State of California
THE RESOURCES AGENCY
Department of Fish and Game

RIPARIAN HABITATS AND AVIAN DENSITIES ALONG THE SACRAMENTO RIVER[1/]

by

FRANK J. MICHNY[2/]
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and
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Wildlife Management, Region 2

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Under the Direction
of
Fred A. Worthley
Wildlife Management Branch
Region 2, Sacramento

ABSTRACT

From August 1973 to June 1974, a study was made of the value of the riparian vegetation along the Sacramento River to avian and mammalian populations. Avian populations of nine selected quadrats were studied to determine bird density and diversity. A total of 72 species, including the rare yellow-billed cuckoo (Coccyzus americanus), were identified.

Censuses of each quadrat varied from eight to thirteen. All of the wooded riparian habitat locations, except one, supported high bird populations. Densities ranged from 11.6 to 18.2 birds per acre with an average density of 14.9. Principal vegetation species were determined, and major plant associations for each quadrat are described along with qualitative description of resident mammals.

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INTRODUCTION

The Sacramento River of northern California has along its banks significant wooded stands of riparian habitat. These wooded stands, depending on the configuration of the levee system, range from a few meters wide where the levee serves as the riverbank, to a berm of varying width, to a flood plain of several hundred meters wide. The banks in some areas have growths of native vegetation and in other areas have been cleared and armored with rock.

The purposes of the study described in this report were: 1) to observe and record avian populations associated with the riverine habitat and, throughout the year, to determine bird densities and species diversity in specific plant communities, 2) to obtain a quantitative and qualitative description of all major plant species on selected study areas, and 3) to study mammalian populations and provide qualitative information for each study area. The need for such information arises from requirements for wildlife mitigation measures to be incorporated in reclamation, flood control and levee protection projects affecting important lands along the river.

METHODS

Study Areas

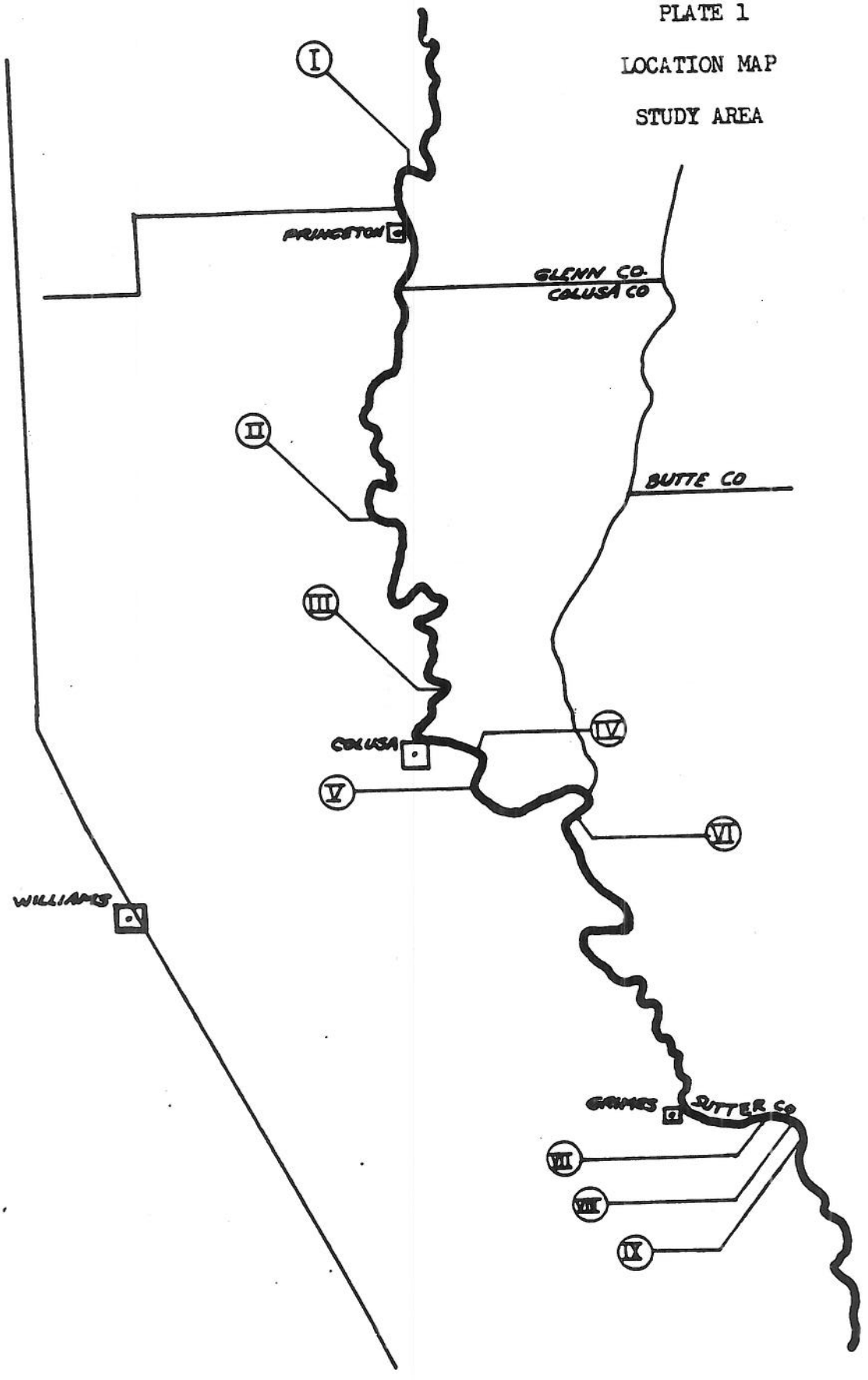
The three objectives were met by selecting a variety of representative areas along the Sacramento River and conducting wildlife censuses at those sites. Each of the nine study areas selected differed in vegetative composition and bank-berm configuration. The purpose in selecting widely divergent areas was to obtain a cross-section of avian populations in various habitat types.

The northernmost area is one mile (1.6 kilometers) north of Princeton in Glenn County, and the southernmost area is one mile (1.6 kilometers) south of Grimes in Colusa County. The remaining areas are between those points and scattered on both sides of the river (Plate 1).

PLATE 1

LOCATION MAP

STUDY AREA



Study area designations, exact locations, bank-berm configurations and dimensions are provided in the **Appendix**.

Vegetation in all nine areas is dominated by Fremont cottonwoods (Populus Fremontii) to varying degrees. Accompanying the cottonwoods are various other species of trees and shrubs. Ground cover is generally a mixture of forbs and grasses.

Avian Species

The sample plot method (Pettingill 1970) was employed to sample avian species. Each quadrat was limited to approximately three acres (1.2 hectares) measured with a metal tape and marked with red flagging. The quadrats were somewhat rectangular in shape with a levee for one lineal border and the river for the other. This type of situation enhances census accuracy as the longer borders are well defined and most sighted birds can be definitely determined to be either in or out of the study area.

Observations were made on 33 different days from August 6, 1973 to June 19, 1974. Ninety-four of the 101 censuses were conducted between 0600 and 1200 hours to improve the accuracy of the counts (high afternoon temperatures of the summer decreased bird activity markedly in most cases).

Areas I, II and III are parts of large wooded areas and could be censused later in the day as, because of heavy shade, activity remained high throughout the afternoons.

Censusing was done by walking slowly through the quadrat and observing birds with 8 x 50 field glasses and listening for bird songs. All birds listed as identified were actually seen, but listening for songs assisted in locating the smaller and more secretive species.

A tape recording of the yellow-billed cuckoo was used to verify a possible cuckoo heard in study area I. Birds unable to be seen or those not seen well enough for positive identification were listed in the census tally (Table 1) as unidentified. This listing, therefore, should signify birds unidentified in a particular census period and not interpreted as an unrecognized species during the entire reporting period.

In the long quadrats, censusing was done in one direction only. The remaining areas were censused by setting up a path covering the area, using it each time and counting while walking in one direction only.

All identifications (Table 2) were based on Robbins (1966).

Weather conditions were varied in accordance with the season. Cloud cover and temperatures fluctuated, but censusing took place only on days of little or no wind.

Vegetation

Vegetation sampling was accomplished by using a rectangular quadrat method (Oosting 1956). Varying sizes of quadrats were used to sample the overstory, midstory and understory on each of the nine study areas. The overstory was sampled by using 100-square yard (83.6 square meter) plots. The midstory, all vegetation approximately five feet (1.53 meters) to 25 feet (7.63 meters), was sampled by using a 20-square yard (16.7 square meter) plot. A one-square yard (.91 meter) plot was used for the understory.

The diagram of Plate 2 shows how the plots were constructed. Each overstory plot of 100-square yards (83.6 square meters) included two 20-square yard (16.7 square meter) plots for the midstory and ten one-square yard (.91 square meter) plots for the understory.

AVIAN CENSUS DATA FOR ALL STUDY AREAS

SPECIES	OBSERVATION DATES 1973														OBSERVATION DATES 1974																TOTAL OBSERVATION IN STUDY AREA								
	8-6	8-7	8-8	8-9	8-15	8-16	8-19	8-20	8-23	8-27	8-28	8-29	8-30	12-8	12-9	2-6	2-7	2-12	2-13	2-14	2-20	2-21	2-22	2-26	2-27	3-14	3-19	3-20	3-21	5-13	5-14	6-5	6-18	6-19	I	II	III	IV	V	VI	VII	VIII	IX
Unidentified	13	10	2	15	33	11	8	9	15	10	8	9	8																		12	9	22	4	38	43	66	16	17	12	11		10
Great blue heron					1													1								3								1		1							2	3
Mallard																2							4															4	2				
Wood duck					2					1									2			1											1		4	3							
Turkey vulture										1																					1				2		1						
Cooper's hawk						1				1		3		3	1		1	1	2	1	1	1	1	1	1		1								4	3		1	2	1	5		2
Red-tailed hawk															1						1																	1	1				
Red-shouldered hawk																																						3	2	5			
American kestrel			2								1			1			1	1					4				5		13	2		2	3		17	7			5	14	17		10
California quail	8			2	7	5		2		2		12		7										3			2		2							2	1			9		8
King-necked pheasant		2		2							6	3						1																						1		1	
Killdeer				1																							4								4							
Band-tailed pigeon																											2		6	3	3		4		3	7	13		4	14	1	12	21
Mourning dove	2	3	3	6	12	1	1	4	1	3	3	10	7	1																					6								
Yellow-billed cuckoo	1					2	1					2																							2								
Barn owl						1						1															1		1		1				1	1				1			
Great horned owl																																							2			1
Belted kingfisher				1	2																																					
Common flicker		3	4	7	5		4	1	4	2	2	4	3	3	3	2	5	1	3	8	5	5	6	3	1	2	5	5		1					18		13	7	19	15			26
Yellow-bellied sapsucker														1		3									1	3	1									2							
Hairy woodpecker																										3										1				6		
Acorn woodpecker	1							1							1	1			1		1	1				3		2			2		2			4		1	1		5		
Downy woodpecker	2	2		2		4	2	3	4	3				1	1	2	5	3	5	3	5	8	7	3	12	1	9	1	2		7	4	9	3	31	27	11	4	15	12	9		3
Nuttall's woodpecker	2	2	1	2	2	1	3	3	3	4	2	6	7			2		3	7	1	8	9	3	3	2	3	7		2	2	1	3			28	18	7	4	7	2	14		15
Western kingbird	1			1																											2		1	1		1			1		1		
Ash-throated flycatcher		1					1					1																			3	2	7	1	6	2	5		3				
Black phoebe					2	2										1			2		1				2	1		1		1		1	1	5	5	3	1		2			3
Willow flycatcher				1							2		1																							1						
Western flycatcher											1																								6	20	12				1		
Western wood pewee	2	3		2	4	5	1	5	2		3	1								2			6		2		4				2	1	4		8	13	10	2	6	2	1		
Tree swallow		7			5		3		6																						16						16					
Cliff swallow																																											
Scrub jay	10	10	1	20	16	13	7	8	15	10	14	11	2	17	8	11	11	4	12	15	13	15	10	10	7	8	18	6	8	1	9	2	11	3	49	51	30	21	43	64	42	2	34
Yellow-billed magpie	8	4	8	4	4	11	12	8		1	7	6		18	4	10	29	19		7	9	6	14	18		8		15	12		9					10		66	50	8	87		10
Common crow				1											4	9				5			5	4		3					1								10	4		17
Pinon titmouse	1	3		4	12	2	1		2	2	1	6			5	3	15	3	8	8	7	8		7	5	1	2		4				4	8	27	15	15	6	5	26	12		16
Bushtit	5	9			30	6	1	3	5		23			5											5					9	2	14	3	14	65	10	2	27	2			
White-breasted nuthatch			1		3	1		1	1																										2	3	3				1		
House wren																											4		2		1				2	2	1				2		
Winter wren														1																						1							
Bewick's wren	2	3		5	12	7	4	3	2	8	3	3	1	6		7	5	4	7	1	9	10	5	3	5	3	10		1	2	5		11		34	43	14	12	6	11	18		9
Mockingbird				1																																			1				
Robin	1	3		2	8	1		2									6			1		4	6				2			8		5	4		4	26	1	22				
Hermit thrush																											1									1							
Western bluebird						7		1			3			9			9	2	1	1			3					2	1								5	1		23	7	1		2
Golden-crowned kinglet																6					4				15	2		1							4				2	1		21
Ruby-crowned kinglet																5	4	11	11	7	22	8	13	8	8	9	9		4						36	24		6	7	10	3		15
Starling		2	6	3	2		3	1	4	1	5	1		12	3	14	3	1	3	16	6	17	7	9		11	3	4	13	6	6				17	21	2	19	25	13	55		10
Warbling vireo							1					1																							2								
Nashville warbler		2			4		3	6	11	1	4	2																							5	1	21		3				3
Yellow warbler																										1			1											2			
Yellow-rumped warbler														7	3	15	1	10	1		8	14	11		22	12	34	6	10						34	34			17	19	26		24
Black-throated gray warbler		1					1		2		2																				2				1	3	2				2		
Hermit warbler				1																																	1						
MacGillivray's warbler				6																																	6						
Wilson's warbler			3	4	4	7		4	7		2						7			3		1						2				3		8		6	3	2	1	4		
Western meadowlark																																						6	7			

TABLE 1 (CONT)

Red-winged blackbird																		14						4		3		2											2		21		
Northern oriole	4				5					1		1																		4	2	1	2		10	4	5	1					
Brewers blackbird	2	29						6		2					2	4	10													3	5	6	3	4	16	1	18	2	31	6	2		
Brown-headed cowbird																														2	4		1		2	4	1						
Western tanager	1	2	1		3	2	1		5	1	2	2																			7				5	2	7	4	7	1	1		
Black-headed grosbeak		1		4	4	6		6	2	6	3	2							2												8	3	19	6	18	15	31	2	6				
Evening grosbeak																									26		17								43								
Lazuli bunting																																	2		2								
House finch	5					1		3	2	1	3	2		3					29		4		2		1					1					4	37	5		5				
Lesser goldfinch																	5																						5				
Rufous-sided towhee	9	4	1	3	3	6	2		4	2		2		2		2	4	2	4	3	5	5	5		3	2	7	2	1				2		20	25	6	8	4	13	5		5
Brown towhee	3	3	2	2	3	3		4	4	6	2	1		1			2	3	4	7	3	6	1	2	1		2		1		1	1		1	8	15	7	3	12	9	2		11
Dark-eyed junco														40	29	2	2			63	11	29	59	12		11	20	6	7							21		47	96	56	41		30
White-crowned sparrow																5	3											7										10		5			
Golden-crowned sparrow														13	6				2	2	4	5	5	9												15		5	9	2			
Song sparrow														4																						4							
	88	109	35	102	188	105	62	84	101	68	105	89	29	155	41	106	128	84	106	154	127	153	177	99	104	103	170	63	92	27	129	37	140	40	540	590	378	255	499	356	421	18	309

Table 2

List of Avian Species Identified in the Study Areas
(Nomenclature Reflects the Most Recent AOU Revisions - AUK 1973)

Great blue heron	Ardea herodias
Mallard	Anas platyrhynchos
Wood duck	Aix sponsa
Turkey vulture	Cathartes aura
Cooper's hawk	Accipiter gentilis
Red-tailed hawk	Buteo jamaicensis
Red-shouldered hawk	Buteo lineatus
American kestrel	Falco sparverius
California quail	Lophortyx californicus
Ring-necked pheasant	Phasianus colchicus
Killdeer	Charadrius vociferus
Band-tailed pigeon	Columba fasciata
Mourning dove	Zenaida macroura
Yellow-billed cuckoo	Coccyzus americanus
Barn owl	Tyto alba
Great-horned owl	Bubo virginianus
Belted kingfisher	Megaceryle alcyon
Common flicker	Colaptes auratus
Yellow-bellied sapsucker	Sphyrapicus varius
Hairy woodpecker	Dendrocopos villosus
Acorn woodpecker	Melanerpes formicivorus
Downy woodpecker	Dendrocopos pubescens
Nuttall's woodpecker	Dendrocopos nuttallii
Western kingbird	Tyrannus verticalis
Ash-throated flycatcher	Myiarchus cinerascens
Black phobe	Sayornis nigricans
Willow flycatcher	Empidonax traillii
Western flycatcher	Empidonax difficilis
Western wood pewee	Contopus sordidulus
Tree swallow	Iridoprocne bicolor
Cliff swallow	Petrochelidon pyrrhonota
Scrub jay	Amphelocoma coerulescens
Yellow-billed magpie	Pica nuttalli
Common crow	Corvus brachyrhynchos
Plain titmouse	Parus inornatus
Bushtit	Psaltriparus minimus
White-breasted nuthatch	Sitta carolinensis
House wren	Troglodytes aedon
Winter wren	Troglodytes troglodytes
Bewick's wren	Thryomanes bewickii
Mockingbird	Mimus polyglottos
Robin	Turdus migratorius
Hermit thrush	Catharus guttata
Western bluebird	Sialia mexicana
Golden-crowned kinglet	Regulus satrapa
Ruby-crowned kinglet	Regulus calendula
Starling	Sturnus vulgaris
Warbling vireo	Vireo gilvus
Nashville warbler	Vermivora ruficapilla

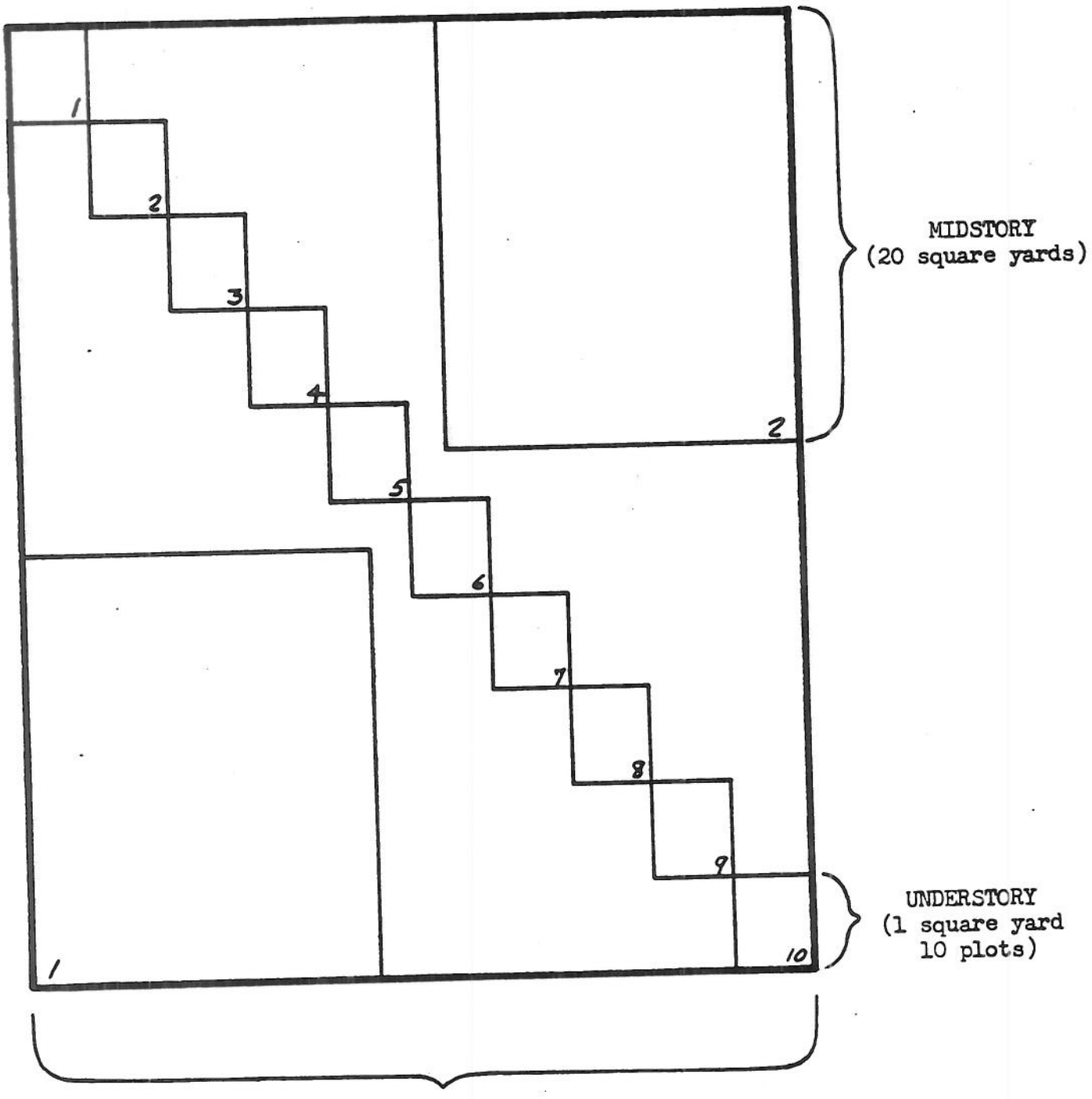
(CONT.)

Table 2
(Cont.)

Yellow warbler	Dendroica petechia
Yellow-rumped warbler	Dendroica coronata
Black-throated gray "	Dendroica nigrescens
Hermit warbler	Dendroica occidentalis
MacGillivray's warbler	Oporornis tolmiei
Wilson's warbler	Wilsonia pusilla
Western meadowlark	Sturnella neglecta
Red-winged blackbird	Agelaius phoeniceus
Northern oriole	Icterus galbula
Brewer's blackbird	Euphagus cyanocephalus
Brown-headed cowbird	Molothrus ater
Western tanager	Piranga ludoviciana
Black-headed grosbeak	Pheucticus melanocephalus
Evening grosbeak	Hesperiphona vespertina
Lazuli bunting	Passerina amoena
House finch	Carpodacus mexicanus
Lesser goldfinch	Spinus psaltria
Rufous-sided towhee	Pipilo erythrophthalmus
Brown towhee	Pipilo fuscus
Dark-eyed junco	Junco hyemalis
White-crowned sparrow	Zonotrichia leucophrys
Golden-crowned sparrow	Zonotrichia atricapilla
Song sparrow	Melospiza melodia

PLATE 2

QUADRAT CONFIGURATION



Mammals

Mammalian censusing was accomplished by direct observation during all visits to the sample areas. Also, on three occasions in March, May and June of 1974, mammal tracks and signs were keyed to species. No attempts were made to quantify mammalian numbers.

RESULTS

Bird Censuses

The number of bird counts made at the various census sites varied from 8 to 13 (see Plate 3). Seventy-two species of birds were identified in this time period (Table 2). A summary of observations appears in Table 3.

Using accepted statistical procedures (Cox 1972), the mean number of birds per acre (or hectare) and confidence limits were calculated and tabulated (Table 2). For example, for Area 1 the mean of observed occurrences is 12.1 birds per acre (bpa) or 30.1 birds per hectare (bph). On a 95 percent confidence level, the true mean would lie between 9.7 and 14.5 bpa or 24.0 and 35.9 bph. In Table 4 a converted bar graph is used to show differences between study areas.

A noteworthy observation is that of the August, 1973 survey in which the yellow-billed cuckoo was seen at Area I on four separate occasions. Two of these birds, a nesting pair, were twice observed at the site.

Vegetation

The results of the vegetation survey by sites are summarized in the Appendix.

Relative figures for the sample areas were obtained by following procedures outlined by Cox (1972). Relative density, dominance and frequency were calculated for the overstory and midstory. Relative density was eliminated from the understory because of complications discussed later.

CENSUS DAYS FOR EACH STUDY AREA

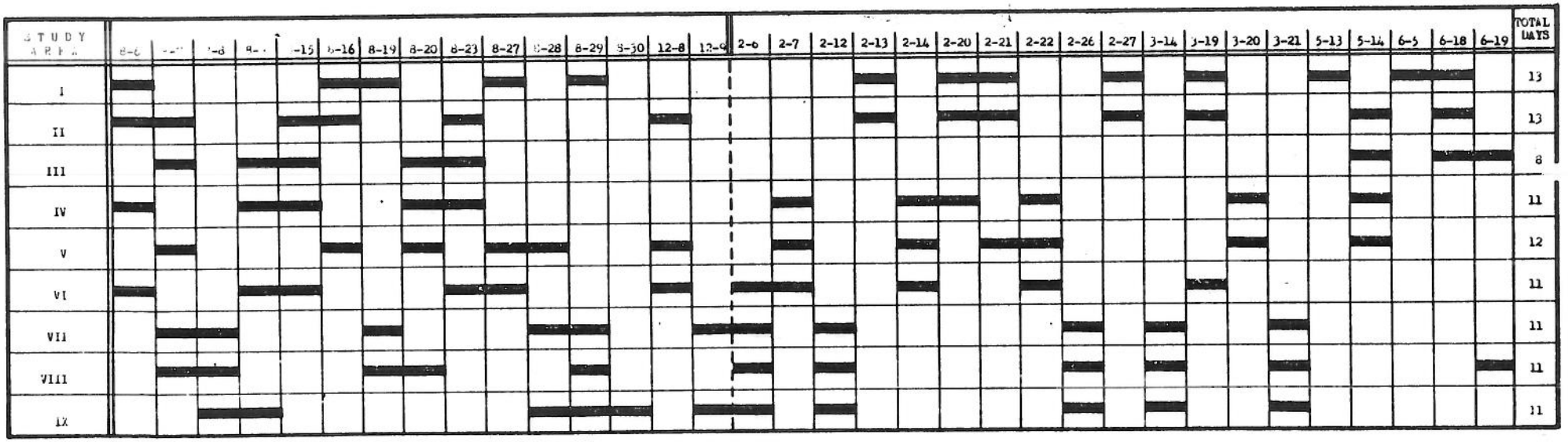


PLATE 3

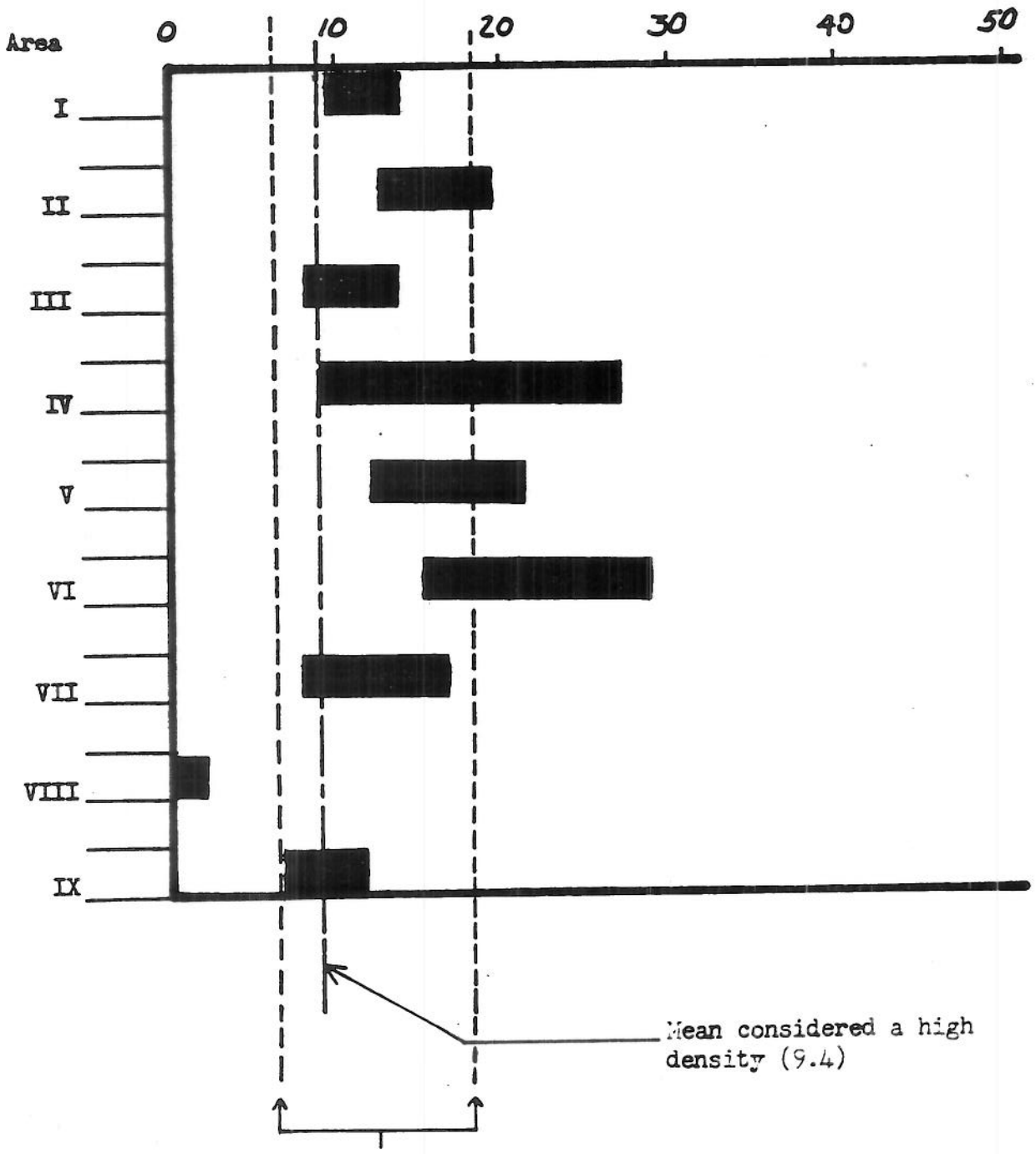
Table 3

Summary of Avian Study Data

Area	Size (acres)	Number of species	Mean birds per acre	Density limits (95 percent)
I	3.4	38	12.1	9.7 - 14.5
II	3.0	48	15.8	12.5 - 19.1
III	4.7	36	10.9	8.4 - 13.4
IV	1.5	27	18.4	9.3 - 27.5
V	2.5	36	16.9	12.3 - 21.5
VI	1.5	34	21.9	15.4 - 28.4
VII	3.1	38	13.2	8.7 - 17.7
VIII	1.9	6	1.1	0 - 2.7
IX	3.0	26	9.8	7.6 - 12.0

Table 4

Bar Graph Representing the Limits of the Possible True Mean for Bird Densities in Study Areas



An 'importance value' was included to aid in comparing individual plant species and study areas. A list of the most common species encountered on the nine areas is included in Table 5 (woody species) and Table 6 (herbaceous plants). Approximately 16 species of woody plants and 15 species of herbaceous plants were identified.

Mammals

The presence of eleven species of mammals was established by actual observation or identification of tracks, scats or pellets. Table 7 lists these species and the area in which they occurred.

DISCUSSION

Birds

Table 3 shows that in all study areas except VIII there is a 95 percent probability that actual bird densities exceed the high density limits established by Peterson (1941). According to Peterson, high density areas would have 6 to 18 bpa with a mean of 9.4. Low density areas would have 1 to 3.25 bpa.

The only area showing a low avian density was Area VIII. Levee stripping operations along this section of the river had left it essentially without vegetative cover of any kind. By the end of the study period, sandbar willow (Salix Hindsiana) had become reestablished and cottonwood seedlings and an assortment of forbs were beginning to appear. Inadequate vegetative cover throughout the study period is reflected in the extremely low mean density of 1.1 bpa (2.4 bph) and density limits of from 0 to 2.7 bpa (6.7 bph).

Because the study extended over most of a year, differences between the time of year and species numbers and composition could be predicted. These seasonal variations are apparent, for example, in results of sightings at Area I. In August of 1973 there was a mean of 9.6 bpa (23.8 bph) and density limits of 8.6 to 11.2 bpa or 21.2 to 27.7 bph. This same area, when censused

Table 5

List of Predominant Woody Vegetation Encountered in Study Areas
(Nomenclature After Munz, 1970)

Common Name	
1. Fremont cottonwood	Populus Fremontii
2. Box elder	Acer negundo
3. Oregon ash	Fraxinus latifolia
4. Black locust	Robinia pseudo-acacia
5. Blue elderberry	Sambucus caerulea
6. Valley oak	Quercus lobata
7. Black walnut	Juglans Hindsii
8. Longleaf willow	Salix melanopsis
9. Sandbar willow	Salix Hindsiana
10. Orroyo willow	Salix lasiolepsis
11. Poison oak	Rhus diversiloba
12. Coyote bush	Baccharis pilularis
13. Mule fat	Baccharis viminea
14. California wild rose	Rosa californica
15. California wild grape	Vitis californica
16. California blackberry	Rubus vitifolius

Table 6

Partial List of Herbaceous or Grassy Plants of Study Areas
(Nomenclature after Munz, 1970)

1. Wild oat	Avena fatua
2. Wild barley	Hordeum leporinum
3. Perennial ryegrass	Lolium perenne
4. Italian ryegrass	Lolium multiflorum
5. Soft chess	Bromus mollis
6. Canary grass	Phalaris minor
7. Rye grass	Elymus glaucus
8. Wild cucumber	Marak fabaceus
9. Mexican tea	Chenopodium ambrosioides
10. Mugwort	Artemisia douglasiana
11. Horsetail	Equisetum sp.
12. Sorrel	Rumex sp.
13. Bindweed	Convolvulus arvensis
14. Star thistle	Centaurea melitensis
15. Filaree	Erodium cicutarium

Table 7

List of Mammals or Identifiable Tracks Observed in the Study Areas

Species	Study Areas								
	I	II	III	IV	V	VI	VII	VIII	IX
Black-tailed jackrabbit *Lepus californicus*		X	X	X	X	X	X	X	X
Western gray squirrel *Sciurus griseus*	X	X	X						
Beaver *Castor canadensis*	X	X		X	X		X	X	X
Muskrat *Ondatra zibethica*	X	X		X		X	X	X	X
Other unidentified rodents	X	X	X	X	X	X	X	X	X
Gray fox *Urocyon cinereoargenteus*	X	X	X	X				X	X
Ringtail cat *Bassariscus astutus*	X								
Raccoon *Procyon lotor*	X	X		X	X	X			
Mink *Mustela vison*								X	X
River otter *Lutra canadensis*							X	X	X
Striped skunk *Mephitis mephitis*					X	X			
Black-tailed deer *Odocoileus hemionus columbianus*	X	X	X						

in February and March, produced counts of with a mean of 16.2 bpa (40.1 bph) with a range of 12 to 20.4 bpa (29.7 to 50.5 bph) Effects of migration are also obvious when these figures are compared with those of the spring (May and June) census of 1974 (Table 8).

In general, bird numbers appeared high for all three periods in the study. However, there was a significantly different winter density and a greater number of species in August (as shown in Table 8).

By August, most nesting had been completed and few territories were being defended. This change in toleration results in a larger number of birds per unit area. Midday temperatures, frequently in excess of 100°F, drive many avian species into these cool, protected, areas.

Winter months resulted in a different situation. Bird numbers were even higher than during the August census. Several causes could be responsible. One reason could be the increased gregariousness of some bird species in winter. Such birds as the evening grosbeak, dark-eyed junco, and fellow migrants were observed in relatively large flocks. Secondly, it is possible that during the winter months, with farm lands relatively bare, the birds are forced to congregate in the riparian habitat where food and cover are available. Thirdly, avian species are much easier to census in the winter because the trees and most shrubs have lost their leaves and the birds are easier to observe.

In constrast to the spring months, both late summer and winter are times when birds are not defending nesting territories. This was quite evident, for example, in the case of the woodpeckers which are normally very territorial during the breeding season. At times, three and four woodpeckers of the same species would be seen in the same tree during the winter months.

Table 8

Relation of Time of Year to Bird Densities and Composition in Area I

	Mean number of birds per acre	Density limits	Number of species
Summer	9.6	8.6 - 11.2	26
Winter	16.2	12 - 20.4	18
Spring	9.7	5.7 - 13.5	20

Reference to Table 8 will show the diversity of bird species in the August survey. Some of this difference can be explained by the characteristic "layering" effect of the Sacramento River riparian habitat. This three-layered characteristic is well-known and common to eastern deciduous forests. The variety of birdlife is directly attributable to the vegetative layering (Walcheck 1970, MacArthur et al.1962, MacArthur 1964).

In winter months, however, the understory is commonly covered by flood waters, thus eliminating several ground dwelling species (as the winter wren) that would have otherwise been present.

As already mentioned, the yellow-billed cuckoo, a rare species in California, was sighted in Area I in August. Attempts to locate this species again in the spring had, as could be expected, negative results (the cuckoo normally doesn't arrive until later in the season). Riparian habitat similar to that of Area I is critical to survival of the species in California (California Department of Fish and Game 1972).

Despite the difference in density and diversity from season to season, the results clearly show that the riparian habitat along the Sacramento River supports high bird concentrations throughout the year and supplies critical nesting habitat for the yellow-billed cuckoo. This finding supports conclusions reached in other studies on the distribution of birds in varying habitat types. (Grinnel and Miller 1944, Walcheck 1970, MacArthur et al.1962, MacArthur 1964).

Vegetation

As already indicated in the discussion on avian species, the best riparian habitat is typically layered. More specifically it is divided into three more-or-less distinct layers as in the cottonwood forests of the eastern United States. (Walcheck 1970). The methods used in this study recognized the distinct layering of understory, midstory and overstory found in woodlands along the Sacramento River.

Cottonwood, sycamores, and large arroyo willows predominate in the overstory. Saplings of all these species as well as Oregon ash, box elder, and various shrubs including coyote bush, comprise the midstory. The understory is represented by such species as poison oak, California blackberry, mugwort, sorrel and others.

The layering is partially attributable to spring flooding which sets back plant succession that, if left unchecked, would result in primarily an even-aged stand of cottonwoods, a limited understory and little, if any, midstory. Bird diversity and density would suffer as a result.

The relative values presented in the tables of appendix are a guide to the vegetative composition of each individual area. Such values can be used to compare different areas and to find possible relationships between bird or mammal densities and plant species composition. Such studies were beyond the intended scope of this report.

Dominance and frequency values were calculated for the understory plots. However, density was not included, because the possibility of counting individual plants was unrealistic in many cases. This was particularly true of vines, especially those with the tendency of rooting from runners. It was very difficult to determine if one or several plants were to be counted.

The entries in Table 7 show that a number of diverse mammalian species also frequent the nine study areas. Various species of rodents and black-tailed jackrabbit are apparently the most common. Without this riparian vegetation the number of water-oriented mammals such as beaver, racoon, and muskrat would be seriously reduced.

Likewise, in winter months, when current agricultural practices dictate bare fields, these narrow strips supply needed food and cover. Further work should be undertaken to determine the density of mammals listed in this study.

General

Results of studies described in this report have confirmed the belief that riparian habitat found along the Sacramento River does, in fact, support high avian population densities throughout the year. Secondly, the results parallel those of other studies wherein high avian diversity was related to the layering effect of the vegetation. Lastly, this habitat type was shown to supply critical needs of many different species of mammals. Considering the intensive clean-farming practices on adjacent lands, the remaining riparian habitat along the Sacramento River should be considered extremely important in the perpetuation of bird and mammal populations of the valley.

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APPENDIX

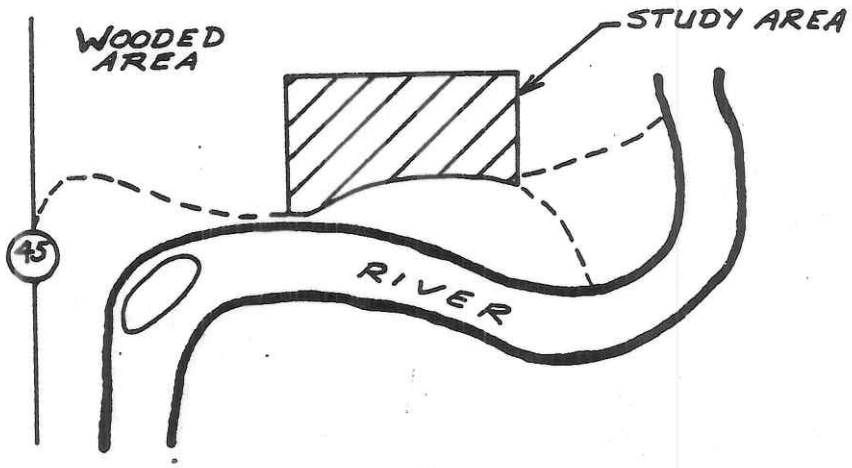
Study Area Descriptions

Site and Vegetation Description, Area I

Location: West bank of river, 1.75 miles north of Princeton (T18N, R1W, Sec.8)

Bank-berm configuration: There is no bank involved, this area was part of a wide flood plain.

Study Area:



Description

An area of very dense growth. Mature cottonwood and box elders predominate with a few black walnut trees. There are heavy mats of poison oak, a few elderberry bushes and scattered dense tangles of blackberry and grape vines.

(Cont.)

Evaluation of Vegetation,

Area I

Overstory

	Rel. Density	Rel. Dominance	Rel. Frequency	Imperial value (Summation)
Cottonwood	58	72	57	187
Box elder	25	26	29	80
Black walnut	17	2	14	33
Elderberry	T	T	T	T

T = Trace

Midstory

Cottonwood	T	T	T	T
Box elder	86	88	75	249
Black walnut	14	12	25	51
Elderberry	T	T	T	T

Understory

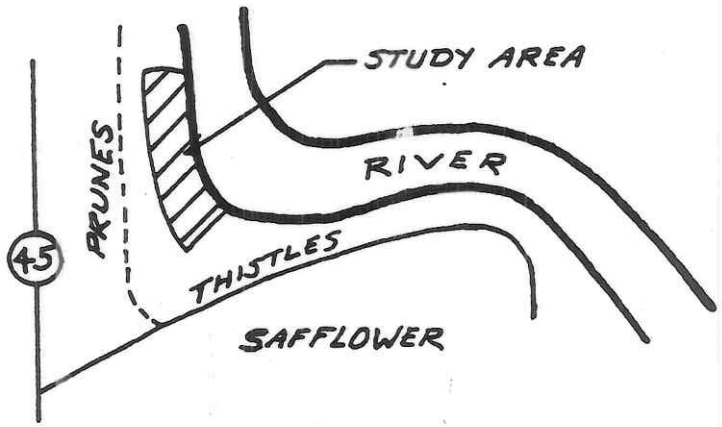
Poison oak	46	40	87
Blackberry	36	35	74
Wild grape	T	9	2
Box elder (seedling)	2	6	9
Sorrel	T	2	2
Mugwort	11	4	16
Blue wild rye	5	4	10

Site and Vegetation Description, Area II

Location: West bank of river, 0.75 miles west od Cachil Dehe Rancheria (T17N, R2W, Sec. 25)

Bank-berm configuration: A 15 foot-wide bank area, rocked quite some time ago. Study area is part of a wide flood plain.

Study area:



Description

A relatively open woodland of mature cottonwoods that clearly predominate over other overstory species. Midstory is a fairly even mixture of cottonwood, arroyo willow and valley oak. Understory is dense wild rose in one section, poison oak throughout, and a few grape vines.

(Cont.)

Evaluation of Vegetation,

Area II

Overstory

	Rel. Density	Rel. Dominance	Rel. Frequency	Imperial value (Summation)
Cottonwood	94	99	80	273
Arroyo willow	6	1	20	27
Black walnut	T	T	T	T
Valley oak	T	T	T	T
Elderberry	T	T	T	T
Box elder	T	T	T	T
Oregon ash	T	T	T	T
Sandbar willow	T	T	T	T

Midstory

Cottonwood	33	12	50	95
Arroyo willow	42	29	25	96
Black walnut	8	1	13	22
Valley oak	17	58	12	87
Elderberry	T	T	T	T
Box elder	T	T	T	T
Oregon ash	T	T	T	T
Sandbar willow	T	T	T	T

Understory

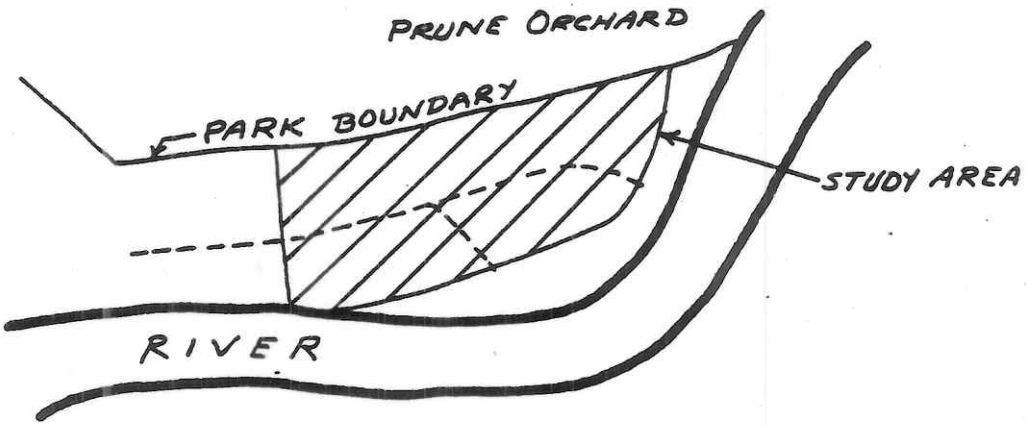
Poison oak		46	23	69
Calif. blackberry		8	18	26
Wild grape		1	5	6
Box elder (seedling)		T	T	T
Correl		T	T	T
Mugwort		21	19	40
Blue wild rye		23	26	49
Wild rose		1	9	10

Site and Vegetation Description, Area III

Location: Within borders of Colusa-Sacramento River State Park (T16N, R1W, Sec. 19)

Bank-berm configuration: Study area was part of a wide flood plain, no bank was involved.

Study area:



Description

This is essentially an open woodland dominated by mature cottonwoods. Interspersed are a few arroyo willow and black walnuts. The midstory largely consists of box elder. The understory, when not covered with flood sediments, includes poison oak, arroyo willow seedlings and annual rye grass.

(Cont.)

Evaluation of Vegetation,

Area III

Overstory

	Rel. Density	Rel. Dominance	Rel. Frequency	Imperial value (Summation)
Cottonwood	63	90	67	220
Arroyo willow	37	10	33	80
Box elder	T	T	T	T
Black walnut	T	T	T	T

Midstory

Cottonwood		T	T	T
Arroyo willow		T	T	T
Box elder	93	83	75	251
Black walnut	7	17	25	49
Long leaf willow	T	T	T	T

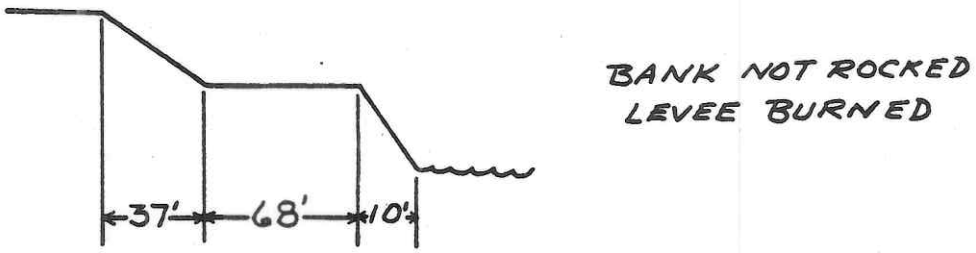
Understory

Poison oak	T	2	2
Calif. blackberry	T	T	T
Wild grape	4	2	6
Box elder (seedlings)	8	23	31
Sorrel	3	5	8
Mugwort	1	7	8
Blue wild rye	4	1	5
Arroyo willow (seedlings)	18	35	53
Cottonwood (seedlings)	·1	9·	10
Annual rye grass	61	16	77

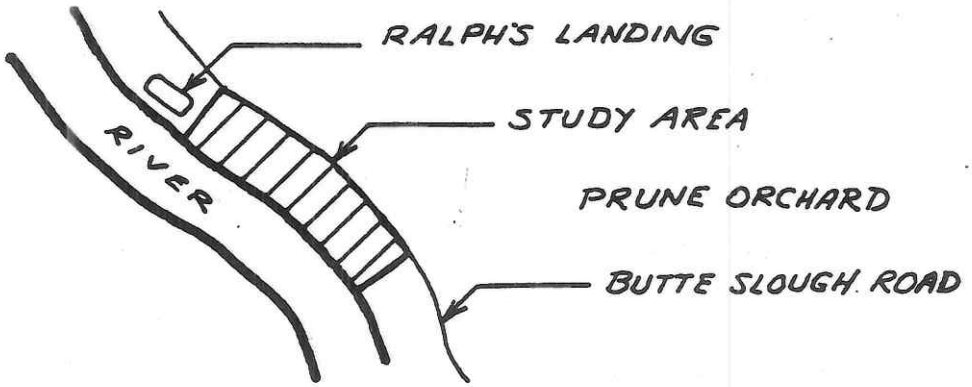
Site and Vegetation Description, Area IV

Location: East bank of river, 1.0 miles south of Colusa (T16N, R1W, Sec. 28-29)

Bank-berm configuration:



Study area:



Description

A relatively open area of mature cottonwoods and willows. Understory consists primarily of blue wild rye, mugwort, annual rye grass and wild grape.

(Cont.)

Evaluation of Vegetation,

Area IV

Overstory

	Rel. Density	Rel. Dominance	Rel. Frequency	Imperial value (Summation)
Cottonwood	54	76	43	173
Arroyo willow	20	11	14	45
Valley oak	T	T	T	T
Elderberry	6	T	15	21
Black locust	14	2	14	30
Sycamore	6	11	14	31
Box elder	T	T	T	T

Midstory

Cottonwood	T	T	T	T
Arroyo willow	56	87	33	176
Valley oak	5		17	22
Elderberry	6	5	17	28
Black locust	5	6	16	27
Sycamore	T	T	T	T
Box elder	28	2	17	47

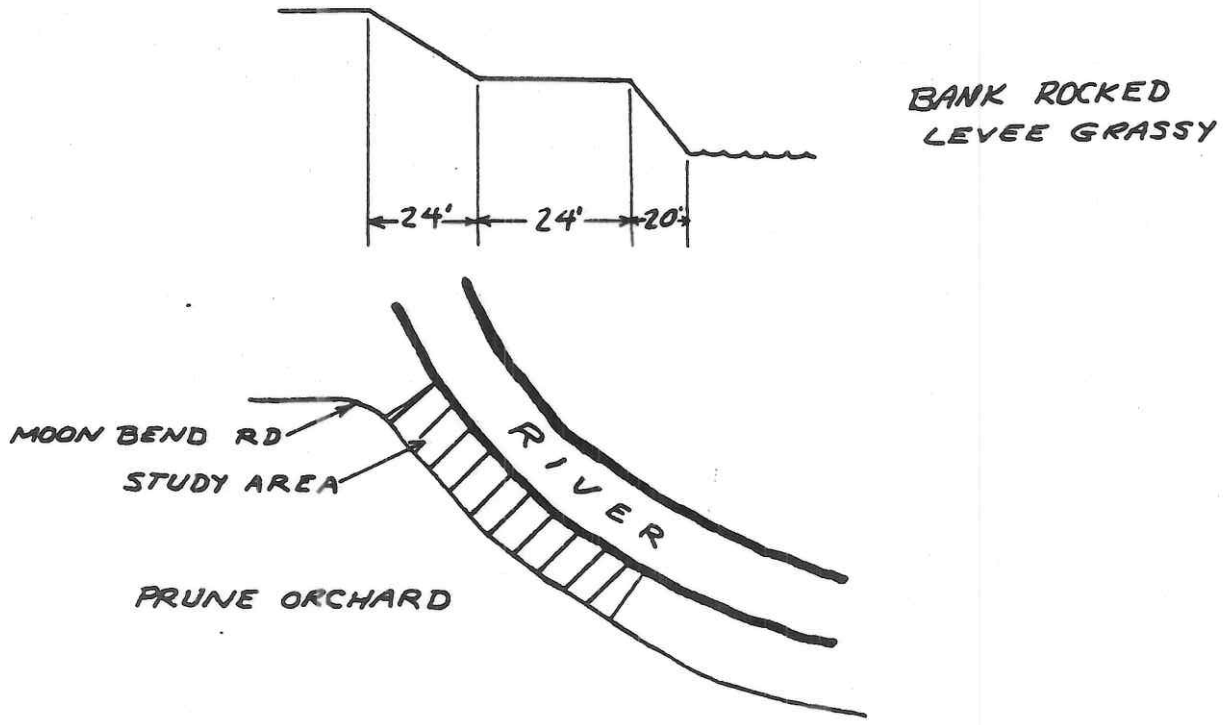
Understory

Poison oak		2	8	10
Calif. blackberry		9	6	15
Wild grape		10	7	17
Box elder (seedlings)				
Sorrel		1	4	5
Mugwort		27	21	48
Blue wild rye		43	27	70
Annual rye grass		9	27	36

Site and Vegetation Description, Area V

Location: On west bank of river along Moon Bend Road (T16N, R1W, Sec. 32-33)

Bank-berm configuration:



Description

This area is nearly 100 percent cottonwoods of an even age class. All vegetation is in a narrow band at the junction of the bank and berm. There are a few grape vines, poison oak vines and young willows.

(Cont.)

Evaluation of Vegetation,

Area V

Overstory

	Rel. Density	Rel. Dominance	Rel. Frequency	Imperial value (Summation)
Cottonwood	84	91	67	242
Arroyo willow	16	9	33	58
Black locust	T	T	T	T
Poison oak	T	T	T	T
Oregon ash	T	T	T	T

Midstory

Cottonwood	11	25	14	50
Arroyo willow	34	47	29	110
Black locust	11	13	14	38
Poison oak	11	3	15	29
Oregon ash	33	12	28	73

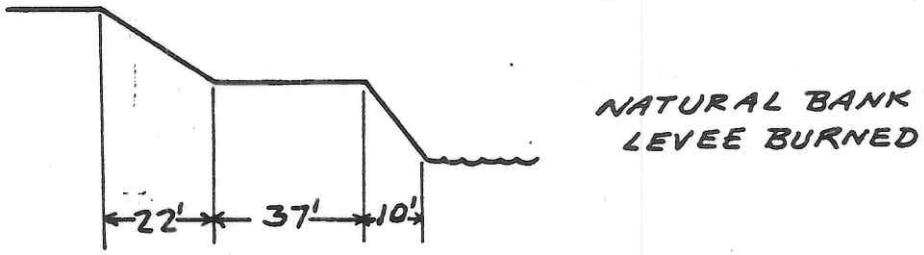
Understory

Poison oak			9	11
Calif. blackberry		10	14	24
Wild grape		T	2	2
Valley oak		T	2	3
Blue wild rye		T	3	3
Wild oats		70	46	116
Convolvulus		13	11	24
Lupine		T	2	2
Black walnut (seedlings)		T	1	1
Filaree		5	9	14

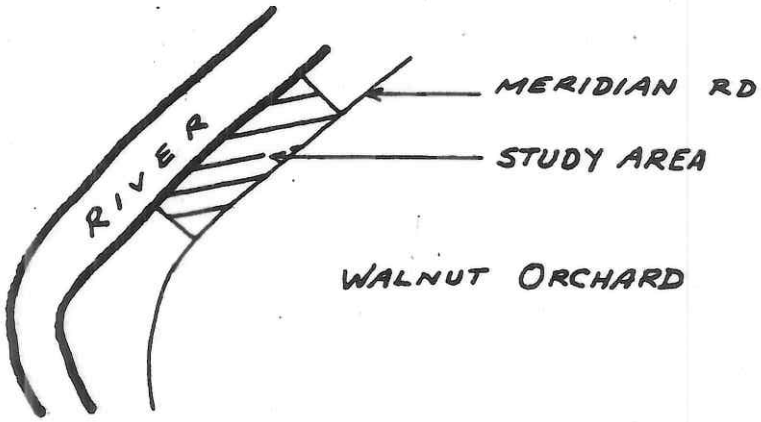
Site and Vegetation Description, Area VI

Location: East bank of river, 3.5 miles north of Meridian, along Meridian Road (T15N, R1W, Sec. 2)

Bank-berm configuration:



Study area:



Description

This area has a number of mature sycamore and black locust trees with a few Oregon ash. Midstory is primarily elderberry and small black locusts. Wild oats predominate in the understory.

(Cont.)

Evaluation of Vegetation,

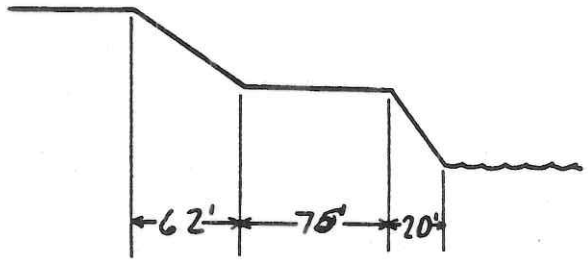
Area VI

	Rel. Density	Rel. Dominance	Rel. Frequency	Imperial value (Summation)
Overstory				
Cottonwood				
Oregon ash	20	10	33.3	63
Elderberry				
Sycamore	34	44	34	112
Black locust	46	46	33	125
Arroyo willow				
Midstory				
Cottonwood	T	T	T	T
Oregon ash	3	4	17	24
Elderberry	57	56	33	146
Sycamore	3	9	17	29
Black locust	37	31	33	101
Arroyo willow	T	T	T	T
Box elder	T	T	T	T
Understory				
Blue wild rye				
Calif. blackberry		15	7	22
Wild grape				
Canary grass		4	3	7
Sorrel			4	4
Mugwort		2	13	15
Elderberry			1	1
Wild oats		70	28	98
Filaree			14	14
Star thistle			2	2
Convolvulus			13	13
Wild cucumber		9	13	22

Site and Vegetation Description, Area VII

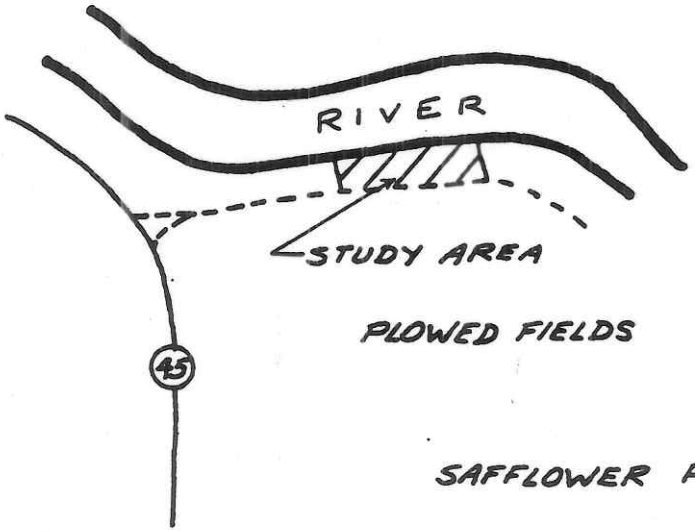
Location: South bank of river, 0.75 miles east of Grand Island (T14N, R1E, Sec. 15)

Bank-berm configuration:



BANK ROCKED
LEVEE BURNED

Study area:



Description

A relatively open woodland of young cottonwoods with a few blackberries and grapes in the understory. Box elder, valley oak, coyote bush and mule fat make up the midstory.

(Cont.)

Evaluation of Vegetation,

Area VII

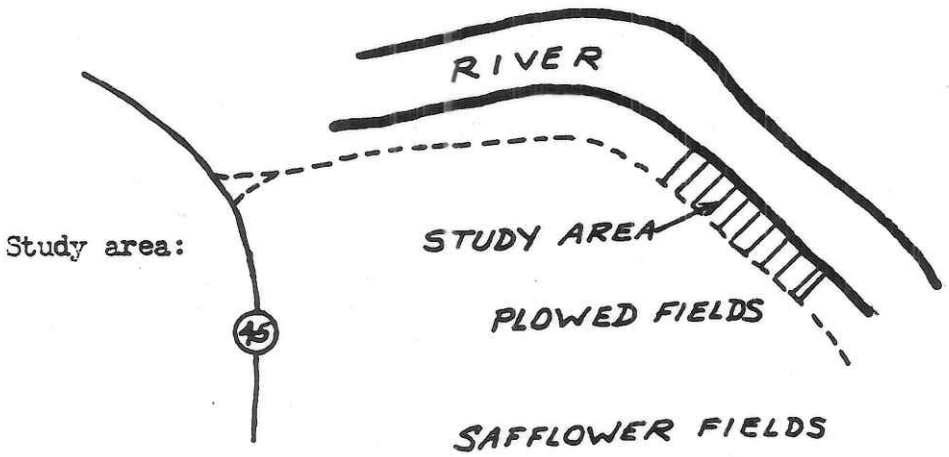
Overstory

	Rel. Density	Rel. Dominance	Rel. Frequency	Imperial value (Summation)
Cottonwood	90	92	67	249
Box elder	T	T	T	T
Valley oak	T	T	T	T
Arroyo willow	10	8	33	51
Oregon ash	T	T	T	T
Midstory				
Cottonwood	T	T	T	T
Box elder	55	64	37	156
Valley oak	13	25	36	74
Coyote bush	8	3	9	20
Mule fat	24	8	18	50
Arroyo willow	T	T	T	T
Oregon ash	T	T	T	T
Understory				
Poison oak			2	2
Calif. blackberry		38	19	57
Wild rose		17	3	20
Box elder (seedlings)		9	14	22
Sorrel		3	12	15
Mugwort		12	19	31
Wild barley		17	17	34
Valley oak (seedlings)			3	3
Coyote bush			3	3
Canary grass				
Annual rye grass		3	4	7

Site and Vegetation Description, Area VIII

Location: South bank of river, 0.8 miles east of Grand Island (T14N, R1E, Sec. 15)

Bank-berm configuration:



Description

This area was primarily devoid of all woody vegetation at the start of the study in August, 1973. A very few small sandbar willows and cottonwood seedlings were becoming established toward the end of the study. A replanting of Atriplex sp. had been attempted, but the plants were accidentally burned during regular levee maintenance procedures.

(Cont.)

Evaluation of Vegetation,

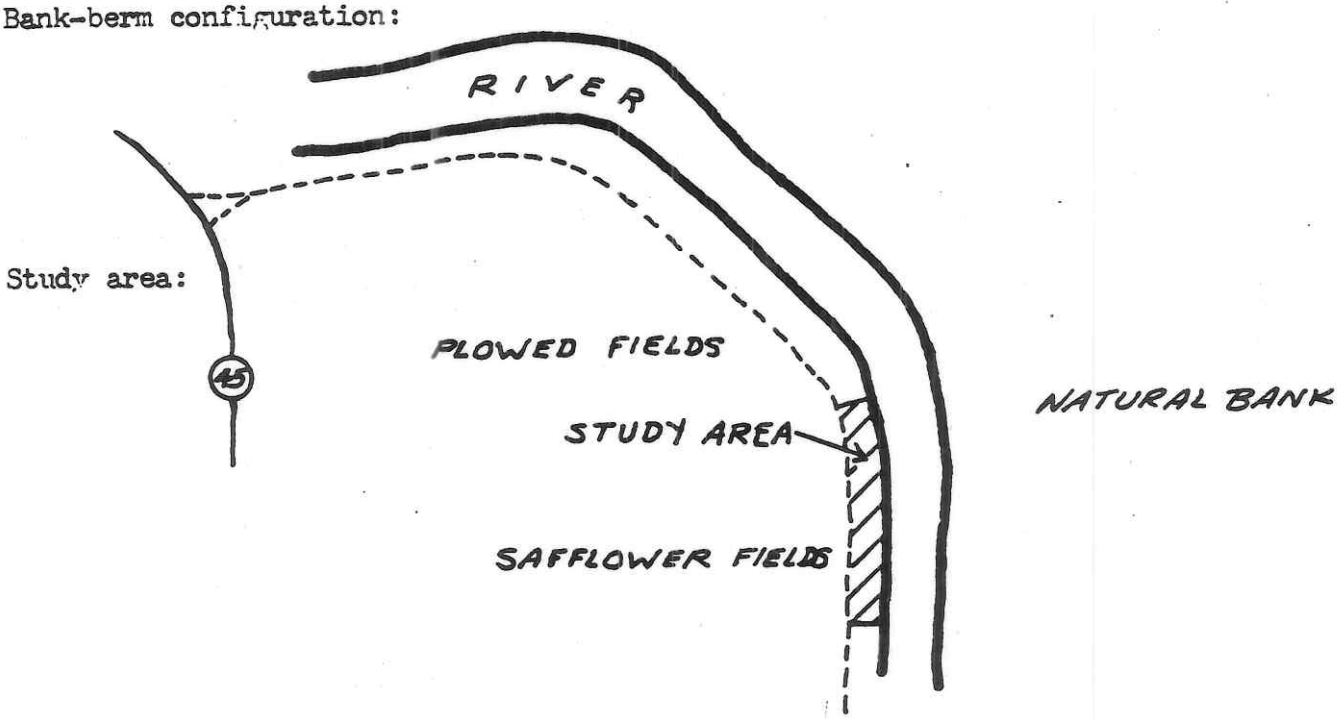
Area VIII

	Rel. Density	Rel. Dominance	Rel. Frequency	Imperial value (Summation)
Overstory				
NONE				
Midstory				
Sandbar willow	100	100	100	100
Understory				
Sandbar willow		44	22	66
Sorrel		24	24	48
Cottonwood (seedlings)		T	9	9
Canary grass		T	2	2
Filaree		5	5	10
Perennial rye grass		5	6	11
Composites		T	2	2
Assorted forbs		22	30	2

Site and Vegetation Description, Area IX

Location: South bank of river, 0.85 miles east of Grand Island (T14N, R1E, Sec. 15)

Bank-berm configuration:



Description

This is essentially an even-age stand of cottonwoods. The midstory is also dominated by smaller cottonwood and sandbar willow. Sorrel, California blackberry and cottonwood seedlings make up the understory.

(Cont.)

Evaluation of Vegetation,

Area IX

Overstory

	Rel. Density	Rel Dominance	Rel. Frequency	Imperial value (Summation)
Cottonwood	9[illegible]	98	75	270
Sandbar willow				
Oregon ash			25	31

Midstory

Cottonwood	35	78	42	155
Sandbar willow	52	4	33	89
Oregon ash	10	18	17	45
Mule fat	3	T	8	11

Understory

Calif. blackberry		32	10	42
Wild grape		6	2	8
Sorrel		5	46	51
Cottonwood (seedlings)		57	38	95
Mule fat		T	2	2
Coyote bush		T	2	2