HARZA Consulting Engineers and Scientists

September 16, 1994

Mr. Dave Jennings
City of Renton
Municipal Building
200 Mill Avenue S.
Renton, WA 98055

File: 7135.G.210
Ser: 94-510

Subject: Cedar River Smelt Spawning Study Report

Dear Dave:

Enclosed please find a copy of the Cedar River Smelt Egg report, revised based on comments by the Corps of Engineers letter of June 29, 1994. I have also included some responses to their specific comments on a separate sheet.

We have the preserved smelt egg samples and a copy of the field notes ready to transmit to the Corps of Engineers. Perhaps a fax or written direction from you would be a good idea before we give them the eggs, or we could give them to you and you could give them to the COE.

After you review the report, let me know how many copies you would like for your use and distribution. I think we have used the allotted budget and have finished the tasks for this project. I have included a few comments at the end of the report on the type of additional information that could be collected to increase our knowledge of the Cedar River smelt run if you are interested in pursuing additional information on smelt spawning in future years.

Very truly yours,
Harza Northwest, Inc.

Kathy Vanderwal Dubé
Geologist

Encl: Report
Response to COE Letter

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Distribution of Longfin Smelt (*Spirinchus thaleichthys*) Eggs in the Cedar River, Washington

Introduction

Longfin smelt (*Spirinchus thaleichthys*) from Lake Washington are one of only three known non-migratory, fresh water populations of longfin smelt in North America[1]. The longfin smelt in Lake Washington are known to spawn in the lower Cedar River, May Creek, Coal Creek, and Juanita Creek (Moulton 1970). Spawning occurs from mid-January through mid-April (Wydoski and Whitney 1979). Smelt are scatter spawners, with females producing 1,500 small (1-2 mm) white eggs that adhere to the substrate.

Little is known about the distribution of longfin smelt spawning in the Cedar River and spawning habitat requirements (i.e. water depth and velocity, and substrate composition). In March and April 1994, the U.S. Army Corps of Engineers (COE) performed spawner surveys to determine the timing and distribution of longfin smelt spawning in the lower Cedar River. They were unable to identify specific spawning areas due to turbid water conditions. The objective of this study was to determine the distribution of longfin smelt eggs in the lower Cedar River, and to characterize the water depth and velocity and grain size of gravel near the eggs.

Previous Studies

Previous studies of longfin smelt populations in Lake Washington include unpublished theses by Dryfoos (1965) and Moulton (1970). Dryfoos concentrated on the population and ecology of smelt in Lake Washington with little information on spawning locations except to note that spawning may occur in the Cedar River. The objectives of Moulton's study were to describe spawning areas and timing and development of smelt eggs. He sampled nine tributaries to Lake Washington for smelt eggs in 1969 and 1970 and found eggs in the Cedar River, May Creek, Coal Creek, and Juanita Creek. No eggs were found in Thorton Creek, McAleer Creek, Lyon Creek, Swamp Creek, or a tributary in O.O. Denny Park. The majority of eggs were found in the lower Cedar River, with no eggs found over 1.25 miles from the mouth of the river.

[1]Other non-migratory freshwater smelt populations are found in Harrison Lake and the Fraser River, British Columbia.

Moulton found that the smelt spawning run begins in mid-January, peaks in mid-March and tapers off into April. Timing is thought to be controlled by increasing water temperatures in the spring, with peak spawning occurring when water temperatures were 5.6° to 6.7°C. Smelt move upstream into the river in the early evening, with males moving upstream first. Spawning occurs at night, and the smelt return to Lake Washington by dawn.

Dave Seiler, who operates the Washington Department of Fish and Wildlife (WDFW) fry trap near the mouth of the Cedar River has observed similar patterns of smelt movement in recent years (personal communication). While the WDFW trap is not operated primarily for smelt, it does collect smelt incidentally. Smelt were trapped in 1992, 1993, and 1994. Few smelt were collected in 1993. In 1992, smelt were trapped from late February through April 1. The peak run was March 10 through March 25, with a maximum catch of 1,300 fish in a single night. Seiler indicated the 1994 run seemed to be following similar patterns.

Methods

In order to identify longfin smelt spawning distribution in the lower Cedar River, smelt eggs were sampled on April 14 and 15, 1994. Discharge on April 14 and 15 was 857 and 985 cfs, respectively. Flows during March, the primary spawning period, ranged between 357 and 991 cfs (Figure 1). Thus, water depths and velocities collected were more representative of the higher discharge periods during spawning.

A total of 12 transects were placed at about 0.1 mile intervals from a point approximately 700 feet upstream from the river confluence with Lake Washington to the Logan Street bridge, and at sites approximately 0.25, 0.5 and 0.75 miles upstream from the Logan Street bridge (Figure 2). Placement of transects and sample sites was influenced by water depth and velocity. Sample sites were limited to water depths less than about 2.5 feet. The McNeil corer and egg sampling efforts were not effective at greater depths.

At each of the 12 transects, between 2 and 4 one-meter square sample plots were placed across the river. Plots were marked with flagging, water depth and velocity were determined, and a visual estimate of substrate size distribution over each plot was made prior to sampling for eggs.

Eggs were sampled with a fine mesh kick net that was placed immediately downstream from the sample plot. Gravel in each plot was scrubbed to dislodge any eggs and wash them into the net. A five-minute sampling effort was conducted at each plot. Samples collected in the net at each plot were preserved in a buffered formalin solution, transported to the office, and counted using a 2X dissecting scope. In samples that contained a large number of eggs (over 250 eggs), a subsample was used to estimate the total number of eggs in each sample. Eggs were very adhesive, particularly when attached to organic material and/or fine sediment.

Gravel samples were taken at each of the 16 sample sites that were found to contain smelt eggs. Four additional samples were taken at sites where no smelt eggs were recovered. At each site, a single gravel sample was collected using a McNeil coring device, commonly used to sample spawning gravel for salmonid fish (McNeil and Ahnell 1964, Cedarholm et al. 1978). About 0.05 ft^3 of sediment was recovered in each sample, taken to a depth of 3 to 3.5 inches. Gravel samples were dried and sieved, and the cumulative size distribution was determined.

Results and Discussion

The distribution of smelt eggs in the Cedar River is shown in Table 1. Smelt eggs were recovered from the first sample site 700 feet upstream from Lake Washington, and from all other sample sites to 3,500 feet upstream. No eggs were found at sample locations over 3,500 feet from the mouth. For the samples from which smelt eggs were recovered, the size of sampled sediment ranged from 0.063 to 32 mm (very fine sand to very coarse gravel); median size ranged from 2 to 11 mm (very fine to medium gravel). Water depth at these locations ranged from 0.6 to 2.2 feet, and water velocity ranged from 0.7 to 2.7 feet/sec.

Figure 3 graphically presents the number of smelt eggs recovered from each sample site with respect to distance upstream from Lake Washington (from the lower Boeing bridge), median size of sampled sediment (derived from the cumulative size distribution), water depth and water velocity. Considering all samples, the number of recovered eggs shows no apparent correlation with median grain size, water depth or water velocity within the range of values recorded in this study (Figure 3). Excluding the four largest sample populations (which are shown as square outlines), the number of smelt eggs shows a weak inverse relation with grain size, water depth and water velocity. The four largest sample populations were recovered from sites that include a wide range of values recorded for grain size, water depth and water velocity. Hence, the distribution and abundance of longfin smelt eggs in the Cedar River does not appear to be strongly related with any specific values of sampled sediment grain size, water depth or water velocity based on the data collected in this study.

In addition to taking substrate samples with a McNeil corer, a visual estimate of surficial substrate size distribution was made at each sample site prior to sampling for eggs. Table 2 shows the number of smelt eggs recovered from each sample site and the aerial distribution of surficial sediment sizes for three size classes, derived from a visual estimate of the substrate at each sample site. The data are separated into three groups. In group A the percentage of fine sediment (less than 0.5 inches diameter), is greater than the percentage of fine sediment in groups B and C. In general, a greater number of eggs were recovered from the sample sites in group A. While groups B and C have about the same distribution of sediment sizes, smelt eggs were recovered in group B but not in group C. These data suggest smelt egg densities may be higher in areas of finer substrate.

The abundance of smelt eggs appears to be most strongly related with distance upstream from Lake Washington and somewhat related to finer surficial substrate. These two variables are difficult to separate since substrate generally fines in a downstream direction. The similarities between surficial substrate size and differences in egg densities in groups B and C (Table 2), along with similarities in egg densities but differences in substrate between samples 1, 2, and 3 suggest egg densities may be best explained by distance from the river.

Figure 4 shows in three graphs the number of smelt eggs plotted against distance upstream from Lake Washington. The upper graph shows the total number of smelt eggs that were recovered from the two largest samples at each station, the middle graph shows the number of eggs recovered from the single largest sample at each station, and the lower graph shows the number of eggs recovered from the single smallest sample at each station. Collectively, the data suggest a strong relationship between abundance of smelt eggs and distance from the mouth of the river.

The relationship between the declining abundance of smelt eggs with distance upstream from Lake Washington has been noted in a previous study. Moulton (1970), who noted that smelt spawning was limited to the lower reach of the river (below the Logan Street bridge), also recorded a declining abundance of smelt eggs with distance upstream.

Results from this study indicate that longfin smelt eggs are distributed in the Cedar River over a wide range of water depths (up to 2.5 feet deep) and velocities (up to 2.7 feet /sec). Egg distribution in deeper water was not sampled and is not known. Median grain size at locations with eggs ranged between 2 and 11 mm (very fine to medium gravel). Within the range of variables investigated in this study, proximity to Lake Washington appears to be the dominant variable controlling the distribution of longfin smelt egg densities in the Cedar River. This is consistent with trends reported by previous investigators.

The data collected during this study reflects conditions during a single sample effort. In order to gain more information regarding smelt spawning preferences, actual observations of smelt spawning and measurements of water depth, velocity, and substrate at known sites would be required. Observations of spawning would also help establish if eggs are actually placed in or on the gravel or if the eggs are left to drift. It appears from data collected during this study that collection of surficial substrate characteristics may be adequate to indicate substrate preferences. Visual estimation of surficial substrate is much less time consuming than collecting and analyzing substrate samples.

References

Cedarholm, C.J., L.C. Lestelle, B.G. Edie, D.J. Martin, J.V.Tagart, and E.O. Salo, 1978. The effects of landslide siltation on the salmon and trout resources of Stequaleho Creek and the main Clearwater River, Jefferson County, Washington, 1972-1975. Final Report - Part II. University of Washington, College of Fisheries, Fisheries Research Institute, FRI-US-7804.

Dryfoos, R.L., 1965. The life history and ecology of the longfin smelt in Lake Washington. Ph.D. Thesis, University of Washington, 159 p.

McNeil, W.J. and W.H. Ahnell, 1964. Success of pink salmon spawning relative to size of spawning bed materials. U.S. Fish and Wildlife Service, Special Science Report 469.

Moulton, L.L., 1970. The 1970 longfin smelt spawning run in Lake Washington with notes on egg development and changes in the population since 1964. M.S. Thesis, University of Washington, 84p.

Scott, W.B. and E.J. Crossman, 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada, Ottawa, Bulletin 184, pp. 318-320.

Wydoski, R.S. and R.R. Whitney, 1979. Inland fishes of Washington. University of Washington Press, pp 68-70.

Station	Sample No. (and distance from east bank)	Distance from Mouth (ft)	Estimated Density of Smelt Eggs (no. per sq. meter)	Sampled Substrate Diam. Range (mm)	Median (mm)	Water Depth (ft)	Velocity (ft/sec)
1	1 (35)	700	240	0.063 - 32	5	0.6	0.8
	2 (50)	700	756	0.063 - 32	4	0.9	1.0
	3 (60)	700	1,048	0.063 - 16	2	1.5	0.9
	4 (45)	700	308	0.125 - 32	2	2.1	1.0
2	1 (30)	1,000	275	0.063 - 32	5	0.7	0.7
	2 (75)	1,000	1,134	0.125 - 32	5	1.4	1.8
3	1 (90)	1,500	790	0.125 - 32	11	2.2	2.5
	2 (75)	1,500	212	0.063 - 32	10	0.6	1.2
	3 (50)	1,500	32	0.125 - 64	9	1.9	1.9
4	1 (15)	2,200	144	0.125 - 32	10	1.3	1.8
	2 (35)	2,200	176	0.125 - 32	5	0.6	1.4
5	1 (45)	2,800	10	0.250 - 32	8	2.2	2.7
	2 (25)	2,800	20	0.250 - 32	5	2.0	2.7
6	1 (95)	3,500	5	0.063 - 32	11	1.5	2.3
	2 (50)	3,500	15	0.250 - 32	8	2.1	2.5
	3 (10)	3,500	10	0.125 - 32	8	1.7	2.0
7	7 (10)	3,900	0	0.063 - 64	16	1.7	2.1
	2 (50)	3,900	0	0.125 - 32	12	2.0	2.1
8	1 (25)	4,800	0	--	--	2.7	2.5
	2 (35)	4,800	0	--	--	2.6	2.5
	3 (20)	4,800	0	--	--	1.7	2.0
9	1 (10)	5,300	0	0.125 - 32	11	1.8	2.0
	2 (4)	5,300	0	--	--	1.2	1.3
	3 (30)	5,300	0	0.250 - 64	10	2.4	2.7
10	1 (50)	6,900	0	--	--	2.7	2.7
	2 (15)	6,900	0	--	--	2.7	2.7
11	1 (6)	8,200	0	--	--	1.9	1.5
	2 (15)	8,200	0	--	--	2.5	2.5
12	1 (4)	9,100	0	--	--	2.5	1.0
	2 (4)	9,100	0	--	--	2.5	1.8

Table 1. Density of longfin smelt eggs in the Cedar River with sampled sediment size, water depth, and water velocity.

	Station	Sample No.	Estimated Density of Smelt Eggs	Visual Estimate of Surficial Substrate Size Distribution		
				(<0.5")	(0.5" to 1")	(1" to 3")
	1	1	240	10	80	10
		2	756	60	35	5
A		3	1,048	85	15	0
		4	308	95	5	0
	2	1	275	40	50	10
		2	1,134	50	25	25
	3	1	790	10	45	45
		2	212	10	80	10
		3	32	20	50	30
	4	1	144	20	60	20
B		2	176	20	60	20
	5	1	10	10	50	40
		2	20	20	60	20
	6	1	5	0	60	40
		2	15	10	55	35
		3	10	10	70	20
	7	1	0	0	60	40
		2	0	10	55	35
	8	1	0	10	70	20
		2	0	10	60	30
		3	0	10	70	20
C	9	1	0	10	60	30
		2	0	10	60	30
		3	0	10	40	40
	10	1	0	20	50	30
		2	0	20	50	30
	11	1	0	25	65	10
		2	0	25	65	10
	12	1	0	20	50	30
		2	0	10	45	45

Table 2. Density of smelt eggs, and visual estimate of substrate size distribution.

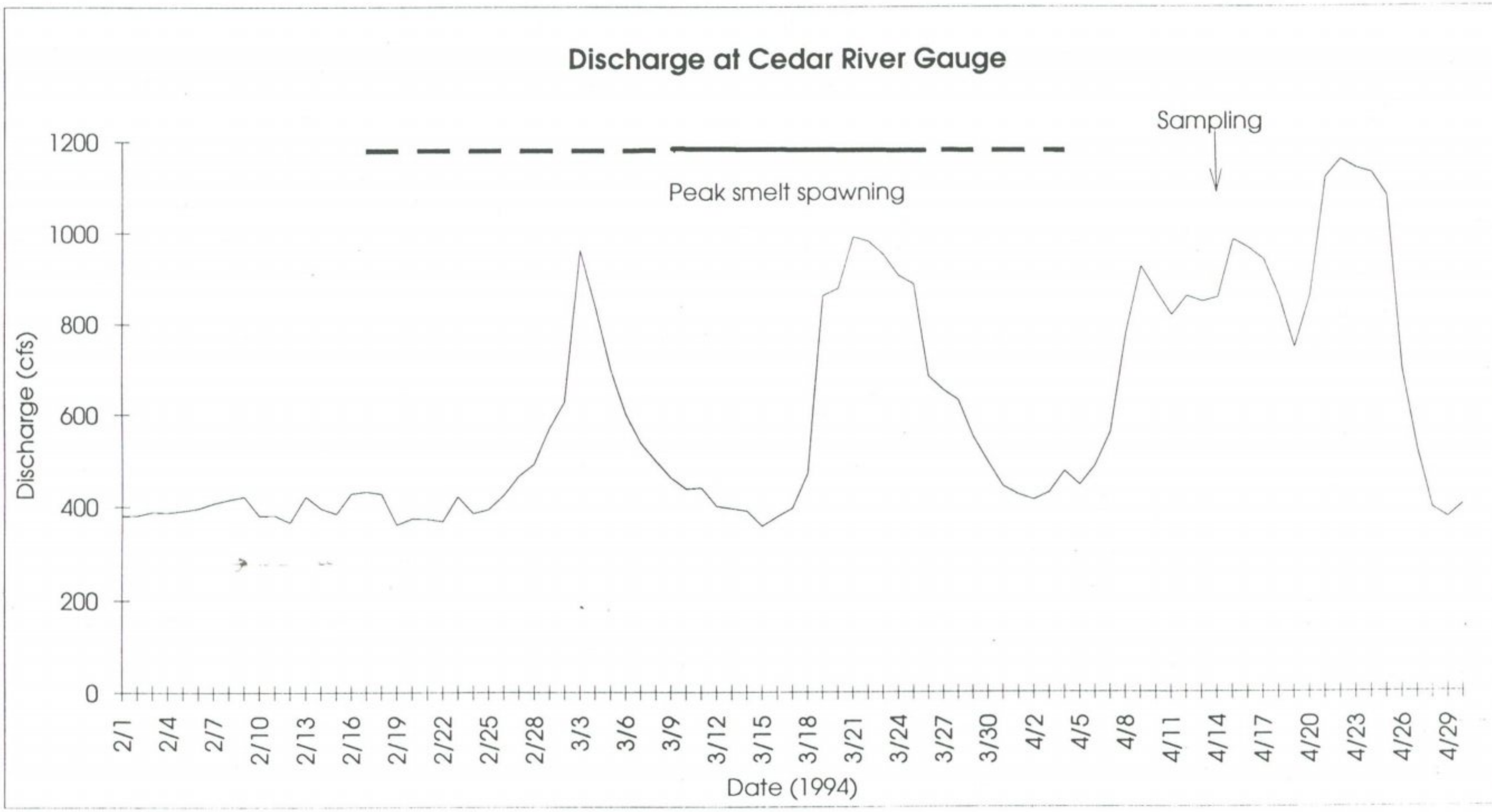

Figure 1. Discharge at Cedar River at Renton Gauge (USGS 12119000), February through April 1994.

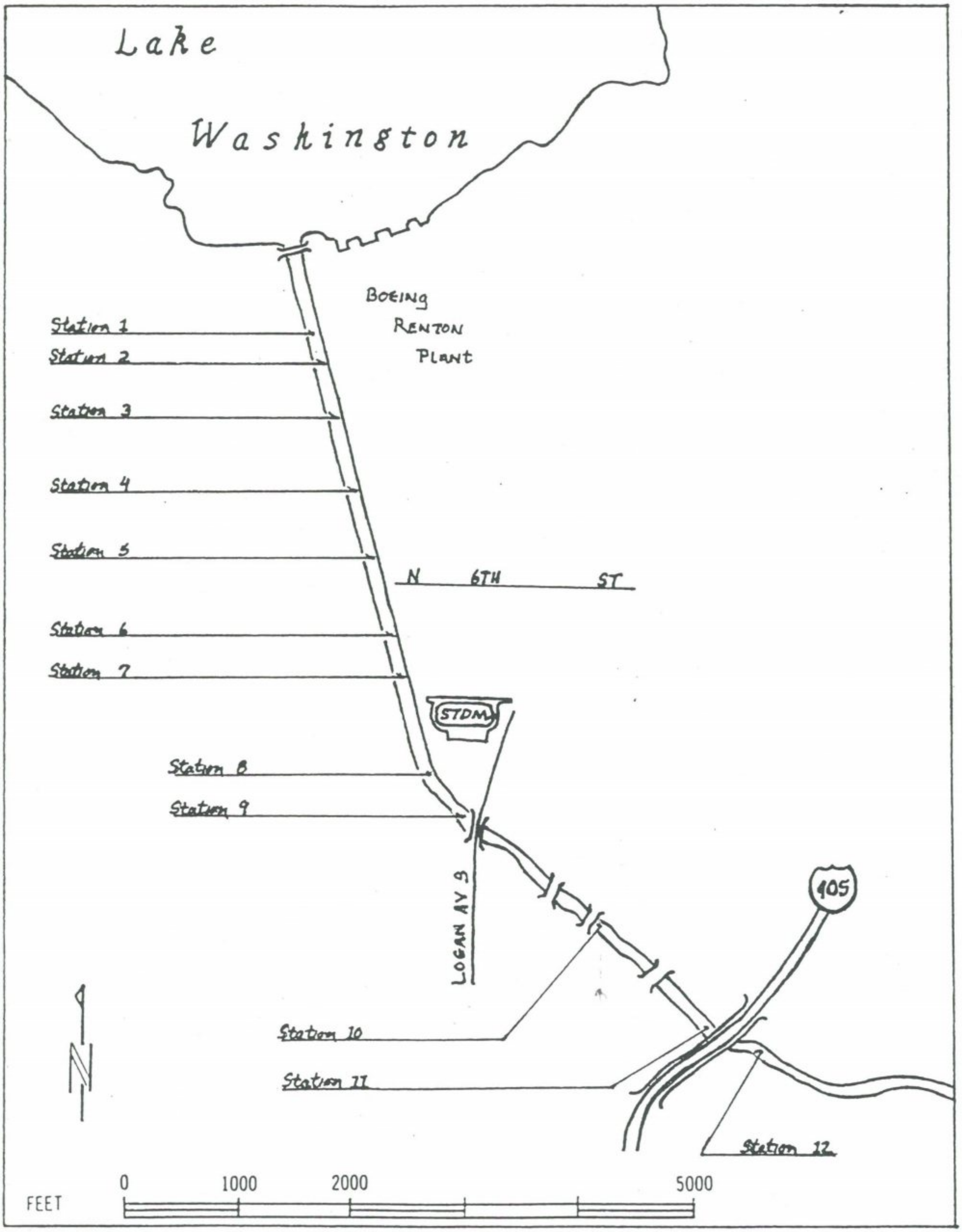

Figure 2. Location of longfin smelt sampling station on the Cedar River.

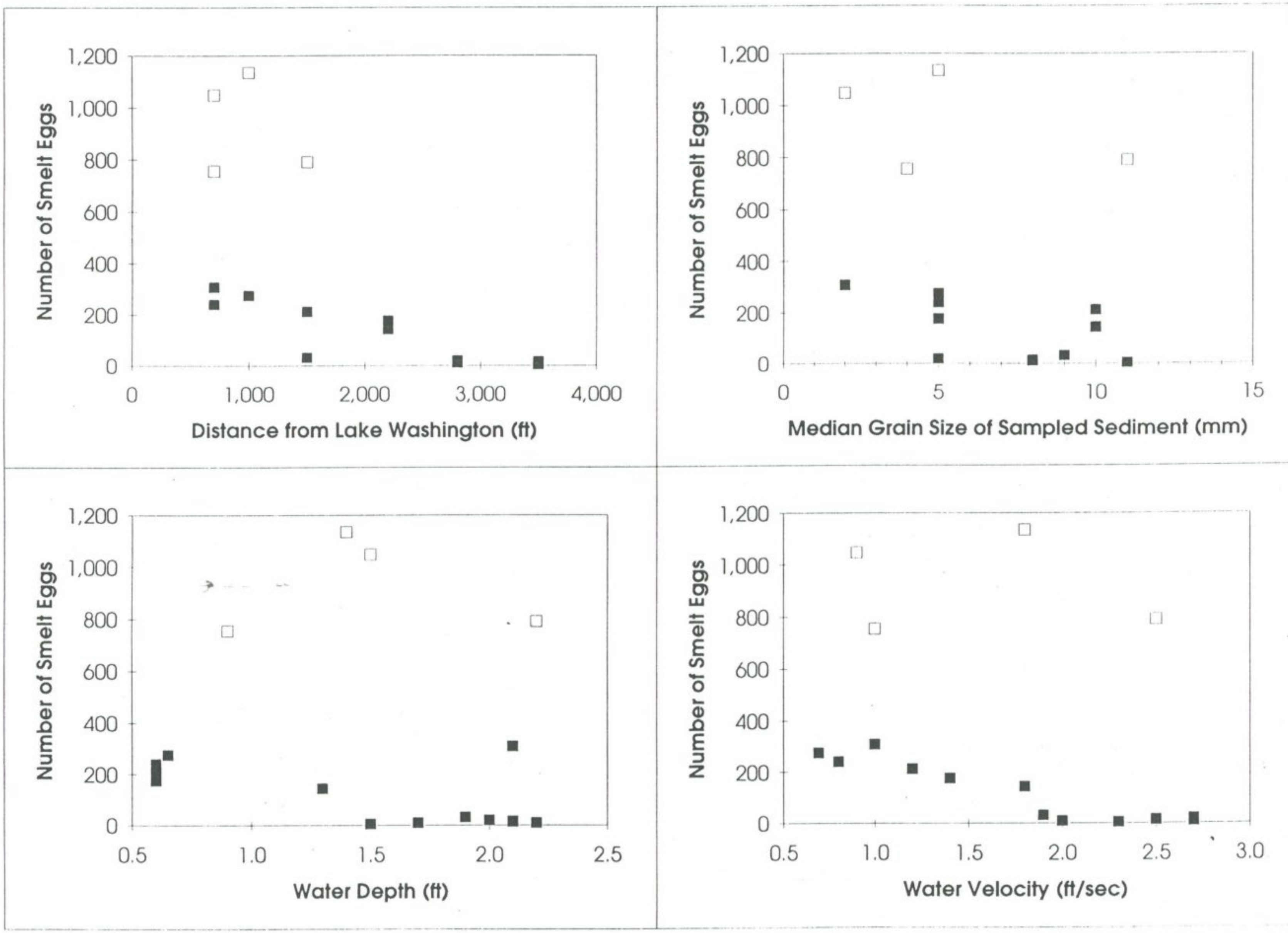

Figure 3. Smelt egg density versus distance from mouth, grain size, water depth, and velocity.

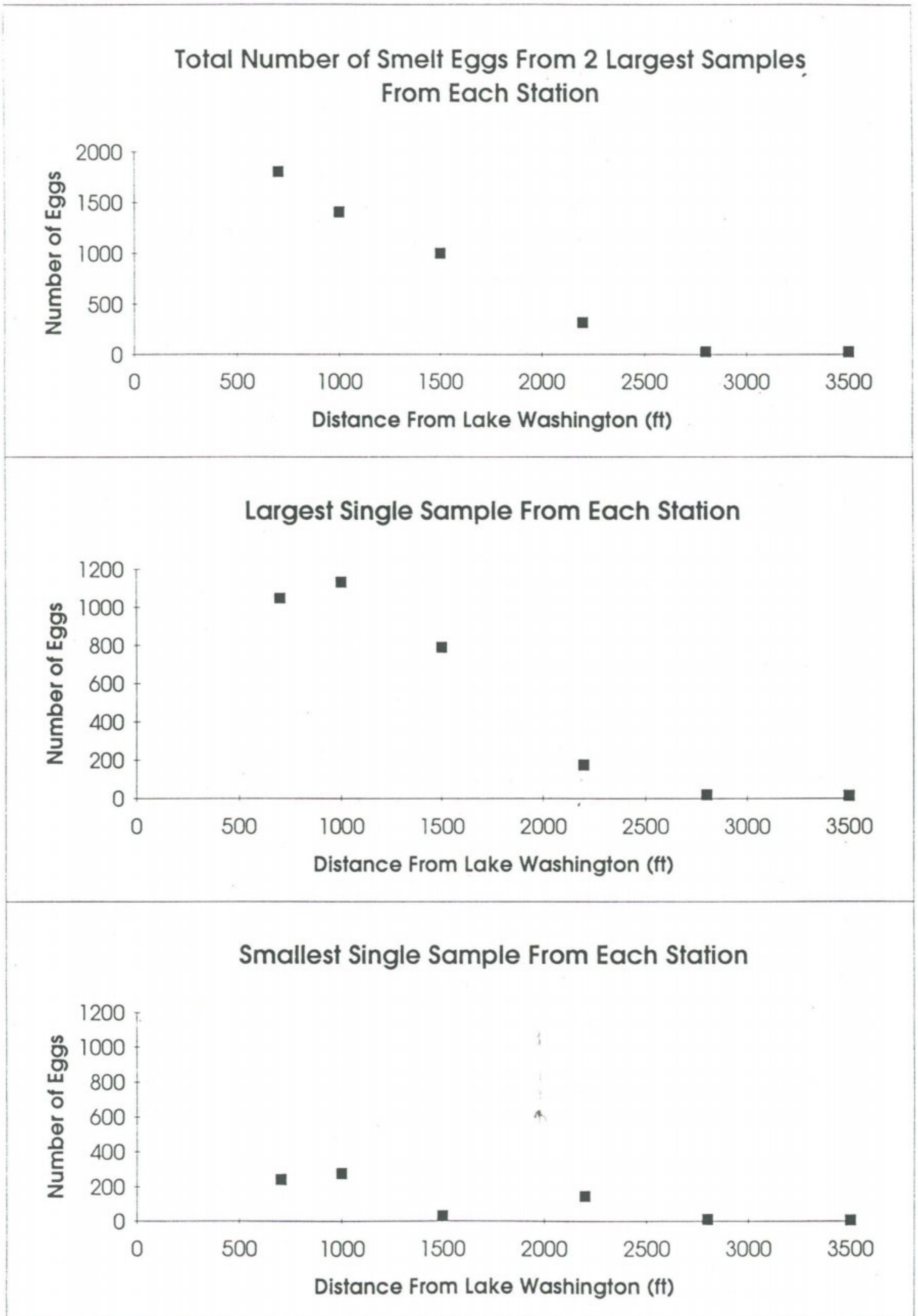

Figure 4. Smelt egg density versus distance from river mouth.