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BIRD DIETS AND PREY AVAILABILITY IN THE WESTERN SIERRA NEVADA, CALIFORNIA [1]

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We analyzed the stomach contents of 199 birds of 27 species collected in the western Sierra Nevada during 1980. The availability of certain prey was also assessed. Only nine of the bird species showed over 10% vegetable matter in their stomachs. Sparrows and a finch showed the highest content of vegetable matter. Birds usually considered insect eaters had a high content of animal matter. Most items were insects except for spiders and snails. Data indicated the wide variety of food items taken by birds in the western Sierra Nevada.

INTRODUCTION

The role of birds in forest ecosystems has long intrigued biologists. Of special interest both ecologically and economically is the effect of bird predation on insects. Although some attention has been given this topic, results are equivocal, with some authors concluding that birds prevent or control insect outbreaks, while others ascribe birds a reduced role (Bruns 1960; Tinbergen 1960; Otvos 1965; McCambridge and Knight 1972; Holmes, Schultz, and Nothnagle 1979; Torgersen and Campbell 1982).

Before the effect of birds on their prey base can be determined one must first assess the prey available and taken by the birds. It was thus the objective of this paper to present data on prey availability and prey taken by birds in a mixed-conifer forest of the western Sierra Nevada. Further, we hope that these baseline data will generate further research into the role of birds in California forests.

STUDY AREA AND METHODS

We analyzed stomachs from birds collected at the Blodgett Forest Research Station of the University of California-Berkeley, El Dorado County, California. The 1500 ha study area is a mixed-conifer forest on the west slope of the Sierra Nevada at about 1400 m elevation. The forest is characterized by mature Douglas fir, *Pseudotsuga menziesii;* white fir, *Abies concolor;* ponderosa pine, *Pinus*

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ponderosa; sugar pine, *P. lambertina;* incense cedar, *Calocedrus decurrens;* and black oak, *Quercus kelloggii.* A complete description of this area was given by Airola (1979) and Cohen (1982).

During June and July 1980, 199 birds were collected using mist nets. These dates correspond to the nesting period of most birds at Blodgett. Stomachs were taken from the birds and stored in vials of 70% ethanol. Twenty-seven species were collected; sample sizes ranged from 1 to 25. Stomach contents were analyzed in March 1983.

Stomach volumes were measured by displacement, i.e., 2 to 3 ml of 70% ethanol were poured into a 5 ml volumetric flask and measured to the nearest 0.1 ml. Stomach contents were scraped into the flask and the difference between the new and original volume recorded. Flask contents were emptied into glass petri dishes and placed over one-tenth inch grid paper. The proportions of each of mineral (grit), vegetable, and animal matter were measured. This was done by counting the number of $\frac{1}{10}$ inch squares covered by each type of material.

Contents in the petri dishes were sorted for identifiable items and/or parts. We attempted to estimate numbers of individuals within a given taxonomic group. Many stomach contents were too ground up to identify beyond "insect". Due to these problems, we chose to record only the presence or absence of the various animal forms. The items were recorded by life stage (egg, larva, pupa, and adult) and classified to the lowest taxon possible.

One sticky trap was placed on the bole at three heights (5, 10 and 15 metres on each of eight randomly selected trees for a 2 wk period in June and July 1980 (notes recording tree species used were lost). The traps were 15 x 30 cm, 6 mm mesh hardware cloth screens and were coated with Stick-em Special [R] (Michel and Polton, Emeryville, California.). The purpose was to trap prey items in areas where the birds were foraging, and to obtain information on abundance (qualitative measure primarily and a general quantitative measure).

The traps were cleaned in hot kerosene in the laboratory and the items were placed in kerosene-filled screw cap vials. The vials were stored until early 1983 when the vials were drained and replaced with 70% ethanol.

RESULTS AND DISCUSSION

Only nine of the 27 bird species showed over 10% vegetable matter in their stomachs (Table 1). Of these nine species, only the purple finch (scientific names in Table 1), fox sparrow, and chipping sparrow showed over one-third vegetable matter; the chipping sparrow (at 79.1% vegetable matter) was represented by only one individual.

These results are mostly consistent with the feeding habits of the species. That is, high animal percent for "insect" eaters (e.g., vireos, warblers, flycatchers) and high vegetable percent for "seed" eaters (e.g., sparrows). Several exceptions are noteworthy, however. The dark-eyed junco, usually classified as a "ground-seed forager" (Martin, Zim and Nelson 1951), showed 74.6% animal matter. This is in contrast to other "seed-eaters", such as the fox sparrow. Likewise, the black-headed grosbeak, another species seemingly adapted to seed eating, showed only 1.4% vegetable matter in its stomach. It is not unusual, however, for species adapted to seed-eating (i.e., heavy bill) to take large quantities of animal matter during the nesting period (e.g., see Martin *et al.* 1951). Of course, this does not explain why other seed-eaters did not show

higher percentages of animal matter in their stomach. In contrast, the yellow-rumped warbler, a bird usually associated with insect-gleaning in forest canopies, showed 18.9% vegetable matter. It is possible, of course, that much of the vegetable matter in the stomach of this warbler was accumulated incidentally while foliage-gleaning for insects.

Further identification of animal content in the stomachs revealed about 40 groupings of animals at various taxonomic levels; some of these groups were divided by life stage (Table 2). Most items in the stomachs were insects except for some spiders and snails. Of these groups, ten or more appeared in the stomachs of seven bird species. Adult coleopterans (especially weevils), homopterans (especially cicadellids), hymenopterans (especially formicids), and spiders (araneida); larval lepidopterans, and dipterans of various life stages were the most frequently observed items. Because of wide variations in sample size among bird species, a rigorous analysis of the frequency of occurrence of stomach items is inappropriate. Thus the rare occurrence of an item in the stomach of a particular species, while possibly significant after accumulation of a larger sample, should only be listed without undue speculation at this time.

It is interesting, however, that several species with good sample sizes varied widely in the frequency of occurrence of certain stomach items. For example, the golden-crowned kinglet (n =9) showed only five identifiable items. In contrast, the black-headed grosbeak (n = 7) showed 14 identifiable items. Further, the dark-eyed junco (n =22) and *Empidonax* flycatchers (n = 25) showed only 12 and 14 items each, respectively. These results could be an indication of specialization or generalization in food habits by certain species.

About three-quarters of the items obtained from the sticky traps were dipterans (Table 3). Hymenopterans and homopterans were the only other groups with over 7% occurrence. Most items were identified to at least the familial level and are available from the authors (but are too numerous to present here).

TABLE 1. Analysis of Stomach Contents of 27 Species of Birds by Percent Animal, Vegetable and Mineral Material, sampled at Blodgett Forest, El Dorado County, California, June–July 1980.

Species [a]	*No. of stomachs*	*Volume (ml)* $\bar{x}$	*SE*	*Stomach contents (%)* Mineral	Vegetable	Animal
Red-breasted sapsucker *Sphyrapicus ruber* (RBSA)	8	0.49	0.12	0.0	11.7	88.3
Olive-sided flycatcher *Contopus borealis* (OSFL)	1	0.25	0.00	0.0	0.0	100.0
Empidonax flycatcher [b] (EMFL)	25	0.22	0.03	0.0	1.0	99.0
Steller's Jay *Cyanocitta stelleri* (STJA)	1	1.40	0.00	0.0	0.0	100.0
Chestnut-backed chickadee *Parus rufescens* (CBCH)	2	0.10	0.00	0.0	18.2	81.8
Brown creeper *Certhia americana* (BRCR)	5	0.06	0.02	0.0	0.0	100.0
Golden-crowned kinglet *Regulus satrapa* (GCKI)	9	0.10	0.02	0.0	27.5	72.5
Townsend's solitaire *Myadestes townsendi* (TOSO)	2	0.35	0.12	0.6	1.0	98.4

TABLE 1. Analysis of Stomach Contents of 27 Species of Birds by Percent Animal, Vegetable and Mineral Material, sampled at Blodgett Forest, El Dorado County, California, June–July 1980.—Continued

Species [a]	*No. of stomachs*	*Volume (ml)* $\bar{x}$	*SE*	*Stomach contents (%)* Mineral	Vegetable	Animal
Hermit thrush ..... *Catharus guttatus* (HETH)	12	0.24	0.07	0.0	1.3	98.7
American robin ..... *Turdus migratorius* (AMRO)	14	0.73	0.12	0.2	0.3	99.5
Solitary vireo ..... *Vireo solitarius* (SOVI)	6	0.13	0.04	0.6	0.0	99.4
Warbling vireo..... *V. gilvus* (WAVI)	6	0.16	0.05	0.0	1.3	98.7
Nashville warbler ..... *Vermivora ruficapilla* (NAWA)	12	0.07	0.01	1.0	0.9	98.1
Yellow warbler ..... *Dendroica petechia* (YEWA)	4	0.09	0.03	20.0	0.0	80.0
Yellow-rumped warbler ..... *D. coronata* (YRWA)	3	0.17	0.03	0.0	18.9	81.1
Black-throated gray..... warbler—*D. nigrescens* (BTGW)	1	[c]	0.00	0.0	0.0	100.0
Hermit warbler ..... *D. occidentalis* (HEWA)	6	0.10	0.02	1.5	7.9	90.6
MacGillivray's warbler ..... *Oporornis tolmiei* (MAWA)	15	0.10	0.02	0.0	0.0	100.0
Wilson's warbler ..... *Wilsonia pusilla* (WIWA)	8	0.07	0.02	1.0	3.3	95.7
Western tanager ..... *Piranga ludoviciana* (WETA)	2	0.90	0.00	2.5	2.5	95.0
Black-headed grosbeak ..... *Pheucticus melanocephalus* (BHGR)	7	0.67	0.09	0.2	1.4	98.4
Rufous-sided towhee ..... *Pipilo erythrophthalmus* (RSTO)	6	0.68	0.24	2.7	13.2	84.1
Chipping sparrow ..... *Spizella passerina* (CHSP)	1	0.20	0.00	2.9	79.1	18.0
Fox sparrow..... *Passerella iliaca* (FOSP)	13	0.23	0.05	5.6	47.4	47.0
Dark-eyed junco ..... *Junco hyemalis* (DEJW)	22	0.15	0.02	17.9	7.5	74.6
Purple finch ..... *Carpodacus purpureus* (PUFI)	7	0.18	0.03	17.7	34.6	47.8
Evening grosbeak ..... *Coccothraustes vespertinus* (EVGR)	1	0.40	0.00	2.7	24.0	73.3

[a] Common and scientific names follow AOU (1983).
[b] *E. hammondii* and *E. oberholseri;* specimens not retained so positive identification not possible.
[c] Not available.

The sticky trap data gave only a cursory indication of prey available to the birds. At best, these traps sample insects found at least occasionally on tree boles; they did not sample foliage dwelling insects. This may in part account for the low frequency of dipterans in stomach samples (8 of 27 bird species) relative to trap samples. The four remaining items with the highest trap frequency were: hymenopterans, homopterans, spiders, and coleopterans. These were also some of the most frequently observed stomach items.

CONCLUSIONS

This paper provides identification of the stomach contents of birds occurring in a coniferous forest of the western Sierra Nevada, as well as a crude estimate of available prey. It is hoped that these data will serve as useful baseline material for future studies.

TABLE 2. Presence of Animals in Stomachs (n = 199) of 27 Species of Birds by General Taxon. Birds Collected at Blodgett Forest, El Dorado County, California, in June–July 1980.[a]

Taxon[b]	RBSA	OSFL	EMFL	STJA	CBCH	BRCR	GCKI	TOSO	HETH	AMRO	SOVI	WAVI	NAWA	YEWA	YRWA	BTGW	HEWA	MAWA	WIWA	WETA	BHGR	RSTO	CHSP	FOSP	DEJU	PUFI	EVGR	Total
Insecta																												
Orthoptera—unk.			x																		x							2
Isoptera—A.				x										x						x					x			4
Hemiptera—A.						x			x								x	x			x							5
—P.																								x				1
Pentatomidae—A.												x													x			2
—E.					x												x				x							3
Homoptera—A.							x					x	x				x	x			x				x			7
Aphididae—A.																										x		1
Cicadellidae—A.			x		x		x					x	x								x		x		x			8
Cicadidae—A.			x									x									x							3
Coccidae—A.												x									x							2
Fulgoridae—A.														x									x					2
Psyllidae—A.					x									x						x					x			4
Neuroptera—L.			x																					x				2
—P.							x																					1
Coleoptera—A.		x	x					x	x	x	x	x	x	x	x		x				x	x		x	x	x		16
—L.									x	x											x							3
Anobiidae—A.													x															1
Buprestidae—A.												x																1
Carabidae—A.																						x						1
Cleridae—L.			x																									2
Elateridae—A.			x															x										2
—L.									x																			1
Lampyridae—A.									x																			1
Scarabidae—A.										x										x					x			3
Tenebrionidae—A.										x							x					x						3
Curculionoidea—A.			x		x	x	x		x	x	x	x	x				x	x	x		x	x		x	x			16

TABLE 2. Presence of Animals in Stomachs (n = 199) of 27 Species of Birds by General Taxon. Birds Collected at Blodgett Forest, El Dorado County, California, in June–July 1980.[a]—Continued

Taxon[b]	RBSA	OSFL	EMFL	STJA	BRCR	CBCH	GCKI	TOSO	HETH	AMRO	SOVI	WAVI	NAWA	YEWA	YRWA	BTGW	HEWA	MAWA	WIWA	WETA	BHGR	RSTO	CHSP	FOSP	DEJU	PUFI	EVGR	Total
Mecoptera—A.									x																			1
Lepidoptera—A.		x																										1
—L.				x			x	x		x	x	x		x											x	x		9
Diptera—E.			x																					x				2
—L.										x			x															2
—P.					x						x							x							x			4
Hippoboscidae—A.			x																									1
Mycetophilidae—A.									x					x					x									3
Tipulidae—A.										x			x									x						3
—L.										x																		1
Hymenoptera—A.			x									x	x	x			x	x	x							x		8
—P.														x														1
Formicidae—A.	x		x					x	x	x				x	x	x		x			x	x		x	x			13
Ichneumonidae—A.			x																									1
Vespidae—A.	x																											1
Symphyta—A.											x															x		2
—L.																					x							1
Larva—unk.											x							x			x				x	x	x	6
Pupa—unk.																	x											1
Other taxa																												
Gastropoda (snail spp.)—A.	x								x											x	x					x		5
Chilopoda—A.										x																		1
Arachnida																												
Phalangida—A.										x																		1
Araneida (spider spp.)—A.			x							x		x		x	x				x	x		x				x	x	10
Total	3	2	14	2	5	2	5	3	10	14	6	11	8	10	3	1	8	8	4	5	14	7	2	6	12	7	3	175

[a] See Table 1 for reference to bird species.
[b] Unk. = unknown; A = adult; E = egg; L = larva; P = pupa.

TABLE 3. Occurrence of Items on Sticky Traps on Trees at Blodgett Forest, El Dorado County, California, June–July 1980.

Order	*Number items*	*Percent*	*Cumulative percent*
Diptera	7,263	76.8	76.8
Hymenoptera	1,025	10.8	87.6
Homoptera	709	7.5	95.1
Arachnida (spiders)	158	1.7	96.8
Coleoptera	120	1.3	98.1
Thysanoptera	61	0.7	98.8
Hemiptera	52	0.6	99.4
Neuroptera	25	0.3	99.7
Lepidoptera	16	0.2	99.9
Psocoptera	15	0.2	100.1
Others	9	0.1	100.2
Total [a]	9,453	–	–

[a] Other unidentified specimens (and parts of specimens) are not included in this table.

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