

Value of Riparian Vegetation to Avian Populations Along the Sacramento River System¹

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Abstract.--The purpose of this study was to determine the value of riparian habitat along the Sacramento River to birds. Comparisons of avian populations through the year on riparian and riprapped berms, and agricultural lands associated with each, were made. Avian diversity (species/ha) was 71 percent and avian density (total number of birds) 93 percent less, on riprapped than on riparian plots. Avian diversity was 32 percent and avian density 95 percent less, on agricultural lands associated with riprapped vegetation than on those associated with riparian. Spring and fall migratory peaks of bird density and diversity were higher in riparian and associated vegetation than in riprapped and associated vegetation. Riparian vegetation appears to control avian density and diversity in associated vegetation.

INTRODUCTION

The Sacramento River System is the largest watershed in California and is recognized as a resource of exceptional natural, as well as manmade, values. It presently drains 67,340 square kilometers of the Central Valley, the Coast Range, the Sierra Nevadas, and the Cascade Range. Prior to the impact of man, the mainstream of the Sacramento from Keswick Dam to Collinsville (483 river kilometers) supported a riparian forest of about 313,000 hectares (McGowan 1961, Thompson 1961, Smith 1977) comparable to some of the finest riparian habitat anywhere. Lush, often continuous, riparian woodlands of valley oak (*Quercus lobata*), interior live oak (*Q. wislizenii*), California sycamore (*Platanus racemosa*), Oregon ash (*Fraxinus oregona*), cottonwood (*Populus fremontii*), alder (*Alnus rhombifolia*), and willow (*Salix* spp.), usually ranged from 4-5 miles in width on natural levees formed by the System (Thompson 1977).

Because of ever-increasing demands for agricultural lands and timber, increased

flood control, and the need for a water conveyance system from northern to southern California, drastic changes in the Sacramento River and associated vegetation have occurred. Mining, grazing, water pollution, urbanization, and recreation have accounted for further losses (Roberts et al. 1977). As of today, the riparian forest comprises only 4,856 hectares (Smith 1977, Roberts et al. 1977), or about 1.5 percent of the acreage originally available to wildlife. The remaining fragments generally form a belt less than 100 yards wide along the watercourses (Thompson 1977). A Sacramento River Task Force Special Report (Burns et al. 1975) indicated that about 3,642 hectares per year of riparian vegetation have been lost between Keswick Dam and Colusa over the past 20 years. At the present rate of destruction, nearly all riparian vegetation on the Sacramento River could be eliminated in the next 20 years.

The value of California riparian habitat to birds seems well established. Gaines (1974) found that the remaining cottonwood-willow riparian forest along the Sacramento River supported a density and diversity of breeding birds equal to or greater than those

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in other California habitats. Michny et al. (1975) found that riparian areas supported densities of birds in excess of a typical "high density area," as established by Peterson (1941). Alteration of riparian vegetation along the Sacramento through channel improvement resulted in fewer birds than would be found on one of Peterson's (1941) "low density areas" in one case, and reduced avian populations 75 to 80 percent in another case along the Kings River (Hines et al. 1966).

In 1974, a three-year study was initiated to determine the values of naturally vegetated and riprapped banks and berms and associated agricultural lands to avian populations. Plant species were recorded on each study site, baseline data were established, and the results of vegetational removal were also assessed. The results of the first year's study are summarized here.

METHODS

Study Areas

Eight sample plots were selected along the Sacramento River near Knights Landing, California, for intensive study (Fig. 1). The northernmost of the eight plots selected is 3.06 kilometers north and the southernmost is 1.6 kilometers south of Knight's Landing in Sutter and Yolo Counties, California. Plots averaged 402.3 meters in length and ranged from 30 to 39 meters in width. Riparian vegetation was present on two of the plots, grass and/or shrubs on two riprapped plots from which riparian vegetation identical to that on existing riparian plots had been removed, and agricultural crops on the remaining four plots (Figs. 2 and 3). Agricultural plots were located perpendicular to the River while riparian and grass/shrub (riprapped) plots were located parallel to the River. Two plots were located at each of four locations; each perpendicular agricultural plot was situated adjacent to a riparian or grass/shrub plot parallel to the River. All plots were located near identical agricultural vegetation.

Sampling of Vegetation

Riparian and riprapped plots parallel to River (Plots A-1, B-1, C-1, and D-1) were sampled via three line quadrats (Gates 1949, Greig-Smith 1957, Phillips 1959, and U.S. Forest Service 1959) in each plot (Table 1). Quadrats were 1.83 meters in width, 0.91 meters on each side of transect lines. The length of each quadrat varied with distance

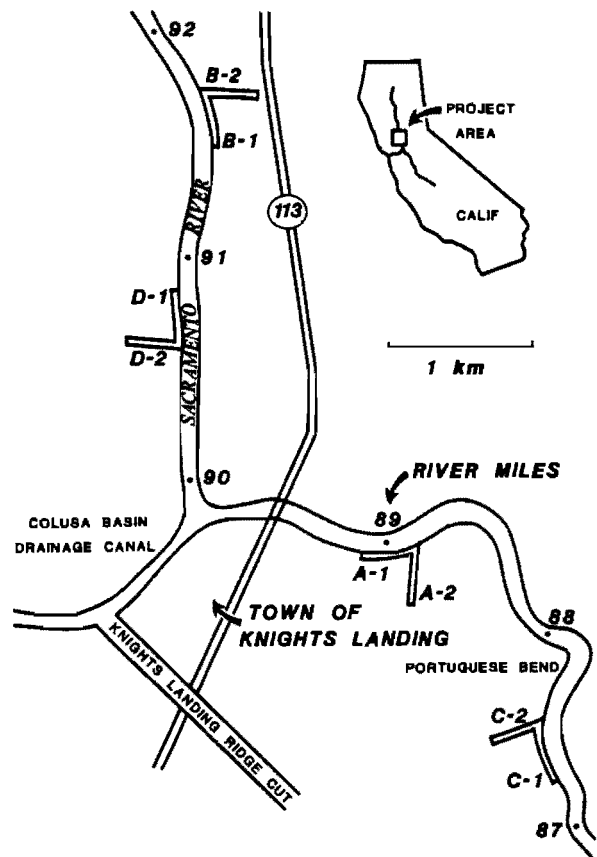


Figure 1. Avian survey plots in the vicinity of Knights Landing, California.

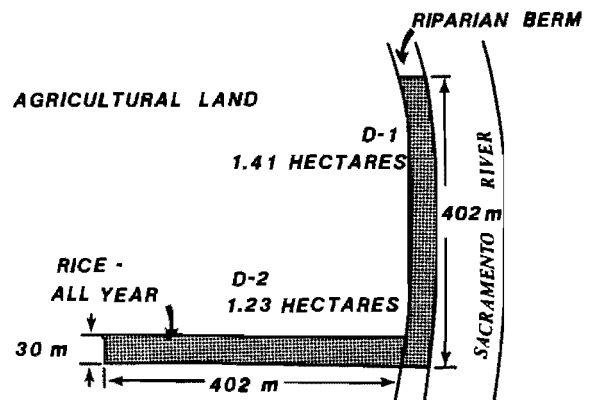


Figure 2. Location and arrangement of a riprapped and a riprapped-agricultural plot.

from the top of the levee to the low water line. River quadrats averaged 1.83 meters in width, 34.3 meters in length, and 62.8 square meters in area.

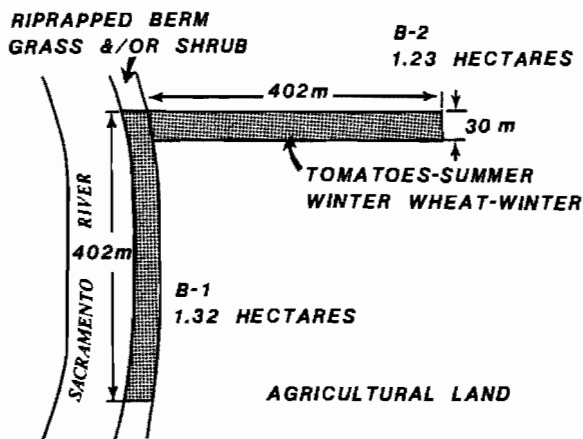


Figure 3. Location and arrangement of a riparian and a riparian-agriculture plot.

Table 1.--Summary of vegetation survey quadrat data.

Quadrat	WIDTH		LENGTH		AREA	
	(m)	(FE)	(m)	(FE)	Square meters	Square yards
Riparian and Riprapped areas						
1. A-1-A	1.83	6	34.4	113	62.9	75.3
2. A-1-B	"	"	32.9	108	60.2	72.0
3. A-1-C	"	"	34.1	112	62.5	74.7
4. B-1-A	"	"	34.4	113	62.9	75.3
5. B-1-B	"	"	31.1	102	56.8	68.0
6. B-1-C	"	"	32.9	108	60.2	72.0
7. C-1-A	"	"	33.2	109	60.8	72.7
8. C-1-B	"	"	35.1	115	64.1	76.7
9. C-1-C	"	"	38.7	127	70.8	84.7
10. D-1-A	"	"	34.1	112	62.5	74.7
11. D-1-B	"	"	36.0	118	65.8	78.7
12. D-1-C	"	"	35.1	115	64.1	76.7
AVERAGE	1.83	6	34.3	112.7	62.8	75.1
Agricultural Areas						
13. A-2-A	1.83	6	402.3	1320	736	880
14. B-2-A	"	"	"	"	"	"
15. C-2-A	"	"	"	"	"	"
16. D-2-A	"	"	"	"	"	"
AVERAGE	1.83	6	402.3	1320	736	880

Agricultural plots perpendicular to the River (A-2, B-2, C-2, and D-2) were sampled via one line quadrat in the center of each plot for the entire length of the plot. These quadrats averaged 1.83 meters in width, 402.3 meters in length, and 736 square meters in area.

All vegetation within each plot was recorded by species. Cover density was estimated by the "ocular estimation" technique (Webb 1942). Density classes used were: (1) Density T (trace) - leaves cover less than 1/80 of the area of the quadrat; (2) Density 1 - leaves cover 1/80 to 1/3 of the area of the quadrat; (3) Density 2 - leaves cover 1/3 to 2/3 of the area of the quadrat; (4) Density 3 - leaves cover more than 2/3 of the area of the quadrat.

After sampling each quadrat for species composition, coverage, and density, entire plots were checked for species not found on sample quadrats. All vegetation surveys were completed in the spring of 1975.

Sampling of Avian Populations

Rectangular sample plots (Pettingill 1970) of approximately 1.2 hectares were chosen on each study site. Levees or farm roads established one linear plot border and enhanced accuracy of plot definition. Each plot was censused 26 times or twice monthly in the 12+ month period from September 6, 1974, to August 22, 1975, between the hours of 6:00 a.m. and 12:00 p.m. The schedule was rigidly adhered to regardless of weather conditions.

Birds were identified by sight or sound while the observer walked in one direction to minimize duplication of recordings. Any birds observed but not identified were included in the total number of birds seen, but listed as species unidentified. Species and numbers of birds were recorded on a standard survey sheet. The order in which plots were counted was reversed on each census round to minimize time bias.

RESULTS

Sampling of Vegetation

Only riparian quadrats contained woody species, with overstory trees averaging 51.7 and midstory trees and shrubs 73.3 percent cover density (Table 2). Percent ground

Table 2.--Percent cover density¹ for plant strata in four vegetational types (summary of 16 quadrats surveyed during spring of 1975).

Habitat types	Overstory trees (%)	Midstory trees & shrubs (%)	Ground cover (grasses & sedges)
Riparian berms (Plots C-1 & D-1)	51.7	73.3	30.2
Riprapped berms (Plots A-1 & B-1)			81.5
Agricultural lands associated with riparian berms (Plots C-2 & D-2)			72.3 ²
Agricultural lands associated with riprapped berms (Plots A-2 & B-2)			74.1 ²

¹Coverage density = $\frac{\text{area covered by plant strata}}{\text{total area of berm}}$ (100)

²Mainly agricultural plants.

cover on riparian plots (30.2) was considerably less than on agricultural lands (72.3-74.1) or riprapped berms (81.5). Fourteen species of woody plants were recorded on riparian berms (Table 3), with Fremont cottonwood and poison oak providing the most cover. Natural riparian habitat is typically layered, with cottonwood, sycamore, and arroyo willow overstory; saplings of

Table 3.--Dominant woody vegetation on 2 riparian plots located on the Sacramento River near Knights Landing, California.

Common name	Scientific name	Density ¹ on riparian berms
1. Fremont Cottonwood	<i>Populus fremontii</i>	2
2. Box Elder	<i>Acer negundo</i>	1
3. Oregon Ash	<i>Fraxinus latifolia</i>	1
4. Blue Elder Berry	<i>Sambucus caerulea</i>	1
5. Longleaf Willow	<i>Salix melanopsis</i>	1
6. Valley or Sandbar Willow	<i>Salix hindsiana</i>	1
7. Arroyo Willow	<i>Salix lasiolepis</i>	1
8. Common Fig	<i>Ficus carica</i>	1
9. Poison Oak	<i>Rhus diversiloba</i>	2
10. Coyote Bush	<i>Baccharis pilularis</i>	T
11. Mule Fat	<i>Baccharis viminea</i>	T
12. Calif. Wild Rose	<i>Rosa californica</i>	T
13. Calif. Wild Grape	<i>Vitis californica</i>	1
14. Calif. Wild Blackberry	<i>Rubus vitifolius</i>	1

¹Densities: T (Trace) = Leaves cover less than 1/80 of the plot area.
 1 = Leaves cover 1/80 to 1/3 of the area of the plot.
 2 = Leaves cover 1/3 to 2/3 of the area of the plot.
 3 = Leaves cover more than 2/3 of the area of the plot.

these species and box elder, Oregon ash and various shrubs as midstory; and poison oak, California blackberry, California wild rose, and mule fat as understory (Table 4).

Sampling of Avian Populations

During the 208 surveys (26 on each of 8 plots), 10,371 birds of 90 species were recorded (Table 5). The largest number of birds (5,441) was recorded on agricultural lands associated with riparian vegetation, and the lowest number of birds (254) was

recorded on agricultural lands associated with riprapped berms. The number of species/hectare observed was greatest (32.1) in riparian vegetation, and least on riprapped berms (9.2). Fifty of the 90 avian species recorded in the riparian type were not recorded in any of the other habitat types. Woodpeckers, flycatchers, wrens, thrushes, vireos, warblers, and grosbeaks were among those dependent upon riparian types (Detailed information on seasonal abundance of each species by type is available in tabular form from the senior author).

About 85 percent of the total number of birds using agricultural lands were blackbirds and sparrows. Twelve species used agricultural lands associated with riparian vegetation but neither riprapped berms nor agricultural lands associated with them. Green herons, snow geese, wood ducks, Cooper's hawks, red-tailed hawks, merlins, rock doves, belted kingfishers, common flickers, California quails, red-winged blackbirds, and dark-eyed juncos were in this group.

The number of species per hectare (species density) on agricultural lands associated with riprapped berms was 32

Table 4. Predominant herbaceous vegetation on 16 vegetation quadrats from 8 plots located on the Sacramento River near Knights Landing, California.

Common name	Scientific name	Density ¹ on riparian berms	Density on riprapped berms	Agricultural lands associated with riparian berms	Agricultural lands associated with riprapped berms
1. Wild Oat	<i>Avena fatua</i>	1	1		
2. Ripgut	<i>Bromus olandus</i>	1	1		
3. Bermuda Grass	<i>Cynodon dactylon</i>	1	1		
4. Wild Barley	<i>Hordeum teporinum</i>	1	1		
5. Annual or Italian Ryegrass	<i>Lolium multiflorum</i>		1		
6. Johnson Grass	<i>Sorghum halepense</i>		T		
7. Garden Lippia	<i>Lippia nodiflora</i>		1		
8. Horsetail	<i>Equisetum laevigatum</i>		1		
9. Sorrel	<i>Rumex crispus</i>	1	1		
10. Sky Lupine	<i>Lupinus nanus</i>	T			
11. Bird Weed	<i>Convolvulus arvensis</i>	T	T		
12. Star Thistle	<i>Centaurea melitensis</i>	T	1		
13. Red Stem Filaree	<i>Erodium cicutarium</i>	T	1		
14. Slender Wild Oat	<i>Avena barbata</i>	1	1		
15. Black Mustard	<i>Brassica nigra</i>	T	T		
16. Common Vetch	<i>Vicia sativa</i>	T	T		
17. Carex Sedge	<i>Carex barbarae</i>	1			
18. Tomato	<i>Lycopersicon esculentum</i>			2	2
19. Rice	<i>Oryza sativa</i>			3	3
20. Winter Wheat	<i>Triticum aestivum</i>			3	3

¹Densities: T (Trace) = Leaves cover less than 1/80 of the area of plot.
 1 = Leaves cover 1/80 to 1/3 of the area of the plot.
 2 = Leaves cover 1/3 to 2/3 of the area of the plot.
 3 = Leaves cover more than 2/3 of the area of the plot.

percent less than on agricultural lands associated with riparian vegetation (Table 5). Total number of species on agricultural lands associated with riprapped berms was also 32 percent less than on agricultural lands associated with riparian berms (Table 5), and total number of birds was about 95 percent less. Chi square analyses showed that avian density and diversity on agricultural lands associated with riparian vegetation both differed significantly ($p < 0.01$) from those on agricultural lands associated with riprapped berms.

Table 5.--Summary of first year's bird survey data (9/6/74 - 8/22/75) on riparian, riprapped, and agricultural plots near Knights Landing, California.

Habitat and plot	Hectares	Total # birds	Acc. Total # species	Total # birds/ha	Total # species/ha
Riprap (A-1)	1.3	186	20	143.0	15.4
Agricultural lands associated with riprap (A-2)	1.2	121	17	100.8	14.2
Riprap (B-1)	1.3	104	17	80.0	13.1
Agricultural lands associated with riprap (B-2)	1.2	133	18	110.8	15.0
Riparian (C-1)	1.4	2,048	76	1,462.8	54.3
Agricultural lands associated with riparian (C-2)	1.2	3,787	25	3,139.2	20.8
Riparian (D-1)	1.4	2,338	65	1,670.0	46.4
Agricultural lands associated with riparian (D-2)	1.2	1,674	33	1,395.0	27.5
Total Riprap (A-1 & B-1)	2.7	290	25	107.4	9.2
Total Riprap-Ag lands (A-2 & B-2)	2.4	254	25	105.8	10.4
Total Riparian (C-1 & D-1)	2.8	4,386	90	1,566.4	32.1
Total Riparian-Ag Lands (C-2 & D-2)	2.4	5,461	37	2,287.1	15.4
TOTAL		10,371	90		

The number of species per hectare (species density) observed on riprapped berms was about 71 percent less than on riparian berms. The total number of species was about 72 percent less on riprapped berms than on riparian berms. Total number of birds was about 93 percent less on riprapped than on riparian plots. Chi square analyses revealed that there were significant differences ($p < 0.01$) in both avian diversity and density between riparian and riprapped berms.

Annual cycles of use for each of the four vegetational types are depicted in Figures 4 and 5. Avian densities and diversities varied through the year with food availability, amount of cover, and bird migration. In general, the expected spring and fall peaks in density and diversity occurred in each type, but were higher in riparian and associated agricultural vegetation than in riprapped and associated agricultural vegetation. The annual cycle of diversity on riparian berms and agricultural lands associated with them were correlated ($r = 0.84$, $p < 0.05$). Density data for the two types over the year were also correlated ($r = 0.87$, $p < 0.05$) when blackbird data were deleted, but not if they were included. Berms with riparian vegetation averaged 14 times the number of species (diversity index) of riprapped berms in the fall, 7 times in the winter, 4 times

in the spring, and 3 times the number in the summer. Avian diversity on agricultural lands associated with riparian berms averaged 6 times that of agricultural lands associated with riprapped berms in the fall, 1.8 times in the winter, 1.3 times in the spring, and 1.5 times the number in the summer.

Avian densities throughout the year showed similar trends. Riparian berms averaged 35 times as many birds as riprapped berms in the fall, 11 times in the winter and summer, and 6 times in the spring. Avian densities on agricultural lands associated with riparian berms averaged 18 times as many birds as agricultural lands associated with riprapped berms (former riparian) in the fall, 10 times in the winter, 32 times in the spring, and 4 times in the summer.

Density disparity between riparian berms and riprapped berms was greatest in late September when riparian berms had 56 times as many birds as riprapped berms. Density disparity was lowest in late January when riparian berms contained only 1.3 times as many birds as riprapped berms. Similar disparities in diversity were noted, with 16 times as many species in riparian as in riprapped vegetation in late September and 3.8 times as many in late January. It is evident that timing of studies is very important in drawing conclusions about avian use of different vegetational types.

DISCUSSION

The basic three-layered composition of the riparian vegetation is partly a result of late winter and spring flooding that retards succession to even-aged cottonwood or to the valley oak type which supports a less diverse and dense avifauna (Gaines 1977). Avian density and diversity in the cottonwood-willow riparian vegetation were probably underestimated because of the dense vegetation; however, bird use data (60.2 bhd) were still in excess of the high density limits established by Peterson (1941). High bird species diversity is associated with vegetational layering (Walchuk 1970, MacArthur et al. 1962, and MacArthur 1964) and foliage volume, but other factors may also be involved (Gaines 1977). Some 67 species of birds are known to nest in the limited riparian forests of the Sacramento Valley (Gaines 1977). This is about 24 percent of the 277 regular nesters in California (Small 1974).

As indicated earlier, densities and diversities of birds on agricultural lands associated with riparian berms were correlated

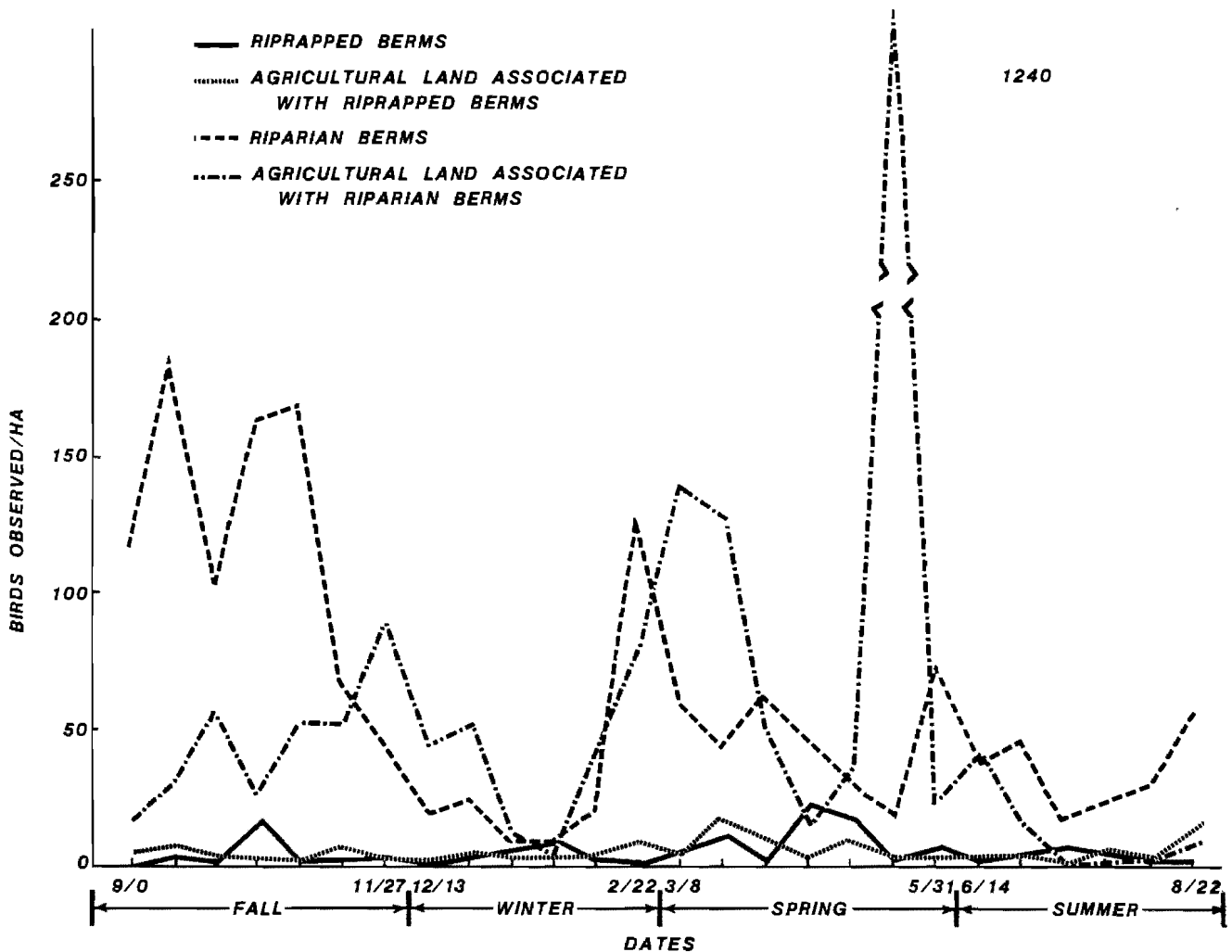


Figure 4. Numbers of birds/hectare observed on sample plots throughout the year.

with those found on riparian berms themselves throughout the year. The effects of "edge" surrounding riparian lands on birds found within riparian habitat seem minor (Gaines 1977) in this study, but the opposite effect on agricultural lands is striking. Not only were 93 percent fewer birds and 72 percent fewer species found on berms from which riparian vegetation had been removed, but on agricultural lands in association with riprapped berms, there were 95 percent fewer birds and 32 percent fewer species than on agricultural lands in association with riparian vegetation. Riparian vegetation appears to be the major factor controlling avian diversity and density in the Sacramento Basin. The value of riparian vegetation to avian populations is evident, especially when

the alternative of little or no vegetation resulting from the removal of riparian forests is considered.

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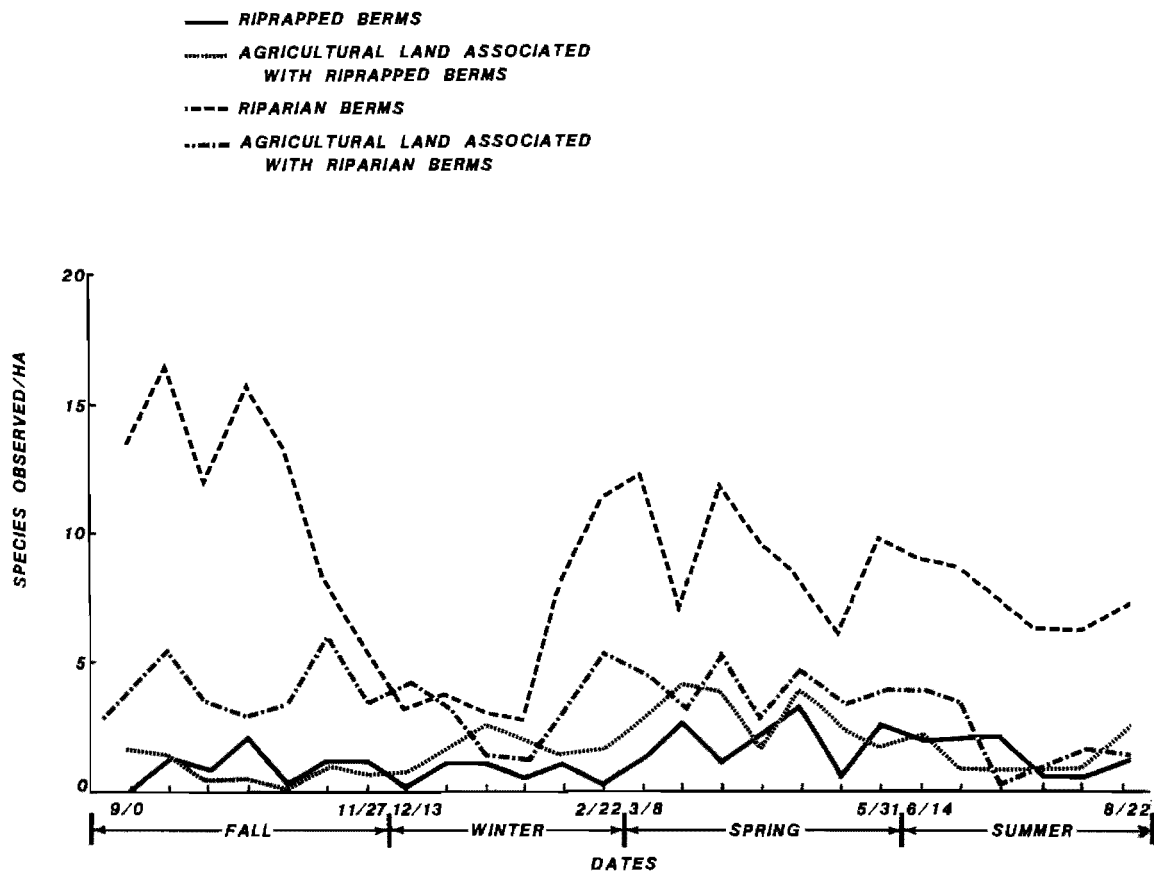


Figure 5. Numbers of species/hectare observed on sample plots throughout the year.

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