State of California
THE RESOURCES AGENCY
Department of Fish and Game

Sacramento Valley Critical Riparian Forest Inventory [1]

by

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August 1978

ABSTRACT

During late spring and summer of 1978, a study was conducted in the
Upper Butte Basin of the Sacramento Valley to document the vegetation
and wildlife resources of riparian zones, and to provide a data base
from which management decisions appropriate to the preservation of
this habitat type may be made. Three study areas of low-terraced ri-
parian growth were selected along the Sacramento River in Glenn and
Colusa counties, and one along Butte Slough in Sutter County.

A total of 51 species of birds, including the state-listed rare
California Yellow-billed Cuckoo (Coccyzus americanus mearnsi) were
observed, with an average nesting density of 15.6 pairs of birds per
hectare. Sixteen mammal species were noted by direct observation, analysis
of tracks and scats, and snap trapping. A quantitative vegetation analysis
showed 48 plant species occurring in a layered structure forming rather
distinct overstory, midstory and understory components. Major plant asso-
ciations of each study area were mapped.

RECOMMENDATIONS

As a result of this study the following is recommended:

1. Develop an effective working relationship with landowners and other governmental agencies concerning the preservation of riparian forest.

2. Acquire additional riparian areas through purchase or easement.

3. Adopt zoning ordinances to make it economically feasible for landowners to preserve riparian vegetation.

4. Include riparian forests under guidelines of the Forest Practice Act.

5. Evaluate current bank protection techniques and recommend alternative methods minimizing habitat destruction.

6. Conduct additional wildlife inventories within the riparian community throughout the state, and during periods other than bird breeding seasons.

INTRODUCTION

The vegetation and wildlife resources of four riparian areas along the Sacramento River were studied from 23 May to 9 August 1978. The areas surveyed, in Glenn, Colusa and Sutter counties, contain riparian forest habitat that the Department wishes to acquire, either through long-term leases or purchase. Analyses of the vegetation and avian and mammalian faunal components were made to document the wildlife resources of a diminishing habitat type, riparian forest, and to provide a data base from which management decisions appropriate to the preservation of this habitat type may be made.

The Sacramento River and other rivers of the Sacramento Valley historically have supported extensive riparian forests. In the mid-nineteenth century the riparian forests of California, still in a pristine state, were several miles wide in places and occupied the natural levees of the river system (Thompson 1961). It was estimated that 800,000 acres of riparian vegetation bordered the Sacramento River in 1848 (Roberts et. al. 1977). Discovery of gold in California in 1849 and subsequent settling of the Central Valley, led to changes in land use. Few habitat types in California have been affected more adversely by land use changes than riparian forests.

The coarse, well aerated, highly fertile soils that allowed the proliferation of the riparian forest also were sought by early settlers for agriculture. Much land sustaining riparian forest subsequently was cleared, a process that continues today. The effects of agriculture, streambank stabilization, channelization and other water control activities reduced the 800,000 acres of riparian growth that lined the Sacramento River in 1848 to 20,000 acres in 1952 and to 12,000 acres in 1972 (Smith 1977). From 1952 to 1972, along 164 miles of the Sacramento River between Redding and Colusa, 8,600 acres of high terraced riparian lands have been converted to agricultural uses. In 1972, 7,810 acres of riparian vegetation remained on these high terraced lands (McGill 1975).

Riparian vegetation is one of the most valuable habitats in California in terms of the diversity and density of wildlife it supports (California Department of Fish and Game 1965). Recent studies (Brumley 1976, Stone 1976, Michney et. al. 1975, Gaines 1974, 1977) have again demonstrated the value of riparian forest habitat to wildlife. Some species such as California's rare Yellow-billed Cuckoo, are dependent upon riparian forests for their continued existence.

Riparian forest is also of value in a hydrological sense; in many areas it is considered to be beneficial to flood control projects. A recent report to the Department of Water Resources concluded that key stands of riparian vegetation along the Sacramento River "stabilize the river channel, protect levees from wind driven wave wash, reduce bank erosion, assist in maintaining hydraulic control for the proper operation of the Sacramento River Flood Control Projects and in some instances protect flood control project features from potentially damaging high velocity flows" (Murray et. al. 1978) (Figure 1). Study area I, the only large stand of riparian vegetation for a reach of over 5 river miles, and study area II are considered key stands of riparian vegetation in the previously cited report.

Figure 1a. Loss of low-terraced riparian forests to orchards along the
Sacramento River.

Figure 1b. Bank erosion due to orchards replacing riparian vegetation.

Three study areas were selected for wildlife inventories and analysis of plant cover along the Sacramento River. A vegetation analysis only was conducted on a fourth area, bordering Butte Slough (Figure 2). All four areas flood to varying degrees on a yearly basis. Major habitat types found in the study areas included cottonwood forest, river shrub, river grassland, gravel bar, and oak woodland (Figure 3).

Study area I is located 6.9 km (4.3 mi) north of Glenn, Glenn County, on the west bank of the Sacramento River between river mile 179.8 and 181.6 (mileage is upstream from the mouth of the Sacramento River at Collinsville). A riparian forest of cottonwood and willow dominates 59% of this 59 ha (146 acres) study area. A large gravel bar is found between the forested area and the river and a successional riparian grassland intrudes into the northern part of the riparian forest.
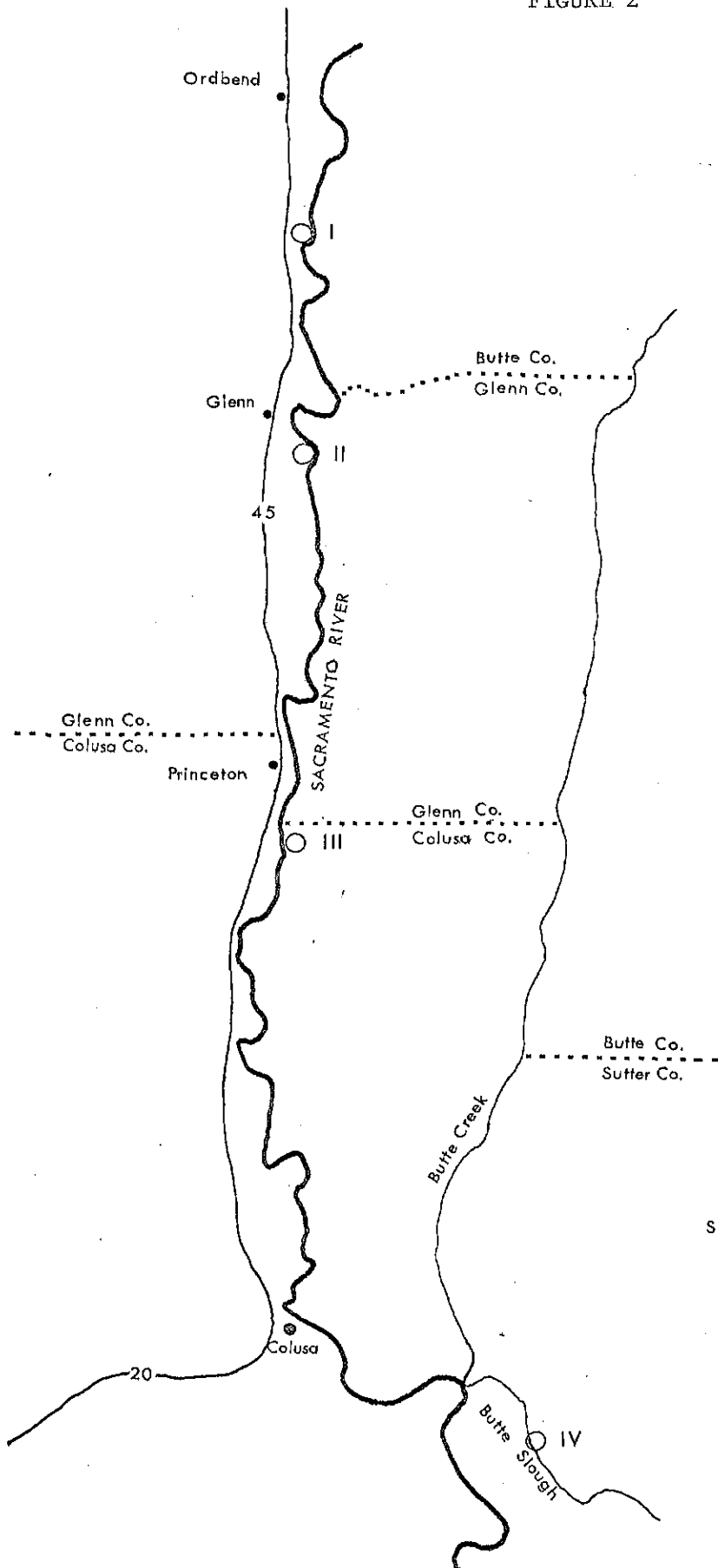
Study area II is located 2.4 km (1.5 mi) south of Glenn, Glenn County, on the west bank of the Sacramento River between river mile 172 and 173. This 65 ha (160 acres) study area is on the inside or growing edge of a river bend. As a result, the habitat types form parallel strips with a gravel bar adjacent to the river. A riparian shrub strip occurs between the gravel bar and the predominantly cottonwood riparian forest. Each of these three habitat types cover approximately equal areas, with the riparian forest covering 31% of this study area.

Study area III is located 2.4 km (1.5 mi) south of Princeton, Colusa County, on the east bank of the Sacramento River between river mile 161 and 162. A riparian forest covers 72% of this, the largest of the four study areas at 104 ha (257 acres). However, valley oak is an important constituent of the forest along with cottonwood and willow. This study area is further differentiated from the other study areas by the presence of a 2.15 km (1.34 mi) long oxbow and two small ponds. Successional riparian grasslands and shrublands separate the river from the riparian forest.

Study area IV is located on both sides of Butte Slough in Sutter County and is in the south half of Section 6, R1E, T15N. Habitat is broken into numerous blocks with riparian grasslands the most abundant habitat type, but comprising only 44% of the study area's 53 ha (131 acres). The riparian forest is primarily an even-age stand of cottonwood. A separate habitat of oak woodland composed entirely of valley oak also is present.

FIGURE 2

Ordbend

I

Location of the four riparian
forest study areas in the
Upper Butte Basin of the Sacramento
Valley, 1978.

Butte Co.
Glenn Co.

Glenn

II

4 5

SACRAMENTO RIVER

Glenn Co.
Colusa Co.

Princeton

Glenn Co.
Colusa Co.

III

Butte Co.
Sutter Co.

Butte Creek

Scale 1:250,000

Colusa

20

Butte Slough

IV

Figure 3a. Cottonwood forest riparian community along the Sacramento River.

Figure 3b. River grassland riparian community.

Figure 3c. River shrub riparian community.

Figure 3d. Gravel bar.

Vegetation

Vegetation sampling and analysis of the riparian forest habitat type was accomplished by using the plotless point-quarter method of Cottan and Curtis (1956) for the overstory and midstory components, while the quadrat method described by Cox (1972) was utilized to evaluate the understory. All plants over 7.6 m (25 ft) in height were considered part of the overstory while plants 1.5 m (5 ft) to 7.6 m in height formed midstory vegetation. Plants less than 1.5 m in height were classified as part of the understory. Points for data collection were randomly selected along transect trails previously established for the collection of bird census data.

Avian Species

Avian populations in the riparian forests were sampled by transect methods described by Emlen (1971, 1977) to estimate nesting density. A transect of 600 m (1968 ft) was established on two of the study areas while a 900 m (2953 ft) transect was established on study area III. The effective width of these transects was 125 m (410 ft). Birds were censused along each transect once a week for 10 weeks. The census period ran between 23 May and 4 August 1978. Bird counts were initiated and completed between 0615 and 1015 hours due to the adverse effects of afternoon heat on bird activity. Transects were limited to the riparian forest habitat type described by Stone (1976) as climax low terrace habitat or described by Brumley (1976) as the cottonwood forest plant community.

A tape recording of the Yellow-billed Cuckoo was utilized to elicit calls and to verify the existence of this rare bird on the three main study areas.

Temperatures fluctuated during the census period with lows of $10^{o}C$ ($50^{o}F$) to $25^{o}C$ ($77^{o}F$) and highs of $13^{o}C$ ($55^{o}F$) to $32^{o}C$ ($90^{o}F$). Cloud cover was variable, but censusing only took place on fair days with little or no wind.

Mammals

An attempt to quantify small mammal numbers using a declining rate of capture method (Cox 1972) was made on each of the three main study areas. A 50 m by 50 m (164 ft by 164 ft) grid was established on study area I with trap sites every 5 m (16 ft). A "Victor" rat trap and 2 mouse traps baited with a mixture of peanut butter and oats, and placed approximately 46 cm (18 in) apart, comprised a trap site. Trap site spacing was increased to 10 m (33 ft) between adjacent stations on study areas II and III, and grid shapes were altered to 100 m by 100 m (328 ft by 328 ft) and 10 m by 500 m (33 ft by 1640 ft) respectively.

Trapping was performed on the three study areas from mid-June through late July. In each area, trapping was conducted for five consecutive nights resulting in 500 trap station nights (1500 trap nights) per study area.

Large mammals were noted by direct observation or by analyzing tracks or scats.

Vegetation

The riparian forest studied contained 48 species of plants in a layered structure forming rather distinct overstory, midstory and understory components (Table 1). Despite this floral diversity the vegetation of each layer was dominated by fewer species (Table 2). Relative figures for density, dominance, and frequency along with a relative importance value (importance as to the habitat's floral composition) were calculated (Cox 1972) for plants occurring in the vegetation sampling. The results of these calculations and habitat maps of each study area are provided in the appendix. Relative values for density in the understory were not calculated due to difficulties encountered in determining individual plants of such species as wild grape, blackberry, and poison oak.

There was a great deal of similarity in the vegetation composition of study areas I, II, and III. The riparian forests at these areas were dominated by cotton-woods as was part of the riparian forest at study area IV. However, the dominant midstory and understory components differed at study area IV (Table 2). Also, an oak woodland constituted a substantial amount of the riparian forest found at study area IV. The oak woodland was found further from water and represents the forest development in more xeric situations where periodic flooding is uncommon.

Avian species

Forty-two species of birds were observed in the three study areas; however, only 24 species were present in numbers large enough to calculate density values (Table 3). The nesting densities, pairs of birds per hectare (bph) of sampled habitat and number of species were as follows: study area I, 16 bph with 22 species; study area II, 18 bph with 21 species; study area III, 13 bph with 23 species. It should be noted that other breeding species were observed during the censuses but were not included in calculations due to insufficient data.

Other species observed along the banks of the Sacramento River or nesting in the parcel under study, though not included in the census were: Mallard (Anas platyrhynchos), Swainson's Hawk (Buteo swainsoni), Killdeer (Charadrius vociferus), Forster's Tern (Sterna forsteri), Belted Kingfisher (Megaceryle alcyon), Black Phoebe (Sayornis nigricans), Bank Swallow (Riparia riparia), Rough-winged Swallow (Stelgidopteryx ruficollis), and Tricolored Blackbird (Agelaius tricolor).

A heronry of approximately 21 Great-blue Heron nests and 10 Great Egret nests was observed on the east bank of the Sacramento River directly across from study area I. The heronry was located in a clump of large sycamores and cottonwoods that probably contained many more nests than the number observed. A second heronry of at least 22 Great-blue Heron nests and 15 Great Egret nests occupied several large cottonwoods approximately 100 meters from the transect trail in study area III.

Sightings and activity of Yellow-billed Cuckoos were noted on study areas I, II, and III. The first cuckoo was observed on study area I on 8 June when it flew into view in response to a tape recorded call. Only one cuckoo was apparent at this time. The cuckoo was again heard on 13 June. The tape recorded call did not elicit a response, so its use was discontinued. Gaines (1974) has established

Table 1. Major plant species found on the four riparian study areas.

Plant Species		Over-story	Mid-story	Under-story
Fremont cottonwood	(Populus Fremontii)	X	X	
Box elder	(Acer Negundo)	X	X	X
Oregon ash	(Fraxinus latifolia)	X	X	X
Valley oak	(Quercus lobata)	X	X	X
Black walnut	(Juglans Hindsii)	X	X	X
Willow sp.	(Salix sp.)	X	X	
Sycamore	(Platanus racemosa)	X		
Blue elderberry	(Sambucus caerulea)		X	
Poison oak	(Rhus diversiloba)		X	X
California wild rose	(Rosa californica)		X	X
California wild grape	(Vitis californica)		X	X
California blackberry	(Rubus vitifolius)			X
Buttonwillow	(Cephalanthus occidentalis)		X	
Fig	(Ficus Carica)		X	X
Dutchman's pipe	(Aristolochia californica)			X
Bed straw	(Galium Aparine)			X
Mugwort	(Artemisia Douglasiana)			X
Wild cucumber	(Marah fabaceus)			X
Horseweed	(Conyza canadensis)			X
Cockelbur	(Xanthium strumarium)			X
Small-flowered nightshade	(Solanum nodiflorum)			X
Baltic rush	(Juncus balticus)			X
Gum plant	(Grindelia camporum)			X
Bird's foot trefoil	(Lotus corniculatus)			X
Common spikeweed	(Hemizonia pungens)			X
Bulrush	(Scirpus sp.)			X
Nettle	(Urtica holosericea)			X
Shepherd's purse	(Capsella sp.)			X
Old man of spring	(Senecio vulgaris)			X
Bermuda grass	(Cynodon Dactylon)			X
Foxtail	(Hordeum jubatum)			X
Italian ryegrass	(Lolium multiflorum)			X
Curly dock	(Rumex crispus)			X
Blue wildrye	(Elymus glaucus)			X
Ripgut grass	(Bromus diandrus)			X
Horsetail	(Equisetum sp.)			X
Common chickweed	(Stellaria media)			*
Dog fennel	(Anthemis Cotula)			*
White sweet clover	(Melilotus albus)			*
Yellow sweet clover	(Melilotus indicus)			*
Rabbit's-foot grass	(Polypogon monspeliensis)			*
Star thistle	(Centaurea solstitialis)			*
Vetch	(Vicia sp.)			*
Johnson grass	(Sorghum halepense)			*
Wild oat	(Avena fatua)			*
Soft chess	(Bromus mollis)			*
Poison hemlock	(Conium maculatum)			*
Undetermined grass				X

*Not encountered during plant transects.

Table 2. Distribution of major plant species on the four riparian study areas.

| Species | \
Study Areas | | | | |
|---|---|---|---|---|---|
| | I | II | III | IV a [1] | b [2] |
| **Overstory** | | | | | |
| Cottonwood | X | X | X | X | |
| Willow sp. | X | | X | | |
| Valley oak | | | X | | X |
| **Midstory** | | | | | |
| Blue elderberry | X | X | X | | |
| Box elder | X | X | X | X | |
| Black walnut | X | X | X | | |
| California wild grape | | | X | | |
| Oregon ash | | | | X | |
| Buttonwillow | | | | X | |
| Willow sp. | X | | | | |
| Valley oak | | | | X | |
| **Understory** | | | | | |
| Mugwort | X | X | | | |
| Poison oak | X | X | X | X | |
| Box elder | X | | X | | |
| California blackberry | X | X | X | | |
| Grasses | X | | | | |
| California wild grape | | X | X | X | |
| Cockelbur | | | | X | |
| Italian rye grass | | | | | X |
| Common spikeweed | | | | | X |
| Oregon ash | | | | X | |

1/ Cottonwood forest   2/ Valley oak woodland

Table 3. Species density (pairs per 100 hectares) of comparable riparian forest.

	A[1/]	B[2/]	I	II	III
					[3/]*
Great Blue Heron *Ardea herodias*					
Great Egret *Casmerodius albus*					*
Wood Duck *Aix sponsa*					*
Turkey Vulture *Cathartes aura*			*	*	*
Red-Tailed Hawk *Buteo jamaicensis*		*	*	*	*
American Kestrel *Falco sparverius*			*	*	
California Quail *Lophortyx californicus*	80	29	33	40	*
Ring-necked Pheasant *Phasianus colchicus*				*	
Mourning Dove *Zenaida macroura*		*	6.5	37.5	3.5
Yellow-billed Cuckoo *Coccyzus americanus*		*	*	*	*
Great Horned Owl *Bubo virginianus*		*		*	*
Hummingbird sp.			*		
Common Flicker *Colaptes auratus*		*		*	*
Downy Woodpecker *Picoides pubescens*		29	54	30	22
Nuttall's Woodpecker *Picoides nuttallii*	330	48	111.5	111.5	71
Western Kingbird *Tyrannus verticalis*	160		*	26.5	9
Ash-throated Flycatcher *Myiarchus cinerascens*	250	39	61.5	91.5	91.5

Table 3 (cont.)

	A[1]	B[2]	Study Areas I	II	III
Western Flycatcher Empidonax difficilis	160		*		*
Western Wood Pewee Contopus sordidulus		43	148.5	166.5	72
Tree Swallow Iridoprocne bicolor		*	*	*	*
Scrub Jay Aphelocoma coerulescens	330	34	44	53	38.5
Yellow-billed Magpie Pica nuttalli				*	
Plain Titmouse Parus inornatus	330	29	143.5	106.5	106.5
Bushtit Psaltriparus minimus		29	47	*	22
White-breasted Nuthatch Sitta carolinensis		*	20	*	14.5
House Wren Troglodytes aedon		29	16.5	53	24.5
Bewick's Wren Thryomanes bewickii	250	77	224	107	220
Mockingbird Mimus polyglottos				*	
American Robin Turdus migratorius		48	16.5	80	15.5
Starling Sturnus vulgaris			10	26.5	11
Yellow warbler Dendroica petechia		*	*	*	
Townsend's Warbler Dendroica townsendi				*	
Common Yellowthroat Geothlypis trichas	410	*			
Yellow-breasted Chat Icteria virens	160	*		*	

Table 3 (cont.)

	A[1]	B[2]	Study Area I	II	III
Wilson's Warbler Wilsonia pusilla			*		
Northern Oriole Icterus glabula	80	48	26.3	135	84.5
Brewer's Blackbird Euphagus cyanocephalus	80				
Brown-headed Cowbird Molothrus ater	80	39	120	133	66.5
Western Tanager Piranga ludoviciana					*
Black-headed Grosbeak Pheucticus melanocephalus	410	125	190.5	186.5	93
Lazuli Bunting Passerina amoena	80	*		*	26.5
House Finch Carpodacus mexicanus		34	16.5	66.5	27.5
American Goldfinch Carduelis tristis		77	16.5	10	15.5
Lesser Goldfinch Carduelis psaltria		*			
Rufous-sided Towhee Pipilo erythrophathalmus	750	60	250	261.5	211.5
Brown Towhee Pipilo fuscus	80	*	20	26.5	46.5
Song Sparrow Melospiza melodia	80				

1/ Stone (1976) Climax Low Terrace April-June 1973 mapping quadrat method.

2/ Gaines (1973) Cottonwood Forest (Study Area I) April-June 1973 mapping quadrat method.

3/ Data insufficient for density determination or transient.

that cuckoos rarely respond to tape recorded calls after the first day. Other detections of the presence of cuckoos occurred on 21 June, 27 June, and 12 July when two separate cuckoos were heard in what appeared to be one established territory of 10 to 12 hectares. The last observation of a cuckoo occurred on 19 July with an individual appearing to have a tail only half the size of those previously observed. The bird appeared normal in all other respects and it was assumed that this sighting was of a juvenile or of a moulting adult. No nest or direct evidence of a successful breeding attempt was observed during the course of the study.

A Yellow-billed Cuckoo was first observed on study area II on 14 June when a single individual responded and flew toward the tape recorded call. This individual, a female, was observed for approximately 35 minutes while it called in a second cuckoo. After a period of exaggerated tail wagging and vocalization by the female (the male was perched above the female and not visable), an attempt at copulation was observed. Cuckoos were again noted on the study area on 29 June, 6 July, 10-15 July, 20 July and 3 August. The single individual of 3 August was assumed to be a transient because of its direct movement through the study area. No nest or direct evidence of a successful breeding attempt was observed. The cuckoos occupied an area of approximately 12 hectares.

The first observation of a Yellow-billed Cuckoo on study area III occurred on 15 June when a single bird responded to the recorded call. The presence of a cuckoo on this study area was not noted again until 20 July, 24 July and 4 August when on each occasion a single individual was heard calling. Although a breeding territory may have been established on this study area, it seems more likely that the observed birds were transients.

Mammals

The presence of 16 species of mammals on the four study areas was established by snap trapping, direct observation, and analysis of tracks and scats (Table 4). A total of 23 mammals of 5 species were captured in study area I. Study area II yielded only 1 mammal, while 24 mammals of 4 species were caught in study area III (Table 5).

The ornate shrew and western harvest mouse made up the largest percentages of the total catch; 35 percent and 23 percent respectively. The total number of mammals captured based on a catch per 100 trap nights for each study area is listed in Table 5. This value ranged from a low of .06 for study area II to a high of 1.6 at study area III. A breakdown of capture per unit effort on a nightly basis for each study area is detailed in Table 6. Understory and its occurrence at each trap site are summarized in Table 7. The density of small mammals calculated from catch per unit effort data with the least squares linear regression technique described by Cox (1972) resulted in 65 small mammals per hectare at study area I and 54 small mammals per hectare at study area III. These figures must be interpreted with caution due to the small amount of data upon which they are based.

DISCUSSION

Avian Species

Perhaps the most obvious reason for the strikingly high diversity and density of bird life inhabiting the riparian forest is the stratification of

Table 4. Mammals observed or detected on study areas.

Species	Study Areas			
	I	II	III	IV
Opossum Didelphis marsupialis	X	X	X	X
Ornate shrew Sorex ornatus	X		X	
Broad-handed mole Scapanus latimanus	X	X	X	X
Black-tailed hare Lepus californicus	X	X	X	X
Western gray squirrel Scirus griseus	X	X	X	X
Botta pocket gopher Thomomys bottae	X	X	X	X
Beaver Castor canadensis	X		X	
Western harvest mouse Reithrodontomys megalotis	X		X	
California vole Microtus californicus	X		X	
Black rat Rattus rattus	X	X	X	
House mouse Mus musculus	X			
Gray fox Urocyon cinereoargenteus	X			
Raccoon Procyon lotor	X	X	X	
Ringtail Bassariscus astutus	X	X	X	
Striped skunk Mephitis mephitis	X	X	X	
Mule deer Odocoileus hemionus	X	X	X	X

Table 5. Summary of mammal snap trapping on three riparian study areas in the Sacramento valley.

SPECIES	STUDY AREA		AGE & SEX			COMMENTS
		Total	Adult	Juvenile	Unkn.	
Ornate shrew	I	7	4M 3F			
Sorex ornatus	II	0				
	III	10	4M 4F	1F	1	2F lact.
Western harvest mouse	I	4	3M 1F			1F lact.
Reithrodontomys megalotis	II	0				
	III	7	5M 2F			
California vole	I	1			1	
Microtus californicus	II	0				
	III	1	1M			
Black rat	I	2	1M 1F			
Rattus rattus	II	1	1M			
	III	6	5M	1M		1M parasitized by nematoda
House mouse	I	9	6M 3F			1F lact.
Mus musculus	II	0				
	III	0				

	STUDY AREA		
	I	II	III
Species/Area	5	1	4
Total Catch	23	1	24
Total Trap Nights/Area	1500	1500	1500
Catch/100 Trap Nights	1.5	.06	1.6

Table 6. Comparison of catch per unit effort of small mammals in each study area.

HABITAT AND METHOD	TRAP NIGHT					TOTAL	$\bar{x}$ [1]	s [2]
	1	2	3	4	5			
Cottonwood Forest I								
50 Meter grid						1500		
Ornate Shrew	1	3	1	1	1	7	1.4	1.4
Western harvest mouse		2			2	4	.8	1.2
California vole				1		1	.2	---
Black rat	1		1			2	.4	1.2
House mouse	3	3	1	2		9	1.8	1.9
Cottonwood Forest II								
100 Meter grid						1500		
Ornate shrew								
Western harvest mouse								
California vole								
Black rat			1			1	.2	---
House mouse								
Cottonwood Forest III								
10 X 500 Meter transect						1500		
Ornate shrew	3	3	3	1		10	2	2.3
Western harvest mouse		1		4	2	7	1.4	2.5
California vole	1					1	.2	---
Black rat	2	1	1	2		6	1.2	1.1
House mouse								

1/ Mean number of animals captured per trap night

2/ Standard deviation

Table 7.   Understory plant species and occurrence within 2 m of trap sites.

PLANT SPECIES	STUDY AREA		
	I	II	III
Bare Ground	3	34	3
Debris	4	10	12
Poison oak	13	25	19
Italian ryegrass	23		24
Undetermined grass	16		2
Blue elderberry	4	1	8
Mugwort	14	2	1
California blackberry	10	24	24
California wild grape	26	18	59
Box elder seedling	5	7	1
Cockelbur	1		
Bed straw	5	7	
Dutchman's pipe		6	2
Wild cucumber		4	2
California wild rose		1	1
Horseweed			8
Yellow sweet clover			1

the forest foliage. The dense, oftentimes closed canopy of the cottonwood forest allows only the growth of a shade tolerant midstory made up of such plants as box elder, blue elderberry, California black walnut, and Oregon ash. An understory of wild grape, blackberry, poison oak and mugwort is frequently present. This large volume of foliage supports a higher diversity and density of birds due to increased surface area for foraging as well as the potential number of nest sites. Densities determined by Gaines (1973) and Stone (1976) in a similiar habitat type (Gaines surveyed study area I five years earlier) but with a different census method have been included for comparison (Table 3). The climax low terrace habitat type of Stone (1976) shows 18 nesting species at 41 bph while the cottonwood-willow forest of Gaines (1973) shows 25 nesting species at 9 bph.

A number of studies, notably MacArthur (1964), have correlated the diversity of bird life with foliage height diversity and foliage volume. Densities were not calculated for flocking birds such as swallows or raptors due to the unreliability of the census technique for these species (Emlen 1971).

Mammals

Mammal trapping data is sparse, since relatively little trapping was conducted. The results should not be used as actual density figures, but may be used in comparing populations of the three study areas. Snap-trapping, direct observations, and analysis of tracks and scats during this study resulted in only a partial list of mammals actually present on the study area.

The apparent lack of small mammals on study area II may be related to the large amounts of sediment and silt deposited by flood waters the previous winter. Consequently, a larger number of traps were associated, at least in part, with bare ground than on other study areas (Table 7). Secondly, the lack of an established ground cover in the form of seed producing grasses (Table 7) may have had some effect on the density of rodents inhabiting the area sampled. Boeer and Schmidly (1977) in comparing the rodent populations of riparian growth, woodland, grassland, and desert shrub communities of Big Bend National Park, found that the riparian community showed the lowest evenness, richness, and diversity figures; one or two species dominated the rodent fauna of the riparian community. A similiar situation is evident in the trapping results of this study; two species, the ornate shrew and western harvest mouse, made up 58 percent of the total catch.

ACKNOWLEDGEMENTS

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APPENDIX

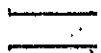Vegetation Analysis Results and Habitat

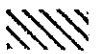Mapping of Study Areas

LEGEND
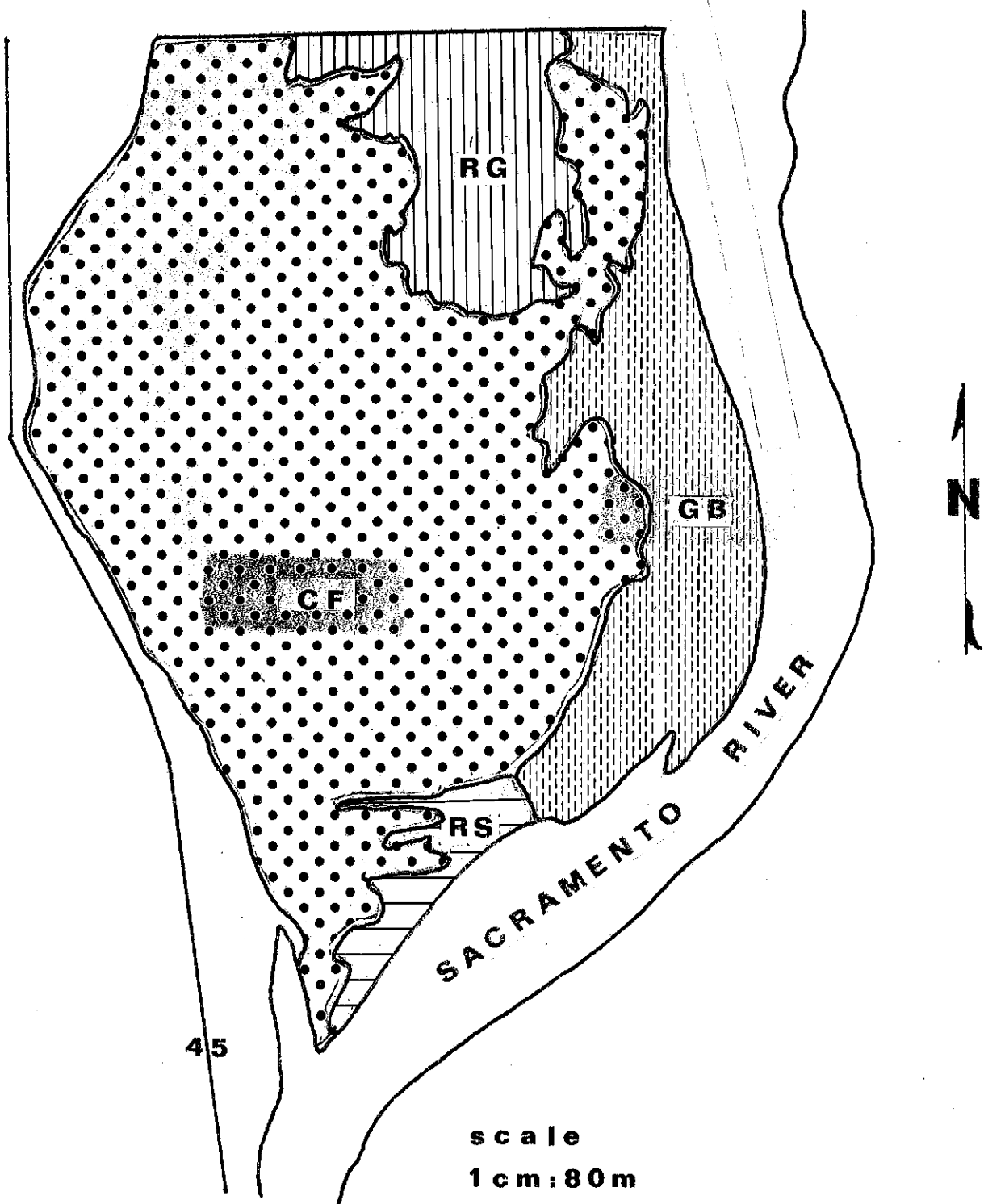
GB GRAVEL BAR

RG RIPARIAN GRASSLAND

RS RIPARIAN SHRUB

CF COTTONWOOD FOREST

OW OAK WOODLAND

RG

GB

CF

RS

SACRAMENTO RIVER

N

4\5

scale
1 cm : 80 m

Vegetation Evaluation
Area I Cottonwood Forest

	Relative Density	Relative Dominance	Relative Frequency	Importance Value
Overstory				
Cottonwood	38	64	38	140
Willow sp.	32	26	32	90
Box elder	16	6	16	38
Black walnut	13	3	13	29
Sycamore	2	1	2	5
Midstory				
Blue elderberry	29	34	29	92
Willow sp.	26	17	26	69
Box elder	24	20	24	68
Black walnut	10	16	10	36
Fig	4	6	4	14
Cottonwood	6	3	6	15
Oregon ash	1	4	1	6
Understory				
Mugwort	--	53	20	73
Box elder seedling	--	5	11	16
Wild cucumber	--	7	9	16
Bed straw	--	1	14	15
Poison oak	--	5	9	14
Blue wildrye	--	1	11	12
Cockelbur	--	5	6	11
Black walnut seedling	--	7	3	10

Vegetation Evaluation
Cottonwood Forest

	Relative Density	Relative Dominance	Relative Frequency	Importance Value
Understory cont.				
California blackberry	--	6	3	9
California wildgrape	--	5	3	8
Undetermined grass	--	2	6	8
Dutchman's pipe	--	1	6	7
Horsetail	--	T	T	T
Small-flowered nightshade	--	T	T	T

CF
RS
RS
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SACRAMENTO RIVER

scale
1 cm : 80 m
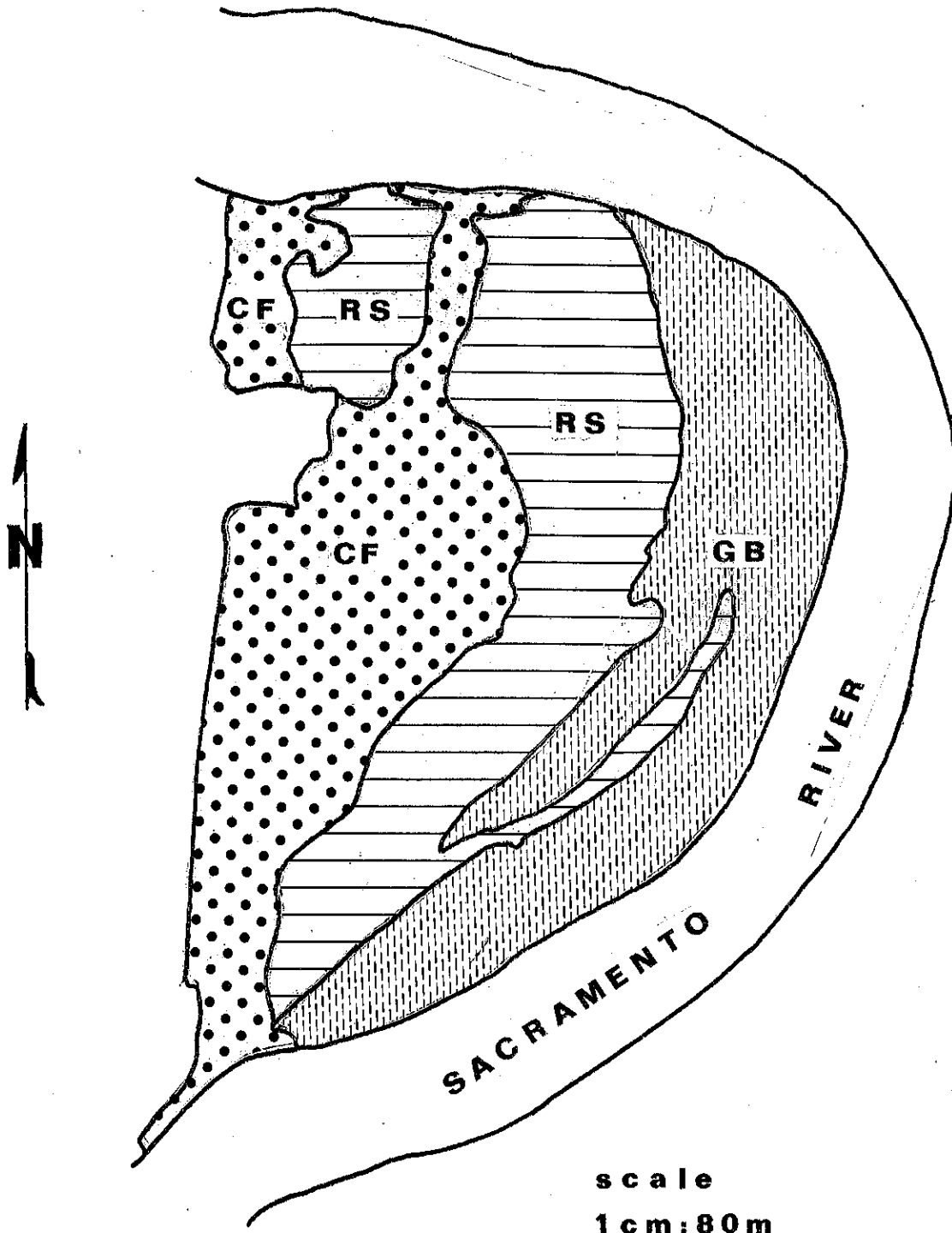
Vegetation Evaluation
Area II Cottonwood Forest

	Relative Density	Relative Dominance	Relative Frequency	Importance Value
Overstory				
Cottonwood	78	92	78	248
Willow sp.	16	5	16	37
Balck walnut	4	2	4	10
Box elder	T	T	T	T
Midstory				
Box elder	51	50	51	152
Black walnut	25	24	25	74
Blue elderberry	18	22	18	58
Willow sp.	4	2	4	10
Fig	3	3	3	9
Understory				
Mugwort	--	29	21	50
California wild grape	--	30	15	45
California blackberry	--	15	15	30
Poison oak	--	9	9	18
Dutchman's pipe	--	4	9	13
Wild cucumber	--	4	9	13
Box elder seedling	--	7	6	13
Ripgut grass	--	2	6	8
Italian rye grass	--	T	T	T

Vegetation Evaluation
Cottonwood Forest

	Relative Density	Relative Dominance	Relative Frequency	Importance Value
Understory cont.				
Bed straw	--	T	T	T
Blue wildrye	--	T	T	T
Nettle	---	T	T	T
Undetermined grass	---	T	T	T

STUDY AREA III

scale
1 cm : 80 m

A-8
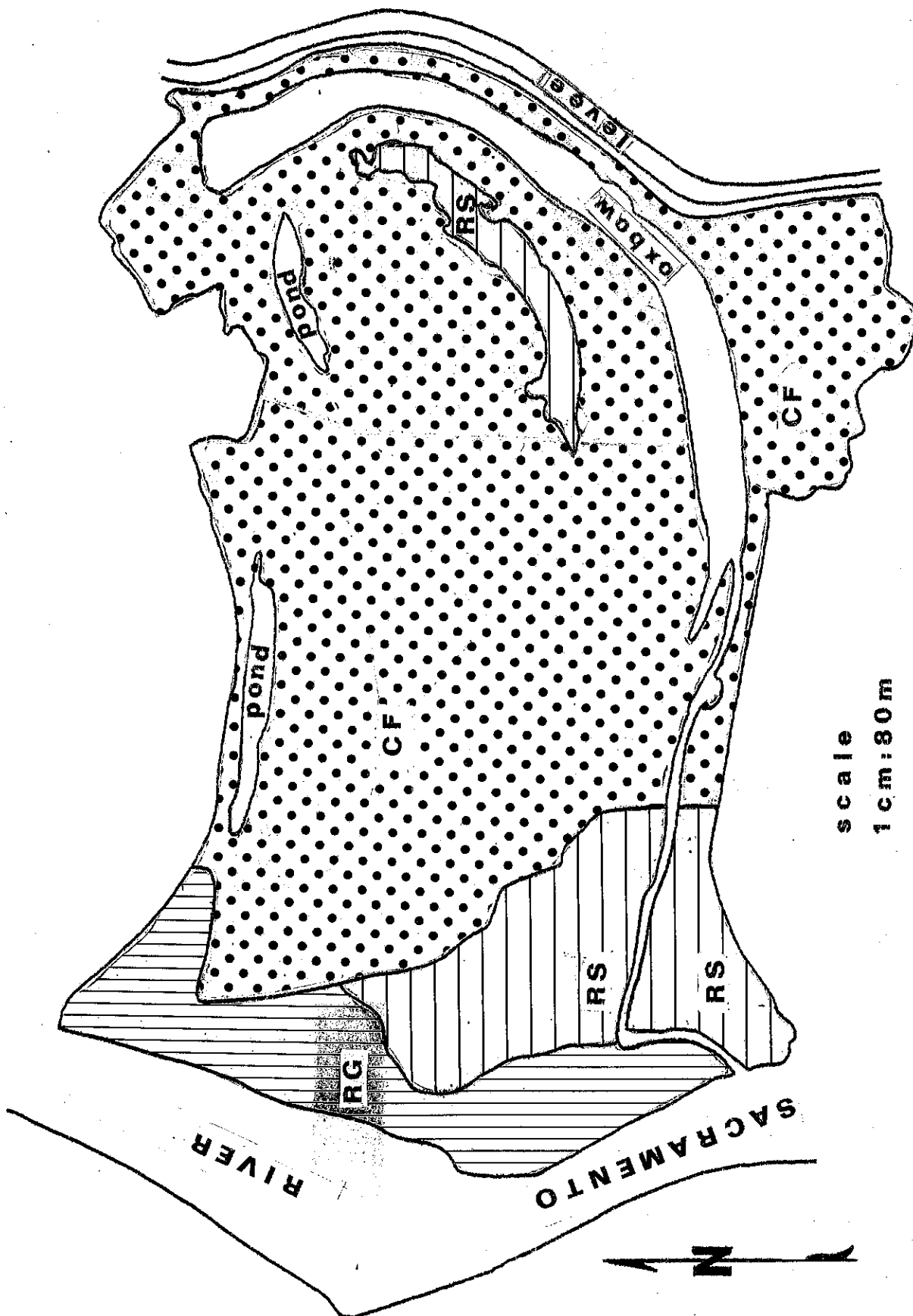
Vegetation Evaluation
Area III Cottonwood Forest

	Relative Density	Relative Dominance	Relative Frequency	Importance Value
Overstory				
Cottonwood	45	69	43	157
Willow sp.	15	20	14	49
Valley oak	16	5	16	37
Black walnut	15	4	14	33
Oregon ash	8	1	7	16
Box elder	T	T	T	T
Sycamore	T	T	T	T
Midstory				
California wild grape	30	24	30	84
Blue elderberry	19	32	19	70
Black walnut	20	16	20	56
Box elder	18	18	18	54
Valley oak	6	3	6	15
Willow sp.	4	1	4	9
California wild rose	1	3	1	5
Fig	1	2	1	4
Oregon ash	T	T	T	T
Understory				
California wild grape	--	34	19	53
California blackberry	--	21	17	**29**

Vegetation Evaluation
Cottonwood Forest

	Relative Density	Relative Dominance	Relative Frequency	Importance Value
Understory cont.				
Poison oak	--	15	14	29
Box elder seedling	--	7	10	17
Wild cucumber	--	3	12	15
California wildrose	--	5	5	10
Dutchman's pipe	--	4	5	9
Cockelbur	--	5	3	8
Fig	--	4	2	6
Horseweed	--	2	2	4
Old man of spring	--	T	T	T
Blue wildrye	--	T	T	T
Shepard's purse	--	T	T	T
Undetermined grass	--	T	T	T

scale
1 cm : 80 m

Vegetation Evaluation
Area IV Cottonwood Forest

	Relative Density	Relative Dominance	Relative Frequency	Importance Value
Overstory				
Cottonwood	96	99	96	291
Willow sp.	3	1	3	7
Valley oak	T	T	T	T
Midstory				
Oregon ash	61	68	61	190
Buttonwillow	11	16	11	38
Valley oak	14	7	14	35
Box elder	11	8	11	30
Willow sp.	T	T	T	T
Poison oak	T	T	T	T
Understory				
Poison oak	--	43	26	69
California wild grape	--	15	12	27
Cockelbur	--	12	11	23
Oregon ash seedling	--	11	8	19
California blackberry	--	8	10	18
Small-flowered nightshade	--	4	8	12
Horseweed	--	1	7	8
Box elder seedling	--	4	4	8
Undetermined grass	--	1	6	7
Bermuda grass	--	1	6	7
Valley oak seedling	--	T	T	T
Bulrush	--	T	T	T

Vegetation Evaluation
Oak Woodland

	Relative Density	Relative Dominance	Relative Frequency	Importance Value
Overstory				
Valley oak	100	100	100	300
Understory				
Italian rye grass	72	6	29	107
Common spikeweed	2	33	2	37
Old man of spring	2	23	7	32
Foxtail	11	3	12	26
Undetermined grass	7	8	2	17
Baltic rush	2	3	7	12
Curly dock	1	3	7	11
Gum plant	1	5	5	11
Blue wildrye	4	1	5	10
Bird's foot trefoil	T	T	T	T
Cockelbur	T	T	T	T
Bermuda grass	T	T	T	T