Fall Chinook Salmon Spawning Escapement Estimate for a Tributary of the Smith River, California

Second Interim Report
(1980-1987)

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FALL CHINOOK SALMON SPAWNING ESCAPEMENT ESTIMATE FOR A TRIBUTARY OF THE SMITH RIVER, CALIFORNIA: SECOND INTERIM REPORT

INTRODUCTION

In the fall of 1980 a salmon spawning escapement study was started on the West Branch Mill Creek, a major fall chinook salmon (Oncorhynchus tshawytscha) spawning tributary of the Smith River, Del Norte County, California. The purpose of this 10 year study and a description of the study section was detailed by Waldvogel (1985). The study is being conducted through the University of California Cooperative Extension office in Crescent City, California.

This report analyzes the data collected during the past eight salmon spawning seasons (1980-1987). The intent of the chinook spawning escapement study was to monitor the population over a ten year period. However, the recent development of a large California State Correctional Facility (Pelican Bay State Prison) in Del Norte County has necessitated an extension of the study.

Pelican Bay Prison will be discharging sewage effluent from the facility into holding ponds in the Smith River flood plain. The effects that the tertiary treated wastewater will have on anadromous fish in the Smith River system are not known. In light of this development, the author will continue this chinook escapement study for another 10 year period.

Interim reports will be completed every four years to document the monitoring of the chinook salmon spawning population in the West Branch Mill Creek drainage. The 20 year spawning study will identify any sudden population changes in the number of spawners utilizing Mill Creek.

SAMPLING METHODS

The 1.7 mile study section of the West Branch Mill Creek was chosen because of its historic chinook salmon spawning pattern and accessibility. The stream has excellent chinook spawning densities and consistent "run" returns. The West Branch can be surveyed easily when flows drop below 150 c.f.s. The creek clears quickly and flows of 70-100 c.f.s. are common during the winter months.

Surveys were conducted once a week (flow rates permitting), starting with the heavy rains in November and continuing through February. Live chinook sighted during surveys were listed as males, females, unknown adults, or jacks. No attempt was made to mark or bother live, spawning salmon. Other species of salmonids (coho and chum salmon, or steelhead) seen spawning were noted.

Data collected during the weekly spawning surveys included: stream flow rate (c.f.s.), water clarity (visual), weather conditions, water temperature (^{o}F), number of live chinook seen, number of carcasses recovered, skeletons noted, and the number of fresh redds. All carcasses were jaw-marked using hog rings with colored flagging and sexed, fork length (cm) was measured, and scales were sampled (except in 1980). No carcasses were weighed, but all chinook were checked for fin clips, hook scars, and completeness of spawning.

The annual spawning estimates of chinook salmon were determined by using combination counts of live fish and carcasses. This method was described by Waldvogel (1985) and provides "minimum" spawning escapement estimates. Since the purpose of the long-term research project is to annually compare relative spawning escapement estimates, the total spawning population was not estimated.

RESULTS AND DISCUSSION

Spawning surveys of West Branch Mill Creek began each season with the heavy rains in November and concluded in February/March when the last spawning fall chinook were observed. Table 1 lists the number of surveys conducted each season.

Table 1: Number of spawning surveys conducted on the West Branch Mill Creek in 1980-1987

Season	Surveys Completed	Unsurveyable Weeks	Inclusive Dates
1980	12	2	Nov. 25-Feb. 10
1981	11	3	Nov. 6-Jan. 25
1982	9	4	Nov. 22-Feb. 3
1983	9	5	Nov. 28-Feb. 27
1984	13	4	Nov. 13-Mar. 7
1985	12	5	Oct. 30-Feb. 28
1986	11	1	Nov. 24-Feb. 20
1987	12	2	Dec. 4-Mar. 3

Chinook Spawning Escapement

Adult chinook salmon counts were separated from jack counts so spawning escapement results from Mill Creek could be compared to Oregon coastal stream estimates (McGie, 1981-1982). Table 2 summarizes the minimum spawning escapement estimates of fall chinook in the study section for the past eight seasons, 1980-1987.

The minimum spawning escapement estimates of adult fall chinook salmon for 1980-1987 range from 59.0-91.1 fish/mile for the West Branch. The spawning escapement of jacks shows a wide density range (7.0-34.1 fish/mile). Regressions have

Table 2: Minimum spawning escapement estimates of fall chinook salmon in the West Branch Mill Creek study section (1980 - 1987). *

	1980	1981	1982	1983	1984	1985	1986	1987
Total Chinook Observed	128	107	155	110	111	185	180	153
m = males	28	35	36	37	42	53	55	59
f = females	43	44	42	45	42	84	59	59
? = unknown adults	14	13	36	15	13	18	8	12
j = jacks	43	15	41	13	14	30	58	23
Adults (fish/mile)	50.0	54.1	67.0	57.0	57.0	91.2	71.8	76.5
Jacks (fish/mile)	25.3	8.8	24.1	7.6	8.3	17.6	34.1	13.5
Total Chinook Salmon (fish/mile)	75.3	62.9	91.1	64.6	65.3	108.8	105.9	90.0

* The study section of West Branch Mill Creek is 1.7 river miles.

shown that no relationship exists between the number of jacks returning in one year and the resulting number of adults returning in subsequent years (r^2=.007). This indicates that jack counts cannot be used to reliably predict subsequent spawning escapement in the Mill Creek system.

Results of the West Branch spawning estimates (Table 2) for the eight seasons are very similar to fall chinook spawning densities of "good" Oregon coastal index streams as defined by McGie (1981). McGie estimated the average number of chinook spawners in eleven standard index streams from 1970-1981. The range of Oregon adult chinook spawners varied from 39.5 to 81.5 fish/mile, and jack counts ranged from 5.4 to 22.8 fish/mile.

The highest number of adult chinook spawners occurred in Mill Creek in 1985, and since that time adult returns have exceeded any returns during 1980-1984. This sudden increase in returning adults may be attributed to two factors. First, ocean conditions improved dramatically for the survival of salmon after the 1983-1984 El Niño occurrence, as evidenced by the rapid recovery of salmon populations all along the Pacific Coast after the El Niño condition passed. Second, the Pacific Fisheries Management Council (PFMC) instituted severe fishing regulations on the commercial salmon fleet in 1983. In the Klamath Management Zone (KMZ) not one day of commercial fishing was allowed. Since that time, fishing by commercial vessels has been allowed, but with very restricted seasons.

The sudden increase in chinook salmon escapement into the Mill Creek system reflected both factors. It is not possible to determine which factor (El Niño decline, or commercial fishing regulations) had the greater effect on the escapement, since each occurred simultaneously. However, a strong recovery after El Niño does not explain why returns were also better than the 1980-1983 returns, before El Niño occurred.

The male to female ratio of adult chinook spawners in the West Branch was compared for eight seasons. During two years there were equal numbers of male and female spawners; in all other years females were more abundant. These ratios were consistent with results from other fall chinook spawning research studies (Nicholas and Downey, 1983; Burck and Reiners, 1978). The male to female ratios in the West Branch Mill Creek for 1980-1987 were:

1980 - 1.0/1.4	1984 - 1.0/1.0
1981 - 1.0/1.2	1985 - 1.0/1.5
1982 - 1.0/1.1	1986 - 1.0/1.1
1983 - 1.0/1.2	1987 - 1.0/1.0

Age Structure

Scale samples were taken from all fresh chinook carcasses recovered during 1981-1987 seasons. The age of each chinook salmon was determined using methods described by Waldvogel (1983, 1984a). Every chinook was classified as a wild or hatchery reared salmon using scale growth patterns.

Table 3 lists the percent age composition of male and female fall chinook scale sampled in the study section from 1981-1987. The results of seven spawning seasons indicated that the West Branch "run" was dominated by 4-year-old females, with varying numbers of 3-year and 5-year-old fish. The male spawning component showed a high degree of variability in its age structure. Chinook of age 2, 3 and 4 were dominant annually, but age 5 and 6 fish were present in most spawning seasons. No female spawners were found during any of the seasons that were age 2 or 6.

Table 3 : Percent age composition of male and female fall chinook salmon scale sampled in the West Branch Mill Creek study section (1981 - 1987).

FEMALES : Age					YEAR	MALES : Age				
2	3	4	5	6		2	3	4	5	6
0	11	78	11	0	1981 n = 73 salmon	7	28	21	41	3
0	39	58	3	0	1982 n = 55 salmon	27	14	41	9	9
0	54	35	11	0	1983 n = 56 salmon	25	47	21	7	0
0	29	68	3	0	1984 n = 52 salmon	14	43	43	0	0
0	11	72	17	0	1985 n = 119 salmon	45	8	36	9	2
0	26	52	22	0	1986 n = 97 salmon	65	9	7	15	4
0	19	68	13	0	1987 n = 91 salmon	39	30	21	6	4

The age composition of the West Branch chinook salmon population is very similar to that of other coastal southern Oregon rivers (Nicholas and Hankin, 1988). The population seems to be a mid-maturing stock, as defined by Nicholas and Hankin, being dominated by age 4 females and age 3, 4, 5 males. Southern Oregon rivers that show this similar age structure include the Sixes, Elk, Pistol, Chetco and Winchuck.

Waldvogel (1985) speculated that the high percentage of 3-year-old chinook salmon spawning in 1983 may have been a result of the oceanographic stress conditions caused by El Niño. It is apparent from Table 3 that this indeed was an abnormal occurrence. It should be noted that the female portion of the population reflected this stress to a greater degree than the male component.

Hatchery Salmon

Rowdy Creek Fish Hatchery planted yearling chinook salmon smolts in the West Branch from 1977-1982. These plantings were part of their salmon enhancement efforts within the Smith River system. The 1985 report lists numbers of chinook released and fin marks used. Adults from these plants appeared in the spawning chinook population from 1981-1986 and are enumerated in Table 4.

Table 4: Percentage and number of hatchery chinook spawning in the West Branch Mill Creek study section from 1981-1987.

Year	Chinook Sampled	Hatchery Fish	Percent
1981	73	12	16.5
1982	55	10	18.2
1983	56	12	21.4
1984	53	19	36.5
1985	119	9	7.5
1986	87	4	4.7
1987	61	0	0.0

The returns of hatchery chinook to the West Branch Mill Creek increased gradually from 1981-1984 (although the sample size decreased). In 1985 the number of hatchery chinook in the system decreased dramatically. There were several possible explanations for this decrease.

The last of the Rowdy Creek smolts released in the West Branch in 1982 were reaching their peak spawning ages in 1984 and 1985. El Niño conditions of 1983-84 caused coastwide stress in all chinook populations, but wild salmon smolts seemed to be more severely affected than hatchery smolts (Nicholas and Hankin, 1988). However, many hatcheries experienced an abnormal number of chinook returning at an earlier age due to this stress (personal communications with ODFW & CDFG hatchery managers).

Rowdy Creek Hatchery had a high percentage of 3-year-old, small adults in 1983 and 1984 (Hatchery Biologist, personal comm., 1985). After the El Niño condition disappeared in 1985, most coastal chinook streams showed an increase in wild chinook spawners (Nicholas and Hankin, 1988).

The combination of stressful El Niño conditions decreasing wild chinook stocks, the better survival but earlier return of hatchery adults in 1983-84 to the system, the age group losses in 1985-87 of hatchery chinook returning, and the sudden increase in 1985 of wild chinook survival, may be some of the reasons for the percentage decrease in hatchery returns to the West Branch. After 1986, the West Branch system should be indicative of the wild chinook stream it was before the 1977 hatchery plantings.

Chinook Salmon Growth

All chinook salmon carcasses from which scales were collected were also measured for fork length (cm). Average fish lengths are listed in Tables 5 & 6 for 1981-1987 seasons. Growth differences occurred consistently for all seven seasons in two major categories.

Table 5 : Average fork length (cm) at age for female chinook salmon scale sampled in the West Branch Mill Creek study section, 1981 - 1987.
(W = wild, H = hatchery, standard deviations are given in parentheses)

YEAR	AGE					
	3		4		5	
	W	H	W	H	W	H
1981	81.3 (7.1)	76.7 (2.5)	90.2 (4.6)	82.6 (5.3)	97.3 (3.8)	93.5 (6.4)
1982	90.4 (6.6)	-	93.7 (5.1)	90.2 (3.8)	104.1 (0.0)	-
1983	78.8 (8.4)	70.1 (5.3)	92.9 (11.7)	-	-	95.3 (3.3)
1984	79.0 (6.4)	73.2 (2.8)	89.2 (3.8)	83.3 (5.1)	99.1 (0.0)	-
1985	87.4 (4.6)	-	90.4 (5.1)	-	97.3 (5.3)	96.0 (7.1)
1986	78.0 (7.4)	73.2 (1.0)	90.2 (4.3)	-	104.9 (3.6)	-
1987	75.4 (6.6)	-	89.4 (3.8)	-	99.6 (5.6)	-

Table 6 : Average fork length (cm) at age for male chinook salmon scale sampled in the West Branch Mill Creek study section, 1981 - 1987.
(W = wild, H = hatchery, standard deviations are given in parentheses)

YEAR	AGE									
	2		3		4		5		6	
	W	H	W	H	W	H	W	H	W	H
1981	54.6 (1.8)	-	80.8 (5.6)	68.1 (1.0)	97.0 (5.8)	-	107.2 (5.6)	100.8 (8.1)	114.3 (0.0)	-
1982	52.6 (10.2)	52.1 (0.0)	88.9 (2.5)	-	103.1 (3.3)	91.4 (0.0)	115.6 (5.3)	-	-	108.7 (4.6)
1983	55.9 (0.0)	47.2 (6.4)	76.2 (11.9)	58.4 (0.0)	101.6 (6.4)	78.7 (0.0)	111.8 (0.0)	109.2 (0.0)	-	-
1984	44.4 (1.3)	-	70.4 (8.1)	63.5 (0.0)	89.9 (8.9)	86.9 (6.4)	-	-	-	-
1985	52.8 (3.8)	-	74.2 (7.6)	-	97.5 (7.1)	-	109.7 (3.8)	-	124.5 (0.0)	-
1986	51.1 (6.4)	48.8 (4.6)	76.2 (7.4)	-	93.7 (7.9)	-	104.4 (6.8)	-	111.8 (0.0)	-
1987	54.4 (5.8)	-	74.9 (8.4)	-	92.5 (4.1)	-	102.4 (3.8)	-	120.6 (1.8)	-

Average fork lengths for male chinook were longer than female chinook in every age class except 3-year-olds. Also, the average fork length for all male and female wild chinook salmon exceeded the average fork length for hatchery chinook of corresponding age groups and year classes for every season. These observations indicate that Rowdy Creek Hatchery chinook consistently return as smaller fish than Smith River wild chinook for all age classes and each sex.

Redd Counts

Fresh chinook redds were counted during each weekly survey, and the total number of redds each season was tabulated. Two statistics were determined from this count utilizing the total number of adult chinook salmon seen spawning in the study section: redds per adult salmon and redds per female salmon.

These statistics have been developed to see if redd counts can be used as a valid, long-term spawning estimate for a small tributary stream. It was noted during all eight spawning seasons that some adult chinook salmon dig "false" redds prior to spawning and after completing a spawn. Table 7 lists the chinook salmon redd counts in the West Branch study section at the completion of each spawning season.

The average redd counts for the eight seasons were 1.4 redds/adult salmon and 2.5 redds/female salmon. Regressions indicate that the estimate of redds/adult salmon and redds/female salmon may not be a usable statistic to determine spawning counts in a small tributary like the West Branch (redds/adult, r^2=.28; redds/female, r^2=.31). However, the occurrence of different storm events each year make redd counts difficult at times. Redd counts will continue to be tabulated in future spawning seasons to determine if this statistic is usable.

Table 7 : Chinook salmon redd counts tabulated at the completion of each spawning season, 1980 - 1987.

YEAR	# Redds counted	Redds / adult salmon	Redds / female salmon
1980	84	1.0 (85 adults)	1.7 (50 females)
1981	153	1.7 (92 adults)	3.1 (50 females)
1982	236	2.1 (114 adults)	3.9 (60 females)
1983	139	1.4 (97 adults)	2.7 (52 females)
1984	135	1.4 (97 adults)	2.8 (49 females)
1985	224	1.4 (155 adults)	2.4 (93 females)
1986	126	1.0 (122 adults)	2.0 (63 females)
1987	110	0.85 (130 adults)	1.7 (65 females)

Hook Scars

The presence of hook scars on chinook carcasses was recorded for each fish sampled in the 1981-1987 seasons (Table 8).

Table 8: Number and percentage of hook scars on chinook sampled in West Branch Mill Creek in 1981-1987)

Season	#Chinook Sampled	#Chinook With Hook Scars	% Hook Scars
1981	73	5	6.8
1982	55	1	1.8
1983	56	3	5.4
1984	52	3	5.8
1985	119	8	6.7
1986	97	4	4.1
1987	91	7	7.7

The average percentage of hook scars in chinook salmon sampled for the entire seven seasons was 5.7%. The percentage of hook scars appearing in the West Branch spawning population has been fairly consistent and is similar to results of other researchers looking at wild chinook populations. (Bender, 1975; McGie, 1981; and personal communications, Calif. Dept. Fish & Game Biologists, Klamath River).

Hook scars are the result of chinook salmon that have escaped hooking by the ocean commercial and sport fisheries. The scars indicate the contact of Smith River wild chinook populations by these fisheries, but no estimates can be made of the extent of the impact.

Timing of Chinook Runs

Eight seasons of chinook salmon spawner sampling have verified that there are three distinct runs of fall chinook salmon into the West Branch Mill Creek. The timing of these runs was described by Waldvogel (1985) and some minor variations have appeared since that report.

The three distinct runs of fall chinook entering the West Branch are described below:

Run #1 - enters the study section during mid-November and lasts until mid-December. In the 1980-1983 seasons, this run comprised the second largest number of spawning chinook for each season. During the 1984-1987 seasons, the first run had the largest number of chinook spawners.

Run #2 - enters the study section during late December and lasts until mid-January. In 1980-1983 this run had the largest number of spawners; in 1984-1987 this run had the second largest number of spawners.

Run #3 - enters the study section in late January and lasts until mid-February. This run is always characterized by a small number of spawners and very few jacks. The third run usually spawns in mixed association with the first steelhead spawners.

The three distinct chinook runs had some overlap time during several seasons which were dependent on stream flows during time of return. However, the time of return for all runs each season did not vary by more than one week if sufficient stream flows were present.

There were several periods of distinct low rain and stream flow patterns that seemed to affect specific runs of chinook during several seasons. These are noted below for future reference.

1983 season - Little rain (less than 2") from December 29-February 10. The second run of chinook reached the study section and spawned. The third run was greatly delayed by low flows and only 4-5 salmon were observed when the run finally arrived.

1984 season - Another long period of dry weather during December 15-February 10 (less than 1" rain). The second run was able to use only the lower ¼ mile of the study section and most of the run spawned below that point. The third run was delayed several weeks and when rain finally came only a small number of spawners (8-10 fish) were detected.

1985 season - Plenty of water all season. However, a major flood period occurred in February. The West Branch flows may have reached 2,000 c.f.s. Many of the December chinook redds seemed to be damaged and the creek changed course in several locations.

1986 season - Low rain periods in January and February may have limited the number of chinook spawners entering the study section for the second and third runs. Both counts were low and mild rainfalls were very erratic.

1987 season - Almost no rain until December 1. The first run was late, but the number of spawners was high. However, many fish may have spawned below the study section prior to the first big rains. There was only 2"-3" of rain during the months of February and March. The third run of chinook spawners was not able to enter the study section due to low flows. (No chinook observed.)

COMMENTS

Other Salmonid Species Observed

Silver Salmon - Oncorynchus kisutch

The Smith River system does not have large numbers of silver salmon spawners. However, each spawning season silver salmon have been observed in the West Branch study section. Table 9 lists the number of silver salmon and dates of spawning for the 1980-1987 seasons.

Time of spawning was consistent each season. Silver salmon entered the West Branch in late December and were spawned out by late January. This silver run was frequently concurrent with the second chinook salmon run that entered the study section.

In the 1987 season an unusual run of silver salmon spawners appeared with the first run of chinook salmon. Scale samples indicated that all 14 salmon were of hatchery origin. This was the first time in eight seasons that silver salmon appeared in early December in the West Branch.

Rowdy Creek Fish Hatchery had released 22,000 silver salmon smolts two years earlier. They were expecting a good return from those smolts as 3-year-olds in 1987. The hatchery trapped very few adults during the early December high water. It appears that much of this silver salmon run may have bypassed Rowdy Creek, continued up the mainstem Smith River, and distributed itself in tributaries like Mill Creek. None of the silver salmon were fin-clipped on smolt release, but all showed hatchery growth patterns.

Chum Salmon - Onchorynchus keta

No chum salmon were observed spawning in the West Branch Mill Creek study section during the 1980-1983 seasons. However, chum salmon were observed spawning in the 1984 season and have been noted each season since then. Their time of return was coincidental with the first run of chinook salmon and occurred during the first three weeks of December.

Table 9 : The number of silver salmon observed spawning in the West Branch Mill Creek study section, 1980 - 1987.

YEAR	Number of Salmon / Spawning Dates
1980	11 salmon (wild)- 5 males, 2 females, 4 jacks (Dec.23 - Jan.14)
1981	2 salmon (wild)- 1 male, 1 jack (Jan.10 - Jan.25)
1982	4 salmon (wild)- 1 male, 2 females, 1 jack (Dec.26 - Jan.8)
1983	3 salmon (wild)- 1 male, 2 females (Jan.7 - Jan.13)
1984	6 salmon (wild)- 3 males, 2 females, 1 jack (Jan.4 - Feb.27)
1985	28 salmon (wild)- 12 males, 13 females, 3 jacks (Dec.20 - Feb.7)
1986	11 salmon (wild)- 3 males, 5 females, 3 jacks (Dec.8 - Jan.26)
1987	27 salmon (two distinct runs)
	1st run - 14 salmon (hatchery)- 5 males, 7 females, 2 jacks (Dec.16 - Jan.4)
	2nd run - 13 salmon (wild)- 8 males, 4 females, 1 jack (Jan.13 - Feb.2)

The following chum salmon numbers were observed during the 1984-1987 seasons:

1984 - 4 salmon (2 males, 2 females)
Dec. 8-Dec. 20

1985 - 2 salmon (1 male, 1 female)
Dec. 13-Dec. 20

1986 - 8 salmon (3 males, 5 females)
Dec. 8-Dec. 23

1987 - 1 salmon (1 female)
Dec. 16

The chum salmon run seemed to be a very small run of fish. Their presence did not appear to be in conflict with chinook or silver salmon runs.

Steelhead - Salmo gairdneri

A large number of steelhead trout spawned in the West Branch Mill Creek each season. They first appeared in the study section in February and were found spawning throughout May. No complete seasonal counts of steelhead spawners were made in the West Branch. However, the number of adults spawning in the study section may be equal to the chinook salmon spawnings.

Cutthroat Trout - Salmo clarkii

Sea run cutthroat trout and resident cutthroat trout resided in the west Branch. No signs of spawning cutthroats were noted during the chinook spawning surveys.

Spawning Gravel Utilization

The study section of the West Branch is considered excellent chinook spawning habitat (CDFG Habitat Survey, 1977 and CH_2M Hill Report, 1980). Table 2 shows that the West Branch has exceeded 50 salmon/mile spawning densities each of the eight sampling seasons. However, the chinook presently spawning in the creek seem to utilize only the best spawning locations.

The increase in chinook spawners in 1986-1987 increased the spawning densities in the system, yet large sections of good spawning gravel in the creek were not utilized. This continuing occurrence indicates that the West Branch Mill Creek has not reached maximum spawning densities for chinook salmon. Chinook salmon spawn throughout long reaches of Oregon coastal river basins, but the species is characterized by dense aggregations of spawners in short stream reaches rather than by an even distribution of spawners throughout the river basin. (Nicholas & Hankin, 1988).

Predators

The West Branch clears very quickly and the number of animal predators was high. Bear, weasel, raccoon, otter and heron were major predators of chinook carcasses. All season there were continuous signs of these natural predators removing salmon from the stream banks. This is a major problem in obtaining accurate total spawning counts in the West Branch. Human predators were not a problem in the study section.

Behavioral Spawning Observations

Several chinook spawning habits were noticed on a regular basis each season. These behavioral patterns are not well documented in the literature and are mentioned here for future reference:

1. Single adult male chinook salmon were observed spawning with two or three adult female chinook.

2. Two-four jack salmon were frequently seen spawning with single female adult chinook.

3. Whenever adult males were present with a female chinook, they aggressively chased away all jack salmon.

4. Spawning pairs of adult salmon occasionally dug two or three redds that were 10 to 30 yards upstream or downstream from each other.

5. Chinook salmon and silver salmon were never seen spawning in close proximity to each other.

6. Spawning behavior (redd digging and in-stream location of salmon) was dramatically different between sunny days and cloudy overcast days.

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