CHEHALIS SPRING CHINOOK
PROGRESS REPORT 1984

Fisheries Assistance Office
U.S. Fish and Wildlife Service
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by

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ABSTRACT

The Fisheries Assistance Office (FAO), U.S. Fish and Wildlife Service (FWS), Olympia, Washington has been working in cooperation with the Washington Department of Fisheries (WDF) and the Chehalis Indian Tribe, to restore the depleted spring chinook run on the Chehalis River since 1980. In 1984 the Chehalis watershed was surveyed for spring chinook escapement. We also took scales of carcasses for life history determination, measured various parameters of the spawning habitat for establishment of habitat utilization curves, and documented instances of environmental disturbance on the potential spawning grounds.

The resulting escapement estimate of 1,060 fell considerably short of the goal of 1,400 set by the Washington Department of Fisheries. Nonetheless, escapements have been increasing since 1980. The average distribution of spawning in the watershed over the last three years verified WDF's index expansion factor in the years before FWS began surveying other parts of the system. Nonetheless, to insure continued accuracy we recommend that the Chehalis tribe augment the WDF spawner surveys by surveying the Newaukum system and the upper mainstem.

In spite of the general underescapement, fall chinook appeared to be superimposing redds on those of spring chinook between Miles 6.4 and 22.0 of the Skookumchuck River. Superimposition was greatest in a two-and-a-half mile reach below the Skookumchuck Dam. We recommend reconsideration of a weir below this area to protect the spring run spawners.

Life history of 53 returnees in 1984 was dominated by age-V adults, in contrast to the two previous years when most had returned as four-year olds. As in previous studies, all had migrated to salt water as subyearlings.

Measurements on 113 redds over the last three seasons indicated that 72 percent of the redds occurred at depths of 0.6 to 1.1 feet; 76 percent of the redds occurred at current velocities ranging from 0.7 to 2.4 feet per second; and 77 percent of the redds had mean gravel diameters from 7 to 10 centimeters. Also, 64 percent of the redds were constructed within 75 feet of instream or streamside cover, to which fish escaped when disturbed from the redd. This information may be useful for flow protection in the North Fork Newaukum or other areas of the Chehalis watershed if the need should occur.

The spawning grounds in the Chehalis system suffered numerous environmental disturbances over the years surveyed. The most frequent impacts observed over the last several years have been gravel removal, riprapping, and poor management of cattle crossings.

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ACKNOWLEDGEMENTS

Field Technician Jeff McKee conducted most of the FWS field work and instructed Chehalis Tribal personnel in spawner survey techniques. Chehalis Tribal biologists Gene Deschamps and Ted Arnold provided technical advice and field assistance throughout the season. They, along with Chehalis Tribal members Al Ortirez, Maynard Starr, Bill Secena, Jerry Youckton, and Dennis Cayenne did a very large part of the field work. Dick Stone and Rick Brix of the Washington Department of Fisheries provided much of the field data and technical review of the final escapement estimate. Thanks are also due to Nancy Evans and Della McCrowell for typing some of the tables and preparing the copies.

INTRODUCTION

The Olympia Fisheries Assistance Office (FAO) of the U.S. Fish and Wildlife Service (FWS) has been working for several years to restore certain depleted salmon runs in both Puget Sound and coastal Washington. Most coastal spring chinook are generally considered to be depressed. Of the five coastal spring chinook runs, the Chehalis run is thought to be the most significantly depressed and is documented with the least amount of available data regarding run size, spawner distribution, and life history patterns. For this reason the Chehalis spring chinook run has been receiving our restoration efforts since 1980.

Our efforts (Hiss et al. 1983; 1984) have centered around spawning ground survey because previous Washington Department of Fisheries (WDF) escapement estimates had to rely on only a few index areas and these were relatively small compared to the available habitat. With the cooperation of the WDF and the Chehalis Tribe we have gradually been able to expand the area of spawning ground coverage so that during the 1984 run virtually all available spawning areas were surveyed at least once.

Spawner surveys have also provided the opportunity to collect information on life history, spawning habitat utilization, and incidence of environmental disturbance. Life history information was obtained for eventual use in run size prediction. This information was collected by analyzing scales taken from carcasses on the spawning grounds. Instream flow protection data was gathered by taking habitat measurements at occupied redds. These measurements are of use in constructing habitat utilization curves. Environmental disturbances observed during spawner surveys were noted and reported to the WDF.

In addition, we took the first step in studying the marine distribution of the stock by examining the feasibility of collecting wild outmigrant juveniles for coded wire tagging (CWT).

Our specific objectives for 1984 were:

1. Complete our supplementation of WDF spawner surveys.

2. Continue documenting life history by taking scales from carcasses, to eventually allow a better prediction of the run size.

3. Continue gathering data on depth and current velocity at redds for potential instream flow protection.

4. Document environmental damage observed on spawner surveys.

5. Investigate the feasibility of capturing sufficient wild juvenile outmigrant spring chinook to permit CWT in the field.

This report describes progress toward the first four objectives. A separate report (Hiss and Boomer 1985) discusses the feasibility of capturing enough outmigrants to support a CWT study. The report indicates the need for tagging hatchery-reared juveniles if a study of the marine contribution pattern is to be conducted.

METHODS

FAO and the Chehalis Tribe helped to refine spawning escapement estimates by making redd counts in several areas not surveyed by WDF. Using the spawning distrubution suggested by the 1983 survey, index areas were established on the South Fork Newaukum River between river miles (RM) 13.7 and 30.3, the North Fork Newaukum from RM 0.3 to 6.8, and the mainstem Chelalis from RM 108.7 to 113.5 and 100.3 to 106.2. To insure that all redds were counted, surveys were made approximately every 10 days through the run. Cumulative redd counts for each area were made possible by flagging each redd with surveyor's tape when the redd was first observed.

Spawning distribution at the peak of the run was investigated by means of supplemental surveys on the Skookumchuck River (RM 0.0 to 18.5), the South Fork and mainstem Newaukum (RM 4.2 to 13.7), the mainstem Chehalis (RM 117.0 to 119.0 and RM 94.3 to 97.0), the South Fork Chehalis (RM 5.0 to 8.5), and Stillman Creek (RM 0.0 to 4.1). Several supplemental surveys were required in the Skookumchuck to get an accurate peak visible redd count.

We separated fall from spring run redds based on known timing from previous years, on the freshness of live fish on the redds, and the distribution of new redds over the survey season.

We calculated the 1984 escapement based only on the areas actually surveyed. We felt this was justifiable because of the extensive area of supplementary surveys this year. In contrast, previous years' calculations had expanded index and supplementary counts to account for unsurveyed areas. As in previous years, the number of adult spawners was obtained by multiplying the cumulative redd count by 2.5. This is the factor WDF uses for other coastal chinook runs (D.Stone, personal communication). The cumulative redd count in supplementary areas was estimated by taking the peak visible redd count and expanding by the ratio of the cumulative redd count to the peak redd count in the nearest index area. Thus, for the upper mainstem Chehalis, escapement was estimated by:

Index area escapement = mainstem Chehalis index area cumulative redd count X 2.5 adults/redd.

Supplementary area escapement = (Mainstem Chehalis supplementary area peak redd count) X (Mainstem Chehalis index area cumulative redd count) /(Chehalis index area peak redd count) X 2.5

and the Newaukum System escapement was estimated by:

Index area escapement = (North and South Fork index area cumulative redd counts) X 2.5

Supplementary area escapement = (South Fork Newaukum supplementary area peak redd count) X (South Fork Newaukum index area cumulative redd count) / (South Fork Newaukum index area peak redd count) X 2.5

Spawn timing in various parts of the watershed was examined by plotting visible redd counts against date for all years for which sufficient data was available.

We continued to measure depth and velocity at occupied redds using the same method as in previous years (Hiss et al. 1983).

RESULTS AND DISCUSSION

Escapement Estimate

The total escapement for 1984 was estimated at 1,060 fish (Table 1). This fell short of the WDF goal of 1,400. The combined WDF, FWS, and Chehalis Tribal surveys were probably more accurate than in previous years because so many areas were surveyed (Table 2). Approximately 22 miles were surveyed in the Skookumchuck River, 33 in the Newaukum system, and 24 in the upper Chehalis watershed. Data for each survey appear in Appendix I.

Two of the new areas in 1984 had considerable spawning activity. For example, mainstem Chehalis RM 100.3 to 105.0 received most of the upper mainstem spawning this year. Also, the mainstem and South Fork Newaukum RM 4.1 to 13.5 supported considerable chinook spawning. However, the observed distribution in both the upper mainstem Chehalis and in the mainstem Newaukum far exceeded the river miles we had predicted the fish would use (Hiss et al 1984). In our earlier report we estimated the preferred stream gradient by plotting known spawning areas on U.S. Geological Survey 7 1/2 minute quadrangle maps. This method does not appear accurate enough to predict spawning use within a two to three mile reach of stream and its utility in establishing survey areas or expanding index counts is quite limited.

The distribution of spawning in the upper mainstem Chehalis suggested two blocks to adult passage in 1984, one partial and one complete. The partial block was probably located at the cascades at RM 108.0 and known as the Tin Bridge Cascades. This block was suggested by the relatively low escapement above this point, in relation to previous years (Table 3), coupled with the relatively good escapement elsewhere in the system this year. Passage at the Tin Bridge Cascades might be improved by moving some of the boulders there (Greg Johnson, WDF, personal communication). This could probably create more of a pool-and-falls effect during the low flow period, and thus provide easier passage for spring chinook.

A complete block at Fisk Falls was suggested by the apparent absence of spawning above this point, in contrast to good use of the area above the falls last year. The unusually late arrival of the rainy season in the fall of 1984 very likely contributed to these problems. It is probably not possible to improve Fisk Falls for passing fish during low flow. The spawning observed above that point in 1983 may have been due to unusually high summer flows that year.

Spawning distribution over the principal areas of the watershed averaged over the last several years conformed fairly well to WDF assumptions regarding percentages of the total spawning supported by each of these areas Table 4). The assumed distribution was used in expanding Skookumchuck escapement to estimate the total Chehalis system escapement, in the years before other major parts of the watershed were surveyed. Since 1983, escapement estimates have been based on a larger area of the watershed, and the assumed percentages have been shown to be reasonable.

Although the assumed percentage distribution appeared reasonable, the observed distribution over the last several years was wider than formerly assumed. Spring chinook in the Skookumchuck utilized all but the lower 2.4 miles, implying a range of 19.6 miles instead of the assumed 17.0. On the Newaukum spawning occurred over a total of 29.4 miles instead of the 18.0 formerly assumed. That is, the fish used 22.6 miles of mainstem/South Fork above RM 7.7 plus 6.8 miles of the North Fork. The upper Chehalis appeared to have 16.3 miles of fairly good habitat--that is, Stillman Creek RM 0.0 to 4.1, Elk Creek RM 0.0 to 1.5, and mainstem RM 100.3 to 106.5 and 108.7 to 113.5--instead of the 15.0 formerly assumed.

Although the observed spawner distribution agreed with WDF assumptions, WDF escapement goals for various parts of the watershed differed greatly from the observed spawning distribution over the last three years (Table 5; data presented in Appendix II). WDF assumptions on spawner distribution used for expansion of index area escapement did not correspond to the desired distribution expressed in the various escapement goals for separate parts of the watershed. For example, the Skookumchuck and Elk Creek goals represent a much higher percentage of the total desired escapement than has recently been observed. On the other hand, the Newaukum goal is much lower than the average of our observations. However, these

Table 1. Spring chinook escapement for 1984.

Location	Estimated Escapement
Skookumchuck River	323
Newaukum system	542
South Fork Chehalis system	0
Upper Mainstem Chehalis	173
Elk Creek	22
Total	1,060

discrepancies do not alter our opinion that the existing total escapement goal is reasonable, based on our comparison to the goals for other watersheds (Hiss et al 1983) and our estimates of the degree of habitat utilization in the Chehalis system (Hiss et al 1984).

Spring and fall chinook runs were only partially separated in terms of timing and area used, based on 1984 surveys. This was the first year that enough areas were surveyed far enough into the fall to get this information (Table 2). The observed overlap was not extensive enough to greatly affect the accuracy of the escapement estimate. The only incidence of significant overlap in both timing and area was in the lower South Fork Newaukum and mainstem Newaukum (RM 4.1 to 13.5).This is based on observation of very bright chinook and fresh redds in the mainstem Newaukum in mid-October at a time when no fresh redds were observed in the North and South Forks. This overlap was not a problem in calculating 1984 spring chinook escapement, however, because only about four percent of the escapement was estimated to occur here. In calculating future escapements, the supplementary redd count should be made in the first week of October to minimize the influence of the fall run.

Overlapping spawn timing does not appear to exist in other parts of the watershed. For example, spring and fall run spawning appear to be separated in time on the upper mainstem. The number of visible redds in the Pe Ell- Doty area decreased considerably before new redds attributable to fall run spawning began to occur. Spring and fall run fish were also fairly well separated over time in the Skookumchuck.

Despite the fair separation in timing in the Skookumchuck, however, fall run fish were apparently superimposing their own redds on the spring run redds throughout the river (Gene Deschamps, Chehalis Tribe, personal communication). The number of redds thus disturbed was not determined. The potential impact is greatest in the Skookumchuck index area where there is a high density of spring chinook redds (see Table 2) and where spring and fall runs are using much of the same area (Table 6). In addition, the WDF estimated that 500 to 600 coho also spawned in the Skookumchuck index area in 1984. This may be a further

Table 2. Calculation of total spring chinook escapement for 1984. See text for methods and Appendix I for data.

Location	Type	River Mile Lower	River Mile Upper	Redds Peak Vis. Date	Redds Peak Vis. Count	Redds Cum. Date (a)	Redds Cum. Count	Estimated Escapement
Skookumchuck	Index	18.5	22.0	10-3	38	10-3	42	105
	Supp.	10.8	18.5	9-27	38		42(b)	105
	Supp.	0.0	10.8	10-3	41		45(b)	113
South Fork	Index	23.1	30.3	9-10	58	10-22	77	192
Newaukum	Index	13.7	23.1	10-3	77	10-23	84	210
South Fork/ Mainstem Newaukum	Supp.	7.7	13.7	10-18	15		18 (b,c)	45
Mainstem Newaukum	Supp.	4.2	7.7	9-25	2		2	5
North Fork Newaukum	Index	0.3	6.8	10-1	31	10-16	36	90
South Fork Chehalis	Supp.	5.0	8.5	10-4	0		0	0
Stillman Cr.	Supp.	0.0	4.1	10-9	0		0	0
Chehalis	Index	108.7	113.5	10-9	8	10-9	8	20
	Index	100.3	106.2	10-5	49	10-15	59	148
	Supp	117.0	119.0	9-26	0		0	0
	Supp.	94.3	97.0	10-15	2		2(b)	5
Elk Creek	Index	0.0	1.5	10-4	9	10-4	9	22
Total								1,060

(a) Last date of cumulative counts. New redds observed after this date were attributed to fall chinook.
(b) Estimated; see methods section of text.
(c) See Appendix I, footnote (d) for calculation.

negative impact on spring chinook survival, due to the partial overlap in spawning habitat utilized by these species.

Recent surveys suggest that a weir to protect spring chinook redds from fall chinook spawning should be considered. Just after the Skookumchuck Dam was completed in 1973 the WDF placed a weir

Table 3. Upper mainstem Chehalis spawning distribution, 1982-84.

Location	River Miles	Escapement 82	83	84
Above Fisk Falls	118.0-120.0	unk.	93	0
Tin Bridge Cascade to Fisk Falls	108.7-113.5	38(a)	138	20
Below Tin Bridge Cascade	100.3-106.2	unk.	unk.	148

(a) 1982 peak visible redds X (1983 cumulative redds/1983 peak visible redds) X 2.5.

Table 4. Observed 1982-84 spawning distribution compared to WDF's assumed distribution for expansion of 1970-82 Skookumchuck escapements to rest of watershed.

Location	Observed Escapement less Elk Creek		WDF Assumed Distribution	
	Number	Percent	Miles	Percent
Skookumchuck	285	35.4	17	33.7
Newaukum	378	42.6	18	35.6
South Fork Chehalis and Upper Mainstem Chehalis	196	22.0	15.5	30.7

Chi-squared = 3.927 p ¼ 0.1

in the Skookumchuck in the vicinity of Johnson Creek (RM 19.0), but unusually low water levels in the early years after the dam resulted in little use of this are by either run early in the spawning period. Later in those years, high flows made it difficult to keep the weir in place. Nonetheless, we believe the recent findings justify reconsideration of some form of artificially separating the runs in this heavily used area.

Viewed historically, spring chinook escapement to the Chehalis system has been increasing since 1980, but has yet to meet the WDF goal (Table 7). Escapements are expected to improve if the U.S./Canada treaty effectively reduces ocean interception of this run, but habitat restoration is still needed, due to the obvious degradation of the Chehalis habitat in comparison to other coastal streams.

Spawn timing, as indicated by visible redds in various parts of the watershed is presented in Figure 1 for all years and index areas for which sufficient information was available. The index areas fell into two groups, according to timing of spawning. The

Table 5. 1982-84 mean spawning distribution compared to WDF goals for various parts of the watershed. Annual distribution data presented in Appendix II.

Location	Observed		WDF Goal	
	Number	Percent	Number	Percent
Skookumchuck	296	34.3	700	50.0
Newaukum system	386	40.9	300	21.4
South Fork Chehalis system	30	3.0	50	3.6
Mainstem Chehalis	166	17.3	200	14.3
Elk Creek	35	4.6	150	10.7

Chi-squared = 27.106 $p \le 0.005$

Table 6. 1983 and 1984 Skookumchuck index (RM 18.5-22.0) spawner surveys.

Year	Race	Date	Redds		
			New	Visible	Cumulative
83	S	9-8	10	10	10
	S	9-15	10	18	20
	S	9-22	20	38	40
	S	9-29	4	37	44
	S	10-5	2	39	46
	F	10-12	11	36	(a)
84	S	9-12	13	13	13
	S	9-19	12	24	25
	S	9-26	11	(b)	36
	S	10-3	6	38	42
	F	10-10	10	39	(a)
	F	10-26	(b)	110	(b)

(a) Not applicable.
(b) Not counted.

first group of areas consisted of the Skookumchuck River and both the North and South Forks of the Newaukum, where peak spawning usually occurred in the last two weeks of September. The second group consisted of Elk Creek and the upper mainstem Chehalis, where peak spawning usually occurred in the last week of September and the first week of October. However, each of these groups exhibited a very high variability in timing from one year to another. Consequently, the timing of the two groups overlapped considerably. Nonetheless, it would be advisable in any broodstocking program to collect adults from both areas of

Table 7. Historical escapement of Chehalis spring chinook. 1970-82 estimates by WDF; 1983-84 by FWS.

Year	Escapement	Year	Escapement
70	240	78	1,030
71	250	79	340
72	250	80	250
73	260	81	580
74	350	82	610
75	460	83	1,190
76	650	84	1,060
77	840		

the watershed to insure a good representation of the run as a whole. In particular, a broad-based broodstocking program could contribute to a more reliable evaluation of marine distribution than if broodstock were taken from only one area of the watershed.

Life History

All 53 of the fish with readable scales had migrated to saltwater as subyearlings. This agrees with our previous investigations (Hiss et al 1983; 1984), with WDF scales from previous years' tribal catches (R. Brix, WDF, personal communication), and with the length frequency distribution of WDF beach seine catches (Hiss and Boomer 1985).

Most adults returned as age V (Table 8), in contrast to the last two years, when four-year-olds were more frequent. Females tended to be older than males in all three years for which we took scales.

Spawning Habitat Utilization Measurements for Flow Protection

From 1982 to 1984 we measured the chartacteristics of the spawning habitat at 113 redds a few days after observing adults on them. Complete data appear in Appendix III.

The spawners appeared to select depths of 0.6 to 1.1 feet (Table 9). Selection of current velocity was less pronounced (Table 10). The favored velocity was 1.3 to 1.8 feet per second, but use of 0.7 to 2.4 feet per second was fairly common.

Nearly all spawners selected gravel between 3 and 10 centimeters in mean diameter (Table 11), with mean sizes from 7 to 10

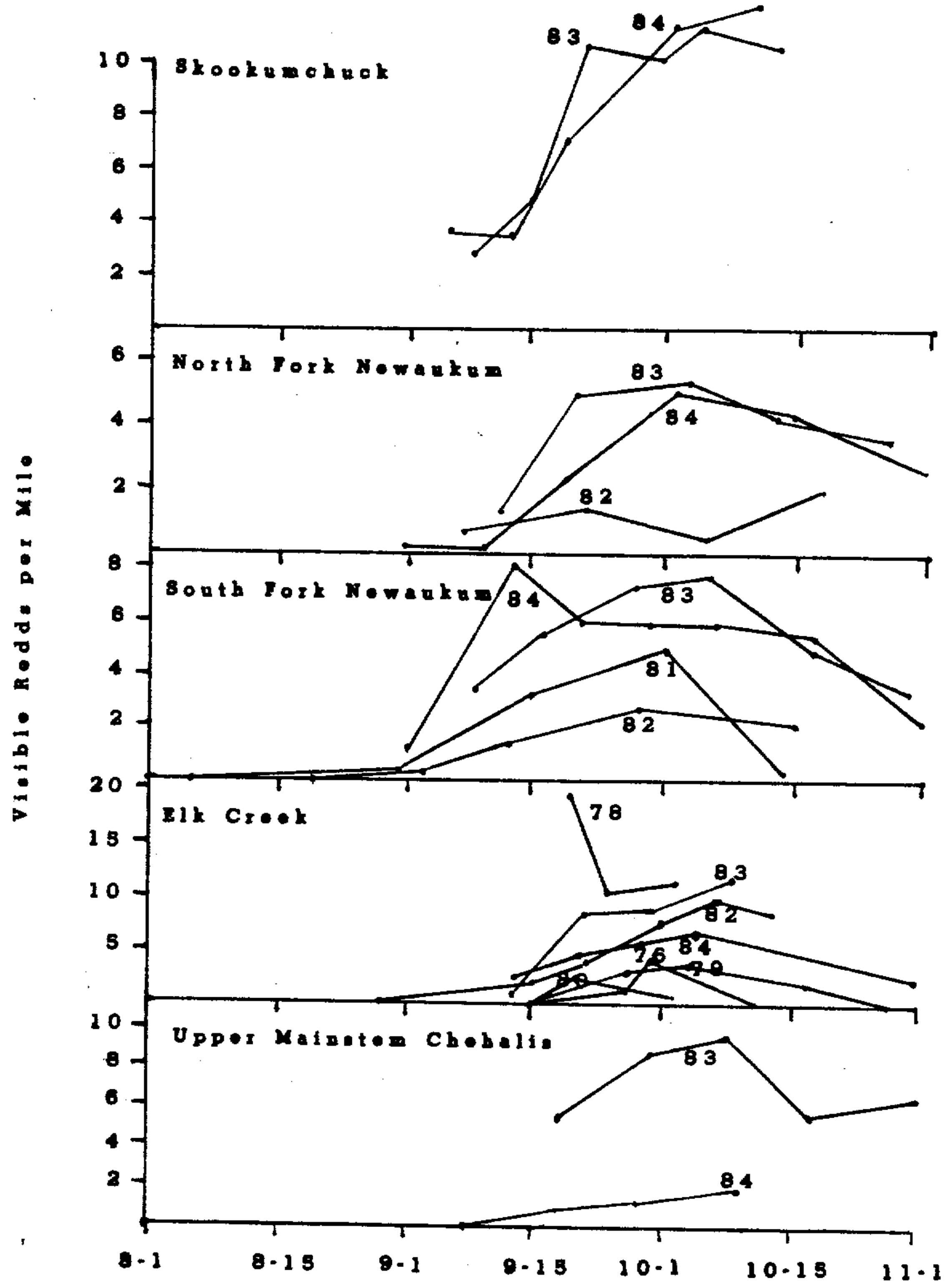

Figure 1. Timing of spawning in various parts of the Chehalis watershed, 1976-84.

Table 8. Age Composition of Chehalis system spawners, 1982-84.

Year	Sex	Sample	Percentage by Age Class				
			II	III	IV	V	VI
82	M	8	12.5	37.5	50.0	0.0	0.0
	F	10	0.0	0.0	70.0	30.0	0.0
	Total(a)	21	4.8	19.0	57.1	19.0	0.0
83	M	20	5.0	20.0	50.0	25.0	0.0
	F	32	0.0	3.1	59.4	37.5	0.0
	Total(b)	53	1.2	9.4	56.6	32.1	0.0
84	M	20	15.0	25.0	35.0	25.0	0.0
	F	33	0.0	0.0	27.3	69.7	3.0
	Total	53	5.7	9.4	30.2	52.8	1.9

(a) Sex of three fish not determined.
(b) Sex of one fish not determined.

centimeters being more frequent. These estimates were made by judging, with the aid of a ruler, the mean gravel diameter in the undisturbed stream bottom immediately upstream of the redd. The subjectivity of this method limits its usefulness in determination of habitat utilization. A more precise method for assessing gravel size would be useful.

Table 9. Stream depth at occupied redds.

Depth (feet)	Frequency	Percent
0.2-0.3	1	0.9
0.4-0.5	11	9.9
0.6-0.7	28	25.2
0.8-0.9	29	26.1
1.0-1.1	23	20.7
1.2-1.3	8	7.2
1.4-1.5	6	5.4
1.6-1.7	2	1.8
1.8-1.9	2	1.8
2.0-2.1	1	0.9
Total	111	

Most redds were found near some sort of cover into which the fish escaped when disturbed from spawning (Table 12). The two general categories were streamside and instream cover. Streamside cover was the category most favored. Within this category, undercut banks were most frequently used. Overhanging trees, logs, shrubs, or grass could also serve this function. Instream cover

Table 10. Current velocity at 0.3 X stream depth at occupied redds.

Velocity (feet/second)	Frequency	Percent
0.1-0.3	4	3.6
0.4-0.6	5	4.5
0.7-0.9	14	12.6
1.0-1.2	15	13.5
1.3-1.5	20	18.0
1.6-1.8	20	18.0
1.9-2.1	15	13.5
2.2-2.4	9	8.1
2.5-2.7	3	2.7
2.8-3.0	4	3.6
3.1-3.3	2	1.8
total	111	

Table 11. Estimated mean gravel diameter visually estimated at occupied redds.

Diameter (cm)	Frequency	Percent
1-2	5	4.7
3-4	15	14.0
5-6	24	22.4
7-8	31	29.0
9-10	27	25.2
11-12	5	4.7
Total	107	

was also common. This usually took the form of pools, even if they were no more than a few feet deep. Submerged logs and boulders were used less, probably because they were often not close enough to the spawning riffles. About 20 percent of the cover sites consisted of a combination of cover types. Cover was usually within 75 feet of the redd, although a few fish were observed to travel much farther when disturbed (Table 13).

Cover utilization should be borne in mind in habitat restoration, stream clearance projects, and logging operations. Our observations of cover types also suggest that WDF's habitat improvements, although designed to benefit juvenile coho, may also help spring chinook adults. Specifically, submerged logs and roots anchored along riprapped banks might serve as adult cover, given sufficient depth of water.

Table 12. Cover type at occupied redds.

Total redds examined	113
Redds with cover	99
Streamside cover only	49
Instream cover only	30
Combination	20
Frequency of streamside cover types	
Undercut bank	29
Overhanging tree(s)	15
Overhanging log(s)	15
Overhanging shrubs or grass	15
Frequency of instream cover types	
Pool	35
Submerged log(s)	8
Boulder(s)	7
Submerged roots	2
Frequency of cover type combinations	
Pool with overhanging trees	7
Submerged and overhanging log(s)	5
Pool with adjacent undercut bank	4
Boulder(s) and overhanging tree(s)	3
Undercut bank and overhanging trees	3
Submerged log(s) and roots	2
Submerged log(s) and undercut bank	2
Undercut bank and overhanging shrubs or grass	2
Pool with overhanging shrubs or grass	1

Table 13. Distance from occupied redds to actual or potential cover.

Distance (feet)	Frequency
0-24	21
25-49	19
50-74	24
75-99	12
100-124	8
125-149	6
150-174	5
175-199	1
200-224	2
225-249	0
250-274	1
Total	99

Environmental Monitoring

Most impacts noted over the last three years fall into a few general classes: (1) removal or destabilization of potential spawning gravel, either by gravel mining or construction of temporary bridges; (2) poor management of cattle crossings and watering areas, leading to accelerated erosion and possible siltation of gravel beds; (3) placement of riprap to retard erosion of farmlands and homesites, with consequent loss of gravel recruitment; (4) major water withdrawal during summer low flow in the North Fork Newaukum for the cities of Centralia and Chehalis; (5) a large landslide on the North Fork Newaukum upstream of the spring chinook spawning area, and (6) clearcutting down to the streambank in the upper mainstem.

New incidents of environmental damage this year included (1) a gravel removal operation at RM 4.0 on the North Fork Newaukum and (2) a manure spill near RM 8.5 on the South Fork Chehalis. The manure settled out over most of the potential spawning area in the South Fork Chehalis, thus making an already rather poor spawning ground even less suitable for spring chinook production.

CONCLUSIONS

1. Escapement of spring chinook in 1984 was 1,060 fish. This was well below the total Chehalis River system goal of 1,400. Nonetheless, escapements have been increasing over the last five years.

2. Spawning distribution in the upper Chehalis appears largely controlled by two partial blocks to adult passage, one at RM 108.0 and the other at Fisk Falls (RM 114.5). The block at RM 108.0 appears to be a problem in very low water years such as 1984. It might be alleviated temporarily by rearranging the boulders there. Fisk Falls, at RM 114.5, is probably impassable for spring chinook except in relatively high water years such as 1983. No means appear feasible to improve low flow passage at this site.

3. Observed spawning distribution over the last three years has verified the WDF's assumptions on actual distribution of spawning in the watershed. This suggests that the factor formerly used to expand Skookumchuck redd counts to represent the rest of the watershed was reasonable.

4. The individual escapement goals for various parts of the system do not correspond well to the observed distribution of spawning. However, our evaluation of the degree of habitat use in past years suggests the total escapement goal for the system is reasonable.

5. Spring and fall runs are well enough separated in time and

area to permit accurate evaluation of spring run escapement. However, there is some evidence for fall chinook spawning on top of spring run redds in the Skookumchuck index area.

6. Age composition changed considerably this year, with five-year-old fish predominating instead of four-year-olds as in the previous two years.

7. We now have good information on the spawning habitat utilization in terms of depth and current velocity. We also have a fair idea of utilization of gravel size, cover type, and distance to cover from the redd.

8. Many incidents of degradation of the potential spawning habitat have been observed over the course of FWS spawner surveys. Gravel mining and poorly managed cattle access in the Newaukum system may removing, destabilizing, and silting-in potential spawning areas. Moreover, riprapping in the South Fork Newaukum is shutting off sources of new gravel.

RECOMMENDATIONS

1. Index areas should be maintained in the Newaukum system and upper mainstem Chehalis to insure accuracy of escapement estimates. The Chehalis Tribe is now capable of carrying out this function.

2. Escapement in the upper mainstem below Pe Ell should be carefully monitored in coming years to see whether the moderately heavy spawning observed there this year is typical or if it was the result of passage problems at the cascades upstream.

3. Escapement to the Chehalis index area above the cascades at RM 108 should be monitored to assess the effect of planned WDF modification of the cascade in the summer of 1985.

4. The effects of low summer flows on North Fork Newaukum spring chinook escapement should be investigated. This would consist of (1) looking at summer discharge as related to annual escapement; (2) determining if flows in these years have fallen below limits set on the City of Chehalis water withdrawal facility, and (3) deciding if instream flow methods would be appropriate to determine adequate discharge requirements for spring chinook spawning there.

5. Installation of a weir at the lower end of the Skookumchuck index area should be considered to protect spring chinook redds from superimposition of redds by fall chinook spawners.

6. A program of freshwater salmonid habitat restoration should be initiated. FWS might (1) identify areas most in need of restoration in conjucntion with the Chehalis Tribe, WDF, and the U.S. Soil Conservation Service; (2) participate in constructing habitat improvements; (3) determine which, if any, improvements can be monitored in terms of gravel composition,juvenile salmonid abundance, spawner density, or other parameters; and (4) determine the practicality of monitoring the habitat improvements now in place in WDF's bank protection program.

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APPENDIX I: 1984 SPAWNER SURVEY DATA

Location	Type	River Mile Lower	River Mile Upper	Date	Redd Count New	Redd Count Vis.	Redd Count Cum.
Skookumchuck	Index	18.5	22.0	9-4	(a)	13	(a)
				9-12	13	13	13
				9-13	(a)	15	(a)
				9-19	12	24	25
				9-26	11	(a)	36
				10-3	6	38	42
				10-10	10	39	(b)
				10-26	(a)	98	(b)
	Supp.	0.0	10.9	9-19		21	
				10-3		41(c)	
				11-1		99(b)	
	Supp.	10.8	18.5	9-13		17(d)	
				10-3		38	
	Supp.	14.6	18.5	9-13		12	
				9-27		38	
				10-26		50(b)	
South Fork Newaukum	Index	23.1	30.3	8-30	7	7	7
				9-10	53	58	60
				9-19	10	42	70
				9-28	4	42	74
				10-8	3	42	77
				10-22	0	39	77
				11-1	1	17	(b)
	Index	13.7	23.1	9-18	44	44	44
				10-3	36	77	78
				10-23	7	67	84
South Fork and Mainstem Newaukum	Supp.	7.7	13.7	10-18		15(e)	
Mainstem Newaukum	Supp.	4.2	7.7	9-25		2	
North Fork Newaukum	Index	0.3	6.8	8-31	2	2	2
				9-11	2	2	4
				9-20	12	13	16
				10-1	19	31	35
				10-16	1	27	36
				10-30	5	17	(b)

Appendix I Continued.

Location	Type	River Mile Lower	River Mile Upper	Date	Redd Count New	Redd Count Vis.	Redd Count Cum.
South Fork Chehalis	Supp.	5.0	8.5	10-4		0	
Stillman Creek	Supp.	0.0	4.1	10-9		0	
Chehalis River	Index	108.7	113.5	9-7	0	0	0
				9-17	4	4	4
				9-26	1	5	5
				10-9	3	8	8
	Index	100.3	106.2	9-26	40	40	40
				10-5	13	49	53
				10-12	4	22	59
				10-25	31	38	(b)
	Supp.	117.0	119.0	9-26		0	
	Supp.	94.3	97.0	10-15		2	
	Supp.	44.1	66.4	9-14,17		6(f)	
				10-2		14(f)	
	Supp.	42.3	53.0	10-25		59(f)	
Elk Creek	Index	0.0	1.5	9-14	2	2	0
				9-21	4	6	6
				9-28	2	8	8
				10-4	1	9	9
				11-1	(a)	3(b)	(a)

(a) Not counted.
(b) Fall run has begun spawning.
(c) Also observed 7 redds attributed to fall chinook.
(d) Most redds occurred between RM 14.6 and 18.5.
(e) Considerable overlap occurred between fall and spring run spawning. Total spring chinook redds were estimated as (Total redds) X (Occupied spring chinook redds / Total occupied redds).
(f) WDF considers all lower mainstem spawners to be fall run. They are not included on our estimate of escapement.

APPENDIX II: ESCAPEMENT TO VARIOUS PARTS OF THE CHEHALIS WATERSHED, 1981-84

Location	81	82	83(a)	84
Skookumchuck River	187(a)	217(a)	350	322
Newaukum system	177(b)	170(c)	447	542
South Fork Chehalis system	0	10(d)	81	0
Upper Mainstem Chehalis	112(e)	71(f)	254	172
Elk Creek	8(a)	42(a)	40	22

(a) Source: WDF records.
(b) Peak visible redds in South Fork Newaukum indes X mean 1982-84 cumulative-to-peak ratio X mean 1983-84 total-to-index ratio for South Fork and mainstem Newaukum X 2.5 fish per redd. We did not expand to account for North Fork Newaukum because no escapement was observed there in a survey early in October, 1981.
(c) (Cumulative redds in South Fork Newaukum index X mean 1983-84 total-to-index ratio for South Fork and mainstem Newaukum + cumulative redds in North Fork Newaukum) X 2.5 fish per redd.
(d) Peak visible redds in Stillman Creek X mean 1983-84 cumulative-to-peak ratio for upper mainstem Chehalis X 2.5 fish per redd. No redds were observed in the South Fork Chehalis survey in 1982.
(e) (Total escapement - Elk Creek escapement) X mean 1983-84 ratio of upper mainstem Chehalis escapement to (total - Elk Creek).
(f) Peak visible redds in upper mainstem X mean 1983-84 cumulative-to-peak ratio X mean 1983-84 total-to-index ratio X 2.5 fish per redd.

Appendix III. Spring chinook spawning habitat measurements, 1982-1984.

Stream	Year	Depth (ft)	Velocity (fps)	Substrate size (cm)	Cover Type Instream	Cover Type Streamside	Cover Distance from redd (ft)
Skookumchuck	82	1.0	0.9	3	SL	OHL	26
		1.0	2.1	6		OHV	13
	83	1.6	2.3	5	SL	OHL	12
		1.7	2.8	3		OHV	6
North Fork Newaukum	82	0.7	0.4	8		UCB	6
	83	0.8	1.4	7			a/
		0.7	1.4	8			a/
		1.2	1.4	7	P		41
		1.5	1.1	5	P	OHT	55
		1.0	0.9	5	P	OHT	115
	84	0.5	1.0	5	P		112
		0.4	0.6	5	P		56
		0.6	1.0	3	P		78
		0.6	1.1	3	P	UCB	87
		1.4	0.4	8	P	UCB	60
		0.6	0.3	5	P		34
		0.9	0.3	8	P	UCB	54
		0.4	0.6	5	P		0
		0.6	0.8	8	P		50
		0.4	0.2	8	P	OHT	146
		0.6	0.7	5		UCB	26
		0.3	1.3	10		UCB	61
		0.6	1.8	8	SL		26
		0.9	0.3	5		UCB	71
South Fork Newaukum	82	0.9	0.8	b/		OHV, UCB	6
		0.9	1.7	b/		OHV	0
		0.6	2.8	b/		OHV	0
		0.6	1.6	b/	SL	OHL	6
		0.5	1.6	b/	SL	OHL	6
	83	0.9	1.3	8		OHL	97
		0.6	1.6	4	SR,SL	OHL	28
		0.8	2.1	3		UCB	82
		1.0	3.1	5		OHL	38
		0.8	1.5	4	SL	UCB	52
		0.8	2.2	3		UCB	90
		0.8	2.1	3	SR		47
		1.1	1.6	10	P	OHT	73
		0.9	2.1	7			a/
		0.9	2.4	9	SL	OHL	135
		1.1	2.0	4			a/
		0.8	2.4	9		OHT	51
		1.2	0.7	2		UCB, OHT	250

Appendix III (continued)

Stream	Year	Depth (ft)	Velocity (fps)	Substrate size(cm)	Cover Type Instream	Cover Type Streamside	Cover Distance from redd (ft)
South Fork Newaukum	83	0.8	0.9	11		NCB	62
		1.5	2.5	11		UCB, OHT	160
	84	0.8	2.0	5		UCB	100
		1.1	2.0	10		UCB	28
		0.8	1.3	6		UCB	37
		1.2	1.7	10		UCB	52
		1.2	1.7	10		UCB	105
		0.7	1.3	10		UCB	132
		1.0	1.5	5	P		80
		0.7	2.1	8	P		139
		0.8	2.0	8	P		162
		1.0	1.6	5	P		61
		0.8	0.8	5		UCB	b/
		1.0	1.4	10		UCB	46
		1.0	0.9	4	P		56
		0.7	1.6	10			a/
		0.4	0.7	10	P		61
		0.8	1.1	10	P		126
		1.0	1.2	10		OHV	3
		1.1	1.4	10		OHV	4
		0.8	1.4	8		OHV	63
		0.8	1.3	8		OHV	69
		0.6	1.0	10			a/
		0.6	1.0	8	P		161
		0.9	1.4	8	P		153
		1.0	1.6	5		OHV	6
		0.5	1.5	10		UCB	29
		0.6	1.0	10		UCB	40
		0.4	0.9	5	P		69
		0.7	1.7	10		UCB	78
		1.0	1.8	10	P		129
		0.6	2.1	b/	P	UCB	155
		0.6	1.1	10		OHL	93
		0.5	0.6	10		OHL	62
		1.0	1.0	8			a/
		0.6	1.3	5		OHL	98
		0.6	1.6	5		OHL	52
Chehalis	82	1.2	1.6	2		OHV	92
		0.4	1.9	7		OHV	98
		0.7	1.4	2		OHV	82
	83	1.0	1.1	3	P		70
		1.1	1.1	6		UCB	9
		0.8	1.5	8		OHL	108
		0.8	1.6	10		OHL	40
		1.0	2.2	9		OHL	9

Appendix III (continued)

Stream	Year	Depth (ft)	Velocity (fps)	Substrate size(cm)	Cover Type: Instream	Cover Type: Streamside	Cover: Distance from redd (ft)
Chehalis	83	0.7	1.4	10	B		4
		0.8	2.1	7	B		10
		1.0	0.9	4	P	OHT	87
		0.8	2.5	7	P		63
		0.6	1.9	7	B	OHT	210
		0.7	2.8	10	B	OHT	200
		1.0	2.1	9	B	OHT	190
		1.2	1.7	11		OHT	0
		1.3	2.2	7		OHT	46
		0.9	1.0	2			a/
		1.4	0.8	7	P		100
		2.0	0.7	4	P		10
		1.2	1.0	2	P		100
		0.8	1.1	3			a/
		0.6	1.8	7	B		55
		1.4	1.3	12		OHT, UCB	12
		1.0	1.2	12	B		100
		b/	b/	5		OHT	36
		b/	b/	7		UCB, OHV	25
	84	1.8	2.8	6			a/
		1.8	2.4	6			a/
		1.5	3.3	8			a/
		0.4	1.8	8	P	OHV	33
		1.0	2.1	7			a/
		1.8	2.6	9			a/
Total measured		111	111	107	113	113	99

a/ Not applicable
b/ Not measured

Key to cover types:

- SL Submerged log(s)
- P Pool
- SR Submerged roots
- B Boulder(s)
- OHL Overhanging log(s)
- OHV Overhanging brush or grass
- UCB Undercut bank
- OHT Overhanging tree(s)