



12 January 1992

Department of Fisheries

Mr. Alan Wilkinson,
Chief Ranger
Prairie Creek State Park
Orick, CA 95555

Dear Alan:

Thank you again for allowing my Limnology Practicum class to sample water, substrate and aquatic invertebrates in Prairie Creek State Park on 5 October 1991. Enclosed is a summary report titled "Physical, Chemical and Biological Characteristics of Prairie Creek -- October 1991", which includes the data we collected at the three study sites on Prairie Creek.

If you have questions, feel free to telephone me at 707-826-3951.

Sincerely,

Joseph S. Meyer, Ph.D.

Enclosure: Prairie Creek report

✓ cc: Carolyn Meyer, Redwood National Park

PHYSICAL, CHEMICAL AND BIOLOGICAL CHARACTERISTICS
OF PRAIRIE CREEK -- OCTOBER 1991

Submitted to

Mr. Alan Wilkinson, Chief Ranger
Prairie Creek State Park
Orick, CA

Submitted by

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10 January 1992

INTRODUCTION

On 5 and 6 October 1991, the Limnology Practicum class (FISH 320L) in the Fisheries Department at Humboldt State University (HSU) sampled and subsequently analyzed physical, chemical and biological characteristics at 5 study sites on Prairie Creek in northern Humboldt County, California. The purposes were to (1) allow students to test whether physical, chemical and biological features of Prairie Creek change in a predictable sequence from the headwaters to the mouth of the creek, as predicted by the River Continuum Concept (Vannote et al. 1980), and (2) compile information about Prairie Creek as it flows through Prairie Creek State Park. This report presents results of that study to the California Department of Parks and Recreation.

STUDY SITES

Prairie Creek originates about 18 km north of Orick in Humboldt County, California, at the northern end of Prairie Creek State Park (Fig. 1). The creek flows south approximately 19 stream km to its confluence with Redwood Creek, at the northern end of Orick. Much of Prairie Creek's 95-km² watershed contains old-growth redwood forests, although pastures and several residences line much of the lower half of the creek. In 1984, the California Department of Transportation began constructing an 18-km bypass for U.S. Highway 101 around Prairie Creek State Park. During the construction phase, fine sediment eroded from the construction site into Prairie Creek and its tributaries.

The following 5 study sites were established on the mainstem of Prairie Creek (Fig. 1):

Site 1: Immediately upstream from the confluence with Ten Tapo Creek.

Site 2: At the ZigZag Trail #2 bridge.

Site 3: Immediately upstream from the confluence with Godwood Creek.

Site 4: Immediately downstream from the confluence with Lost Man Creek.

Site 5: Between the Bald Hills Road bridge and the confluence with Redwood Creek.

Sites 1, 2 and 3 were visited on 5 October; sites 4 and 5 were visited on 6 October.

METHODS

Morphology, Flow and Substrate Measurements

At each study site, two stream transects were established -- one in a riffle zone, and one in a pool. Wetted width of the riffle or pool was measured with a cloth tape, and water depth was recorded at 5 to 10 approximately equally-spaced intervals across the stream. Water velocity at 60% depth was measured using a Pygmy current meter, at each place water depth was recorded and was deep enough to totally submerge the current-meter cups. Surface-water velocity over the thalweg was estimated by timing the downstream

movement of a floating object (e.g., a twig) along a measured distance (e.g., 1 m).

Cross-sectional area of the stream in each pool or riffle was estimated by plotting the cross-section profile on graph paper and using a polar planimeter to measure the area. Average depth was calculated as cross-sectional area divided by wetted width. Average stream velocity was estimated two ways: 1) assuming average velocity equalled the velocity at 60% depth in the thalweg, and 2) assuming average velocity equalled 0.8 times the surface velocity over the thalweg. Then, discharge was estimated by multiplying average stream velocity by cross-sectional area.

To estimate the size distribution of substrate in riffles, either 150 pebbles (sites 1 and 3) or 200 pebbles (sites 2, 4 and 5) were randomly selected at each site and measured along the second-longest axis. Proportions of the total sample were then computed for each of the following 8 size classes: ≤ 2 mm, $>2 - 4$ mm, $>4 - 8$ mm, $>8 - 16$ mm, $>16 - 32$ mm, $>32 - 64$ mm, $>64 - 128$ mm, $>128 - 256$ mm, $>256 - 512$ mm.

Physical-chemical Measurements

At each of the 5 study sites, 6 parameters indicating physical or chemical quality of Prairie Creek water were analyzed.

Temperature and dissolved oxygen were measured using an air-calibrated Yellow Springs Instrument Company (YSI) Model 58 Dissolved Oxygen Meter. Percent O_2 saturation was calculated as follows:

$$\text{percent } O_2 \text{ saturation} = 100 * [O_2]_{\text{measured}} / [O_2]_{\text{solubility}}$$

where $[O_2]_{\text{solubility}}$ over a range of common water temperatures is tabulated in Lind (1985:76). Conductivity was measured using a YSI Model 33 SCT Meter, and was later adjusted to a standard temperature of 25°C using the following equation:

$$\text{conductivity}_{25C} = \text{conductivity}_T / [1 + 0.019 * (T - 25)]$$

where T = water temperature (°C), and conductivity_T = conductivity measured at temperature T .

Alkalinity and hardness were determined in the field using HACH kits. Additionally, water samples were collected in two 300-ml amber glass bottles and returned to Humboldt State University for more precise analyses during the afternoon of the same day in which the samples were collected. In the laboratory, pH was measured using a Fisher Accumet Model 810 pH meter equipped with an Orion combination electrode. Then, 100 ml of the sample was titrated for total alkalinity (Lind 1985:62-66) and 50 ml was titrated for EDTA hardness (Lind 1985:67-69).

Macroinvertebrate Sampling

Nine aquatic macroinvertebrate samples were collected at each site -- either 5 or 6 samples in a riffle downstream from the stream transects (designated riffle samples), and either 3 or 4 samples collected from any habitat the students wished to sample (designated free-ranging samples). Riffle samples were collected using a Surber sampler with a 30-cm x 30-cm sampling frame; whereas the free-ranging samples were collected using bare hands, dip nets, Surber samplers, or any other means desired to find a

diversity of aquatic invertebrates. For all samples, students collected for 10 minutes and then transferred organisms for 15 minutes from white enamel pans into labeled glass jars.

Ethanol was added to the water in each jar to produce an approximately 70% EtOH solution. The jars were returned to HSU, and later in the semester the macroinvertebrates were identified to order in the laboratory, using dissecting microscopes and taxonomic keys (McCafferty 1983; Merritt and Cummins 1978; Pennak 1978, 1989).

Diversity of aquatic invertebrates in the riffle samples was evaluated two ways: 1) number of orders of aquatic invertebrates represented at each site; and 2) Shannon-Wiener diversity index (H') based on the orders of aquatic invertebrates present, which was calculated as follows:

$$H' = \sum [p_i * \ln(p_i)]$$

where p_i = proportion of organisms in order i . For this calculation, numbers of aquatic invertebrates in all riffle samples at a site were combined to yield a composite sample, from which the Shannon-Wiener diversity index was then computed.

Because of the variety of techniques used to collect free-ranging invertebrate samples, diversity indexes for free-ranging samples will not be compared in this report.

RESULTS AND DISCUSSION

Physical and chemical characteristics of Prairie Creek were relatively uniform throughout the stream (Table 1) and generally similar to values reported by Mushet (1990). Temperatures on 5 and 6 October 1991 ranged from 11.5 to 13.8°C, whereas Mushet (1990) reported temperatures between 12.5 and 16.5°C on 29 and 30 September 1990. Dissolved oxygen ranged from 8.9 to 10.5 mg/L (89-101% saturation) and decreased in the downstream direction between study sites 2 and 5; Mushet (1990) reported oxygen concentrations between 8.0 and 9.9 mg/L, also with concentrations decreasing in the downstream direction. Dissolved oxygen concentrations decreased by 1.5 mg/L between study sites 4 and 5 in 1990 and by 1.0 mg/L in 1991. Values of pH also decreased in the downstream direction between study sites 2 and 5, in 1991 (range = 6.6-7.1 pH units) and in 1990 (range = 6.8-7.3 pH units; Mushet 1990). Alkalinity and hardness values in 1991 (ranges = 30-36 and 28-32 mg/L as CaCO_3 , respectively) were similar to those reported in 1990 (ranges = 30-37 and 26-34 mg/L as CaCO_3 , respectively; Mushet 1990).

The only major difference in physical-chemical characteristics between the two study years was conductivity. In 1990, Mushet reported a wide range of conductivity in Prairie Creek (80-203 $\mu\text{mhos/cm}$), with the highest value at study site 3; conductivity further downstream returned to values equal to the conductivity reported for study site 1. However, in 1991, conductivity was relatively uniform among the 5 study sites (range = 88-97 $\mu\text{mhos/cm}$), showing only a slight decreasing trend in the downstream direction. Apparently, the source of increased conductivity at study site 3 in 1990 was not present in 1991.

Morphological characteristics at the 5 study sites in 1991 were similar to those observed in 1990 (compare Table 2 in this report to Tables 3 and 4 in Mushet 1990). Discharge in 1991 (range = 0.01-0.40 m^3/sec) tended to be slightly lower than in 1990 (range = 0.01-0.53 m^3/sec ; compare Table 2 in this

report to Table 5 in Mushet 1990). However, the 1991 discharge estimate for the riffle at study site 2 ($0.14 \text{ m}^3/\text{sec}$) appears to be erroneously high, probably because the velocity of a floating object over the thalweg severely overestimated the average velocity of water flowing through this shallow, 6.0-m-wide riffle.

Substrate size distributions in Prairie Creek riffles in 1991 generally were similar among study sites, except that there was a trend toward smaller size classes at the most downstream study site (Table 3). These distributions also were generally similar to those found in 1990 (cf. Figure 4 in Mushet 1990), except that there was a trend toward slightly larger substrate at study site 3 in 1990 and a trend toward slightly smaller substrate at study site 4 in 1990.

The number of orders of aquatic invertebrates found in riffles in 1991 was higher in the 3 upstream study sites (1, 2 and 3) than in the 2 downstream sites (4 and 5), with the largest number (14 orders) found at site 3 (Table 4). Shannon-Wiener diversity of the invertebrate orders was highest at sites 1 and 3 and was lowest at site 5 (Table 4). A similar trend was reported by Mushet (1990; c.f. his Tables 6 and 7); however, the total number of orders present was greater in 1991 than in 1990, probably because of the more intense sampling effort in riffles in 1991 (5 or 6 riffle samples collected in 1991 versus 1 or 2 in 1990).

Similar to Mushet (1990), we found that the dominant orders of aquatic invertebrates changed noticeably from upstream to downstream sites. At study site 1 (the most upstream site), scuds (Amphipoda) and mayflies (Ephemeroptera) were the most abundant invertebrate orders numerically in the riffle samples (Table 5); at site 2, caddisflies (Trichoptera), stoneflies (Plecoptera) and mayflies dominated (Table 6); at site 3, mayflies, stoneflies, snails (Gastropoda) and caddisflies dominated (Table 7); at site 4, mayflies, snails, stoneflies and caddisflies dominated (Table 8); and at site 5 (the most downstream site), mayflies and stoneflies dominated (Table 9). Riffle samples from study sites 2, 3 and 4 contained two to five times more individuals than were found at sites 1 and 5 (Tables 5 to 9).

In summary, except for the unexplained high conductivity at study site 3 (between Boyes Creek and Godwood Creek) in 1990, physical, chemical and biological characteristics of Prairie Creek were similar in late-September 1990 and early-October 1991.

ACKNOWLEDGMENTS

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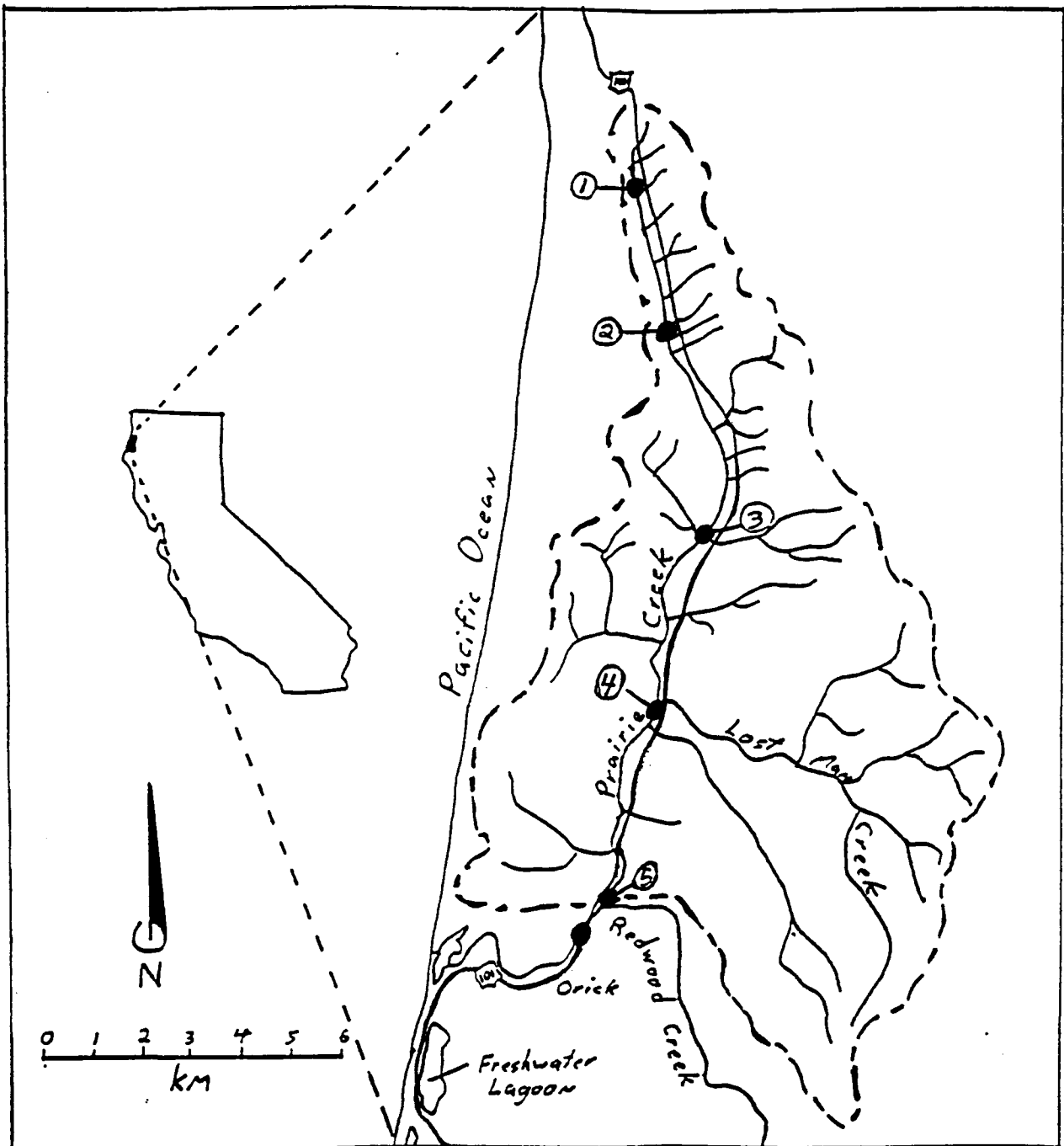


Figure 1. Locations of study sites on Prairie Creek, northern Humboldt County, California (modified from Mushet 1990).

Table 1. Physical and chemical characteristics at the 5 study sites on Prairie Creek, Humboldt County, California, analyzed on 5 and 6 October 1991.

Characteristic	Study site				
	1	2	3	4	5
Date sampled	10-5-91	10-5-91	10-5-91	10-6-91	10-6-91
Time sampled	15:00	13:00	11:00	09:30	12:45
Temperature (°C)	11.5	12.0	12.5	12.6	13.8
Conductivity (µmhos/cm)					
Measured value	72	71	69	67	71
Converted to 25°C	97	94	90	88	90
Dissolved oxygen					
Measured value (mg/L)	9.8	10.5	10.4	9.9	8.9
Percent saturation (%)	93	101	101	96	89
pH (units)	7.0	7.1	6.8	6.7	6.6
Alkalinity (mg/L as CaCO ₃)	32	34	36	32	30
Hardness (mg/L as CaCO ₃)	28	29	32	28	28

Table 2. Morphological and flow characteristics at the 5 study sites on Prairie Creek, Humboldt County, California, measured on 5 and 6 October 1991.

Characteristic	Study site				
	1	2	3	4	5
Date sampled	10-5-91	10-5-91	10-5-91	10-6-91	10-6-91
Time sampled	14:00	12:00	10:00	08:30	12:00
Wetted width (m)					
Pool	1.0	2.5	3.8	6.4	4.9
Riffle	1.4	6.0	2.0	7.2	3.8
Cross-sectional area (m ²)					
Pool	0.065	0.32	1.46	1.31	1.06
Riffle	0.035	0.35	0.10	0.61	0.35
Maximum depth (m)					
Pool	0.09	0.27	0.72	0.40	0.56
Riffle	0.04	0.09	0.10	0.14	0.16
Average depth (m)					
Pool	0.06	0.13	0.38	0.20	0.21
Riffle	0.02	0.06	0.05	0.08	0.09
Average velocity (m/sec)					
Pool					
Current meter	0.16	0.04	0.18	0.10	0.23
Floating object	0.14	--	0.04	0.12	0.25
Riffle					
Current meter	--	--	0.59	0.61	0.32
Floating object	0.38	0.40	0.59	0.65	0.31
Discharge (m ³ /sec) ^a					
Pool	0.010	0.013	0.06 ^b	0.13	0.24
Riffle	0.013 ^c	0.14 ^c	0.06	0.40	0.11

^aDischarges are based on average velocity estimated from the current meter, except as noted.

^bDischarge was based on average velocity estimated from a floating object, because velocity based on the current meter reading in the thalweg did not adequately represent the average water velocity across the stream cross-section.

^cDischarge was based on average velocity estimated from a floating object, because the water was too shallow to submerge a current meter.

Table 3. Substrate size distributions at the 5 study sites on Prairie Creek, Humboldt County, California, measured on 5 and 6 October 1991.

Characteristic	Study site				
	1	2	3	4	5
Date sampled	10-5-91	10-5-91	10-5-91	10-6-91	10-6-91
Size class (mm)	Proportion in size class				
<2	0.013	0.000	0.073	0.010	0.045
>2 - 4	0.013	0.000	0.040	0.000	0.025
>4 - 8	0.013	0.050	0.120	0.050	0.055
>8 - 16	0.133	0.140	0.233	0.165	0.370
>16 - 32	0.413	0.330	0.173	0.305	0.370
>32 - 64	0.373	0.360	0.227	0.405	0.090
>64 - 128	0.040	0.115	0.113	0.065	0.045
>128 - 256	0.000	0.005	0.020	0.000	0.000
>256 - 512	0.000	0.000	0.000	0.000	0.000
	(n=150)	(n=200)	(n=150)	(n=200)	(n=200)

Table 4. Diversity of orders of aquatic insects at the 5 study sites on Prairie Creek, Humboldt County, California, collected on 5 and 6 October 1991.

Date	Study site	Number of orders of aquatic invertebrates	Shannon-Wiener diversity index
10-5-91	1	11	1.90
10-5-91	2	10	1.51
10-5-91	3	14	1.85
10-6-91	4	9	1.58
10-6-91	5	7	1.33

Table 5. Aquatic invertebrates sampled in riffles and various other habitats (free-ranging) at Site 1 (upstream from Ten Tapo Creek) in Prairie Creek, Humboldt County, California, on 5 October 1991.

Phylum	Class	Order	Riffles								Free-ranging					
			Sample number						Mean	s.d.	Sample number					
			1	2	3	4	5	6			1	2	3	4	Mean	s.d.
Annelida	Hirudinea		0	0	0	2	0		0.4	0.89	0	0	0	0	0.0	0.00
	Oligochaeta		2	0	6	0	1		1.8	2.49	0	0	0	0	0.0	0.00
Arthropoda	Arachnida	Acari	0	0	0	0	0		0.0	0.00	0	0	0	0	0.0	0.00
	Crustacea	Amphipoda	0	13	7	11	5		7.2	5.12	5	2	6	10	5.8	3.30
		Isopoda	0	0	0	0	0		0.0	0.00	0	0	1	0	0.2	0.50
		Mysidacea	0	0	0	0	0		0.0	0.00	0	0	0	0	0.0	0.00
	Insecta	Coleoptera	1	0	4	0	0		1.0	1.73	0	0	1	0	0.2	0.50
		Diptera	3	0	0	0	3		1.2	1.64	1	2	0	4	1.8	1.71
		Ephemeroptera	3	7	4	7	3		4.8	2.05	7	6	7	13	8.2	3.20
		Hemiptera	0	0	0	0	0		0.0	0.00	0	0	0	0	0.0	0.00
		Lepidoptera	1	0	0	0	0		0.2	0.45	0	0	0	0	0.0	0.00
		Megaloptera	0	0	0	0	0		0.0	0.00	0	0	0	0	0.0	0.00
		Odonata	0	1	0	0	0		0.2	0.45	0	0	0	0	0.0	0.00
		Plecoptera	0	3	5	2	5		3.0	2.12	10	8	2	5	6.2	3.50
		Trichoptera	0	3	3	4	9		3.8	3.27	3	2	2	15	5.5	6.35
Mollusca	Gastropoda	not identified	0	0	0	0	0		0.0	0.00	0	0	0	0	0.0	0.00
		Pulmonata	0	0	0	0	0		0.0	0.00	0	0	0	0	0.0	0.00
		Ctediobranchiata	0	0	0	1	0		0.2	0.45	0	0	0	1	0.2	0.50
	Pelecypoda	Eulamellibranchiata	0	0	0	0	0		0.0	0.00	0	0	0	0	0.0	0.00

Table 6. Aquatic invertebrates sampled in riffles and various other habitats (free-ranging) at Site 2 (Zig-Zag Trail #2 bridge) in Prairie Creek, Humboldt County, California, on 5 October 1991.

Phylum	Class	Order	Riffles								Free-ranging					
			Sample number						Mean	s.d.	Sample number				Mean	s.d.
			1	2	3	4	5	6			1	2	3	4		
Annelida	Hirudinea		0	0	0	0	0	0	0.0	0.00	0	0	0		0.0	0.00
	Oligochaeta		0	0	0	3	0	1	0.7	1.21	2	1	1		1.3	0.58
Arthropoda	Arachnida	Acari	0	0	0	0	0	0	0.0	0.00	0	0	1		0.3	0.58
	Crustacea	Amphipoda	5	0	2	6	3	7	3.8	2.64	0	2	4		2.0	2.00
		Isopoda	0	0	0	0	0	0	0.0	0.00	0	0	0		0.0	0.00
		Mysidacea	1	0	0	0	0	1	0.3	0.52	0	0	0		0.0	0.00
	Insecta	Coleoptera	6	0	1	3	0	8	3.0	3.35	1	0	0		0.3	0.58
		Diptera	1	1	0	0	3	0	0.8	1.17	0	0	7		2.3	4.04
		Ephemeroptera	16	5	14	4	8	16	10.5	5.50	13	14	11		12.7	1.53
		Hemiptera	0	0	0	0	0	0	0.0	0.00	0	0	1		0.3	0.58
		Lepidoptera	0	0	0	0	0	0	0.0	0.00	0	0	0		0.0	0.00
		Megaloptera	0	0	0	0	0	0	0.0	0.00	0	0	1		0.3	0.58
		Odonata	0	1	0	0	0	0	0.2	0.41	0	1	0		0.3	0.58
		Plecoptera	16	3	8	17	2	31	12.8	10.91	9	13	9		10.3	2.31
	Trichoptera	63	0	13	52	18	45	31.8	24.94	20	18	7		15.0	7.00	
Mollusca	Gastropoda	not identified	2	0	0	0	0	0	0.3	0.82	0	0	0		0.0	0.00
		Pulmonata	0	0	0	0	0	0	0.0	0.00	0	0	0		0.0	0.00
		Ctediobranchiata	0	2	0	1	2	1	1.0	0.89	2	3	0		1.7	1.53
	Pelecypoda	Eulamellibranchiata	0	0	0	0	0	0	0.0	0.00	0	0	0		0.0	0.00

Table 7. Aquatic invertebrates sampled in riffles and various other habitats (free-ranging) at Site 3 (upstream from Godwood Creek) in Prairie Creek, Humboldt County, California, on 5 October 1991.

Phylum	Class	Order	Riffles								Free-ranging					
			Sample number						Mean	s.d.	Sample number					
			1	2	3	4	5	6			1	2	3	4	Mean	s.d.
Annelida	Hirudinea		0	0	0	0	0		0.0	0.00	0	0	0	0	0.0	0.00
	Oligochaeta		0	0	1	1	2		0.8	0.84	0	0	0	0	0.0	0.00
Arthropoda	Arachnida	Acari	0	0	0	0	1		0.2	0.45	0	0	0	1	0.2	0.50
	Crustacea	Amphipoda	0	0	0	1	0		0.2	0.45	0	0	3	0	0.8	1.50
		Isopoda	0	0	0	1	0		0.2	0.45	0	0	0	0	0.0	0.00
		Mysidacea	0	0	0	1	0		0.2	0.45	0	0	0	0	0.0	0.00
	Insecta	Coleoptera	16	0	0	6	0		4.4	6.99	0	2	11	8	5.2	5.12
		Diptera	1	0	0	1	1		0.6	0.55	0	10	0	1	2.8	4.86
		Ephemeroptera	35	11	4	21	28		19.8	12.52	7	9	6	24	11.5	8.43
		Hemiptera	0	0	0	0	3		0.6	1.34	0	0	0	0	0.0	0.00
		Lepidoptera	0	0	0	0	0		0.0	0.00	0	0	0	0	0.0	0.00
		Megaloptera	0	0	0	0	1		0.2	0.45	0	0	0	2	0.5	1.00
		Odonata	2	2	0	0	0		0.8	1.10	0	0	2	2	1.0	1.15
		Plecoptera	20	0	3	5	10		7.6	7.83	0	4	11	11	6.5	5.45
	Trichoptera	16	0	3	2	4		5.0	6.32	9	93	20	11	33.2	40.12	
Mollusca	Gastropoda	not identified	3	0	0	0	0		0.6	1.34	0	0	0	0	0.0	0.00
		Pulmonata	0	1	3	0	0		0.8	1.30	0	0	0	0	0.0	0.00
		Ctediobranchiata	0	2	0	2	28		6.4	12.12	43	41	24	19	31.8	12.04
	Pelecypoda	Eulamellibranchiata	0	0	0	0	0		0.0	0.00	0	0	0	0	0.0	0.00

Table 8. Aquatic invertebrates sampled in riffles and various other habitats (free-ranging) at Site 4 (downstream from Lost Man Creek) in Prairie Creek, Humboldt County, California, on 6 October 1991.

Phylum	Class	Order	Riffles								Free-ranging					
			Sample number						Mean	s.d.	Sample number					
			1	2	3	4	5	6			1	2	3	4	Mean	s.d.
Annelida	Hirudinea		0	0	0	0	0		0.0	0.00	0	0	0	0	0.0	0.00
	Oligochaeta		0	2	10	0	2		2.8	4.15	0	1	1	1	0.8	0.50
Arthropoda	Arachnida	Acari	0	0	0	0	0		0.0	0.00	0	0	1	1	0.5	0.58
	Crustacea	Amphipoda	0	0	1	0	0		0.2	0.45	0	0	0	0	0.0	0.00
		Isopoda	0	0	0	0	0		0.0	0.00	0	0	0	0	0.0	0.00
		Mysidacea	0	0	0	0	0		0.0	0.00	0	0	0	0	0.0	0.00
	Insecta	Coleoptera	1	0	0	2	1		0.8	0.84	5	0	2	3	2.5	2.08
		Diptera	19	1	2	1	1		4.8	7.95	3	0	4	18	6.2	8.02
		Ephemeroptera	15	24	86	30	70		42.2	34.89	11	10	20	28	17.2	8.46
		Hemiptera	0	0	0	0	0		0.0	0.00	0	0	0	0	0.0	0.00
		Lepidoptera	0	0	0	0	0		0.0	0.00	0	0	0	0	0.0	0.00
		Megaloptera	0	0	0	0	0		0.0	0.00	0	1	1	3	1.2	1.26
		Odonata	0	0	0	0	0		0.0	0.00	0	0	0	3	0.8	1.50
		Plecoptera	27	6	18	18	26		19.0	8.43	4	6	21	8	9.8	7.68
		Trichoptera	10	4	13	26	22		15.0	8.94	49	1	14	121	46.2	53.80
Mollusca	Gastropoda	not identified	0	0	0	0	0		0.0	0.00	3	0	0	0	0.8	1.50
		Pulmonata	2	0	0	3	0		1.0	1.41	0	4	0	10	3.5	4.73
		Ctediobranchiata	22	5	26	15	40		21.6	13.00	0	3	0	68	17.8	33.53
	Pelecypoda	Eulamellibranchiata	0	0	0	0	0		0.0	0.00	0	0	0	1	0.2	0.50

Table 9. Aquatic invertebrates sampled in riffles and various other habitats (free-ranging) at Site 5 (upstream from Redwood Creek confluence) in Prairie Creek, Humboldt County, California, on 6 October 1991.

Phylum	Class	Order	Riffles							Free-ranging						
			Sample number						Mean	s.d.	Sample number				Mean	s.d.
			1	2	3	4	5	6			1	2	3	4		
Annelida	Hirudinea		0	0	0	0	0	0	0.0	0.00	0	0	0		0.0	0.00
	Oligochaeta		0	0	0	0	0	2	0.3	0.82	0	0	0		0.0	0.00
Arthropoda	Arachnida	Acari	0	0	0	0	1	0	0.2	0.41	0	0	0		0.0	0.00
	Crustacea	Amphipoda	0	0	0	0	0	0	0.0	0.00	0	0	0		0.0	0.00
		Isopoda	0	0	0	0	0	0	0.0	0.00	0	0	1		0.3	0.58
		Mysidacea	0	0	0	0	0	0	0.0	0.00	0	0	0		0.0	0.00
	Insecta	Coleoptera	2	0	1	0	1	0	0.7	0.82	4	12	20		12.0	8.00
		Diptera	0	0	0	1	1	2	0.7	0.82	3	0	0		1.0	1.73
		Ephemeroptera	18	6	1	10	13	6	9.0	6.00	3	18	7		9.3	7.77
		Hemiptera	0	0	0	0	0	0	0.0	0.00	1	0	2		1.0	1.00
		Lepidoptera	0	0	0	0	0	0	0.0	0.00	0	0	0		0.0	0.00
		Megaloptera	0	0	0	0	0	0	0.0	0.00	0	0	1		0.3	0.58
		Odonata	0	0	0	0	0	0	0.0	0.00	0	0	0		0.0	0.00
		Plecoptera	5	4	1	7	8	4	4.8	2.48	2	4	8		4.7	3.06
	Trichoptera	4	4	0	3	1	2	2.3	1.63	2	15	5		7.3	6.81	
Mollusca	Gastropoda	not identified	0	0	0	0	0	0	0.0	0.00	0	0	0		0.0	0.00
		Pulmonata	0	0	0	0	0	0	0.0	0.00	0	12	0		4.0	6.93
		Ctediobranchiata	0	0	0	0	0	0	0.0	0.00	2	5	0		2.3	2.52
	Pelecypoda	Eulamellibranchiata	0	0	0	0	0	0	0.0	0.00	0	0	0		0.0	0.00