STATUS OF THE SPOTTED OWL IN SIX RIVERS NATIONAL FOREST, CALIFORNIA

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Knowledge of the distributional status of the Northern Spotted Owl (*Strix occidentalis caurina*) in northwestern California is incomplete. Gould (1974) surveyed the North Coast region and recorded 41 pairs in four counties, 6 pairs of which were found on the Six Rivers National Forest. Recent updates to Gould's surveys (Gould 1977, 1978) added 35 pairs to the four-county list, and other records (Six Rivers National Forest files) of unverified sightings added 14 more, for a total of 90 pairs. Gould (1977) reported a statewide total of 191 Northern Spotted Owls, representing 122 pairs.

The present study was prompted by a need for more intensive and local surveys on the Six Rivers National Forest. The goals of our research were to: survey 25 potential timber sale areas for presence of Spotted Owl breeding territories; assess ecological distribution of Spotted Owls; and develop preliminary guidelines for management and future research on Spotted Owls on the Six Rivers National Forest.

STUDY AREA AND METHODS

Timber sale areas surveyed were in the Coast Range of northwestern California. Study areas included two lower elevation and two higher elevation vegetation types (Küchler 1977). The lower elevations contained Mixed Evergreen Forest with Chinquapin (*Castanopsis chrysophylla*) or Rhododendron (*Rhododendron macrophyllum*), dominated by Douglas-fir (*Pseudotsuga menziesii*) and with subdominants of Tanoak (*Lithocarpus densiflora*), Pacific Madrone (*Arbutus menziesii*), and Canyon Live Oak (*Quercus chrysolepis*); and Oregon Oak Forest, an oak woodland dominated by Oregon White Oak (*Q. garryana*), with subdominants of Douglas-fir and California Black Oak (*Q. kelloggii*). The higher elevations contained Klamath Montane Forest with Douglas-fir, dominated by Douglas-fir and White Fir (*Abies concolor*), with a subdominant of Shasta Red Fir (*Abies magnifica* var. *shastensis*); and Coast Range Montane Forest, dominated by Douglas-fir, with subdominants of White Fir and Ponderosa Pine (*Pinus ponderosa*).

Field surveys of Spotted Owls were conducted by soliciting call responses, from 22 March to 30 June 1978. During this period,

vocalizations of Spotted Owls are at a maximum, corresponding with average times of egg-laying (29 March) and fledging (early May to mid-June) (Forsman 1976).

Calling stations were at intervals of 0.8 km along predetermined transects (Jackman and Scott 1975, Gould 1974) within individual timber sale study areas, which totaled 33,439 ha and ranged from 327 to 5816 ha. At each calling station, responses were solicited by playing a prerecorded cassette tape of Spotted Owl calls, and occasionally by vocal imitation.

The tape consisted of mixed location calls (a four-hoot sequence), contact calls (a rising whistle), and scolding barks (a crow-like call) (Forsman 1976), played several times for 4 minute intervals for approximately 15 minutes at each station. Field surveys were made between dusk and dawn, mostly between 2000 and 0300.

Breeding territories were documented if: 1) a male (which has a noticeably deeper voice) and female were both heard exchanging location calls, indicating a pair bond; 2) an unremitting series of contact calls, given mostly by the female to maintain contact with her mate or young (Forsman 1976), was heard; 3) a scolding bark, given mostly by the female during territorial encounters or as a long-distance contact call between paired birds (Forsman 1976), was heard; or 4) a single owl giving location calls could not be persuaded with intensive soliciting by taped calls to change location.

Three relative frequency indices of Spotted Owl territories were calculated from each survey: number of territories per calling station, per 100 minutes of calling, and per kilometer of transect. The three indices were compared to one another, and the index of number of territories per kilometer was compared to similar indices noted by Forsman et al. (1977), Gould (1974), and E. Garcia (1979).

Crude density (including areas of unsuitable habitat) and ecological density (areas of suitable habitat only) of Spotted Owl territories were estimated, and ecological factors of the habitat were assessed.

RESULTS AND DISCUSSION

RELATIVE FREQUENCY INDICES

A total of 315 calling stations, representing 5494 min (91.6 hr) of calling along 222.8 km of transects, yielded overall relative frequency indices of 0.17 territories per calling station, 0.98 per 100 min calling, and 0.24 per km. These three indices were found to be highly correlated to one another (all at $p<0.001$). On individual transects, the number of territories per station ranged from 0.07 to

1.00; the number of territories per 100 min calling ranged from 0.48 to 5.48; and the number of territories per km ranged from 0.10 to 2.49.

In general, estimates of the number of territories per km were higher in this study than in similar surveys conducted in California, Oregon and Washington, with the exception of Forsman et al.'s (1977) survey in more extensive old growth stands in western Oregon (Table 1). However, Forsman et al.'s survey areas generally represented a different vegetation type than did this study's survey areas. Also, owing to timber harvesting, most of this study's survey areas were much more mosaic in stand structure, compared to the more extensive tracts of old growth and thinned second growth in the Oregon survey areas.

Most surveys were conducted and most of the Spotted Owl territories were discovered in two general vegetation types: Klamath Montane Forest with Douglas-fir, and Mixed Evergreen Forest with Chinquapin or Rhododendron. There was no significant statistical difference between the relative frequency of Spotted Owl territories in each vegetation type (Mann-Whitney U, $p > 0.20$). However, average relative frequency in lower elevation (submontane) vegetation types was higher than in upper elevation (montane) types, although Oregon Oak Forest wholly lacked suitable Spotted Owl habitat in the sites surveyed (Table 2).

Zarn (1974) wrote that Spotted Owls tend to prefer dense, old growth conifer stands found in the Mixed Conifer (*Pinus-Pseudotsuga-Calocedrus-Abies*) Zone (Franklin and Dyrness 1973) of the Cascade Range of southwest Oregon, and in the extensive *Tsuga heterophylla* Zone (Franklin and Dyrness 1973) of the Coast and Cascade ranges of western Oregon and Washington. The former of these vegetation types corresponds to Küchler's (1977) Coast Range Montane Forest, in which we found Spotted Owl territories of relative frequencies in agreement with Forsman's (1977) findings. Also, we found Spotted Owl territories in Klamath Montane Forest with Douglas-fir in relative frequencies comparable to Forsman's (1977) findings (Table 1).

CRUDE AND ECOLOGICAL DENSITIES

All study areas combined totaled 33,439 ha, of which 12,079 ha were mature and old growth (D4= to D4≡ and D5— to D5≡, U.S. Forest Service timber type classifications; see U.S. Forest Service Manual), and 4287 ha were just old growth (D5— to D5≡ timber classifications). Thus, overall crude density based on all timber types was 0.65 territories per 400 ha. Average ecological density based on

Table 1. Relative frequency of Spotted Owl territories in Six Rivers National Forest, northwestern California, during March-June 1978, compared with that found in three other studies.

AREA	NO. TERRITORIES PER KM Mean, range	INVESTIGATOR
Six Rivers Natl. For.	0.24, 0.10-2.49	Marcot and Gardetto (present study)
Pinchot Natl. For. Washington	0.10,0.07-0.31	Garcia (1979)
Northwestern California	0.15[1], 0.10-0.27[2]	Gould (1974)
Western Oregon	0.36[3] and 0.03[4]	Forsman et al. (1977)

[1]In Six Rivers National Forest.

[2]In Humboldt, Trinity and Siskiyou counties.

[3]In old growth.

[4]In second growth.

the amount of mature and old growth was 1.71 territories per 400 ha. Average ecological density based only on old growth was 4.8 territories per 400 ha. Spotted Owls using an old growth Douglas-fir stand seemed to use contiguous stands of at least moderately dense mature Douglas-fir (D4= to D4≡) more than other timber types. Indeed, 95% of all Spotted Owls encountered during the surveys occurred in either mature or old growth stands. Spotted Owls also prefer to forage in the denser canopies of mature and old growth stands (Forsman 1976, Jackman and Scott 1975). Thus, the most useful estimate of ecological density, which would best facilitate management, is based on mature and old growth timber types. However, other size trees may help support Spotted Owls by providing needed buffers. Whereas ecology and habitat use of Spotted Owls is incompletely known, certain of their habitat requirements (e.g., nesting) are dependent on older age stands.

Crude density, calculated by the "nearest-neighbor method" (Caughley 1977), was 0.31 territories per 400 ha. This is lower than the above estimate of crude density based only on total area surveyed and total number of territories located (0.65 territories per 400 ha), because measurements between "nearest neighbor" territories were made only within study area boundaries. Existence of potentially closer (and unsurveyed) territories just outside survey area boundaries would increase the estimate to a more comparable value.

Table 2. Relative frequency of Spotted Owl territories in four major vegetation types on the Six Rivers National Forest, northwestern California.

VEGETATION TYPE[1]	TOTAL TERRITORIES	TOTAL KM SURVEYED	TERRITORIES PER KM
SUBMONTANE			
Oregon Oak Forest	0	7.2	0.00
Mixed Evergreen Forest	30	112.6	0.27
MONTANE			
Klamath Montane Forest with Douglas-fir	16	73.2	0.22
Coast Range Montane Forest	3	15.3	0.20

[1]After Küchler (1977).

Table 3. Crude density[1] of Spotted Owl territories in Six Rivers National Forest, northwestern California, compared with that found in two other studies.

AREA	TERRITORIES PER 400 HA	INVESTIGATOR
Six Rivers Natl. For.	0.65	Marcot and Gardetto (present study)
Trinity Co., California	0.20[2]	Gould (1974, 1977)
Benton Co., Oregon	0.42[3]	Forsman (1976)
Lane Co., Oregon	0.26[4]	Forsman (1976)
Coast Range, Oregon	0.09[5]	Forsman (1976)
Siskiyou Mtns., Oregon	0.13 to 0.17[6]	Forsman (1976)

[1]Crude density includes areas of unsuitable habitat.

[2]Along South Fork Trinity River drainage, South Fork Mountain. Estimate based on 16 pairs found in an area 48 km long by 3 to 10 km wide.

[3]Estimate based on 4 pairs found in an area of roughly 39 km^2.

[4]Estimate based on 6 pairs found in one township.

[5]Included areas of extensive private inholdings or areas where old growth forests on federal lands were depleted. Estimate based on less than 2 pairs found per township.

[6]Including primarily uncut, old growth forests on federal land. Estimate based on up to 3 or 4 pairs found per township.

Estimates of crude density of Spotted Owl territories from other studies ranged from less than 0.09 to 0.42 per 400 ha (Table 3). All of these figures are lower than the estimate of crude density from the present study, but are comparable to estimates of many individual potential timber sale areas in this study.

SPACING OF TERRITORIES

Distances of 26 territories to the next nearest known territory averaged 1.75 km and ranged from 0.43 to 4.54 km. Sixty-one percent of the minimum distances between pairs were from 1.00 to 2.00 km.

Gould (1974) reported minimum distances between Spotted Owl territories in areas of major concentrations in California to average 3.5 km and to range from 0.2 to 11 + km. Sixty-three percent of 70 minimum distances between pairs were from 1.3 to 2.9 km.

The data from this study of average minimum distances, density of territories, and relative frequencies of territories, all indicate higher concentrations of Spotted Owl territories on the Six Rivers National Forest than Gould (1974) reported statewide or in the four North Coast counties of California.

PROXIMITY OF SPOTTED OWLS TO GREAT HORNED OWLS

On various occasions during the study, contact with Great Horned Owls (*Bubo virginianus*) occurred while we were calling for Spotted Owls. Two pairs of Spotted Owls ceased responding immediately, and one male Spotted Owl switched from a location call to an agitated location call (Forsman 1976), when the call of the Great Horned Owl was imitated. In one study area, also in Mixed Evergreen Forest, we heard both species of owls simultaneously from the same calling station; the Great Horned Owl was within a 10 ha clear-cut and the Spotted Owl was 100 to 125 m away in a dense, mature Douglas-fir stand. Also, at dusk in June 1976 Bruce Marcot observed a silent Great Horned Owl in a 10 ha clear-cut bordered on opposite sides by mixed conifer stands from which Spotted Owls were calling.

These observations indicate that Great Horned and Spotted owls are found in the same vicinity, in contrast to several investigators' conclusions that they do not occur together (Zarn 1974). Forsman (1976) found many Spotted Owl territories in "close proximity" to Great Horned Owls and he reported evidence of at least one case of Great Horned Owl predation on juvenile Spotted Owls. However, in Arizona, Spotted Owls seem to be absent from areas inhabited by Great Horned Owls (Phillips et al. 1964).

MINIMUM HABITAT AREA

Minimum area of habitat needed to support a pair of Spotted Owls is probably smaller in stands of mature and old growth Douglas-fir offering close proximity to permanent water, sufficient refuge and thermal cover, available nest sites and abundant prey. Where any of these factors are less available or of lesser quality, the minimum area sufficient for retaining a breeding pair of Spotted Owls may be larger. Knowing the necessary minimum area and recognizing the special habitat requirements would facilitate timber harvest planning to maintain the Spotted Owl population.

Gould (1977) found that destruction of habitat, especially from logging, was associated with the absence of Spotted Owls at five historical locations. On the Sequoia National Forest, he also found Spotted Owls in high quality habitat with as much as 30% of the habitat clear-cut; in lower quality habitat, Spotted Owls were found only in areas with less than 10% clear-cut. Minimum area sufficient for retaining Spotted Owls thus varied as a function of habitat quality.

The size of old growth and mature forest area occupied by Spotted Owls observed in this study rarely fell below 120 ha per territory and none were under 80 ha per territory. Perhaps this indicates a critical minimum area. If Spotted Owl home ranges overlap, total area necessary for the survival of greater numbers of breeding pairs in an area may be disproportionately less per breeding pair. Yet, much remains to be learned of foraging home range sizes, the degree of overlap of home ranges, prey abundance, and effects of edge and seral habitat on Spotted Owls in the mixed conifer forests, all of which may affect minimum habitat area and breeding success. The quantity and quality of habitat needed to support pairs which will produce enough young to replace those lost by natural mortality is unknown. Such replacement is the ultimate test of the long-term viability of the species.

LONG-TERM VIABILITY OF SPOTTED OWL POPULATIONS

Construction and placement of nest boxes for Spotted Owls may entice breeding pairs into an area deficient in nest sites (cavities in trees, old raptors nests, etc.) but otherwise suitable for breeding. Nest boxes have been successfully used with Tawny Owls (*Strix aluco*) in England (Southern 1970), Great Gray Owls (*Strix nebulosa*) in Sweden (Hoglund and Lansgren 1968), and Ural Owls (*Strix uralensis*) in Finland (Lahti 1972). In fact, over half the population of Tawny Owls in Wytham Woods, England, was induced to use nest boxes (Southern 1970). Because these species, like the Spotted Owl, maximally occupy suitable habitat, population densities cannot

be increased by nest box placement in undisturbed areas (Southern 1970). However, nest boxes in areas devoid of natural nest sites, such as in young growth stands, could have high value. The caution must be made that nest boxes provide just one of many necessary habitat components and would not replace other key habitat requirements, such as the need for thermal cover on daytime roosts (Barrows and Barrows 1978).

Nest boxes for the Ural Owl were made from a hollowed, round log, 50 to 80 cm tall, 30 to 40 cm in diameter, with the top left open and sawed off at an angle (Lahti 1972). This design may suffice for Spotted Owls, but Southern's (1970) prescription may do better.

Southern (1970) discovered that Tawny Owls did not use nest boxes with the entrance hole in the side; Tawny Owls, like Spotted Owls, use a hollow, broken-off branch or bole with a large mouth gaping upwards as an entrance. The nest boxes were made of four 0.9 m lengths of 2.5 cm plank nailed together to produce a simple, elongated box, square in section with an 18 cm internal measurement.

To monitor long-term viability and response to forest management activities, the Six Rivers National Forest established a data file for Spotted Owl management. This file contains descriptions of each breeding pair of Spotted Owls noting: 1) sightings; 2) probable impacts from initially proposed forest management activities; 3) coordination measures and mitigation proposed and implemented to maintain the integrity of the territory; and 4) follow-up surveys and monitoring to assess actual impacts on habitat and birds from activities near the territory. In this manner, the intensities and ranges of forest management activities compatible with Spotted Owls may be determined.

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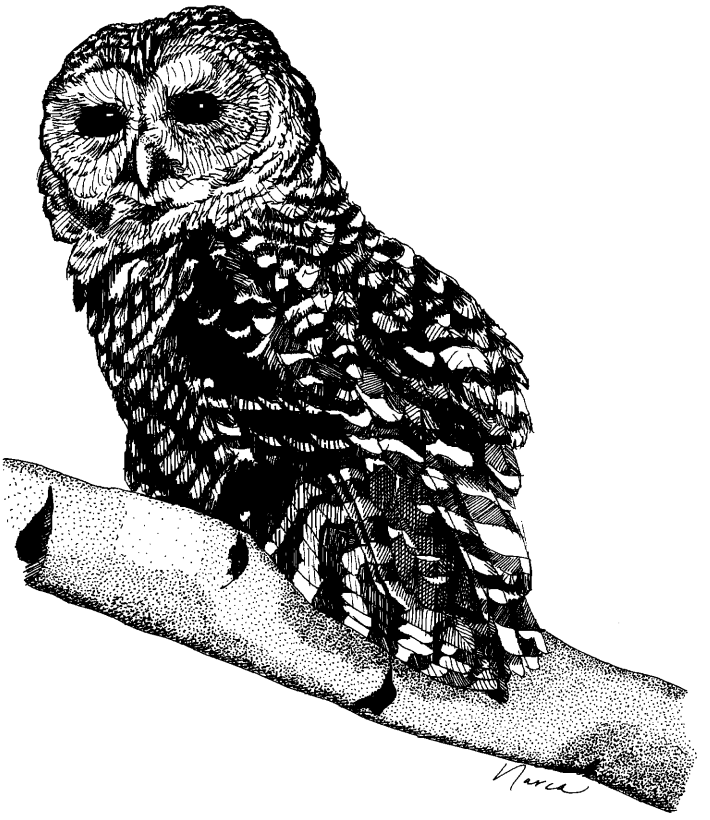

Sketch by Narca Moore

WFO Annual Convention, Estes Park, Colorado, 26-28 June 1981

Our sixth annual convention, the second outside California, will be held jointly with the Colorado Field Ornithologists at YMCA of the Rockies. Estes Park, at the entrance to Rocky Mountain National Park, is also reasonably close to Pawnee National Grasslands.

Mountain and tundra specialties include White-tailed Ptarmigan, Brown-capped Rosy Finch, Northern Three-toed Woodpecker and Boreal Owl. Grassland birds include Mountain Plover, Upland Sandpiper and Chestnut-collared and McCown's longspurs.

Convention details will be in the next issue of *Western Birds*.