Wildlife Diversity in Valley-Foothill Riparian Habitat: North Central vs. Central Coast California[1]

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Abstract: Habitat characteristics and diversity of terrestrial vertebrates were studied September 1989 to August 1990 in valley-foothill riparian habitat on two study areas: Dye Creek, Tehama County, and Avenales Ranch, San Luis Obispo County, California. The assumption considered was that differences between study areas in physical and vegetation characteristics would be reflected in wildlife diversity. Spring-season results showed that species richness of both higher plants and terrestrial-vertebrate wildlife averaged about twice as great at Dye Creek as at Avenales Ranch. No differences in vegetation structure between study areas were evident, thus, other factors such as elevation, mean annual rainfall, and plant-species richness were apparently influencing terrestrial vertebrate richness on these sites.

Valley-foothill riparian habitat (Mayer and Laudenslayer 1988) is vital for wildlife on California's three million ha (Bolsinger 1988) of oak-woodland (Griffin 1988) habitat. Valley-foothill riparian habitat provides for the needs of more California mammals than any other habitat in the state (Williams and Kilburn 1984). No other habitat in California compares in either bird density or species richness (Laymon 1984). Reptiles and amphibians also abound (Brode and Bury 1984).

During the past decade, Californians have become increasingly concerned about degradation of the state's valley-foothill riparian habitat and reductions in the wildlife that depend on it. The major oak component of valley-foothill riparian habitat, valley oak (*Quercus lobata*), is not regenerating well (Griffin 1971, 1976, Steinhart 1978, Muick and Bartolome 1986). Coupled with poor regeneration is increased use of valley-foothill riparian areas for livestock grazing, intensive agriculture, recreation, urbanization, and wood products. To ensure that oaks and wildlife remain a healthy component of valley-foothill riparian areas, it is imperative that we learn more about the characteristics that make riparian habitat of particular value to wildlife. With this information, land managers and biologists will be better prepared to develop management strategies for maintaining the valley-foothill riparian resource. Here we report preliminary results from spring 1990 sampling of valley-foothill riparian habitat characteristics and terrestrial vertebrate wildlife diversity (richness) at two geographic locations in California.

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STUDY AREAS

Dye Creek Study Area

The Dye Creek study area is located at the eastern edge of the Sacramento Valley in Tehama County on the 18,180-ha Dye Creek Ranch, about 25 km southeast of Red Bluff (fig. 1). Topography is generally flat along lower Dye Creek where it dissects the valley floor prior to entering the Sacramento River, but rugged at the valley edge where the creek enters the foothills of the Sierra Nevada. Elevation ranges from 76 m in the valley to 762 m in the foothills (Barrett 1978); mean elevation of valley-foothill riparian habitat where study data were collected was 115 m (range 75 to 180 m).

Average monthly temperatures at Dye Creek range from 7° C in January to 27° C in July and average yearly precipitation on the study area totals about 65 cm (Barrett 1978). Little rain falls during summer—90 pct of the yearly total falls in the seven winter months from October to April. Snowfall is rare.

Valley-foothill riparian habitat at Dye Creek is dominated by interior live oak (*Quercus wislizenii*), valley oak, sycamore (*Platanus racemosa*), and white alder (*Alnus rhombifolia*). California wild grape (*Vitis californica*), poison oak (*Rhus diversiloba*), and Himalaya berry (*Rubus procerus*) are important understory species. Since the late 1800's, the primary land-use at Dye Creek has been cattle grazing. A recreational hunting enterprise has operated on the ranch since 1965.

Avenales Ranch Study Area

The Avenales Ranch study area is located in the western foothills of the Coast Range on the 7,085-ha Avenales Ranch in south-central San Luis Obispo County about 34 km east of San Luis Obispo, California (fig. 1). Elevation ranges from 366 to 952 m; at sites where data were collected, elevation averaged 490 m (range 421 to 573 m).

Average monthly temperatures at Avenales Ranch range from 6° C in January to 21 ° C in July. Precipitation averages 53 cm, falling primarily during October to May (U.S. Weather Bureau, Sacramento, CA). Snowfall is rare.

Canopy trees in valley-foothill riparian habitat at Avenales Ranch are valley oak, blue oak (*Quercus douglasii*), coast live oak (*Q. agrifolia*), sycamore, and Fremont cottonwood (*Populus fremontii*). Where subcanopy occurs, it consists of willow (*Salix* spp.), redberry (*Rhamnus crocea*), chaparral honeysuckle

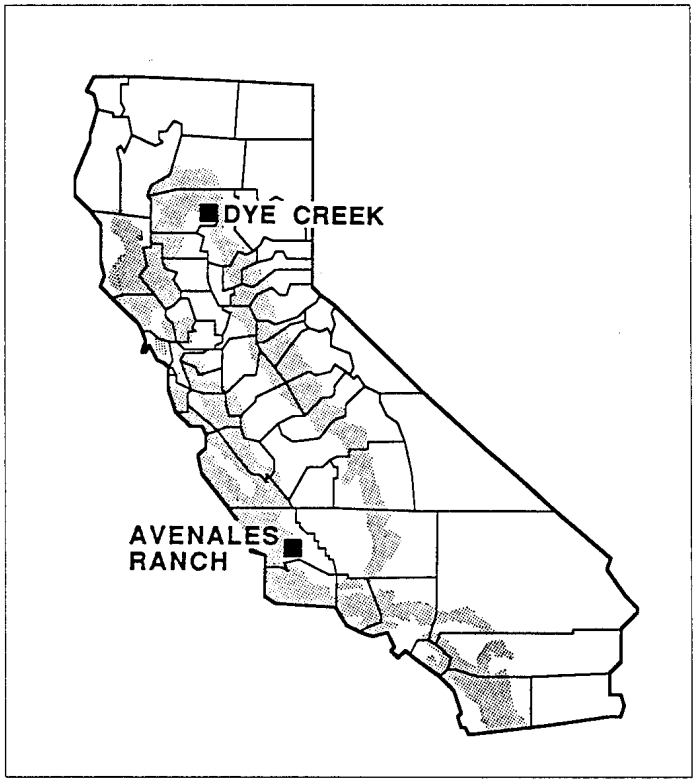

Figure 1—Location of the Dye Creek study area in Tehama County and the Avenales Ranch study area in San Luis Obispo County, California.

(*Lonicera interrupta*), and poison oak. The primary land use since the late 1800's has been cattle grazing.

METHODS

Survey Design

With minor modifications, survey design followed that described by Dedon and Barrett (1982). At each study area, a two-person field crew housed on site collected all habitat and wildlife data. During July and August 1989, the field crews familiarized themselves with the identification of the local flora and fauna, and with field methodologies. Thirty 0.25-ha (50- by 50-m square) permanent sampling plots were established systematically along 10 km stretches of Dye Creek on the Dye Creek Study Area (half the plots were along lower Dye Creek on the valley floor and half along the creek where it enters the Sierra foothills) and Alamo Creek on the Avenales Ranch study area. Plot centers were about 250 m apart; aspects included all cardinal directions. Forty 0.001-ha circular (3.56 m radius) subplots (*elements*) were established at 5-m intervals along eight transects radiating from each plot center (fig. 2). On both study areas, a year of almost daily collection of field data began on 1 September 1989 and continued to 31 August 1990. This period was divided into fall (September to November), winter (December to February), spring (March to May), and summer (June to August) seasons. In this report, data are presented from only the spring season.

Habitat Sampling

On the 20 even-numbered elements within each sampling plot, percentages of an element covered by water, soil (< 2 cm diameter), rock (> 2 cm diameter), litter (< 2 cm diameter), dead wood (> 2 cm diameter), and all live vegetation were estimated ocularly within eight vertical strata (1= ground to 0.5 m, 2 = 0.5 to 2 m, 3 = 2 to 5 m, 4 = 5 to l0 m, 5 = 10 to15 m, 6 = 15 to 20 m, 7 = 20 to 30 m, and 8 = 30 to 40 m). An optical rangefinder was used to assign the vertical strata. Botanical composition was also recorded for each even-numbered element with a cover class (0-5 pct, 6-25 pct, 26-50 pct, 51-75 pct, 76-90 pct, 91-100 pct) estimated for each species (Dedon and Barrett 1982).

All tree stems larger than 2 cm diameter breast high (dbh), i.e., 1.4 m (4.5 feet) above ground level, were identified and the dbh, height, and plant condition (live or dead) recorded. Percent canopy cover for each plot was determined using a spherical densiometer (Lemmen 1956). Basal area was calculated by tree species and diameter class.

Wildlife Sampling

Small mammals were inventoried by positioning a Sherman live trap baited with Purina lab rat chow within each of the 40 elements of each sampling plot. Traps were checked each morning for three consecutive days. Ear marks were used to identify recaptures. A frequency index was calculated as the proportion of the 40 trap stations (elements) that caught at least one individual of a given species. Abundance was the number of different individuals of a given species captured.

One track plate (Barrett 1983) per sampling plot (fig. 2) was used to detect mammalian carnivores. A track plate consisted of two 800- by 400-mm aluminum sheets, blackened by a kerosine flame and placed side-by-side on an area cleared of debris. Track plates were baited with a can of tuna pet food. All tracks found over a 10-day period were identified and measured in the field using keys developed by Taylor and Raphael (1988). Tracks not easily identified in the field were collected by pressing transparent tape over the track and mounting it onto a white sheet of paper for later identification and measurement. Freshly blackened plates were provided as necessary.

Ungulates (mule deer [*Odocoileus hemionus*], wild pigs [*Sus scrofa*], horses [*Equus caballus*], and cattle [*Bos tarus*]), black-tailed jackrabbits *(Lepus californicus),* broad-foot moles (*Scapanus latimanus*), and Botta's pocket gophers (*Thomomys bottae*) were surveyed by noting presence of sign (droppings and digging) while sampling vegetation within each of the 20 even-numbered elements on each plot.

Pitfall traps were used to capture amphibians, reptiles, and certain mammals. Within each sampling plot, but outside any element (fig. 2), a 19-1 plastic bucket was buried flush with the

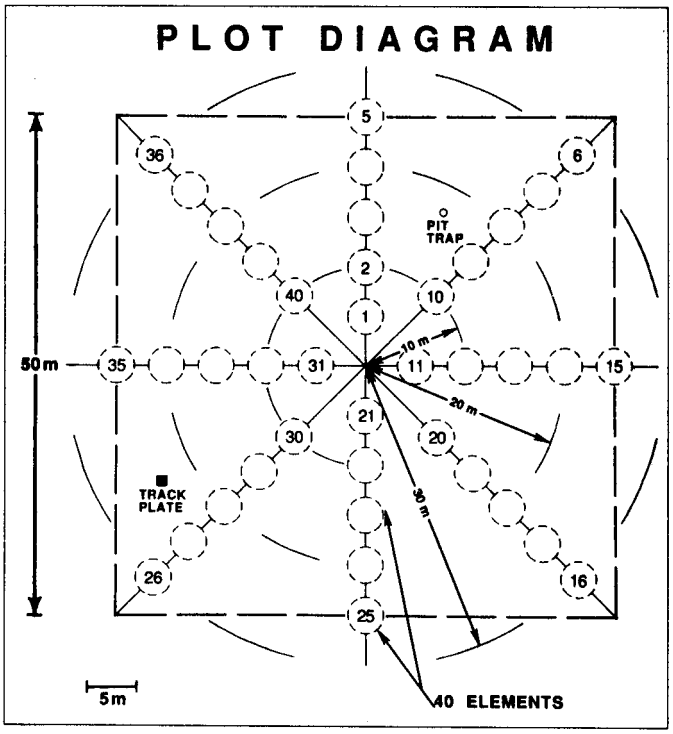

Figure 2—Diagram of a 0.25-ha sampling plot. Elements used for vegetation analysis, dead-and-down wood survey, small mammal trap sites, and animal-signs sampling. The square is a track plate and the small open circle is a pitfall trap.

ground and a square 1- by 46- by 46-cm plywood cover supported by rocks was placed about 7 cm over it. Pitfall traps were run consecutively with track plates. Captured animals were identified, marked, and released.

Birds were censused seasonally on each of the 30 sampling plots on each study area using a modification of the variable circular-plot method (Reynolds and others 1980). Counts began 30 minutes after sunrise. During the succeeding 20 ten-minute periods, the species and number of birds detected visually or acoustically (either perched on or flying over the plot) were recorded. Only different individuals were recorded within a 10-minute period, but these individuals could be recorded again in a subsequent period. Cloud cover and wind speed were recorded each 10-minute period; temperature was recorded at the start and end of each bird census.

Finally, we recorded as an incidental observation, any wildlife species or its sign observed anywhere within a sample plot. In this study, a detected wildlife species was counted only if it was judged (based on a review of all observations regardless of technique used) as having a seasonal home range covering at least half of a plot.

Data Analysis

Mean frequency and abundance of all habitat and wildlife variables were calculated across all 30 plots for the Dye Creek and the Avenales Ranch study areas. Student's *t*-tests were used to estimate the significance ($P \leq 0.05$) of study area differences in habitat characteristics.

RESULTS

Physical Characteristics Between Study Areas

At Dye Creek and Avenales Ranch, over three years of drought occurred prior to beginning the study in September 1989. The drought continued during the study period (1 September 1989 to 31 August 1990), but considerably more rain fell at Dye Creek (51.0 cm) than at Avenales Ranch (36.6 cm).

Vegetation Characteristics Between Study Areas

Vegetation Structure.—Vegetation characteristics measured on the Dye Creek and Avenales Ranch study areas were similar (table 1). Most notably, tree canopy cover averaged about 25 pct at both study areas. Although there were several vertical strata-cover characteristics that, ostensibly, were much different between study areas in stratum 1(e.g., rock, litter, forbs and ferns, evergreen broadleaf foliage, and deciduous broadleaf foliage) and in each of the four vegetation characteristics (dead wood, live wood, evergreen broadleaf foliage, and deciduous broadleaf foliage) examined in strata 2-8, the differences were in both directions and none was significant (table 1). The total volume of vegetation on the sampling plots (total live plant cover index) (table 1) was also similar between study areas (83.9 at Dye Creek and 90.0 at Avenales Ranch; $P > 0.05$).

Botanical Composition.—A total of 281 different species of higher plants was recorded at Dye Creek and Avenales Ranch in spring 1990. These included 43 species of grasses, 191 forbs, 31 shrubs, and 16 different tree species. Comparison of plant-species richness between study areas in spring revealed a clear trend (table 2). We observed 1.6, 2.5, 2.8, and 2.9 times as many species of forbs, grasses, trees, and shrubs, respectively, at Dye Creek (209 species) as at Avenales Ranch (111 species) (table 2).

Most recorded plant species, moreover, were unique to either Dye Creek or Avenales Ranch. An average of only 15 pct (range 13 pct for shrubs to 19 pct for trees) of the total number of different species of grasses, forbs, shrubs, or trees found on Dye Creek and Avenales Ranch study areas was found on both (table 2). For example, 11 trees were unique to Dye Creek compared to two on the Avenales Ranch study area; interior live oak was found only at Dye Creek and coast live oak only at Avenales Ranch. Blue oak and valley oak occurred on both sites. The species with the highest frequency times abundance (F by A) for grasses, forbs, shrubs, and trees in spring on the Dye

Table 1—*Comparison of selected habitat characteristics averaged across thirty 0.25-ha plots at the Dye Creek (DC) and Avenales Ranch (AR) study areas (data are presented from four of the eight vertical stata examined) during Spring 1990. One Standard Error (SE) is in parentheses.*

Habitat Characteristic	Study Site DC	AR
Litter and Trees		
Litter depth (cm)	1.3(l.3)	1.0(0)
Canopy height (m)	4.1 (3.8)	3.4 (3.0)
Canopy closure (percent)	25.2 (18.7)	23.0 (21.9)
Basal area (m^2/ha)	7.8 (7.4)	8.2 (6.5)
Selected Vertical Strata Cover (percent)		
Strata 1 ground level; 0.0-0.5 m)		
Water	0.7(l.6)	0.0 (0.0)
Rock	16.9 (11.4)	6.5 (4.2)
Bare soil	10.3 (6.4)	13.7 (6.3)
Litter	18.5 (11.2)	10.6 (4.7)
Dead wood	1.4(l.8)	1.7(l.3)
Moss	1.2 (2.8)	0.2 (0.8)
Grass	26.3 (18.1)	24.4 (9.6)
Forbs and ferns	18.5 (9.8)	42.3 (9.8)
Live wood	0.6 (0.7)	0.4 (0.6)
Evergreen broadleaf foliage	0.6 (0.9)	<0.1 (0.2)
Deciduous broadleaf foliage	5.2 (7.2)	0.1 (0.4)
Strata 3 (2-5 m)		
Dead wood	0.1 (0.3)	1.1 (1.4)
Live wood	1.1 (1.2)	2.5 (2.5)
Evergreen broadleaf foliage	3.4 (4.5)	1.1 (2.6)
Deciduous broadleaf foliage	4.8 (4.4)	2.9 (2.7)
Strata 5 (10-15 m)		
Dead wood	<0.1 (0.2)	0.6(l.0)
Live wood	0.5(l.0)	1.6 (2.2)
Evergreen broadleaf foliage	0.2 (0.5)	0.6(l.9)
Deciduous broadleaf foliage	3.0 (4.5)	2.1 (3.2)
Strata 7 (20-30 m)		
Dead wood	0.0 (0.0)	0.0 (0.0)
Live wood	0.1 (0.4)	0.0 (0.0)
Evergreen broadleaf foliage	0.0 (0.0)	0.0 (0.0)
Deciduous broadleaf foliage	0.2 (l.1)	0.2(l.3)
Total live plant cover index (sum of all living plant cover in the vertical strata)	83.9 (27.5)	90.0 (20.9)

Creek and Avenales Ranch study areas are given in table 3.

Wildlife Characteristics Between Study Areas

Accumulated detections of terrestrial vertebrates on the Dye Creek and Avenales Ranch study areas during spring 1990 totaled 138 different species (table 2). Records included seven species of amphibians, 10 reptiles, 90 birds, and 31 mammals. As with plants, there were more species of amphibians, reptiles, birds, and mammals detected in spring at Dye Creek than at Avenales Ranch (table 2). Species richness of mammals, birds, amphibians, and reptiles was 1.6, 1.7, 1.7, and 2.3 times greater, respectively, at Dye Creek (120 species) as at Avenales Ranch (70 species).

Also similar to the plant data, many species of terrestrial vertebrates detected were unique to each study area (table 2). An average of only 30 pct (range 14 pct for amphibians to 41 pct for birds) of the total number of different species of amphibians,

Table 2—*Numbers of species of plants (by life form) and animals (by class), found during spring at only Dye Creek (DC), only the Avenales Ranch (AR), on both study areas (DC & AR); and the total number of species found on Dye Creek and Avenales Ranch.*

Life form/Class	Only DC	Only AR	Both DC & AR	Total Species DC	AR
Plants					
Grass	29	8	6	35	14
Forbs	108	57	26	134	83
Shrubs	22	5	4	26	9
Trees	11	2	3	14	5
Totals	**170**	**72**	**39**	**209**	**111**
Animals					
Amphibians	4	2	1	5	3
Reptiles	6	1	3	9	4
Birds	43	10	37	80	47
Mammals	15	5	11	26	16
Totals	**68**	**18**	**52**	**120**	**70**

reptiles, birds, and mammals found on Dye Creek and Avenales Ranch was found on both study sites.

During spring, 43 and 10 bird species were unique to the Dye Creek and Avenales Ranch study areas, respectively. Each species was placed into a foraging guild based on information from *The Birder's Handbook* (Ehrlich and others 1988) (table 4). Many more ground feeders and aquatic feeders (mostly ducks) were recorded at Dye Creek than at Avenales Ranch.

Rodent Control on Avenales Ranch

We learned after the study began that during June 26-30, 1989, 1080 (sodium monofluroacetate) had been applied around ground squirrel (*Spermophilus beecheyi*) burrows on about 5,000 ha (application rate of 0.16 kg/treated ha) of the Avenales Ranch (pers. comm.; San Luis Obispo County Agricultural Commissioner's Office). Our study plots were included in the treated area. Field observations indicated that ground squirrel burrows were prevalent during summer and fall, 1989, while sightings of ground squirrels were virtually nonexistent. This observation suggests the poisoning program at Avenales Ranch was so effective that it may have influenced the results of our survey of small mammal populations (and some other wildlife) on the ranch.

Table 3—*Plant species, by life form, with the highest frequency (F) times abundance (A) numbers (F by A) in spring 1990 on the Dye Creek (DC) and Avenales Ranch (AR) study areas.*

	Study area						
	DC			AR			
Life form	Species	F	A	F by A	Species	F	A	F by A
Grasses								
	Ripgut grass *(Bromus diandrus)*	72.5	8.4	609	Slender wild oat *(Avena barbata)*	72.9	9.5	693
	Soft chess *(Bromus mollis)*	50.7	2.8	142	Ripgut grass *(Bromus diandrus)*	53.4	6.2	331
	Hare barley *(Hordeum leporinum)*	25.7	2.7	69	Soft chess *(Bromus mollis)*	67.7	4.6	311
Forbs								
	Broadleaf filaree *(Erodium botrys)*	46.7	9.5	444	Storksbill *(Erodium obtusiplicatum)*	86.2	18.1	1,560
	Barnaby's thistle *(Centaurea solstitialis)*	51.0	2.6	133	Redstem filaree *(Erodium cicutarium)*	59.8	7.6	455
	Proliferous pink *(Tunica prolifera)*	50.8	1.5	76	Clarkia (Clarkia spp.)	27.9	2.0	5 6
Shrubs								
	Himalaya-berry *(Rubus procerus)*	13.0	2.3	30	Chaparral honeysuckle *(Lonicera interrupta)*	5.0	0.3	2
	Poison oak *(Rhus diversiloba)*	18.8	0.9	17	Poison oak *(Rhus diversiloba)*	3.2	0.3	1
	California wild grape *(Vitis californica)*	11.5	1.1	13	Redberry *(Rhamnus crocea)*	2.0	0.3	1
Trees								
	Valley oak *(Quercus lobata)*	16.7	5.3	89	Blue oak *(Quercus douglasii)*	18.0	5.7	103
	Interior live oak *(Quercus wislizenii)*	18.0	3.4	61	Valley oak *(Quercus lobata)*	7.8	3.5	27
	Blue oak *(Quercus douglasii)*	7.5	2.0	15	Coast live oak *(Quercus agrifolia)*	5.5	2.5	14

Table 4—*Number of bird species that were unique to Dye Creek (DC) and Avenales Ranch (AR) study areas during spring 1990, grouped by foraging guilds.*

	Study area	
Guild	DC	AR
Omnivores	4	0
Ground feeders	13	1
Foliage gleaners	3	4
Bank feeder	1	0
Air insect feeders	1	2
Aquatic feeders	16	0
Vertebrate feeders	5	3
Totals	43	10

DISCUSSION

The most apparent difference between oak riparian habitat at Dye Creek Ranch, Tehama County, and Avenales Ranch, San Luis Obispo County, is the greater number of higher plant and terrestrial vertebrate wildlife species at Dye Creek. Physical and vegetation factors may be involved. Perhaps reflected in the presence of more aquatic-feeding birds, Dye Creek has a higher rainfall than the Avenales Ranch. Moist sites commonly have greater plant and animal diversity than dry sites (Harris 1984, Perkins and others 1984, Krzysik 1990). Avenales Ranch was especially dry during the study; the 1989 to 1990 field season occurred during the fourth year of a severe drought on California's central coast. Terrestrial vertebrate species diversity also increases with vegetation diversity (Smith 1986). The data analyzed to date do not show that vegetation structure was more complex at Dye Creek although plant-species richness was greater.

Diversity of terrestrial vertebrates in California's three million hectares of oak woodland habitat is high, apparently due to regional and local differences in temperature, rainfall, botanical composition, and vegetation structure. In a field study conducted during 1986-1988 in oak woodland habitat at three study sites, Block (1989) accumulated 90 species of birds during the spring breeding seasons in north-central California (Sierra Foothill Range Field Station, Yuba County), 88 species in southeast California (San Joaquin Experimental Range Field Station, Madera County), and 83 species in south-central California (Tejon Ranch, Kern County). Notably, this trend of fewer species from north to south parallels the trend in the present

study. During spring and fall 1988 at the Sierra Foothill Range Field Station, two amphibian, seven reptile, and seven small mammal species were detected (Block and Morrison 1990).

To what extent a rodent control program caused a low trapping frequency of small mammals at Avenales Ranch is unknown. Since the poisoning certainly depressed ground squirrel numbers on Avenales Ranch, it may have affected occurrence of other animals as well. But, consistently fewer species of amphibians, reptiles, birds, and mammals at Avenales Ranch compared to Dye Creek suggests that other factors, such as geographic location of the study areas, mean annual precipitation, and vegetation composition and structure were more influential for most wildlife species. This set of circumstances highlights the importance of care in choosing a study area and of replicating study areas to minimize the effect of confounding by uncontrolled factors.

We have presented only partial results from only one season of a year-long study. When all available data have been analyzed we expect to provide recommendations on what specific characteristics of riparian habitat are correlated with the presence of particular wildlife and the implications for managing valley foothill riparian habitat for wildlife in conjunction with other land uses.

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