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NESTING HABITAT OF FLAMMULATED OWLS IN OREGON

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ABSTRACT.—Thirty-three Flammulated Owl (*Otus flammeolus*) nests were located in northeastern Oregon during 1987–1988. The average nest tree dbh and height of the cavity were 72 cm and 12 m, respectively. Important characteristics of nest habitat included: large-diameter dead trees with cavities at least as large as those made by Northern Flickers (*Colaptes auratus*); located on ridges and upper slopes with east or south aspects; in stands of large diameter (>50 cm dbh) ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*) or grand fir (*Abies grandis*) with ponderosa pine in the overstory.

Habitat para anidar de los Otus flammeolus en Oregón

EXTRACTO.—Treintitres nidos de buhos (*Otus flammeolus*) han sido localizados en el noreste de Oregón durante 1987–1988. Los promedios de profundidad y altura de la cavidad en el árbol fueron de 72 cm y 12 m respectivamente. Las características más notables del habitat para los nidos incluían: árboles secos de gran diámetro con cavidades por lo menos tan grandes como las que hacen los *Colaptes auratus*; ubicados en cumbres y altas pendientes con frentes al este o sur; en Pinos Ponderosa (*Pinus ponderosa*) de gran diámetro (>50 cm de profundidad) Abetos Douglas (*Pseudotsuga menziesii*) o Abetos Grandes (*Abies grandis*), con Pinos Ponderosa en la parte alta.

[Traducción de Eudoxio Paredes-Ruiz]

The Flammulated Owl (*Otus flammeolus*) is a small, migratory, insectivorous cavity-nester of coniferous forests in western North America (Bent 1938). This species was once considered rare (Bent 1938), but recent studies have shown it to be common in some areas of Colorado (Reynolds and Linkhart 1987a), New Mexico (McCallum and Gehlbach 1988), California (Winter 1974, Marcot and Hill 1980), and Oregon (Goggans 1986).

Detailed information on nesting habitat is essential for effective management of habitat for this owl. Land management agencies are maintaining dead trees for cavity-nesting birds, but need more detailed information on the species and size of dead trees and sites best suited to Flammulated Owls. Our objective was to describe the nesting habitat of Flammulated Owls in northeastern Oregon.

STUDY AREA

The study was conducted on a 5270-ha area on the Starkey Experimental Forest (Starkey) located 35 km southwest of La Grande in northeastern Oregon. Starkey is characterized by undulating uplands dissected by moderately- to steeply-walled drainages with elevations of 1070 to 1525 m. The study area consisted of a mosaic of forests (84% of area) interspersed with shallow-soil grasslands (16%). Forest types (classified by Burr 1960) were 14% open ponderosa pine (*Pinus ponderosa*), 41% ponderosa pine/Douglas-fir (*Pseudotsuga menziesii*), and 45% grand fir (*Abies grandis*) with Douglas-fir/ponderosa pine/western larch (*Larix occidentalis*).

Fire suppression and selective timber harvesting in the 1930s resulted in uneven-aged stand structure. Multilayered canopies with some much larger trees characterized most stands. As these large trees died or were cut, favorable conditions allowed new tree establishment. Over time, this created multilayered stands with numerous patches of young, even-aged trees and a few large, overmature trees. We assigned stands into 1 of 3 successional stages. Class A were stands with all trees <30 cm dbh; class B were stands with >12 trees 30–50 cm dbh/ha; class C were stands with >12 trees >50 cm dbh/ha. Ninety percent of the area had not been logged in 40 years; the remainder had a partial removal of the overstory within the last 15

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years. Large-diameter dead trees containing nest cavities were abundant (98/40 ha) and distributed throughout the study area.

METHODS

We searched for Flammulated Owls during April–July in 1987 and 1988. In April and May of each year we walked 26 routes totaling 220 km through the study area after sunset listening for Flammulated Owl vocalizations. Routes were 0.3–0.5 km apart and followed roads when available; the entire study area was covered in 2 months. We stopped every 0.3 km for 5 min. We first listened for vocalizations; if none were heard, we imitated the owl's vocalization. If an owl was heard, we recorded date, time, location, and forest type.

In June and July we searched for nests during the day in areas within 0.5 km of where individual owls were heard at night. We scratched the bark of all trees with a cavity large enough to accommodate a Flammulated Owl in order to get the owl to reveal itself. A Flammulated Owl in a cavity in June or July during the day was classified as a nest. We believe this was a valid assumption because radio-tagged male Flammulated Owls roosted on branches of live trees during nesting, not in cavities (Goggans 1986, Reynolds and Linkhart 1987b). Reynolds (pers. comm.) confirmed that cavities containing an owl during the day were always nests.

At each nest we recorded: tree species, condition (live or dead), dbh, height, cavity type (Pileated Woodpecker *Dryocopus pileatus,* Northern Flicker *Colaptes auratus,* or natural), and cavity height from the ground. Pileated Woodpecker cavities were dome-shaped and approximately 12 cm high and 9 cm wide; Northern Flicker cavities were round and approximately 6–8 cm in diameter. Habitat characteristics were measured in a 0.1-ha circular plot centered on the nest tree: location (ridge, slope, draw), slope aspect (measured with compass) and gradient (measured with clinometer), forest type and successional stage, tree density (number stems/0.1 ha), distance to opening >1 ha in size, canopy closure (measured with spherical densiometer), and number of canopy layers.

To obtain a sample of available dead trees, we searched 1534 ha of the study area and measured dead trees >50 cm dbh with potential nest cavities for Flammulated Owls. We located 3706 dead trees, 342 of which contained cavities that had been excavated by Pileated Woodpeckers or Northern Flickers, as determined by size and shape of the cavity entrance. Cavities in live trees were not recorded due to the difficulty in finding them. We did not climb trees with potential cavities to verify that they were cavities, because the majority of the trees were unsafe to climb. Only dead trees >50 cm dbh were characterized because 88% of the Flammulated Owl nests occurred in dead trees this size. These data were considered representative of the entire study area because of the homogeneity in habitat type, successional stage, and snag density throughout the study area. Cost and time constraints prohibited a complete survey of all snags on the study area.

At each dead tree with a potential cavity we recorded tree species, dbh, height, size of cavity, forest type, successional stage class, logging activity, slope aspect, and slope position. Chi-square analyses were used to compare the number of nests observed with the number expected based on data from available dead trees with cavities: 1) by forest type, 2) by tree species, 3) by type of cavity (Pileated Woodpecker versus Northern Flicker cavities), 4) by successional stages, 5) by logging activity, 6) by slope position, and 7) by slope aspect. An unpaired t-test was used to compare dbh and height of nest trees with those of available dead trees. Significance was established when $P \leq 0.05$.

RESULTS

In 1987 the first Flammulated Owl was heard on 3 May, and 24 calling sites were located in May during 19.5 hours of walking routes. In 1988 the first Flammulated Owl was heard on 10 May, and 62 calling sites were located in May during 108.5 hours of walking routes. No Flammulated Owls were heard in April either year.

Calling activity was greatest within 2 hr after sunset when 77% of the owls were first heard. Only 26% of the time spent listening was within this 2-hr period. The remainder of the time was spent listening 2–7 hr after sunset. The location of singing owls detected was independent of forest type ($\chi^2 = 0.64$, 2 df, $P = 0.73$).

We located 13 nests in 1987 and 21 nests in 1988. All nests were located in June and July, and only 1 tree was used both years by nesting Flammulated Owls. Of these 33 different nest cavities, 67% had been excavated by Pileated Woodpeckers, 27% had been excavated by Northern Flickers, and 6% had been created by decay. By comparison, the available cavities large enough to accommodate these owls included 45% Pileated Woodpecker and 55% Northern Flicker cavities. Relative to availability, Flammulated Owls used a higher percentage of Pileated Woodpecker cavities than expected ($\chi^2 = 8.15$, $P < 0.01$).

Ninety-one percent of nests were in dead trees and 9% in live trees. Seventy percent of the nests were in ponderosa pine, 27% in western larch and 3% in grand fir trees. There was no difference between species ($\chi^2 = 1.47$, 2 df, $P = 0.49$) or dbh ($t = 0.37$, 368 df, $P = 0.71$) of dead trees used as nests and those available with cavities large enough to accommodate the owls (Table 1). Height of nest trees was significantly greater than of available trees ($t = 3.49$, 368 df, $P < 0.01$).

Fifty-eight percent of the nests occurred in ponderosa pine/Douglas-fir forest types, while the re-

mainder occurred in grand fir forest. Ponderosa pine was an overstory species at 73% of the nest sites. Although there was no difference between used and available dead trees by forest type ($\chi^2 = 3.20$, 2 df, $P = 0.13$) or logging activity ($\chi^2 = 1.6$, 1 df, $P = 0.22$), there was a difference among successional stage ($\chi^2 = 6.35$, 1 df, $P = 0.04$), slope aspect ($\chi^2 = 8.87$, 3 df, $P < 0.05$), and slope position ($\chi^2 = 9.86$, 3 df, $P < 0.05$). Ridges and the upper third of slopes were used more and lower slopes and draws were used less often than expected if selection was random. East and south slopes were used in greater proportion and north and west slopes used in lesser proportion than if used at random based on available dead trees with cavities large enough to accommodate the owls. Stands with trees >50 cm dbh were used as nest sites in greater proportion than if selected at random; 42% of the nests occurred here, yet only 24% of available cavities were in these stands.

Table 1. Measurements taken at 33 Flammulated Owl nest trees in Oregon, 1987–1988.

VARIABLE	MEAN	SD
Nest tree		
DBH (cm)	72	14.4
Height (m)	24	9.1
Cavity height (m)	12	4.7
Nest habitat		
Trees >10 cm/0.1 ha	33	14.6
Trees 2–10 cm/0.1 ha	48	29.6
Canopy closure (%)	55	20.1
Number of canopy layers	2.5	0.5
Slope gradient (%)	18	11.8
Distance to opening (m)	50	51.3

DISCUSSION

The detection of 62 singing owls during 1 nesting season suggests that Starkey had a high density of Flammulated Owls. Only a portion of the owls were detected because the entire study area could not be covered in the 2–3 week period that the birds vocalized intensively. Densities of singing owls have been reported as 0.72/40 ha in Oregon (Goggans 1986), and 2.1/40 ha (Winter 1974) and 0.03–1.09/40 ha (Marcot and Hill 1980) in California. Density of pairs has been reported as 0.47/40 ha in Oregon (Goggans 1986) and 0.03–0.5/40 ha in Colorado (Reynolds and Linkhart 1987b).

Apparent preference for Pileated Woodpecker cavities as nest sites was perhaps due to the larger cavities Pileated Woodpeckers excavate or the higher placement above the ground of these nests compared to those of flickers ($\bar{X} = 15$ m, SD = 5.6; $\bar{X} = 8$ m, SD = 6.2, respectively; Bull et al. 1986). Nests in live trees may have been underrepresented as such cavities are more difficult to detect. Nonetheless, large snags with Pileated Woodpecker cavities are clearly an important part of Flammulated Owl nesting habitat.

Ridges and upper slopes were perhaps preferred because they provided the gentlest slopes, which would minimize the energy expenditure of birds carrying prey to nests or because of prey availability. Goggans (1986) suggested such preference may be related to the diversity and density of prey. Prey may also be more abundant or at least more active on higher slopes because these slopes are warmer than lower ones (Reynolds, pers. comm.). The preference for east and south aspects may also be related to temperature and availability or abundance of prey.

Reynolds and Linkhart (1987b) suggested that stands with trees >50 cm dbh were preferred because they provided better habitat for foraging due to the open nature of the stands, allowing the birds access to the ground and tree crowns; stands of dense, young trees were avoided. Some stands of larger trees also allow more light to the ground which produces ground vegetation, serving as food for some insects preyed upon by owls.

Our findings suggest that the best way to manage habitat for the Flammulated Owl is to leave dead trees (>50 cm dbh and >6 m tall) with cavities at least as large as a Northern Flicker cavity. These trees are best left on ridges or upper slopes with east or south aspects in stands of large-diameter (>50 cm dbh) ponderosa pine/Douglas-fir or grand fir forest types, with ponderosa pine in the overstory. Retaining large diameter live trees in addition to snags, will provide for future snags. Another approach is to manage habitat for Pileated Woodpeckers and Northern Flickers in these same situations, as they will provide nest sites for these small owls over time.

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