

TASK 18.

AQUATIC HABITAT AND FISH ABUNDANCE BETWEEN PARDEE AND CAMANCHE RESERVOIRS, 1990-1991

18.1 OBJECTIVES

The objective of this task was to document habitat conditions and fish abundance in the Mokelumne River between Pardee and Camanche reservoirs. Surveys characterized habitat conditions and fish abundance in this river reach during low flows (3-5 cfs) and low reservoir elevation (57.3-58.1 m).

18.2 METHODS

18.2.1 Habitat Characterization

Aquatic habitat in the Mokelumne River between Pardee Dam and Camanche Reservoir was mapped between 20-21 November 1990. Flow in the river during the survey was 5 cfs (EBMUD 1991). When Camanche Reservoir is full (elevation 71.8 m), water backs up to Pardee Dam and floods this river reach. The elevation of the reservoir during habitat mapping ranged from 58.0 and 58.1 m creating approximately 3.1 km of river. Our habitat survey began downstream of the afterbay below Pardee Dam and continued to the influence of Camanche Reservoir.

Habitats were classified as pools, runs, riffles, cascade, or variable. Variable habitats consisted either of riffle/cascade or riffle/run complexes in which individual habitats could not be separated. The length, width, and depth of each habitat were measured at representative transects. Depths were measured across the channel, one at the thalweg (deepest point) and one on each side of the thalweg mid-way to the opposing bank. The distance from the downstream end of the habitat to each transect was also recorded. Substrate composition was visually estimated by percentage in each habitat. Substrate categories used were fines (<2 mm), gravel (2 mm-64 mm), cobble (64-256 mm), boulder (>256 mm), and bedrock. Spawning substrate potential was also noted using rainbow trout (*Oncorhynchus mykiss*) as our target species.

At each habitat the azimuth was measured with a Silva Ranger compass. The clines of the right and left streambanks were estimated visually. The riparian community was also described briefly at each habitat.

18.2.2 Fish Population Surveys

A quantitative fish population survey was conducted between 13 December 1990 and 17 January 1991 on the Mokelumne River from Pardee Dam to the influence of Camanche

Reservoir. During the survey, flow in the river was 3 cfs and Camanche Reservoir elevation ranged from 57.8 to 57.3 m. "Flowing water" habitats (i.e., riffles, runs, cascades, and variable) identified during habitat mapping were electrofished to determine fish species composition, population density, age-class structure, condition factors, fish distribution, and the incidence of parasites or disease.

Electrofishing sites were randomly selected from the habitat survey. The random selection of shocking sites eliminated personal biases that arise when sites are chosen. For example, where the physical environment between sites varies greatly, the selection of representative habitats becomes subjective. By sampling several randomly-selected sites for each habitat type, this bias is eliminated.

Prior to electrofishing, each habitat was isolated upstream and downstream with block nets. A four-person team (two shockers, two netters) sampled each site using backpack electrofishing units (Smith-Root Models 12A and Model 15). A multiple-pass removal method was used (Zippen 1958) to collect fish in the various habitats. The number of passes required to provide statistically significant results was determined in the field from depletion patterns (Price et al. 1979). To assure equal effort, the time to complete the first pass was recorded, and the effort in each successive pass was closely matched for consistency. The length and width of each habitat sampled was measured for later estimations of fish density and standing crop.

Each fish collected during the survey, except for young-of-the-year trout, was weighed, measured, and inspected for the presence of disease or parasites. Lengths of young-of-the-year trout were estimated to minimize handling stress. Water temperatures were taken at each habitat.

A qualitative population survey was conducted in pools using monofilament gill nets measuring 1.8 m deep by 24.4 m long. Each net was divided into four 6-m-long panels with 1.3, 2.5, 5.1, and 7.6 cm ($\frac{1}{2}$, 1, 2, and 3 in) mesh. To sample the entire water column, several nets were set in each pool at varying depths. Each net was placed in the pools for approximately 20 hours (17 to 22 hrs). All fish collected in the nets were weighed, measured, and inspected for disease or parasites.

Moran-Zippen fish population estimates and associated 95 percent confidence intervals were calculated from electrofishing data (Zippen 1958). Densities at each site were standardized to number of trout per 1,000 ft² then converted to fish/100 m². Biomass (lbs/ac and kg/hect) were calculated based on population estimates and mean weights of trout. The age structure of trout and sculpin was determined by length-frequency histograms. Fulton condition factor K_{TL} (Anderson and Gutreuter 1983) was also calculated for trout collected in the electrofishing and gill netting surveys.

18.3 RESULTS

18.3.1 Habitat Characterization

The Mokelumne River between Pardee Dam and the influence of Camanche Reservoir is relatively straight and flows through a steep canyon. The mean cline of the right bank walls is 63° and the left bank is 67°. The river drops approximately 12.2 m over the 3.1 km (mean 4 m/1,000 m) from the base of Pardee Dam to Camanche Reservoir. The riparian vegetation is very sparse through this reach, comprised mainly of oaks, willows, and grasses, none of which offer substantial cover for fish. Flow in this section of river is controlled by releases from Pardee Reservoir. Our survey was conducted when river flow was 5 cfs. At higher flows, habitat composition would change considerably.

During our surveys, a total of 3,053 m of river was mapped. Pools (83%) were the most abundant habitat by area in the river followed by runs (8%) (Figure 18-1). The remaining area (9%) was composed of variable, riffle, and cascade habitats. The average width of the river was 11.0 m but this is influenced by the width of the pools (17.4 m) (Table 18.1). The mean river depth at our transects was 0.8 m with a range of 0.1 to 5.4 m. Overall, fines (50%) was the predominant substrate in the river. Cobble (22%) and boulder (18%) made up most of the remaining substrate. Characteristics of specific habitat types are described in Table 18.1.

The amount of quality spawning habitat for rainbow trout was minimal throughout this reach. Much of the cobble was too large (17.8 to 25.4 cm) to be suitable. The high percentage of pool habitat and the associated fines also reduced the amount of spawning habitat area.

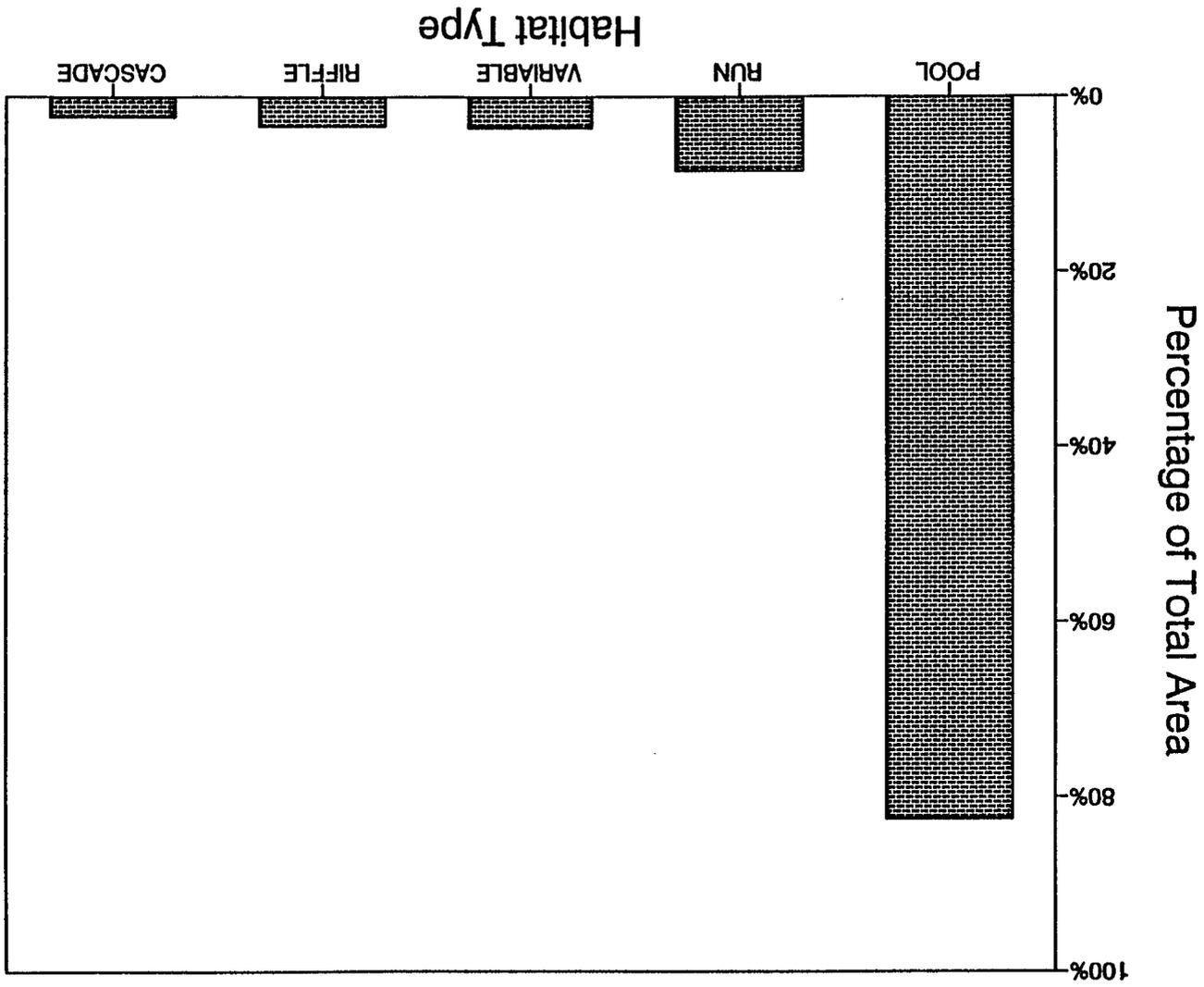
18.3.2 Fish Population Surveys

Seven habitats in the Mokelumne River between Pardee Dam and the influence of the Camanche Reservoir were electrofished. The sites consisted of three riffles, three runs, and one variable (riffle/run) habitat (Table 18.2). During the electrofishing surveys, water temperatures ranged from 8° to 10° C. A total of five pool habitats were sampled with gill nets.

A total of 309 fish were collected in the surveys, more than half (245) were sculpins (*Cottus* spp.). The second most commonly captured fish (49) was rainbow trout (*Oncorhynchus mykiss*). Other species collected in much lower numbers were Sacramento suckers (*Catostomus occidentalis*), green sunfish (*Lepomis cyanellus*), smallmouth bass (*Micropterus dolomieu*), and spotted bass (*Micropterus punctulatus*). Overall, fish abundance is relatively low in this reach.

Only six rainbow trout and three sculpin were collected in the three riffle habitats electrofished (Table 18.2). Average trout density in the riffles was estimated to be 1.2 fish/100 m². The mean biomass for trout in riffle habitat was 3.0 kg/hect (2.7 lbs/ac).

Figure 18-1. Relative percentage of aquatic habitat in the Mokolunne River between Pardee and Camanche reservoirs.



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Table 18.1. Characteristics of aquatic habitats surveyed on the Mokelumne River between Pardee and Camanche reservoirs in December 1990. Standard deviation of means are given in parentheses.

| HABITAT | N | TOTAL LENGTH (m) | MEAN LENGTH (m) | MEAN WIDTH (m) | TOTAL AREA (m ²) | MEAN AREA (m ²) | MEAN DEPTH (m) | % OF AREA WITH SUBSTRATE | | | | |
|-----------------------|-----------|---------------------|--------------------|-------------------|---------------------------------|--------------------------------|-------------------|--------------------------|------------|-------------|-------------|------------|
| | | | | | | | | Fines | Gravel | Cobble | Boulder | Bedrock |
| POOL | 17 | 1,935.5 | 113.9 (69.9) | 17.4 (6.1) | 37,889.0 | 2,228.8 (1,721.0) | 1.6 (1.2) | 59.5 | 7.0 | 16.2 | 15.8 | 1.5 |
| RUN | 7 | 478.8 | 68.4 (39.0) | 8.7 (2.6) | 3,811.5 | 544.5 (285.0) | 0.4 (0.2) | 0.0 | 2.4 | 37.9 | 17.6 | 42.1 |
| RIFFLE | 11 | 289.0 | 26.3 (16.9) | 5.2 (1.3) | 1,498.4 | 136.2 (83.6) | 0.1 (0.1) | 0.2 | 12.9 | 51.1 | 35.8 | 0.0 |
| VARIABLE ¹ | 5 | 221.6 | 145.4 (87.7) | 6.3 (2.1) | 1,632.3 | 326.5 (234.8) | 0.2 (0.1) | 3.1 | 20.5 | 49.8 | 26.5 | 0.0 |
| CASCADE | 2 | 128.3 | 64.2 (43.6) | 7.5 (5.8) | 1,029.2 | 514.6 (248.9) | 0.5 (0.2) | 0.0 | 2.4 | 37.9 | 17.6 | 42.1 |
| TOTAL | 42 | 3,053.2 | 72.7 (61.4) | 11.0 (6.9) | 45,860.4 | 1,091.9 (1,456.7) | 0.8 (1.0) | 49.5 | 8.6 | 22.3 | 17.5 | 2.2 |

¹ Variable habitat consisted of either riffle/run or riffle/cascade combinations.

Table 18.2. Summary of fish caught during electrofishing surveys on the Mokelumne River between Pardee and Camanche reservoirs, 13 December 1990 — 17 January 1991. Standard deviation of means are given in parentheses.

| HABITAT TYPE/NUMBER | AREA (m ²) | NUMBER OF FISH CAUGHT | | | | TOTAL # FISH | TOTAL FISH DENSITY (#/100 m ²) | TOTAL FISH BIOMASS ¹ (Kg/Hac) | RAINBOW TROUT DENSITY (#/100 m ²) | RAINBOW TROUT BIOMASS (Kg/Hac) |
|-------------------------------|---------------------------|-----------------------|---------|--------|---------|-----------------|--|--|--|---|
| | | TROUT | SCULPIN | SUCKER | SUNFISH | | | | | |
| RIFFLES | | | | | | | | | | |
| 1 | 174.7 | 3 | 1 | 0 | 0 | 4 | 2.1 | 4.0 | 1.7 | 3.8 |
| 2 | 192.3 | 1 | 2 | 0 | 0 | 3 | 1.4 | 2.0 | 0.5 | 1.1 |
| 3 | 133.8 | 2 | 0 | 0 | 0 | 2 | 1.3 | 4.0 | 1.5 | 4.1 |
| TOTAL: | | 6 | 3 | 0 | 0 | 9 | MEAN: 1.6 | 3.3 | 1.2 (0.5) | 3.0 (1.3) |
| RUNS | | | | | | | | | | |
| 1 | 382.7 | 17 | 95 | 1 | 0 | 113 | 28.4 | 6.0 | 4.9 | 0.0 |
| 2 | 1,120.3 | 3 | 82 | 3 | 1 | 89 | 9.0 | 11.0 | 0.5 | 2.3 |
| 3 | 394.1 | 13 | 15 | 0 | 0 | 28 | 6.6 | 16.0 | 3.3 | 11.9 |
| TOTAL: | | 33 | 192 | 4 | 1 | 230 | MEAN: 14.7 | 11.0 | 2.8 (1.9) | 4.7 (5.1) |
| VARIABLE | | | | | | | | | | |
| 1 | 7,279 | 2 | 50 | 0 | 0 | 52 | 7.8 | 9.0 | 0.3 | 0.9 |
| TOTAL FISH COLLECTED: | | 41 | 245 | 4 | 1 | 291 | | | | |
| PERCENTAGE OF GRAND TOTAL: | | 14.1% | 84.2% | 1.4% | 0.3% | 100.0% | | | | |

¹Total biomass values derived by combining total biomass of each species.

A total of 33 trout, 192 sculpin, 4 Sacramento suckers, and 1 green sunfish was captured in three runs surveyed (Table 18.2). Average trout density in run habitat was 2.8 fish/100 m². The mean biomass for trout in run habitat was 4.7 kg/hect (4.3 lb/ac).

The variable site (riffle/run) surveyed covered 676.5 m². Two trout and 50 sculpins were collected. Average trout density was estimated to be 0.3 fish/100 m². An average biomass for trout was 0.9 kg/hect (1.0 lb/ac).

Five pools, ranging in depth to a maximum depth of 5.5 m, were sampled using gill nets. Table 18.3 lists the number of nets used, total number of species collected, and mean number of fish collected per net. Trout (8) and suckers (8) made up 88.8% of the catch. One smallmouth bass and one spotted bass were also collected. During retrieval of the nets in one pool, a carp (*Cyprinus carpio*) was observed swimming near the net but was not captured.

A length frequency histogram for trout collected during electrofishing and gill netting surveys is illustrated in Figure 18-2. Five age-classes are depicted on the histogram. Young-of-the-year range between 25 and 35 mm, one-year olds range from 125 to 200 mm, two-year olds range from 240 to 260 mm, three-year olds range from 340 to 400 mm, and four-year olds range from 420 to 440 mm. The mean condition factor of trout (K_{TL}) collected in electrofishing and gill netting surveys was 1.66. The high number of young-of-the-year trout collected suggest a fall spawning strain of rainbow trout may inhabit this reach. A length histogram for sculpin is illustrated in Figure 18-3.

Table 18.3. Summary of gill netting surveys conducted on the Mokelumne River between Pardee and Camanche reservoirs, 8-16 January 1991.

| POOL LOCATION | NET # | HABITAT AREA (m ²) | NUMBER OF FISH COLLECTED | | | |
|---------------------------|-------|--------------------------------|--------------------------|-------------------|-----------------|--------------|
| | | | RAINBOW TROUT | SACRAMENTO SUCKER | SMALLMOUTH BASS | SPOTTED BASS |
| 511 m below afterbay | 1 | 1,304 | 0 | 0 | 0 | 0 |
| MEAN # FISH/NET | | | 0.0 | 0.0 | 0.0 | 0.0 |
| 749 m below afterbay | 1 | 5,829 | 0 | 0 | 0 | 0 |
| | 2 | | 0 | 0 | 0 | 0 |
| | 3 | | 0 | 0 | 0 | 0 |
| | 4 | | 2 | 0 | 0 | 0 |
| | 5 | | 0 | 0 | 0 | 0 |
| TOTAL | | | 2 | 0 | 0 | 0 |
| MEAN # FISH/NET | | | 0.4 | 0.0 | 0.0 | 0.0 |
| 1,079 m below afterbay | 1 | 3,544 | 0 | 4 | 0 | 0 |
| | 2 | | 0 | 1 | 0 | 0 |
| | 3 | | 0 | 0 | 1 | 0 |
| | 4 | | 1 | 0 | 0 | 0 |
| | 5 | | 3 | 1 | 0 | 0 |
| TOTAL | | | 4 | 6 | 1 | 0 |
| MEAN # FISH/NET | | | 0.8 | 1.2 | 0.2 | 0.0 |
| 1,342 m below afterbay | 1 | 2,494 | 0 | 0 | 0 | 0 |
| | 2 | | 1 | 0 | 0 | 1 |
| | 3 | | 1 | 0 | 0 | 0 |
| TOTAL | | | 2 | 0 | 0 | 1 |
| MEAN # FISH/NET | | | 0.7 | 0.0 | 0.0 | 0.3 |
| 1,567 m below afterbay | 1 | 5,560 | 0 | 0 | 0 | 0 |
| | 2 | | 0 | 0 | 0 | 0 |
| | 3 | | 0 | 2 | 0 | 0 |
| | 4 | | 0 | 0 | 0 | 0 |
| TOTAL | | | 0 | 2 | 0 | 0 |
| MEAN # FISH/NET | | | 0.0 | 0.5 | 0.0 | 0.0 |
| GRAND TOTAL (ALL POOLS) | | | 8 | 8 | 1 | 1 |
| PERCENTAGE OF GRAND TOTAL | | | 44.4% | 44.4% | 5.6% | 5.6% |

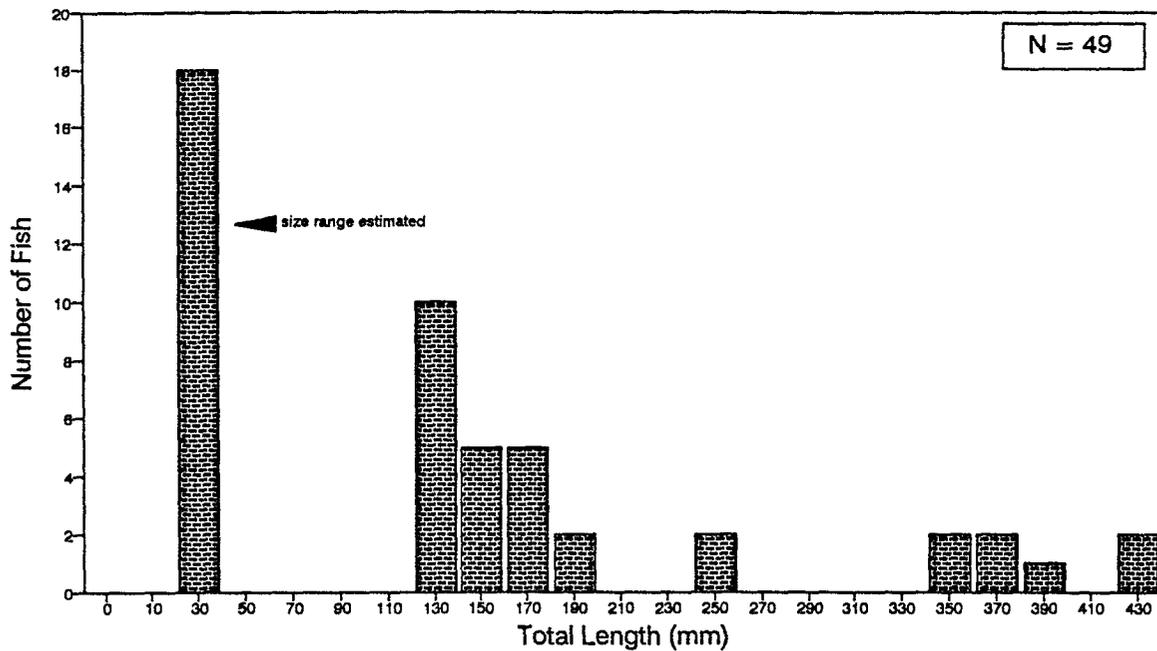


Figure 18-2. Length frequency distribution of rainbow trout caught during surveys on the Mokelumne River between Pardee and Camanche reservoirs, December 1990 - January 1991.

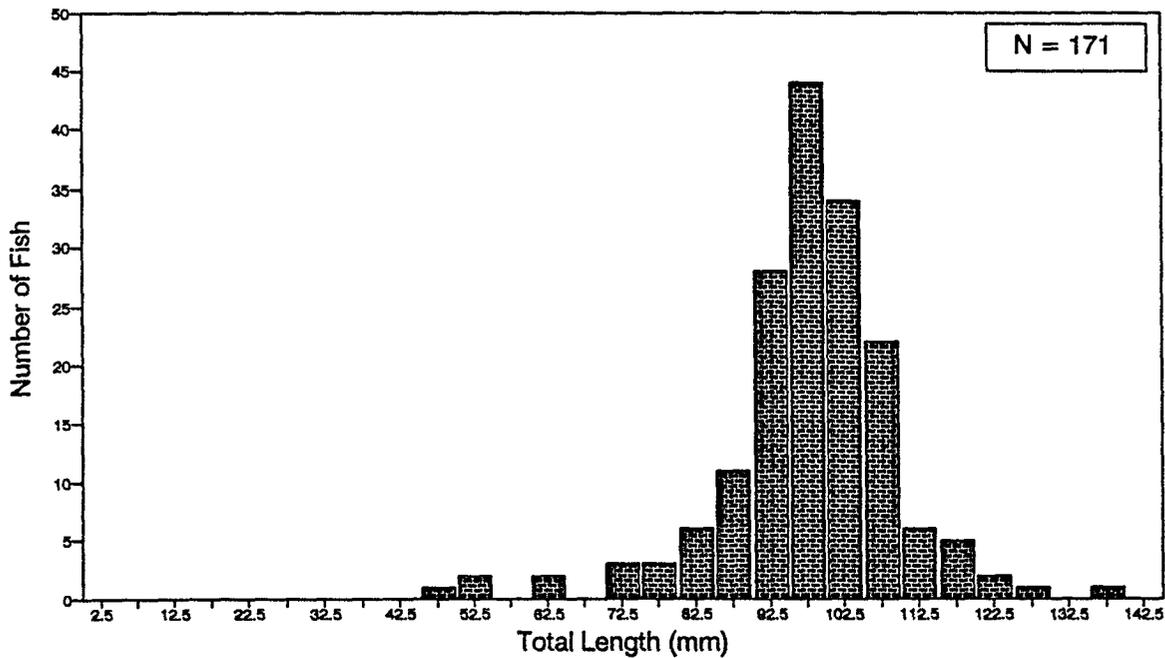


Figure 18-3. Length frequency distribution of sculpins caught during electrofishing surveys on the Mokelumne River between Pardee and Camanche reservoirs, December 1990 - January 1991.