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ROOST SELECTION BY SPOTTED OWLS: AN ADAPTATION TO HEAT STRESS

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ABSTRACT.—The microclimate at the summer roosts of Spotted Owls (*Strix occidentalis*) was investigated as a factor contributing to the species' narrow range of habitat. Habitat features surrounding the roosts were quantified; a dense canopy above the roost, and north-facing slopes were characteristic of all sites. The combined physical features created a microclimate that was 1° to 6°C cooler than that of more open areas. The owls showed signs of heat stress when temperatures reached and exceeded 27° to 31°C. The microclimate at summer roosts was effective in reducing the extent to which the owls used gular flutter. Winter roosts differed markedly from summer roosts, providing additional evidence supporting the importance of summer roosts to Spotted Owls. The owls' apparent intolerance to high temperatures was, at least in part, related to their having plumage as thick as that of boreal-zone owls. Such plumage appears to be an adaptation for enduring periods of winter stress. Selecting cool summer roosts may be a behavioral adaptation to compensate for the owls' observed inefficiency in dissipating body heat.

The Spotted Owl (*Strix occidentalis*) occurs in western North America from southern British Columbia and southern Colorado south to central Mexico (A.O.U. 1957). Within this range, it has a discontinuous distribution and is apparently restricted to dense forests, often within deep canyons (Binford 1974, Gould 1974, Forsman 1976, Kertell 1977). The narrow range of habitat selected by this species suggests a limited tolerance to certain environmental conditions. Binford (1974) suggested that one of the major habitat requirements of Spotted Owls is the absence of sunlight. Kertell (1977) emphasized that the relatively cool temperatures of deep canyons in Zion National Park attracted Spotted Owls. Gould (1974, 1977) and Forsman (1976) pointed out the presence of water, a dense forest canopy, and slope exposure as characteristics of Spotted Owl locations. The consistent presence of these features implies that these birds select habitats with a particular set of features that moderate the microclimate.

Spotted Owls respond to temperature conditions in a variety of ways. During warm weather, they augment heat loss by exposing the legs and the pads of the feet, erecting the contour feathers and drooping the wings (Barrows and Barrows 1978). In addition, they start gular flutter at lower ambient temperatures (Forsman 1976, Barrows and Barrows 1978) than those reported for other owl species of temperate environments (Bartholomew et al. 1968, Ligon 1968, Coulombe 1970). The degree of heat stress eliciting gular flutter in Spotted Owls has not been measured, but such activity in other species indicates a high heat load and increased energy expenditure (Ligon 1969, Coulombe 1970, Calder and King 1974).

In this paper I compare microclimates of Spotted Owl roosts over much of the species' range in California, using data gathered since a preliminary report (Barrows and Barrows 1978). I evaluate features of the habitat surrounding the roosts in both summer and winter, together with behavioral observations, in order to gain insight into factors influencing the distribution of this owl in California.

STUDY AREA AND METHODS

I studied the habitats and behavior of Spotted Owls in nine areas, including 15 major roost sites. Four areas were investigated in northern California: two locations within the Nature Conservancy's Northern California Coast Range Preserve (NCCRP) in Mendocino Co. (seven roosts); one location near Palomarin, Marin Co. (two roosts); and one site near San Geronimo, Marin Co. (one roost). Five areas were investigated in southern California: two sites in Cuyamaca Rancho State Park, San Diego Co. (SDCUYAA and SDCUYAB, one roost in each area); one site near Palomar Mountain State Park, San Diego Co. (one roost); one location in Trabuco Canyon, Orange Co. (one roost); and one site at the James Reserve, San Bernardino National Forest, Riverside Co. (one roost).

The study was conducted over three years, though the data-gathering was largely confined to the summer months of 1977, 1978, 1979, and the winters of 1978 and 1979. I observed 21 different owls for approximately 230 h.

Only those roosts that showed evidence of long periods of use were considered in the habitat analysis. They always had large accumulations of fecal matter and at least five pellets on the ground below. With these criteria I distinguished casual roosts from "major" ones, those roosts that were used frequently.

Tree density, canopy cover and species composition were measured within a 20-m diameter circular area (314.2 m^2) centered on each roost site. All plants taller than 5 m were considered in measures of tree density, expressed as trees per m^2, and species composition, which included a calculation of the percent of hardwood species. Canopy cover was estimated by evaluating the amount of incident light penetrating the canopy. Incident light was measured at or about 12:00 h on cloudless days, 2 m above the ground with an exposure meter. Light measurements were taken at regular intervals along four transects extending north, south, east, and west to the circle perimeter. Twenty-eight light values were collected within a half-hour period, and averaged for each roost area. Those light measurements obtained directly below the roost (four measurements) were considered separately as indicative of the canopy directly above the roost. Light values determined from these measurements were converted to units of lux and then calculated as a percent of potential unobstructed light. The unobstructed light value for all measurements during the midsummer months was calculated as 40,960 lux. Measurements of slope direction, distance to surface water and to the nearest ravine were made from below the roost tree.

I also quantified height and orientation of roosts. Roost height was estimated using a clinometer. Orientation of roosts was taken by a compass sighting from a fecal accumulation to the center of the roost tree trunk. Major and secondary roosts were included in this analysis.

During observations of the owls, humidity, ambient temperature, and wind speed were recorded. Ambient temperatures were recorded at roost level and at 1 m above the ground using mercury thermometers and thermistor probes connected to a model 43TD YSI telethermometer. Wind speed was measured at 1 m above the ground with a Dwyer Wind Meter. I watched owls from distances of 5 to 10 m and noted no signs of disturbance caused by my presence.

An adult male at the Cuyamaca State Park (SDCUY-AB) location in San Diego Co. was equipped with a radio transmitter and followed on 11 nights over a six-week period. Radiotelemetry equipment included a model LBT-401 Davtron transmitter and DM10 receiver.

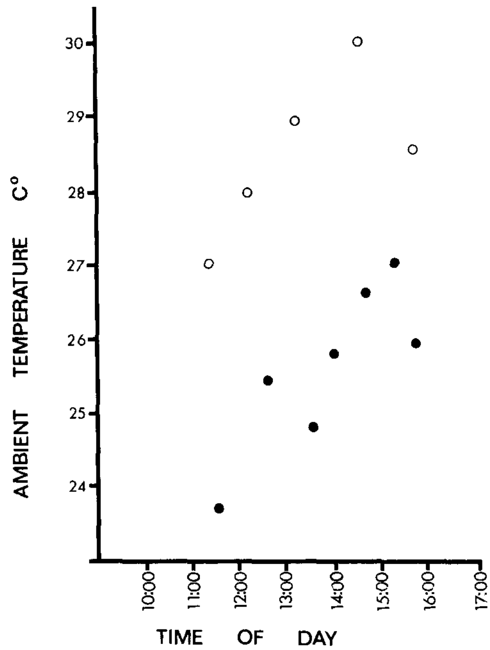

FIGURE 1. Ambient temperatures at one of the NCCRP major roost sites. The open circles indicate open canopy temperatures; the solid circles indicate temperatures below the roost. All measurements are from 1 m above ground level.

RESULTS AND DISCUSSION

SUMMER ROOST CHARACTERISTICS

Tree species composition at Spotted Owl locations in California was described by Gould (1977) and Barrows and Barrows (1978). Northern California and southern California sites differed significantly ($P < .02$, Mann-Whitney U-test) in measurements of tree density, canopy cover in the roost area, and the distance to surface water from the roost (Table 1). These statistical differences reflect differences in the moisture regimes characterizing the two regions. In these mixed evergreen forests, hardwood trees tend to be more abundant on damper sites and less abundant, creating a more open stand, at dryer locations (Sawyer et al. 1977). I noted a similar trend from northern to southern sites.

The canopy cover above the roost was significantly denser than that surrounding the roost at all locations ($P < .05$, Mann-Whitney U-test). These data, along with the lack of a regional statistical difference in roost canopy cover between northern and southern sites (Mann-Whitney U-test), strongly indicate the importance of a dense roost canopy in Spotted Owl summer roost selection. These factors, along with a marked tendency for roosts to be situated on north-facing slopes and in ravines (Table 1), point to the value of a cool microclimate at Spotted Owl summer roosts.

SUMMER MICROCLIMATE ANALYSIS

At mid-day in a dense European oak forest, the forest floor is 5° to 7°C cooler than the canopy (Geiger 1965). In order to investigate whether such stratification occurs at Spotted Owl summer roosts, I measured temperatures below the roosts and in areas of reduced canopy closure. Temperature measurements were also made in a vertical transect to reduce the influence of topography on the data interpretation. I found a 3° to 5°C temperature differential at nearly all the roosts sampled. Figure 1 is representative of this daytime moderation in roost ambient temperatures.

Consistent temperature stratification through the forest canopy was absent at the

TABLE 1. Habitat characteristics at preferred summer roosts of the Spotted Owl in northern and southern California.

	Compass direction of slope	Habitat variables[a]					
		Distance to water (m)	Distance to a ravine (m)	Percent light penetration: roost area	Percent light penetration: below roost	Tree density (trees/m²)	Percent hardwoods
Northern sites (n = 10)							
Means	349°	165	6	1.02	0.86	0.08	79.0
Ranges	45°–240°	25–225	0–25	.43–1.48	.43–2.34	.02–.13	0–100.0
SD[b]	46°	81	10	0.37	0.61	0.03	31.5
Southern sites (n = 5)							
Means	329°	51	6	1.78	0.98	0.08	43.1
Ranges	5°–265°	3–100	3–12	1.37–2.97	0.78–1.37	0.02–0.08	18.8–63.6
SD[b]	41°	42	4	0.61	0.49	0.03	32.9

[a] See methods section for complete description of habitat variables.
[b] Standard deviation of slope direction is a calculation of angular dispersion, "s" (Zar 1974).

two Cuyamaca sites. Here, the owls commonly roosted in incense cedar (*Calocedrus decurrens*) or white fir (*Abies concolor*) and apparently compensated for the reduced canopy cover by selecting roosts on the northwestern side of the large conifer trunks (Fig. 2B, D, E). Roost placement at all other sites was found to be random with respect to the roost tree (Fig. 2A). Except at the Cuyamaca sites, all frequently used roosts were in hardwoods or in large, spreading coast redwoods (*Sequoia sempervirens*). At Cuyamaca, the few casually used roosts that were in hardwood trees showed no directional trends. The three summer representations of roost directions (Fig. 2B, D, E) do not differ significantly from each other; they are also not significantly different from the array of slope directions (Table 1) selected by the owls (Watson-Williams test, Zar 1974).

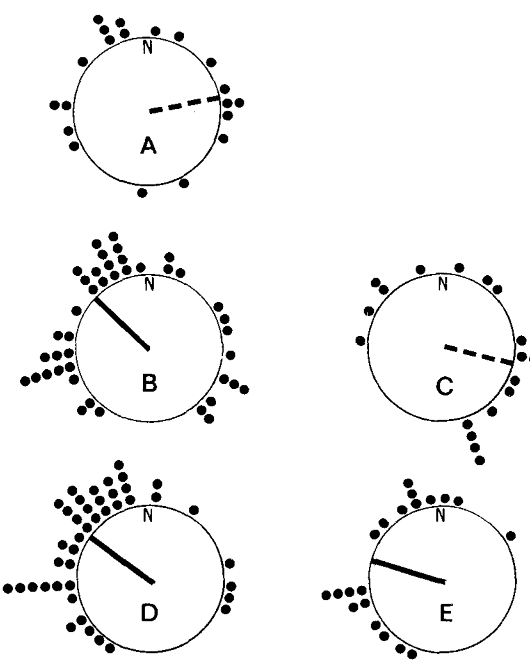

FIGURE 2. Directions of major and secondary roosts with respect to the roost tree; each solid circle represents one roost location. Lines drawn from the center of the circle to the circle perimeter describe sample means. Solid lines represent significant means (Rayliegh's test, $P < .01$ [Zar 1974]); a broken line indicates a mean that does not reach statistical significance ($P < .05$). Location and season of the samples are as follows: A, summer 1979, Trabuco Canyon, Orange Co.; B, summer 1979, Cuyamaca Rancho State Park, San Diego Co.; C, winter 1978–79, Cuyamaca Rancho State Park, San Diego Co.; D, summer 1978, Cuyamaca Rancho State Park, San Diego Co.; E, summer 1979, Cuyamaca Rancho State Park, San Diego Co.

The importance of shade in Spotted Owls' summer roost selection was demonstrated by a series of observations of roosting owls at the Palomar site in July 1979. I found a pair of owls at an infrequently used roost during a period of cool weather; mid-day temperatures ranged from 20° to 25°C. The canopy cover above the roost was relatively sparse with a light penetration value of 3.91%. At these initial temperatures the owls showed no signs of heat stress. On subsequent days the mid-day temperature gradually increased to 29°C. As the air temperature approached 27°C, the owls, when in shade, showed little behavioral response to the heat. Soon after sunlight fell upon the birds, they behaved as if heat stressed: exposing the feet and legs, assuming an erect posture, and lightly fluttering the gular area (Barrows and Barrows 1978). The owls moved deliberately to avoid the direct sun. One crouched below a large branch, while the other flew from branch to branch, moving each time sunlight struck it. The owl that crouched below the branch never received direct sun again throughout the observation period and showed no sign of heat stress. The other owl received direct sun for brief periods, and continued to gular flutter regularly. Movements to other perches noticeably increased the rate of gular flutter for brief periods. After the owl remained shaded, the frequency of flutter decreased relative to that of the same owl on a sun-lit perch. Examination of this roost two months later revealed no further signs of use by the owls. I observed similar responses to direct sunlight by Spotted Owls at other locations.

When ambient temperatures exceeded 27°C, all owls showed a strong tendency to perch with their backs to the sun. They consistently reversed their position 180° as the sun arced over their heads and light struck their underparts. In conjunction with this shift, the owls erected the feathers of their upperparts. For a discussion of the relative thermal advantage of erecting feathers during heat stress see Marder (1973) and Walsberg et al. (1978).

Within a dense oak forest, airflow is abruptly reduced from above the canopy to the forest floor (Geiger 1965). I found a similar gradient at the northern California sites. Despite fairly strong winds above the canopy, wind below the roosts (1 m above the ground) never exceeded 3–5 km/h. Southern California sites had a much different wind profile. At many of these sites, wind speed near the ground almost daily reached 8–16 km/h or more. This regional difference is likely explained by the difference in tree density and percent hardwoods; more open stands pose less of a barrier to air movement.

I did not measure wind speed at the owls' positions at the roosts. Noticeable gusts during periods when the owls were apparently experiencing heat stress (i.e., engaged in gular flutter) were followed by a reduction in apparent heat stress. The frequency of gular flutter was reduced, or more often ceased, during, and for minutes following, windy periods. During a period of nearly continuous strong winds (ground speed of 25–30 km/h) I watched an owl (at SDCU-YAA) roosting without showing signs of gular flutter, though temperatures ranged between 31° and 32°C. The same bird was seen the following day when air movement was reduced to gusts of approximately 15 km/h at ground level. The owl began gular flutter when temperatures reached 31° to 32°C and the air was still. Air movement continued to decrease throughout my observation period; the owl gular fluttered continuously with increased extension of the gular area.

If a cool microclimate is important for Spotted Owls in selecting summer roosts, then air movement and the temperature gradient through the forest canopy should each be expressed in the roost characteristics. Roosts close to the ground would receive the full advantages of the forest temperature stratification; higher roosts would receive more air movement. The relative importance of each of these two factors should influence roost height and so differences should occur between northern and southern sites. The southern roosts, with a mean height of 8.5 m, were significantly higher above the ground than were the northern roosts, with a height of 5.2 m ($P < .005$, Mann-Whitney U-test). Shade requirements may influence vertical orientation of the roost, potentially setting an upper limit on roost height.

The value of surface water in contributing to a cool microclimate at the roost showed considerable variation. A temperature reduction of 2° to 5°C from the surrounding forest was noted at water-side locations; major roosts were, however, rarely situated close enough to water to be influenced by this condition. The San Bernardino National Forest site was the only major roost that was near surface water: a small pool, with a large stream 40 m away. At this site, when ambient temperatures reached and exceeded 28° to 30°C, the owl abandoned its major roost and selected a secondary roost within 15 m of the large stream. The ambient temperature at this new roost was 1° to 2°C cooler than before.

Over 80% of the nests located by Forsman (1976:104) were within 300 m of permanent water. Of those nests farther than 300 m from water, the adults "visited areas where water was available in late summer, but their less mobile owlets were without water until they dispersed in late September or October." At NCCRP (Mendocino Co.) I noted that the owlets of one pair roosted directly above a small stream during a period of very warm weather (Barrows and Barrows 1978). These owlets engaged in vigorous gular flutter before bathing in the water, after which flutter ceased for 2.5 h.

Tree densities at Spotted Owl locations were higher in ravines and/or adjacent to water sources, relative to the surrounding forest. This pattern was less obvious at the more mesic northern sites, but was pronounced at all of the southern locations. The microclimate created by the high tree density and resultant canopy closure at the southern sites was thus a direct correlate of the distance to water or a ravine. The statistical difference in the distance from the

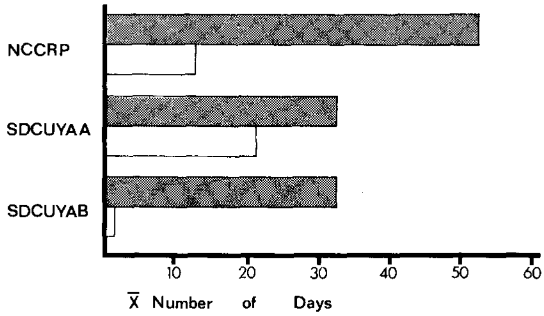

FIGURE 3. Estimated mean number of days per year that Spotted Owls engage in continuous gular flutter. Shaded bars represent open canopy situations, unshaded bars indicate site conditions at preferred roosts.

roost to water (Table 1) between northern and southern sites may be explained in part by this relationship. The owls may have been selecting roosts that received the cool microclimate provided by the dense forest, but were not close enough to the water source to inhibit evaporative water loss due to increased humidity.

Measurements of ambient temperatures at the "roost ravine" and nearby south-facing slopes were confounded by obvious differences in vegetation, but temperatures were regularly 5° to 6°C lower at the roosts. Steep north-facing slopes receive direct sunshine only at sunrise and at sunset (Geiger 1965). The impact of both direct and reflected solar radiation on the roosting owls is therefore reduced.

SUMMER HEAT STRESS

Spotted Owls were observed to begin gular fluttering at ambient temperatures from 27° to 31°C. Intermittent flutter became virtually continuous at ambient temperatures exceeding 29° to 32°C. At these temperatures the owls also drooped their wings and held them away from their body. Under laboratory conditions, nearly continuous gular flutter is coupled with a doubling of oxygen consumption for the Elf Owl (*Micrathene whitneyi*; Ligon 1968), and increased heart rate and more than doubling of oxygen consumption for the Burrowing Owl (*Athene cunicularia*; Coulombe 1970).

The average number of days per year during which open canopy ambient temperatures reached and exceeded 30°C can be calculated from the temperature records kept at the NCCRP and Cuyamaca sites. The location and physical characteristics of major Spotted Owl summer roosts, however, can result in a 1° to 6°C reduction in ambient temperature (Fig. 1). At the NCCRP sites this temperature reduction was consistently 3° to 5°C. At Cuyamaca State Park, the temperature reduction was only 1°C at SDCUYAA, but 5° to 8°C at SDCUYAB. These data were used to estimate the average number of days that Spotted Owls at these locations would facilitate heat loss via continuous or nearly continuous gular flutter. These estimates were made for both relatively open canopy, and preferred roost areas (Fig. 3).

The actual number of days of continuous gular flutter at preferred roosts is probably lower than those given in Figure 3; the effect of air movement in convectional heat loss and the at least occasional use of secondary water-side or near water roosts is not considered here. Even so, the preferred roost sites appear to have considerable value in reducing the heat stress potentially incurred by the Spotted Owls.

WINTER ROOST SELECTION

The best evidence of the importance of a cool microclimate in Spotted Owl summer roost selection is perhaps the contrast with their winter roosts. These were highly variable at the sites studied, and were rarely used day after day in the manner of summer roosts. This irregularity, along with frequent winter precipitation, makes the identification and study of winter roosts difficult. Consequently, my winter data are based largely on one owl, at the Cuyamaca (SDCUYAB) location, who was equipped with a radio transmitter during October and November of 1979. Additional observations were made at other locations in southern (SDCUYAA) and northern (NCCRP and San Geronimo) California.

Owing to the oblique angle of the winter sun, the degree of canopy closure directly above winter roosts had little effect on the amount of direct solar radiation received by the owl. With the sun's low arc, however, the owls' orientation in the roost tree had considerable influence on the amount of sun received. The distribution of winter roosts in Figure 2C differs significantly from those of the three summer roosts (Watson-Williams test, $P < .005$). The winter distribution is not significantly different from a random distribution, but tends toward a south-east orientation. The radio-equipped owl was, without exception, located roosting on the southern side of its roost tree. Regardless of canopy closure directly above the owl, which varied from zero to 100%, the owl received sun throughout the day. In contrast with summer roosting behavior, during the winter months Spotted Owls consistently face the sun.

With the aid of the radio-equipped owl, I was able to observe winter roost habitat selection in one area. During the winter I never found this owl roosting within the canyon where all of the preferred summer roosts were located (Fig. 4). All winter roosts were in the black oak (*Quercus kelloggi*)–incense cedar forest type. Nocturnal radio-tracking of this owl revealed that it preferred to hunt in the same areas where its winter diurnal roosts were located. I rarely found it near major summer roosts even while it was hunting. Winter roost habitat was characterized by relatively wide spacing between trees and numerous small meadows. Compass directions of slopes at these roosts ranged from 30 to 160 with a mean of 112 (nine roosts). This distribution is significantly different (Watson-Williams test, $P < .005$) from the slope directions of summer roosts. These winter roosts also showed no apparent relationship with ravines or water sources.

The winter climate of the Spotted Owl's range in California is cold and wet. At some locations (e.g., NCCRP) precipitation falls on over 40% of the winter days; heavy snowpacks are common at many of the high (1,700–2,200 m) elevation locations reported by Gould (1974, 1977). While I did not directly investigate the owls' hunting efficiency in this study, I feel certain that it is decreased during periods of precipitation. During periods of rain, Barn Owls (*Tyto alba*) have been found not to hunt, and for many days afterward they bring fewer prey items to the nest (Walker 1974).

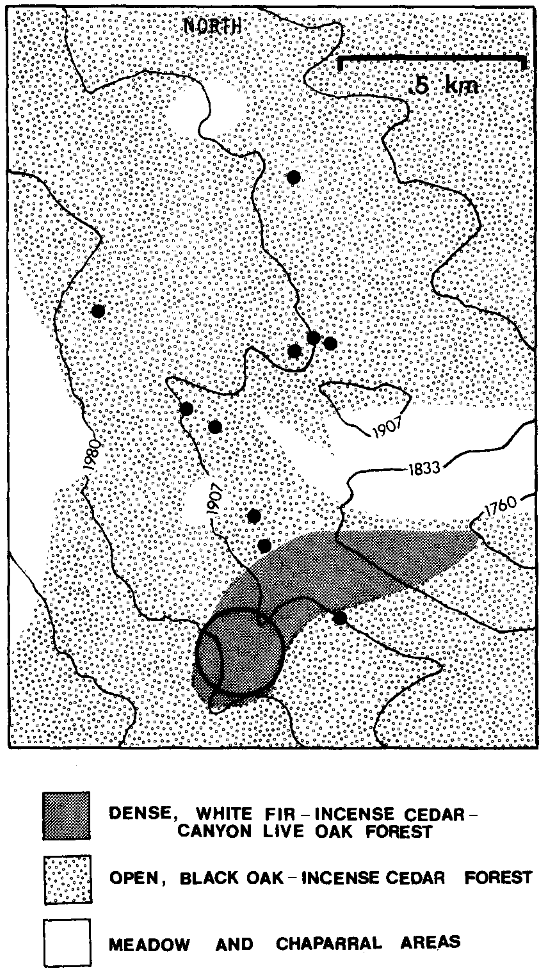

FIGURE 4. Winter roost locations of the adult male Spotted Owl at Cuyamaca Rancho State Park (site B), San Diego Co. The black dots indicate winter roost sites; the large open circle represents the summer roost area. Elevation is in meters.

Kelso and Kelso (1936) described the feathering on the feet of American owls and showed strong correlations with climatic conditions. While their findings were qualitative, they inferred this feathering to be an adaptation for protection from cold. I measured the length of feathers at the base of the second toe of North American owls (Table 2) and, following Clark's (1979) sug-

TABLE 2. Length of toe feathers in several species of North American owls.

Species[a]	Number of specimens	$\sqrt[3]{\text{Body weight (g)}}$[b]	Feather length[c]	Index of toe feather length[d]
Nyctea scandiaca	3	12.13	33.3	0.36
Surnia ulula	4	6.85	11.0	0.62
Aegolius funereus	4	4.92	7.8	0.63
Strix occidentalis occidentalis	9	8.47	10.7	0.79
Strix nebulosa	1	10.34	13.0	0.80
Strix varia varia	8	8.91	7.9	1.13
Aegolius acadicus	6	4.34	3.7	1.17
Bubo virginianus pacificus	3	10.42	8.3	1.26
Asio flammeus	6	7.00	5.3	1.32
Asio otus	5	6.38	4.6	1.39

[a] Subspecies can differ in this character and hence are designated when possible.
[b] A mean value (males combined with females) calculated from data presented by Earhart and Johnson (1970).
[c] Measured at the base of the second toe (mm).
[d] Calculated by dividing the cube root of the body weight by the toe feather length.

gestion, divided this length into the cube root of the owl's weight to obtain an index of feather length. The value for this index in Spotted Owls is comparable to those for several species of boreal-zone owls. The Spotted Owl does not range north of southern British Columbia so their foot feathers are relatively longer than those of other sympatric owl species. This feature appears to have adaptive value as insulation against harsh winter conditions.

Since dense foot plumage would decrease the rate of heat loss, it may in part be responsible for the Spotted Owls' relative intolerance to high temperatures. Other owls that have been studied show a much greater tolerance to high temperatures (Ligon 1968, Coulombe 1970). The Great Horned Owl (*Bubo virginianus*) has been observed under laboratory conditions to begin gular flutter at ambient temperatures of 38.6°C and to flutter continuously above 40.2°C (Bartholomew et al. 1968). My observations of three Great Horned Owls in outdoor cages revealed that while intermittent gular flutter began at 32° to 33°C, they did not flutter continuously, even with ambient temperatures exceeding 38°C. These owls did not raise their toes, conspicuously expose their legs, or droop their wings, in marked contrast to the actions accompanying gular flutter in Spotted Owls.

CONCLUSIONS

The relative intolerance to heat shown by Spotted Owls appears to be an important factor in their choice of habitat. A cool microclimate is most important at places where ambient temperatures often reach and exceed 29°C. At one Marin County site (Point Reyes), and possibly at high elevations, ambient temperatures rarely reach 29°C and the selection for characteristic summer roost features is somewhat relaxed. At most locations where these owls occur, however, ambient temperatures regularly exceed 29°C. Here, the selection for dense, often multi-layered canopies, and for north-facing slopes in steep-sided canyons or ravines is most pronounced. Spotted Owls do not appear to select any one habitat characteristic, but a combination of features which together ensure a cool microclimate. When temperatures nearby exceed 29°C, the coolness of the roost effectively reduces the heat stress experienced by these owls. Selection of a moderating microclimate at preferred summer roosts may represent a behavioral compensation for the birds' apparent inefficiency in dissipating body heat.

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RECENT PUBLICATIONS

Endangered Birds of the World/The ICBP Bird Red Data Book.—Compiled by Warren B. King. 1981. Smithsonian Institution Press in cooperation with the International Council for Bird Preservation, Washington, DC. 624 p. Paper $8.95, cloth $19.95. Source: Smithsonian Institution Press, P.O. Box 1579, Washington, DC 20013. The Red Data Books are detailed catalogues of threatened plants and animals on a worldwide basis, prepared for the International Union for the Conservation of Nature and Natural Resources. This volume is a reprint of Volume II, *Aves*, in that series, which was compiled by the ICBP and originally published by IUCN in a loose-leaf format in 1978 and 1979. It lists 437 species or subspecies in taxonomic order. For each taxon, the degree of threat is indicated and information is summarized on its status, distribution, population size and trend, existing or proposed conservation measures, and a selected list of references. Certainly, "This volume is an indispensible reference for government agencies dealing with national resources, environmental organizations, and individuals concerned about endangered species." *All* ornithologists, however, whether or not they are actively involved in such work, should see this important but dispiriting book and read the roll call.

Threatened and Endangered Species and Habitats in British Columbia and the Yukon.—Edited by Richard Stace-Smith, Lois Johns, and Paul Joslin. 1980. British Columbia Ministry of Environment, Fish and Wildlife Branch, Victoria, B.C. 302 p. Paper cover. This volume consists of the proceedings of a broadly-based symposium, held in 1980, to consider the problem of threatened species and habitats in B.C. and the Yukon. Of the 30 papers, 9 deal specifically with birds; hence, much attention is also given to other vertebrates, plants, and habitats. These reports, will, of course, chiefly interest biologists and conservation authorities in British Columbia. However, the keynote address, "The basis of endangerment," by Ian McTaggart Cowan and the papers by P. Joslin and by F. L. Bunnell and R. G. Williams on the ethos of preserving species and habitats merit wide consideration.

Finding Birds Around the World.—Peter Alden and John Gooders. 1981. Houghton Mifflin Co., Boston. 683 p. $17.95. Thirty years ago, Sewall Pettingill produced a new kind of book, the first guide to bird finding. The present book represents the culmination of that trend, being a worldwide directory to the best and most accessible places for birding. It is, of course, selective, the 111 localities having been chosen with an eye to transportation and political considerations as well as their avifaunas. The book nonetheless covers the world's major ecosystems. For each place, it tells about special birds, lodging, seasons, guides, transportation, specific locations, and important travel considerations. Each account includes a map and a nearly complete list of species. The information is detailed and accurate (within this reviewer's experience), being based on the first-hand experience of the authors and many others who have led birding tours. An introductory chapter gives sound, practical advice about traveling in quest of birds. A list of useful publications and a full taxonomic index are appended. Altogether, this guide will be invaluable in planning a birding tour to an exotic place and getting the most out of one's trip.

The Audubon Society Handbook for Birders.—Stephen W. Kress. 1981. Charles Scribner's Sons, New York. 322 p. $17.95. This is an introductory manual of techniques and source book for birding. It explains field identification, selection and use of optical equipment, observation methods, bird photography, and sound recording. In order to guide birders beyond listing, it also gives detailed and annotated lists of educational programs in ornithology and research activities that welcome participation by amateurs. Finally, it surveys periodicals, organizations, and books about birds, chiefly in North America. Three appendices list sources for equipment, supplies, and books, plus bird-related publications available from U.S. and Canadian government agencies. Advanced birders as well as novices will find a wealth of information, much of it hard-to-come-by, compiled here. This book would also be a handy reference for libraries, schools, and nature centers. Drawings, photographs, index.