VISIBILITY AND BIAS IN AVIAN FORAGING DATA

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Foraging behavior of woodland passerines is often studied using a "standard observation technique" (Hartley 1953, Gibb 1954, Root 1967, Morse 1970), in which one set of observations is recorded on each bird seen. Some workers argue that this method is biased in favor of conspicuous foraging locations (Sturman 1968, Austin and Smith 1972, Hertz et al. 1976); they recommend continuous recording of data over longer periods on each individual. Continuous recording methods can also introduce biases, however, particularly if rules for starting and stopping are not used and individuals cannot be recognized (Altmann 1974). I collected data on several insectivorous passerines in a California oak woodland which allow comparison of results obtained by the two sorts of methods.

In the standard observation technique (method 1), I recorded one observation on each bird when first identified; the two components considered here are substrate (plant type) and perch size. For comparison (method 2), on as many of these same individuals as possible I recorded substrate and perch data at 10-s intervals for 30–110-s periods (minimum 4 observations per bird), using an electronic metronome similar to that described by Wiens et al. (1970). Substrate and perch choices were each grouped into four categories for analysis (Table 1).

Distributions of substrate choices differed significantly in G tests (Sokal and Rohlf 1969) between methods for all four bird species. In each case, deciduous trees, the most commonly chosen substrate, accounted for a larger proportion of the observations with method 2 than with method 1. Birds were more visible in the leafless deciduous trees than in evergreen trees and shrubs, so that an observation sequence once begun was more likely to last the minimum 30 s if in a deciduous tree. Method 2 therefore increased rather than reduced any bias of method 1 toward visible locations. This effect would have been smaller if the 30-s rule had not been followed; shorter observation periods would, of course, resemble single observations more closely.

Choices of perch size differed by the two methods for only one of the four species. In contrast to substrate choice, the distribution of perch choices was more equitable by method 2 than by method 1. Twigs <1 cm in diameter were the most commonly chosen perch; since small perches are presumably concentrated in the outer, more visible portion of the vegetation, their lesser importance under method 2, at least for *Parus rufescens*, suggests that method 1 may have been biased toward more visible perch sizes.

I conclude that the method of recording data does have an effect on the results, but that method 1 is not always more biased toward visible locations than method 2. Several factors, including behavioral variation among individual birds, may account for the differences between methods; certainly the differences indicate that caution is required in comparing studies that used different methods. My study site is an open woodland 5–10 m tall; in taller, denser forests visibility is a greater problem, but so is the probability of losing track of a bird before an observation sequence is completed. One advantage of a continuous recording method is that more data can be gathered in the same amount of field time. A method of choice therefore might often be a continuous recording method based on focal animal sampling for unmarked individuals (Altmann 1974). One should not assume, however, that such a method is less biased toward visible locations than is a standard observation technique.

LITERATURE CITED

ALTMANN, J. 1974. Observational study of behavior: sampling methods. Behaviour 49:227–267.
AUSTIN, G. T., AND E. L. SMITH. 1972. Winter foraging ecology of mixed insectivorous bird flocks in oak woodland in southern Arizona. Condor 74:17–24.
GIBB, J. A. 1954. Feeding ecology of tits, with notes on treecreeper and goldcrest. Ibis 96:513–543.

TABLE 1. Distribution of substrate and perch choices as measured by two methods. Method 1 = one observation recorded per bird when first identified. Method 2 = observations recorded at 10-s intervals; 4–12 observations per bird. Data from October 1975–January 1976. NS indicates $P > .05$ in a G test that distributions obtained by the two methods are the same.

Species	Method	Substrate					Perch				
		Decid-uous tree	Ever-green tree	Shrub	Other	Signif. of G	>5 cm	1–5 cm	<1 cm	Other	Signif. of G
Chestnut-backed Chickadee	1	41	15	13	0	$P < .05$	0	11	51	1	$P < .005$
(*Parus rufescens*)	2	161	26	10	3		22	50	119	3	
Plain Titmouse	1	91	21	21	0	$P < .05$	10	52	64	0	NS
(*Parus inornatus*)	2	108	19	7	0		9	49	74	1	
Ruby-crowned Kinglet	1	101	72	56	0	$P < .01$	2	35	181	3	NS
(*Regulus calendula*)	2	96	57	45	7		5	40	151	4	
Hutton's Vireo	1	41	9	15	0	$P < .005$	1	11	49	0	NS
(*Vireo huttoni*)	2	71	0	17	2		0	23	64	2	

HARTLEY, P. H. T. 1953. An ecological study of the feeding habits of the English titmice. J. Anim. Ecol. 22:261–288.

HERTZ, P. E., J. V. REMSEN, JR., AND S. I. ZONES. 1976. Ecological complementarity of three sympatric parids in a California oak woodland. Condor 78:307–316.

MORSE, D. H. 1970. Ecological aspects of some mixed-species foraging flocks of birds. Ecol. Monogr. 40:119–168.

ROOT, R. B. 1967. The niche exploitation pattern of the Blue-gray Gnatcatcher. Ecol. Monogr. 37:317–350.

SOKOL, R. R., AND F. J. ROHLF. 1969. Biometry. W. H. Freeman, San Francisco.

STURMAN, W. A. 1968. The foraging ecology of *Parus atricapillus* and *P. rufescens* in the breeding season, with comparisons with other species of *Parus*. Condor 70:309–322.

WIENS, J. A., S. G. MARTIN, W. R. HOLTHAUS, AND F. A. IWEN. 1970. Metronome timing in behavioral ecology studies. Ecology 51:350–352.

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GROWTH OF A NESTLING MARBLED MURRELET

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On 6 July 1979, we found a nest of a Marbled Murrelet (*Brachyramphus marmoratus*) on East Amatuli Island in the Barren Islands, south of Cook Inlet, Alaska. The nest was 10 m south of the 1978 nest site described by Simons (Condor 82:1, 1980). We provide additional observations on the nest site, chick growth and fledging.

The shallow nest cup was located beneath a 1.5-m high rock ledge, which afforded more protection from inclement weather than the 1978 nest. The nest was on a northeast-facing heath and grass-covered slope overlooking a sheltered cove about 75 m away from the nest. New observations of the Marbled Murrelet's breeding biology are provided in Table 1. We noted chiefly: 1) confirmation of a 28-day nestling period; 2) indication of variability in growth and in hatching and fledging dates for this species; 3) both adults feeding the chick during one evening, and 4) behavior on the night of nest departure.

The chick's weight and wing length were measured on all but three days until it left the nest on the night of 16 August (Fig. 1). Comparing our data with Simons', the following differences are apparent. The hatching weight of the chick in 1978 was 34.5 g, in 1979 it was 32 g. This probably corresponds to the 2.5-g difference in egg weights between the two years. During the first seven days of growth, weights of the 1979 chick were significantly lower than 1978 weights recorded over the same period. In 1979 a significant growth spurt occurred between days 7 and 9 while early weight increase was more regular in 1978. A pre-fledging weight recession was seen in 1979; the chick lost 16 g during the last four days before fledging. Overall, the growth rate was slower (k = 0.144) during 1979, and the as-

ymptote of the growth curve was greater (166 g). These values were calculated using the same computer methods employed by Simons. Wing lengths recorded in 1979 were consistently 10 mm less than those recorded

TABLE 1. Additional features of Marbled Murrelet breeding biology.

	1978[1]	1979
Egg weight	41.0 g	38.5 g
Egg length	61.2 mm	58.9 mm
Egg width	36.3 mm	36.3 mm
Hatching date	1 August	20 July
Hatching weight	ca. 35 g	32 g
Flapping response present		Day 18
Egg tooth present		Day 23
Loss of down	Day 26	Day 26
Nestling period	ca. 27 days	28 days
Nestling food		
Feeding frequency	1 or perhaps 2 trips/day	2 trips/day
Length of feeding bouts	3 min	1 min 43 s
	8 min	2 min 34 s
Feeding arrival times	21:02	21:24
	20:45	21:28
	20:49	21:54
		21:33
Load size	15 g	13 g
	20 g	5 g
	8 g	
Nestling growth		
Asymptote (a)	144 g	166 g
R = a/adult weight (W = 222 g)	0.65	0.75
Fledging weight (FW)	ca. 150 g	140 g
FW/W (%)	68	63
K	0.230	0.144
Fledging wing length	ca. 114 mm	103 mm
Fledging date	ca. 27 August	16 August

[1] Simons 1980.