

A TEST OF THE CALIFORNIA WILDLIFE-HABITAT RELATIONSHIP SYSTEM FOR BREEDING BIRDS IN VALLEY-FOOTHILL RIPARIAN HABITAT¹

Stephen A. Laymon²

Abstract: The California Wildlife-Habitat Relationship (WHR) system was tested for birds breeding in the Valley-Foothill Riparian habitat along California's Sacramento and South Fork Kern rivers. The model performed poorly with 33 pct and 21 pct correct predictions respectively at the two locations. Changes to the model for 60 species on the Sacramento River and 66 species on the Kern River are recommended. Special problems, such as differences in habitat suitability among study areas and how the model treats threatened and endangered species, are discussed and solutions are suggested.

The California statewide Wildlife-Habitat Relationship (WHR) system was developed to produce lists of wildlife species expected to occur at any location in the state (Airola 1988). This model is intended for use as a preliminary step in the environmental review or inventory process that should be followed by fieldwork if key species are identified as having potential to occur. The statewide model or its regional precursors have been tested in Douglas-fir (Raphael and Marcot 1986), mixed-conifer (Dedon and others 1986), black-oak (Dedon and others 1986) and red-fir habitats (Hejl and Verner 1988) with varying levels of performance. In this paper I present a preliminary test of the WHR model for birds in Valley-Foothill Riparian habitat (Mayer and Laudenslayer 1988) along the Sacramento and Kern rivers.

Study Areas

The study areas consisted of riparian habitat along the Sacramento River from Red Bluff, Tehama County to Colusa, Colusa County (106 km) and the South Fork Kern River, Kern County from Onyx Ranch downstream to Lake Isabella (15 km). The Sacramento River varied in elevation from 15 to 100 m, while the Kern River varied from 750 to 800 m. Riparian habitat along the Sacramento River are dominated by Fremont cottonwood (*Populus fremontii*), willow (*Salix* spp.), California sycamore (*Platanus racemosa*) and valley oak (*Quercus lobata*). Dominant understory trees are box elder (*Acer negundo*), Oregon ash (*Fraxinus latifolia*)

and willow. The shrub layer consists of mugwort (*Artemisia douglasiana*), or blackberry (*Rubus* spp.). The Kern River riparian zone is dominated by Fremont cottonwood and willow, with an understory of willow and a shrub layer of mule fat (*Baccharis viminea*) and stinging nettle (*Urtica holosericea*) (pers. observ.)

Methods

WHR Predictions

Species lists were generated from the WHR database for species reproducing in all seral stages of Valley-Foothill Riparian. Because the birds were surveyed in all seral stages of this habitat, the highest suitability prediction for the species on each study site was used to compare to the survey data. The bird species list for the Sacramento River was generated for the Oroville latilong and the list for the Kern River was generated for Kern County. These geographic areas were the smallest areas that entirely contained each study area.

Surveys

I conducted surveys on the Sacramento River by canoe on a total of 48 days in May, June and July from 1976 to 1987. Each survey covered 16 to 24 km and lasted 8 to 12 hours. I conducted surveys on the Kern River on foot on 38 days in June and July from 1985 to 1987. Each survey covered 3 to 6 km and lasted 5 to 7 hours. I recorded the number of individuals of each species seen or heard during each survey.

The surveys were conducted in conjunction with tape recorder play-back surveys for yellow-billed cuckoos. The surveys were used to obtain species lists, frequency of occurrence and relative abundance of birds. The relative abundance values are not directly comparable from one site to the other because the data were collected differently.

Data Analysis

Based on frequency (# surveys with detections/total # surveys) and abundance (mean # per survey), a

¹ Presented at the California Riparian Systems Conference; September 22-24, 1988; Davis, California.

² Graduate Student, Department of Forestry and Resource Management, University of California, Berkeley, Calif.

recommended rating of high, moderate or low habitat suitability was assigned to each species at each site. These ratings were made prior to the generation and study of the WHR predictions. In general, species with frequency >66 pct and abundance >4/day were assigned a high rating, those frequencies 33-66 pct and abundance of 1-4/day were rated moderate and those frequency <33 pct and abundance <1/day were rated low. Species not recorded on the survey were assigned an unsuitable rating. If the frequency and abundance measures were in conflict, more weight was given to the frequency measure. Consideration for low detectability (e.g. owls and nightjars) and large home ranges (e.g. raptors and cuckoos) was given by rating these species one category higher than the data indicated (i.e. 33-100 pct frequency and abundance of >1/day were rated high, and <33 pct frequency and <1/day abundance were rated moderate). The WHR predictions and the recommended ratings were then compared and differences were noted. Errors of omission, i.e. species that were observed but were not predicted, were considered more serious than errors of commission, i.e. species that were predicted but were not observed. Likewise it was judged to be a more serious error if a species was predicted in low numbers and many were observed than when a species was predicted in high numbers and few were observed. The results of the analysis are summarized in table 1.

Results

Sacramento River

A total of 106 bird species were predicted by the WHR model and 86 bird species were found during the survey, for a total of 117 bird species considered in the analyses (see table 1 for species and scientific names of bird species). Of these, 38 (32.5 pct) of the predictions matched the recommendations generated from the data (fig. 1). An additional 19 species (16.2 pct) were similar in that survey results closely approach the criteria used to define categories. The survey data differed greatly (generally more than 2 categories) from the predicted WHR status for 58 species. Of these 58 species 11 species were observed, but not predicted and 30 species were predicted, but not observed. Fifteen species were predicted to be high but were observed in low numbers and 4 species were predicted low but were observed in high numbers.

SACRAMENTO RIVER						KERN RIVER					
N = 117 SPECIES						N = 112 SPECIES					
WHR PREDICTION						WHR PREDICTION					
H M L U						H M L U					
SAMPLED	H	M	L	U		SAMPLED	H	M	L	U	
	24.8	4.3	3.4	2.5	35.0		17.9	1.8	0.9	1.8	22.3
	6.8	3.4	1.7	0.9	12.8		14.3	2.7	3.6	0.9	21.4
	12.8	3.4	4.3	6.0	26.5		11.6	2.7	0.9	8.0	23.2
U	9.4	11.1	5.1		25.6	U	10.7	15.2	7.1		33.0
53.8 22.2 14.5 9.4						54.5 22.3 12.5 10.7					

Figure 1– Matrix of percentages of species in 15 cells, representing predicted versus sampled WHR categories on the Kern and Sacramento rivers. Species on the diagonals from the upper left to the lower right are correctly predicted. H = high, M = medium, L = low and U = unsuitable.

Table 1. Common and scientific name, frequency (F), mean abundance (X), 2SE, California Department of Fish and Game WHR model rating (WHR), and recommendations based on data from this study (REC), for bird species found in riparian habitats on the Sacramento and the Kern river, California.

Common Name	Scientific Name	Sacramento River (n=48)					Kern River (n=38)				
		F	X	2SE	WHR	REC	F	X	2SE	WHR	REC
Great Blue Heron	<i>Ardea herodias</i>	96	16.8	3.96	H	H	82	3.6	1.84	H	H
Great Egret	<i>Casmerodius albus</i>	79	5.6	3.03	L	H*	--	---	----	L	U
Snowy Egret	<i>Egretta thula</i>	31	1.5	1.32	M	L	--	---	----	M	U
Cattle Egret	<i>Bubulcus ibis</i>	--	---	----	U	U	--	---	----	L	U
Green-backed Heron	<i>Butorides striatus</i>	79	3.1	1.02	M	H	--	---	----	M	U
Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	19	0.4	0.25	M	L	24	0.8	0.66	M	L*
Wood Duck	<i>Aix sponsa</i>	69	3.3	1.22	H	H	32	0.7	0.45	H	M
Mallard	<i>Anas platyrhynchos</i>	63	5.3	5.00	L	Ms	58	12.4	8.56	L	Ms
Cinnamon Teal	<i>Anas cyanoptera</i>	8	0.1	0.13	U	L*	16	1.1	1.25	U	Ls
Common Merganser	<i>Mergus merganser</i>	75	11.5	3.74	M	H	--	---	----	M	Us
Turkey Vulture	<i>Cathartes aura</i>	79	26.5	5.61	H	H	55	1.6	0.84	H	M
Osprey	<i>Pandion haliaetus</i>	27	0.6	0.3	U	L*	3	0.0	0.05	U	Ls
Black-shouldered Kite	<i>Elanus caeruleus</i>	13	0.1	0.12	H	M*	21	0.3	0.21	H	Ms
Bald Eagle	<i>Haliaeetus leucocephalus</i>	--	---	----	M	U	--	---	----	U	U
Northern Harrier	<i>Circus cyaneus</i>	6	0.1	0.10	L	L	5	0.1	0.07	L	L
Cooper's Hawk	<i>Accipiter cooperii</i>	6	0.1	0.07	H	Ls	8	0.1	0.09	H	L*
Red-shouldered Hawk	<i>Buteo lineatus</i>	65	1.4	0.41	H	H	74	1.2	0.38	H	H
Swainson's Hawk	<i>Buteo swainsoni</i>	38	0.5	0.25	H	M	--	---	----	H	Us
Red-tailed Hawk	<i>Buteo jamaicensis</i>	92	5.6	1.35	H	H	79	1.6	0.46	H	H
Golden Eagle	<i>Aquila chrysaetos</i>	--	---	----	M	U*	--	---	----	M	Us
American Kestrel	<i>Falco sparverius</i>	31	0.4	0.18	H	Ms	55	1.0	0.36	H	M
Peregrine Falcon	<i>Falco peregrinus</i>	--	---	----	M	Us	--	---	----	M	Us
Prairie Falcon	<i>Falco mexicanus</i>	--	---	----	L	U*	--	---	----	L	Us
Chukar	<i>Alectoris chukar</i>	--	---	----	U	U	--	---	----	H	U*
Ring-necked Pheasant	<i>Phasianus colchicus</i>	31	0.4	0.19	L	L	--	---	----	L	U
Turkey	<i>Meleagris gallopavo</i>	--	---	----	H	U*	--	---	----	U	U
California Quail	<i>Callipepla californica</i>	85	8.5	2.90	H	H	58	6.2	3.68	H	M
Mountain Quail	<i>Oreortyx pictus</i>	--	---	----	M	U*	--	---	----	M	U*
Virginia Rail	<i>Rallus limicola</i>	--	---	----	L	U	--	---	----	L	U
Killdeer	<i>Charadrius vociferas</i>	92	16.3	4.41	U	H*	34	0.5	0.28	U	L*
Spotted Sandpiper	<i>Actitis macularia</i>	94	15.8	3.74	U	Hs	16	0.3	0.23	U	Ls
Rock Dove	<i>Columba livia</i>	13	0.5	0.48	U	Ls	--	---	----	U	U
Band-tailed Pigeon	<i>Columba fasciata</i>	4	0.2	0.27	M	Ls	--	---	----	M	U*
Mourning Dove	<i>Zenaidura macroura</i>	100	26.6	7.86	H	H	95	14.1	4.18	H	H
Yellow-billed Cuckoo	<i>Coccyzus americanus</i>	44	1.3	0.54	L	H*	79	1.9	0.51	L	Hs
Common Barn Owl	<i>Tyto alba</i>	6	0.1	0.07	H	L*	16	0.2	0.12	H	L*
Flammulated Owl	<i>Otus flammeolus</i>	--	---	----	M	Us	--	---	----	M	Us
Western Screech Owl	<i>Otus kennicottii</i>	2	0.0	0.04	H	L*	--	---	----	H	U
Great Horned Owl	<i>Bubo virginianus</i>	67	1.1	0.39	H	H	21	0.3	0.22	H	M
Northern Pygmy Owl	<i>Glaucidium gnoma</i>	--	---	----	H	U*	--	---	----	H	Us
Long-eared Owl	<i>Asio otus</i>	--	---	----	H	U	3	0.0	0.05	H	L*
Northern Saw-whet Owl	<i>Aegolius acadicus</i>	--	---	----	H	U*	--	---	----	H	U*
Lesser Nighthawk	<i>Chordeiles acutipennis</i>	21	0.8	0.52	U	Ms	3	0.1	0.16	U	L
Common Nighthawk	<i>Chordeiles minor</i>	10	0.5	0.79	L	L	--	---	----	U	U
Common Poorwill	<i>Phalaenoptilus nuttallii</i>	--	---	----	M	U*	--	---	----	M	Us
Vaux's Swift	<i>Chaetura vauxi</i>	--	---	----	L	Us	--	---	----	U	U
Black-chinned Hummingbird	<i>Archilochus alexandri</i>	13	0.2	0.14	H	Ls	37	0.6	0.30	H	M
Anna's Hummingbird	<i>Calypte anna</i>	15	0.3	0.30	H	Ls	34	0.6	0.31	H	M
Costa's Hummingbird	<i>Calypte costae</i>	--	---	----	U	U	3	0.0	0.51	M	Ls
Belted Kingfisher	<i>Ceryle alcyon</i>	90	10.3	2.62	M	H*	--	---	----	M	Us
Lewis' Woodpecker	<i>Melanerpes lewis</i>	--	---	----	M	Us	--	---	----	U	U
Acorn Woodpecker	<i>Melanerpes formicivorus</i>	71	3.6	1.00	M	M	--	---	----	M	Us
Nuttall's Woodpecker	<i>Picoides nuttallii</i>	10	12.6	2.46	H	II	97	5.6	1.32	H	H
Downy Woodpecker	<i>Picoides pubescens</i>	96	5.4	0.94	H	H	92	4.4	1.05	H	H
Hairy Woodpecker	<i>Picoides villosus</i>	2	0.1	0.07	L	L	58	0.9	0.35	L	Ms
Northern Flicker	<i>Colaptes auratus</i>	65	1.7	0.52	H	M	97	4.7	1.04	H	H
Western Wood-pewee	<i>Contopus sordidulus</i>	94	15.4	2.82	H	H	76	3.1	1.44	H	M
Willow Flycatcher	<i>Empidonax traillii</i>	6	0.2	0.11	U	L	58	2.0	0.83	U	Hs
Western Flycatcher	<i>Empidonax difficilis</i>	2	0.0	0.04	H	Ls	11	0.1	0.10	H	Ls
Black Phoebe	<i>Sayornis nigricans</i>	92	13.6	3.75	H	H	82	4.5	1.75	H	H
Ash-throated Flycatcher	<i>Myiarchus cinerascens</i>	92	9.9	2.08	H	H	97	5.9	1.36	H	H
Brown-crested Flycatcher	<i>Myiarchus tyrannulus</i>	--	---	----	U	U	3	0.0	0.05	U	L

Table 1. Continued.

Common Name	Scientific Name	Sacramento River (n=48)					Kern River (n=38)				
		F	X	2SE	WHR	REC	F	X	2SE	WHR	REC
Western Kingbird	<i>Tyrannus verticalis</i>	98	15.7	4.16	H	H	63	2.5	1.03	H	M
Purple Martin	<i>Progne subis</i>	4	0.4	0.59	L	L	--	---	---	U	U
Tree Swallow	<i>Tachycineta bicolor</i>	81	62.1	26.60	H	H	79	6.3	2.55	H	H
Violet-green Swallow	<i>Tachycineta thalassina</i>	--	---	---	H	U*	--	---	---	H	U*
N. Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>	54	7.7	4.39	H	M	24	0.3	0.25	H	L*
Bank Swallow	<i>Riparia riparia</i>	73	137.2	50.92	L	H*	--	---	---	U	U
Cliff Swallow	<i>Hirundo pyrrhonota</i>	67	121.8	60.30	H	H	24	13.6	17.93	H	M
Barn Swallow	<i>Hirundo rustica</i>	29	2.6	2.39	H	M	3	0.0	0.05	H	L*
Steller's Jay	<i>Cyanocitta stelleri</i>	--	---	---	L	U*	--	---	---	L	U*
Scrub Jay	<i>Aphelocoma coerulescens</i>	96	8.7	1.47	H	H	21	0.3	0.18	H	L*
Yellow-billed Magpie	<i>Pica nuttalli</i>	17	1.0	0.92	H	L*	--	---	---	U	U
American Crow	<i>Corvus brachyrhynchos</i>	60	2.3	1.11	M	M	--	---	---	M	U*
Common Raven	<i>Corvus corax</i>	--	---	---	U	U	87	3.7	2.11	U	Ni
Chestnut-backed Chickadee	<i>Parus rufescens</i>	--	---	---	L	U*	--	---	---	U	U
Plain Titmouse	<i>Parus inornatus</i>	92	8.0	1.68	H	H	92	4.3	0.92	H	H
Bushtit	<i>Psaltiriparus minimus</i>	71	6.7	1.90	M	M	66	8.6	2.98	M	M
White-breasted Nuthatch	<i>Sitta carolinensis</i>	83	3.0	0.86	H	M	79	2.1	0.63	H	M
Bewick's Wren	<i>Thryomanes bewickii</i>	100	11.3	1.67	H	H	79	2.4	0.71	H	H
House Wren	<i>Troglodytes aedon</i>	75	3.5	1.40	H	M	95	11.6	2.46	H	H
Winter Wren	<i>Troglodytes troglodytes</i>	--	---	---	H	U*	--	---	---	H	U*
American Dipper	<i>Cinclus mexicanus</i>	--	---	---	M	U*	--	---	---	M	U*
Blue-gray Gnatcatcher	<i>Poliophtila caerulea</i>	--	---	---	L	U*	--	---	---	L	U*
Western Bluebird	<i>Sialia mexicana</i>	10	0.3	0.27	H	L*	58	2.4	0.92	H	M*
Swainson's Thrush	<i>Catharus ustulatus</i>	--	---	---	H	U*	--	---	---	U	U
American Robin	<i>Turdus migratorius</i>	88	5.2	1.28	H	H	89	3.0	0.86	H	H
Wrentit	<i>Chamaea fasciata</i>	6	0.1	0.19	U	L	--	---	---	U	U
Northern Mockingbird	<i>Mimus polyglottos</i>	13	0.3	0.22	H	L*	3	0.0	0.05	M	L*
California Thrasher	<i>Toxostoma redivivum</i>	--	---	---	M	U*	--	---	---	M	U*
Phainopepla	<i>Phainopepla nitens</i>	--	---	---	M	U*	--	---	---	M	U*
Loggerhead Shrike	<i>Lanius ludovicianus</i>	2	0.0	0.04	H	L*	5	3.0	0.86	H	L*
European Starling	<i>Sturnus vulgaris</i>	77	8.6	3.72	H	H	61	14.4	10.66	H	H
Solitary Vireo	<i>Vireo solitarius</i>	--	---	---	M	U*	--	---	---	U	U
Hutton's Vireo	<i>Vireo huttoni</i>	--	---	---	H	U*	--	---	---	H	U*
Warbling Vireo	<i>Vireo gilvus</i>	6	0.1	0.13	H	L*	11	0.2	0.18	H	L*
Orange-crowned Warbler	<i>Vermivora celata</i>	23	0.3	0.20	H	L*	11	0.2	0.19	H	L*
Yellow Warbler	<i>Dendroica petechia</i>	69	4.2	1.19	M	H	74	2.5	1.24	M	H
Macgillivray's Warbler	<i>Oporornis tolmiei</i>	--	---	---	H	U*	--	---	---	H	U*
Common Yellow throat	<i>Geothlypis trichas</i>	69	4.1	1.21	M	H	79	2.3	0.80	M	H
Wilson's Warbler	<i>Wilsonia pusilla</i>	H	--	---	H	U*	--	---	---	H	U*
Yellow-breasted Chat	<i>Icteria virens</i>	88	10.4	2.15	L	H*	68	1.3	0.42	L	M*
Summer Tanager	<i>Piranga rubra</i>	--	---	---	U	U	74	2.3	0.63	U	H*
Black-headed Grosbeak	<i>Pheucticus melanocephalus</i>	100	20.7	2.82	H	H	39	0.6	0.26	H	L*
Blue Grosbeak	<i>Guiraca caerulea</i>	58	2.3	1.25	H	M	92	3.7	1.03	H	H
Indigo Bunting	<i>Passerina cyanea</i>	4	0.0	0.10	U	U	32	0.5	0.30	U	L*
Lazuli Bunting	<i>Passerina amoena</i>	94	6.6	1.56	H	H	63	3.4	1.25	H	M
Rufous-sided Towhee	<i>Pipilo erythrophthalmus</i>	100	12.9	1.98	H	H	37	1.0	0.50	H	M*
Brown Towhee	<i>Pipilo fuscus</i>	77	3.3	1.10	H	M	39	1.2	0.60	H	M*
Chipping Sparrow	<i>Spizella passerine</i>	--	---	---	M	U*	--	---	---	M	U*
Lark Sparrow	<i>Chondestes grammacus</i>	46	1.1	0.46	L	M	61	4.6	2.70	L	M*
Song Sparrow	<i>Melospiza melodia</i>	31	0.7	0.42	H	L*	100	20.8	4.37	H	H
Dark-eyed Junco	<i>Junco hyemalis</i>	--	---	---	H	U*	--	---	---	H	U*
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	38	6.5	5.99	M	M	82	17.5	8.48	M	M
Brewer's Blackbird	<i>Euphagus cyanocephalus</i>	77	9.0	3.73	H	H	16	1.6	1.61	H	L*
Brown-headed Cowbird	<i>Molothrus ater</i>	90	10.0	5.50	U	H*	97	18.1	5.13	H	H
Hooded Oriole	<i>Icterus cucullatus</i>	2	0.0	0.04	U	L	--	---	---	L	U
Northern Oriole	<i>Icterus galbula</i>	96	11.4	2.00	H	H	100	11.8	3.10	H	H
Purple Finch	<i>Carpodacus purpureus</i>	--	---	---	M	U*	--	---	---	U	U
House Finch	<i>Carpodacus mexicanus</i>	90	10.5	2.68	H	H	61	2.8	1.24	H	M
Lesser Goldfinch	<i>Carduelis psaltria</i>	83	8.6	2.98	H	H	92	7.3	1.77	H	H
Lawrence's Goldfinch	<i>Carduelis lawrencei</i>	21	0.4	0.25	M	L*	63	2.5	1.05	M	M
American Goldfinch	<i>Carduelis tristis</i>	96	17.0	3.92	H	H	--	---	---	H	U*
House Sparrow	<i>Passer domesticus</i>	21	0.9	0.88	U	L*	--	---	---	U	U

H = High Suitability, M = Moderate Suitability, L = Low Suitability, U = Unsuitable.

* = Survey data differs sufficiently from WHR prediction that a change in rating is recommended.

South Fork Kern River

A total of 98 bird species were predicted by the WHR model and 73 bird species were observed during the survey, for a total of 110 bird species considered in the analysis (table 1). Of these, 24 (21.8 pct) of the predictions matched the recommendations generated from the data (fig. 1). An additional 32 species (29.1 pct) were similar in that survey results closely approach the criteria used to define the categories. The survey data differed greatly from the predicted WHR status for 60 species. Ten species were observed, but not predicted, 37 species were predicted, but not observed. Thirteen species were predicted high and were observed in low numbers and 1 species was predicted low and was observed in high numbers.

Discussion

Sacramento River

In general, the WHR system performed poorly for this habitat. Only 32.5 pct of the predictions correctly matched the collected data. Fifty-eight predictions were sufficiently different from the data that a change in the model is recommended.

Four species (killdeer, spotted sandpiper, lesser night-hawk, and brown-headed cowbirds) were not predicted to occur, but were found in high or moderate numbers. The first three nest in the earliest riparian successional stages on sand and gravel bars. The cowbird is a serious omission since its nest parasitism has been linked to the decline of riparian passerines (Laymon 1987). These four species should be added to the WHR model.

Seven species were not predicted but were found in low numbers. Cinnamon teal and osprey are uncommon but regular breeders in the riparian zone. Rock doves and house sparrows breed in the riparian zone near towns and ranches. Wrentits and hooded orioles probably breed at low densities in this habitat. Willow flycatchers may not breed in the Sacramento Valley but one territorial male was found throughout June near Woodson Bridge in 1987. All of these except willow flycatchers should be added to the WHR model.

Thirty species were predicted but were not observed on any of the 48 surveys. Long-eared owls may have been missed. This species breeds sparingly in the Sacramento Valley and should be rated low in the data base. Sixteen species breed only in montane conifer forest types. Several montane species (Steller's jay, chestnut-backed chickadee, winter wren, Swainson's thrush, Wilson's warbler, dark-eyed junco, and purple finch) may breed in coastal Valley-Foothill Riparian

habitat. These species should be removed from the database as breeders in inland, lowland areas. A split of the Valley-Foothill Riparian habitat into coastal and inland categories may be appropriate in updates of the model. The other montane species (mountain quail, pygmy owl, saw-whet owl, flamulated owl, Vaux's swift, American dipper, MacGillivray's warbler, solitary vireo and chipping sparrow) probably never breed in this habitat type (Grinnell and Miller 1944, pers. observ.) and should be removed from this habitat in the database.

Nine species that were predicted but not observed are primarily oak woodland and chaparral species. Turkey, Hutton's vireo, California thrasher and blue-gray gnat-catcher may nest in certain Valley-Foothill Riparian habitat but their proper status should be low. Golden eagle, Lewis' woodpecker, common poorwill, violet-green swallow, and phainopepla are not known to breed in these habitats and should be removed from the WHR list.

The Virginia rail, a marsh species, may nest in some moist riparian situations and should remain on the list with a low status. Peregrine and prairie falcons nest on cliffs and are not associated with riparian habitat for nesting. If they nest in the vicinity of riparian vegetation it is incidental to the existence of suitable nest cliffs. They should be removed from the Valley Foothill Riparian habitat. The bald eagle is a localized and irregular breeder in Valley-Foothill Riparian habitat in the Sacramento Valley. However, recent nesting attempts (T. Brumley, P. Detrich, and M. Halterman pers. comm.) suggest that the species should be retained on the list at least at low suitability to ensure its consideration in potential habitat.

Kern River

The WHR model performed poorly at the Kern River. Only 21.4 percent of the WHR predictions correctly matched the collected data. Sixty WHR predictions were sufficiently different from the data that I recommend a change of status in the WHR database.

Three species that were not predicted were found in high or moderate numbers; willow flycatcher, summer tanager and common raven. The South Fork Valley has the largest California populations of both willow flycatchers and summer tanagers, each numbering between 25 and 50 pairs. Seven additional species were not predicted but were found in low numbers. Five of these (cinnamon teal, osprey, killdeer, spotted sandpiper and indigo bunting) regularly nest in riparian habitats in the valley and should be added to the WHR model. The indigo bunting is of particular interest since it is not listed in the data base in any habitat. Approximately 10 pct of the buntings nesting in South Fork Valley are of this species. Lesser nighthawks nests have not been found and they may nest primarily in dryer habitats adjacent

to the riparian and therefore need not be added to the WHR model. The brown-crested flycatcher was a single individual which arrived at the site in 1986 and returned in 1987. Three individuals were found in 1988 and apparently bred. In the future the species may have to be added to the model for this location. Thus, 8 of these 10 species should be added to the model at this time.

Thirty-seven species were predicted but not found. Twelve of these were montane species discussed for the Sacramento River (table 1). These should be removed from the WHR database. Nine oak and chaparral species (golden eagle, band-tailed pigeon, common poorwill, acorn woodpecker, violet-green swallow, blue-gray gnatcatcher, California thrasher, phainopepla and Hutton's vireo) should also be removed. Chukar, peregrine falcon and prairie falcon occur at rock and cliff areas and should be removed from the model as breeders in riparian habitat. Four species predicted to occur (snowy egret, cattle egret, green-backed heron, and ring-necked pheasant) do not breed in the South Fork Valley but may breed elsewhere in riparian habitat in Kern County. These species should remain in the WHR model. An additional four species (Swainson's hawk, belted kingfisher, American crow and American goldfinch) do not breed in Kern County and should be removed from the WHR system for that location.

Several species that were predicted, but not observed may occur at times. Great egrets have not bred in the South Fork Valley in the past 80 years, but appear likely to colonize the valley in the near future, as evidenced by many sightings late into the breeding season in the past 2 years. The western screech owl was predicted, but not found on the surveys, but was observed several times while not surveying. Virginia rails are primarily a marsh species which sometimes may nest in wet riparian habitats.

Difference in Suitability

The current WHR model only records a single habitat suitability rating throughout a species' range; it cannot provide different suitability ratings within a habitat type between various geographic areas. Species at the periphery of their range may be much less numerous than at the center of their range. Also, habitat differences not reflected in the WHR model, (e.g. tree and shrub species) might have an effect on the abundance of certain species. Based on the survey data, 7 species (killdeer, spotted sandpiper, willow flycatcher, scrub jay, black-headed grosbeak, song sparrow and Brewer's blackbird) showed a habitat suitability difference from high to low numbers between the study sites. Eight species (American kestrel, black-chinned hummingbird, Anna's hummingbird, hairy woodpecker, rough-winged swallow, barn swallow, western bluebird and Lawrence's goldfinch) differed from moderate to low numbers be-

tween the study sites. Fourteen species (wood duck, turkey vulture, California quail, great horned owl, northern flicker, western wood pewee, western kingbird, cliff swallow, house wren, yellow-breasted chat, blue grosbeak, lazuli bunting, rufous-sided towhee and house finch) differed from high to moderate between the study sites. Several of these species (e.g. blue grosbeak and Lawrence's goldfinch) are at the northern limit of their range in the Sacramento Valley, but are nearer the center in the Kern Valley. Other species (e.g. yellow-breasted chat and rufous-sided towhee) may find the blackberry shrub layer of the Sacramento River more suitable than the mule fat and nettle shrub layer on the Kern River. The lack of elderberries and box elders may make the Kern River much less suitable for black-headed grosbeak than is the Sacramento River.

I recommend that the structure of the WHR data base be changed to recognize these differences in site suitability. This should be one of the goals of the next generation of WHR models. At present, the user should adjust for this by reading the species notes and studying the range maps.

Threatened and Endangered Species

Another problem with the WHR database is that threatened or endangered birds (e.g. Swainson's hawk and yellow-billed cuckoo) and bird species of special concern (e.g. willow flycatcher, bank swallow, summer tanager, yellow-breasted chat and yellow warbler) are poorly represented. These species are often the most important ones in an environmental assessment since they have more effect on whether, and in what form, a project can proceed. These species' distribution and habitat relationships are fortunately generally well known. Little of this knowledge, however, is reflected in the WHR model for Valley-Foothill Riparian habitat. Several examples are discussed below.

The Swainson's hawk was predicted to have high suitability in this habitat on both study areas. Surveys have shown that Kern County is outside of its' current breeding range (Bloom 1980). These findings should be incorporated into the data base.

Valley-Foothill Riparian was predicted to have low suitability for yellow-billed cuckoos. This species, while uncommon, is an obligate riparian species and is found in virtually all suitable willow-cottonwood riparian habitats (Gaines and Laymon 1984, Laymon and Halterman 1987 and 1988). Despite its low density and absence from many riparian sites, the suitability of the habitat should be rated high because this is the optimal habitat type and it is found in no other.

Valley-Foothill Riparian habitat was predicted as unsuitable for willow flycatchers and summer tanagers at both sites. While this may be true on the Sacramento River, it certainly is not true on the Kern River where

populations of 25 to 45 pairs have been monitored for both species for the past 8 years (Unitt 1987, B. Barnes pers comm., pers. observ.).

Results of research on these species should be incorporated into the WHR. In addition, experts on these species should be consulted to review status and distribution and habitat ratings. It is essential that developers and resource managers be aware of possible occurrence of endangered and threatened species in their project areas.

Conclusions

The results of this test indicate that the model for birds in Valley-Foothill Riparian habitat still needs refinement before the WHR system can yield reliable predictions for this habitat. This test combined all seral stages and should have given the system the best opportunity to perform well, but it performed poorly. The WHR model for Valley-Foothill Riparian is still in the developmental stage. Any use for project planning should recognize that the information may be incomplete or inadequate. The changes to the WHR model recommended here should be made and more detailed studies should be undertaken to further refine the model.

This test is a first step to refining the WHR model for Valley-Foothill Riparian habitat. A more detailed study that would examine riparian bird distribution by seral stages is needed. In addition, study sites throughout the geographical and altitudinal range of this habitat should be chosen. Special attention should be paid to elevational differences in riparian bird distribution. Valley and foothill riparian avifaunas may be too different to include in the same habitat category. The same is true of coastal and inland riparian avifaunas. Designing a study design in this habitat would be difficult since most extant riparian habitats are linear and very fine grained. Finding patches of a single seral stage, large enough to survey without influence from other seral stages, would be difficult, if not impossible, in most riparian settings.

Acknowledgments

I thank Mary Halterman for assisting the data collection on the Sacramento River in 1987, and Daniel Airola, Reginald Barrett, Mary Halterman, Irene Timossi, Pamela Williams and an anonymous reviewer for reviewing this paper.

References

- Airola, Daniel A. 1988. A guide to the California Wildlife-Habitat Relationship system. California Department of Fish and Game, Rancho Cordova, CA. 74p.
- Barnes, Robert, 1987, Field ornithologist, Porterville, CA. Personal communications.
- Bloom, Peter H. 1980. The status of the Swainson's hawk in California, 1979. Federal Aid in Wildlife Restoration, Project W-54-R-12. Sacramento, CA: California Department of Fish and Game Nongame Wildlife Investigations; 24p.
- Brumley, Terry, 1988, Wildlife biologist, Redding, CA. Personal communications.
- Dedon, Mark F.; Laymon, Stephen A.; Barrett, Reginald H. 1986. Evaluating models of Wildlife-Habitat Relationships of birds in Black-oak and Mixed-Conifer habitats. In: Verner, Jared; Morrison, Michael L; and Ralph, C. J., eds. Wildlife 2000. Madison: Univ. of Wisconsin Press; 115-119.
- Detrich, Philip, 1986, Biological consultant, Sacramento, CA. Personal communications.
- Gaines, David; Laymon, Stephen A. 1984. Decline, status and preservation of the yellow-billed cuckoo in California. Western Birds 15(2):49-80.
- Grinnell, Joseph; Miller, Alden H. 1944. The distribution of birds of California. Pacific Coast Avifauna 27:1-608.
- Halterman, Mary, 1988, Graduate student, California State University, Chico, CA. Personal communications.
- Hejl, Sallie J.; and Verner, Jared. 1988. Evaluating avian-habitat relationships in red fir forests of the Sierra Nevada. Transactions Western Section the Wildlife Society. [In Press].
- Laymon, Stephen A. 1987. Brown-headed cowbirds in California: historical perspectives and management opportunities in riparian habitats. Western Birds 18(1):63-70.
- Laymon, Stephen A.; Halterman, Mary D. 1987. Can the western subspecies of the yellow-billed cuckoo be saved from extinction? Western Birds 18(1):19-25.
- Laymon, Stephen A.; Halterman, Mary D. 1988. A proposed habitat management plan for yellow-billed cuckoos in California.
- Mayer, Kenneth E.; Laudenslayer, William F. Jr. 1988. (In press) A guide to wildlife habitats of California. California Department of Forestry and Fire Protection. Sacramento, CA.
- Raphael, Martin G.; Marcot, Bruce, G. 1986. Validation of a Wildlife-Habitat-Relationships Model: vertebrates in a Douglas-fir sere. In: Verner, Jared; Morrison, Michael L; and Ralph, C.J., eds. Wildlife 2000. Madison: Univ. of Wisconsin Press; 129-138.
- Unitt, Phillip. 1987. *Empidonax trallii extimus*: an endangered subspecies. Western Birds 18(3):137-162.