CLEARWATER RIVER WILD STEELHEAD SPAWNING TIMING

C. J. Cederholm
Washington State Department of Natural Resources
Rural Route 1, Box 1375
Forks, Washington 98331

ABSTRACT: Steelhead spawning timing in the mainstem and tributaries of the Clearwater River was monitored from 1973 to 1980. Generally, spawning begins in January and lasts until late June with most tributaries peaking in March and April, and the main river peaking in early May. The spawning timing in the tributaries is more protracted when compared to the main river which is sharply peaking. Spawning generally occurs in the spring, well after the major annual freshets of November through February. It is suggested that this spring spawning timing is an adaptation to avoid egg loss caused by streambed scour, and to eliminate competition with salmon spawners. Commencement of spawning coincides with springtime declining streamflows and increasing water temperatures.

Spawning escapements in the Clearwater River have increased steadily over the study period, due mainly to reductions in the Quinault Tribal commercial gill net fishery catch at Queets, and possibly due to an overall improvement in logging road construction and maintenance practices in the watershed.

The largely indigenous native steelhead spawning populations of the Clearwater River may also be influenced by straying adults returning from extensive hatchery smolt plants in the Queets and closely adjoining rivers. This paper could provide background data for future comparisons between pre- and post-hatchery plant spawning populations.

INTRODUCTION

Wild winter-run steelhead are an important renewable natural resource base for several small communities along the western coast of the Olympic Peninsula. They provide several months of outdoor enjoyment for sportsfishermen, income for local businesses, and a commercial fishery for several Indian tribes. Over the past 8 years steelhead spawning counts on the Clearwater River in Jefferson County have been conducted to document spawning population size and annual variations in abundance, timing, and distribution.

I have become concerned about the high level of hatchery steelhead smolt plants being made on several Olympic Peninsula coastal rivers, by both the State and local Tribal entities. This is occurring on the Queets, Quinault, Hoh, and Quillayute Rivers; where each spring, plants of 50-300,000 smolts per river are made. It is apparent that these fish have a high degree of within- and between-river straying (Larry Lestelle, Quinault Fisheries and Jim Jorgenson, Hoh Fisheries pers. comm.), and may be interbreeding with the wild strains of similar spawning timing. In the long-term, spawning timing, growth, and survival of wild fish could be changed with a continued policy of hatchery smolt planting. Recent research by the Washington State Department of Game on the Kalama River (Chilcote 1983) indicates that hatchery/wild crosses on the spawning beds result in a lower survival of offspring, when compared with wild/wild crosses. At this point in time the spawning populations in the Clearwater River system are still dominated by the indigenous native strains; and therefore I felt it would be a good time to present this steelhead spawning timing data on wild Clearwater River stocks, for it may be useful in determining the hatchery influence in the future.

It is also my intention to discuss how steelhead may have adapted to a late spring spawning timing to avoid the streambed scour which is characteristic of fall and winter streamflow periods.

METHODS

During the winter-spring period (January through June) of 1973 through 1980, steelhead spawning redds were surveyed and counted in the lower mainstem and selected tributaries of the Clearwater River. The Clearwater River, a tributary of the Queets Rivers is located approximately 40 kilometers south of Forks, and east of Highway 101 (fig. 1). In general, mainstem surveys were carried out by viewing spawning redds from a helicopter, and tributary counts were determined by foot surveys. An average of six aerial counts and five foot counts of each index area were made per year.

Each mainstem count consisted of a helicopter flight from the mouth of the Clearwater River to

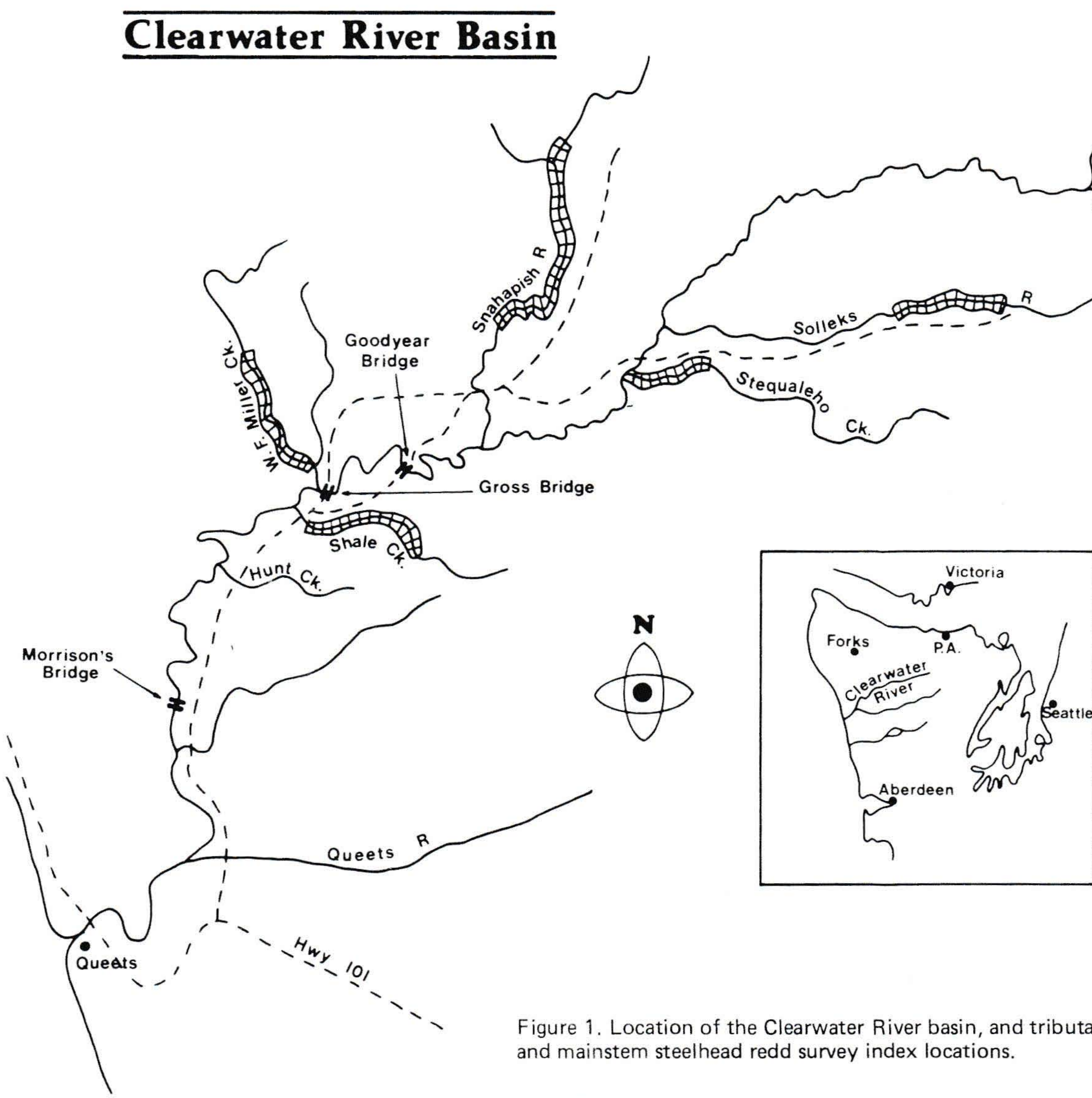

Figure 1. Location of the Clearwater River basin, and tributary and mainstem steelhead redd survey index locations.

Stequaleho Creek mouth, covering about 36 kilometers. This standard index area was broken into five subsections, which were areas designated between tributary mouths and bridges. The sections were as follows: mouth to Morrison's Bridge, Morrison's Bridge to Hunt Creek, Hunt Creek to Gross Bridge, Gross Bridge to Goodyear Bridge, and Goodyear Bridge to Stequaleho Creek (fig. 1). The helicopter would fly at an altitude of 30-100 meters above the water surface, always traveling in an upstream direction along the west edge of the river. Each full sized nest or combination of nests that was judged to constitute one female's digging was counted as one redd. Over all, there was an average of 1.2 nests per redd. Survey timing was separated by about 2-4 weeks, depending on the weather. On each survey, all fresh and complete (larger than 1 m^2 in area) redds were counted. There was a danger of recounting redds from previous surveys; however, care was taken to minimize this as a serious source of error.

The tributary foot surveys were carried out in the upstream direction by a person walking in the creeks. Surveys were conducted during 1978, 1979, and 1980. Index sections were established on representative streams, and these sections were walked several times over a spawning season. Index sections covering a total of 22 kilometers were established on five different tributaries. These tributaries were West Fork Miller Creek (4.0 km), Stequaleho Creek (2.7 km), Solleks River (2.2 km), Snahapish River (8.5 km), and Shale Creek (4.2 km) (fig. 1). On each succeeding survey, newly counted redds were marked with colored plastic ribbon to avoid duplication of counts on future surveys.

A supplemental experiment was conducted during the 1974-75 winter season to determine changes in streambed elevation from summer to midwinter and from midwinter to the following summer. We were interested in knowing the degree of streambed scour over a winter season, to give some measure of potential redd loss. Net streambed scour and deposition rates were estimated by a survey technique described by Cederholm (1972). Wood benchmarks were established on each stream embankment at each of 39 cross sections. A cross section was located every 150 meters, with nine or ten cross sections on each of four spawning tributaries. The cross sections were not always located at potential spawning sites, they were meant as an index to streambed stability. The progression of cross sections always started at the tributary mouth and proceeded upstream. The tributaries examined included Stequaleho Creek, Christmas Creek, Hurst Creek, and Shale Creek. Elevations were established using standard land surveying techniques; using a rod, level, and measuring tape.

Water temperature was recorded at the mouth of the Clearwater River with a Partlow (model FRHTT) continuous recording thermograph. Stream discharge was recorded at a point 24 kilometers up from the mouth, at Goodyear Bridge. Standard stream gauging techniques were used to estimate streamflow. A Fisher-Porter punch-tape recorder was used to record stage, and a current meter was used to measure water velocity. The streamflow records are reported in Larson and Jacoby (1976), Larson and Jacoby (1977), Abercrombie et al. (1978), and Abercrombie et al. (1979).

RESULTS

Over the course of eight spawning seasons (1973-80), 52 helicopter surveys were conducted on the main river index area. During these surveys a total of 2,234 redds was counted (table 1), with the lowest total annual count in 1974 (45) and the highest annual count in 1980 (629).

In most years, the peak count occurred on or near the first or second week of May. The two notable exceptions were in 1975 when the peak was late (June 7), and in 1978 when it was early (April 29). On most years, few redds were counted until April, however some redds were noted as early as January. Due to frequent freshets and the lack of algae on the substrate during the winter and early spring, it was difficult to ensure that all the spawning activity was detected. Although no surveys were conducted after June 27th, it appears that spawning in the main river is essentially over by the end of June. The general trend was that major spawning activity would begin in April, peak in May, and be over by the end of June (fig. 2).

A total of 68 separate foot surveys for counting redds in the tributaries was made in 1978, 1979, and 1980 (table 2).

The timing of tributary spawning varied widely between streams. Generally, major spawning activity was spread over a longer period of time than in the main river (fig. 3). Spawning activity in most tributaries peaked prior to peaking in the mainstem, and spawning activity was noted as early as January and as late as June. Spawning activity in Stequaleho Creek and Solleks River continued strong into late May, while the activity was earlier in Shale and West Fork Miller Creeks. Spawning was intermediate in timing, in the Snahapish River with the peaks usually occurring in March and April.

During the winter of 1974-75 the changes in streambed cross-sectional area (i.e., scour and depositon) in four steelhead spawning tributaries were measured. There was a total of 38 cross-sectional surveys made at three different times: September 1974, February 1975, and June 1975; and during this time scour was the major streambed change between September 1974 and February 1975, while deposition was the major change between February 1975 and June 1975. Between September 1974 and February 1975 there was 3.7 times more scour (246.6 m^2) than deposition (65.8 m^2) on the four study streams. All four streams had more scour than deposition. However, between February 1975 and June 1975 there was 3.5 times more deposition (136.3 m^2) than scour (39.1 m^2). Three out of four streams had more deposition than scour, and the fourth (Christmas Creek) had nearly equal amounts of scour and deposition (table 3, fig. 4).

Table 1--Mainstem River steelhead redd counts, 1973-80.

Survey Date	Mouth to Morrison's Bridge	Morrison's Bridge to Hunt Ck.	Hunt Ck. to Gross Bridge	Gross Bridge to Goodyear Bridge	Goodyear Bridge to Stequaleho Creek	
03/15/73	0	8	8	1	9	
04/06/73	8	8	12	6	11	
05/04/73	5	3	16	12	27	
05/21/73	5	19	17	8	13	
03/08/74	0	0	0	0	0	
04/13/74	0	0	0	0	0	
04/24/74	0	0	0	1	3	
04/29/74	1	1	0	2	5	
05/06/74	3	0	2	8	9	
05/15/74	1	1	1	1	2	
05/31/74	0	0	0	1	3	
03/05/75	0	0	0	0	0	
03/24/75	0	1	0	1	4	
04/04/75	0	1	1	3	6	
04/15/75	1	2	5	4	7	
05/10/75	3	4	6	5	6	
05/25/75	4	14	17	25	27	
06/07/75	6	21	14	29	33	
06/27/75	2	0	0	0	2	
01/31/76	0	0	0	0	0	
03/13/76	0	0	0	0	3	
04/05/76	1	5	0	2	4	
04/22/76	5	1	4	7	4	
05/06/76	8	2	5	10	8	
05/11/76	2	3	0	7	4	
05/18/76	5	7	5	12	10	
04/02/77	1	5	2	1	5	
04/16/77	5	10	8	11	27	
04/27/77	10	20	13	31	24	
05/06/77	13	26	18	23	48	
05/18/77	15	34	18	12	21	
06/06/77	7	9	6	1	10	
01/30/78	0	0	0	1	3	
02/24/78	2	2	0	0	2	
03/14/78	2	2	0	2	5	
04/04/78	5	5	1	5	6	
04/12/78	5	14	7	20	34	
04/29/78	17	20	17	32	64	
05/17/78	3	21	5	5	6	
06/06/78	3	6	6	3	12	
03/14/79	0	0	0	0	0	
04/02/79	2	4	2	9	7	
04/20/79	6	3	3	4	16	
05/09/79	14	11	22	19	35	
05/18/79	5	10	12	8	25	
06/23/79	3	1	1	1	2	
02/12/80	0	0	0	0	0	
04/07/80	12	7	2	7	15	
05/01/80	48	36	22	15	53	
05/08/80	41	44	42	38	108	
05/31/80	17	21	23	12	47	
06/19/80	0	3	9	2	5	
Surveys N = 52	292	407	348	407	780	2,234

Table 2--Tributary steelhead redd counts, 1978-80.

1978							
Stream	Index length (km)	January (20-31)	February (16-24)	March (13-21)	April (17-28)	May (22-30)	Total
Stequaleho Creek	2.7	1	2	8	15	2	28
Sollecks River	2.2	0	0	8	8	5	21
Snahapish River	8.5	3	6	18	28	0	55
Shale Creek	4.2	7	11	6*	3	0	27
West Fork Miller Creek	4.0	-	2	4	0	1	7
Total	21.6	11	21	44	54	8	138

1979						
Stream	Index Length (km)	March (19-23)	April (16-25)	May (14-17)	June (13-19)	Total
Stequaleho Creek	2.7	7	7	6	3	23
Solleks River	2.2	-	10	6	1	17
Snahapish River	8.5	8	2	6	1	17
Shale Creek	4.2	3	2	2	1	8
West Fork Miller Creek	4.0	3	4	2	0	9
Total	21.6	21	25	22	6	74

1980							
Stream	Index Length (km)	February	March	April	May	June	Total
Stequaleho Creek	2.7	0	11	14	7	0	32
Solleks River	2.2	0	1	5	22	2	30
Snahapish River	8.5	0	16	17	6	4	43
Shale Creek	4.2	0	0	5	5	0	10
West Fork Miller Creek	4.0	2	2	3	3	0	10
Total	21.6	2	30	44	43	6	125

*Expanded from half the study section.

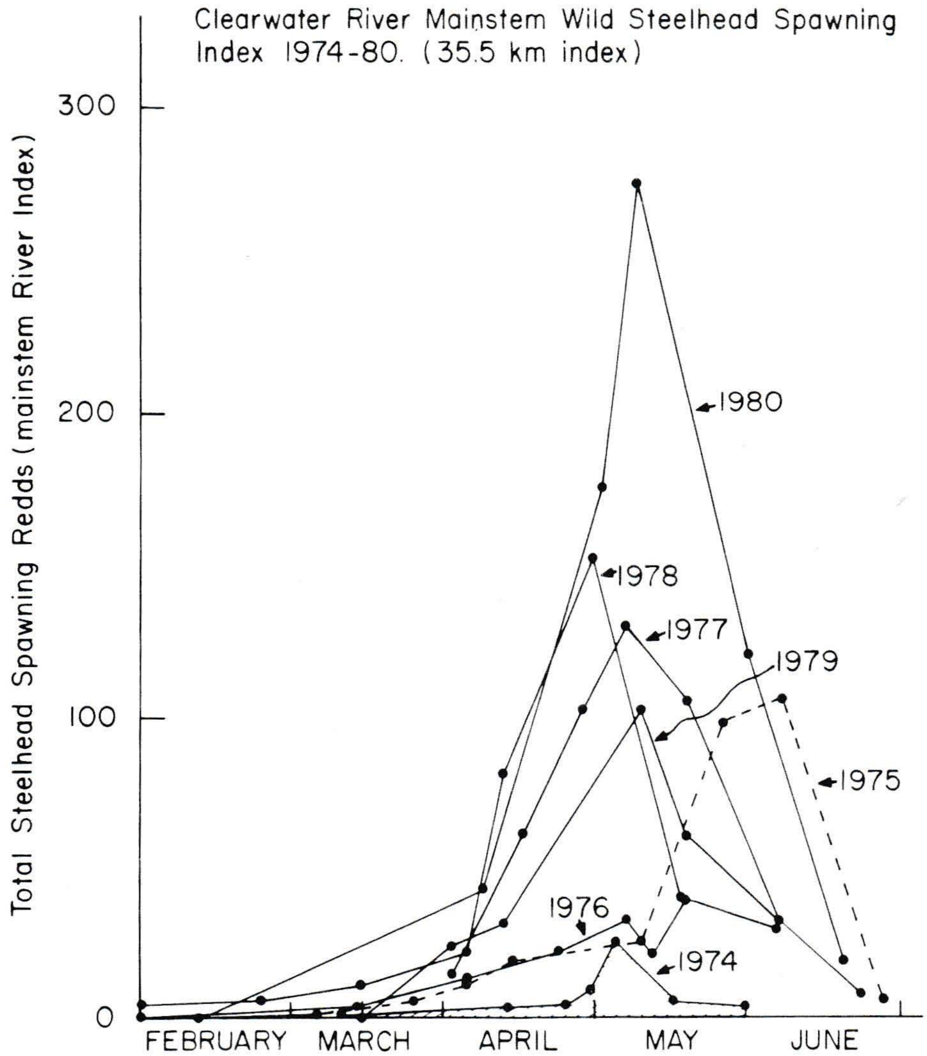

Figure 2. Mainstem Clearwater River steelhead redd counts, 1974-1980.

Table 3--Changes in streambed cross-sectional area expressed as scour and fill (m^2), during 1974-75.

September 1974 - February 1975								
	Stequaleho Creek		Christmas Creek		Shale Creek		Hurst Creek	
Cross section	scour	fill	scour	fill	scour	fill	scour	fill
1.	0.93	0.44	0.86	1.49	1.81	0.14	18.50	13.50
2.	0.56	0.00	1.77	0.14	0.35	0.23	44.25	35.75
3.	2.39	1.07	0.67	0.47	0.14	0.16	30.25	00.00
4.	1.28	0.37	0.65	0.00	1.72	1.46	21.25	00.00
5.	1.67	0.49	0.40	0.16	0.53	0.42	12.75	00.00
6.	0.84	0.00	1.07	0.00	1.74	0.00	5.25	4.00
7.	3.30	0.49	1.16	0.00	0.30	1.44	26.50	0.50
8.	1.77	0.05	0.84	0.07	4.51	0.49	25.25	1.00
9.	1.02	0.05	0.74	0.09	0.79	0.00	20.50	0.80
10.	--	--	0.35	0.53	--	--	8.00	0.00
Total	13.75	2.95	8.50	2.95	11.89	4.34	212.50	55.55

Table 3 (cont'd)-Changes in streambed cross-sectional area expressed as scour and fill (m^2), during 1974-75.

			February 1975 - June 1975					
1.	1.12	1.46	2.62	0.42	0.32	0.40	15.25	5.75
2.	1.02	0.00	0.09	0.51	0.40	0.84	3.50	9.00
3.	1.65	2.14	1.51	0.09	0.74	0.00	0.75	7.00
4.	0.00	1.70	0.05	0.40	0.60	0.30	0.50	26.00
5.	0.16	2.74	0.12	0.86	0.09	0.47	0.00	6.75
6.	1.42	0.09	0.05	0.74	0.05	0.58	1.50	5.75
7.	0.12	3.74	0.14	0.33	0.05	0.33	3.00	33.00
8.	0.05	1.14	0.00	0.28	0.49	2.44	0.25	2.75
9.	0.14	1.05	0.70	0.21	0.07	0.58	0.50	8.75
10.	--	--	0.07	0.74	--	--	0.00	7.00
Total	5.67	14.05	5.34	4.58	2.81	5.94	25.25	111.75

Clearwater River Wild Steelhead Spawning Densities in the Mainstem and in the Tributaries.

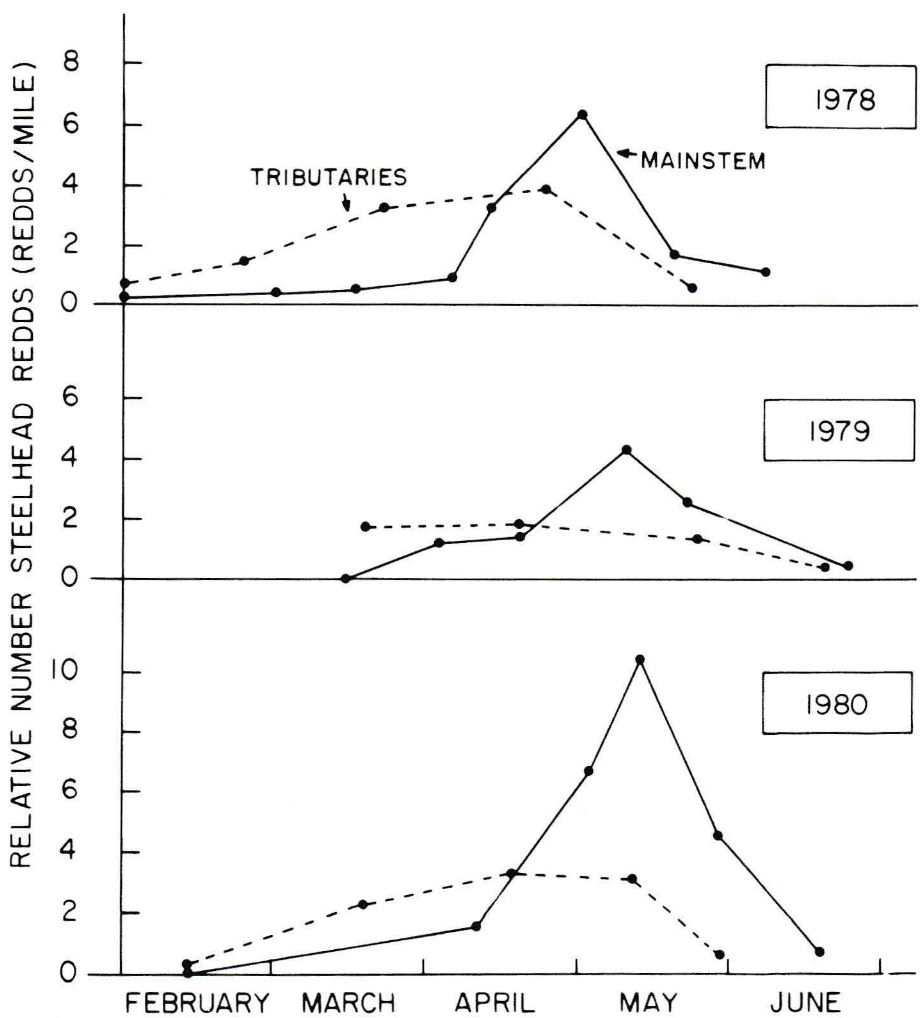

Figure 3. Mainstem Clearwater River and mean tributary steelhead redd counts, 1978-1980.

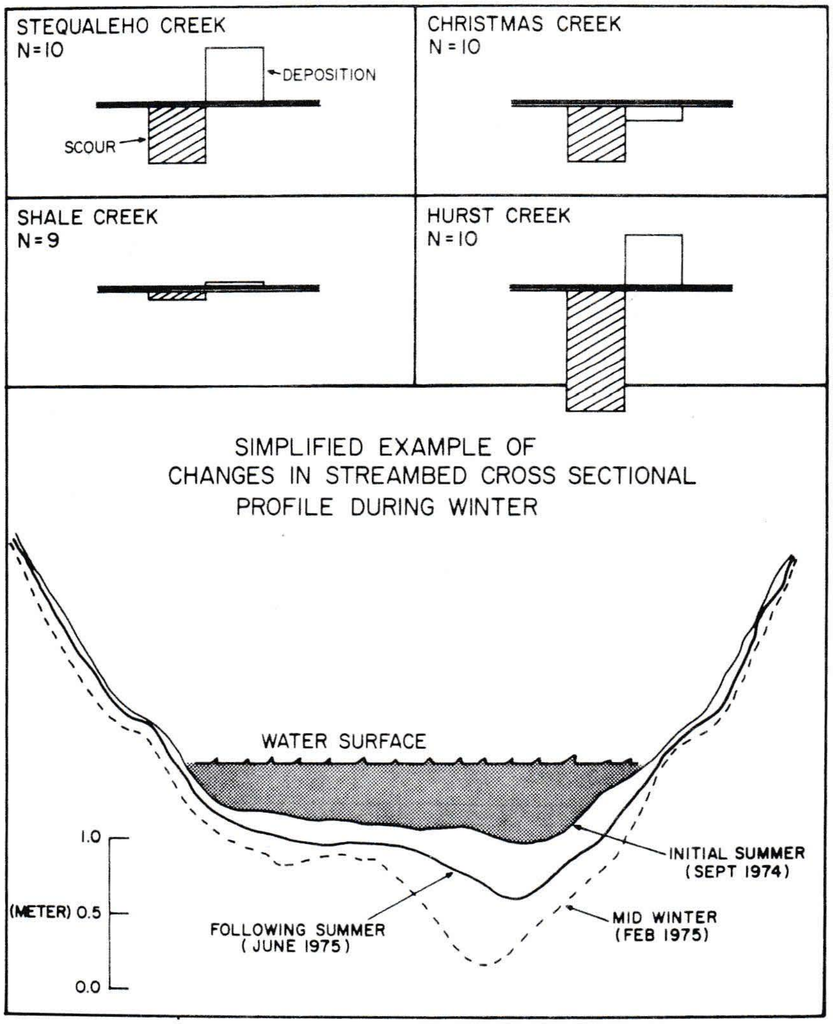

Figure 4. Streambed cross-sectional changes in Stequaleho, Christmas, Shale, and Hurst Creeks, 1974-75.

From 1974 through 1978 there were 28 individual storm peaks between the months of September and February, that exceeded 40 m^3/sec discharge in the Clearwater River; and only five similar magnitude storms after February. This storm flow pattern indicates how few storms occur during the steelhead spawning season (January-June), and particularly the mainstem spawning season (April-June), compared to the salmon spawning season (August-January) (fig. 5).

During the 1975 and 1978 seasons the main river spawning peaks occurred later and earlier respectively, than the average of the other 5 years (fig. 6). In 1975 the spring water temperatures were colder than in 1978. In that year the spring water temperature did not rise above 7°C [midpoint recommended water temperature for steelhead spawning, Reiser and Bjornn (1979)] until April 10. While in 1978 the water temperature reached 7°C on or before March 16. Peak timing of spawning in these 2 years is separated by 39 days, which compares reasonably well with the 25-day difference in achievement of the midpoint recommended spawning temperature between the 2 years (fig. 6). River entry timing through the fishery at Queets was not different in 1975, when compared to other years (Quinault DNR 1982).

During the period of 1974 through 1982 (nine spawning seasons) there has been a trend toward larger wild steelhead spawning escapements in the Clearwater River (Larry Lestelle, unpublished data). These increased escapements have followed a general decrease in the Queets River Tribal gill net catch of wild steelhead, and a general increase in total Queets River run size (Quinault DNR: fig. 8). The runs were low in the middle 70's and appear to be about twice as high in the late 70's and early 80's.

DISCUSSION

Main river and tributary spawning occurs principally between January and the end of June, and this activity peaks in April and May. This spring spawning timing is fairly typical of rivers along the Olympic Peninsula coast. For example wild steelhead in the Calawah, Sol Duc,

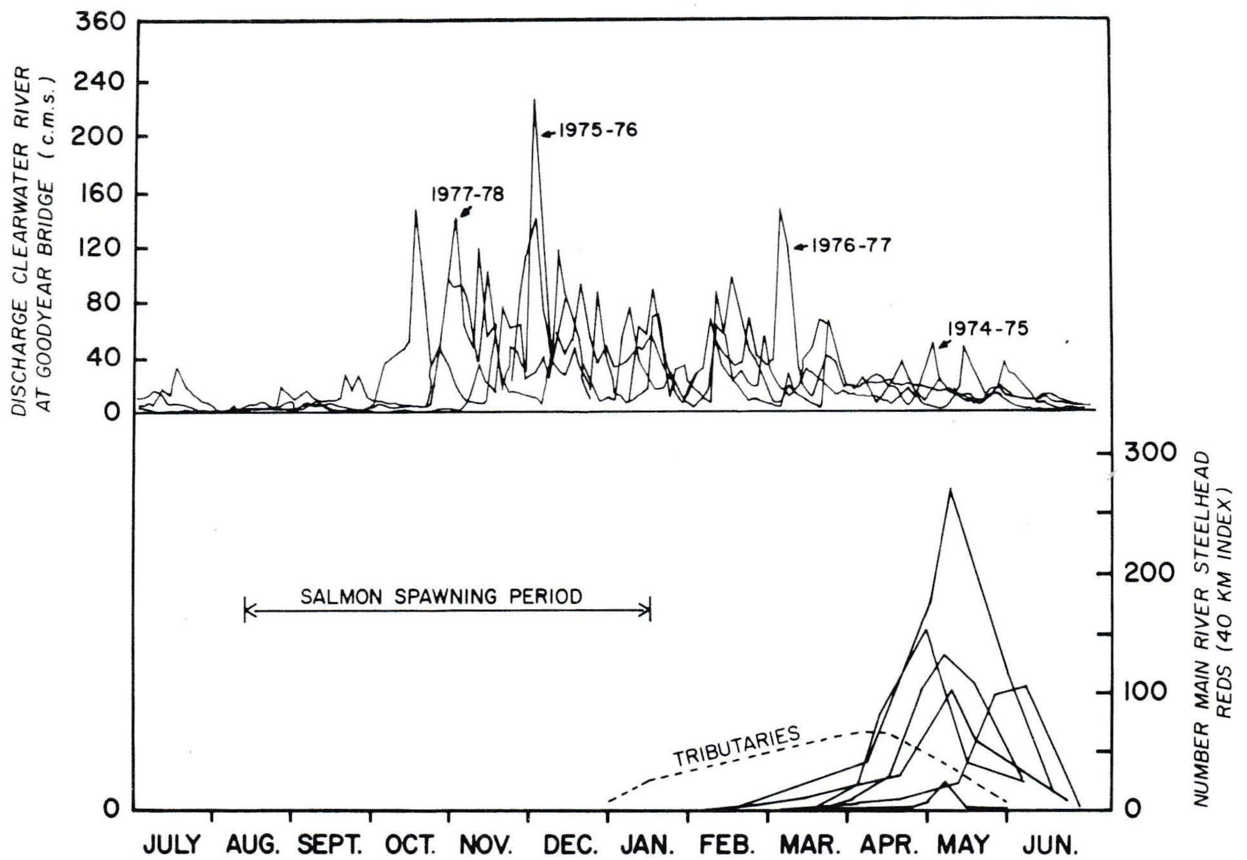

Figure 5. Clearwater River and tributary's steelhead redd counts compared to four years (1974-78) of streamflow records.

and Bogachiel Rivers all follow a similar pattern (U.S.F.W.S. and W.S.G.D. 1978).

One advantage of spring spawning is the avoidance of redd loss caused by major fall-winter freshets and floods. Freshets and floods have been found to cause excessive streambed erosion and scour, with resultant mortality of salmon eggs (Gangmark and Broad 1955; McNeil 1966; Lister and Walker 1966; and Wood unpublished data). Our tributary cross-sectional survey data further suggest that spring spawning in the Clearwater River may be an advantage. September to February was found to be a period of net streambed scour; while the period from February to June, a period of net streambed deposition (fig. 4). This suggests that steelhead spawners may have taken advantage of the spring period to avoid gravel degradation; however, streambed deposition of "fine" sediment may also create problems for emerging fry.

Spring spawning also eliminates competition between steelhead and salmon for spawning sites. In the Clearwater River system the chinook and coho salmon often spawn in the same locations as the steelhead. Both of these species bury their eggs deeper than steelhead, and would dig up the steelhead eggs in a habitat co-utilization situation.

Spring spawning has a disadvantage for some juvenile steelhead cohorts because they emerge from the gravel in mid- to late summer (June-August), approximately 3-5 months after the chinook and coho (February-June). A major disadvantage of late emergence is that many of the later spawning steelhead are of small size going into their first winter, and therefore must spend two or more winters in freshwater (suffering high mortality) before achieving smolt size.

The Clearwater River spawning escapement and overall wild Queets River steelhead run size have increased over the past 8 years (Quinault DNR 1982). The increased Clearwater River spawning escapements correlate with a corresponding decrease in the Queets Tribal gill net catch, and improved logging road construction and maintenance practices in the watershed (Cederholm et al. 1982). The Queets Tribal catch of native steelhead was over 6,000 in 1974 and under 1,000 in 1980. The use of new logging road construction and maintenance techniques by the State Department of Natural Resources (i.e., good locationing, paving, culverting, etc.) has helped reduce erosion and sedimentation.

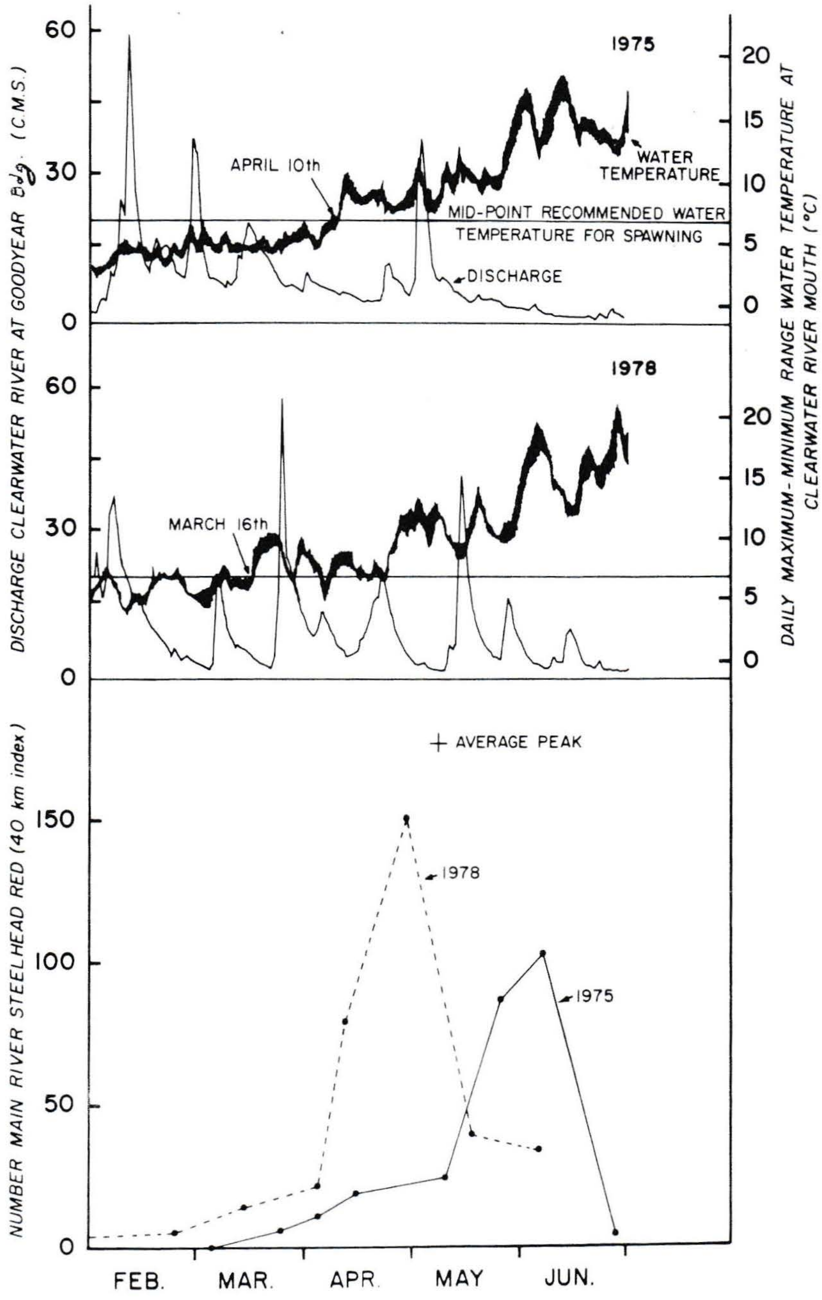

Figure 6. Spring water temperature and streamflow in the main-stem Clearwater River, compared to peak steelhead spawning counts in 1978 and 1975.

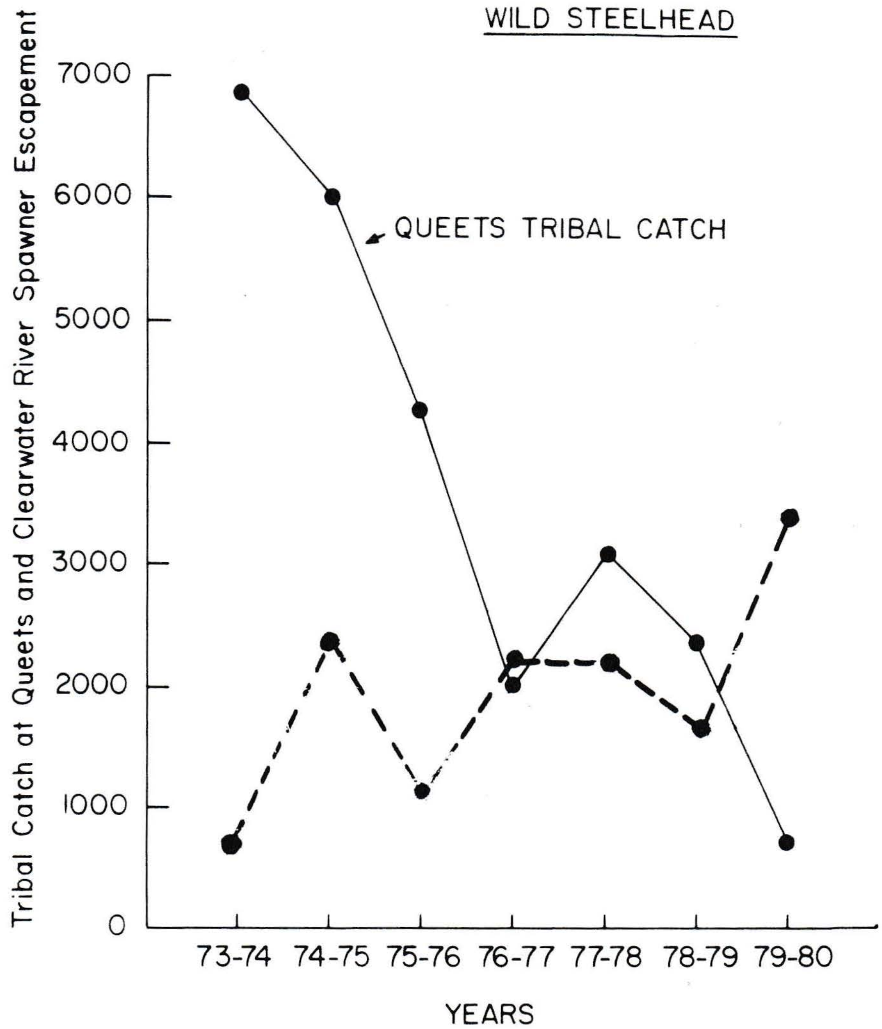

Figure 7. Queets River wild steelhead gill-net catch compared to wild Clearwater River spawning escapement estimates, 1973-80 (Quinault Department Natural Resources, 1982; and Larry Lestelle, unpublished data).

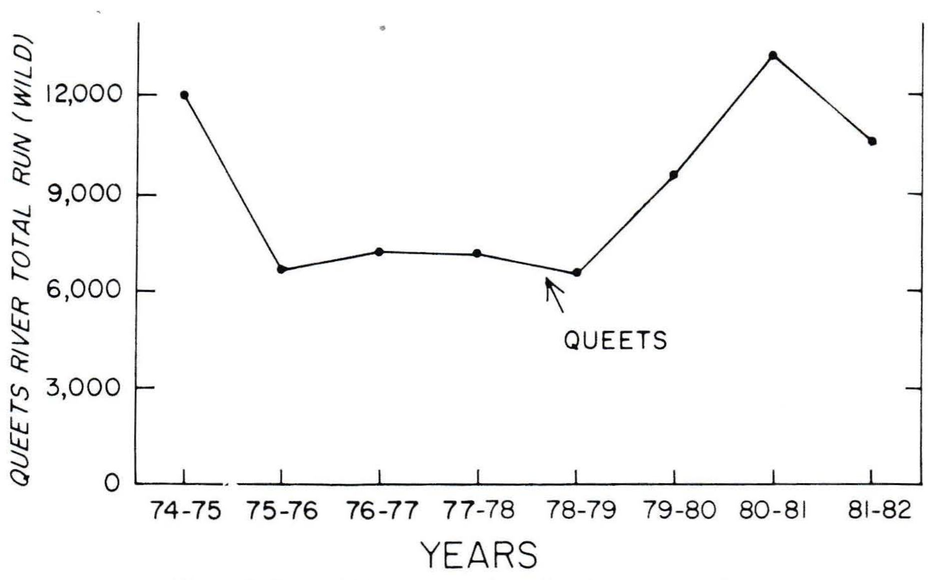

Figure 8. Queets River total wild steelhead annual run size, 1974-82 (Quinault Department Natural Resources, 1982).

LITERATURE CITED

Abercrombie, W. B., J. M. Hunt, and A. G. Larson. 1978. Hydrologic data summary Clearwater River basin, water year 1976-77. College Forest Resources, Univ. Wash.

Abercrombie, W. B., J. M. Hunt, and A. G. Larson. 1979. Hydrologic data summary Clearwater River basin, water year 1977-78. College Forest Resources, Univ. Wash.

Cederholm, C. J. 1972. The short-term physical and biological effects of stream channelization at Big Beef Creek, Kitsap County, Washington. M.S. Thesis, Univ. Wash., Seattle. 80 p.

Cederholm, C. J., L. M. Reid, B. G. Edie, and E. O. Salo. 1982. Effects of forest road erosion on salmonid spawning gravel composition and populations of the Clearwater River, Washington. In. Proceedings of a Symposium: Habitat Disturbance and Recovery. Calif. Trout Inc., pages 1-17.

Chilcote, M. W. 1983. The reproductive fitness of hatchery and wild steelhead. Proceedings of the wild salmon and trout conference. Washington Environmental Foundation. Seattle Univ., Seattle, Wash. March 11-12, 1983. Pages 80-87.

Gangmark, H. A. and R. D. Broad. 1956. Further observations on stream survival of king salmon spawn. Cal. Fish. and game. 42(1):37-49.

Larson, A. G. and H. J. Jacoby. 1977. Hydrologic data summary Clearwater River basin water year 1975-1976. College of Forest Resources, Univ. Wash.

Lister, D. B. and C. E. Walker. 1966. The effect of flow control on freshwater survival of chum, coho, and chinook salmon in the Big Qualicum River. Can. Fish Cult. 37:3-26.

McNeil, W. J. Effect of the spawning bed environment on reproduction of pink and chum salmon. U.S. Fish and Wildlife Service, Fish. Bull., Vol. 65, No. 2. Contrib. No. 198, College of Fisheries, Univ. Wash., Seattle, Wash.

Quinault Department of Natural Resources. 1982. Preseason management report for 1982-83 winter steelhead fisheries in the Queets, Quinault, Humptulips, and Chehalis Rivers. the Q.D.N.R. Fish. Div. Havest Management Section.

Reiser, D. W. and T. C. Bjornn. 1979. Influence of forest and rangeland management on anadromous fish habitat in western North America - Habitat Requirement of Anadromous Salmonids. USDA Forest Service, Gen. Tech. Rept. PNW-98. 54 p.

United States Fish and Wildlife Service and Washington State Game Department. 1978. Progress Report. Cooperative Agreement No. 14-16-0001-6345 IFC.

LESTELLE

Proceedings of the

OLYMPIC WILD FISH CONFERENCE

J.M. Walton and
D.B. Houston, Editors

March 23-25, 1983

Fisheries Technology Program
Peninsula College

Olympic National Park

Port Angeles, Washington
1984