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**TASK REPORTS OF FISHERIES STUDIES ON THE
MOKELUMNE RIVER, 1990-1992**

TASK 18.

**AQUATIC HABITAT AND FISH SPAWNING ACTIVITY
IN THE UPPER MOKELUMNE RIVER
1990-1991**

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WATER SUPPLY IMPROVEMENTS

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TASK 18. AQUATIC HABITAT AND FISH SPAWNING ACTIVITY IN THE UPPER MOKELUMNE RIVER, 1990-1991

18.1 OBJECTIVE

The purpose of this task was to characterize aquatic habitat in the Upper Mokelumne River from Electra Dam downstream to Pardee Reservoir and to document temporal and spatial use of the habitat by spawning kokanee salmon (*Oncorhynchus nerka kennerlyi*) and brown trout (*Salmo trutta*). Since proposed increases to Pardee Reservoir capacity would result in inundation of the river to Highway 49, the river was divided into two reaches: one between Electra Dam and Highway 49, the other from Highway 49 to Middle Bar Bridge (the designated upper limit of Pardee Reservoir).

18.2 METHODS

18.2.1 Habitat Mapping

We mapped aquatic habitats in the Mokelumne River from the Electra Dam downstream to the influence of Pardee Reservoir (Middle Bar Bridge) on 14-15 April 1991. We designated this stretch of the river as the Upper Mokelumne River (Figure 18-1). Flows on these two days ranged from 314 to 353 cfs; water elevations in Pardee Reservoir ranged from 165.6 to 165.7 m.

Aquatic habitats were classified as pools, runs, riffles, or cascades, according primarily to flow characteristics, channel morphology, and substrate type. We measured total length, width, and depth of each habitat, recorded at three evenly-spaced locations along a transect. Substrate type was characterized within in each habitat by estimating the river bottom area covered by fines, gravel, cobble, boulder, or bedrock. Total length, area, average width,

and depth were determined for each habitat and reach, as well as the entire river. The percentage of the river composed of each habitat type was calculated based on length; the area was derived by multiplying length by width. All areas were summed to produce total area habitat type, and for the entire river. Mean depth of the entire river and each habitat type was determined by averaging all depths recorded.

18.2.2 Fish and Redd Surveys

We conducted weekly visual fish surveys in the Mokelumne River from Electra Dam downstream to Middle Bar Bridge from 17 October through 6 December 1990. Flows during the study fluctuated widely, from 564 cfs on 24 October to 46 cfs on 6 December (Figure 18-2).

The study area was surveyed weekly by a team of three biologists. We surveyed the upper portion of the river between Electra Dam and Highway 49 on the first day of the weekly survey, and the lower portion between Highway 49 and Middle Bar Bridge on the second day. Biologists snorkeled downstream three abreast; each observer was responsible for one third of the river. To maintain consistency, each biologist surveyed the same transect every week.

The number of live and dead fish observed was recorded onto underwater slates and transferred later to notebooks. Dead kokanee and brown trout were collected and measured to determine size, and were cut open to determine sex, and whether they were spawned out. Air and water temperatures were recorded before and after each survey.

The number of redds was also recorded. When an area containing kokanee or brown trout redds was identified, team members estimated the number of redds by drifting over each area twice. Because counts were generally consistent (within 10% of each other), the number of passes was reduced to one per observer per spawning area, to save time and minimize disturbance to fish. For analysis, we averaged the number of redds counted by each

observer. On completion of the study, redds were located on a topographic map and identified by their kilometer (km) location (Figure 18-1). Our study area covers river km 12-21, with river km 0 located at Pardee Dam.

Because it was often difficult to distinguish newly constructed redds from old redds, we determined "new" redds by subtracting the number of redds counted during the previous survey from the number counted during the current survey.

18.3 RESULTS

18.3.1 Habitat Mapping

We mapped a total of 8,157 m of the Mokelumne River between Electra Dam and Middle Bar Bridge; 5,113 m in the upper section between Electra Dam and Highway 49 and 3,045 m between Highway 49 and Middle Bar Bridge (Table 18.1). In general, the Upper Mokelumne River is characterized by long stretches of boulder-strewn runs separated by short riffles and cascades. The river averaged 27.6 m wide and 1.0 m deep.

Over 60 percent of the runs and riffles were above Highway 49. Since these habitat types are used generally by spawning salmonids, this upper reach offers more spawning habitat than the lower reach. Sixty-five percent of pools were found below Highway 49, although one large pool is located immediately below Electra Dam. Backwater habitat was only found above Highway 49.

Substrate composition in the Upper Mokelumne River was similar in both reaches (Table 18.1). Overall, the river substrate is dominated by boulder (50%), followed by cobble (21%). The pool below Electra Dam has predominantly sand substrate.

18.3.2 Fish and Redd Surveys

The cumulative number of fish (including dead fish) and redds observed during our visual surveys is summarized in Table 18.2. Species observed in order of abundance are kokanee salmon, brown trout, rainbow trout, Sacramento suckers (*Catostomus occidentalis*), and hardheads (*Mylopharodon conocephalus*). We observed a peak number of 1,709 kokanee salmon and 30 brown trout in the river on 17-18 October. A peak number of 39 rainbow trout was observed during our 15-16 November surveys. After our 15-16 November surveys, the total number of fish observed in the Upper Mokelumne River dropped considerably (Table 18.2).

Most fish, especially kokanee salmon, were observed in the river above Highway 49 (Table 18.2). We often saw large schools of kokanee (up to 100) concentrated in the large pool below Electra Dam (km 21.4). This area also contained the highest number of kokanee redds: on 8-9 November, a peak number of 135 redds was observed (Table 18.3). It was difficult to count redds at Electra during peak spawning because of the high number and possible superimposition of redds. Other major spawning grounds were located above Highway 49 (Figure 18-1); 49 redds were counted at km 19.8 on 8 November, and 67 redds were counted at km 17.2 on 9 November. Redds above Highway 49 accounted for approximately 86 percent of the peak number of redds observed in the entire study area.

Below Highway 49, the highest total number of redds observed was 63 on 27-28 November (Table 18.2). Twenty-two of these were at km 13.2 (Table 18.3). In general, the number of fish observed in this reach was consistently less than 20 percent of the total fish in the river.

The occurrence of "new" kokanee redds over time is illustrated in Figure 18-2. Spawning grounds were first noted in the river above Highway 49 at km 20.3 when flows were high. In November, when flows were continuously dropping, we began to see redd construction occurring below Highway 49, specifically between km 12 and km 14 near Middle Bar Bridge.

Of the 14 total kokanee spawning areas identified, nine were found in run habitats, two in riffles and one in the large pool located below the Electra pool. In these redd areas, the river averaged 1.3 m deep, although redds were found in water as deep as 5 m. Kokanee redds were found typically in sand and gravel substrate in slow to moderately flowing water in eddies below cascades or in tail ends of such large pool areas such as km 20.3 (Electra). We saw no redds in substrate larger than gravel size.

Because of fluctuating flows, redds located in shallow water were occasionally dewatered at flows less than 200 cfs; this was observed both below (km 12.6, 12.7) and above (km 17.1, 18.9) Highway 49. We also observed dead kokanee eggs (noted by their color and opacity) in spawning areas. We do not know how much egg loss was caused by fluctuating flows, since we did not survey the redds every day. At Electra Dam, egg mortalities could have also been due to the high numbers of kokanee attempting to spawn in the area, causing old redds to be disturbed and replaced by new redds. We also observed rainbow trout feeding on kokanee eggs in the Electra area.

The mean total length (TL) of dead kokanee collected during our study was 306 mm (N=18, std. dev.=16); the standard length (SL) was 254 mm (N=30, std. dev.=13). We were unable to measure total length on 12 of the 30 dead fish due to deterioration of the caudal fin. Thirty two of 50 dead females (64%) examined were spawned out. Two dead male brown trout collected on 6 December 1990 measured 520 mm and 675 mm TL (445 and 590 mm SL, respectively).

We did not observe brown trout redds until our 5-6 December surveys. At that time, a total of 12 redds were observed in the study section, most below Highway 49 (Figure 18-1). Three of five brown trout spawning areas were found in runs, the rest in riffles. Compared to kokanee redds, brown trout redds were larger and found in shallower (0.7 m), faster-flowing water in large gravel substrate. Because they sometimes occurred in similar locations as kokanee redds, brown trout redds could have previously been mistaken for kokanee redds, especially in instances where we did not observe any fish defending a redd.

Water temperatures ranged from 14.8° C (1 Nov.) to 5.0° (6 Dec.) during our surveys. Air temperatures ranged from 26° to 3.8° C. Because of dropping water temperatures, we were unable to snorkel the river after 6 December.

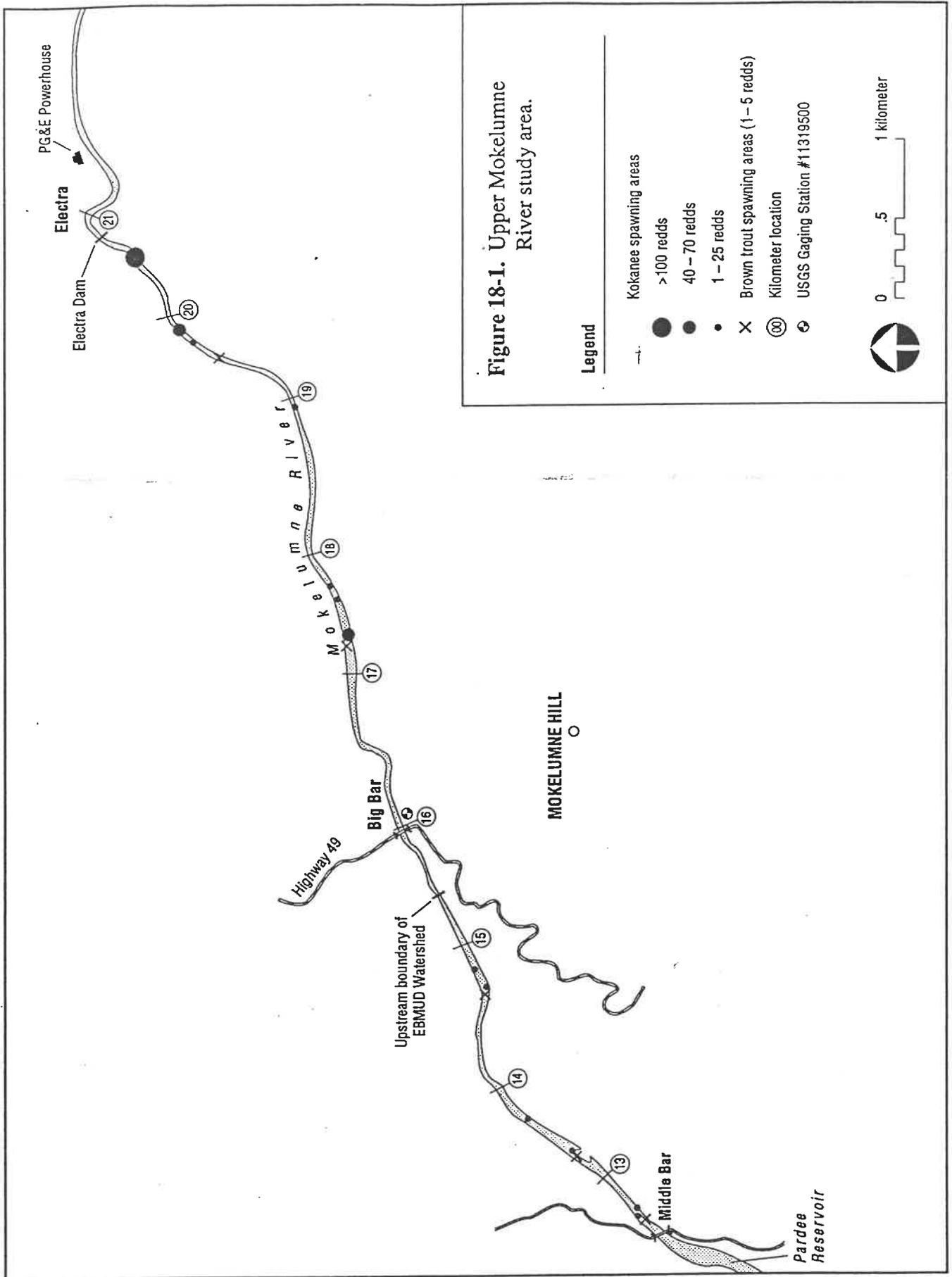
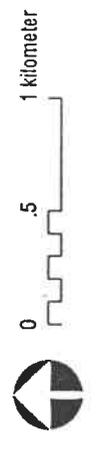


Figure 18-1. Upper Mokelumne River study area.

Legend

- Kokanee spawning areas
- > 100 redds
- 40 – 70 redds
- 1 – 25 redds
- × Brown trout spawning areas (1 – 5 redds)
- ⊙ Kilometer location
- ⊕ USGS Gaging Station #11319500



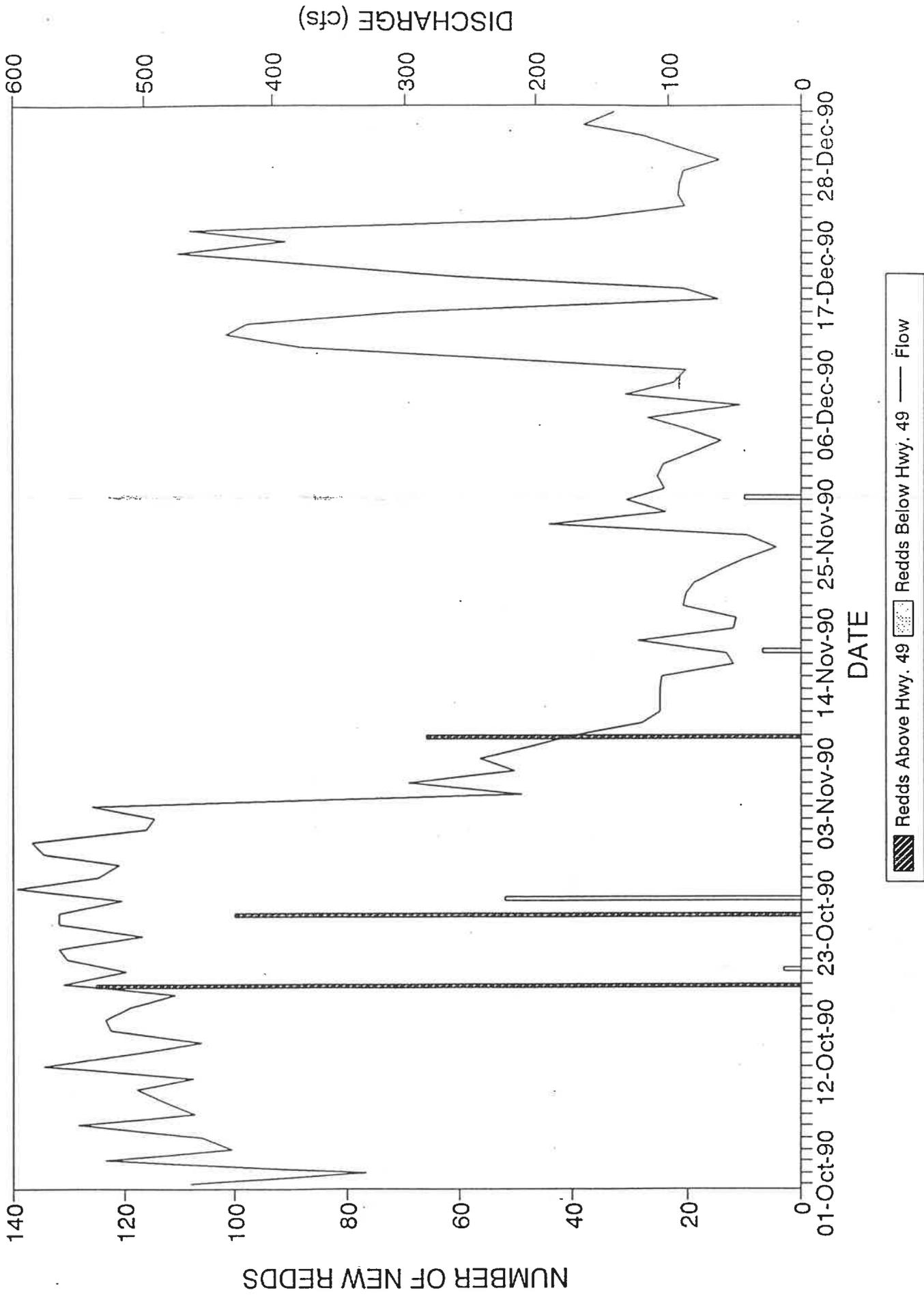


Figure 18-2. Number of "new" kokanee redds observed and flows during surveys on the Upper Mokolunne River, October - December 1990.

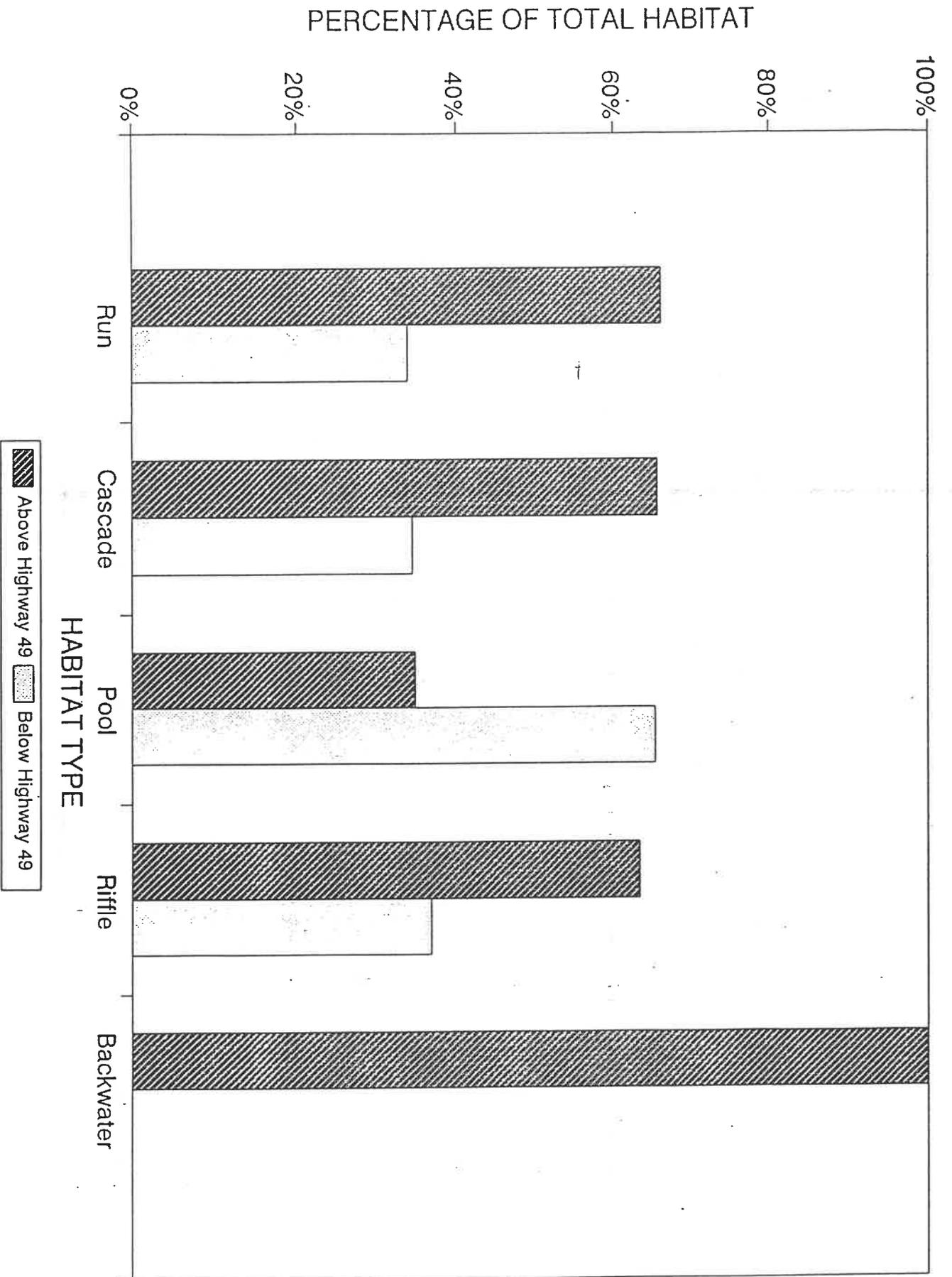


Figure 18-3. Percentage of each habitat type (by area) found above and below Highway 49 on the Upper Mokelumne River, April 1991.

Table 18.1. Characteristics of aquatic habitats surveyed on the Upper Mokelumne River, April 1991. 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	
ABOVE HIGHWAY 49												
POOL	2	235.6	117.8 (68.7)	34.3 (4.4)	8,686.3	4,343.2 (2,877.4)	3.0 (1.5)	83.3	0.0	10.9	0.0	5.8
RUN	24	3,669.5	174.7 (104.5)	20.0 (9.9)	105,378.1	4,390.8 (3,179.7)	1.1 (0.6)	13.4	7.1	14.5	57.0	8.0
RIFFLE	4	306.0	76.5 (8.4)	37.5 (4.3)	11,550.0	2,887.5 (555.3)	0.5 (0.1)	1.6	4.7	28.6	65.1	0.0
CASCADE	14	778.2	55.6 (36.1)	22.1 (9.0)	17,734.1	1,226.7 (1,210.8)	0.5 (0.4)	0.0	1.0	7.1	78.8	13.0
BACKWATER	2	123.4	61.7 (5.3)	13.6 (7.8)	1,591.4	795.7 (407.4)	0.4 (0.2)	30.2	0.0	9.8	60.0	0.0
TOTAL	46	5,112.7	--	26.7 (10.4)	144,939.9	--	1.0 (0.8)	15.3	5.6	14.5	56.9	7.7
BELOW HIGHWAY 49												
POOL	3	507.8	169.3 (33.7)	33.0 (6.0)	16,203.1	5,401.0 (387.7)	2.7 (1.6)	37.7	0.0	16.2	41.5	4.6
RUN	17	1,974.8	539.92 (444.24)	28.8 (9.3)	54,156.9	3,185.7 (3,871.7)	0.9 (0.6)	12.2	11.3	29.1	44.8	2.6
RIFFLE	3	100.1	60.0 (38.8)	38.2 (4.6)	6,742.3	2,247.4 (1,545.9)	0.3 (0.1)	4.8	23.9	55.7	12.6	3.0
CASCADE	9	381.9	42.4 (16.2)	24.2 (3.9)	9,325.2	1,036.1 (404.4)	0.4 (0.3)	0.0	0.0	15.6	82.8	1.6
BACKWATER	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL	32	3,044.6	--	28.8 (8.4)	86,427.5	--	0.9 (1.0)	13.7	9.5	28.0	46.0	2.8
GRAND TOTAL	78	8,157.3	--	27.6 (9.7)	231,367.4	--	1.0 (0.9)	15.0	9.0	20.7	49.7	5.6

Table 18.2. Summary of number of fish and redds observed during visual surveys on the Upper Mokelumne River, October - December 1990. "Upper" totals are the total number counted from Electra to Highway 49; "Lower" totals are the total number counted from Highway 49 to Middle Bar Bridge.

DATES	NUMBER OF FISH (BY SPECIES)			NUMBER OF REDDS			CARRION
	KOKANEE	BROWN TROUT	RAINBOW TROUT	KOKANEE	BROWN TROUT	KOKANEE	
Oct. 17-18	Upper	1,447	18	5	125	0	104
	Lower	267	12	7	3	0	30
	TOTAL	1,709	30	12	128	0	134
Oct. 24-25	Upper	904	24	10	225	0	204
	Lower	129	2	1	55	0	78
	TOTAL	1,033	26	11	280	0	282
Nov. 08-09	Upper	864	16	25	291	0	260
	Lower	17	4	3	49	0	140
	TOTAL	881	20	28	340	0	400
Nov. 15-16	Upper	1,004	10	27	248	0	300
	Lower	68	3	12	56	0	85
	TOTAL	1,072	13	39	304	0	385
Nov. 27-28	Upper	94	4	0	172	0	194
	Lower	0	4	0	67	0	30
	TOTAL	94	8	0	239	0	224
Dec. 05-06	Upper	55	4	0	157	3	118
	Lower	0	1	0	49	9	2
	TOTAL	55	5	0	206	12	120

