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## USE OF TREE SPECIES BY FOREST BIRDS DURING WINTER AND SUMMER

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**Abstract:** We recorded the foraging behavior of bird species during winter and summer in a mixed conifer forest of the western Sierra Nevada. All bird species increased their relative use of incense cedar (*Calocedrus decurrens*) in winter compared to summer. We noted no obvious difference in the vigor (health) of trees used by birds between seasons. Most species revealed a general trend towards increased use of the bark of incense cedar in winter relative to summer. It appears that birds are able to obtain food from under the loose, flaky bark of incense cedar more easily than from under the more firm, compact bark of other timber species in winter. The overwinter survival of birds may be lowered by reduction in the stocking level of small (<30 cm dbh) incense cedar.

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Birds are known to alter patterns of habitat use and foraging behavior between seasons (Willson 1970, 1971; Travis 1977; Conner 1980, 1981; Hutto 1981; Lewke 1982). These variations are of importance in land use planning because the manager may have to allow for a different suite of habitat needs on both species-specific and season-specific bases. Although vegetation structure (both vertical and horizontal) has been inferred to be important in influencing the species composition and abundance of birds (MacArthur and MacArthur 1961, Karr and Roth 1971, Willson 1974, Roth 1976), bird diversity may also be influenced by the diversity of plant species present, independent of structural considerations (MacArthur and MacArthur 1961, Holmes and Robinson 1981, Robinson and Holmes 1984). Therefore, the task of providing adequate habitat is complicated by many factors.

The land manager changes the composition of plant species in an area based on numerous, often competing, factors (e.g., economical, biological, sociological). In the western Sierra Ne-

vada, for example, the composition of the forest is being changed as areas are harvested and replanted (converted) to economically desirable species. Although the response of birds to gross changes in their habitats has been examined (e.g., see Verner and Boss 1980), the effects of more subtle changes in plant species composition are not well known, especially interseasonally.

Our objective in this study was to determine if the use of tree species by birds differed between winter and summer in the western Sierra Nevada. Our intent was to describe general patterns that might deserve increased attention by resource managers.

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### STUDY AREA

This study was conducted at the Blodgett Forest Research Station of the University of California, Berkeley, El Dorado County, Cali-

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fornia. This 1,200-ha forest is located in the mixed conifer zone at 1,200–1,450 m elevation in the western Sierra Nevada. Predominant tree species, in decreasing order of canopy cover, were: incense cedar, white fir (*Abies concolor*), sugar pine (*Pinus lambertiana*), Douglas-fir (*Pseudotsuga menziesii*), California black oak (*Quercus kelloggii*), and ponderosa pine (*P. ponderosa*) (Airola and Barrett 1981; see also Griffin and Critchfield 1972). The Forest has been divided into 5 to 20-ha compartments to be managed under various silvicultural systems (R. C. Heald, pers. commun.).

During the spring and summer (May through Aug, hereafter referred to as the summer season), 20 compartments were randomly selected from those available; only compartments with mature trees were selected. Because access to much of the Forest was limited in winter, a reduced subset of four large (>15-ha) compartments was selected for winter study (Nov through Mar). A complete list of compartments used in this study is on file at Blodgett Forest Research Station.

## METHODS

The foraging behavior of seven permanent resident bird species and one winter resident species (list of species and scientific names are given in Fig. 1) was recorded during the winters of 1982–83 and 1983–84 and the summers of 1983 and 1984. During summer, each compartment was visited for 2–4 hours on four to five occasions (at 7–10-day intervals between visits). During winter, each compartment was visited for about 7 hours during a 2–3-day period on four to six occasions (at 2–3-week intervals).

When we encountered a foraging bird, we recorded the following information: species; sex; foraging mode (e.g., gleaning, bark-probing); the species, dbh, height, and vigor (see later) of the tree within which the bird was observed foraging; perch diameter; the substrate (twig, limb, trunk) on which the bird was foraging; and the vigor of the substrate. Vigor was defined as either healthy (stage 1) or unhealthy (stages 2–7), based on categories defined by Thomas et al. (1979:fig. 38). During winter 1982–83, the activity of a bird was recorded every 30 seconds until it was lost from sight (see Morrison 1984). For the remainder of the study, data were recorded by timing the activities of an individual on each foraging substrate; typi-

cal time periods were 10–60 seconds. Because multiple methods were used for data collection, and because of questions concerning the independence of some observations in our data set (see Morrison 1984), we have refrained from detailed statistical treatment of foraging mode and foraging substrate and report only obvious, substantial differences based on percent changes between seasons. Previous work (Morrison 1984) indicated that a sample of 30–40 individuals adequately described foraging behavior. Because we could not obtain this sample for each species each season, data were combined for the two winters and two summers of our study. Because the sexes for most species could not be distinguished in the field, data for males and females were combined for this analysis. Because of low sample sizes for some bird species, some analyses (see Results) were conducted after lumping certain tree species into groups. All analyses were run using SPSS (Nie et al. 1975), SPSSX (SPSS, Inc. 1983), and SAS (SAS Institute, Inc. 1982) computer packages.

## RESULTS

All bird species increased their relative use of incense cedar in winter compared with summer (Fig. 1). All bird species concentrated foraging time on either ponderosa pine (brown creeper, hairy and white-headed woodpeckers) or white fir (both chickadees, golden-crowned kinglet, and red-breasted nuthatch) in summer. In winter, however, incense cedar provided the dominant or codominant foraging substrate for all birds except the chestnut-backed chickadee, which used only about 18% cedar in winter (up from about 6% in summer). The only winter resident studied, the ruby-crowned kinglet, spent nearly half of its foraging time on incense cedar. The use of tree species was not the same between seasons ( $P < 0.05$ ), however, for only the brown creeper and red-breasted nuthatch; probabilities were between 0.13 and 0.26 for all other species except the hairy woodpecker (where  $P > 0.5$ ;  $\chi^2$  with  $df = 5$ ). When we combined all tree species except incense cedar into one group, the use of cedar and the other tree species were not the same between seasons ( $P < 0.05$ ) for the brown creeper, chestnut-backed chickadee, red-breasted nuthatch, and white-headed woodpecker ( $\chi^2$   $df = 1$ ). For the remaining bird species, the significance level was a weaker  $P < 0.1$ .

Significantly smaller-diameter (dbh) incense

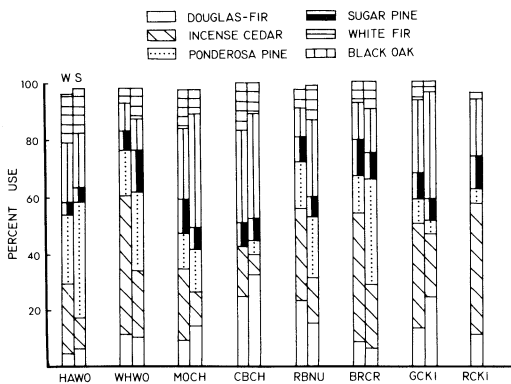


Fig. 1. The use (%) of tree species for foraging by birds at Blodgett Forest during winter (W) and summer (S), 1982–84. Bird species are: hairy woodpecker (HAWO, *Picoides villosus*); white-headed woodpecker (WHWO, *P. albolarvatus*); mountain chickadee (MOCH, *Parus gambeli*); chestnut-backed chickadee (CBCH, *P. rufescens*); red-breasted nuthatch (RBNU, *Sitta canadensis*); brown creeper (BR CR, *Certhia americana*); golden-crowned kinglet (GCKI, *Regulus satrapa*); and ruby-crowned kinglet (RCKI, *R. calendula*). Sample sizes given in Fig. 2.

cedar and sugar pine, and significantly larger black oak and Douglas-fir, were used for foraging in winter compared to summer; ponderosa pine and white fir showed no significant difference between seasons (Table 1). No substantial differences were noted in the percent use of healthy and unhealthy trees between seasons for any bird species (unpubl. data).

A change from the use of twigs (which included foliage) of all tree species in summer to increased use of various parts of incense cedar in winter was noted for all birds except the white-headed woodpecker, which showed virtually no change in use of foraging substrates between seasons (Fig. 2). The golden-crowned kinglet, hairy woodpecker, and nuthatch increased use of limbs and trunks, the chestnut-backed chickadee increased use of limbs, the

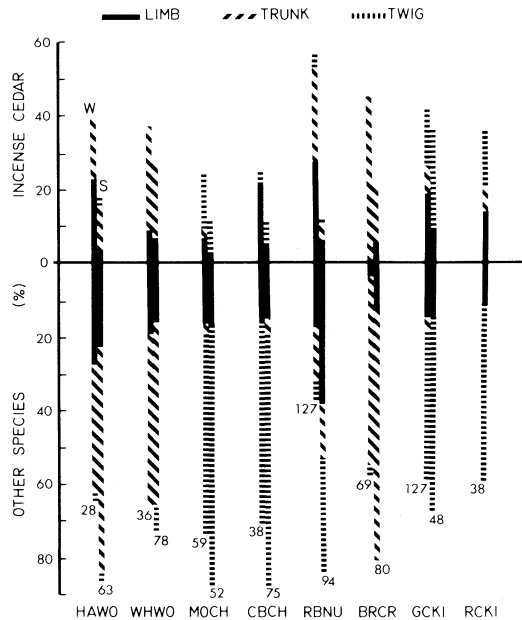


Fig. 2. The use (%) of foraging substrates (limb, trunk, twig) by birds at Blodgett Forest during winter and summer, 1982–84. Data shown are for incense cedar; all other timber species combined. Bird species are given in Fig. 1; values below bars are sample sizes (number of individuals observed) for each bird species during winter (left) and summer (right).

creeper increased use of trunks, and the mountain chickadee increased use of twigs of incense cedar during winter. Many of these differences were slight, however, showing only an overall trend towards increased use of the bark of cedar in winter (Fig. 2).

DISCUSSION

Our results show a substantial increase in the use of the bark of incense cedar as a foraging substrate in winter relative to summer for birds in the western Sierra Nevada. Birds apparently do not often use the foliage of incense cedar as a foraging substrate in any season (see also Airola 1979). Incense cedar may thus play an important role in the overwinter survival of birds. Although some of our data could not be rigorously analyzed, the pattern of increased use of cedar in winter, combined with the significant or near significant results for certain tests, justifies our conclusion.

The bark of incense cedar is loose and flaky compared to the firm and compact bark of the other timber species studied; birds with small and thin bills cannot obtain insects overwintering in or under the bark of these latter species.

Table 1. Diameter at breast height (dbh) of trees used for foraging by birds during winter and summer at Blodgett Forest, California, 1982–84.

Species	Winter dbh (cm)		Summer dbh (cm)	
	$\bar{x}$	SD	$\bar{x}$	SD
Black oak	78	25.3	57	27.7**
Douglas-fir	63	33.5	52	34.2*
Incense cedar	33	23.2	50	43.1**
Ponderosa pine	54	16.7	58	19.6
Sugar pine	59	20.8	71	25.6*
White fir	43	24.4	46	21.5

\*  $P < 0.05$ , \*\*  $P < 0.01$ ,  $t$  test.

Even birds with small bills (contrast, for example, chickadees with woodpeckers) were observed flaking cedar bark. Preliminary examination of the bark of incense cedar at Blodgett (D. L. Dahlsten, pers. commun.) revealed at least one species of scale insect (*Xylococcus macrocarpae*) overwintering under the loose bark of cedar; this insect is specific to cedar at Blodgett. During summer, of course, numerous insects are found on the foliage and bark surfaces of all plants at Blodgett (D. L. Dahlsten, unpubl. data; see also Dahlsten et al. 1985).

The bark of incense cedar becomes more firm and compact (i.e., less flaky) as the tree grows in diameter (pers. observ.). Although we did not quantify the external structure of incense cedar bark (following Jackson 1979, for example), the relatively more flaky bark on smaller vs. larger trees may explain the use of smaller incense cedar in winter. We cannot explain, however, the use of smaller sugar pine and larger black oak and Douglas-fir in winter vs. summer.

Conner (1981) found that smaller-billed woodpeckers foraged more intensively on thin-barked trees relative to larger-billed woodpeckers during winter in Virginia. For the downy woodpecker (*Picoides pubescens*) in Pennsylvania, Travis (1977) showed an increased use of species with flaky bark (relative to smooth-barked trees) during winter. Travis attributed this change to the decreased availability of invertebrates on most bark surfaces. In New Hampshire, Kilham (1970) showed that downy woodpeckers were attracted to birches (*Betula papyrifera*) that were infested with the scale *X. betulae*. It thus appears that the concentration of foraging activities on certain tree species during winter is a common response by birds to prey availability, with availability being a reflection of both prey density and accessibility (see also Jackson 1979).

## MANAGEMENT CONSIDERATIONS

Commercial uses of incense cedar include firewood, poles, siding, shingles, and pencils. Historically, incense cedar has had a low stumpage price relative to other conifers. More recently, prices for incense cedar have become competitive in response to consumer interest in products made from cedar. Markets for traditional and nontraditional incense cedar products have led to increased interest in this species by forest managers (Engstrom 1979).

Incense cedar typically composes 20–40% of

the basal area of an unmanaged stand at Blodgett Forest (R. C. Heald, pers. commun. and unpubl. data on file at Blodgett Forest); this amount of incense cedar is typical of mixed conifer forests in the western Sierra Nevada (Schubert 1957). The stocking level of cedar will be varied, however, based on current market value and the perceived need for different timber species in the future. If the stocking level of small (<30 cm dbh) incense cedar declines either by exploitation or in preference for other timber species (e.g., fir, pine), then the overwinter survival of birds may be lowered. It is thus important that studies be initiated that: (1) quantify prey density and availability on all timber species; (2) determine the impact of birds on prey species; (3) determine the response (e.g., changes in overwinter survival) of birds to various stocking levels of incense cedar; and (4) determine stocking levels of the various timber species required to maintain populations of birds in the western Sierra Nevada.

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## CUES USED BY EUROPEAN STARLINGS FOR DETECTING METHIOCARB-TREATED GRAPES

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**Abstract:** Experiments were conducted to determine the types of cues European starlings (*Sturnus vulgaris*) used to detect methiocarb-treated grapes and to determine whether the use of visual tags would enhance repellency to this chemical. One untreated and one treated grape bunch were offered to individually caged birds during a series of 2-hour feeding trials, with the position of the treated bunch either variable or stationary during successive trials. Starlings relied on locational cues for identifying methiocarb-treated bunches and showed avoidance of untreated grapes later placed on the same side of the cage. Visual tags (3.8-cm<sup>2</sup> pieces of yellow cloth tape with a brown "X" on each side) did not hasten the recognition of locations where methiocarb-treated bunches were placed, nor did they enhance the subsequent repellency. Methiocarb failed to inhibit overall consumption of grapes.

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Recent research on bird damage control has focused on the use of chemical repellents (Stickle and Guarino 1972, Flegg et al. 1977, Bruggers 1979, Benjamini 1981). Of particular interest are secondary repellents that elicit conditioned food aversions by producing noxious or emetic postingestive effects. Such repellents usually result in stronger and longer lasting aversions than repellents that merely have a repugnant taste or smell (Rogers 1974). After ingesting sublethal amounts of food treat-

ed with a secondary repellent, animals presumably learn to avoid that food during subsequent encounters by associating certain critical cues with the postingestive effects (Garcia and Hankins 1977). Our knowledge about how birds learn to recognize repellent-treated food is still fragmentary, and a better understanding could permit the development of more effective strategies for their use. Pairing salient stimuli with applications of repellents might increase effectiveness and reduce the amount of repellent