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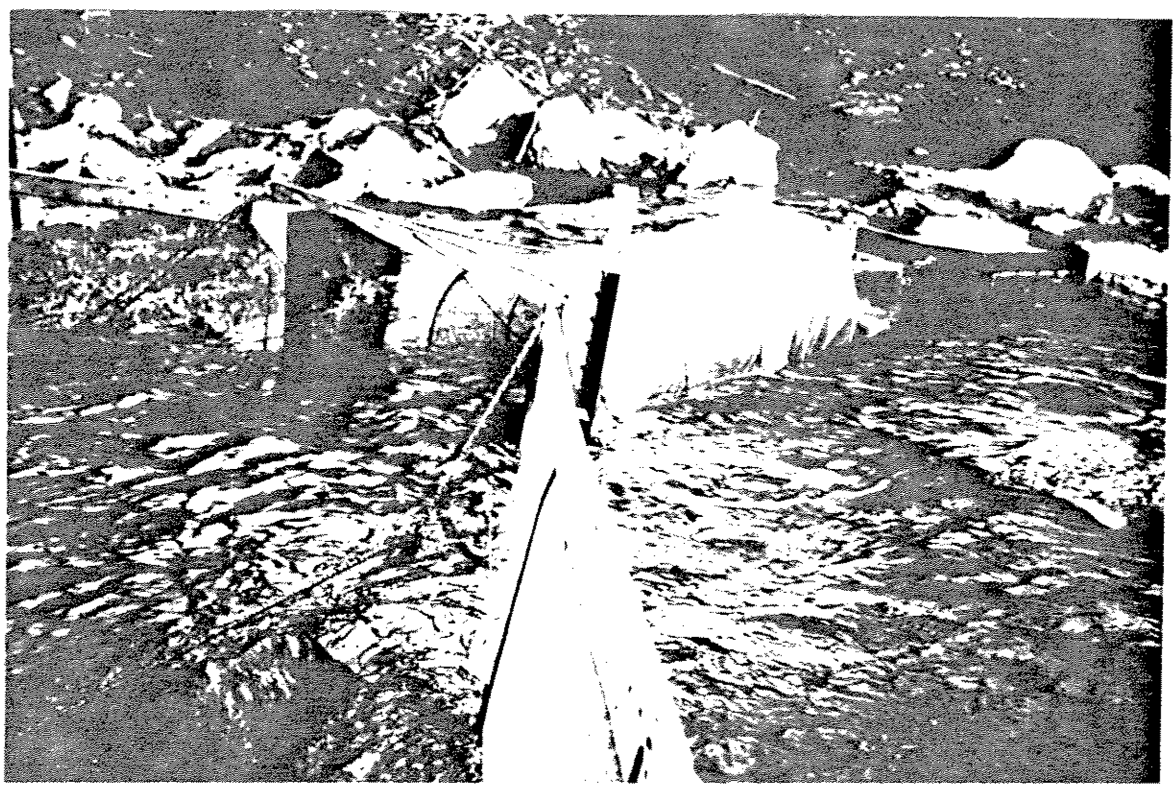
KLAMATH RIVER FISHERIES ASSESSMENT PROGRAM

INVESTIGATIONS ON THE LOWER TRIBUTARIES TO THE KLAMATH RIVER

Annual Progress Report FY 1990

February 1992



Coastal California Fishery Resource Office
Arcata, California

Western Region

PROGRESS REPORT FOR

INVESTIGATIONS ON THE LOWER TRIBUTARIES TO THE KLAMATH RIVER

FY 1990
Second Year of Investigations

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of
U.S. Fish and Wildlife Service
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DISCLAIMER

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PROGRESS REPORT FOR

INVESTIGATIONS ON THE LOWER TRIBUTARIES TO THE KLAMATH RIVER

Second Year of Investigations - FY 1990

ABSTRACT

The U.S. Fish and Wildlife Service at its Coastal California Fishery Resource Office (CCFRO) in Arcata, CA, received funding in fiscal years (FY) 1989 and 1990 to investigate spawning use, juvenile production, habitat availability to chinook salmon, and abundance indices for all salmonid species in 24 streams tributary to the Klamath River downstream of the Hoopa Valley Indian Reservation. Investigations began in October, 1988, and continued through July of 1990. A progress report for tasks completed in fiscal year 1989 was submitted for review in May, 1990. Preliminary spawning ground surveys, cursory habitat inventories, logistics, and historical records were used to assign priorities streams for investigations.

In the spring of 1990, during the fourth year of a drought, six streams (Hunter, Panther, Bear, Tectah, Tully, and Pine Creeks) were selected for investigations on adult spawning, juvenile emigration and production, and condition of stream habitat. Adult spawning surveys in Hunter Creek found 1 chinook redd; Tectah Creek surveys revealed 5 redds while Pine Creek contained 23 redds. No redds were found on Tully Creek. Bear Creek did not have a surface flow by December 7, 1989, and was subsequently not surveyed. A combined seventy nights of outmigrant trapping took place between April 2 and July 5 in the sampled streams, with a total of 33 juvenile chinook captured. Trends in chinook emigration could not be identified due to the low number of juveniles captured. Emigrations of steelhead yearlings exhibited similar trends in Hunter, Panther, Bear, and Tectah Creeks with peaks occurring

in early April and a second smaller peak in mid May. Steelhead fry in Tully and Pine Creeks had similar trends with an initial peak in mid April and a second peak starting in May and continuing into July. Steelhead yearlings were the dominant salmonid captured in Hunter, Bear, and Tectah Creeks; whereas, steelhead fry were dominant in Tully and Pine Creeks. Coho dominated the catch in Panther Creek. Extrapolation of trapping totals resulted in production estimates of only 401 chinook, 483 coho, 10,191 steelhead fry, 2,938 steelhead yearlings, and 94 cutthroat trout emigrating from the creeks between April and July 1990.

Habitat inventories covered 5.0 km in Hunter Creek, 3.4 km of Bear Creek, 8.5 km of Tectah Creek, and 2.75 km of Tully Creek. Since the Hoopa Valley Business Council surveyed Pine Creek in 1990, we did not inventory habitat in this stream. In Hunter Creek, we found adult chinook confined to the first 3.0 km of the stream. The stream was subsurface above this point, and, subsequently, juvenile rearing habitat in this area is of low quality. A cursory survey of Panther Creek found it to be primarily a rearing pond for coho. Bear Creek appears to be lacking spawning gravel in the area surveyed. Tectah Creek is underutilized by adult salmonids and should be able to support larger numbers of adults and juveniles. Tully Creek proved to be primarily a steelhead stream.

INTRODUCTION

Since the turn of the century, people have voiced concerns about perceptible declines in runs of chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), steelhead trout (*O. mykiss*), and cutthroat trout (*O. clarki*) in the Klamath River basin (Basin). These declines have accelerated during recent decades concurrent with increased demands for timber, fish, land, and water resources. In response, Congress enacted P.L. 99-552, the Klamath River Basin Fishery Resources Restoration Act on October 27, 1986, which authorizes the Secretary of the Interior to restore Basin anadromous stocks to "optimum" levels through management and restoration of anadromous species and their habitats under guidance by the Klamath River Fishery Management Council and the Klamath River Basin Fishery Task Force (KRBFTF).

In 1988, the Coastal California Fishery Resource Office (CCFRO) in Arcata, CA, submitted a proposal to the KRBFTF to gain initial funding for investigations on tributaries to the Klamath River downstream of its confluence with the Trinity River (Figure 1) (Appendix A). Investigations were designed to supplement information collected by the California Department of Fish and Game on natural production of chinook salmon in the Basin, to confirm the contributions by these tributaries toward basinwide chinook production, and to provide data necessary for informed decisions to be made on restoration efforts within the Basin. The initial year of the investigations was reported last year (Noble and Lintz 1990). Funding was approved to continue these investigations in Fiscal Year (FY) 1990. The following report summarizes findings during October, 1989, through July, 1990. Efforts were concentrated on juvenile production and habitat inventories, especially for chinook salmon and steelhead trout.

NUMBERED CREEKS:

1 Salt
2 High Prairie
3 Hunter
4 Panther
5 Richardson
6 Hoppaw
7 Saugep
8 Waukell
9 Terwer
10 McGarvey
11 Tarup
12 Omagaar
13 Ah Pah
14 Bear
15 Surpur
16 Tectah
17 Johnson
18 Pecwan
19 Mettah
20 Roach
21 Morek
22 Cappell
23 Tully
24 Pine
25 Trinity River

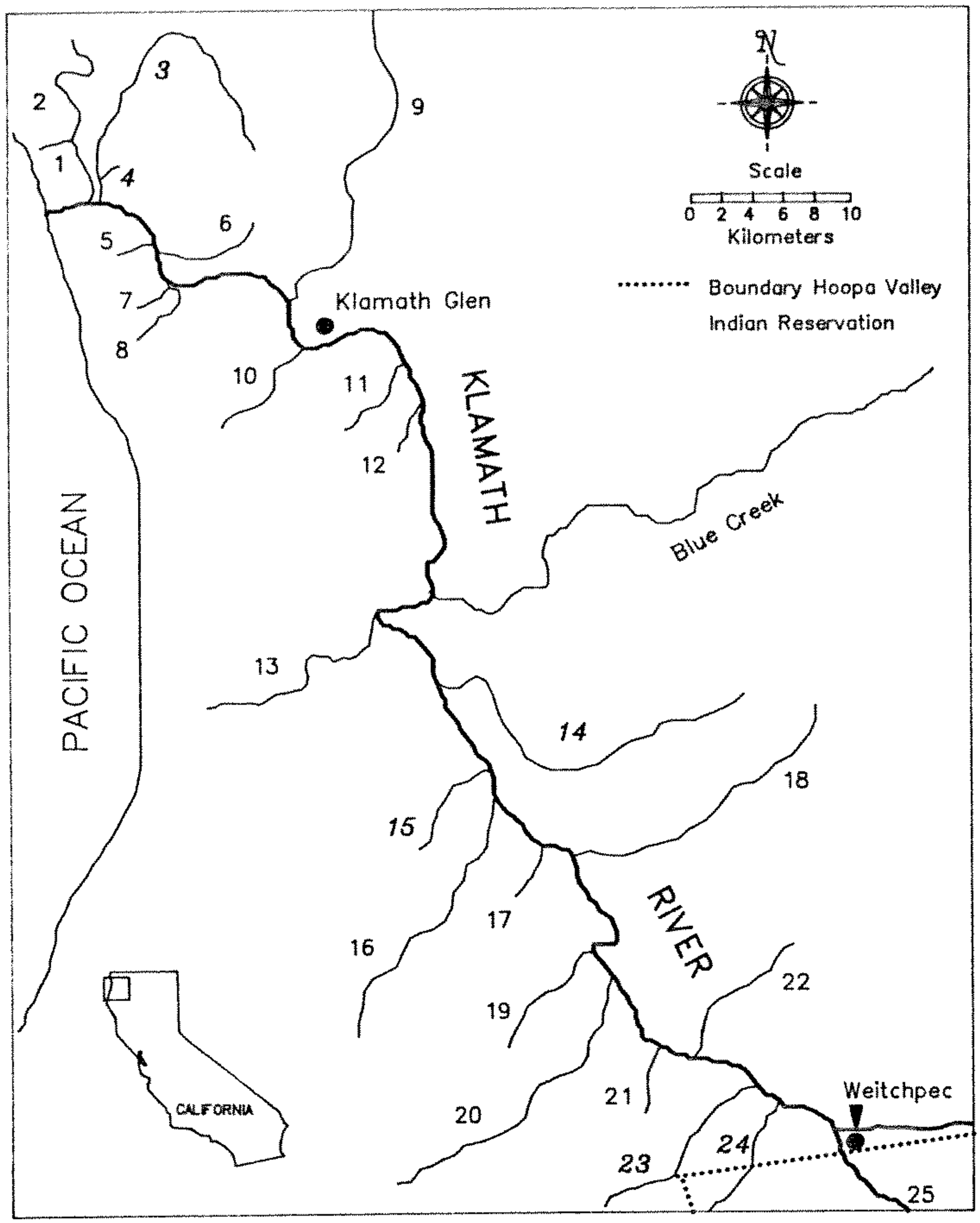

Figure 1. Tributaries to the Klamath River included in this investigation.

The second year of investigations on the lower tributaries of the Klamath River were conducted during the fourth consecutive year of drought. Water year 1987 was the driest in a decade and is compared to the drought of 1976-77 (California Department of Water Resources 1987). These conditions have reduced river and stream flows to critical levels. Subsequently, a lack of surface flow at the mouth of many inventoried streams rendered them inaccessible to adult salmonids most of the spawning season. Present circumstances have resulted in minimal chinook returns to the lower tributaries. Spawner surveys and outmigrant trapping reflect this condition. A more accurate understanding of the potential for salmonid production in these streams would be gained if multiple years of sampling were conducted to document production in "normal" and high water years.

METHODS AND MATERIALS

Selection of Study Areas

All streams included in this investigation enter the Klamath River downstream of the Hoopa Valley Indian Reservation. From a total of 24 streams tributary to the lower Klamath River, excluding Blue Creek, five tributaries (Hunter, Panther, Bear, Tectah, Tully, and Pine Creeks) were selected for investigations in 1990 (Figure 1). These tributaries were chosen based on preliminary investigations in 1988-1989 of juvenile production, spawning ground surveys, cursory surveys for spawning and rearing habitat availability and use (Appendix B), and from findings reported in past reports (Table 1) (Noble and Lintz 1990). Panther Creek was included in investigations during FY90 due to its proximity to Hunter Creek. Panther Creek enters Hunter Creek at river kilometer (rkm) 0.72. Also, Bear Creek was substituted for Terwer Creek when Simpson Timber Company, a major landowner in

Table 1. Tributaries to the lower Klamath River basin considered for investigation, criteria and ratings for potential spawning and rearing habitats, and rankings for investigatory efforts.

Creek name	Entry into Klamath River (kilometers from mouth)	Drainage area (km^2)	Salmonids observed or previously reported [a)]	Ratings for potential spawning habitat [d)]	Ratings for potential rearing habitat [d)]	Ranking for investigations and estimated year for concentrated effort
Salt	1.8	11.4	STH, CUTT	minimal	minimal	Fourth - 1993
High Prairie	enters Salt Creek	10.9	CUTT, CUTT/RBT hybrids	low	moderate	Third - 1992
Hunter	1.8	61.6	CHN, STH, Coho, CUTT	moderate	low	First - 1989, 1990
Panther [b)]	enters Hunter	unknown	Coho, CHN, STH	low	low	Third - 1990
Richardson	4.5	4.7	CHN, STH, CUTT	minimal	minimal	Fourth - 1993
Hoppaw	4.7	12.7	unknown	minimal	minimal	Fourth - 1993
Saugep	5.8	4.4	unknown	minimal	minimal	Fourth - 1992
Waukell	5.8	9.3	unknown	minimal	minimal	Fourth - 1992
Terwer [c)]	8.5	85.0	CHN, STH, Coho	high	moderate	First - 1989,1992
McGarvey	10.6	22.3	CHN, STH, CUTT	minimal	minimal	Fourth - 1993
Tarup	12.6	12.7	CHN, STH, Coho, CUTT	low	moderate	Second - 1989, 1991
Omagaar	16.9	6.5	CHN, RBT/STH	minimal	minimal	Fourth - 1993
Ah Pah	27.7	42.2	CHN, STH, Coho	low	moderate	Second - 1989, 1991
Bear	29.9	50.0	CHN, STH, Coho	moderate	moderate	Second - 1989, 1990
Surpur	33.0	14.8	CHN, STH	low	moderate	Second - 1991
Tectah	35.6	51.5	CHN, STH, Coho	high	high	First - 1989, 1990
Johnson	39.1	8.8	CHN, STH, CUTT	low	low	Third - 1992
Pecwan	40.7	71.7	STH, Coho	minimal	low	Third - 1989, 1992
Mettah	46.3	27.7	STH	low	moderate	Third - 1991
Roach	50.7	76.4	CHN, STH	moderate	high	Second - 1989, 1991
Morek	52.3	10.4	STH	minimal	minimal	Fourth - 1993
Cappell	53.3	22.3	STH	minimal	minimal	Fourth - 1993
Tully	62.0	44.8	STH	low	moderate	First - 1989, 1990
Pine	65.8	123.8	CHN, STH	high	high	First - 1989, 1990

a) Observations were made by Service employees using snorkeling, bankside observations, and/or electroshocking but do not include findings from juvenile sampling in 1989 since ratings were made prior to that operation; CHN = chinook, STH = steelhead, CUTT = Cutthroat trout, RBT = rainbow trout.
b) Panther Creek will be investigated in 1990 since it is a tributary to Hunter Creek.
c) Although rated first for investigations, operations in Terwer Creek will be postponed until 1992 by request of Simpson Timber Company.
d) See Appendix B for rating codes during preliminary evaluations of lower tributary streams in 1989.

the watershed, requested us to delay investigations on Terwer Creek for two years.

Stream Habitat Inventories

The potential for salmonid production in each stream was estimated using data from habitat inventories. A systematic reach approach was used to assess the condition and availability of spawning and rearing habitat in Hunter, Bear, Tectah, and Tully Creeks. Pine Creek was not surveyed since the Hoopa Valley Business Council recently habitat-typed the stream using a modified method by Bisson et al. (1982). In our survey, each kilometer of stream was subdivided into 250 m reaches, and one reach from each kilometer was surveyed progressively upstream. Within each surveyed reach, we recorded channel type (Appendix C) (Rosgen 1985), habitat type of five habitat categories (pool, flatwater, low gradient riffle, high gradient riffle, and cascade/falls) (Appendix D), mean stream width, bankfull width, stream depth, and pool depth. Ratings for rearing habitat, riparian cover (modified from Hamilton and Bergerson 1984), spawning habitat and streambank stability (modified from Armour et al. 1983) were recorded (Appendix E). Ocular estimates of percent substrate composition (Appendix E), substrate embeddedness (Armour et al. 1983), the quantity of large woody debris present in the wetted stream channel and available for recruitment were recorded; dominant instream cover type, barriers and flow obstructions, and observations of upslope condition were also noted.

Fall Spawning Ground Surveys

Spawning ground surveys were conducted to address Objective I of the proposal (Appendix A). Surveys for fall chinook spawners occurred on Hunter, Tectah, Tully, and Pine Creeks from November through mid December during 1989. Attempts were made to survey Bear Creek, but its mouth was subsurface throughout our survey period. Counts for redds and adult salmon began at the mouth of each stream. The location and potential age of redds were recorded. Live adults were counted from bankside and identified to species and sex when possible. Scale samples to determine age and origin (hatchery or wild) were taken from all carcasses encountered during surveys. Differentiation of adult chinook origin was determined using a technique suggested by Williams (pers. comm.) of the Oregon Department of Fish and Wildlife.

Juvenile Trapping Operations

Trapping of downstream migrating juvenile salmonids was conducted to address Objective II of the proposal (Appendix A). In April of 1990, we began to assess juvenile salmonid production by trapping emigrants in the six selected streams. Our objectives were to document the species using a stream for spawning and rearing, determine patterns in timing and duration of juvenile emigration, and estimate the abundances of juveniles of different salmonid species emigrating from a stream.

Traps were operated through the night based on observations by Hoar (1953), Miller (1970), Reimers (1973), and Faudskar (1980), who documented that the majority of juvenile salmonids migrate under the cover of darkness. Two streams were sampled each trap night with one trap set per stream. Traps were set as near to the mouth as possible in areas accessible during periodic spring flood events and where sampling could approach 100% of the stream width. Each trap consisted of a 1.07 m x 1.52 m fyke net of 0.47 cm delta mesh with a live box attached to the cod end. Weir panels, constructed of 0.64 cm hardware cloth mounted on wooden frames, abutted each side of the fyke net to increase the proportion of the stream sampled. In Pine Creek, a larger tributary, a 1.5 m x 3.0 m frame net of 0.47 cm delta mesh was used in place of a fyke net.

All fish were removed from the traps the next day and were identified to species, counted, and released. All chinook, coho, and steelhead were further identified to year class based on size criteria. For each stream, up to 50 individuals of each salmonid species and age class captured in a trap were measured for fork length (to the nearest mm) and volume (volumetric displacement in ml) and then released.

Weather, lunar phase, stream width, and stream depth at the trap mouth were also noted. Stream temperature was recorded over each trap night with a Taylor maximum/minimum thermometer. Stream flow (ft/sec) into the trap mouth was measured with a flow meter. Trapping operations were temporarily halted during a spring high flow event in late May and resumed once flows dropped to suitable trapping levels. Trapping operations ceased in late June when either the mouth of the stream went subsurface (Bear) or emigration ceased or decreased to extreme low numbers (Hunter, Panther, Tectah, Tully, and Pine Creeks).

Treatment of Data

Data were entered onto LOTUS 123 spreadsheets and analyzed using STATGRAPHICS software package. Emigration timing in relation to weather, lunar cycles, stream width, stream velocity, and temperature were compared using ANOVA tests. Comparisons with 1989 data were made regarding outmigration timing, length frequencies, age classes, expanded catch estimates, and actual catch numbers. A trap night was defined as the operation of a trap through one period of darkness (one night). Expanded estimates were made for the total number of juveniles of each species and age class emigrating from a stream each trap night. These estimates were calculated as:

$$E_i = N_i \ / \ P_i$$

where N_i = the actual number of juveniles of each species and age class captured in a trap on night i, P_i = the proportion of total stream width that was sampled during that trap night, and E_i = the expanded number of juveniles of each species and age class emigrating past a trap on night i. Such expansions were made with the assumptions that all species and age classes were equally distributed across the stream channel, juveniles captured were migrating from the stream, and the trap was equally efficient in capturing all migrating fishes.

Estimates were also made for the total number of juveniles of each species and age class that emigrated past a trap site during the entire trapping season. These were made by summing all E_i for a stream and interpolating expanded estimates for nights when traps were not operational. These extrapolated estimates were made under the previously stated assumptions plus: 1) stream width at a trap site did not substantially decrease or increase between one trap night and the next, and 2) emigration rate for a night when a trap was not operational (non-trap night) could be derived by averaging the rates for trap nights immediately preceding and following a non-trap night.

Estimates were made for the number of chinook adults and jacks that used a stream for spawning during the winter of 1989-90. These estimates were formed using the equation:

$$S_j = (E_j / V \times F) \times R$$

where S_j = estimate for male, female, or jack spawners in stream j, E_j = the expanded estimate of chinook fry emigrating from stream j, F = the fecundity for adult fall chinook females in the Klamath River (n=3,634 eggs/female reported by Allen and Hassler 1986), V = the survival of chinook from egg to fry stage using an average estimate from Bogus Creek, tributary to the Klamath River (9.2%), and R = the average sex ratio for male:female:jack fall chinook returning to hatchery racks at Iron Gate State Fish Hatchery from 1980 to 1988 (ratio = 0.838:1:0.254). These estimates were made under the following assumptions: 1) estimates made for chinook fry emigrating streams were reliable, 2) survival of chinook fry from egg to fry stage in lower tributaries was similar to that in Bogus Creek, and 3) sex ratios for fall chinook in natural streams were similar to average ratios observed at hatchery racks in Iron Gate State Fish Hatchery. Given these assumptions, conclusions drawn from expanded estimates should be approached with caution.

RESULTS AND DISCUSSION

Hunter Creek

Habitat Inventories

Hunter Creek is 17.7 km long, drains an area of 61.6 km^2, and enters the Klamath River at rkm 1.8. Hunter Creek was inventoried from the mouth to rkm 5.0. This area is in a low gradient, gravel bed (C3) channel type. Hunter Creek can be divided into three areas: 1) the mouth to rkm 3.0 retains a surface flow year round, 2) from rkm 3.0 to rkm 10.0, the stream becomes subsurface from early spring to winter, and 3) above rkm 10.0, it has a year round surface flow.

The first area is important to fall chinook as they are limited to this area when the stream goes subsurface above rkm 3.0 (Figure 2). This area, which includes survey reaches I, II, and III, has minimal to moderate spawning habitat. Gravel are generally embedded and available in isolated pockets at pool tailouts (Table 2). Although there is a variety of instream cover (large woody debris and terrestrial vegetation), rearing habitat is of moderate quality due to a low average number of pools (Figure 3). Riparian cover is excellent above rkm 0.7, but inadequate immediately downstream. The streambanks are moderately stable with some erosion occurring at corner areas. Below rkm 0.7, livestock cross the stream daily causing the streambanks to erode.

Bell (1986) states that the spawning substrate size preferred by fall chinook salmon is between 1.3 to 10.2 cm and that 85% mortalities can occur to salmon eggs, alevins, and emerging fry when 15 to 20% of the interstices between gravel

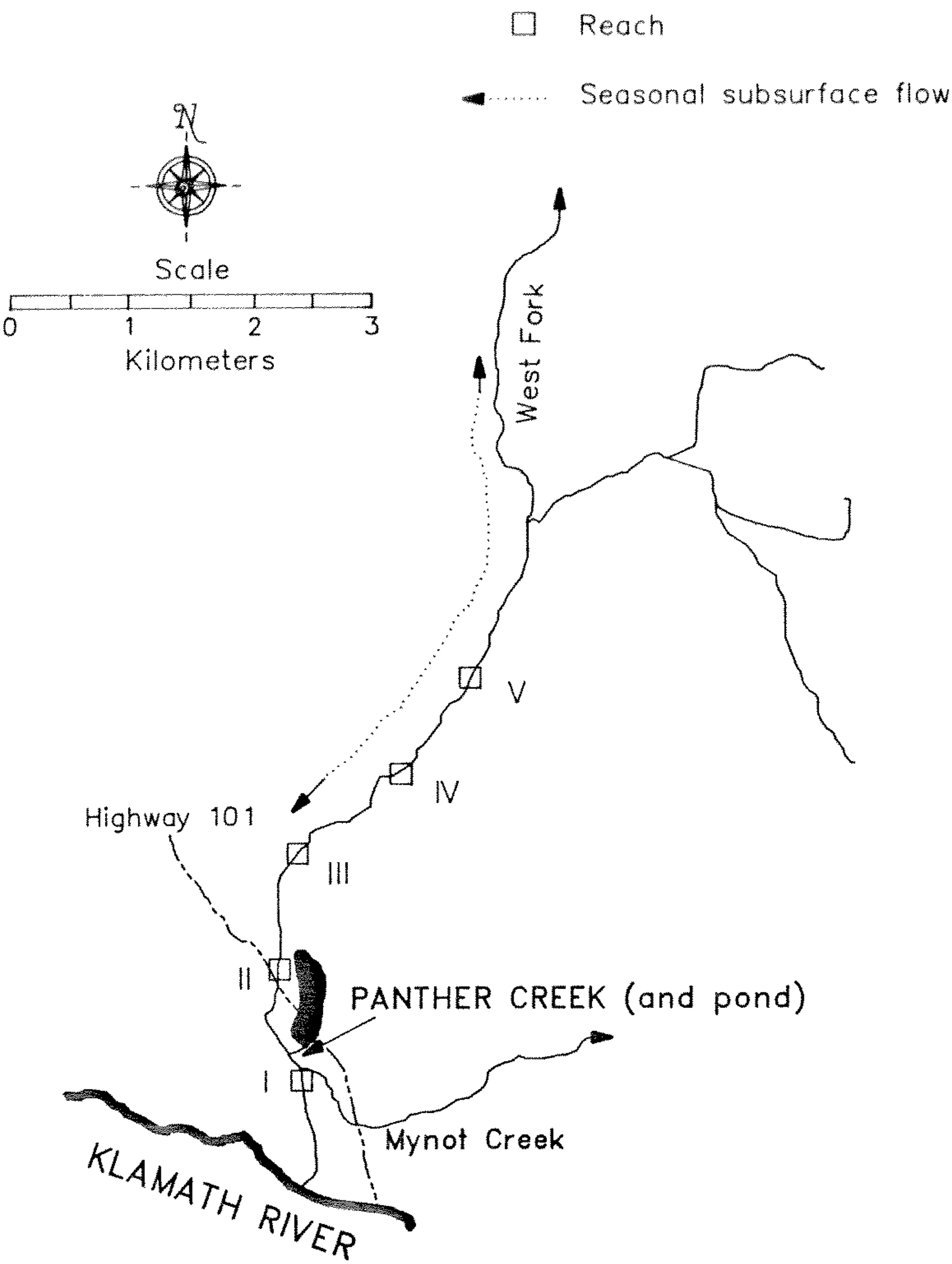

Figure 2. Hunter Creek showing surveyed reaches, and Panther Creek including the pond.

Table 2. Physical stream characteristics and inventory ratings for Hunter Creek.

Reach	RKM	Channel Type	% Habitat Types: Pool	LGR	HGR	Flat Water	Cascade Falls
I	0.75-1.0	C3	5	0	0	95	0
II	1.75-2.0	C3	45	15	0	40	0
III	2.75-3.0	C3	5	5	0	90	0
IV	3.75-4.0	C3	10	40	0	50	0
V	4.75-5.0	C3	40	45	0	15	0

Reach	Avgerage Stream (meters): Width	Depth	Pool Depth	Bankfull Width	Dominant Instream Cover[a]	Substrate Mix[b]	Percent Embeddedness
I	12.0	0.3	1.0	12.0	Ter Veg	SGF	25-49%
II	10.0	0.3	1.2	13.0	Ter Veg	SGF	50-74%
III	9.0	0.1	0.5	27.0	LWD	GSF	5-24%
IV	13.0	0.1	0.4	40.0	Subst	GSC	5-24%
V	12.0	0.1	0.6	24.0	LWD	GSF	5-24%

Reach	Ratings[c]: Rearing Habitat	Spawning Habitat	Riparian Cover	Streambank Stability	Number Instream LWD
I	Mod	Min	Exc	Mod	2
II	Exc	Mod	Exc	Mod	3
III	Fair	Mod	Fair	Mod	1
IV	Min	Fair	None	Min	1
V	Mod	Mod	Mod	Mod	4

[a]Instream Cover: Ter Veg=Terrestrial Vegetation, LWD=Large Woody Debris, Subst=Substrate

[b]Substrate Mix: F=Fines, S=Sand, G=Gravels, C=Cobble, Bo=Bolders, Be=Bedrock: dominant type listed first in sequence.

[c]Ratings: Exc=Excellent, Mod-Moderate, Fair, Min=Minimum, Ext=Extreme

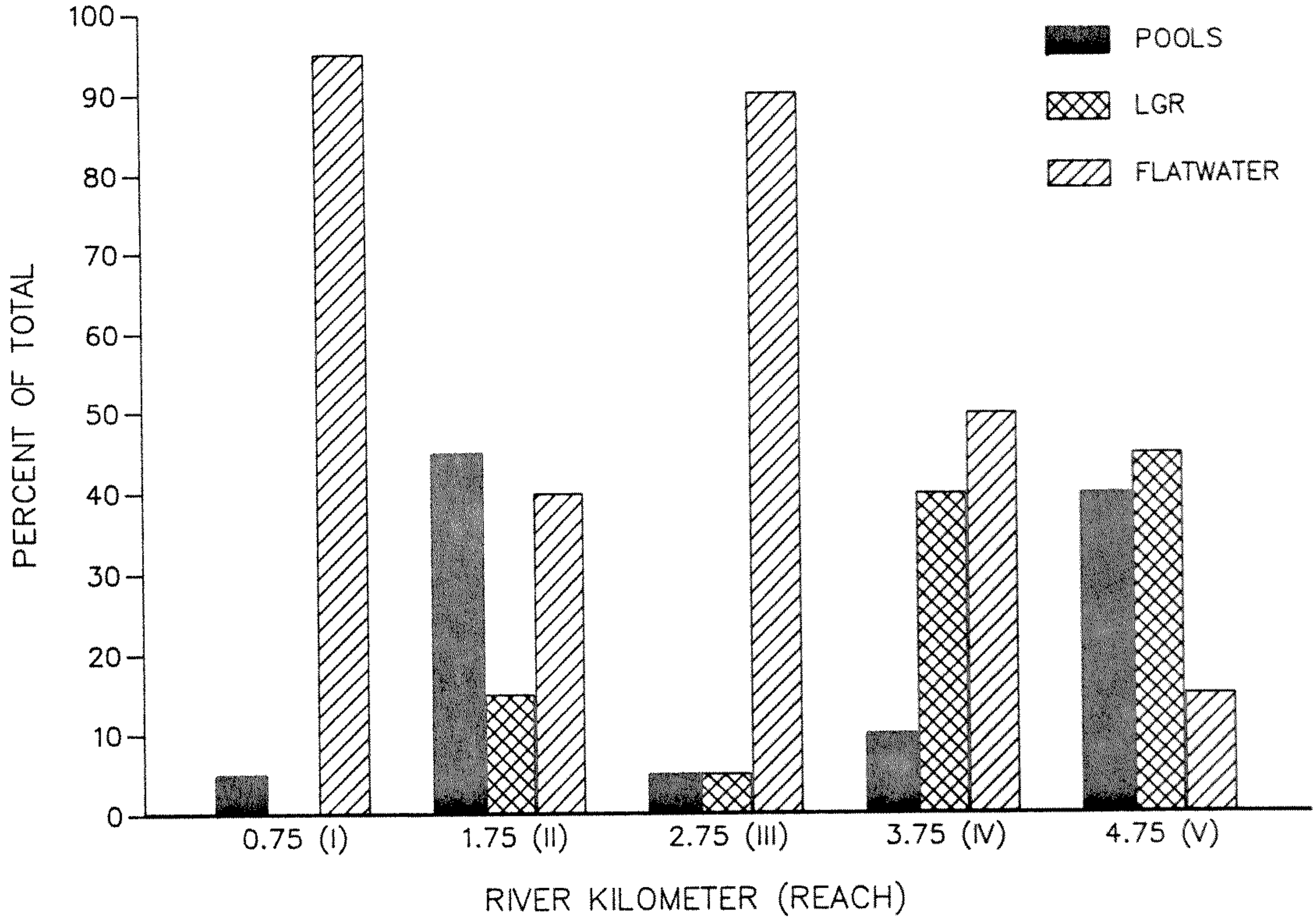

Figure 3. Habitat types occurring in Hunter Creek, channel type C3, 1990.

are filled with sediment. In the first area of the creek, survival may be poor since surface embeddedness was high. In low water years, this portion of the creek may be an important spawning site for fall chinook destined for other small, lower Basin tributaries that have gone subsurface. Therefore, improvements to spawning and rearing habitats in this portion of the creek could enhance survival of the fall chinook run during drought years. Improvements should include increased quality and quantity of spawning gravel, development of pools for adult holding and juvenile rearing, and creation of a riparian corridor along the lower 0.7 km for stream shading, instream cover, streambank stability, nutrient rich allochthonous materials, and terrestrial insects for fish food. Livestock should be restricted from further degradation of streambanks.

The second area encompasses that portion of the stream which becomes subsurface from spring to winter (rkm 3.0 to 10.0), and includes our reaches IV and V. To prevent duplication of effort, we ended our survey at rkm 5.0 since Clearwater BioStudies surveyed the mainstem from rkm 6.0 to 15.45 in 1988. We found that spawning and rearing habitat from rkm 3.0 - 5.0 improved in quality progressively upstream from poor to moderate. Although flatwater habitat decreased in occurrence, low gradient riffles (LGR) and pools increased in frequency (Figure 3). In the lower reach of this middle area, riparian vegetation provided minimal cover or shading. Instream cover was mainly in the form of large substrate. Large woody debris (LWD) increased in occurrence upstream. Streambank stability was moderate to fair with infrequent erosion caused by lateral and corner scour along the streambank. This middle area could be improved by providing instream cover for immigrating adult salmonids that migrate through this area to the upper reaches of the creek during high flows in winter. The cover would also be used by juvenile emigrants in early spring. Deep pools should not be created to provide holding areas for adults, however, since juvenile salmonids could become stranded in the pools in mid to late spring when this area goes subsurface. Riparian vegetation could also be planted to provide shade and cover to this barren stretch.

Clearwater BioStudies (1988) surveyed the third area of Hunter Creek and found that current conditions limit the potential for healthy smolt production. Lack of winter habitat and pools without cover are major habitat deficiencies throughout this section. Channel and bank stability were rated poor to fair. The substrate was found to have an embeddedness of 25-45%. The lower section of this reach is highly aggraded and subsurface flows are common during summer. This section's average stream shade, pool abundance, and instream cover were 49%, 35% and 23%, respectively. Migration barriers were numerous in the mainstem above Kurwitz Creek and in the tributaries of the drainage (Clearwater BioStudies 1988). Clearwater BioStudies (1988) determined that enhancement to the upper portion of Hunter Creek could increase the potential of smolt production within the drainage. Actions recommended were fish rescue, conifer revegetation, and construction of stream enhancement structures. Implementation of these recommendations was initiated by the California Department of Fish and Game in 1989 (Schwabe, pers. comm.).

Our concern for the creek upstream of rkm 10.0 is to ensure that adequate summer rearing habitat is available since juvenile salmonids often become trapped in this area when the stream goes subsurface in early summer. Increased rearing habitat in this area could be a positive influence on the survival and production of coho, steelhead, and cutthroat trout in the stream. During drought years, adult chinook have been limited to the lower areas of the creek; in years when chinook are able to use the upper area, stream improvements would also be to their benefit.

Spawning Ground Surveys

Redd surveys found that adult chinook were confined below rkm 3.0 in the fall of 1989 due to the subterranean character of the stream immediately upstream. Hunter Creek was surveyed for chinook adults and redds on November 20 and December 6, 1989, from the mouth to rkm 3.0 and 5.0, respectively, and on December 19, 1989, from rkm 4.0 to 11.0. Only one redd was found on November 20 at rkm 1.5; at this time the stream went subsurface at rkm 3.0. By December 6, rains had increased the surface flow and the creek went subsurface further upstream at rkm 5.0. The stream had a continuous surface flow by December 9, 1989, but no new redds were found.

The Yurok tribe operated a weir at rkm 0.66 to capture adult fall chinook salmon for a tribal hatchery program. In 1988, the weir captured 5 female and 15 male chinook during 13 days of operation from October 31 to November 12 (Pierce 1989). Over the 79 days of operation in 1989 (September 29 to December 4), 4 female and 7 male chinook and one coho male were captured (Pierce, pers. comm.).

Redd counts in 1988 (13) were much higher then those in 1989 (1). The discrepancy between redd counts in 1988 and 1989 was of a much greater magnitude than the numerical difference in adults captured at the weir during those same years.

In low water years, most fall chinook in Hunter Creek spawn in the lower 3.0 km of the creek. Fish have no choice but to use this area or wait for the stream to rise. The upper reaches of the creek, when available to spawners, has abundant, moderate quality (25-45% embeddedness) spawning habitat that is primarily used by the later running salmonid stocks, coho, steelhead, and cutthroat trout (Clearwater BioStudies 1988).

Juvenile Trapping Operation

Trapping of emigrating juvenile salmonids began on April 2 and continued until June 29, 1990 (Table 3). The trap was located at rkm 0.66, just below the stream's confluence with Mynot Creek (Figure 2). Only 4 juvenile chinook, average FL 68 mm, were captured in 12 nights of trapping. Steelhead yearlings provided the largest portion of salmonids sampled in Hunter Creek (Table 4). A total of 49 steelhead yearlings, 6 cutthroat trout juveniles, 4 chinook fry, 2 coho yearlings, and 1 steelhead fry were captured in 1990; no coho fry (0+) were captured. We estimated an extrapolated total of 23 chinook emigrating over the 88 day trapping period (Table 5). The stream temperature ranged from 9.4 to 18.3°C and averaged 11.6°C during the trapping period. Non-salmonid species captured are listed in Table 4.

The first day of trapping, April 2, produced the peak catch of emigrating yearling steelhead in Hunter Creek (Figure 4). Since catch continued to decline as time progressed, we assume that we missed the peak of yearling steelhead emigration. A second, less pronounced peak of yearling steelhead occurred May 14. No significant relationships between yearling steelhead emigration and weather or lunar phase were noted ($P>0.8$ for both). No trends could be discerned for chinook, coho, and cutthroat trout since catches were extremely low. Only 4 chinook fry were captured in spring 1990. This is considerably lower than captures in 1989 when 28 chinook fry were sampled over 9 sample nights (Noble and Lintz 1989). The catch of chinook fry in 1989 and 1990 probably reflect the low number of redds recorded in these years, 13 and 1, respectively. Steelhead yearlings dominated the salmonid catch in 1990 (79%). Steelhead fry were virtually absent from the catch in both 1989 (n=0) and 1990 (n=1). A potential explanation for this may be that following a late spring emergence, steelhead fry became stranded in the upper portion of the creek that regularly goes subsurface in

Table 3. Hunter Creek trapping and salmonid catch data in 1990.

Date	Weather[a]	Moon Phase[b]	Percent Stream Sampled	Total Hours Fished	Temperature (C°)[c]	Flow (ft/sec)
4/2/90	Clear	FQ	100	22	9.4	1.93
4/9/90	OverC	FM	100	20	14.4-9.4	1.87
4/18/90	OverC	LQ	100	20	12.8-10	0.97[d]
4/24/90	OverC	NM	30	20	11.7	2.73[d]
4/30/90	Clear	FQ	100	23	13.3-9.4	1.82[d]
5/7/90	Clear	FM	100	23	12.8-8.3	1.49[d]
5/14/90	Clear	LQ	71	24	12.2-9.4	2.50
5/21/90	LtRain	LQ	79	21	10.5-10	1.94
6/11/90	Clear	FM	71	25	13.3-9.4	2.53
6/18/90	Clear	LQ	17	22	13.3-10	
6/27/90	Clear	FQ	63	30	18.3-10	1.53
6/29/90	OverC	FQ	63	22	13.3-10	

Salmonid Catch

Date	Chinook	Steelhead Fry	Steelhead Yearlings	Coho	Cutthroat Trout
4/2/90	0	0	17	0	2
4/9/90	0	0	12	0	0
4/18/90	0	0	5	0	0
4/24/90	0	0	0	0	0
4/30/90	0	0	2	0	1
5/7/90	0	0	1	0	1
5/14/90	0	0	7	2	2
5/21/90	0	0	1	0	0
6/11/90	1	1	1	0	0
6/18/90	0	0	1	0	0
6/27/90	1	0	1	0	0
6/29/90	2	0	1	0	0

[a]Weather: Clear, OverC = Over Cast, LtRain = Light Rain

[b]Lunar Phase:NM = New Moon, FQ = First Quarter, FM = Full Moon, LQ = last Quarter

[c]Temperature given as maximum-minimum; single entry for temperature taken during trap installation only

[d]Entire stream discharge

Table 4. Total number, proportion of total, and average catch per night in each tributary sampled during 1990.

Stream	Hunter	Panther	Bear	Tectah	Tully	Pine
Nights Trapped	12	12	10	15	12	9
Date started	4/2	4/2	4/3	4/3	4/4	4/16
Date ended	6/29	6/29	6/12	7/5	7/2	7/2
Total fish captured per species or age class:						
Chinook fry	4	1	6	19	0	2
Steelhead fry	1	0	0	0	278	284
Steelhead Yrlg.	50	6	29	65	9	8
Coho	2	13	1	12	1	0
Cutthroat trout	6	2	1	0	0	0
Stickleback	130	204	20	518	0	0
Sucker	24	108	5	6	0	0
Lamprey	12	37	0	7	0	0
Dace	50	196	110	68	0	1
Sculpin	303	142	44	163	0	0
Smelt	1	1	0	0	0	0
Bullhead	0	1	0	0	0	0
Proportion of Total Salmonids Captured:						
Chinook fry	6.3	4.7	16.2	19.8	0.0	0.7
Steelhead fry	1.6	0.0	0.0	0.0	96.5	96.6
Steelhead Yrlg.	79.0	28.6	78.4	67.7	3.1	2.7
Coho	3.0	62.0	2.7	12.5	0.3	0.0
Cutthroat trout	9.5	4.8	2.7	0.0	0.0	0.0
Average Capture Per Night:						
Chinook fry	0	0	0	1	0	0
Steelhead fry	0	0	0	0	23	32
Steelhead Yrlg.	4	0	3	4	1	1
Coho	0	1	0	1	0	0
Cutthroat trout	0	0	0	0	0	0
Stickleback	11	17	2	34	0	0
Sucker	2	15	0	0	0	0
Lamprey	1	3	0	0	0	0
Dace	4	16	11	5	0	0
Sculpin	25	12	4	11	0	0
Smelt	0	0	0	0	0	0
Bullhead	0	0	0	0	0	0

Table 5. Actual, expanded, and extrapolated numbers of salmonids captured per stream in spring 1990.

Creek	Numbers	Chinook	Steelhead Fry	Steelhead Yearlings	Coho	Cutthroat Trout
Hunter	Actual	4	1	49	2	6
	Expanded	10	2	108	5	13
	Extrapolated	23	12	547	25	61
Panther	Actual	2	0	6	13	1
	Expanded	2	0	6	13	1
	Extrapolated	3	0	57	117	9
Bear	Actual	6	0	29	1	1
	Expanded	7	0	35	1	1
	Extrapolated	14	0	499	2	24
Tectah	Actual	19	0	65	5	0
	Expanded	55	0	164	33	0
	Extrapolated	236	0	1584	307	0
Tully	Actual	0	278	9	1	0
	Expanded	0	439	13	32	0
	Extrapolated	0	4998	135	32	0
Pine	Actual	2	287	5	0	0
	Expanded	3	693	17	0	0
	Extrapolated	125	5181	116	0	0
Totals:	Actual	33	566	166	30	8
	Expanded	77	1134	343	84	15
	Extrapolated	401	10191	2938	483	94

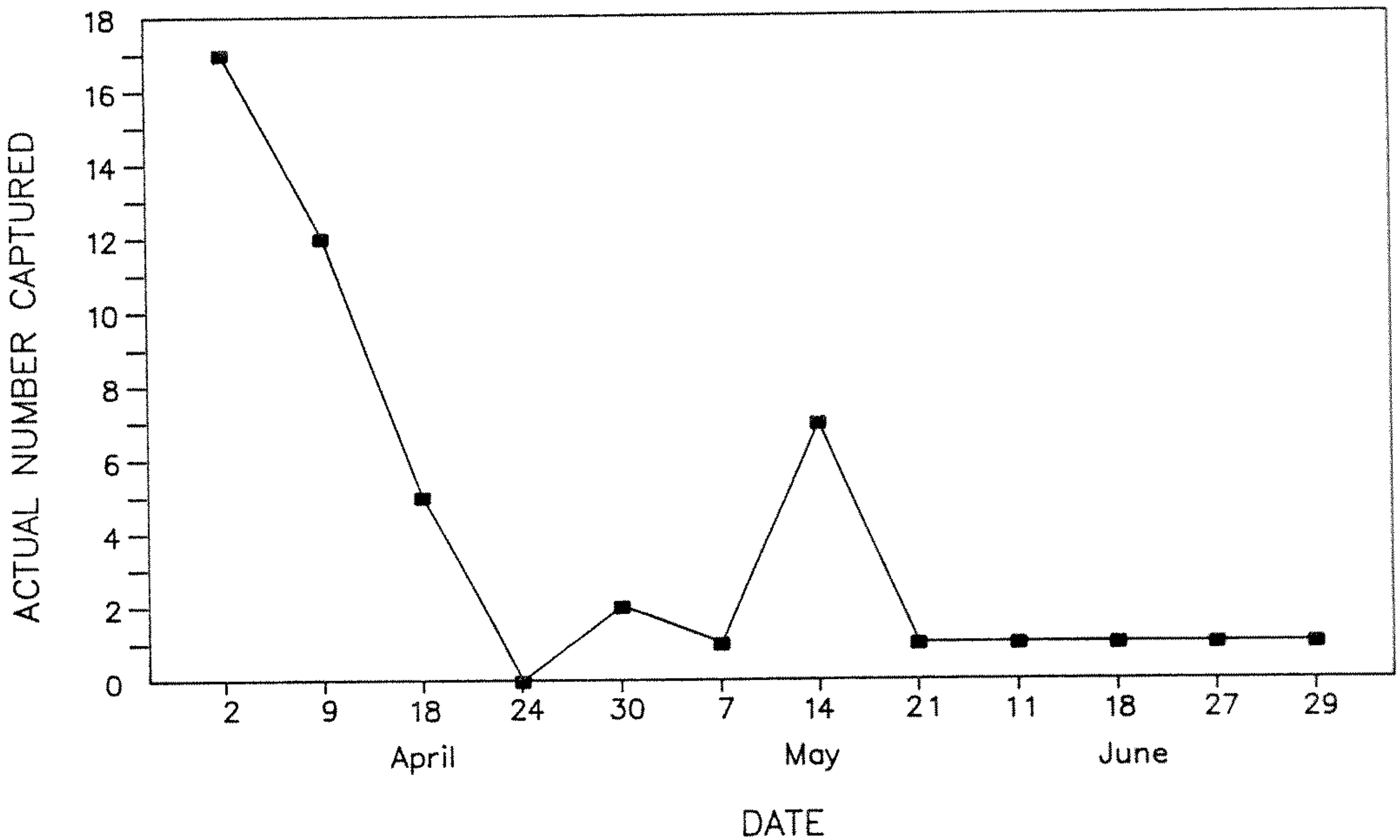

Figure 4. Emigration pattern of yearling steelhead from Hunter Creek, spring 1990.

late spring through late fall/early winter and did not emigrate until the following spring

Panther Creek

Habitat Inventories

Panther Creek was substituted in place of Mynot Creek for emigrant trapping in spring 1990 because Mynot Creek was subsurface (above rkm 0.25) at the initiation of the trapping season. Panther Creek was chosen for a substitute because it flows year round and was easily accessible. Panther Creek is a short, spring fed stream impounded by a beaver dam within 0.1 rkm from it's confluence with Hunter Creek (at rkm 0.72) (Figure 2). The pond created by the beaver dam has an approximate surface area of 1.5 hectors. The dam appears to be a barrier to adult salmonids; however, juvenile salmonids may be able to enter and exit the pond.

Panther Creek was not thoroughly habitat inventoried because of it's short stream length (0.1 km), highly embedded substrate, poor spawning habitat, and minimal instream cover and rearing habitat below the beaver dam. The pond is covered by aquatic and terrestrial vegetation with 20% of the pond's surface exposed to direct solar radiation. Although the pond provides an excellent nursery area for some salmonid species, the lower portion of Panther Creek is short and contains only a small amount of poor quality spawning habitat. We do not feel that this creek warrants restoration activity.

Spawning Ground Surveys

No spawning ground surveys were conducted on Panther Creek. Panther Creek has only a short section of flowing creek over a highly embedded substrate.

Juvenile Trapping Operation

Emigrant trapping took place between April 2 and June 28, 1990, at rkm 0.02. During the twelve nights of trapping, 21 salmonids were captured: 13 coho, 6 steelhead, 1 cutthroat trout, and 1 chinook (Table 6). Of these, only 1 chinook and 1 coho fry were sampled, the remaining fish were yearlings. Coho emigration appeared to peak on April 17 when 8 yearlings were sampled (Figure 5). The expanded number of coho was estimated at 13, and the interpolated number at 117 fish emigrating over the trapping period (Table 5). The creek temperature ranged from 9.9°C to 12.2°C and averaged 11.1°C during the trapping period (Table 6). Non-salmonid species captured are given in table 4.

Bustard and Narver (1975) found that overwintering coho in backwater pools and unused beaver ponds had about twice the survival potential of coho in other areas of a stream system. Our trapping results show that the Panther Creek pond may provide limited but quality rearing habitat for coho that move in from Hunter Creek; it produced more coho (13 captured) than Hunter Creek (2 captured). This pond has adequate flows, temperature, and cover suitable for overwintering and oversummering by coho juveniles (Table 6).

Bear Creek

Habitat Inventories

Bear Creek, with a drainage area of 50 km^2 and a mainstem stream length of 8.0 km, enters the Klamath River at rkm 29.9. The first 3.48 km of Bear Creek was inventoried as well as 0.25 km of its tributary, the North Fork. Bear Creek is predominantly contained in a steep "B" type channel with a low gradient "C" type channel near the mouth. Overall, the stream provides only minimal spawning habitat for chinook and a moderate quantity of spawning habitat for steelhead.

The first two survey reaches represent an unstable, depositional area of the stream (Figure 6). The first reach (rkm 0.0 to 0.25) contains a seasonal barrier: a gravel delta at its confluence with the Klamath River. The stream mouth regularly becomes subsurface from late spring to late winter;

Table 6. Panther Creek trapping and salmonid catch data in 1990.

Date	Weather[a]	Moon Phase[b]	Percent Stream Sampled	Total Hours Fished	Temperature (C°)[c]	Flow (ft/sec)
4/02/90	Clear	FQ	100	23	10.5	
4/09/90	OverC	FM	100	21	11.1-9.4	2.76
4/18/90	OverC	LQ	100	20	12.8-10.5	
4/24/90	OverC	NM	100	21	12.2-11.1	
4/30/90	Clear	FQ	100	25	11.7-8.8	
5/07/90	Clear	FM	100	24	10.5-9.4	
5/14/90	Clear	LQ	100	25	11.1	1.91
5/21/90	LtRain	LQ	100	22	10-10	1.76
6/11/90	Clear	FM	53	26	11.7-10.5	1.46
6/18/90	Clear	LQ	53	22	12.2-11.1	
6/27/90	Clear	FQ	62	31	12.2-11.1	1.41
6/29/90	OverC	FQ	62	22	12.2-11.1	1.41

Salmonid Catch

Date	Chinook	Steelhead Fry	Steelhead Yearlings	Coho	Cutthroat Trout
4/02/90	0	0	1	0	0
4/09/90	0	0	3	1	0
4/18/90	0	0	2	8	0
4/24/90	0	0	0	1	0
4/30/90	0	0	0	1	1
5/07/90	0	0	0	0	0
5/14/90	0	0	0	2	0
5/21/90	0	0	0	0	0
6/11/90	0	0	0	0	0
6/18/90	0	0	0	0	0
6/27/90	0	0	0	0	0
6/29/90	1	0	0	0	0

[a]Weather: Clear, OverC = Over Cast, LtRain = Light Rain

[b]Lunar Phase:NM = New Moon, FQ = First Quarter, FM = Full Moon, LQ = last Quarter

[c]Temperature given as maximum-minimum; single entry for temperature taken during trap installation only

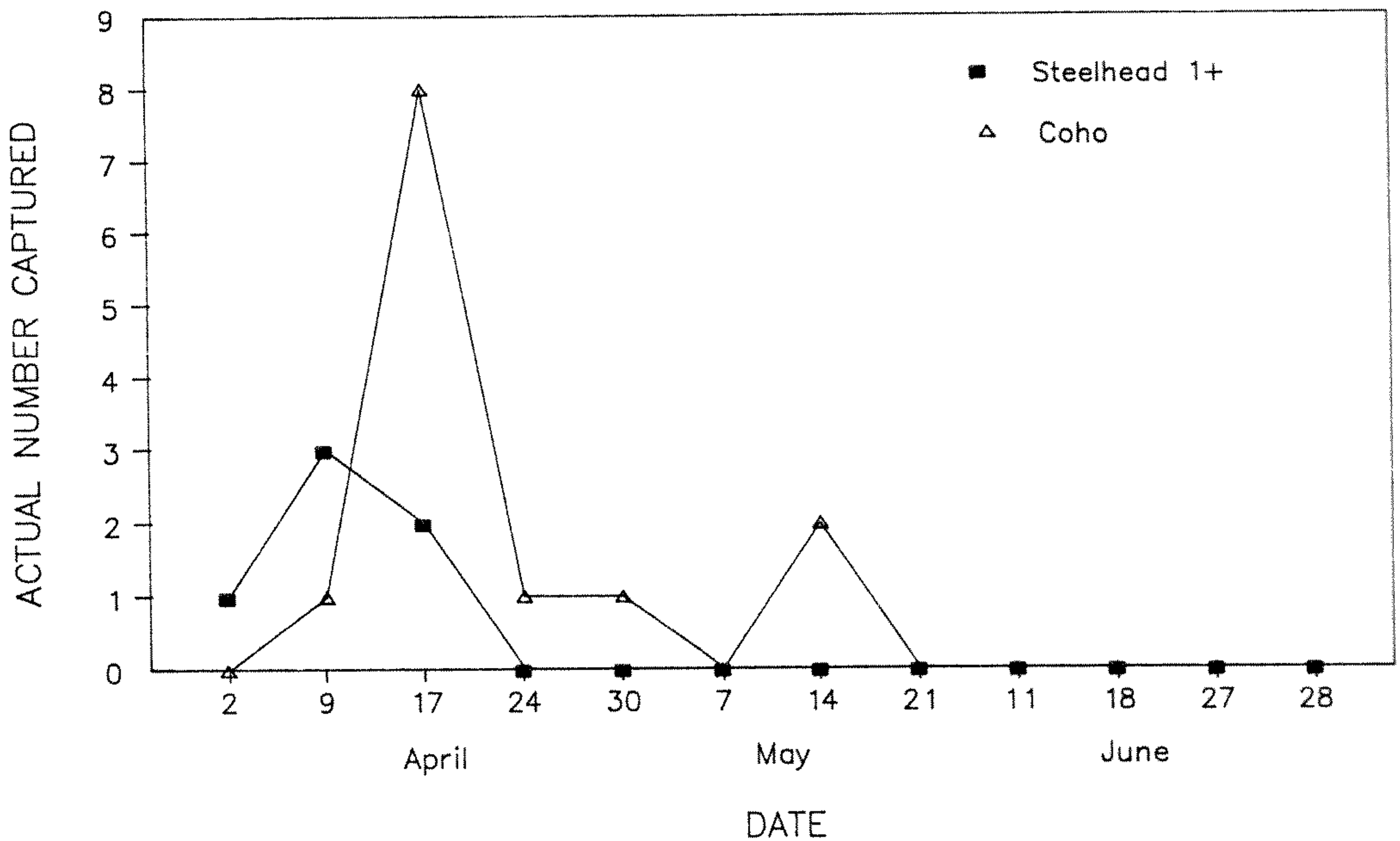

Figure 5. Emigration pattern of juvenile salmonids from Panther Creek, spring 1990.

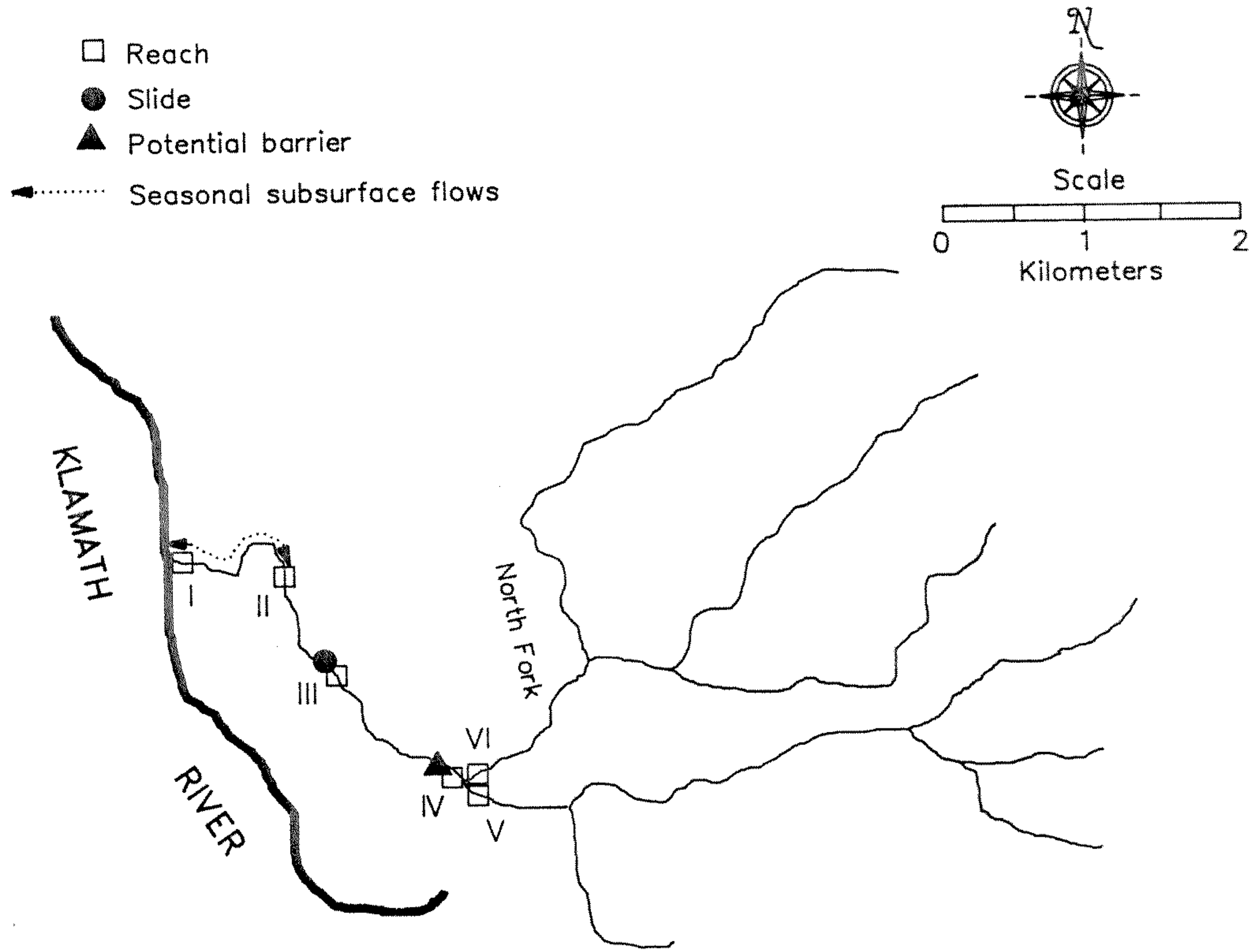

Figure 6. Bear Creek showing surveyed reaches.

on December 7, 1989, Bear Creek had yet to flow into the Klamath River. When the winter rains bring the stream to the surface, it must flow over a 0.04 km wide gravel bar upon entering the Klamath River. This gravel bar causes the stream to become braided and shallow, often denying access to adult salmon and steelhead. Adults enter once high flows cause the stream to deepen its channel or the Klamath River rises above the braided portion of the creek. Payne (1989) estimated that a flow of 10,000 cfs in the Klamath River would be needed to inundate the steepest portion of the deltas, and a flow of 15,000 cfs would completely submerge the deltas allowing unimpeded salmonid entrance. In the creek channel immediately upstream of the Klamath River gravel bar, a large volume of cobble and gravel has accumulated and has buried most large woody debris (LWD) in or near the stream channel. The riparian vegetation is patchy due to the loose cobble substrate of the streambanks. This area is mainly a corridor to the upper reaches. Overhanging terrestrial vegetation and LWD provide some instream cover to adult salmonids and juveniles, but there is a deficiency of adequate pools (Table 7 and Figure 7).

The gradient increases and the stream channel becomes well confined in reach III. As the gradient increases, high gradient riffles (HGR), cascades, and falls become more frequent (Table 7 and Figure 7). Pools also are more numerous in this area. Spawning habitat is poor as only isolated pockets of spawning gravel are available. The riparian cover is excellent with a complete overhead alder canopy, lending to excellent streambank stability. Instream cover is mainly provided by the sizable substrate, moderately deep pools, and woody debris, which provides excellent rearing habitat. On the right bank at rkm 2.0, a small rock slide enters the stream at a cascade/falls. The slide is 5 m wide at the base and ascends 30 m upslope. Since the cascade area is steep in gradient, material entering the stream can be displaced

Table 7. Physical stream characteristics and inventory ratings for Bear Creek.

Reach	RKM	Channel Type	% Habitat Types: Pool	LGR	HGR	Flat Water	Cascade Falls
I	0.0-0.25	C3	10	75	0	15	0
II	1.0-1.25	C3	20	30	10	40	0
III	2.0-2.25	B3	35	9	26	9	18
IV	3.0-3.23	B1	29	0	43	0	28
V	3.23-3.48	B1	43	21	15	0	21
I	0.0-0.25	B1	46	11	16	16	11

Reach	Average Stream (meters): Width	Depth	Pool Depth	Bankfull Width	Dominant Instream Cover[a]	Substrate Mix[b]	Percent Embeddedness
I	5.0	0.3	0.4	23.0	LWD	GCS	25-49%
II	9.0	0.3	1.0	13.0	Ter Veg	CGS	25-49%
III	6.5	0.4	1.3	7.0	Subst	CBeG	25-49%
IV	8.0	0.3	1.5	10.0	Subst	BoCG	25-49%
V	3.2	0.2	0.8	6.2	Subst	BoCG	5-24%
I	3.5	0.3	1.3	5.1	Subst	BoCg	25-49%

Reach	Ratings[c]: Rearing Habitat	Spawning Habitat	Riparian Cover	Streambank Stability	Number Instream LWD
I	Fair	Mod	Fair	Mod	2
II	Mod	Fair	Mod	Mod	7
III	Mod	Min	Exc	Exc	4
IV	Exc	Mod	Exc	Mod	7
V	Mod	Mod	Exc	Exc	26
I	Mod	Fair	Exc	Mod	16

[a]Instream Cover: Ter Veg=Terrestrial Vegetation, LWD=Large Woody Debris, Subst=Substrate

[b]Substrate Mix: F=Fines, S=Sand, G=Gravels, C=Cobble, Bo=Bolders, Be=Bedrock: dominant type listed first in sequence.

[c]Ratings: Exc=Excellent, Mod-Moderate, Fair, Min=Minimum, Ext=Extreme

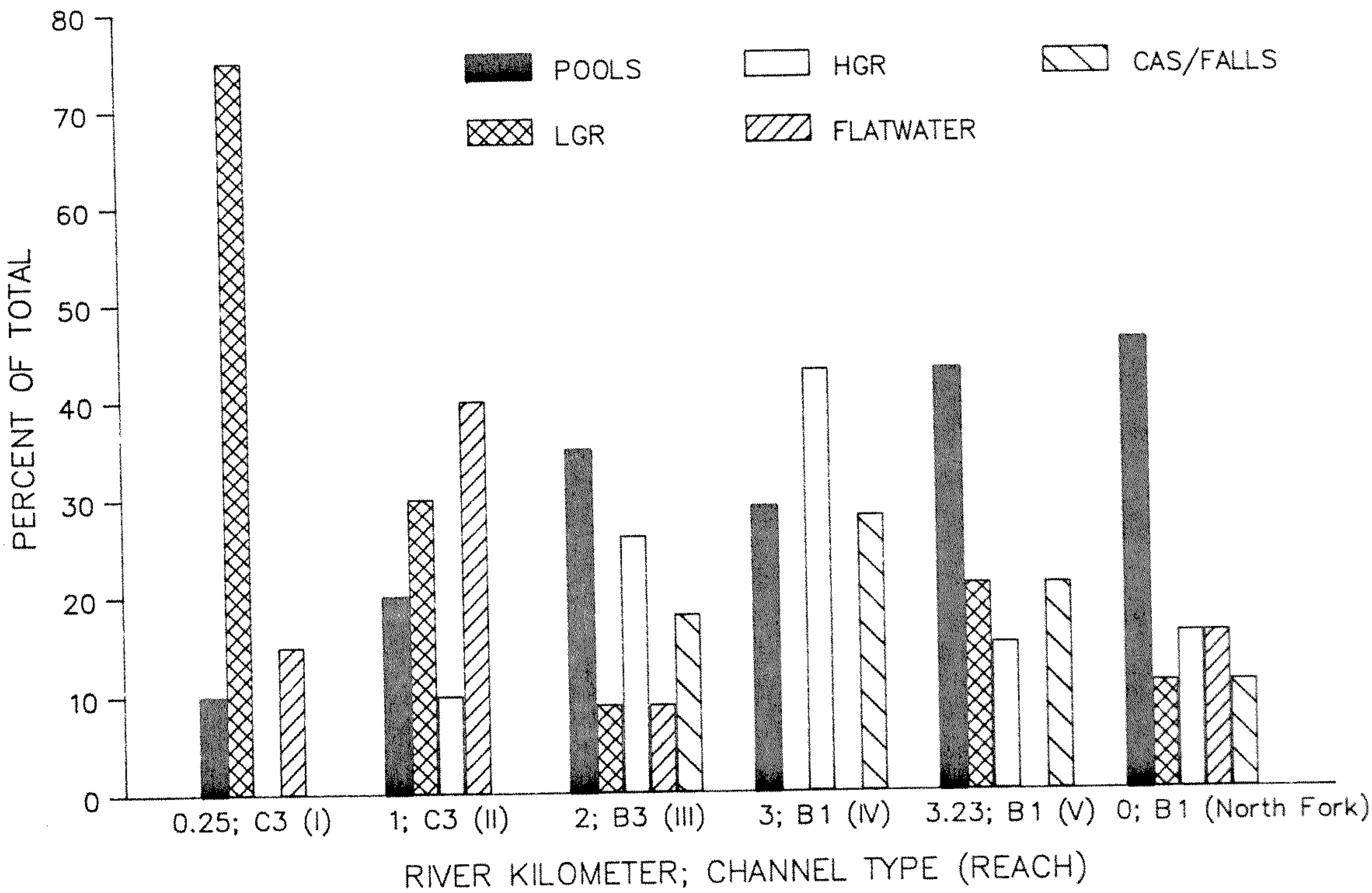

Figure 7. Habitat types occurring in Bear Creek, 1990.

downstream. The falls and cascades may be a migration barrier in low and extreme high flows but could be modified to reduce this possibility.

The last two reaches surveyed on the mainstem (IV and V) are in a steep, well confined stream channel and have a relatively high proportion of pools. Within these reaches rearing habitat, riparian cover, and streambank stability are moderate to excellent in quality and quantity and spawning habitat is more abundant, yet still embedded (Table 7). A 2 m waterfall (at rkm 3.065) is a low flow barrier and its removal would increase access for immigrating salmonids. The gradient in reach V is not as steep as the previous surveyed reach. Pools and flatwater become more abundant while high gradient riffles decrease in occurrence (Figure 7). This portion of the creek is very well confined within steep 15 m high bedrock walls. The bedrock walls are covered by ferns, mosses, a few shrubs, and hardwood trees, six of which show potential for LWD recruitment into the stream and enhance bankside stability. At rkm 3.5, a log jam, which was previously cleared in 1981, is present in a 90° elbow in the stream channel (Figure 8). This jam is not currently a migration barrier but should be inspected after major storm events for any changes in status. In 1978, the USFWS (1979) located a 6.0 m cascade at rkm 4.8 and considered it a natural barrier to fish migration.

The North Fork of Bear Creek is 8.5 km long and was surveyed from its confluence with the mainstem to rkm 0.25. This portion of the creek is in a well confined, steep gradient channel. Adequate instream cover is provided by moderately deep pools, large substrate, and large woody debris (Table 7). Pools made up 46% of the habitat types in this reach followed by riffles (27%), flatwater (16%), and cascades/falls (11%) (Figure 7). Spawning habitat is available in only small isolated pockets of large gravel. The riparian cover is excellent, primarily provided by a canopy of

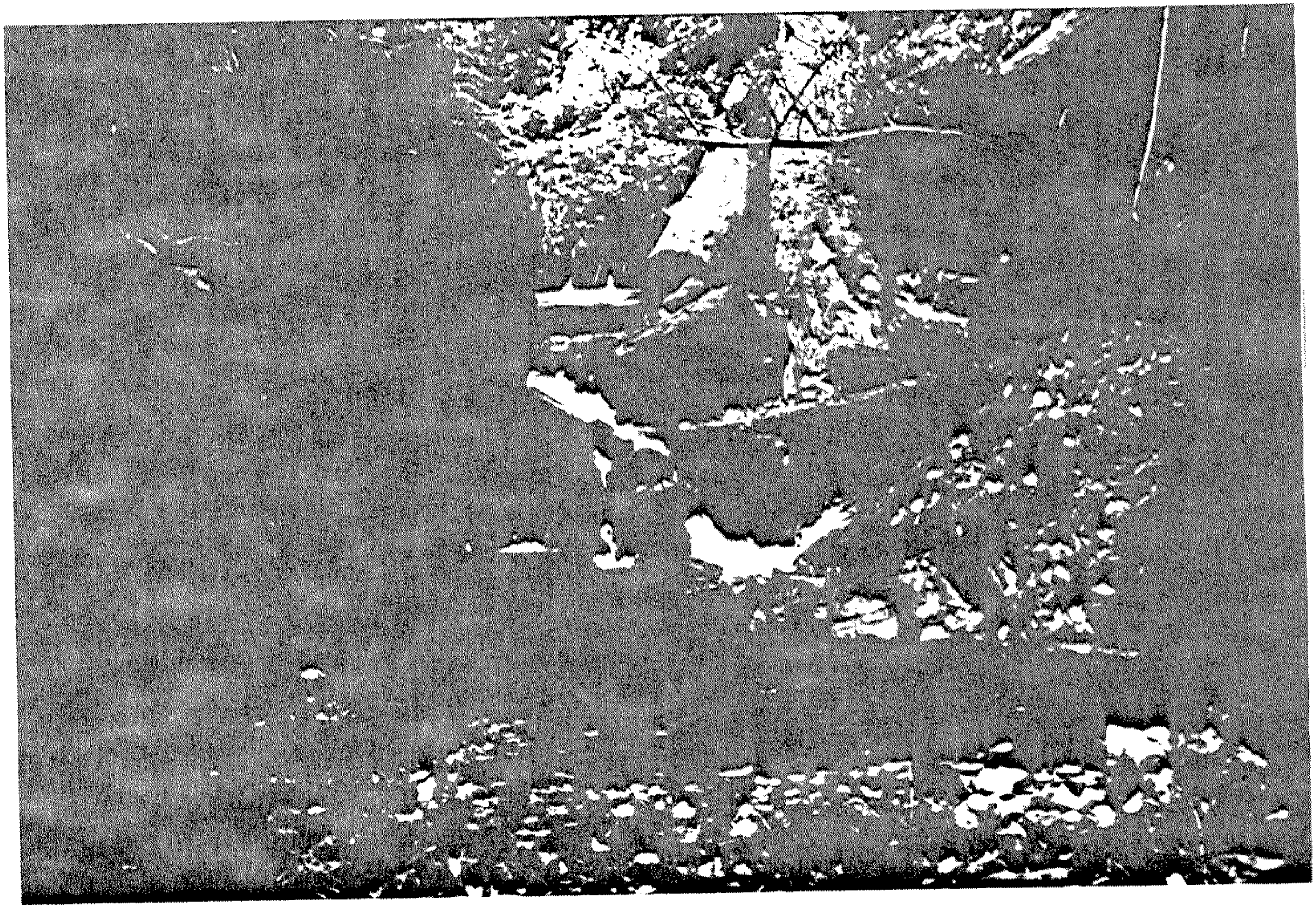

Figure 8. Bear Creek log jam at rkm 3.5.

alders. The immediate streambank is stable, but a small rock debris slide is present on the right bank slope from rkm 0.01 to 0.06. There is a buffer strip of second growth redwoods, alders, shrubs, and grasses that lies between the slide and the streambed. No direct input of sediment or rubble is presently entering the stream from this slide.

Spawning Ground Surveys

As of December 7, 1989, no surface flow had occurred over the mouth of Bear Creek. Bear Creek was not surveyed for spawners as our efforts ended before the stream developed a surface flow. Increased flows after December 7 may have allowed some fish to enter the stream.

Juvenile Trapping Operation

Emigrant trapping ran from April 3 to June 21, 1990, with 10 trap nights completed. The temperature ranged from 10.5 to 16.7°C and averaged 12.6°C over the trapping period (Table 8). The trap was set in a low gradient riffle at rkm 0.2. During the trapping period, Bear Creek went subsurface on two occasions: once in mid- April and again in mid-May. On both of these occasions, 5 cm of precipitation brought the creek back to suitable trapping flows. The creek went subsurface for the remainder of the summer and fall shortly after the last trap day on June 21, 1990.

Bear Creek appears to be predominantly a steelhead stream with only incidental chinook and coho production. The majority of the juvenile catch consisted of yearling steelhead (n=29), followed by chinook (n=7), coho (n=1), and cutthroat trout (n=1) (Table 4). The extrapolated number of yearling steelhead emigrating from the stream over the trapping period was 499 (Table 5). The chinook averaged 78 mm in fork length (FL) and the steelhead yearlings averaged 104 mm FL. Exploratory electroshocking on June 4, 1990, captured 7 steelhead fry from edgewater areas about 0.5 km upstream from

Table 8. Bear Creek trapping and salmonid catch data in 1990.

Date	Weather[a]	Moon Phase[b]	Percent Stream Sampled	Total Hours Fished	Temperature (C°)[c]	Flow (ft/sec)
4/03/90	Clear	FQ	100	22	8.8	2.06
4/23/90	PtCld	NM	26	22	12.2-9.4	1.98[d]
4/27/90	Clear	NM	100	24	12.2	
5/01/90	Clear	FQ	100	22	14.4-8.8	1.10
5/23/90	OverC	NM	26	25	11.7-9.4	3.13
5/24/90	PtCld	NM	100	23	11.7-8.8	2.21
6/07/90	Clear	FM	49	25	14.4-10	2.15
6/13/90	Clear	LQ	100	20	13.3-10	2.25
6/14/90	Clear	LQ	100	24	15-10	
6/21/90	OverC	NM	100	23	17.2-12.8	1.19

Salmonid Catch

Date	Chinook	Steelhead		Coho	Cutthroat Trout
		Fry	Yearlings		
4/03/90	0	0	16	0	0
4/23/90	0	0	0	0	0
4/27/90	0	0	0	0	0
5/01/90	0	0	3	0	1
5/23/90	0	0	2	0	0
5/24/90	0	0	1	0	0
6/07/90	0	0	0	0	0
6/13/90	0	0	1	0	0
6/14/90	0	0	3	0	0
6/21/90	7	0	3	1	0

[a]Weather: Clear, OverC = Over Cast, LtRain = Light Rain

[b]Lunar Phase:NM = New Moon, FQ = First Quarter, FM = Full Moon, LQ = last Quarter

[c]Temperature given as maximum-minimum; single entry for temperature taken during trap installation only

[d]Entire stream discharge

the mouth of the creek. With the presence of fry in the creek, 100% of the stream sampled, and no steelhead fry captured in the trap, it is probable that the fry were not actively migrating out of the system and may overwinter in the stream or move out with fall rains. Non-salmonid species captured are listed in table 4.

Yearling steelhead emigration trends were similar to those of Hunter Creek, with an initial peak on the first day of trapping and a second smaller peak four weeks later (Figures 4 and 9). There was no significant correlation between yearling steelhead emigration and weather or lunar phase (P>0.8 for both).

Tectah Creek

Habitat Inventories

Tectah Creek drains a watershed of 51.5 km^2 and enters the Klamath River at rkm 35.6. Tectah Creek is 23.6 km in length; however, we surveyed only the lower 8.5 km (Figure 10). Channel types in the surveyed areas were a low gradient "C" type near the mouth and upper most surveyed reach, and two "B" types representing areas of increased gradient and channel confinement (Table 9). The mouth of Tectah Creek exits over a gravel, cobble, and sand delta and seasonally becomes subsurface forming an immigration and emigration barrier to salmonids.

Rearing habitat was excellent throughout the surveyed areas with the exception of the first reach which had minimal instream cover (Table 9). The quantity of spawning habitat is moderate to good, but embeddedness often reduces the quality of the gravel. Pools dominate habitat types in most reaches and increase in depth and terrestrial cover above the first surveyed reach (Figure 11). The riparian vegetation zone and the cover it provides is in moderate to excellent condition throughout all but the first reach. Instream cover is provided primarily by a boulder and cobble substrate followed

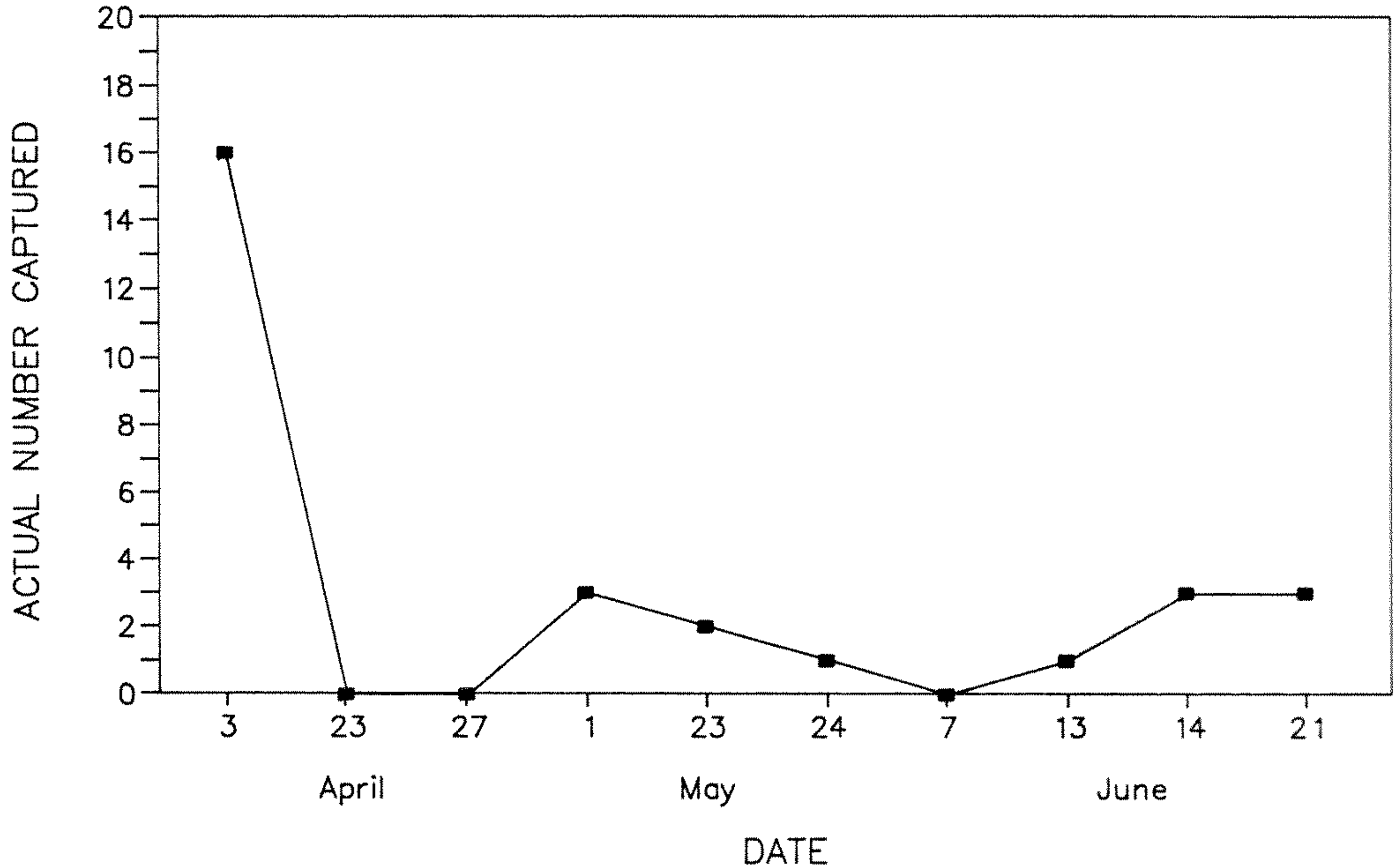

Figure 9. Emigration pattern of yearling steelhead from Bear Creek, spring 1990

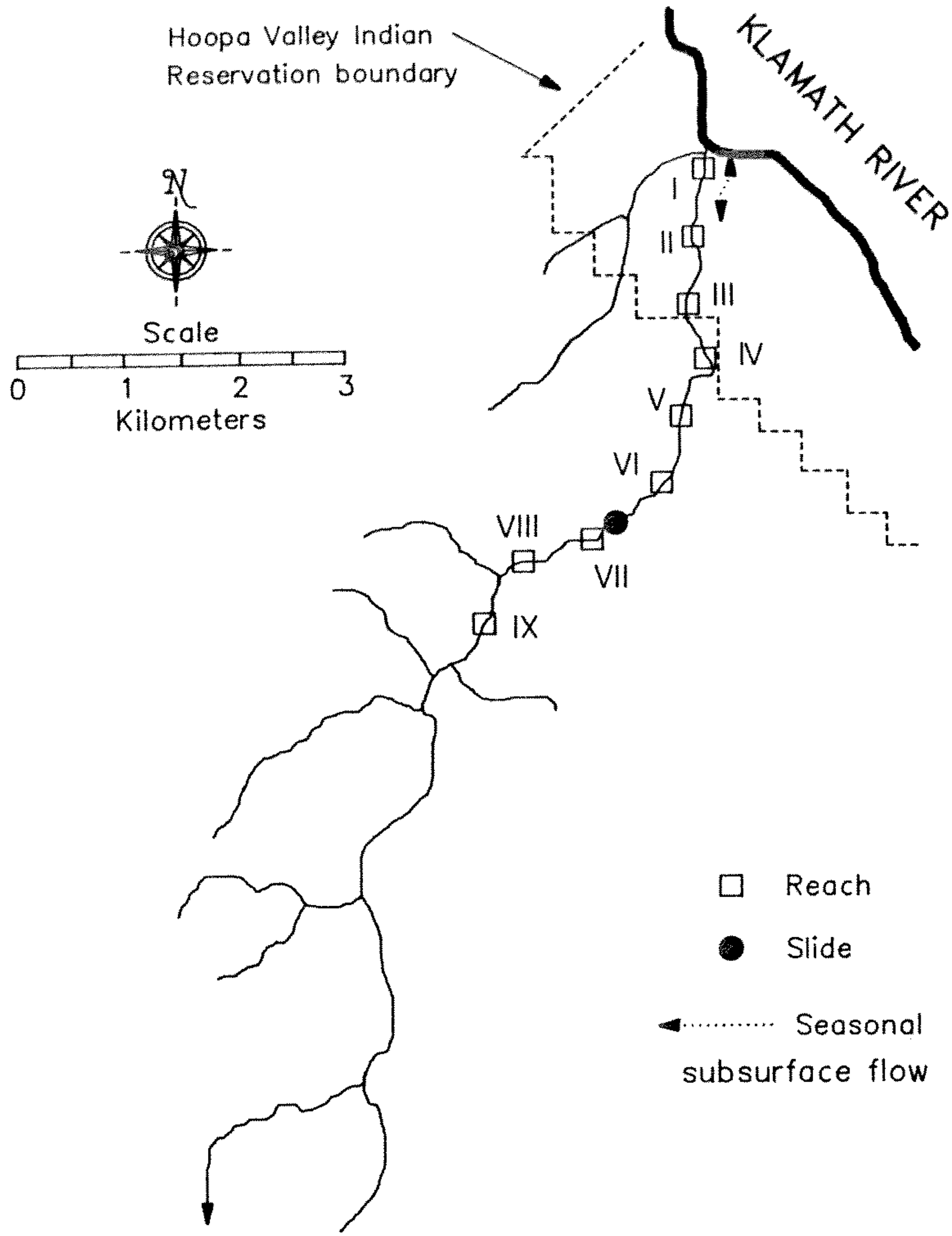

Figure 10. Tectah Creek showing surveyed reaches and large slide.

Table 9. Physical stream characteristics and inventory ratings for Tectah Creek.

Reach	RKM	Channel Type	% Habitat Types: Pool	LGR	HGR	Flat Water	Cascade Falls
I	0.25-0.5	C3	43	29	14	14	0
II	1.25-1.5	C3	57	14	0	29	0
III	2.25-2.5	B2	17	17	33	33	0
IV	3.25-3.5	B2	43	0	29	14	14
V	4.25-4.5	B1	44	0	12	22	22
VI	5.25-5.5	B1	38	12	12	38	0
VII	6.25-6.5	B2	38	38	0	24	0
VIII	7.25-7.5	B2	43	14	0	43	0
IX	8.25-8.5	C3	50	25	0	25	0

Reach	Average Stream (meters): Width	Depth	Pool Depth	Bankfull Width	Dominant Instream Cover[a]	Substrate Mix[b]	Percent Embeddedness
I	8.2	0.3	0.4	15.0	Subst	CGS	5-23%
II	7.0	0.3	1.4	15.0	LWD	CGS	25-49%
III	8.0	0.3	1.1	9.0	Ter Veg	BoCG	25-49%
IV	8.0	0.3	1.4	9.5	Subst	BoCG	25-49%
V	8.0	0.3	1.0	13.0	Subst	BoCS	5-24%
VI	6.0	0.3	0.8	9.5	Bedrk	BeCBo	5-24%
VII	8.5	0.3	0.9	12.0	Subst	CGS	25-49%
VIII	7.5	0.2	1.3	10.0	Subst	GCS	25-49%
IX	8.5	0.4	0.7	14.0	Subst	CBoG	25-49%

Reach	Ratings[c]: Rearing Habitat	Spawning Habitat	Riparian Cover	Streambank Stability	Number Instream LWD
I	Fair	Mod	Mod	Mod	3
II	Exc	Mod	Mod	Mod	5
III	Exc	Mod	Mod	Exc	1
IV	Exc	Mod	Exc	Fair	3
V	Exc	Mod	Mod	Exc	0
VI	Exc	Mod	Mod	Exc	3
VII	Exc	Exc	Mod	Exc	2
VIII	Exc	Exc	Exc	Exc	1
IX	Exc	Mod	Exc	Exc	4

[a]Instream Cover: Ter Veg=Terrestrial Vegetation, LWD=Large Woody Debris, Subst=Substrate
[b]Substrate Mix: F=Fines, S=Sand, G=Gravels, C=Cobble, Bo=Bolders, Be=Bedrock: dominant type listed first in sequence.
[c]Ratings: Exc=Excellent, Mod-Moderate, Fair, Min=Minimum, Ext=Extreme

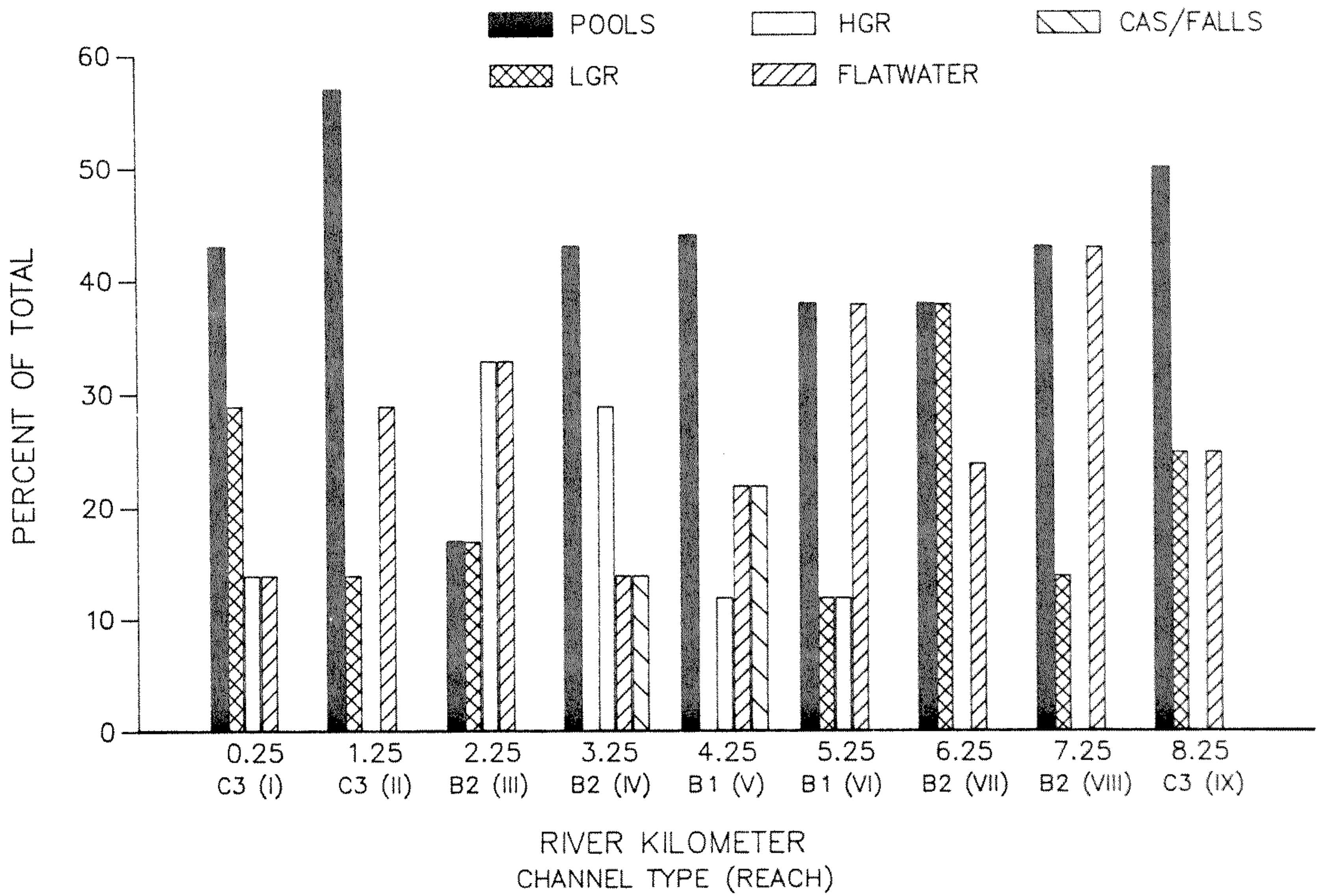

Figure 11. Habitat types occurring in Tectah Creek, 1990.

by terrestrial vegetation and bedrock ledges. Only one potential barrier (at rkm 4.46) may impede adult salmonid migration during low flows: a 1.5 m falls over a wall of boulders that lacks a plunge pool. Historically, clearcut logging has taken place throughout the watershed, and logged areas are now in various stages of recovery (Earth Sciences Associates 1980). On the upper slopes of the lower watershed, recent clearcut logging activities are apparent; however, no slides are visible from the stream channel. Since slope stability often relies on the presence of tree and shrub root systems, the removal of trees and the eventual decomposition of their root systems will increase the instability of a slope (Swanston 1974). The potential of slope failure could increase in this drainage over time as root systems in clearcut areas decompose. This may be occurring in survey reaches IV - VI where four small slides (<20 m across the bases) are delivering cobble, gravel, and fines into the stream channel. These slides may be considered minor, however, when compared to a substantial rock debris avalanche at rkm 6.1. This slide extends 130 m along the right bank and 97 m upslope, is unstable, and is devoid of vegetation (Figure 12). A log jam has formed at the downstream end of the slide. It has resulted in the retention of rock debris and caused a 0.5 m elevational increase in the streambed. Rock debris from this slide can be found 100 m downstream. The presence of this large slide suggests that the watershed has potential for large slope failure.

The possibility for large woody debris recruitment is moderate to excellent as some old growth and second growth redwoods are present along the streambank and on the slopes. Instream large woody debris, however, is sparse throughout the surveyed reaches (22 pieces, all reaches combined) and may have been removed from the stream following the last timber harvest activity in the area. Logging debris along the

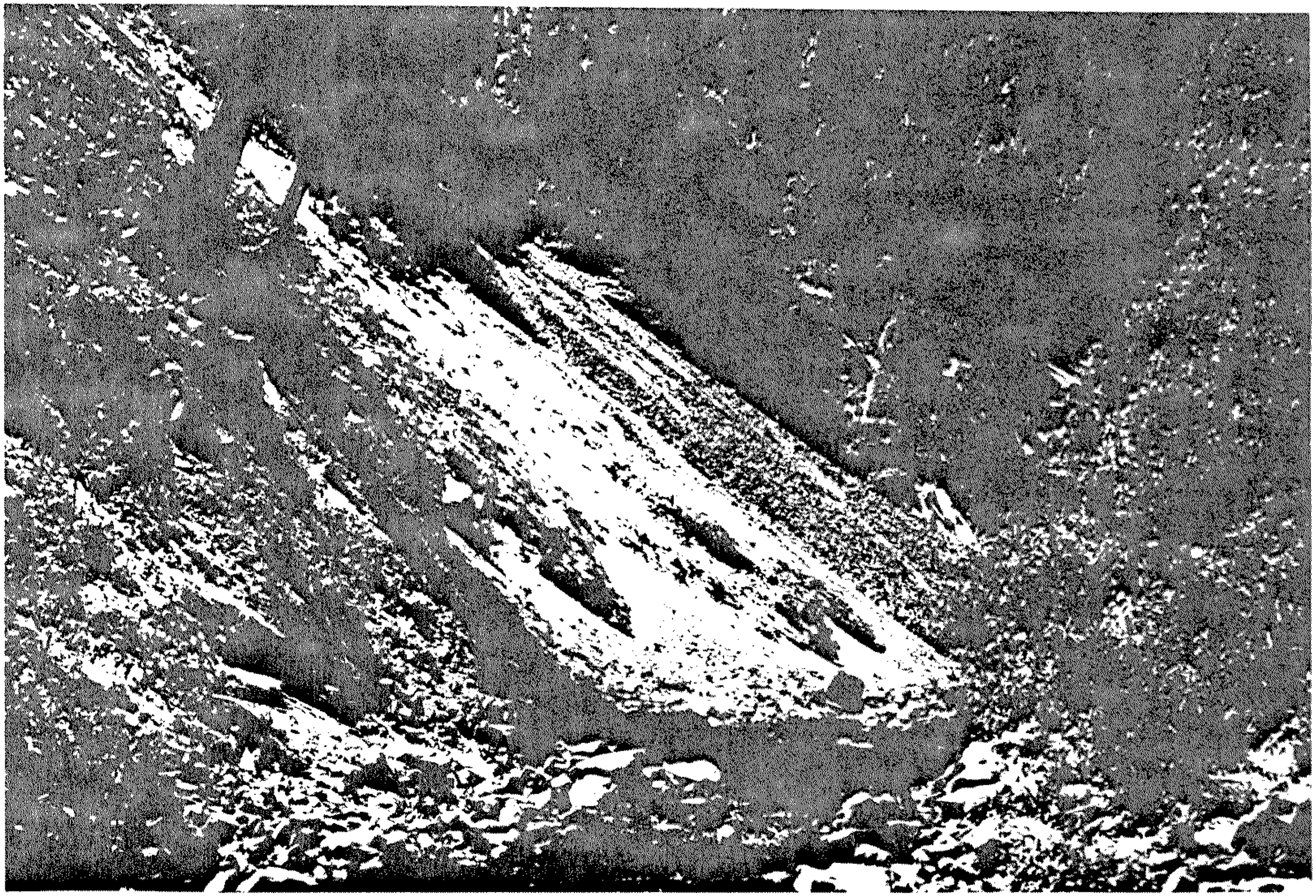

Figure 12. Tectah Creek slide at rkm 6.1, summer 1990.

streamsides and slopes, often exceeding 2 m in diameter, could be brought into the channel following large flood events.

Based on habitat quality and quantity, Tectah Creek may be underused by salmonids. Enhancement efforts to improve cover in the lower 1.5 rkm would benefit both juveniles and adults. Efforts should be made to stabilize slopes and impede sediments from entering the creek from the large slide at rkm 6.1. The healing of the watershed through reforestation in clearcut areas could be enhanced if unused roads were "put to bed".

Spawning Ground Surveys

Tectah Creek was surveyed for spawning chinook on November 17 and 27, and December 7, 1989, from the mouth to rkm 2.0, 3.5, and 2.5, respectively. In November, four redds were found between rkm 1.0 and 2.0, and one fresh redd was found at rkm 2.3 in December. No salmonid carcasses or adults were seen on these surveys.

Juvenile Trapping Operation

Juvenile outmigrant trapping took place at rkm 0.5 from April 3 to July 5, 1990. Fifteen trap nights were completed within this period. Of all streams investigated in 1990, Tectah Creek produced the largest numbers of chinook fry (n=19) and steelhead yearlings (n=65). Average fork length for juvenile chinook, yearling steelhead, and juvenile coho was 78, 96, and 64 mm, respectively. No steelhead fry were captured. Emigration of steelhead yearlings peaked on April 17, with less pronounced peaks occurring on May 15 and June 28 (Figure 13). All juvenile chinook were captured over the last four trap nights with a peak occurring on June 27, 1990 (Figure 13). Juvenile coho (13) were captured throughout the trapping period. Extrapolated numbers for emigrating chinook over the trapping period was 236. There was no significant correlation between yearling steelhead emigration and weather

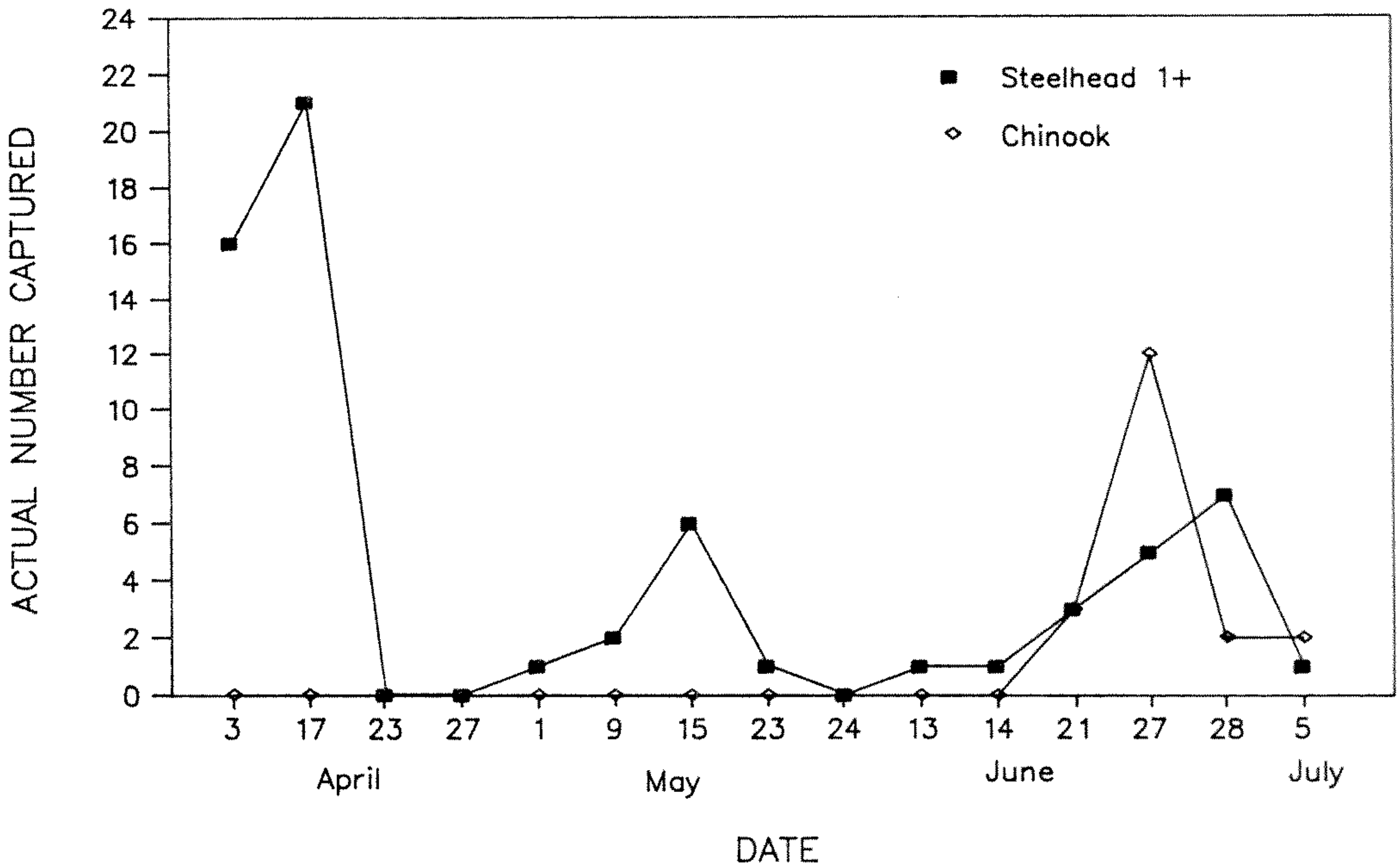

Figure 13. Emigration pattern of juvenile salmonids from Tectah Creek, spring 1990.

or lunar phase (P=0.3 and 0.8, respectively). Temperatures ranged from 12.2 to 16.1°C and averaged 13.3°C over the trapping period (Table 10). Non-salmonid species captured are listed in Table 4.

In 1989, 11 trap nights captured 87 chinook, 85 steelhead fry, 22 yearling steelhead, and 6 coho (Noble and Lintz 1990). There were no similarities between chinook emigrant peaks in 1989 and 1990; however, yearling steelhead showed one similarity between years with the first emigration peak occurring in early April.

Tully Creek

Habitat Inventories

Tully Creek is 15.5 km long with a drainage area of 45 km^2 and enters the Klamath River at rkm 62.0. This stream has a year round surface flow. The mouth of Tully Creek does not have an active delta, but vast amounts of gravel were deposited in the creek just upstream of its mouth by the 1964 flood. The gravel deposit ranges to 30 m in height above the streambed and is approximately 110 m long and 60 m wide. The stream has carved a channel through this immense gravel pile. Just upstream of the gravel deposit and coursing through it (from rkm 0.09 to 0.22), the stream drops down a steep boulder cascade with a 19% (11°) gradient. This may be an effective chinook salmon barrier during low flows.

Habitat conditions from the mouth to rkm 2.75 were assessed in summer 1990. Two channel types were encountered in Tully Creek: a B1-1 in reach I and an A2 in reaches II and III (Figure 14). These channel types have gradients of 1.5 to 4.0% and 4 to 10% (B1-1 and A2, respectively). These steep gradients typically exhibit poor spawning gravel retention. In the areas surveyed, spawning habitat was found to be available in very small isolated pockets of moderately embedded substrate (Table 11). Rearing habitat is abundant in all reaches. Instream cover consists of large substrate and

Table 10. Tectah Creek trapping and salmonid catch data in 1990.

Date	Weather[a]	Moon Phase[b]	Percent Stream Sampled	Total Hours Fished	Temperature (C°)[c]	Flow (ft/sec)
4/3/90	Clear	FQ	100	22	12.8-9.4	1.30
4/17/90	PtCld	LQ	100	24	12.8-10.5	0.68[d]
4/23/90	PtCld	NM	90	22	12.2	2.26[d]
4/27/90	Clear	NM	100	25	12.8-12.2	
5/1/90	Clear	FQ	100	22	13.9-10	1.04[d]
5/9/90	OverC	FM	100	25	13.3-10	0.73
5/15/90	Clear	LQ	100	22	13.9-12.2	0.78
5/23/90	OverC	NM	59	25	11.1-8.8	2.17
5/24/90	PtCld	NM	77	22	13.3-7.8	2.29
6/13/90	Clear	LQ	100	22	14.4-10	1.72
6/14/90	Clear	LQ	100	22	14.4-12.2	1.72
6/21/90	OverC	NM	100	21	18.9-15	1.58
6/27/90	Clear	FQ	100	15	16.7-11.7	1.17
6/28/90	Clear	FQ	100	27	16.1-11.7	1.17
7/5/90	PtCld	FM	89	22	16.7-13.3	1.30

Salmonid Catch

Date	Chinook	Steelhead		Coho	Cutthroat Trout
		Fry	Yearlings		
4/3/90	0	0	16	5	0
4/17/90	0	0	21	1	0
4/23/90	0	0	0	0	0
4/27/90	0	0	0	0	0
5/1/90	0	0	1	2	0
5/9/90	0	0	2	0	0
5/15/90	0	0	6	0	0
5/23/90	0	0	1	1	0
5/24/90	0	0	0	0	0
6/13/90	0	0	1	0	0
6/14/90	0	0	1	1	0
6/21/90	3	0	3	0	0
6/27/90	12	0	5	0	0
6/28/90	2	0	7	0	0
7/5/90	2	0	1	3	0

[a]Weather: Clear, OverC = Over Cast, LtRain = Light Rain

[b]Lunar Phase:NM = New Moon, FQ = First Quarter, FM = Full Moon, LQ = last Quarter

[c]Temperature given as maximum-minimum; single entry for temperature taken during trap installation only

[d]Entire stream discharge

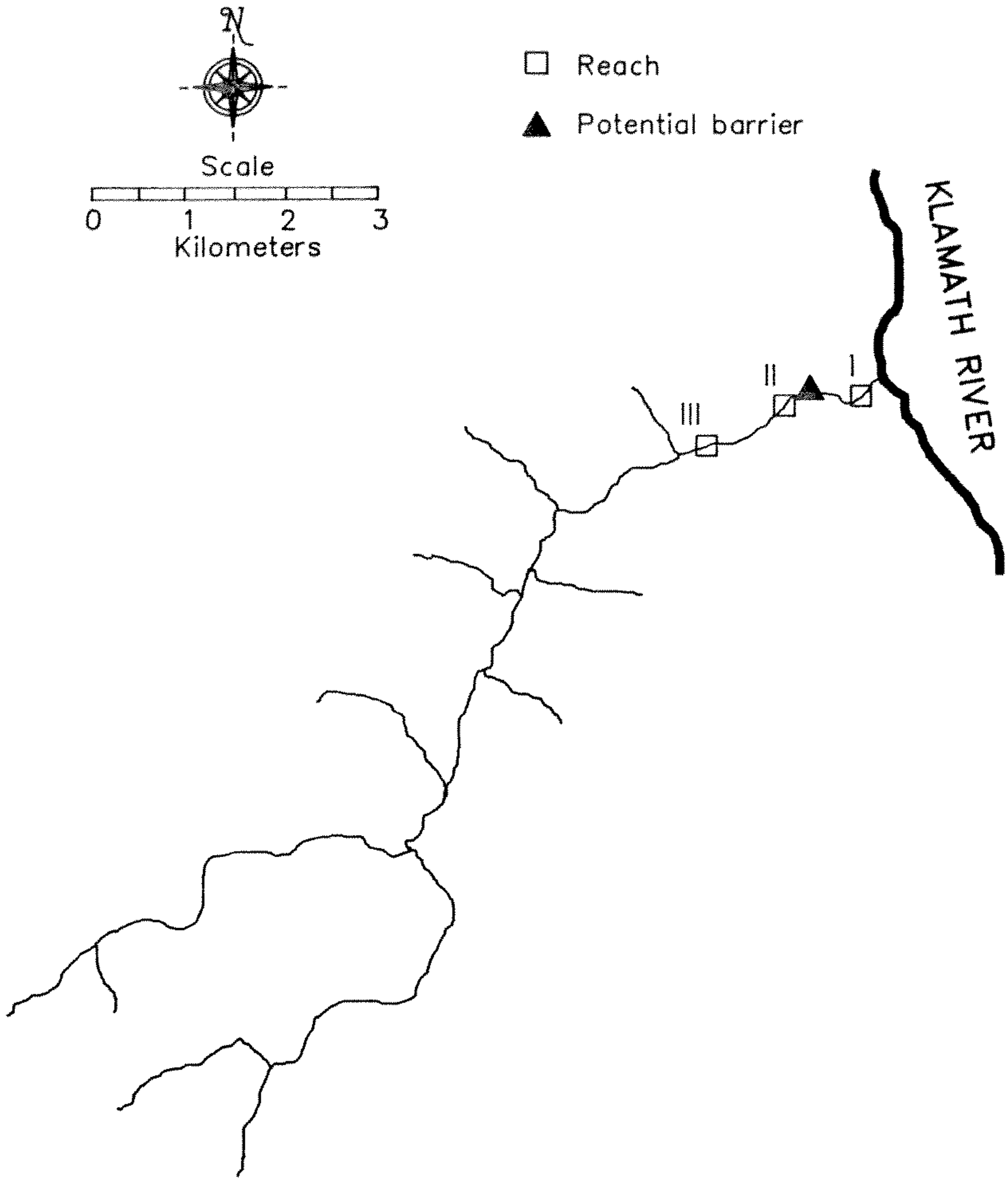

Figure 14. Tully Creek showing surveyed reaches and potential barrier.

Table 11. Physical stream characteristics and inventory ratings for Tully Creek.

Reach	RKM	Channel Type	% Habitat Types: Pool	LGR	HGR	Flat Water	Cascade Falls
I	0.50-0.75	B1-1	37	6	13	65	38
II	1.50-1.75	A2	46	0	15	0	39
III	2.50-2.75	A2	34	11	22	11	22

Reach	Average Stream (meters): Width	Depth	Pool Depth	Bankfull Width	Dominant Instream Cover[a]	Substrate Mix[b]	Percent Embeddedness
I	7.0	0.5	1.0	9.0	Subst	BoCS	25-49%
II	6.0	0.1	0.5	14.3	Subst	BoCG	50-74%
III	6.3	0.3	0.6	17.3	Subst	BoCG	25-49%

Reach	Ratings[c]: Rearing Habitat	Spawning Habitat	Riparian Cover	Streambank Stability	Number Instream LWD
I	Exc	Min	Mod	Exc	5
II	Mod	Fair	Mod	Exc	7
III	Mod	Fair	Mod	Exc	5

[a]Instream Cover: Ter Veg=Terrestrial Vegetation, LWD=Large Woody Debris, Subst=Substrate

[b]Substrate Mix: F=Fines, S=Sand, G=Gravels, C=Cobble, Bo=Bolders, Be=Bedrock: dominant type listed first in sequence.

[c]Ratings: Exc=Excellent, Mod-Moderate, Fair, Min=Minimum, Ext=Extreme

moderately deep pools (Table 11). Riparian vegetation is prolific and provides a fragmented shade canopy over the streambed. The streambanks are steep and appear to be stable; however, in some areas between surveyed reaches, occasional small slides (<30 m across the base) were observed. Instream large woody debris was observed in all the reaches (Table 11). Several potential log jams were found above the wetted stream channel, possibly deposited there by the 1964 flood. The high proportion of cascade/falls (33%) was indicative of the steep nature of the stream (Table 11 and Figure 15). Small pools associated with the cascades were the dominant habitat type in all three reaches (Figure 15).

Several falls, with an average 1.5 m drop into a 2 m pool, were encountered. All of these falls were not impassible barriers, having an average "height-of-falls to depth-of-pool" ratio of 1:1.25 (Stuart 1962). A boulder/log jam at rkm 1.24, however, has a 2 m falls which filters through small and large woody debris before dropping directly onto boulders and an adjacent 1.2 m deep pool (Figure 16). This area is a potential barrier to all salmonids during low flow; only after flows substantially increase could fish ascend this area. At high flows, an overflow channel on the right bank may provide a passage for salmonid migration. The overflow passage includes a 3 m high course over a steep boulder incline. Steelhead fry were found above this barrier in 1989 and 1990.

On Tully Creek, the steep boulder cascade below rkm 0.25 and the boulder log jam at rkm 1.24 may be barriers to chinook and seasonal (low flow) barriers to steelhead and coho. Reducing the gradient down the first 0.25 km and improving passage at rkm 1.24 would allow immigrating steelhead and other salmonids access into the upper reaches of the creek. The removal of the logs from the boulder/log jam may be enough to reestablish the stream flow into the pool below. If water

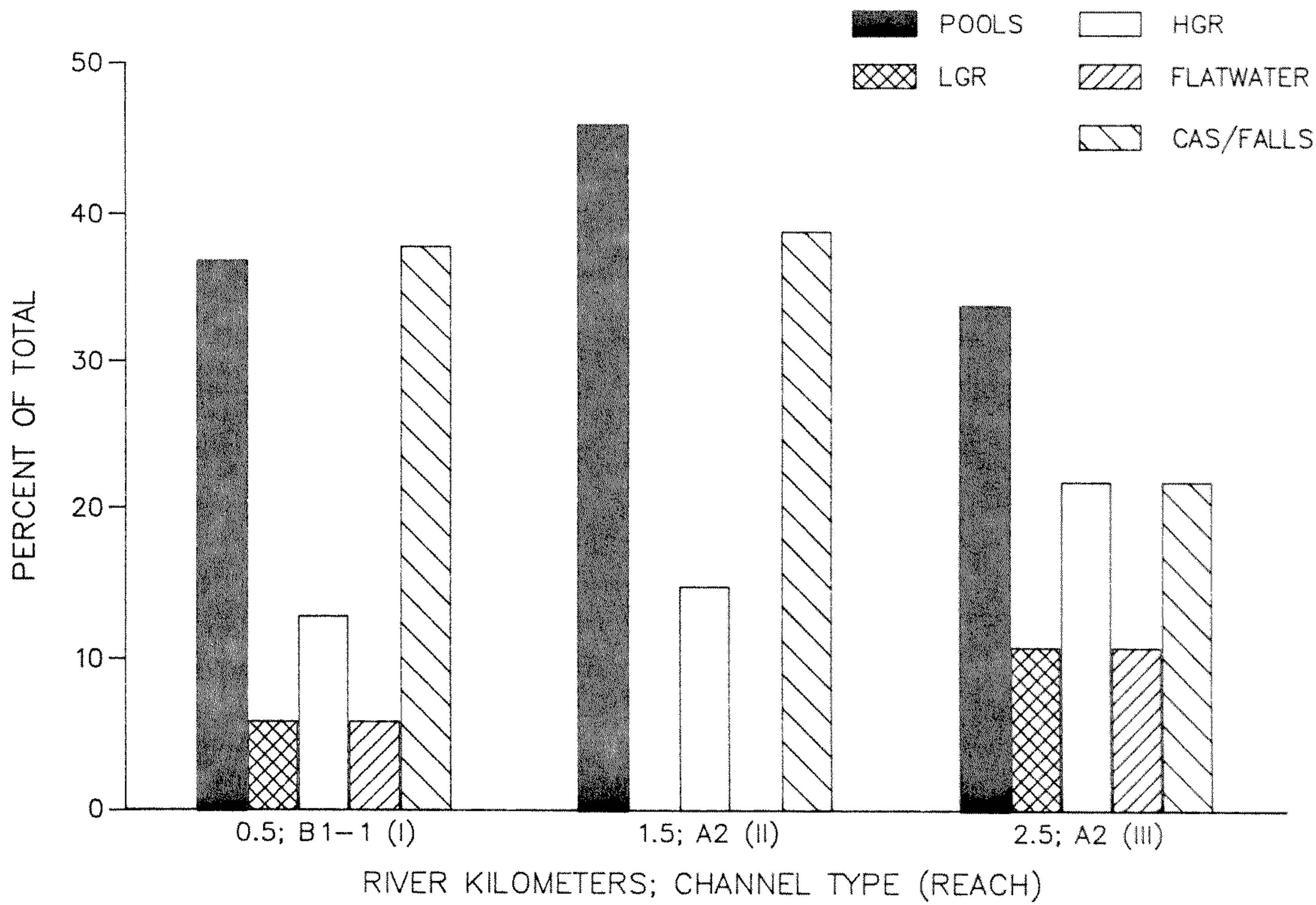

Figure 15. Habitat types occurring in Tully Creek, 1990.

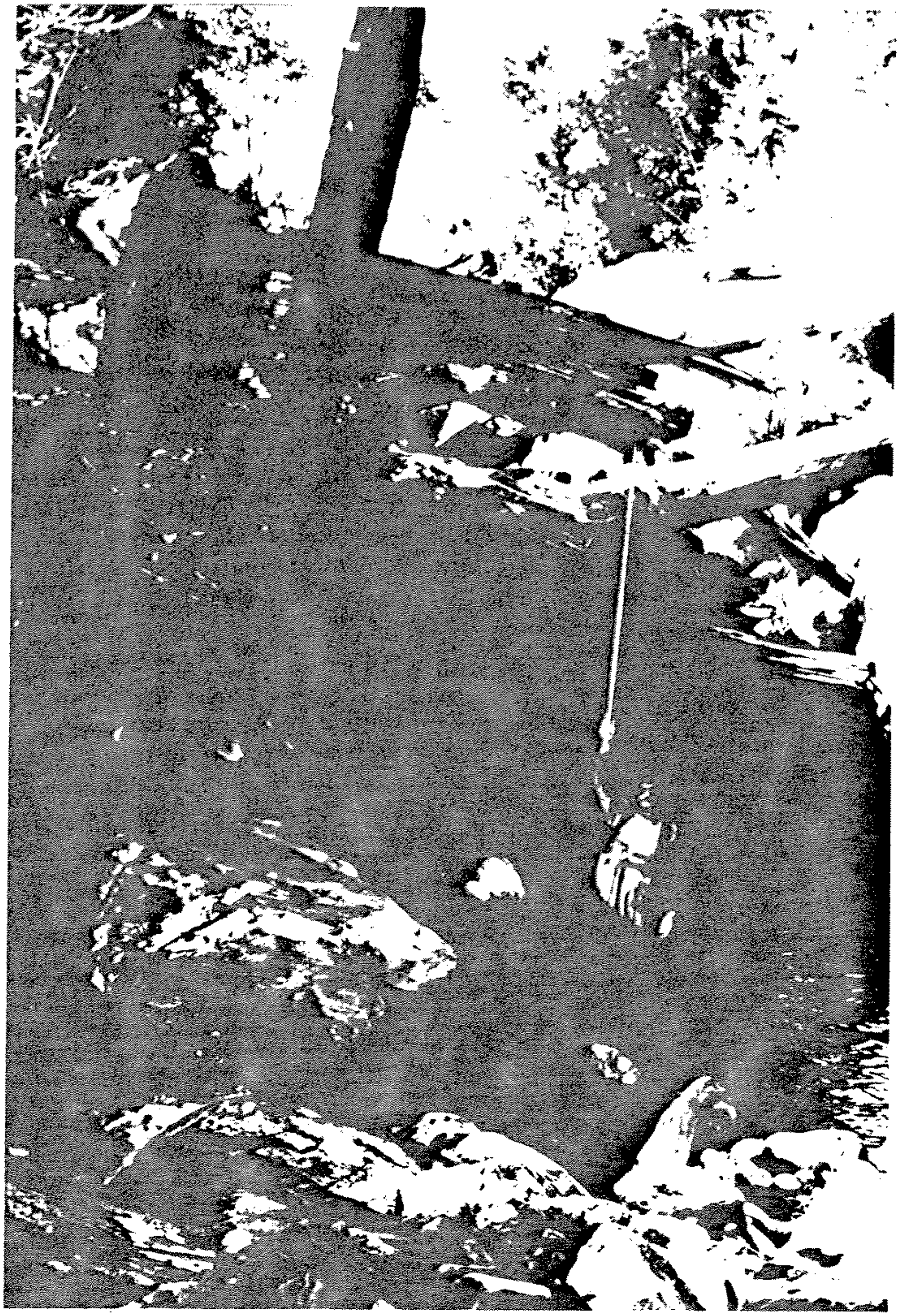

Figure 16. Tully Creek log jam at rkm 1.24, spring 1990.

flowed directly from the falls into the pool, salmonids may be able to ascend this area in most flow stages.

Spawning Ground Surveys

One spawner survey was conducted on December 14, 1989, from the mouth to rkm 1.25. No salmonid redds or carcasses were found. Tully Creek is primarily a steelhead stream, but no adults were observed during the survey.

Juvenile Trapping Operation

Outmigrant trapping occurred from April 4 to July 2, 1990, for a total of 12 nights. The trap was located at rkm 0.26. Steelhead fry dominated the catch with 278 fish sampled during the trapping period (Table 12). No chinook fry were captured. Peak emigration of steelhead fry occurred on May 16 and remained high until June 19, 1990 (Figure 17). During that period, 198 steelhead fry were sampled. There were no significant relationships between emigration of steelhead fry and lunar phase or weather conditions (P=0.5 and P=0.6, respectively). The fry averaged 30 mm in FL and exhibited no change in mean length over the trapping period. This may indicate a protracted spawning period resulting in continued emergence over time.

In 1989 and 1990, steelhead fry made up 100% and 96.7% of the salmonid catch, respectively (Noble and Lintz 1989). The low numbers of steelhead yearlings (n=9) suggest that the fry may not rear in Tully Creek. As rearing habitats were rated moderate to excellent in the three surveyed reaches, some other factor besides rearing habitat must be influencing the fry to leave this watershed.

One coho (46 mm) was trapped in spring 1990, indicating that the steep gradient just above the mouth may not be a total barrier to coho immigration. Stream temperature ranged from 10.5 to 14.4°C with an average temperature of 12.2°C over

Table 12. Tully Creek trapping and salmonid catch data in 1990.

Date	Weather[a]	Moon Phase[b]	Percent Stream Sampled	Total Hours Fished	Temperature (C°)[c]	Flow (ft/sec)
4/4/90	PtCld	FQ	79	18	12.2-10.5	1.98
4/16/90	OverC	LQ	100	27	12.8-10.5	2.28
4/19/90	PtCld	LQ	98	22	12.2-10.5	1.20[d]
4/25/90	Clear	NM	57	26	11.7	1.20[d]
5/2/90	Clear	FQ	100	25	12.2	1.85
5/8/90	Clear	FM	100	22	12.8-10.5	1.69
5/16/90	Clear	LQ	88	21	12.2	1.54
5/17/90	OverC	LQ	88	26	12.2	
6/12/90	Clear	FM	37	23	10.0-11.7	1.08
6/19/90	Clear	LQ	62	22	13.9-12.2	
6/25/90	Clear	NM	63	23	15.0-12.2	1.34
7/2/90	Clear	FQ	60	21	14.4	0.96

Salmonid Catch

Date	Chinook	Steelhead		Coho	Cutthroat Trout
		Fry	Yearlings		
4/4/90	0	0	1	0	0
4/16/90	0	18	0	0	0
4/19/90	0	2	0	0	0
4/25/90	0	0	4	0	0
5/2/90	0	5	1	0	0
5/8/90	0	4	1	0	0
5/16/90	0	44	0	0	0
5/17/90	0	54	1	0	0
6/12/90	0	50	0	0	0
6/19/90	0	50	0	0	0
6/25/90	0	37	0	0	0
7/2/90	0	14	1	0	0

[a]Weather: Clear, OverC = Over Cast, LtRain = Light Rain

[b]Lunar Phase:NM = New Moon, FQ = First Quarter, FM = Full Moon, LQ = last Quarter

[c]Temperature given as maximum-minimum; single entry for temperature taken during trap installation only

[d]Entire stream discharge

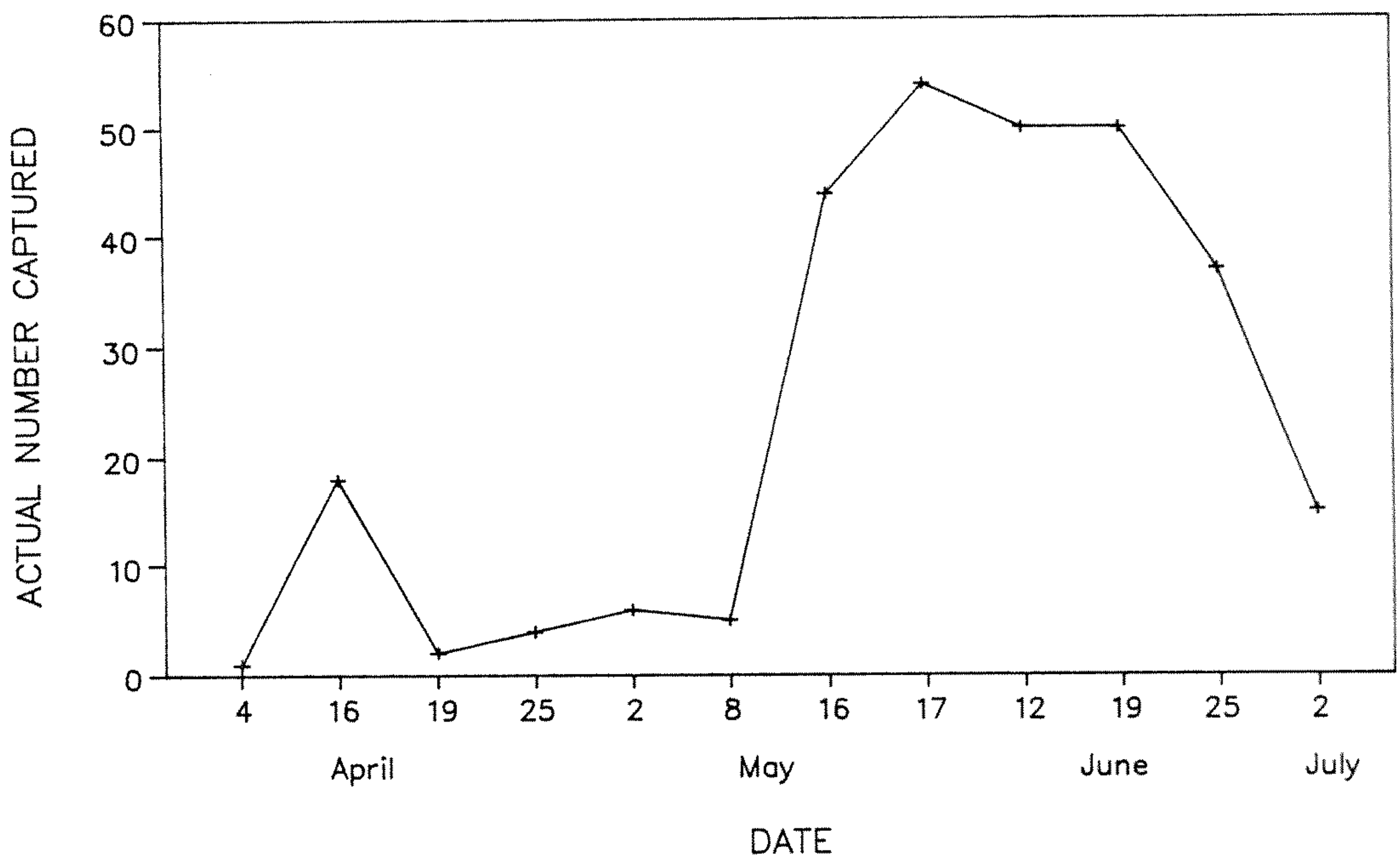

Figure 17. Emigration pattern of steelhead fry from Tully Creek, spring 1990.

the trapping period (Table 12). Non-salmonid species captured are listed in Table 4.

Pine Creek

Habitat Inventories

To avert duplication of effort, we did not habitat inventory Pine Creek. The stream was received a comprehensive habitat survey by the Hoopa Valley Business Council.

Spawning Ground Surveys

On November 13, 1989, a survey for chinook spawners was conducted from rkm 0.7 to 3.0. Eight redds, eight live chinook adults, and one jack chinook were found. A survey two days later (November 15), from rkm 0.7 to 4.5, revealed 15 more redds, three live chinook adults, and one chinook carcass. The carcass was a four year-old, spawned-out chinook female, 74 cm in length. Scale analysis suggested she was possibly of hatchery origin. A survey from the Pine Creek confluence with Little Pine Creek to rkm 4.5 took place on November 16. No redds or adult salmonids were seen. A long cascade (at rkm 4.5) represents a low flow barrier to adult chinook salmon. No adult chinook were seen above this barrier, but yearling steelhead were observed.

Juvenile Trapping Operation

Outmigrant trapping at rkm 0.7 began on April 16 and ended on July 2, 1990; 9 trap nights were completed (Table 13). High flows in early April and again in late May impaired our trapping efforts. Steelhead fry made up the bulk of the catch with 284 sampled (mean FL=33 mm). Eight steelhead yearlings (mean FL=95 mm) and 2 chinook fry (FL=65 and 70 mm) were also captured (Table 13). Steelhead fry emigration first peaked on April 19, with another peak beginning on July 2 (Figure 18). The extrapolated number of steelhead fry emigrating over the trapping period was 5,181 (Table 5).

Table 13. Pine Creek trapping and salmonid catch data in 1990.

Date	Weather[a]	Moon Phase[b]	Percent Stream Sampled	Total Hours Fished	Temperature (C°)[c]	Flow (ft/sec)
4/16/90	OverC	LQ	25	25	13.3-11.1	1.51
4/19/90	PtCld	LQ	47	20	13.3-11.1	1.89[d]
4/25/90	Clear	NM	44	19	9.4	1.69[d]
5/2/90	Clear	FQ	48	26	14.4	1.16
5/8/90	Clear	FM	63	22	12.8	1.11
5/16/90	Clear	LQ	96	22	13.3-15.5	1.53
5/17/90	OverC	LQ	96	25	13.3-10	
6/25/90	Clear	NM	74	24	15.0-12.2	1.68
7/2/90	Clear	FQ	62	23	18.3-12.2	1.75

Salmonid Catch

Date	Chinook	Steelhead		Coho	Cutthroat Trout
		Fry	Yearlings		
4/16/90	0	59	0	0	0
4/19/90	0	73	2	0	0
4/25/90	0	0	1	0	0
5/2/90	0	11	1	0	0
5/8/90	0	3	0	0	0
5/16/90	0	8	0	0	0
5/17/90	2	19	0	0	0
6/25/90	0	52	2	0	0
7/2/90	0	59	2	0	0

[a]Weather: Clear, OverC = Over Cast, LtRain = Light Rain

[b]Lunar Phase:NM = New Moon, FQ = First Quarter, FM = Full Moon, LQ = last Quarter

[c]Temperature given as maximum-minimum; single entry for temperature taken during trap installation only

[d]Entire stream discharge

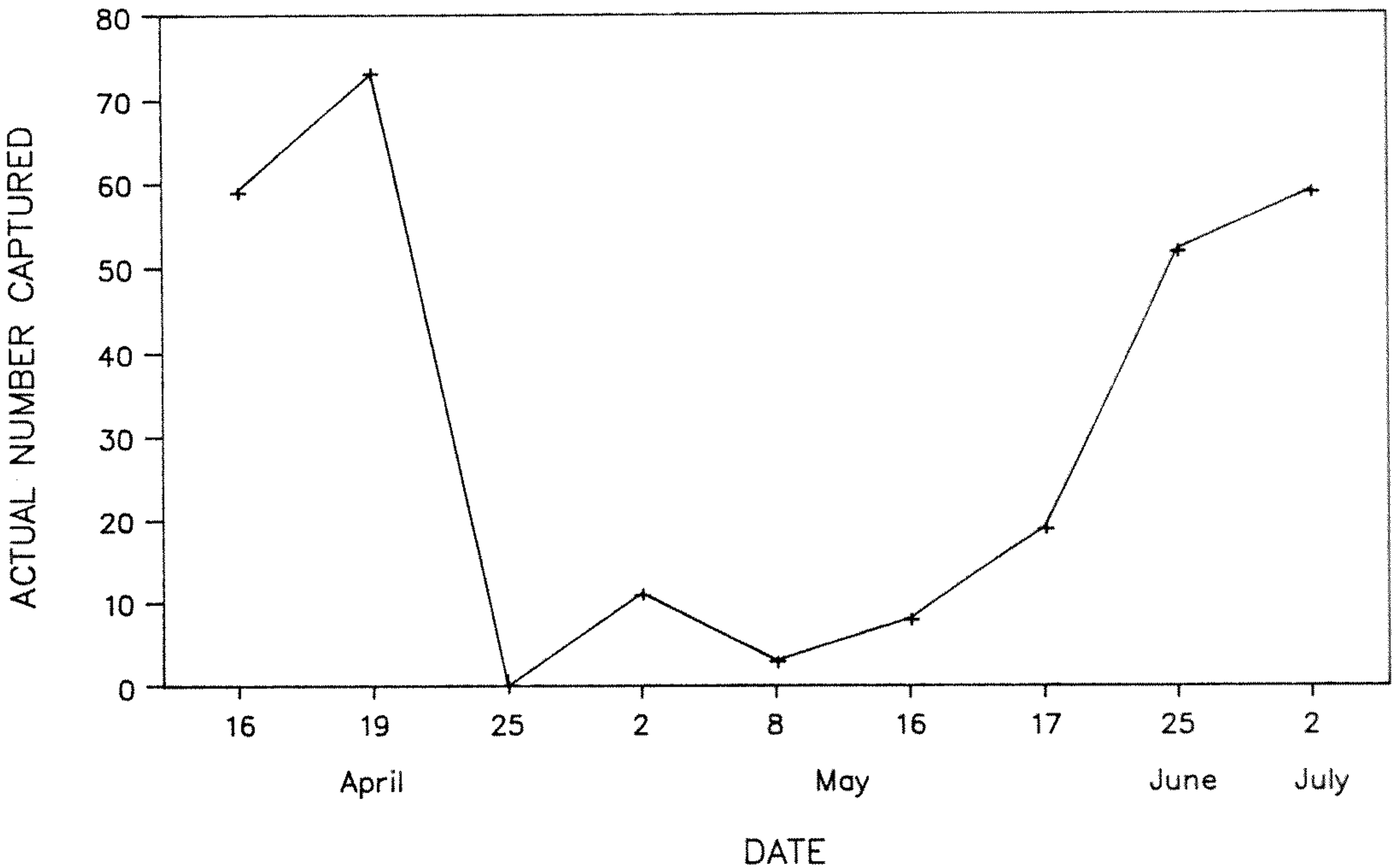

Figure 18. Emigration pattern of steelhead fry from Pine Creek, spring 1990.

There were no discernable relationships between steelhead fry emigration and lunar phase or weather condition ($P>0.4$ and $P=0.3$, respectively). The stream temperature averaged 12.2°C and ranged from 10.0 to 14.4°C over the trapping period (Table 13). Non-salmonid species captured are listed in Table 4.

In 1989, we captured 3 juvenile chinook during 7 trap nights (Noble and Lintz 1990). With the observation of 23 fall chinook redds in fall 1989, we expected a higher capture rate for juvenile chinook in spring 1990. The paucity of juvenile chinook captured in 1989 and 1990 raises some concerns as to the survival of eggs to emigrant size juveniles, outmigrant timing, and trap efficiency in Pine Creek. The fact that a considerable number of chinook redds were found but few chinook juveniles were caught suggests that the survival of chinook in Pine Creek should be more closely examined.

OVERVIEW OF TRAPPING OPERATIONS

Except for Tully Creek, juvenile chinook were trapped in all streams in 1990. All chinook sampled appeared healthy and showed no outward signs of disease.

Steelhead fry were captured in sizable numbers in Tully and Pine Creeks (Table 2). These two streams produced three times the number of steelhead fry in 1990 than in 1989.

The total number of steelhead fry (n=563), yearling steelhead (n=166), coho (n=30), and cutthroat trout (n=8) captured in 1990 are higher than 1989 totals for the same streams (n=275, 36, 10, 1, respectively) (Noble and Lintz 1990). Total chinook catches, however, have decreased in 1990 with only 33 fish sampled; in 1989 111 chinook were sampled. This decline in chinook production parallels overall Basin trends and may be partially attributed to the current drought that has facilitated unseasonably low flows during normal fall chinook spawning periods.

SUMMARY OF RECOMMENDATIONS

Watershed and instream restoration measures could enhance the production and survival of salmonids in the lower Klamath River tributaries. Ecologically sound forestry practices, maintenance of roads, reduction of the present road networks, and revegetation of timber harvested areas, roads, and riparian zones will facilitate watershed recovery and improve instream conditions. Continued degradation of the watersheds, and thus the stream conditions, can only discourage salmonid production.

The genetic diversity of the fall chinook, coho, steelhead, and coastal cutthroat trout stocks which have adapted to the lower tributaries should also be considered for protection. Efforts to enhance the streams and thus the stocks should first be aimed at improving the habitat and letting the stocks recover before encouraging supplementation. Coastal cutthroat trout and coho salmon have been listed by Moyle et al. (1989) as species of special concern and should also be given special attention in order to sustain and enhance their production.

Hunter Creek

Instream enhancement efforts to improve chinook production in Hunter Creek should be directed at improving the lower 3.0 km through planting riparian vegetation from the mouth to the Requa Road bridge, limiting livestock entry to the creek, and enhancing spawning gravel and rearing habitat. From rkm 3.0 to approximately 5.0, improvements could include establishment of riparian vegetation along the stream to enhance cover for adults and juveniles. Upstream of rkm 5.0, the addition of large woody debris would increase habitat diversity and provide overwintering and oversummering habitat for juvenile salmonids.

Panther Creek

Panther Creek provides excellent rearing habitat for coho juveniles. No spawning habitat is present below the beaver dam, and the high silt load of the creek would quickly inundate instream structures. No restoration actions are suggested for Panther Creek.

Bear Creek

The lower 3.5 km of Bear Creek possesses suitable rearing space, but low quantities of spawning habitat. Restoration efforts on Bear Creek should be directed at gravel retention in the stream channel in the lower 3.5 km to produce more spawning habitat. Also, the log debris jam at rkm 3.5 should be periodically inspected following large storm events to determine its potential as an immigration barrier to fish and its need for subsequent modification.

Tectah Creek

In drought years, Tectah Creek may be underutilized by salmonids. Currently, spawning and rearing habitat is available in this creek and is in exceptionally good condition. Efforts should be made to stabilize the large slide at rkm 6.1 and retain subsequent sediments that could enter the stream. The healing of the watershed throughout timber harvested areas is needed to ensure that slides and debris avalanches do not become common in the watershed. There is also a need to "put to bed" (i.e. planting trees and shrubs along roadways) unused roads.

Tully Creek

Tully Creek is a competent steelhead producer. Reduction in gradient of the steep boulder cascade at rkm 0.25 would improve access to the stream for adult salmonids. Also, the removal of the potential seasonal barrier at rkm 1.24 would make the upper reaches of Tully Creek more accessible to adult chinook and other salmonids.

Pine Creek

The HVBC is currently evaluating stream habitat and assessing potential stream improvements for Pine Creek. These should be included in their report. The survival of chinook in this creek, however, should be investigated because of the relatively high redd counts and the low quantity of juveniles noted.

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APPENDIX A

Proposal to Conduct Chinook Salmon Spawning Ground Surveys and Juvenile Production Inventories in Lower Klamath River Tributaries

Submitted By: U.S. Fish and Wildlife Service

Date Submitted: March 31, 1988

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Project Title: Proposal to Conduct Chinook Salmon Spawning Ground Surveys and Juvenile Production Inventories in Lower Klamath River Tributaries

INTRODUCTION

The ability to monitor adult fall chinook salmon abundance and the resulting production of juveniles in the mainstem Klamath River and its tributaries is essential to the management regimes being employed to rebuild the Klamath River fall chinook stocks. Also, any restoration effort must be based on sound biological principles and need.

At present, the only comprehensive survey of the Klamath River tributaries below the confluence of the Trinity River (river mile 40) were conducted by the U.S. Fish and Wildlife Service (Service) in 1977 and 1978 (U.S. Fish and Wildlife Service 1979). Information gathered from this inventory documented limited spawning activity compared to spawning area available. Since the 1977-78 surveys, habitat monitoring, spawning ground surveys and juvenile population estimates have not been conducted. Many changes have occurred since 1978. In 1980, the Bureau of Indian Affairs removed numerous migration barriers, identified by the Service in 1979, on the Hoopa Valley Reservation section of these tributaries. In addition, timber harvest and land use practices may have further degraded the water quality.

The harvest rate management concept agreed to by the various user groups stabilizes the harvest rate impacts of the numerous fisheries and allows escapement to vary between years. The varied escapement will allow information on chinook productivity to be estimated which in turn will provide fishery managers the ability to both protect the Klamath River natural spawning chinook population and allow harvest of this stock. A key data component for estimating basin productivity is an abundance estimate of the naturally spawning chinook. At present, the spawning estimates are limited to Klamath River tributaries above the Trinity River confluence. It is preceived that more comprehensive spawning ground surveys should be conducted to better estimate the number of naturally spawning chinook.

PROBLEM STATEMENT

The present level of knowledge concerning the natural spawning fall chinook in the lower Klamath River tributaries does not allow an informed decision to be made about restoration efforts necessary to assist these stocks, nor does it allow us to ascertain the response of the natural stocks to the harvest rate management scheme.

Because of the restoration efforts and management needs, it is proposed that spawning ground and juvenile production monitoring be initiated on Klamath River tributaries below the Trinity River. This monitoring will provide information on the current status of these chinook populations. These spawning ground surveys will also provide information on run timing. Monitoring conducted by the Service during 1985-87 within Blue Creek, a tributary to the lower Klamath, indicate spawning may protract well in to January. Currently, all available hatchery stocks within the basin are early spawning fish (September - early November). If late fall spawning stocks are characteristic of other lower Klamath tributaries then the use of hatchery stocks for restocking may be inappropriate and have negative effects on the natural stocks. On the other hand, if natural late fall stock are targeted for use as brood stock to seed under utilized tributaries, then care must be exercised not to inadvertantly impact brood stock sources. These observations indicate the complexity of the management decisions that need to be made. Only by collecting data on juvenile and adult salminid population densities can informed recommendations that address rehabilitation and enhancement be made.

OBJECTIVES AND GOALS

This work will allow the current status of salmonid production, primarily chinook and steelhead, to be determined for each tributary. The monitoring of these tributaries must be considered ongoing, as one-year will not adequately reflect longterm trends.

Task I: Determine the presence and extent of chinook spawning.

1.1. Estimate the number of fish spawning in selected creeks.

1.2. Determine timing of spawning activity.

Task II: Determine production of selected creeks.

2.1. Estimate production of chinook and steelhead juveniles through weekly sampling of downstream migrants.

2.2. Identify tributary rearing time and timing of outmigration.

Task III: Data Analysis

3.1. Prepare progress report. Estimates of spawners will be forwarded to the California Department of Fish and Game for inclusion in their run size estimate. Develop recommendations for present stock status by creek. Develop recommendations for restoration activity, if needed, on individual basis.

TIME FRAME

The field work conducted under Task I would run from mid-October to mid-January. The field work conducted under Task II would run from mid-March to mid-June. Data analysis and report writing, Task III, would be conducted from mid-June to the end of September. Yearly progress reports would be available by September 30. Recommendations based on findings would be forwarded as results warrant.

COST

The following cost breakdown is provided to show yearly expenses associated with accomplishing the aforementioned tasks.

<u>Task I</u>:	
- Salary	3,640
- Supervision	3,000
- Equipment	500
- Vehicle	1,500
Total Task I	8,640
<u>Task II</u>:	
- Salary	4,860
- Supervision	4,100
- Equipment	1,500
- Vehicle	2,500
Total Task II	12,960
<u>Task III</u>:	
- Salary	2,400
Total Task III	2,400
Total for FY 1989	24,000

SUMMARY

The need to adequately assess the fall chinook production in the tributary streams in the lower 40 miles of the Klamath drainage is essential to the overall knowledge of the natural spawning chinook resource within the basin.

APPENDIX B

Criteria for rating spawning and rearing habitats during preliminary evaluations of lower tributaries to the Klamath River in 1980

Lower tributary inventory ratings and codes, 1989:

Minimal: Spawning habitat is marginal in character and gravel occur in isolated pockets; embeddedness is high and fines are >25% of total substrate composition; pools for holding adults are few and generally shallow. Rearing habitat consists of isolated pockets of less than quality habitat (due to quantity and quality of cover, condition of edgewater areas, temperature, and/or channel gradient). No adults, carcasses, or redds of anadromous salmonids were observed during preliminary spawning ground surveys. Juvenile salmonids were observed infrequently during bankside observations and/or electroshocking operations.

Low: Spawning habitat is largely marginal in character but quality habitat does occur infrequently in isolated pockets; embeddedness is high and/or fines are 15-25% of total substrate composition; pools are generally shallow. Quality rearing habitat occurs infrequently in distinct pockets primarily along stream edges and the tail of riffles. No adults, carcasses, or redds of anadromous salmonids were observed during preliminary spawning ground surveys. Juvenile salmonids were observed in low numbers during bankside observations and/or during electroshocking operations.

Moderate: Quality spawning habitat is available in frequent isolated pockets often immediately downstream of large substrate or in the tail-out of pools; embeddedness is moderate and fines compose <15% of total substrate composition; pools are usually >1 m in depth but are few in number. Quality rearing habitat does occur in frequent pockets along stream edges and the tail of riffles where cover complexity is moderate. Adults, carcasses, and/or redds of anadromous salmonids were observed during preliminary spawning ground surveys. Juvenile salmonids were observed in moderate numbers during bankside observations and/or during electroshocking operations.

High: Quality spawning habitat is abundant at tail-out of pools, in glides and runs, and in isolated pockets behind large substrate; embeddedness is low and fines compose <10% of total substrate composition; pools are numerous and generally >1 m in depth. Rearing habitat is usually of good quality and cover complexity is high. Adults, carcasses, and/or redds of anadromous salmonids were observed during preliminary spawning ground surveys. Juvenile salmonids were observed in moderate to high numbers during bankside observations and/or during electroshocking operations.

APPENDIX C

Channel classifications as described by Rosgen (1985).

Appendix A. Channel classification as described by Rosgen 1985.

Stream Type	Gradient (%)	Dominant Partical Size of Channel Materials	Channel Entrenchment Valley Confinment
A1	4-10	Bedrock	Very deep; very well confined
A1-a	10+	Same as A1	
A2	4-10	Large & small boulders w/mixed cobbles	Same as A1
A2-a	10+	Same as A2	
A3	4-10	Small boulders, cobbles, coarse gravels, some sand.	Same as A1
A3-a	10+	Same as A3	
A4	4-10	Predominantly gravel, sand, and some silts.	Same as A1
A4-a	10+	Same as A4	
A5	4-10	Silt and/or clay bed and bank materials.	Same as A1
A5-a	10+	Same as A5	

Stream Type	Gradient (%)	Dominant Partical Size of Channel Materials	Channel Entrenchment and Valley Confinement
B1-1	1.5-4.0	Bedrock bed:banks are cobble, gravel, some sand.	Shallow entrenchment; moderate confinment
B1	2.5-4.0 (X=3.5)	Predominately small boulders and very large cobble.	Moderate entrenchment; moderate confinment
B2	1.5-2.5 (X=2.0)	Large cobble mixed w/small boulders and coarse gravels	Moderate entrenchment; moderate confinment
B3	1.5-4.0 (X=2.5)	Cobble bed w/mixture of gravel and sand. Some small boulders	Moderate entrenchment; well confined
B4	1.5-4.0 (X=2.0)	Very coarse gravel w/cobbles, sand and finer materials	Deeply entrenched; well
B5	1.5-4.0 (X=2.5)	Silt / clay	Deeply entrenched; well confined.
B6	1.5-4.0	Gravel w/few cobbles and w/noncohsive sand and finer soil.	Deeply entrenched; slightly confined

Appendix A continued. Channel classification as described by Rosgen 1985.

Stream type	Gradient (%)	Dominant Particale Size of Channel Materials	Channel Entrenchment Valley Confinment
C1-1	1.5 or less (X=1.0)	Bedrock bed, gravel sand or finer banks.	Shallow entrenchment; partially confined.
C1	1.0-1.5 (X= 1.3)	Cobble, coarse gravel bed, gravel, sand banks.	Moderate entrenchment; well confined.
C2	0.3-1.0 (X=0.6)	Large cobble bed w/mixture of small boulders and coarse gravel.	Moderate entrenchment; well confined.
C3	0.5-1.0 (X=0.8)	Gravelbed w/mixture of small cobble and sand.	Moderate entrenchment; slightly confined.
C4	0.1-0.5 (X=0.3)	Sandbed w/mixture of gravel and silt. No bed armor.	Moderate entrenchment; slightly confined.
C5	0.1 or less (X=0.05)	Silt clay w/mixture of medium to fine sand, no bed armor.	Moderate entrenchment; slightly confined.
C6	0.1 or less (X=0.05)	Sandbed w/mixture of silt and some gravel.	Deeply entrenched; unconfined.

Stream Type	Gradient (%)	Dominant Particle Size of Channel Materials	Channel Entrenchment Valley Confinement
D1	1.0 or greater (X=2.5)	Cobble bed w/mixture of coarse gravel, sand, and small boulders.	Slightly entrenched; no confinement.
D2	1.0 or less (X=1.0)	Sandbed w/mixture of small to medium gravel and silt.	Slightly entrenched; no confinement.
F1	1.0 or less	Bedrock bed w/few boulders, cobble and gravel.	Total confinement.
F3	1.0 or less	Cobble/gravel bed with locations of sand in depositional sites.	Same as F1
F4	1.0 or less	Sand bed with smaller amounts of silt and gravel.	Same as F1
F5	1.0 or less	Silt/clay bed and banks with smaller amounts of sand.	Same as F1

APPENDIX D

Habitat types as described by McCain et al. (1990) [1] listing the five general types used on the lower tributaries (pools, flatwater, low gradient riffle, high gradient riffles, cascades/falls).

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[1] McCain, M.E.,, D. Fuller, L. Decker, and K. Overton. 1990. Stream habitat classification and inventory procedures for northern California. FHR Currents. U.S. Forest Service, Region 5. San Francisco, CA. 22 p.

Habitat types and descriptions:

HABITAT TYPES Number	Name	Description
POOLS:		
4	Secondary Channel Pool (SCP):	Pools formed outside of the average wetted channel width. During summer, these pools will dry up or have very little flow. Mainly associated with gravel bars and may contain sand and silt substrates.
5	Backwater Pool (BwBo): Boulder Formed	Found along channel margins and caused by eddies around obstructions such as boulders, rootwads, or woody debris. These pools are usually shallow and are dominated by fine grain substrates. Current velocities are quite low.
6	Backwater Pool (BwRw): Root Wad Formed	Same description as 5.
7	Backwater Pool (BwL): Log Formed	Same description as 5.
8	Trench/Chute (TRC):	Channel cross sections typically U-shaped with bedrock or coarse grained bottom flanked by bedrock walls. Current velocities are swift and the direction of flow is uniform. May be pool-like.
9	Plunge Pool (PLP):	Found where stream passes over a complete or nearly complete channel obstruction and drops steeply into the streambed below, scouring out a depression; often large and deep. Substrate size is highly variable.

Appendix D. Continued.

HABITAT TYPES

Number	Name	Description
10	Lateral Scour Pool (LsL): Log Formed	Formed by flow impinging against one streambank or against a partial channel obstruction. The associated scour is generally confined to <60% of wetted channel width. Channel obstructions include rootwads, woody debris, boulders and bedrock.
11	Lateral Scour Pool (LsRw): Root Wad Formed	Same description as 10.
12	Lateral Scour Pool (LsBk): Bedrock Formed	Same description as 10.
13	Dammed Pool (DPL):	Water impounded from a complete or nearly complete channel blockage (debris jams, rock landslides or beaver dams). Substrates tend toward smaller gravel and sand.
17	Mid-Channel Pool (MCP):	Large pools formed by mid-channel scour. The scour hole encompasses more than 60% of the wetted channel. Water velocity is slow, and the substrate is highly variable.
18	Edgewater (EGW):	Quiet, shallow area found along the margins of the stream, typically associated with riffles. Water velocity is low and sometimes lacking. Substrates vary from cobbles to boulders.

Appendix D. Continued.

HABITAT TYPES

Number	Name	Description
19	Channel Confluence Pool (CCP):	Large pools formed at the confluence of two or more channels. Scour can be due to plunges, lateral obstructions or scour at the channel intersections. Velocity and turbulence are usually greater than those in other pool types.
20	Lateral Scour Pool (LsBo): Boulder Formed	Formed by flow impinging against boulders that create a partial channel obstruction. The associated scour is confined to <60% of wetted channel width.
22	Corner Pool (CRP):	Lateral Scour Pools formed at a bend in the channel. These pools are common in lowland valley bottoms where stream banks consist of alluvium and lack hard obstructions.
23	Step Pool (STP):	A series of pools separated by short riffles or cascades. Generally found in high gradient, confined mountain streams dominated by boulder substrate.
FLATWATER:		
14	Glides (GLD):	A wide uniform channel bottom. Flow with low to moderate velocities, lacking pronounced turbulence. Substrate usually consists of cobble, gravel and sand.

Appendix D. Continued.

HABITAT TYPES

Number	Name	Description
15	Run (RUN):	Swiftly flowing reaches with little surface agitation and no major flow obstructions. Often appears as flooded riffles. Typical substrates are gravel, cobble and boulders.
16	Step Run (SRN):	A sequence of runs separated by short riffle steps. Substrates are usually cobble and boulder dominated.
24	Bedrock Sheet (BRS):	A thin sheet of water flowing over a smooth bedrock surface.
LOW GRADIENT RIFFLE:		
1	Low Gradient Riffle (LGR):	Shallow reaches with swiftly flowing, turbulent water with some partially exposed substrate. Gradient <4%, substrate is usually cobble dominated. Appendix C. Continued.
21	Pocket Water (POW):	A section of swift flowing stream containing numerous boulders or other large obstructions which create eddies or scour holes (pockets) behind the obstructions.
HIGH GRADIENT RIFFLES:		
2	High Gradient Riffle (HGR):	Steep reaches of moderately deep, swift, and very turbulent water. Amount of exposed substrate is relatively high. Gradient is >4%, and substrate is boulder dominated.

Appendix D. Continued.

HABITAT TYPES

Number	Name	Description
CASCADE/FALLS:		
3	Cascade (CAS): (CAS/FALLS)	The steepest riffle habitat, consisting of alternating small waterfalls and shallow pools. Substrate is usually bedrock and boulders.

APPENDIX E

Criteria for rating habitat variables in lower tributaries to the Klamath River during stream habitat inventories

Tributary inventory ratings and codes.

Rearing habitat rating during habitat typing:

Excellent: Quality rearing habitat is abundant, >50% of total 100 m reach; cover complexity is high; water temperatures never reach 21.1 degrees Celsius (°C).

Moderate: Quality rearing habitat is frequent and generally occurs in pockets along stream edges and the tail of riffles where cover complexity is moderate; generally 25 - 50% of total 100 m reach; water temperatures remain below 21.1°C.

Fair: Quality rearing habitat is infrequent and occurs in occasional isolated pockets usually along stream edges, generally <25% of total 100 m reach; cover complexity is low; water temperatures may reach up to 21.1°C infrequently during the summer months.

Minimal: Rearing habitat consists of isolated pockets of marginal habitat at best, <25% of total 100 m reach; very little or no overhead or instream cover; water temperatures may frequently reach or exceed 21.1°C.

No rearing habitat available.

Riparian zone/cover rating: (Modified from Hamilton and Bergerson 1984)

Excellent: Combined cover of trees, shrubs, grass, and forbs >90% of the ground. Openings in this nearly complete cover are small and evenly dispersed. A variety of plant species and age classes are represented. Growth is vigorous and reproduction of species in both the under- and overstory is proceeding at a rate to ensure continued ground cover conditions. A deep, dense root mat is assumed. The potential for recruitment of LWD in the stream is high.

Moderate: Plants cover between 70 and 90% of the ground. Shrub species are more prevalent than trees. Openings in the tree canopy are larger than the space resulting from the loss of a single mature individual. Although growth vigor is generally good for all species, advanced reproduction may be sparse or lacking. A deep root mat is not continuous, and serious erosion is possible in the openings. Potential recruitment of LWD in the stream is moderate.

Fair: Plant cover ranges from 50 to 70%. Lack of vigor is evident in some individuals or species. Seedling reproduction is nil. This condition is ranked fair, based mostly on the percent of the area not covered by vegetation with a deep root mat potential and less on the kind of plants that make up the overstory. Potential recruitment of LWD in the stream is low.