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DISTRIBUTION OF FISHES IN STREAMS OF THE WALNUT CREEK BASIN, CALIFORNIA [1]

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The distribution of fishes in 27 sampling sites on 10 streams of the Walnut Creek basin, Contra Costa County, California, was determined during October and November 1980. Of 20 fish species collected, 13 (65%) were exotic to California, and 7 were native. Pumpkinseed, *Lepomis gibbosus,* were collected in the basin, a new locality for this species in California. The number of species in stream sections altered by flood control levees was greater than in undisturbed sections. The high fish species diversity in the Walnut Creek basin is not typical of other small Central Valley streams.

INTRODUCTION

In recent years several studies have examined the distribution of native and exotic fishes of the Central Valley (Turner and Kelley 1966; Moyle 1973, 1976 *a,b*; Moyle and Nichols 1973, 1974): however, information is limited on the distribution of fishes in streams of the Walnut Creek basin located at the western extreme of the Central Valley (Figure 1). Ayres (1855) identified the presence of steelhead trout/rainbow trout, *Salmo rivularis* (=*Salmo gairdneri*), "back of Martinez, toward the foot of Monte Diablo." The Walnut Creek basin lies between Martinez and Mt. Diablo and is the probable location of Ayres' reference. Steelhead trout and coho salmon, *Oncorhynchus kisutch,* were sighted during spawning migration in streams within the Walnut Creek drainage during the 1950's to mid-1960's (Calif. Dept. of Fish and Game files 1976–1979). Limited sampling of Walnut Creek and its tributaries by the California Department of Fish and Game revealed the occurrence of 11 species (Table 1). The restricted nature of previous surveys with respect to methodology, number of collecting localities, and diversity of stream habitats sampled, prompted this more comprehensive survey.

STUDY AREA

The study was conducted at 10 streams in the Walnut Creek basin of central Contra Costa County (Figure 1). Elevations ranged between 1 m at the confluence of Walnut Creek and Suisun Bay, and 232 m at the headwaters of Bolinger Creek. The 466-km² basin drains into Suisun Bay, an estuarine transition zone between the Sacramento-San Joaquin River Delta and San Francisco Bay. Walnut Creek is the principal stream of the drainage basin. Tributaries to Walnut Creek include Pacheco, Pine, Galindo, San Ramon, Las Trampas, Tice, Lafayette, Green Valley, Sycamore, San Catanio, Bolinger, and Grayson creeks. These streams are perennial during years of normal precipitation.

Much of the Walnut Creek basin has been developed for residential, commercial, and industrial uses. Urbanization of the basin, involving extensive stream channel modification for flood control purposes, has eliminated much of the

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historical riparian and aquatic stream habitats. Approximately 95% of the Walnut Creek-San Ramon Creek stream channel has been altered by levees or concrete channels (U.S. Army Corps of Engineers 1979). Portions of the tributary streams have also been modified for flood control. Subsequent to stream modification activities, plant succession has resulted in limited revegetation of certain levee sections.

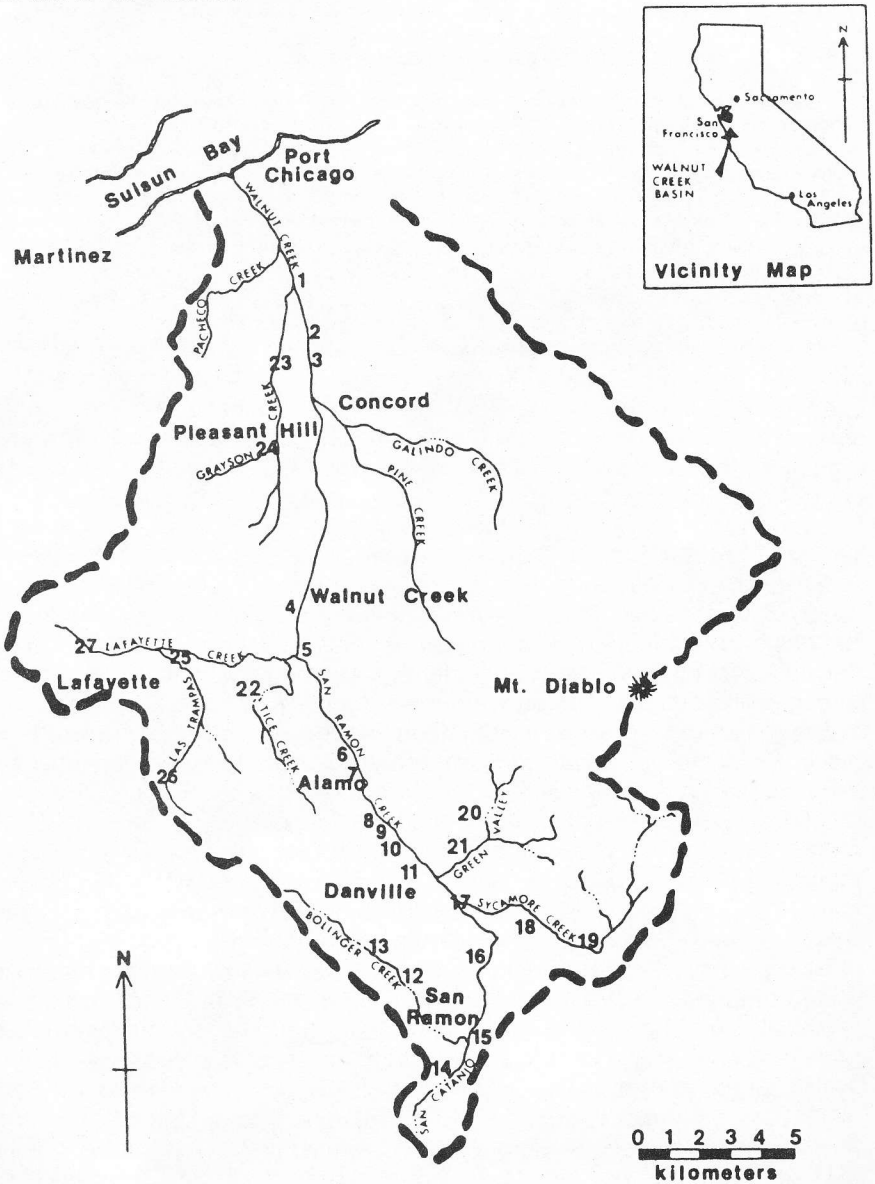

FIGURE 1. General map of the Walnut Creek basin, Contra Costa County, California. Numbers indicate sampling sites.

TABLE 1. Historical Records of Fish Species Occurring in Streams of the Walnut Creek Basin, California [1].

Species	*Historical Records*
Native Species	
Steelhead/Rainbow trout *(Salmo gairdneri)*	1855[2], 1950's to mid-1960's
Coho salmon *(Oncorhynchus kisutch)*	1956, 1950's to mid-1960's
Hitch *(Lavinia exilcauda)*	1978
Sacramento western roach *(Hesperoleucus symmetricus)*	1939[3], 1942[5], 1945[4], 1946[3], 1976, 1977, 1978
Sacramento sucker *(Catostomus occidentalis)*	1942[5], 1945[4], 1977, 1978
Threespine stickleback *(Gasterosteus aculeatus)*	1978
Exotic Species	
Goldfish *(Carassius auratus)*	1977, 1978
Carp *(Cyprinus carpio)*	1977, 1978
Golden shiner *(Notemigonus crysoleucas)*	1977
Mosquito fish *(Gambusia affinis)*	1942[5], 1945[4], 1977, 1978
Green sunfish *(Lepomis cyanellus)*	1945[5], 1976, 1977, 1978
Bluegill *(Lepomis macrochirus)*	1977, 1978
Redear sunfish *(Lepomis microlophus)*	1978[6]

[1] California Department of Fish and Game files (1976–1979)
[2] Ayres (1855)
[3] Hopkirk (1974)
[4] W. I. Follett (pers. commun.)
[5] California Academy of Sciences fish collection
[6] Species not recorded during present study

METHODS

Twenty-seven sites were sampled for fish between 1 October and 21 November 1980 (Table 2). Representative riffle, glide, and pool habitats were sampled throughout the drainage basin.

A 6-mm mesh seine, in combination with a portable Smith-Root Type V electroshocker, was used at sites with depths to 1 m. Sites with greater depths were sampled with 13- and 19-mm mesh gill nets 10 m in length. Gill nets were set at sunset and retrieved at sunrise the following morning. A hand dip net was used to sample intermittent pools characteristic of the headwaters of smaller tributary streams. The number and size range of individuals of each species collected were recorded for each sampling locality. Representatives of each species were preserved in 10% formalin for future reference.

Sixteen environmental variables were recorded at each sampling site to relate fish distribution to habitat characteristics. These included: (1) mean depth; (2) maximum depth; (3) width; (4) percentage of stream bottom composed of rooted aquatic vegetation; (5) percentage of stream surface covered with floating aquatic vegetation; (6) percentage of water surface shaded for the majority of the daylight period; (7) percentage of area pools; (8) percentage of area riffles; (9) percentage of bottom silt; (10) percentage of bottom sand; (11) percentage of bottom gravel; (12) percentage of bottom cobbles; (13) percentage of bottom bedrock; (14) turbidity; (15) quality and amount of cover; and (16) degree of human disturbance. A scaled rating system (0–5) was used

TABLE 2. Number of Native (N) and Introduced (I) Fishes Collected at 20 Sampling Sites in

Species	Walnut Ck. Site 1	2	3	4	San Ramon Ck. Site 5	6	7	8
Ictaluridae								
White catfish (*Ictalurus catus*) I			13 (140–152)					
Balck bullhead (*Ictalurus melas*) I			2 (220–245)		2 (241–254)	17 (152–508)	2 (240–250)	6 (203–305)
Cyprinidae								
Goldfish (*Carassius auratus*) I				1 (178)	2 (203–254)			
Golden shiner (*Notemigonus crysoleucas*) I			1 (140)		2 (137–140)			1 (127)
Carp (*Cyprinus carpio*) I			3 (150–190)					
Sacramento squawfish (*Ptychocheilus grandis*) N	1 (254)	1 (229)	3 (191–280)					
Sacramento blackfish (*Orthodon microlepidotus*) N			1 (216)					
Hitch (*Lavinia exilicauda*) N	4 (51–127)	18 (70–165)	92 (64–225)	1 (114)				25 (57–133)
California roach (*Hesperoleucas symetricus*) N			2 (64)	46 (38–107)	25 (51–89)	1 (152)		
Catostomidae								
Sacramento sucker (*Catostomus occidentalis*) N			5 (121–180)	2 (95–102)	9 (260–315)	19 (152–381)	8 (258–304)	4 (178–318)
Cyprinodontidae								
Rainwater killifish (*Lucania parva*) I		1 (36)						
Poecilidae								
Mosquitofish (*Gambusia affinis*) I			5 (13–25)					
Atherinidae								
Mississippi silverside (*Menidia audens*) I	75 (102–152)	7 (83–108)	3 (83–89)					
Centrachidae								
Green sunfish (*Lepomis cyanellus*) I				2 (95–97)	15 (108–191)	1 (178)		5 (110–130)

Streams of the Walnut Creek Basin, California (Size Range (TL mm) in Parenthesis)[1].

	San Ramon Ck. Site			Sycamore Site	Green Valley Ck. Site		Trice Ck. Site	Grayson Ck. Site		Las Trampas Site	Lafaye Site
9	*11*	*16*	*17*	*18*	*20*	*21*	*22*	*23*	*24*	*25*	*27*
	1 (266)							6 (40–127)			
							1 (102)				
								1 (214)			
100 (76–127)								17 (83–159)			
			31 (44–121)		12 (51–127)	50 (51–104)	25 (51–102)			100 (53–79)	
										20 (102–178)	
								1 (36)			
			1 (32)	10 (25–32)				50 (44–55)			
9 (109–117)								2 (25–178)			

TABLE 2. Number of Native (N) and Introduced (I) Fishes Collected at 20 Sampling Sites in

Species	Walnut Ck. Site 1	2	3	4	5	San Ramon Ck. Site 6	7	8
Bluegill (*Lepomis macrochirus*) I				6 (83–108)				
Pumpkinseed (*Lepomis gibbosus*) I								
Percichthyidae								
Striped bass (*Morone saxatilis*) I	2 (152–203)	1 (95)						
Gobiidae								
Yellowfin goby (*Acanthogobius flavimanus*) I	9 (127–178)	3 (127–152)						
Cottidae								
Prickly sculpin (*Cottus asper*) N	1 (38)	4 (25–44)						
Gasterosteidae								
Threespine stickleback (*Gasterosteus aculeatus*) N		12 (25–44)	1 (13)	8 (44–51)				

[1] No fish were collected at sites 10 and 15 on San Ramon Creek, 12 and 13 on Bolinger Creek, 14 on San Catanio

to simplify the quantification of three evironmental variables. A turbidity rating of 0 is very clear, 5 extremely turbid. The quality and amount of cover available to fish is rated 0 for no cover and 5 for abundant and diverse cover. A human disturbance rating of 0 implies no noticeable human disturbance, while 5 denotes significant alteration of the stream channel and riparian habitat. All scaled ratings were qualitative.

RESULTS AND DISCUSSION

Twenty fish species were collected from 27 sites in the Walnut Creek basin (Table 2). Bolinger Creek and San Catanio Creek, two of the headwater streams, were without fish. Seven of the 20 species collected were native to California. Thirteen species, or 65% of the total species collected, were exotics introduced into California.

Only one specimen of Sacramento blackfish, *Orthodon microlepidotus,* was collected, a species considered rare in the drainage basin. Three species (white catfish, *Ictalurus catus;* bluegill, *Lepomis macrochirus;* and pumpkinseed, *Lepomis gibbosus*) although not numerically rare, were collected at only one locality.

Streams of the Walnut Creek Basin, California (Size Range (TL mm) in Parenthesis)[1].—Continued

				Sycamore	*Green Valley Ck.*		*Trice Ck.*	*Grayson Ck.*		*Las Trampas*	*Lafayette*
San Ramon Ck. Site				*Site*	*Site*	*Site*	*Site*	*Site*	*Site*	*Site*	*Site*
9	*11*	*16*	*17*	*18*	*20*	*21*	*22*	*23*	*24*	*25*	*27*
3											
(97–140)											
		100	100			10	30	6	25	100	12
		(32–44)	(25–44)			(25–38)	(25–61)	(25–32)	(25–38)	(25–51)	(51–64)

Creek, 19 on Sycamore Creek, and 26 on Las Trampas Creek.

The occurrence of the exotic pumpkinseed in the Walnut Creek basin represents a new locality for this species in California. Pumpkinseed have not been previously recorded from the Central Valley, although on 11 November 1980, personnel of the California Department of Fish and Game captured two sunfish believed to be pumpkinseed from Beaver Slough in the Sacramento-San Joaquin River Delta (D. Kohlhorst, Associate Fishery Biologist, California Department of Fish and Game, pers. commun.). The pumpkinseed was formerly known to occur only in the Klamath River drainage, in Honey Lake and Susan River in Lassen County, and in Big Bear Lake in San Bernardino County (Moyle 1976*b*). Fish collection records indicate that at one time this species occurred in a pond at Golden Gate Park in San Francisco (California Academy of Sciences fish collection). The establishment of pumpkinseed in the Walnut Creek basin is probably the result of a recent introduction and not a natural range expansion.

Historical records provide evidence that steelhead trout and coho salmon formerly occurred within the basin (Table 1). Sampling during this study, however, failed to collect either species. It is likely that the extensive modification of streams within the basin for flood control purposes has eliminated suitable salmonid habitat. Among adverse impacts associated with

flood control activities have been channel modification, creation of barriers to fish migration, elimination of riparian vegetation, and deterioration of water quality. Erosion and siltation of some streams within the basin is a noticeable consequence of rapid urbanization. All of these factors, no doubt, have contributed to the elimination of salmonids.

Historical records also indicate the presence of redear sunfish, *L. microlophus,* in the drainage (Table 1). Although habitats typical of this species were sampled, no specimens were collected. If this species is present in the basin, it is likely uncommon.

Sixteen environmental variables were recorded at each collection site, for the purpose of comparing the occurrence and distribution of fishes to habitat characteristics. The wide range in values of most of these variables, the limited number of collection sites with fish ($n=20$), and the highly variable distribution of most species prevented the development of statistically significant correlations between the distribution of each species and its habitat or correlations between and among species. Although statistical correlations were not evident, general conclusions concerning fish distribution can be made.

Species often found in estuarine environments were collected at sites 1 and 2 at the confluence of Walnut Creek and Suisun Bay (Figure 1). These two sites are characterized by diel tidal fluctuations, a silt substrate, turbid water, and limited aquatic vegetation. Estuarine species collected include the yellowfin goby, *Acanthogobius flavimanus*; rainwater killifish, *Lucania parva*; prickly sculpin, *Cottus asper*; Mississippi silverside, *Menidia audens*; and striped bass, *Morone saxatilis*. These species tolerate widely fluctuating salinity levels, high water temperatures, and turbid water conditions (Moyle 1976*b*).

Within the Walnut Creek basin species diversity was greatest in Walnut Creek at site 3. Sixty percent of all species collected were recorded at this locality (Table 2). Site 3, located in a stream section modified by levees, was characterized by low turbidity, a favorable pool to riffle ratio (40 : 60), a substrate consisting of 90% sand and gravel, and abundant cover. Of the 12 species collected at site 3, 6 were native and 6 were exotic. Moyle and Nichols (1974) found that high densities and diversity of exotic fish species in a given area excluded native species. Sacramento squawfish, *Ptychocheilus grandis,* are usually rare or absent in disturbed habitats where exotic fish are common, especially carp, *Cyprinus carpio* (Moyle and Nichols 1973). At site 3, however, squawfish and carp were found to be most abundant when they occurred in the same pools. The diversity of both native and exotic fishes collected at site 3 suggests that habitat and food diversity is high, thus reducing competition among species.

Exotic sunfishes were recorded at sites characterized by deep turbid pools with heavily silted substrates. Sites 4, 5, 6, 8, and 9, in Walnut Creek and San Ramon Creek exemplified these conditions.

Threespine stickleback, *Gasterosteus aculeatus,* the most widely distributed species in the basin, was collected at 41% of the sites sampled. Densities were highest at sites 16, 22, 24, and 25, which were characterized by low turbidity, abundant and diverse types of cover available to fish, and a high percentage of the water surface shaded.

Sacramento western roach, *Hesperoleucus symmetricus,* while collected at 30% of the sites sampled, were most abundant at sites 17, 21, and 25, characterized by heavily silted substrates and extensive aerial coverage of rooted and

floating vegetation, especially floating mats of algae. These sites contained few other species. Moyle (1976*b*) found that the roach was conspicuously absent from stream sections containing other large fish. Filamentous algae constitute the main food in the roach diet (Moyle 1976*b*).

Diversity of species tended to be higher at sites with a high rating of human disturbance when compared to sites with low disturbance ratings. The ability of exotic species to colonize disturbed habitats may account for this increased diversity. Revegetation of disturbed stream sections has increased shading and the quality and quantity of cover available to fish, thus improving the suitability of these areas for fish colonization.

CONCLUSIONS

Fish diversity in the Walnut Creek basin is high when compared with diversity in other Central Valley drainages of similar size. Moyle and Nichols (1976) recorded 24 fish species from 167 sampling locations in a seven county area of the Sierra Nevada foothills. Aceituno *et al.* (1973) collected 13 fish species from Alameda and Coyote creeks, two tributaries to San Francisco Bay. Scoppettone and Smith (1978) recorded 18 species in these streams. The highly diverse fish fauna of the Walnut Creek basin, consisting as it does of native and exotic species is unusual, and is probably related to the highly variable stream habitat characteristics. Moyle (1976*c*) also found that in Rush Creek in the Pit River drainage, the numbers and biomass of some species were significantly lower in channelized stream sections when compared to unchannelized sections. The diversity of species at site 3 in Walnut Creek suggests that exotic and native species are not mutually exclusive if habitat diversity is great enough to reduce competition.

The pumpkinseed collected in the Walnut Creek basin represents a new locality for this species in California. Further sampling is necessary to determine whether this species has established a viable population within the drainage.

Unfortunately, historical records of the fishes of the Walnut Creek basin were extremely limited in extent and cursory in detail. Perhaps if this type of information had been available, more consideration would have been given to the protection and enhancement of aquatic and riparian habitats during development of the basin, especially flood control measures. This is particularly true considering the probable effects of channelization and urban development on the salmonid populations that historically inhabited the basin.

Some opportunities do exist for aquatic and riparian habitat improvements within the Walnut Creek basin. Revegetation of levees in channelized stream sections with native riparian plant species would improve habitat. The establishment and enforcement of land use controls could reduce erosion and improve water quality within the drainage. Also, the feasibility of installing fish ladders over man-made barriers with the goal of reestablishing salmonid populations within the drainage should be studied.

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