INTERNAL REPORT 26

AQUATIC PRODUCTION IN A SOCKEYE SALMON RIVER

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STUDY AREA

Six benthic invertebrate sampling stations were established on the Cedar River (Figure 1), and sampling began June 1971. All stations are riffle areas as near as possible to established U.S. Geological Survey (USGS) gauging stations. Stations were selected to yield data above and below Lake Chester Morse, as well as to assess the impact of sockeye salmon on the lower river. Two stations are above Lake Morse, one on the Cedar River (Station 1), and the other on the Rex River (Station 2), the major tributaries to the lake. The Cedar River below the lake is divided into two discrete sections by the City of Seattle, Water Supply Diversion. The upper section, from which sockeye are excluded, is sampled near Cedar Falls (Station 3) and at Landsburg (Station 4). The river section below the diversion is sampled near Cedar Grove (Station 5) and near Renton (Station 6).

METHODS

A general survey of the invertebrate populations at each of the six stations was made during the first 3 months of the study. Samples were collected each month using a 0.25-m^{-2} quadrat sampler similar to that used by Surber (1937). These samples will establish the dominant taxa at each station during the past summer. In an effort to standardize the sampling of invertebrates in the streams with the methods used at Oregon State University by Norman Anderson, we have adopted the method described by Coleman and Hynes (1970). This technique uses screen pots buried in the substrate. Pots were placed at each station on July 13, 1971 and are being sampled monthly. Sampling will continue with this technique for 1 year. The pots have remained undisturbed at all stations except those below Landsburg. Within a week after the pots were placed in the river at the Cedar Grove and Renton stations, they were removed by vandals and never recovered. We have since modified the outer pot by welding an 18-inch-square foot to one end which is subsequently buried. The foot should increase the difficulty of pulling the pot from the substrate. The inner pot is padlocked to the outer pot.

Invertebrate drift samples are also collected once a month for a 24-hour period. The drift samplers followed the design by Miller (1961) and were constructed of 6.5-inch diameter fiber glass pipe constricted at the mouth to 4.5 inches and fitted with sufficient 351-micron mesh netting to eliminate backpressure. The drift samplers are held in position in the river by two steel fence posts. Sampling of the drift is necessary because of the size of the river, which may not allow recovery of benthic samples during periods of high runoff. Drift samples

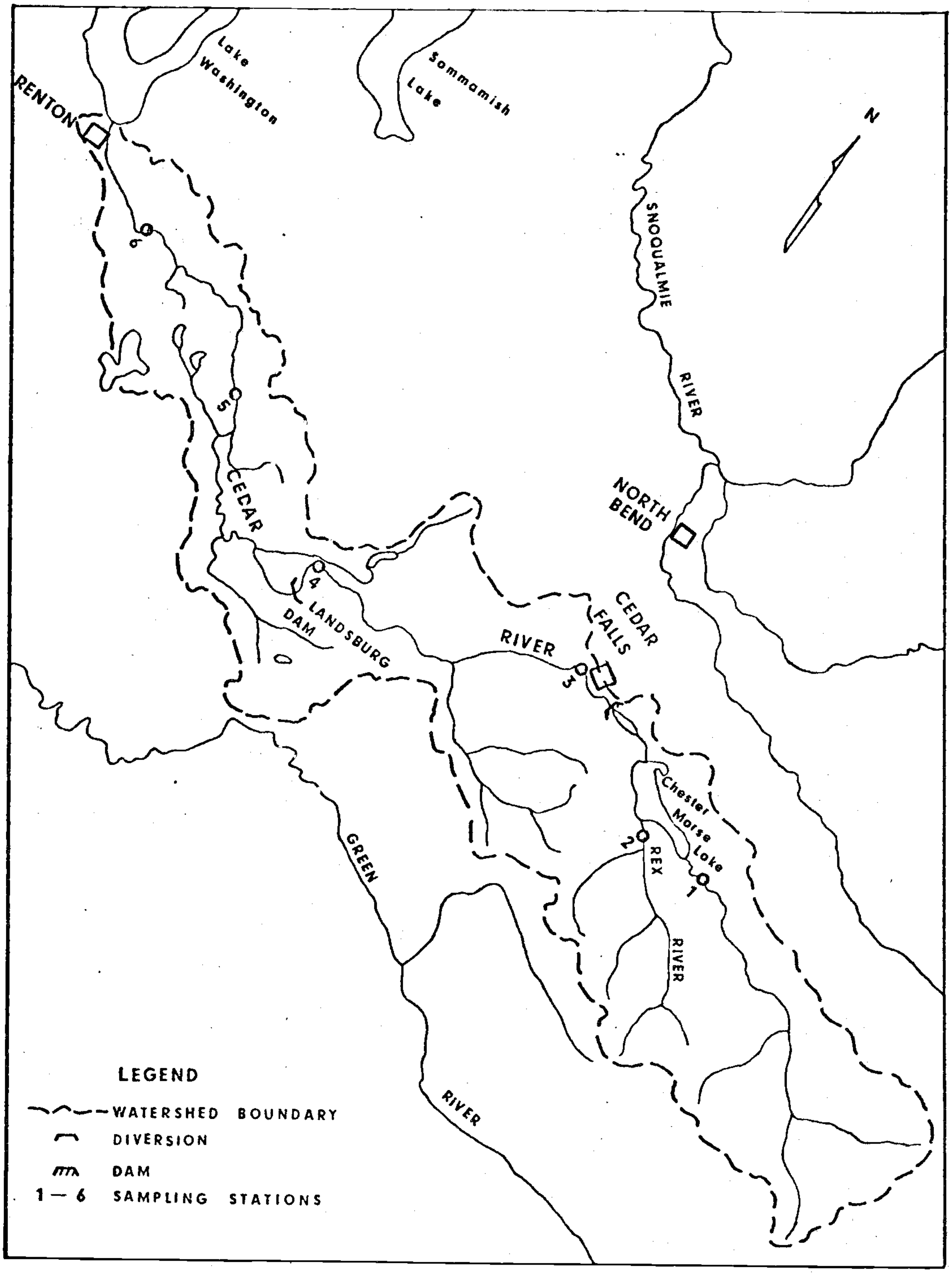

Fig. 1. Cedar River Basin showing sampling stations.

will provide an alternate means from which biomass and production estimates (Dimond, 1967; Heaton, 1966; Peterson, 1962) can be made.

In an attempt to determine the importance of allochthonous material as an energy source for the benthic invertebrates, we measured the detrital material residual at the time of collection of benthic samples. Drift nets yield additional quantitative estimates of particulate organic matter. After separation into groups based on value to foraging invertebrates, its dry weight is determined. In addition, water samples are analyzed for dissolved organic materials. Chapman and Demary (1963) suggest that detritus is important food for aquatic invertebrates, and Egglishaw (1964) has shown a strong correlation between amounts of detritus and the standing crop of aquatic insect species that are not filter feeders.

Benthic production is measured by a method proposed by Hynes and Coleman (1968) and later modified by Hamilton (1969). This method measures production of the benthic community, rather than trying to measure production for each species. Standing crop data are converted to production estimates with size-class measurements as an index of growth and mortality.

Physical measurements include continuous temperature monitoring with 8-day recording thermographs on the Cedar River above and below Lake Morse and at Renton, Stations 1, 3, and 6. Temperature data are also recorded at Landsburg by the U.S.G.S. Water velocities are measured with a Price-Gurley current meter. Discharge data are available from the U.S.G.S. gauging stations.

Routine chemical analyses of water include alkalinity, dissolved oxygen, hardness, pH, and specific conductance, which are determined each time a station is sampled. Alkalinity, dissolved oxygen, and pH are determined in the field with a Hach kit. A detailed anion-cation analysis is conducted quarterly by the City of Seattle, Water Quality Laboratory, according to Standard Methods, 1971.

RESULTS

Results are limited to water-quality analyses at each of the sampling stations (Tables 1 and 2). These data show that the impoundment has a marked effect on the temperature as well as on the dissolved material in the river below. The consistency of these differences in water quality and the resultant impact on the benthic communities are of prime interest to our research.

Analysis of invertebrate samples is proceeding.

RECOMMENDATIONS

Our study could most profitably be expanded to include a project by a graduate student on the resident fish populations of the Cedar River. The relation between an expanding sockeye population and an unfished resident population where anadromous fish are excluded provides a unique situation that could yield valuable basic fisheries information.

A second project for a graduate student, proposed in the Year Two Studies, was to be principally responsible for determinations of primary production in the Cedar River. Developing a reliable technique for the determination of primary production is one of the responsibilities of the research at Oregon State University, however, and, because of the difficulties involved, duplication of effort could be avoided if we delay work in this area. We, therefore recommend that a concurrent study of the resident fish populations of the Cedar River be conducted with the existing study of the aquatic invertebrates.

Because benthic sampling techniques for streams have not been standardized within the Coniferous Biome, much less amoung the several biomes, correlation of the findings will be difficult. A workshop should be held to address the problems of stream sampling techniques to enhance comparison of results.

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Table 1. Water quality data by the City of Seattle Water Quality Laboratory for the six Cedar River stations.

	STATION NUMBER											
	1		2		3		4		5		6	
DATE	6-28	7-12	6-28	7-12	6-28	7-12	6-28	7-12	6-28	7-12	6-28	7-12
CHEMICAL ANALYSIS												
Calcium	7.0	6.5	6.5	6.0	8.0	8.0	14.0	16.0	12.5	18.5	13.5	19.0
Free CO_2 (ppm)	2.6	3.4	2.2	2.5	2.4	1.1	1.9	1.5	1.3	-	3.0	-
Chloride (ppm)	1.1	.8	1.5	1.0	1.4	1.0	1.6	1.1	1.5	1.1	1.8	1.5
Chromium (ppm)	BDL*	BLD	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Copper (ppm)	$<$ .01	$<$ .01	$<$ .01	$<$ .01	.01	$<$ .01	$<$ .01	$<$ .01	$<$ .01	.03	$<$ .01	.02
Fluoride (ppm)	$<$ .1	$<$ .1	$<$ .1	$<$ .1	$<$ .1	$<$ .1	$<$ .1	$<$ .1	$<$ .1	$<$ .1	$<$ .1	$<$ .1
Hardness ($CaCO_3$) (ppm)	10.0	8.5	9.4	8.5	11.6	10.0	19.0	21.0	19.0	22.0	18.0	24.5
Iron (ppm)	.05	.07	.06	.23	.05	.09	.06	.10	.10	.09	.15	.15
Lead (ppm)	$<$ .005	-	$<$ .005	-	$<$ .005	-	$<$ .005	-	$<$ .005	-	$<$ .005	-
Magnesium (ppm)	0.7	0.5	0.7	0.6	0.9	0.5	1.2	1.2	1.6	0.9	1.1	1.3
Manganese (ppm)	$<$ .02	0.0	$<$ .02	0.0	$<$ .02	0.0	$<$ .02	0.0	$<$ .02	0.0	$<$ .02	0.0

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Table 1, continued. Water quality data by the City of Seattle Water Quality Laboratory for the six Cedar River stations.

	STATION NUMBER											
	1		2		3		4		5		6	
Date	6-28	7-12	6-28	7-12	6-28	7-12	6-28	7-12	6-28	7-12	6-28	7-12
CHEMICAL ANALYSIS												
Nitrogen (ppm)												
Ammonia	.015	-	.01	-	.01	-	.01	-	.01	-	.01	-
Nitrate	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
Nitrite	-	-	-	-	-	-	-	-	-	-	-	-
Organic	-	-	.01	-	.03	-	.01	14	.015	-	.01	-
Phosphate (ppm)	BDL	.02	BDL	.01	BDL	.01	BDL	.01	BDL	.02	BDL	.05
Potassium (ppm)	-	.17	-	.17	-	.08	-	.17	-	.25	-	.25
Residue												
Total	35	42	30	47	17	50	28	69	28	60	29	77
Filterable	6	6	2	7	3	9	6	6	8	5	8	5
Nonfilterable	29	36	28	40	14	41	22	63	20	55	21	72
Fixed	35	-	25	-	17	-	26	-	22	-	26	-
Silica	8.5	6.6	8.5	9.6	8.5	8.0	8.5	10.7	9.6	8.3	9.6	11.5
Sodium	-	1.1	-	1.4	-	1.2	-	1.6	-	2.5	-	2.5
Sulfate	1.2	1.0	1.7	0.8	1.1	1.0	1.1	1.1	1.7	1.1	1.1	1.1

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Table 1, continued. Water quality data by the City of Seattle Water Quality Laboratory for the six Cedar River stations

	STATION NUMBER											
	1		2		3		4		5		6	
Date	6-28	7-12	6-28	7-12	6-28	7-12	6-28	7-12	6-28	7-12	6-28	7-12
CHEMICAL ANALYSIS												
Surfactants	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Tannin-Lignin	.09	.07	.05	.32	.01	.12	.01	.07	$<$.01	.02	$<$.01	.02
Physical analysis												
Color units	10	5	11	5	10.5	5	11	5	8	5	11	12
Turbidity (JTU)	0.25	0.3	0.20	0.25	0.25	0.3	0.30	0.2	0.70	0.25	1.10	0.6

* BDL - Below Detectable Limits

Table 2. Physico-chemical observations collected during each trip to the watershed sampling stations

Date	Station	Total Alkalinity	Dissolved Oxygen (ppm)	Hardness ($CaCO_3$)	pH	Specific Conductance (micromhos/cm	Temperature °C
6-28-71	1	10.0	12.0	10.0	7.0	21	6.0
	2	10.0	12.5	9.4	7.1	21	6.0
	3	15.0	14.0	11.6	7.2	24	10.5
	4	17.5	14.0	19.0	7.4	42	10.0
	5	18.7	15.0	19.0	7.6	38	11.2
	6	21.0	15.0	18.0	7.2	41	13.0
7-10-71	1	10.0	14.0	8.5	6.8	23	6.0
	2	10.0	15.0	8.5	6.9	22	5.5
	3	12.5	14.0	10.0	7.4	30	11.0
	4	22.5	14.0	21.0	7.5	51	9.5
	5	25.0	14.0	22.0	7.8	56	11.0
	6	28.5	14.0	24.5	7.4	57	12.0

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Table 2, continued. Physico-chemical observations collected during each trip to the watershed sampling stations

Date	Station	Total Alkalinity	Dissolved Oxygen (ppm)	Hardness ($CaCO_3$)	pH	Specific Conductance (micromhos/cm)	Temperature
7-24-71	1	10.0	15.0	8.0	6.9		10.0
	2	12.5	14.0	8.0	7.3		13.0
	3	20.0	15.0	9.0	7.2		15.0
	4	20.0	15.0	18.0	7.5		12.0
	5	20.0	15.0	22.0	7.7		12.0
	6	23.7	15.0	26.0	7.8		13.0
8-7-71	1	12.5	13.0	9.0	7.0		11.0
	2	15.0	15.0	10.0	7.3		14.0
	3	12.5	13.0	10.0	7.3		18.0
	4	25.0	15.0	25.0	7.5		15.0
	5	30.0	15.0	24.0	7.8		16.0
	6	32.5	13.5	29.0	7.8		16.0

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Table 2, continued. Physico-chemical observations collected during each trip to the watershed sampling stations

Date	Station	Total Alkalinity	Dissolved Oxygen (ppm)	Hardness ($CaCO_3$)	pH	Specific Conductance (micromhos/cm)	Temperature
8-21-71	1	15.0	15.0	12.0	7.1		11.0
	2	17.5	13.5	15.0	7.2		13.0
	3	15.0	15.0	12.5	7.5		18.0
	4	25.0	15.0	26.5	7.5		12.0
	5	30.0	15.0	30.0	7.5		16.0
	6	35.0	13.0	34.0	7.6		18.0
9-7-71	1	17.0	15.0	13.0	7.2	35.0	10.0
	2	15.0	15.0	10.6	7.3	32.0	11.0
	3	12.5	15.0	10.6	7.4	30.0	18.0
	4	25.0	15.0	24.4	7.4	57.0	13.0
	5	30.0	18.0	26.0	7.6	63.0	15.0
	6	32.5	13.0	30.0	7.5	76.0	17.0

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