging from 0.0046–0.0139 nests per 100 ha.

Nest stands were 40–54 yr old and were dominated by conifers (Table 1). Nest stands were densely stocked (496–1132 live trees/ha) on north-facing slopes with high canopy cover (80–90%), low to moderate shrub/sapling cover (20–45%) and high snag densities (155–298/ha). We attributed high snag densities to high suppression mortality, since all stands were still within the stem exclusion stage (Oliver and Larson 1990) for unmanaged (never thinned) second-growth stands in western Washington. At the densest nest site (Mineral Creek),

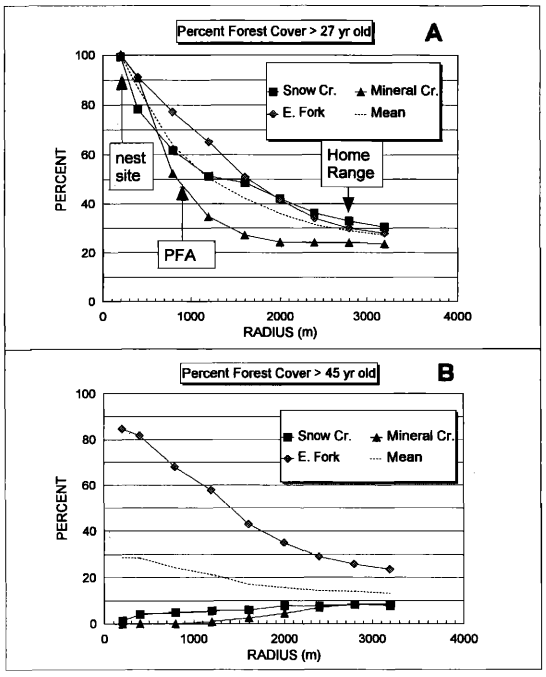

Figure 1. Percent forest cover at increasing distances (circle radii) from three Northern Goshawk nests on the Mineral Tree Farm in western Washington in 1996. Note that the data in Fig. 1a (top graph) is for all forest cover ≥27 yr and is inclusive of the data shown in Fig. 1b (bottom graph) for all forest cover ≥45 yr. The postfledging family area (PFA) is as described in Reynolds et al. (1992).

the nest tree was located on an old, overgrown logging road where the forest was more open and had a higher component of alder. In all cases, nests were built in dominant trees (mean dbh = 55.7 cm) of the stands which averaged only 28.3 cm in qdbh. Nest heights were consistently similar (range = 13.4–14.7 m), despite different nest tree heights and stand ages/types.

All nests were in large contiguous forest patches (range = 210–559 ha) comprised of a mosaic of closed-canopy forest (suitable and marginal habitat) of various ages and tree compositions. Landscape-level analyses of the three goshawk nests showed a similar trend for the amount of closed-canopy forest (Fig. 1a), with mean values of 100% forest cover within 196 m of the nest ("nest site"), 60% cover within 880 m ("PFA") and 30% cover within 2780 m ("home range"). However, the same trend was not apparent for older forest (Fig. 1b), where two of three territories had <10% mature forest cover >45 yr old. All nests were >1.6 km from other landowners and within this distance, there was no old-growth forest at Mineral and Snow Creek nests and only 45 ha at the East Fork nest.

A total of 37 prey items were recorded with grouse representing the most numerous prey item (56.7%). Although we did not differentiate between Blue Grouse (*Dendragapus obscurus*) and Ruffed Grouse (*Bonasa umbellus*) in most cases, Blue Grouse were detected at 25% of point counts whereas Ruffed Grouse were detected at only 5% of point counts on the tree farm (Bosakowski 1997). Steller's Jays (*Cyanocitta stelleri*) were the second most numerous prey items (16.2%), followed by snowshoe hare (*Lepus americanus*, 8.1%) and Northern Flicker (*Colaptes auratus*, 5.4%). Prey items found only once were Pileated Woodpecker (*Dryocopus pileatus*), Varied Thrush (*Ixoreus naevius*), Swainson's Thrush (*Catharus ustulatus*) and Gray Jay (*Perisoreus canadensis*).

DISCUSSION

We found goshawks nesting successfully in younger and denser stands than previously reported for northwestern goshawks (Reynolds 1983, Fleming 1987, Reynolds 1989, Marshall 1992). The spatial analysis revealed that closed-canopy conifer forest cover (≥27 yr old) was a consistent feature at the landscape level for all three nests, with 100% forest cover within the 12-ha nest site, about 60% cover within the 240-ha PFA, and about 30% cover within the 2400-ha home range. Plot samples showed that nest sites were composed of young (40–54 yr old) second-growth conifer-dominated forest with high tree and snag densities. None of these stands had received either commercial or pre-commercial thinning and average qdbh was low (28.3 cm) for goshawks even though saplings (trees <10 cm dbh) were not included in the calculations. Previous measurements of goshawk nest sites in the western Washington Cascades have shown an average stand dbh of 48.3 cm and minimum of 34.5 cm (Fleming 1987).

Nesting stands in our study were at or younger than the usual harvest age (45–60 yr) for industrial forest land in western Washington. Growing conditions in the mesic Western Cascades fosters rapid tree growth, allowing suitable nesting habitat to develop in as little as 40 yr. This age is about half the minimum age (75 yr) needed for goshawk nesting habitat as predicted by a model developed in drier interior Douglas-fir forests of Idaho (Lilieholm et al. 1993). Even though the nesting stands in this study were relatively young, it is noteworthy that all three of the nest trees were dominants or remnants (East Fork Tilton nest), having the largest (or second largest) diameter in the sample plot. Similarly, Fleming (1987) also noted that in younger second-growth stands, goshawks usually selected the largest trees to provide suitable support for the large, heavy nest since larger trees are more likely to have thicker, stronger support branches. These studies indicate the value of remnant trees (residuals) for goshawks and confirm a definite benefit to

maintaining green leave-tree clumps and individual trees after timber harvesting.

We noted that grouse were more prevalent in the diet on the tree farm in comparison to Northwest National Forests, where goshawks relied primarily on forest-interior species (Reynolds and Meslow 1984, Bull and Hohmann 1994). Since one of the principal foods of the Blue Grouse is Douglas-fir needles (Martin et al. 1951), we speculate that replanting clearcut areas with (primarily) Douglas-fir may have helped support successful goshawk nesting under less than optimal habitat conditions.

Our finding of three occupied nests in 1996 on the Mineral Tree Farm represents a nesting density of about one-half to one-fourth of the nesting density that we calculated for three to seven occupied nests located by DeStefano et al. (1994) on the Wallowa-Whitman National Forest in the Oregon Cascades. At least in one year, goshawk reproduction on the Mineral Tree Farm was similar or higher than reproduction occurring in more pristine National Forests of Oregon (DeStefano et al. 1994, Bull and Hohmann 1994). Overall, this study suggests that goshawks may be breeding more commonly on private industrial forests than previously predicted, which might be contributing substantially to the regional population of goshawks. In the Cascades of Washington and Oregon, the frequent intermingling of National Forest land and private industrial timberland further underscores the importance of managing for goshawks under both types of ownerships.

RESUMEN.—Esta investigación reveló que *Accipiter gentilis* anidó en un bosque comercial privado (21 600 ha) en el Condado de Lewis, Washington, Estados Unidos. El número máximo de nidos activos fue de 1–3 lo que se traduce a una densidad de 0.0046–0.0139 nidos por 100 ha. Cada uno de estos tres nidos produjó dos juveniles en 1996, para una productividad de 2.0 juveniles por intento de anidacion. Los árboles del nido eran coníferas de 40–54 años. Todos los nidos estaban ubicados en parches continúos de bosque (entre 210–559 ha) que incluían un mosaico de dosel cerrado (>27 años) de distintas edades y composiciones. Los niveles de análisis de paisaje de los tres nidos revelaron una tendencia similar en relación a la cantidad de bosque de dosel cerrado (>27 años), con valores medios del 100% de cobertura boscosa dentro de 196 mts del nido (sitio del nido), 60% de cobertura dentro de 880 mts (área de la familia posterior a la eclosión) y 30% de cobertura dentro de los 2.780 mts (rango de hogar). Sinembargo, este mismo patrón no es aparente en bosques mas antiguos donde dos de los tres territorios tenían <10% de cobertura madura (>45 años) dentro de su rango de hogar.

[Traducción de César Márquez]

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NOTES ON EGGS OF THE BICOLORED HAWK *ACCIPITER BICOLOR*

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KEY WORDS: *Bicolored Hawk*; Accipiter bicolor; *eggs*; *nest*; *Neotropical raptor.*

Little is known of the breeding habits of Neotropical accipiters, including the widely distributed, but inconspicuous, Bicolored Hawk (*Accipiter bicolor*). From 1991–94, we conducted a study of the breeding biology of this species in Tikal National Park in NE Guatemala. Here, we provide details on Bicolored Hawk eggs found at Tikal and compare them to earlier published descriptions, including some that were probably misidentified.

Fourteen Bicolored Hawk eggs from six nests at Tikal were dull white, unspotted, nonglossy and subelliptical in shape (Preston *in* Palmer 1962). The inner surface of the shells had a light bluish or greenish tinge, as is typical of many *Accipiter* species (Bent 1937, Schönwetter 1961). As measured in the field with Vernier calipers, they averaged 47.1 ± 1.1 mm (±SD, range = 44.9–49.0) × 36.5 ± 1.1 mm (range = 35.0–38.6), and the average mass of eggs at various stages of incubation was 33.5 ± 3.5 g (range = 28.0–38.0), as taken with a 100 g Pesola spring scale. Overall, the eggs closely resembled those of the related Cooper's Hawk (*Accipiter cooperii*), aside from their slightly greater "elongation" (length/breadth ratio) (i.e., 1.29 [this sample] vs. 1.26 [N = 172 for the Cooper's Hawk, Kiff unpubl. data]). Only clutches of 1–3 eggs were observed at Tikal with an average clutch size of 2.4 eggs.

These details differ from some published descriptions of Bicolored Hawk eggs and museum specimens attributed to this species, but they agree with others (Table 1). In order of their collecting year, other purported eggs of this species include the following: Chubb (1910) reported that three eggs, probably representing a single clutch, of the race *A. bicolor pileatus,* taken in Paraguay (locality unknown) on 19 October 1902 were "dull white without any markings beyond a few underlying cloudings of a somewhat darker tint." They measured 1.8–1.9 in (46–48 mm) × 1.4–1.5 in (36–38 mm), thus agreeing closely with the Bicolored Hawk eggs from Tikal. Based on these sparse details, there is no reason to doubt the authenticity of these eggs.

A set of two purported Bicolored Hawk (*Accipiter b. bicolor*) eggs taken near Bartica, British Guiana on 13 April 1927 for the British collector G.D. Smooker is in the Western Foundation of Vertebrate Zoology collection (WFVZ 16 695). According to the accompanying data, the species identity was based on a description of the birds The eggs were in an advanced stage of incubation, and the nest was said to be "composed of sticks and placed high up in a tree—no further particulars given." The egg measurements were noted on the data card as 42.0 × 32.8 and 42.6 × 33.1 mm. The collector of the set was noted as "a native," probably indicating that Smooker did not visit the nest himself. Other misidentified raptor eggs have been reported from the Belcher-Smooker Trinidad collection (e.g., Boyce and Kiff 1981, ffrench 1973, Kiff 1981); thus, all records from Smooker, who evidently relied heavily on native collectors, should be viewed with caution.