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Evaluation of Fish Habitat Condition and Utilization in Salmon, Scott, Shasta, and Mid-Klamath Sub-basin Tributaries 1988 / 1989

Klamath National Forest

Interagency Agreement 14-16-001-89508

EXECUTIVE SUMMARY

This report summarizes field work completed between October 1,1988 and September 30, 1989 under interagency agreement (#14-16-001-89508) between the U.S. Department of Agriculture and U.S. Fish and Wildlife Service. About $148,300 in USFWS funds was expended on salaries, transportation, and equipment. An additional $46,000 in biologist salaries, overhead, and office equipment was contributed to the project by USDA Forest Service, Klamath National Forest. Expenditures are summarized in Appendix N.

The principle objective of field work was to identify existing salmonid spawning and rearing habitat condition and use in eleven streams located in Salmon, Scott, Shasta, and Mid-Klamath sub-basins. The project focuses on habitat conditions encountered during summer base-flow period, however habitat limitations for other periods are described. Crews completed physical habitat assessments and biological surveys for 208 km (125 mi) of streams.

South Fork Salmon study area was located in the upper portion of the basin, from Cecil Creek upstream 18.3 km (11mi.) to Little South Fork. Summer steelhead and spring chinook holding areas are present in this area and poaching may be a serious problem for fish holding in summer months. The broad floodplain results in a poor riparian vegetative condition. The river channel is wide and shallow, deep pools are rare due to stream bed instability.

North Fork Salmon study area was located in the upper part of the basin, from Whites Gulch upstream 18.3 km (11 mi.) to the Right Hand Fork in Marble Mountain Wilderness Area.

Nordheimer Creek study area extends from its confluence with the Salmon River upstream about 6.7 km (4 mi.) to Granite Creek. Fall chinook salmon use is flow dependent, because stream mouth aggradation results in upstream migration blockage during low flows.

Scott River study area extends from the river's confluence with the Klamath upstream about 30 km (18 mi) to Jones Beach Picnic Area. Sand contaminates spawning gravels throughout the study area. Riparian conditions are fair, providing suitable shade.

Shackleford/Mill Creek study area extends from the confluence with Scott River upstream 10 km (6 mi) on Shackleford Creek to a 4 m high waterfall barrier and about 3.3 km (2 mi) upstream on Mill Creek to Quartz Valley School. This flat gradient study area has a broad unconfined channel containing frequent braids and ditch inlets. Clean gravels dominate substrate located in long riffles separated by few pools. Riparian vegetation is in poor condition, providing inadequate stream shade. Raw cutbanks are common because

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EVALUATION OF FISH HABITAT CONDITION AND UTILIZATION IN SALMON, SCOTT, SHASTA, AND MID-KLAMATH SUB-BASIN TRIBUTARIES 1988/1989

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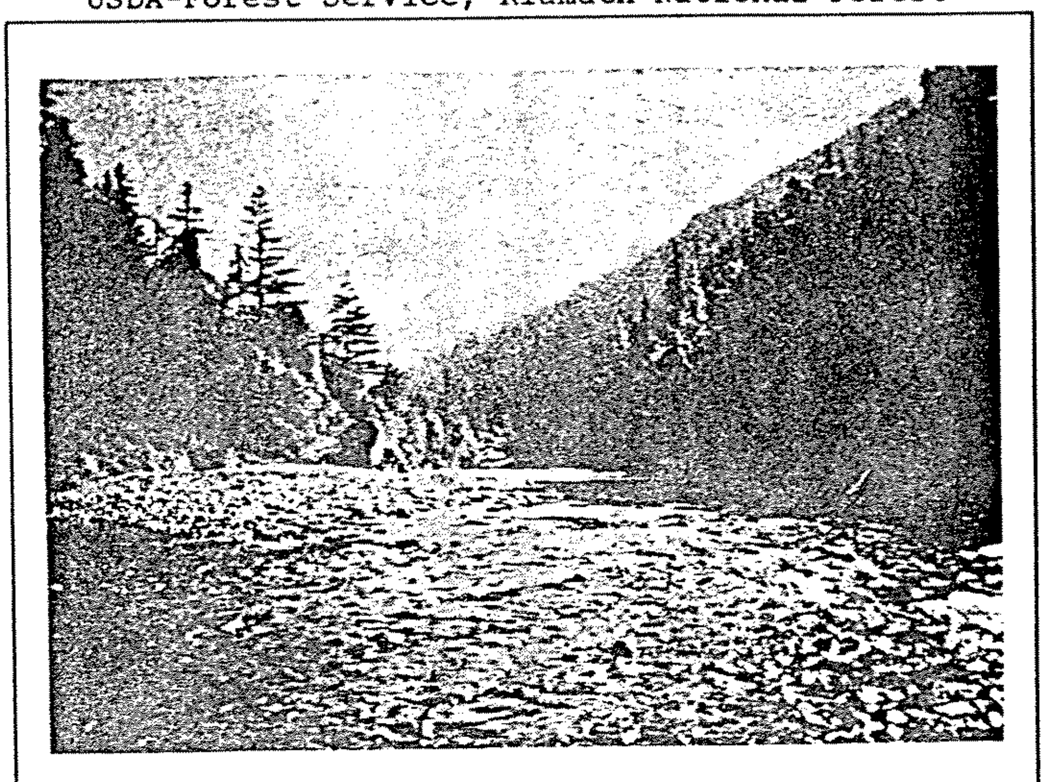

Salmon River Subbasin

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was used to determine where biological and additional physical habitat information (substrate composition, substrate embeddedness, stream shade) would be collected. Riparian area condition, percent composition of deciduous and coniferous trees and potential recruitment of large woody debris, was assessed at each unit. Biological sampling was conducted by two person dive teams enumerating fish by mask-and-snorkel direct observation and calibrated against electrofishing results. Habitat specific "utilization coefficients" were calculated to "relate the fraction of the population found within a particular habitat type to the relative abundance of that habitat type". Spawning habitat adequacy was addressed by establishing how many redds could be accommodated in available habitat. A determination of spawning habitat sufficiency was made for each study area.

During the study period 58,000 m^2 of suitable spawning habitat was present. Chinook redd surface area (4.6 m2; n= 520) and average steelhead redd surface area (1.5 m^2; n= 194) were not significantly different (p=0.05) between study areas or between habitat types. A maximum of 12600 chinook redds and 38600 steelhead redds could be accommodated by existing suitable habitat under base flow conditions.

Spawning habitat in Nordheimer, Shackleford/Mill, and Yreka Creeks was not accessible to chinook during 1988 due to low fall flows. About 41,198 m^2 of spawning habitat was accessible to chinook, which could accommodate a maximum of 8960 redds.

We counted 2174 chinook redds in all study areas during fall 1988. Chinook spawning began in mid-September and concluded by late November. Mid Klamath chinook stocks displayed compressed spawning periods. Chinook of hatchery origin spawned in slow velocity runs, conversely wild stock spawners chose low gradient riffle habitat.

Coho salmon spawning (a total of 2 coho redds) was observed in only several subbasin study areas. Juvenile coho were observed in several tributaries in the summer of 1989. At least some spawning occurred in the fall of 1988.

We counted 757 steelhead redds in all study areas. Steelhead spawning began in mid-February and concluded in mid May. Due to March high flows, some study areas were not counted. Turbidity in Scott and Shasta Rivers made wading hazardous and viewing extremely difficult. Attempts to conduct counts on those two study areas were abandoned. Observations indicate that steelhead spawning is more "bank oriented" than chinook spawning.

We evaluated 2,430,596 m^2 of rearing habitat (1,332,413 m^3). Run and low gradient riffle dominate habitat surface area and volume. Poor salmonid rearing conditions prevail in Shasta River, Yreka Creek, and Shackleford/Mill Creek study areas. Water quantity and quality conditions reach critical or lethal levels there during streamside areas are not fenced and are accessible to livestock. Poaching of adult steelhead may be a problem during spawning season. Because of heavy water withdrawal, adult fish access was not possible until after chinook spawning ended in December.

Shasta River study area extends from Klamath upstream 16.7 km (10 mi) to Oregon Slough. Riparian conditions in this unfenced reach are poor, there is no stream shade. Summer water temperatures limit fish rearing and may cause die-offs.

Yreka Creek study area extends from the creek's confluence with Shasta River upstream 13.3 km (8 mi.) to the base of Forest Mountain. Human garbage is common in the channel. An "oily sheen" was evident in summer months on the water surface where velocity was low. Riparian conditions are poor above Interstate 5 and raw cutbanks are common.

Elk Creek study area extends from the mouth of Elk Creek upstream 23.3 km (14 mi.) to Bear Creek. Unstable spawning gravels may result from extensive suction dredge mining. This has an effect on the success of incubating salmon and steelhead eggs. Habitat for spring chinook and summer steelhead occurs in this area.

Indian Creek study area extends from the mouth upstream 28.3 km (17 mi) to Greens Creek. High summer water temperatures and residual heavy metal pollution may be a problem in this area.

Grider Creek study area extends from the mouth upstream 20 km (12 mi) to Stones Valley Creek. Chinook salmon use is limited to the lower 9.1 km, probably as a result of steepening stream gradient, there is no barrier at that location.

Beaver Creek study area extends from the mouth upstream 20 km. (12 mi.) to Grouse Creek. A debris torrent extensively damaged the stream in August 1989.

Crews surveyed each study area during spawning season at biweekly intervals to locate redds. The habitat type associated with each redd was identified and recorded. Twentyfive percent of redds were sampled to determine mean redd surface area and pott depth. Some reaches were uncountable at times due to adverse viewing conditions. Stream habitat surveyed at base summer flow was classified into one of 22 possible habitat types. Enhanced habitat was included in our assessment. Physical measurements taken for each habitat unit, included length, width, and depth. Surveyors estimated total spawning area and amount of cover available to fish in each unit. To be certain of the amount and suitability of steelhead spawning area available, estimates should be made during spawning season. We plan to sample study areas in spring 1990 to verify steelhead spawning area available during the spawning season. Any gross difference discovered from that reported in this paper will be reported as an amendment. A random sampling method

1) Augment flow or regulate water withdrawal to provide water for summer rearing and chinook spawning migration access in: Scott River, Shackelford/Mill Creek, Shasta River, and Yreka Creek.

2) Revegetate riparian and floodplain areas with native species of deciduous and coniferous vegetation (fence or control grazing as necessary) in: South Fork Salmon River, Scott River valley, Shackleford/Mill Creeks, Shasta River valley, Yreka Creek, and Indian Creek.

3) Provide suitable accumulations of large woody cover in slow velocity habitats and evaluate effectiveness for steelhead and coho rearing in: South Fork Salmon River, Nordheimer Creek, Scott River, Elk Creek, Indian Creek, Grider Creek, and Beaver Creek.

4) Provide adequate, stable spawning areas for salmonids and evaluate effectiveness in: North Fork Salmon River, Shasta River, Elk Creek, Indian Creek, and Grider Creek.

5) Stabilize eroding streambanks by natural methods in: Shackleford Creek and Yreka Creek.

6) Control fish poaching through aggressive enforcement and education in all areas but especially in: South Fork Salmon River, North Fork Salmon River, Shackleford/Mill Creeks, and Indian Creek.

7) Modify seasonal migration barriers in: Scott River, Nordheimer Creek, and Beaver Creek.

8) Investigate lack of chinook salmon spawning on weirs in: Shasta River, Indian Creek, and Beaver Creek.

9) Investigate potential damage of steelhead redds by early season suction dredging and take corrective regulatory action as necessary. Education of suction dredge miners may be a valuable tool.

10) Promote conservation of steelhead juveniles through education of anglers, size restrictions, marking hatchery origin steelhead, and reduced bag limits.

summer months. High water temperatures observed in Shasta River (31°C), Scott River (25°C), and Indian Creek (24°C) may be lethal or sub-lethal to juvenile salmonids rearing there.

Young of the year steelhead, chinook, and coho were found in slower velocity habitat types, a result of their swimming capability.

We observed chinook fry in their natal streams until October. They selected slower velocity habitats or areas including low gradient riffle margins, backwater pools, lateral scour pools, corner pools, and enhanced deflectors.

Coho fry selected margins of low and high gradient riffles, backwater pools, lateral scour pools, enhanced weirs, enhanced deflectors, and enhanced pockets. Coho fry showed a strong affinity for complex cover within their rearing area. Cover was provided by boulders, live vegetation, and woody debris.

Steelhead yearling and older juveniles selected moderately high velocity habitats (or slow velocity habitats with abundant cover) with cover or holding habitat nearby. Steelhead yearlings were found in all habitat types, but selected low and high gradient riffles, secondary channel pools, backwater pools, and lateral scour pools.

Coho fry over-winter habitat in streams with winter water temperatures less than 7° C was described by Reeves, Everest, and Nickelson (1989) as: stream margins with concentrations of large woody debris and boulders that form pockets of deep (>0.5m at winter base flow), slow (<0.3 m/s) water. We assumed juvenile steelhead would need similar habitats to survive the harsh winter period. Many study areas lack those features. Large wood provided cover to less than 10% of the habitat area. Winter cover was provided by large boulders. Woody debris accumulations are scarce, probably as a result of man's activities or high stream power/channel confinement in wilderness study areas that have not been influenced by man.

Spawning area can accommodate a maximum of 38600 steelhead redds. Estimated steelhead standing crops in 1989 rearing habitat should result in an adult escapement which would produce about 6400 redds. Some study areas may serve as "spawning grounds" for fish which rear to smolt elsewhere. Shackleford/Mill Creek and Yreka Creek supported more spawning than could be attributed to their rearing potential. Spawning habitat is probably not limiting steelhead production in any of the study areas.

RECOMMENDATIONS

Implementation of the following actions should be considered to address problems identified by this investigation.

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INTRODUCTION

The Klamath River system provides habitat for chinook salmon (Oncorhynchus tshawytscha), coho salmon (O. kisutch), steelhead trout (O. mykiss), and other anadromous and non-anadromous species. The upper Klamath system (Figure 1) contains salmonid spawning and rearing tributaries of varying size. The Salmon, Scott, and Shasta Subbasins are considered to be important to the maintenance of wild salmonid populations in the Klamath system between Iron Gate dam and the Trinity River. Smaller tributaries (e.g. Elk, Indian, Grider, and Beaver Creeks) provide habitat conditions which maintain basin-wide genetic diversity.

As a result of reported declines in fish production over past decades, Congress enacted the Klamath River Fish and Wildlife Restoration Act (P.L. 99-552) on October 27, 1986. This law authorized the Secretary of the Interior to restore anadromous fish populations to optimum levels in the Klamath and Trinity Rivers through a program of fish harvest management and habitat restoration. A Klamath River Fishery Management Council was established to recommend management of fish harvests and a Task Force was established to implement suitable habitat restorations.

The Klamath National Forest staff proposed investigations of fish habitat as a mechanism which might result in identification of habitat problems and prescriptions for corrective action. That proposal resulted in adoption of an Interagency Agreement in October 1988, directing performance of the work. This report summarizes field work completed between October 1, 1988 and September 30, 1989. Field work focused on identification of salmonid spawning and rearing habitat condition and use. Eleven streams (total length 208 km (125 mi)) located in Salmon, Scott, Shasta, and Mid-Klamath subbasins were surveyed. Performance of ten instream structure types was evaluated under the same agreement, but will be reported separately.

Little site specific information was available on habitats being selected by spawners, duration of spawning, overall condition and availability of spawning habitat, and extent of habitat utilization.

The study proposed to evaluate:

a) What habitats are selectively used by chinook, coho, and steelhead spawners?

b) Do redds constructed in different habitat types differ in size (surface area)?

c) How much suitable spawning habitat is available at base flow levels in each system for each species?

d) What is the spawner "carrying capacity" for each system in its present condition and how close is the system to "carrying capacity?"

e) Is spawning habitat limited for steelhead or salmon?

f) What is the timing and duration of spawning activities in each system?

g) What measures might be employed to increase survival of incubating eggs?

A thorough understanding of physical and biological habitat condition and fish use is key to planning and implementing a successful fishery management, habitat restoration, or habitat enhancement program.

Evaluations of rearing habitat use and condition for Klamath River salmonids have been conducted by agency and private biologists using a variety of methods. Most previously used methods identified physical and biological conditions found in a "representative" stream reach. Recent investigations (Everest, 1986; Bisson, 1988; and others) have demonstrated that use of "representative" reach methods can lead to serious errors if results are extrapolated to an entire stream basin.

Based on findings of those investigations and methodology recommendations of Hankin and Reeves (1989), the USDA-Forest Service, (Pacific Southwest Region) and the CDF&G have decided to use the basin-wide survey approach originally presented by Bisson et al. (1982). A modification of this classification system was used to describe physical and biological conditions in study area streams.

Although this project focuses on habitat conditions encountered during the summer base-flow period, potential winter habitat limitations are described, based on present knowledge of habitat suitability and seasonal requirements described by Reeves, Everest, and Nickelson (1989).

The goal of the rearing habitat evaluation was to address the following questions:

a) What is the present quantity and suitability of habitat available to juvenile and adult salmonids during the summer base flow period?

b) Are any habitats being selectively used by juvenile salmonids for rearing?

c) Do base flow habitat conditions limit the number of juvenile salmonids that survive to smolt?

d) Do habitat unit independent features (riparian condition, water temperature, shade quantity, cover type and quantity, etc.) influence the numbers of juvenile fish found in a unit?

e) Are potential over-winter habitat features present or absent in each system?

f) What habitat or non-habitat related management measures could be employed to increase the potential number of wild salmonid smolts from each stream system?

g) What is the need for further habitat evaluation?

Methods utilized and results obtained from this work are detailed in the report that follows. **Readers are cautioned that study results and conclusions drawn are limited to season and conditions specific to the study period.** Recommendations for further work or specific actions may not completely address potential problems that may be present during other periods.

DESCRIPTION OF STUDY AREAS

As early as 1912 Snyder (as cited by Taft and Shapovalov, 1935) reported: "Depletion of Klamath salmon is not only apparent, but it seems to be progressing at an alarming rate."; possibly as a result of habitat loss and degradation and overharvest near the mouth (to supply a cannery there). As a result of field work conducted in 1934 Taft and Shapovalov (1935) concluded that "...general concensus...is that these (steelhead) runs have decreased alarmingly...". Their work noted that trout fishing (for juvenile steelhead), unscreened water diversions in the Scott and Shasta valleys, sedimentation from hydraulic mining, and dams without adequate fish passage were having significant negative impacts on salmon and steelhead runs in the basin. At that time, steelhead egg taking stations were operated by California Division of Fish and Game at seven locations in the upper Klamath (two on undisclosed Scott River tributaries and five on the Klamath River between Scott River and Copco Dam). Over one million juvenile steelhead were outplanted annually in the Scott, Klamath, and upper tributaries because those streams had "been most seriously depleted, both by angling and by the economic development of the region".

Although specific information was collected on tributaries in the Klamath system during the summer of 1934, Taft and Shapovalov (1935) generally concluded: "The pools, the trees and brush, and the riffles still exist,...white men have upset this balance largely by irrigation ditches, by constructing high dams,... They have also mined to such an extent that the fish food organisms have been smothered by mining silt...From the viewpoint of fishlife the most important improvement that could be effected in the streams would be the general restoration of natural conditions."

In summer 1989, physical habitat assessments and biological surveys were completed for 208 km (125 mi) of streams. Survey stretches were located in the Salmon, Scott, Shasta and Mid-Klamath Subbasins (Figure 1). These "subbasins" were described in the Klamath River Basin Fisheries Resource Plan (CH2M Hill, 1985). Subbasins are discussed separately to facilitate use of this document in planning for specific rehabilitation measures.

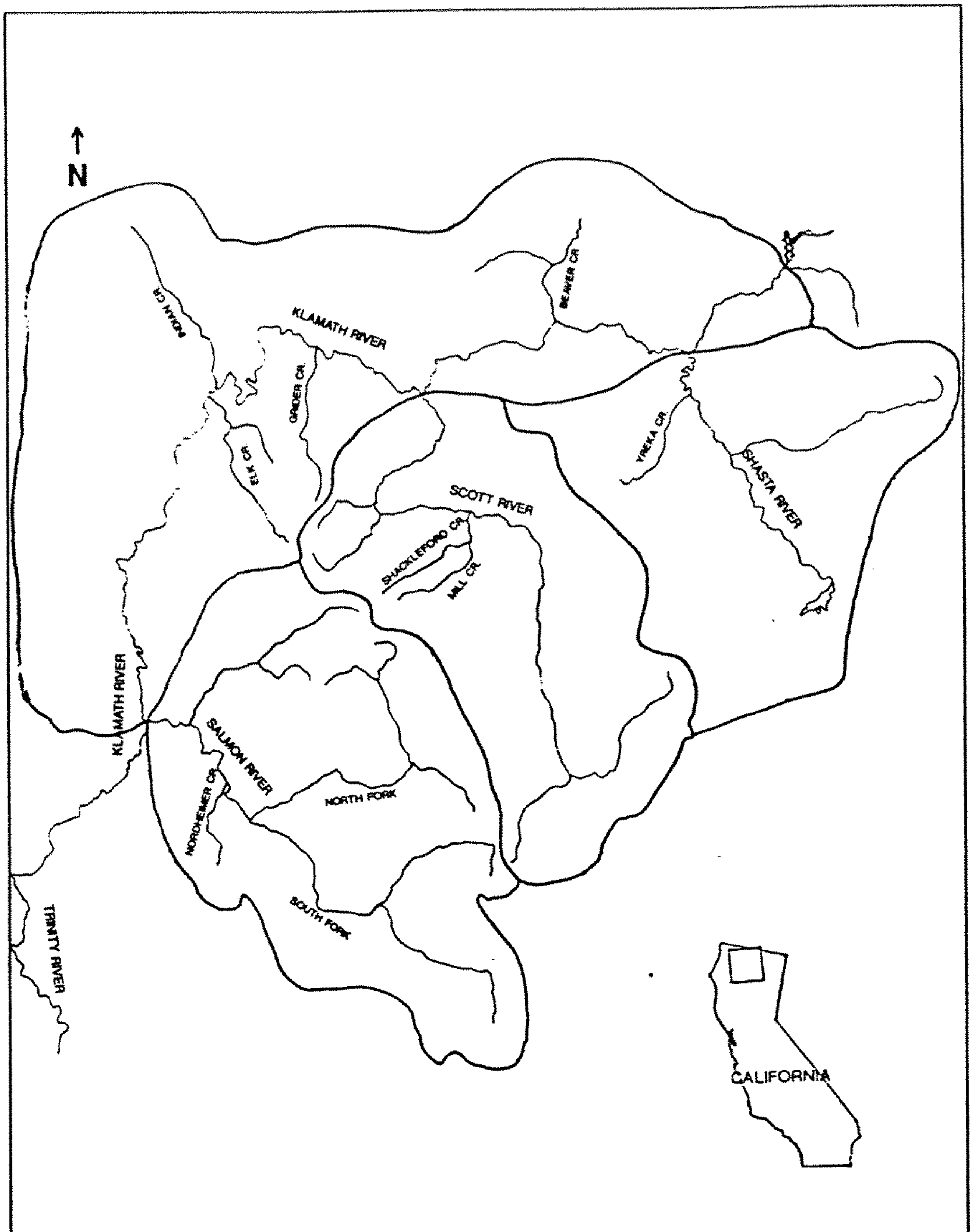
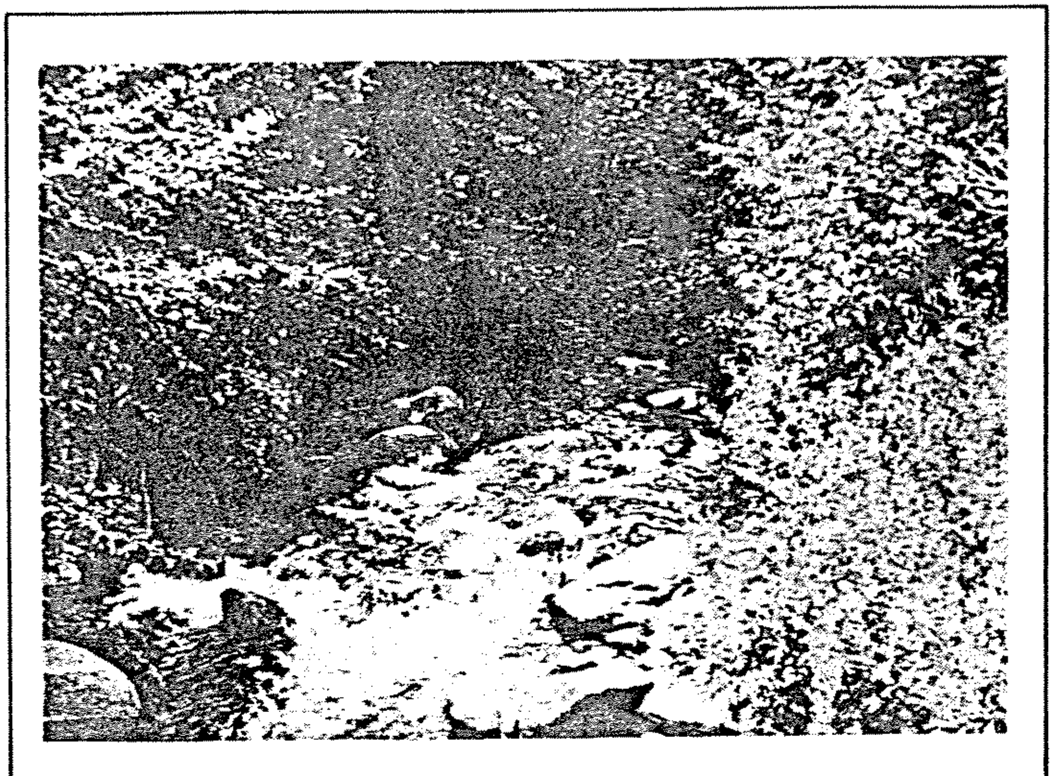
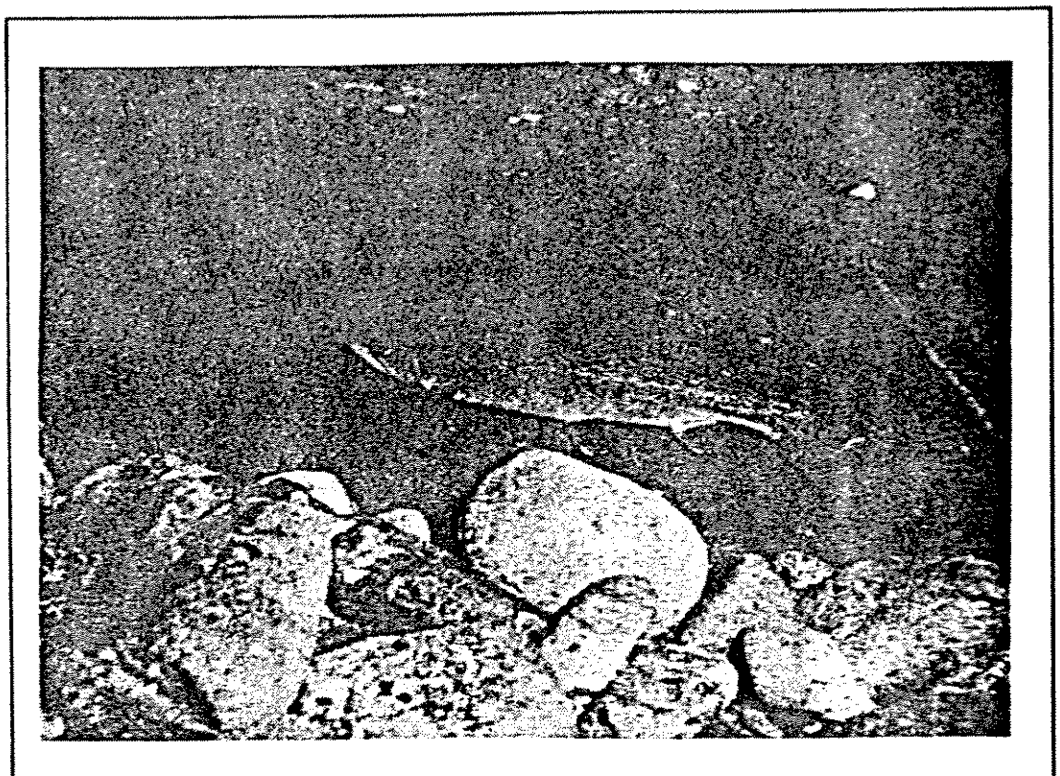


Figure 1 - Project Area Location.

The vegetation community present in riparian zones of the project area is Montane Riparian Scrub which is dominated by *Salix* spp. (willows) and/or *Alnus rhombifolia* (white alder). The community is often present in a thin corridor along low-gradient stream reaches.



Dense Riparian Canopy, Scott Subbasin.



Adult Summer Steelhead in Holding Habitat.

Salmon Subbasin

The Salmon Subbasin ranges from the headwaters of the Salmon River to the Klamath River near Somes Bar (Figure 2). The watershed area is 1943 km^2 (750 mi^2) and nearly all ownership is public, under management of the Klamath National Forest (CH2M Hill, 1985). The Salmon River is a federally designated Wild and Scenic River.

The subbasin has been inhabited by white man since the late 18th or early 19th century. Discovery of gold in California resulted in a tremendous influx of miners in the 1850's. In their search for gold they constructed numerous dams to divert water into hydraulic "giants" to mine hillsides adjacent to the river. Mining of this type was still intense in 1933 when fly fishing in the lower Salmon and Klamath Rivers was reported not possible due to water turbidity (Taft and Shapovalov, 1935) resulting from mining operations. In 1934 dams without adequate fish passage were located on North Fork Salmon (Bonally Dam six miles above Forks of Salmon and another at Finley Camp) and on South Fork Salmon four miles upstream form Forks of Salmon (Bennett Dam). Local residents complained that few fish could pass over these obstructions. A large dam on Nordheimer Creek blocked fish passage in 1934 (Taft and Shapovalov, 1935). Photos of that crib dam indicated that it was constructed on what is now a 5 meter falls. A fish ladder, funded by Calif. Dept. of Fish and Game, was constructed around this falls in 1987 by the Forest Service.

As early as 1933 access to the lower Salmon subbasin was provided by roads constructed by U.S. Forest Service crews. The upper South Fork Salmon and upper North Fork Salmon were only accessible by trail until a later date. Fishing pressure was reported as heavy. Limits were high and included a legal salmon spearing season that was open between August and October (Taft and Shapovalov, 1935). Historic water temperatures were reported to exceed suitable (for salmonids); in summer of 1934 Taft and Shapovalov (1935) reported maxima of 77.5 degrees F. in the North Fork Salmon, 78.5 degrees F. in the South Fork Salmon, and 69 degrees F. in Nordheimer Creek.

South Fork Salmon River

The South Fork Salmon study area is located in the upper portion of the basin, from the mouth of Cecil Creek 18.3 km (11 mi.) upstream to the Little South Fork. The study area was divided into three distinct reaches based on channel confinement and stream gradient.

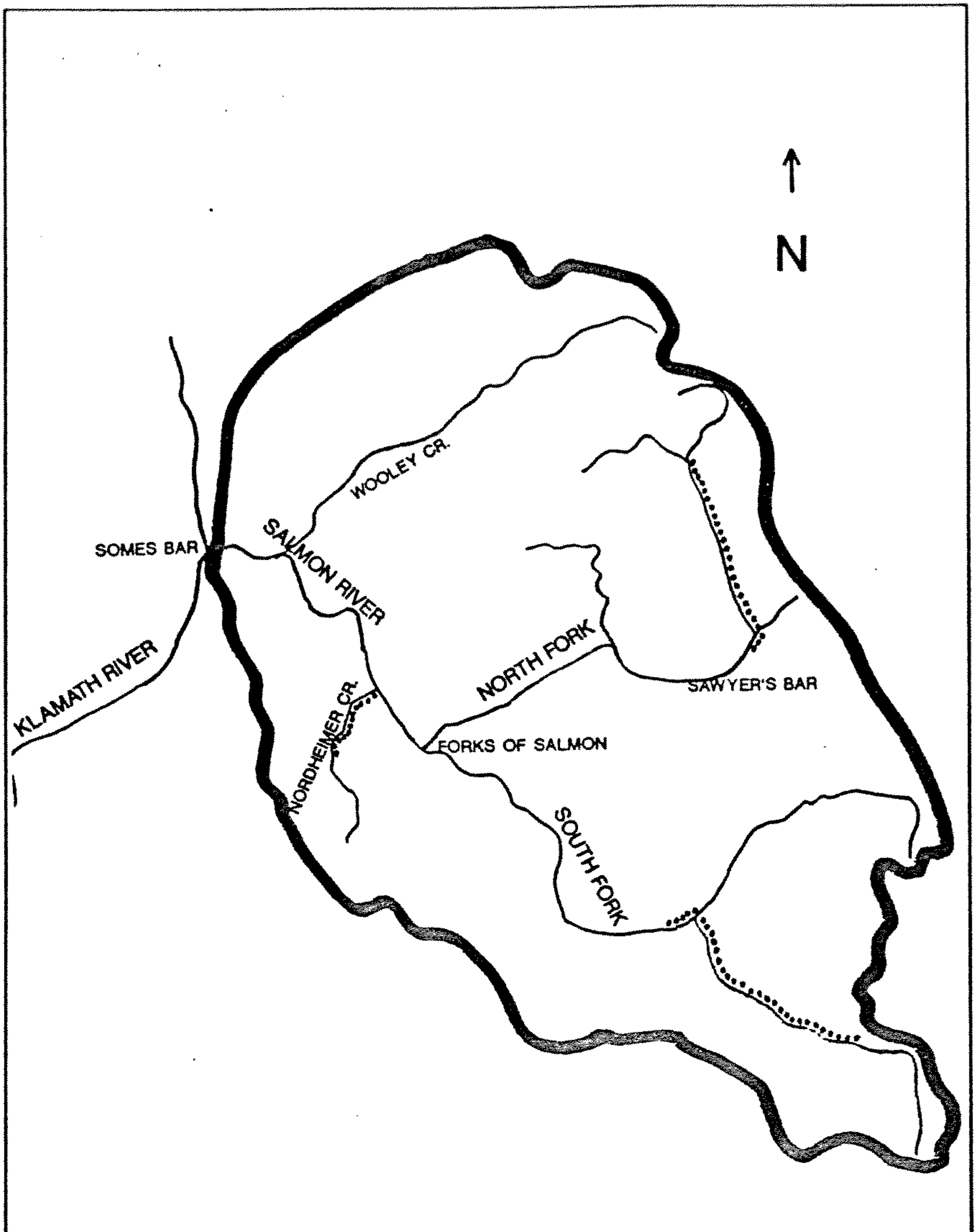


Figure 2 - Salmon Subbasin Study Areas (.....)

The "Gibson" reach is characterized by a bedrock entrenched channel beginning at the mouth of Cecil Creek and extending upstream about 6.4 km (4 mi.) nearly to Long Gulch. This reach is confined by bedrock banks that control channel features during high discharge. Riparian canopy is dense through most of the area, composed of a mix of conifer and deciduous species that provide adequate stream shade (defined as equalling or exceeding 80% of the water surface shaded). Main human uses in the area are mining and recreation. Holding areas for adult summer steelhead and spring chinook are scattered through this reach. The reach receives heavy fishing pressure in fall and winter months. Evidence of poaching (spears, blasting apparatus, snag hooks, etc.) is occasionally found along banks near deeper pools. Poaching may be a serious problem for fish holding in summer months. Access is provided along the entire reach by paved county roads. Flows fluctuate dramatically, and have ranged from a fall base flow of about 0.98 cubic meters per second (cms) (35 cubic feet per second (cfs)) to an estimated high of 252 cms (9,000 cfs) since 1979.

The "Petersburg" reach is characterized by a poorly confined channel that flows through a broad floodplain which begins near Long Gulch and extends upstream about 6.4 km (4 mi.) to Blindhorse Creek. This floodplain is probably a remnant of past hydraulic mining activities and floods, as recent as 1964, and has poor riparian vegetative condition. The channel is wide and shallow for much of the reach and little shade is available. Water temperature increases substantially between the top and bottom of the reach. Deep pools are rare due to the mobile nature of the stream bed, and they are associated with bedrock encroachment in the active channel. Main human uses in the area are mining and recreation. The lack of pools, may be a factor which leads to relatively light fishing pressure during fall and winter. Access was available by road or trail to all of this reach. Extensive instream habitat restoration activities by the USFS and CDF&G have occurred in this reach since 1982. A small hatchery for chinook was operated between 1984 and 1986 by the Pacific Coast Federation of Fisherman's Associations.

The "wilderness" reach is an entrenched channel that begins near Blindhorse Creek and extends 5 km (3 mi.) to Little South Fork, the upper limits of the study area. This reach has abundant bedrock outcrops, however where bedrock is absent, raw banks of gravel and soil are present behind the narrow deciduous riparian zone. It appears that raw cutbanks contribute significantly to bedload and probably provide a source of spawning gravel to downstream areas. Nearly the entire reach is within the Trinity-Alps Wilderness, and is undeveloped except for access trails. Riparian vegetation conditions range from fair to excellent and adequate shade is provided by a combination of vegetation and topographic features. Cool water temperatures (generally less than 20 degrees C.) are common throughout the summer which, combined with numerous pools in this reach, ensures good summer holding conditions for spring run salmonids. Use of the habitat by adult spring run fish is low, possibly a result of poor condition, open habitat in the "Petersburg" reach which must be negotiated before reaching the "wilderness" reach. Mining is the main human use of this area, although there is some limited recreation. Evidence of poaching was occasionally found in this reach.

North Fork Salmon River

The study area is located in the upper part of the North Fork basin, beginning at Whites Gulch and extending 18.3 km (11 mi.) upstream to the Right Hand Fork within the Marble Mountain Wilderness Area. Evidence of poaching (spears and a few dead salmon and steelhead that had been stripped of roe) was found during the study period. The study area was divided into two distinct reaches based on channel confinement and stream gradient.

The "flat" reach is characterized by a broad floodplain located in the lower portion of the study area, that begins at Whites Gulch and extends upstream 10.8 km (6.5 mi.) to Yellow Dog Creek. The broad floodplain is a result of historical floods and hydraulic mining activities which are still evident by steep, unvegetated banks in some areas. Those banks contribute soil and gravel to the bedload during high flow periods. Riparian vegetation is in fair condition, dominated by alders that do not provide shade adequate to maintain cool water temperatures. Most stream shade is provided by topographic features. Human use is limited to recreation and mining. Access is provided by trails and paved county road.

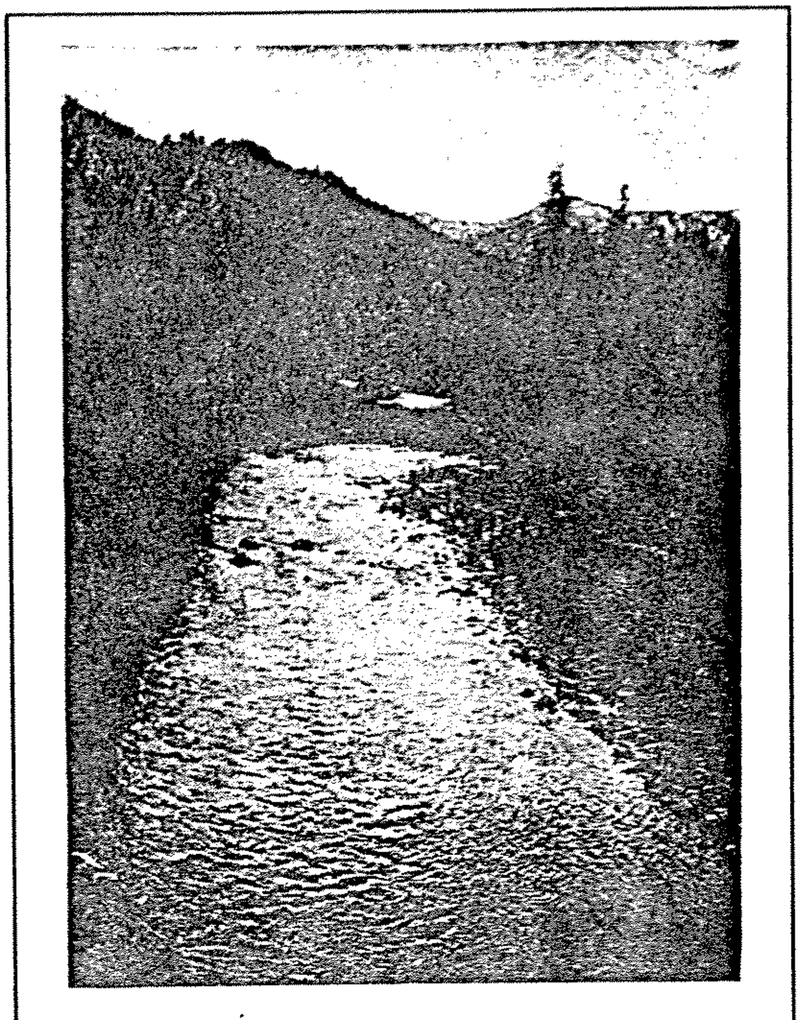
The "Yellow Dog" reach, characterized by a bedrock confined channel, begins at Yellow Dog Creek and extends 7.5 km (4.5 mi.) upstream to the Right Hand Fork and study area limits. The entire reach is within the Marble Mountain Wilderness Area and is paralleled by a trail. Riparian vegetation is in good to excellent condition and provides high quality shade, which maintains cool water temperatures, when combined with topographic features. Since the reach serves as an important trailhead to the Marble Mountain Wilderness Area, recreation is the principal use.

Nordheimer Creek

The Nordheimer Creek study area is predominately public land, except for one private parcel located 1.8 km from the mouth. The study area extends from the Salmon River upstream 6.7 km (4 mi.) to Granite Creek. The entire area is characterized by a steep gradient channel (2%) well entrenched in a bedrock canyon. The lower kilometer of this stream was aggraded 8-10 meters during the 1964 flood as a result of a landslide-caused dam about 2 km downriver (Bloomer Riffle) on the Salmon. The aggraded lower section of Nordheimer has been degrading since the flood, and remains unstable. The 1977 Hog Fire burned nearly the entire watershed which was then helicopter logged until about 1982.

The watershed is now vegetated by a heavy growth of brush and hardwoods. Riparian conditions in the study area are poor to fair and, when combined with the entrenched canyon, provide fair stream shade. Main human use is placer mining. Access is provided by a non-maintained dirt road along the lower 1.9 km and by a difficult trail above that point.

Anadromous fish access to the upper 4.5 km (2.8 mi) was blocked by a 4.5 m high waterfall over bedrock until 1987 when a concrete step and pool fish ladder was constructed. Salmon and steelhead now ascend the ladder and utilize upstream habitat. Over 150 steelhead redds were observed above the fish ladder in spring of 1988. Use of this stream by fall run chinook salmon is flow dependent. Aggradation at the stream mouth results in blockage of upstream migrating adults during low flows.



Scott River near Scott Bar, Calif.

Scott Subbasin

Located between the Shasta and Salmon Subbasins, the Scott Subbasin covers an area of approximately 2072 km^2 (800 mi^2). Land ownership is mainly private. The subbasin ranges from the Scott River headwaters in the Trinity Alps to the confluence of the Scott and Klamath Rivers (CH2M Hill, 1985;Figure 3). The Scott River is federally classified as Wild and Scenic from Meamber Bridge to the mouth.

The subbasin has been occupied by white man for several hundred years. The first visits were in the 1700s by beaver pelt trappers from the Hudsons Bay Company. Since those early years, the subbasin has been drastically modified by land clearing and marsh draining for agricultural purposes.

Taft and Shapovalov (1935) noted water diversion and hydraulic mining (below Scott Bar) as serious problems in 1934, finding numerous temporary dams for water diversion in Scott Valley and Quartz Valley so effective that Shackleford Creek was dry at it's confluence with the Scott on June 9, 1934.

Spring runs of chinook salmon were present in the Scott River system until the 1950's (S. Farrington, personal communication). Endemic stocks of steelhead were used as a source of broodstock for outplanting in the Scott and other areas in the upper Klamath River. Those outplants were composed of fish taken not only from the Scott tributaries, but included other broodstocks from the upper Klamath (Taft and Shapovalov, 1935). As a result, genetic purity of Scott River steelhead stocks is questionable.

Historical water temperatures were suitable for salmon and steelhead survival, 72 degrees F. in summer 1934 (Taft and Shapovalov, 1935), however their readings were taken in late June of that year when temperature may have been influenced by snowmelt runoff.

Considerable logging activities, primarily on private lands, have occurred in this subbasin since the early 1980's. They have resulted in mobilization of large quantities of granitic sediment throughout the river's habitat (personal observation). West (1984) reported little influence of granitic sediment on spawning areas sampled below Scott Bar in 1981. Results of 1989 work indicate that granitic sands heavily influence spawning and rearing habitat throughout the study area.

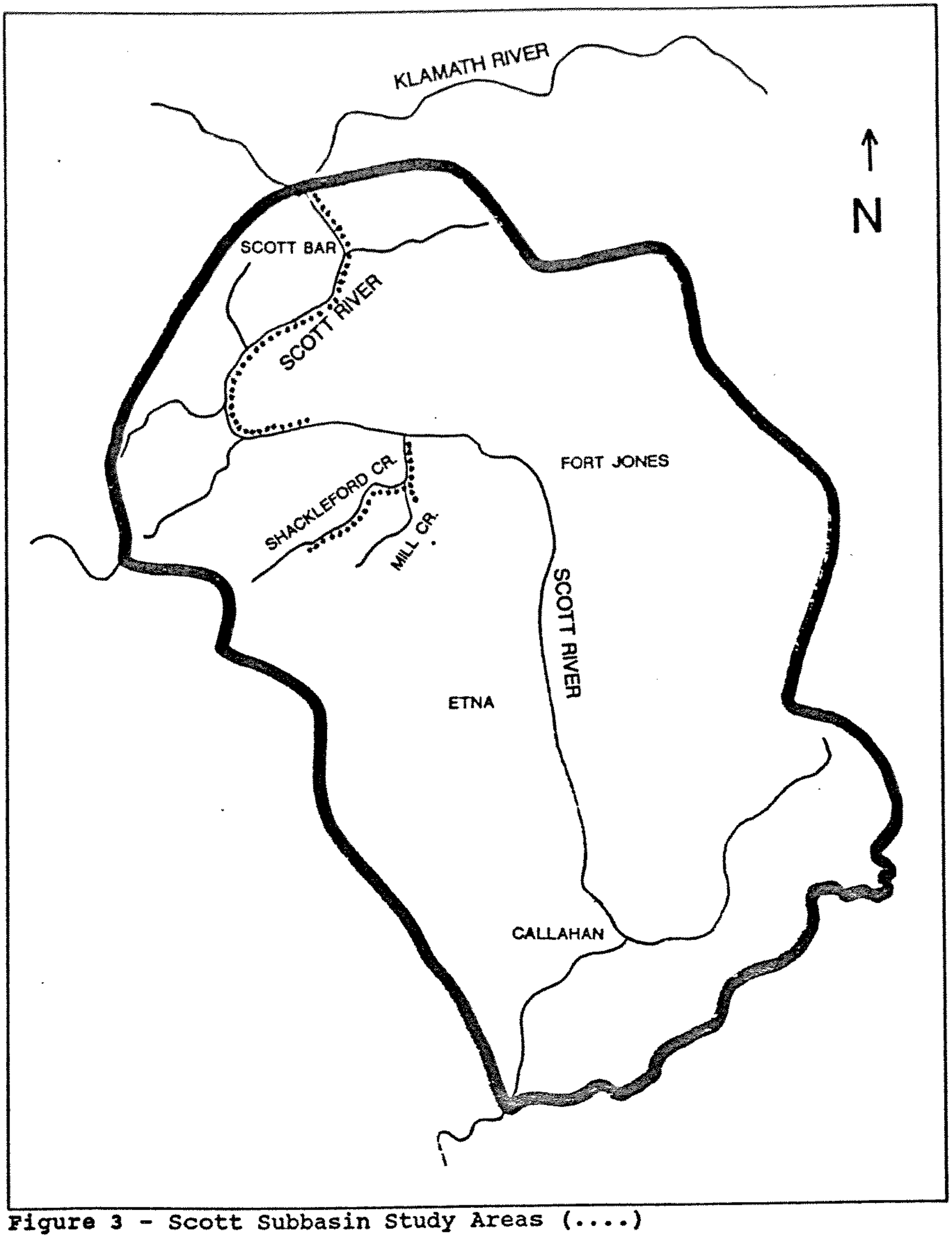


Figure 3 - Scott Subbasin Study Areas (....)

Scott River

The Scott River study area extends 30 km (18 mi) from the Klamath upstream to Jones Beach Picnic Area. The study area was divided into three distinct reaches based on channel confinement and stream gradient.

The "Scott Bar" reach is characterized by a flat gradient (less than 1%) channel with broad vegetated floodplain. This reach begins at the river mouth and extends upstream roughly 10 km (6 mi) to McGuffy Creek. Ownership of the river corridor is about equally split between private owners and public lands administered by the Forest Service. Mining and recreation (fishing, swimming and rafting) are the predominant uses in this accessible reach. Riparian conditions are fair to good though the vegetative canopy is usually not tall enough to cast shade across the wide channel. Lush growths of sedges cover many river bars, trap sediments, and possibly provide winter refuge for juvenile fish. Although fine sediments and granitic sand are common, especially in pools, gravel is less sandy than that found in upriver reaches.

The "canyon" reach is a steep gradient, bedrock-entrenched channel that begins near McGuffy Creek and extends upriver about 14.2 km (8.5 mi) to Boulder Creek. Bedrock and very large boulders shape channel features during high flows. About 80% of this reach is public land administered by the Forest Service, and the remainder is owned by several individuals. Several large cascades are present which may delay fall chinook migrations at certain discharge stages. Recreation is the predominant use in this reach. Access is difficult, provided mostly by foot-trail, to most of the canyon except 4.2 km (2.5 mi) where the county road is within several hundred meters of the river. Riparian vegetation is dominated by willow and sedge along the lower river banks; upper banks are sparsely vegetated because of the bedrock substrate. Most shading is provided by the topography and aspect of the canyon. Little suitable spawning area is present. Substrates are typically bedrock/cobble with some sand in larger pools.

In the "beach" reach, the river returns to a lower gradient broadly confined channel with vegetated floodplain. This reach begins at Boulder Creek and extends upriver 5.8 km (3.5 mi) to Jones Beach (upper limits of the study area). Deposition of granitic sand on lower banks and in the channel is typical throughout. The majority of spawning gravel is contaminated with sand; newly constructed redds were observed in spawning areas where sand was the predominant substrate material. About 20% of the corridor is privately owned and the remaining 80% is public land administered by the Forest Service. Similar to conditions found in the "Scott Bar" reach, sedges and willows grow densely on many river bars and probably trap some sediments in transport during high flows. The channel is characterized by braids caused by large boulders, and is the most structurally complex reach in the study area. Riparian conditions are fair to good in much of the reach, providing suitable shade during the day. Scott River Road, which parallels the entire reach, provides good access for recreation and other uses. Several campgrounds and day use areas receive moderately heavy use during spring, summer, and fall months.

Shackleford/Mill Creeks

The Shackleford/Mill Creek study area extends from the confluence of Shackleford Creek with Scott River upstream about 10 km (6 mi) on Shackleford Creek to a 4 m high waterfall barrier and about 3.3 km (2 mi) upstream on Mill Creek to Quartz Valley School. The entire area is privately owned grazing and timberland. The study area was divided into two distinct reaches based on channel characteristics.

The "Quartz Valley" reach extends upstream from the mouth of Shackleford Creek and includes Mill Creek, comprising about 9.2 km (5.5 mi) of habitat. The "Quartz Valley" reach is characterized by a flat gradient (less than 1%), broad unconfined channel containing frequent braids and ditch inlets. Substrate is dominated by clean gravels located in long riffles separated by very few pools. Riparian vegetation is in poor condition, providing inadequate stream shade. Willows and sedges are the dominant riparian vegetation (no conifers are present), and are limited to localized patches along the stream. Raw cutbanks are common through this reach; however, some isolated areas have been stabilized with rock riprap. Streamside areas are unfenced and accessible to livestock where permanent pasture grazing is the main land use. Based on crew observations, poaching of adult steelhead may be a problem during the spring spawning season. Because of the seasonal nature of flows and heavy withdrawal of water, flow was not available for adult fish access until after chinook spawning had ended in December. Some steelhead spawning was observed in diversion ditches, which were being "maintained" by heavy equipment in spring months.

The "upper" reach begins at the confluence of Mill Creek and extends 4.1 km (2.5 mi) up Shackleford Creek to a 4 m high waterfall over bedrock. This reach is characterized by steeper gradient (>1%), more confined channel with limited spawning areas and numerous pools. Stream substrate is dominated by coarse cobble, rubble, and boulders with very little available spawning gravel. Riparian vegetation is in good condition in the upper 2 km of this reach where alders and conifers dominate. The lower 2 km, in the agricultural area, has poor riparian vegetation conditions. Hence, stream shading is adequate above the valley and poor downstream. Streamside areas are grazed in the lower 2 km and logging adjacent to the stream is evident in the upper 2 km.

Yreka Creek "Municipal Reach" Riparian Area, Shasta Subbasin.

Shasta Subbasin

This subbasin ranges from the headwaters of the Shasta River on Mt.Shasta to the river's confluence with the Klamath and includes the Little Shasta River (Figure 4). The area drained by the watershed totals approximately 1554 km^2 (600 mi^2), and is predominantly privately owned (CH2M Hill, 1985).

Historical evidence, similar to that found in Scott subbasin, suggests that "...as a result of extensive diversion of water fish life has suffered more adverse effects than in any other part of the watershed." (Taft and Shapovalov, 1935). Water temperatures observed by those authors in 1934 were suitable for salmonids (maximum 73 degrees F.). However they noted "... although in this stream the temperature probably goes much higher in the section near the mouth". Mining in the Yreka Creek area and agricultural uses dominate historical records and undoubtedly influence the condition of present-day fish habitats.

Shasta River

The Shasta River study area extends from the Klamath River upstream 16.7 km (10 mi) to Oregon Slough. The study area was split into two channel reaches based on channel confinement and stream gradient.

The "canyon" reach extends from the mouth upstream 11.7 km (7 mi) to the southernmost crossing of California Highway 263. It is a mixture of privately-owned property (old homesteads and patented mining claims) and public lands administered by USDI-Bureau of Land Management. The canyon reach has a steep gradient (2-4%) and two privately owned, low-head dams located 1 km below the Hwy. 263 bridge. Due to the steep, rocky terrain in the canyon, there is little agricultural use other than open range grazing on public lands. Although deciduous riparian vegetation is dense, it is limited in height and tall coniferous trees are absent; therefore, little shade was provided by vegetation. Stream shade is provided by topographic features.

The "valley" reach begins at the Hwy. 263 crossing and continues 5 km (3 mi) upstream to Oregon Slough. The reach is privately owned agriculture land where permanent pasture grazing is the principal use. The reach is a low gradient (0-.5%) meandering channel. The bulk of the flow originates from springs at the upper end of the Shasta Valley. Riparian conditions within this unfenced reach are poor since much deciduous woody vegetation has

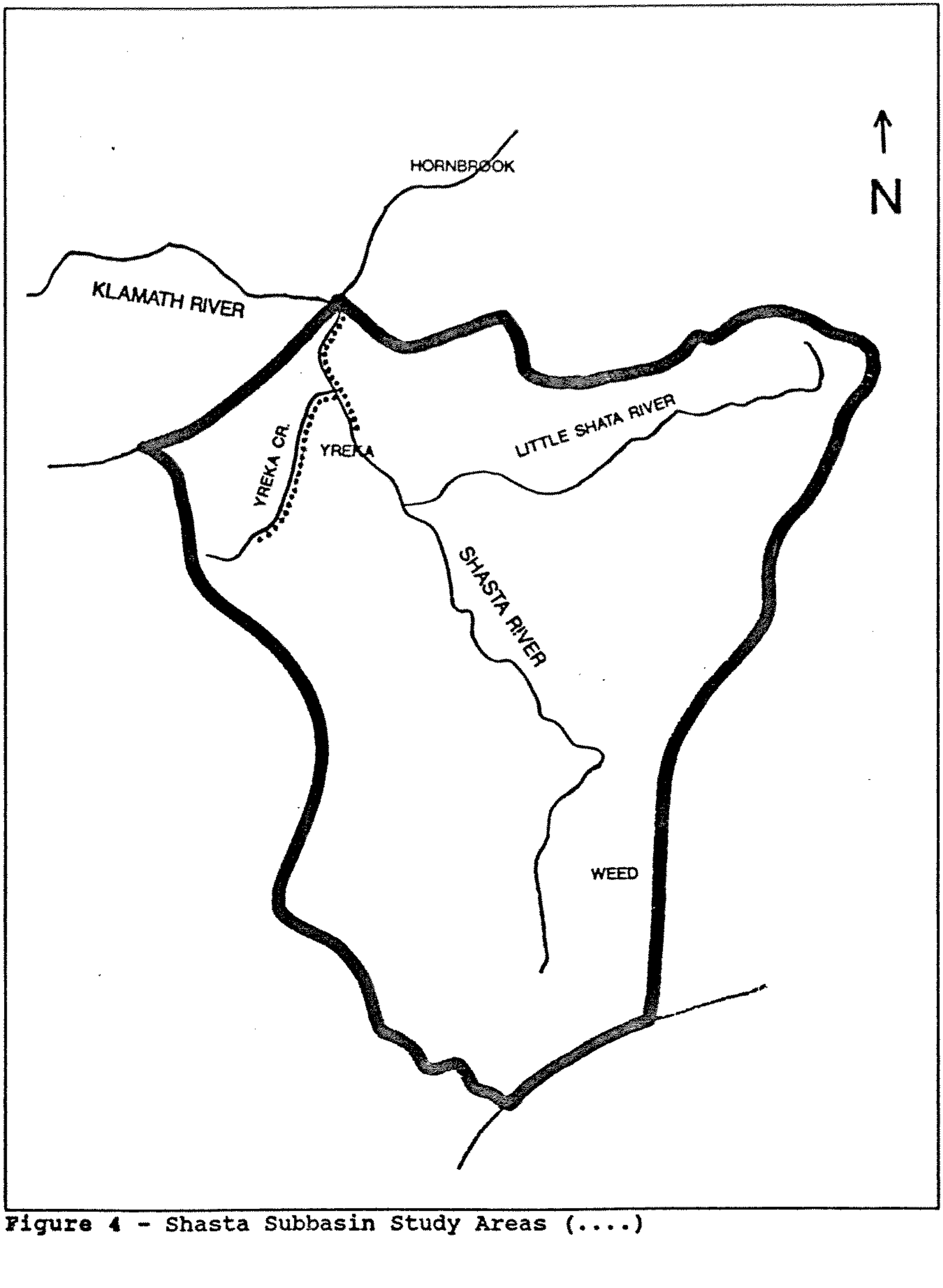


Figure 4 - Shasta Subbasin Study Areas (....)

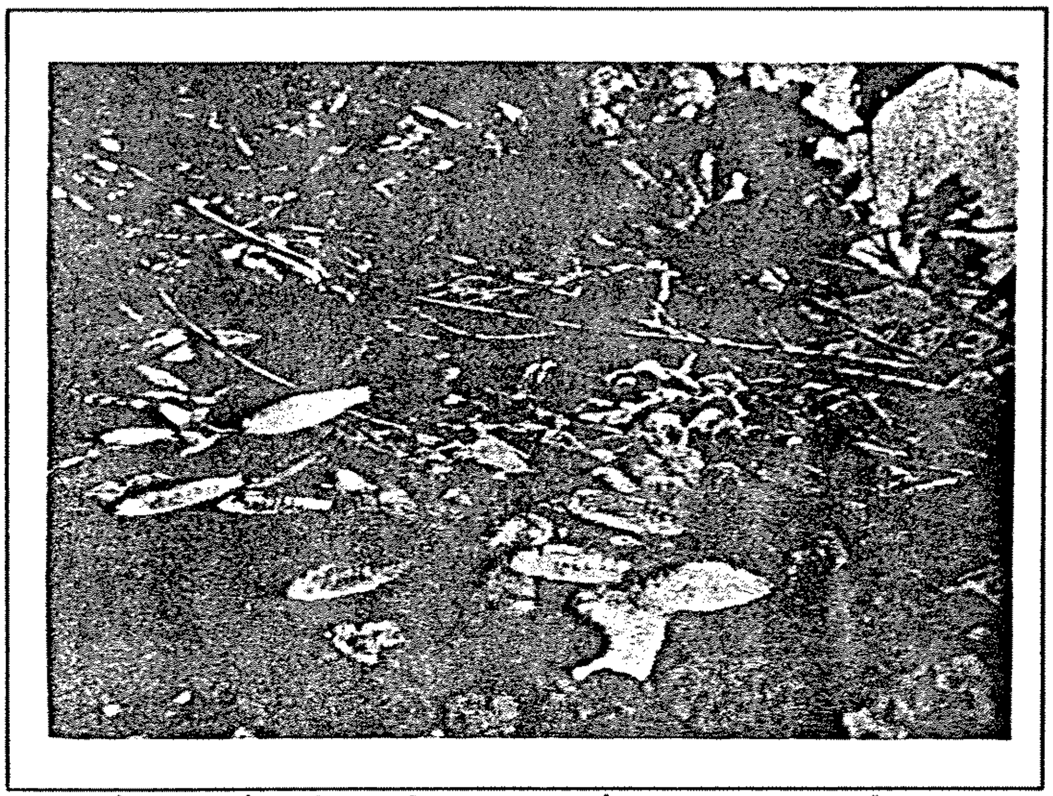
been lost to grazing and browsing animals; there is no stream shade.

Yreka Creek

The Yreka Creek study area extends from the Shasta River upstream 13.3 km (8 mi.) to the base of Forest Mountain. The study area was split into two distinct reaches based on land use patterns.

The "municipal" reach begins at the Shasta River and continues upstream about 9.2 km (5.5 mi) to the Yreka Junction Shopping Center. Municipal uses encroach into the streamside area. This reach is a privately owned, flat gradient (<1%) channel confined by mostly stable or stabilized banks. Riparian conditions are fair to good, consisting of healthy growths of deciduous woody trees, brush, and some conifers. Stream shade is fair to good through most of this area. The channel has been lined with concrete in four areas, totalling about 500 meters in length. Evidence of beaver activity is common throughout the reach where beaver dams are actively maintained. Human garbage is common along and in the channel in the vicinity below Siskiyou General Hospital. Also in this area an "oily sheen" was evident in summer months on the water surface where velocity was low. Discharge of treated effluent from the City of Yreka sewage treatment plant, located about 5 km (3 mi) upstream from the mouth, substantially increases the streamflow of the lower portion of this reach.

The "forest" reach extends from Yreka Junction Shopping Center upstream 4.1 km (2.5 mi) to the upper limits of the study area near Forest House. This reach is privately owned and use is dominated by cattle grazing. Riparian conditions are poor throughout most of the reach and raw cutbanks are common, as a result stream shade is poor and little flow persists through the summer months.



Juvenile Chinook Salmon Rearing Near Woody Cover, Summer 1989.

Mid-Klamath Subbasin

This subbasin includes the Klamath River and its major tributaries from Iron Gate Dam to the Salmon River (Figure 5). It has a total area of approximately 3900 km^2 (1,500 mi^2). Ownership is a mixture of public and private holdings (CH2M Hill, 1985). Survey stretches include: 20 km (12 mi) of Beaver Creek, from the mouth to Grouse Creek; 28.3 km (17 mi) of Indian Creek, from the mouth to Green Creek; 20 km (12 mi) of Grider Creek, from the mouth to Stones Valley Creek; and 23.3 km (14 mi) of Elk Creek, from the mouth to Bear Creek.

Elk Creek

Elk Creek is tributary to the Klamath River and originates in the northern slopes of the Marble Mountains (max elev. 7406). It flows northwesterly through rugged, mountainous terrain for 35 km (22 mi) before entering the Klamath River one mile downstream from Happy Camp (elev. 1040). The Elk Creek watershed covers 254 km^2 (96 mi^2) and is situated entirely within the Klamath National Forest. Approximately 1/3 of the watershed lies within the Marble Mountain Wilderness.

Historical information provided by Taft and Shapovalov (1935) reported that a dam affected fish passage in 1934 when two dead summer steelhead were found in the defective ladder. They reported suitable water temperatures (69° F.) in early July of that year. As recently as 1958, a diversion dam for Happy Camp's water supply prevented adult fish passage. A fish ladder at the site was reported damaged in the flood of 1955 and remained impassable at least until September of 1958.

The Elk Creek watershed has been extensively roaded and managed for timber production outside the wilderness boundaries. In 1987, lightning-caused wildfires burned approximately 113 km^2 (43 mi^2) (44%) of the Elk Creek watershed. Sixty-one percent of the non-wilderness land was burned. Additionally the fire of 1987 severely burned several large watersheds tributary to Elk Creek that have highly erosive soils on steep (>65%) sideslopes. Emergency watershed measures taken immediately following the fires were effective, and degradation of fish habitat has been minimal.

Efforts began in 1984 to bolster depleted runs of natural chinook salmon on Elk Creek. CDF&G established a juvenile fish rearing pond located 4.3 miles upstream from the mouth. Operated by the CDF&G and the Karuk Indian tribe, the rearing facility can

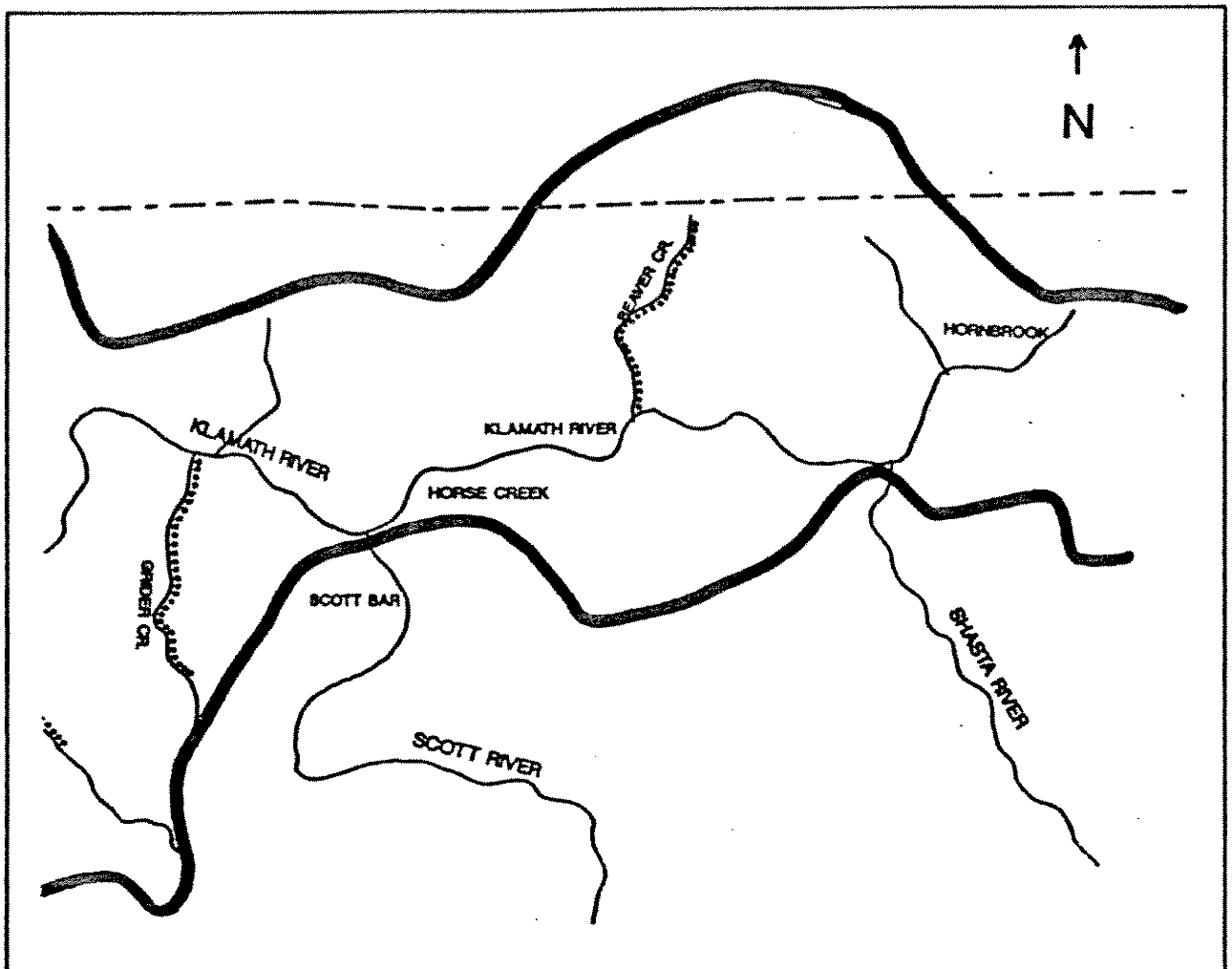


Figure 5 - Mid-Klamath Subbasin Study Areas (....)

produce 40,000 smolts annually. Between 24,000 and 28,800 juvenile coho salmon have been planted annually in Elk Creek since 1986. Small numbers (<4500) of steelhead fingerlings were also planted in Elk Creek tributaries. All salmonids released into Elk Creek are stocks from Iron Gate Hatchery.

The study area extends from the mouth of Elk Creek to Bear Creek 23.3 km (14 mi.) upstream. A road parallels Elk Creek as far as Bear Creek, however, steep canyon slopes make stream access difficult in many areas. The study section was divided into five reaches based on channel confinement and gradient.

Reach I extends from the mouth of Elk Creek to the bridge 5.6 km (3.5 mi) upstream. This reach is characterized by steep, rocky sideslopes and large bedrock formed pools. Pool tailout areas, containing spawning size gravels, receive heavy use by adult salmon and steelhead. Adult holding in the reach is variable despite the presence of pools and may be influenced by temperature. The riparian canopy is in poor condition and provides little shade. A waterfall located 4.8 km (3 mi) from the mouth may hinder adult passage at low flows but is not a passage barrier. Fishing pressure at the mouth (in the Klamath River) is heavy year round and moderate throughout much of the remaining reach. Despite access problems suction dredging pressure is heavy throughout much of the reach. Elk Creek serves as the source for the Happy Camp municipal water supply and is classified as a Class I stream. The pumping station is located approximately 1 km (0.6 mi) from the mouth. Private residences and a commercial campground parallel the creek to a point 1 km (0.6 mi) above the mouth.

Reach II consists of a 2.5 km (1.5 mi) section from stream km 5.6 (3.5 mi) to Twin Creeks. The flat gradient channel is moderately confined, and secondary channels can be found at the upper end of this reach. Some pools within this reach provide well used holding habitat for adult summer steelhead. Stream shade is good, provided by alders. Large conifers are also common on the upper banks. Stream access is excellent and results in heavy recreation and fishing use, as well as extensive recreational suction dredging.

Reach III extends from Twin Creeks to about 12 km (7.6 mi). This well confined reach has large bedrock formed pools which provide excellent steelhead holding habitat. Access to this reach is difficult, however it receives modest dredging pressure and low fishing use.

Reach IV consists of a 2 km (1.3 mi) section between 13 km (7.6 mi) and 15 km (8.9 mi). This reach is well confined with a mild gradient, and contains few pools. Wide low gradient riffles and runs are common.

Reach V extending from the bridge at 15 km (8.9 mi) to Bear Creek is composed of bedrock pools and cascades within a well confined channel. Adult "holding" areas are common, however, few suitable spawning areas exist. Alders and large mature conifers provide adequate stream shade. Although an unsurfaced road parallels this reach, stream access is difficult. Moderate to heavy suction dredging use occurs in this area. Two Forest Service campgrounds and a Marble Mountain Wilderness trailhead adjacent Elk Creek receive moderate to heavy seasonal use.

Indian Creek

Indian Creek originates on the east slope of the Siskiyou Mountains (max elev. 7309) along the Oregon border and flows southeast for 30 km (18 mi) to its confluence with the Klamath River at Happy Camp (elev. 1060). The drainage basin covers 351 km^2 (135 mi^2) and is located entirely within the Klamath and Siskiyou National Forest boundaries.

Historic evidence suggests that mining and agriculture were two principal uses of this stream in the early 1900s (Taft and Shapovalov, 1935). Taft and Shapovalov (1935) reported that Indian Creek suffered from "moderate mining pollution" although it had suitable water temperatures (64° F on July 6, 1934) for salmonid holding and rearing. A twenty-foot high dam, located 4.5 km (2.8 mi) above the mouth, may have inhibited passage of adult fish upstream because of "a ladder in need of repair" at that time. Significant pollution from mining activities was occurring in Indian Creek as recent as the 1970's. Severe water quality degradation, including acidity, high concentrations of heavy metals, and ferric hydroxide precipitates, caused local fish kills and a buildup of heavy metals in resident fish populations in the lower 5 km of Indian Creek (CH2M HILL, 1985). Extensive cleanup efforts and water treatment by the mine owner may have corrected these problems. During summer steelhead surveys conducted in summer 1988, divers observed a "substantial reduction" in numbers of juvenile steelhead downstream from the Noranda Mine ditch outfall (D. Maria, personal communication). Domestic pollution from untreated sewage entering Indian Creek was a problem into the late 1970's until a sewage treatment facility was constructed in Happy Camp. Water quality may still be affected by residents that use leach field systems adjacent to Indian Creek.

The CDF&G and Karuk Indian Tribe have cooperatively operated rearing ponds on Indian Creek since 1980. Current rearing activities include one facility utilizing Iron Gate Hatchery chinook fingerlings that has a capacity to produce 80,000 yearlings for release into Indian Creek. Other releases include 24,000 to 48,000 juvenile coho salmon from Iron Gate Hatchery planted yearly between 1986 and 1989, and 8,000 steelhead fingerlings planted in 1983.

The study area extends 28.3 km (17 mi) from the mouth of Indian

Creek upstream to Greens Creek. A road parallels Indian Creek into Oregon and provides good access to much of the stream; however, access may be difficult in areas between West Branch Campground and Greens Creek due to steep sideslopes. The study area was divided into four distinct reaches based on channel confinement and stream gradient.

The "Happy Camp" reach extends from the Klamath River upstream 7.7 km (4.8mi) to Deer Lick Creek. This reach is well confined and maintains a "flat" gradient (<1%). Large bedrock formed pools are common, however, adult use of this habitat for "holding" during the late summer is variable, possibly due to high (21°C) water temperatures. Little riparian shade is available, though canyon walls provide some additional shade. Most of the stream frontage along Indian Creek from the mouth to South Fork Indian Creek is privately owned with numerous adjacent commercial and residential dwellings. Fishing pressure (in the Klamath River) at the mouth is heavy nearly year round and moderate throughout much of the remaining reach. Suction dredging pressure is low. Buchanan Falls, located at 7.3 km (4.6mi), slows migrating adult salmon and serves as a popular viewing area.

The "South Fork" reach extends from Deer Lick Creek upstream to 15.6 km (9.7mi). This reach exhibits low to moderate confinement and maintains a relatively flat gradient (1.0-1.5%). Secondary and braided channels are common in less confined areas. Consistent with the mobile nature of the streambed, few large pools are present. Pools providing sufficient cover are heavily utilized by summer and fall run fish for "holding" habitat. This reach is heavily utilized by salmon and steelhead for spawning which may be influenced by the CDF&G rearing channel located at 11.4km (7.1mi). The riparian canopy consists largely of alder and willow which provide little stream shade. Fishing pressure along this reach is moderate and localized due to private streamside ownership. South Fork Indian Creek is the largest tributary and enters at 12.5 km (7.8mi). Recreational suction dredging pressure on this tributary is heavy, while dredging pressure on Indian Creek within this reach is relatively light.

The "School House" reach extends from 15.5 km (9.7 mi) to the confluence of West Branch Creek. This confined reach maintains a moderate gradient , riffles and runs are the dominant habitat features, pools are few. Adequate shade is provided by an alder canopy. Mining, channelization, and historic floods are evidenced by large unvegetated flats adjacent to the creek. Fishing and suction dredging is common in this area. Approximately 2 km (1.25 mi) of stream frontage is privately owned.

The "West Branch" reach extends from West Branch Creek to Greens Creek. This reach is well confined and moderately steep (5-10%). Mass wasting is common and damage from historic flooding is evident. Shade is adequate and provided dominantly by alders.

Recreation and fishing use is concentrated around West Branch Campground operated by the Forest Service. Access to much of this reach is limited by steep slopes and road proximity.

Grider Creek

Taft and Shapovalov (1935) found suitable water temperatures in this stream during summer of 1934 (63^{o}F. on July 2, 1934) and noted no pollution from mining or other sources. A 1.5 m high dam located 4 km (2.5 mi) above the mouth was adequately laddered to provide upstream fish passage of adults.

Grider Creek originates from headwaters above 6,000 feet in the Marble Mountain Wilderness and flows north about 24 km. to its confluence with the Klamath River. The watershed encompasses an area of 113 km^2 (43.6 mi^2) much of which was burned in the wildfires of 1987.

Grider Creek is a moderate to high gradient (3 to 6 percent) stream. The watershed is predominantly public land, managed by the Klamath National Forest, however the lower 3 km. of stream is privately owned. A rearing pond located on private land several kilometers upstream from the mouth is operated annually by California Department of Fish and Game. The pond rears an annual average of 26,000 chinook salmon fry from Iron Gate Hatchery for late fall release into Grider Creek.

The study area extends from the Klamath River upstream 19.8 km (12.3 mi) to Stones Valley. Road access is limited to the lower 4.5 km (2.8 mi), with the Pacific Crest Trail (PCT) providing access from 4.5 km to Cliff Valley (14.5 km). An unpaved road accesses the PCT trailhead at Cliff Valley. The study section has been divided into three reaches based on channel confinement and gradient.

The "Campground" reach extends from the mouth to 6.3 km (3.9 mi) and is moderately confined with a moderate gradient (1.0-1.5%). The reach is dominated by runs and riffles, with some channel braiding present. Average stream shading is approximately 40%, provided largely by alders (Alnus sp.).

The "Bark Shanty" reach from 6.3 km (3.9 mi) to 15.2 km (9.5 mi) is well confined with a gradient between 2.5-4.0%. High-gradient riffles and pools dominate the habitat. Average stream shading, provided by a combination of deciduous and coniferous canopy, is approximately 45%. Large woody debris and downed trees are common.

The "Fish Creek" reach extends 4.5 km (2.8 mi) from 15.2 km to Stones Valley (19.8 km) and is moderately confined with a gradient of approximately 5.0%. High-gradient riffles and pools are the dominant habitat types. Average stream shading is approximately 30%, provided largely by alders (Alnus sp.) and willows (Salix sp.). This reach has several slope failures, one of which, associated with a log jam, forms a barrier to migratory salmon and steelhead just below Fish Creek. Large woody debris and downed trees are common.

Beaver Creek

Historical angling use on Beaver Creek was reportedly heavy (Taft and Shapovalov, 1935). Fish were quite small, "the usual catch averaging from 5 to 6 inches in length.", indicating that these trout were probably juvenile steelhead. Because of angling pressure at that time, the 1934 trout season on Beaver Creek did not open until June 16, "due to temporary regulations". The stream was affected by "moderate mining pollution" but had suitable water temperatures (56°F. on May 16, 1934) at least during spring months.

Beaver Creek flows south from its headwaters below Mt. Ashland (7533 ft) 56 km (35 mi) to the Klamath River. The drainage encompasses an area of 316 km^2 (121 mi^2) of mixed ownership lands, 60% publicly owned and managed by the USFS or BLM. The study area extends from the Klamath River upstream 20 km. (12 mi.) to Grouse Creek. Channel gradients range from 2 to 6 percent.

The majority of the drainage is heavily roaded to provide logging access to public and private lands. Beaver Creek and its tributaries exhibit a high suspended sediment load during winter/spring high flows and summer storm events. The sediment results from extremely erosive decomposed granitic soils within the watershed, and road-associated runoff.

The CDFG operated a rearing pond for Iron Gate Hatchery chinook salmon until 1984. That facility, located 1 km upstream from the Klamath River, released an average of 35,000 chinook smolts each fall between 1980 and 1984. Coho salmon from Iron Gate Hatchery have sporadically been released into Beaver Creek.

The study area extends 17.9 km (11.1 mi) from the Klamath River to Grouse Creek. Good stream access is provided throughout the study area by paved road. Four reaches were developed based on channel confinement and gradient.

The "Dutch Creek" reach, extending from the mouth to 6.0 km (3.7 mi), exhibits low channel confinement and a relatively flat (1.0-1.5%) gradient. This reach is dominated by riffles and runs. Stream shade, provided by alder (Alnus sp.) and willow (Salix sp.), averages 15%.

The "Campground" reach extends from 6.0 km (3.7 mi) to 8.2 km (5.1 mi). The channel is moderately to well confined with a moderate gradient (2.0-2.5%). Riffles and runs compose the dominant habitat with pools interspersed. A deciduous riparian area provides stream shade averaging 60%.

The "Bumblebee Creek" reach from 8.2 km (5.1 mi) to 14.0 km (8.7 mi) is moderately to well confined with a gradient between 2.5-4.0%. Runs, riffles and pools are all well represented. Average stream shade is approximately 40% and is provided largely by deciduous riparian species.

The "Grouse Creek" reach extends from 14.0 km (8.7 mi) to 17.9 km (11.1 mi). Channel confinement is moderate and gradient ranges from 2.0 to 2.5%. Riffles and runs are dominant habitat types represented. Deciduous riparian species provide approximately 20% stream shade.

MATERIALS AND METHODS

Spawning Ground Evaluation

Each study area was surveyed during spawning season (salmon: October through mid-December; steelhead: March through mid-May) at biweekly intervals by two-person crews wearing either chest waders or wetsuits. Surveyors wore polarized fisherman's glasses to aid in locating redds and improve wading safety. Once each day water and air temperatures were recorded, streamflow was estimated, and weather conditions were noted.

Redds were counted and each was marked by hanging colored flagging on nearby vegetation, adjacent to the redd pott to reduce the likelihood of duplicate counts of the same redd. The habitat type (McCain, et al, unpublished) associated with the redd was identified and recorded. Occasionally spawning areas were associated with "non-typical" habitat types (ie: spawning might be found in tailouts of pools which were not large enough to be classified as a distinct habitat type). On those occasions, spawning habitats were categorized into a major spawning habitat type based on velocity associated with that area (eg: glide = low velocity spawning areas; run = higher velocity areas). Enhanced habitats were classified according to structure present. Because enhanced deflector and enhanced pocket types occurred together in the field, they were lumped together. Final groupings used for analysis were: low

Measuring Redd Surface Area, Salmon Subbasin.

gradient riffle (Type 1); high gradient riffle (Type 2), glide (Types 14, 4, 5, 6, 7, 9, 13, 17, 18, 19, and 22), run (Types 15, 8, 10, 11, 12, 20, and 21), step run (Type 16); enhanced weir (Type 30), and enhanced deflector/pocket (Type 31 and 32).

Twentyfive percent of all redds encountered were sampled to determine mean redd length, width, and pott depth. This information was utilized to compare redd surface area by species, among habitat types within a study area, and among like habitats in different study areas.

Habitat specific spawner "utilization coefficients" were developed using the formula described by Bisson et al. (1982) to "relate the fraction of the population found within a particular habitat type to the relative abundance of that habitat type" in the study area. The formula used is:

Utilization=

$$\frac{\text{habitat specific density} - \text{average total density}}{\text{average total density}}$$

where:

habitat specific density = average density (redds/sq.m.) in the habitat type of interest

average total density = average density (redds/sq.m.) over the entire study area, all habitat types containing spawning areas

Values of this coefficient can range from -1 to positive infinity; a negative value indicates that use of a specific habitat for spawning is less than the average use throughout the reach. A positive value indicates habitat specific spawning use greater than average. A value of 0 indicates that the specific habitat is being used in proportion to it's occurrence in the study area. Some reaches were uncountable at times, especially during steelhead spawning, due to adverse viewing conditions.

Rearing Habitat Evaluation

Unmodified stream habitat surveyed at base summer flow in 1989 was classified into one of 22 possible habitat types utilizing the system originally described by Bisson, et al. (1982) and later modified by McCain, et al (unpublished). Each habitat type is derived from either pool, riffle, run, or cascade (Appendix A). The length of each habitat unit had to equal or exceed the width of the wetted channel at the time of assessment to be designated. To include enhanced habitat in our assessment, we added three additional habitat types: enhanced weir (#30), enhanced deflector (#31), and enhanced pocket water (#32). In many situations deflectors had been placed in the same reach as boulder groups (enhanced pocket water), and because of the criteria defining a distinct habitat unit they were lumped together.

Physical measurements were taken for each habitat unit, including mean unit length, width, and depth, maximum depth, and depth at riffle crest (where applicable). Azimuths and mean percent slopes were measured, and Rosgen channel type was determined utilizing Laird's (1989) stream classification table. Surveyors ocularly estimated total spawning area and amount of cover available to fish in each unit (of that total, the percentage of each cover type: undercut banks, small woody debris, large woody debris, terrestrial vegetation, aquatic vegetation, white water, boulders, and bedrock ledges). Spawning area suitability was determined using depth, velocity, and substrate suitability criteria described by Reiser and Bjornn (1979). We assumed that because these areas were observed under low flow conditions they may not be suitable during other discharge levels. However, most of the chinook spawning in this area occurs during base flow. During steelhead spawning, which occurs at higher discharge stage, we assumed that areas thought suitable during the summer base flow were probably not as suitable, but additional areas (dry stream bars) then replaced those we had seen at lower flow. To be certain of the amount and suitability of steelhead spawning area available, it would be necessary to estimate spawning area during the spawning period, which we omitted due to limited financing. Spot air and water temperature and estimated streamflow (cfs) were recorded each day during the habitat assessments.

Suitable over-winter habitat for coho fry in streams with mean winter water temperatures less than 7° C was described by Reeves, Everest, and Nickelson (1989) as: "Beaver ponds and off channel areas associated with an abundance of cover, primarily large woody debris; also stream margins with concentrations of large woody debris and boulders that form pockets of deep (>0.5m at winter base flow), slow (<0.3 m/s) water." We assume that similar conditions are required for other salmonids. Because of the time of year that physical data were collected in the study areas, it is not possible to determine more than presence or absence of features which may meet those criteria under winter flow conditions.

A systematic sampling method (25% of the habitat units assessed) was used to determine where biological sampling and additional physical habitat information would be collected. Hankin and Reeves' (1989) method for estimating fish abundance was modified by further stratification of habitat types. Hankin and Reeves stratified habitats into broad categories of riffle, pool, glide or side channel. We designated the modified Bisson habitat types as sampling units (eg., low-gradient riffle, high-gradient riffle, main channel pool, etc.).

In 1987 and 1988 surveys, crews had determined 25% sampling units by rolling dice at each station. We found this method was limited because some seldomly-encountered habitat types were not sampled, and biological data was unavailable for those types. We modified the sampling method to designate the first unit of each habitat type encountered per study area as a sample unit. From then on, every fourth unit of each habitat type was sampled. The habitat typing crews used tally sheets to track the number of units per habitat type encountered for each stretch.

Additional physical data gathered at each sample unit included ocular estimation of substrate composition (percent fines, gravel, cobble, boulder and bedrock), mean substrate embeddedness, percent of exposed substrate, and percent stream shade at noon. Riparian area condition criteria were established and adopted by Klamath National Forest Fisheries Biologists based on information presented by Sedell, et al (1984) to define "old growth" riparian vegetative condition. We assessed riparian condition by determining percent composition of deciduous and coniferous trees and by categorization of the adjacent acre of forest as either poor, good or excellent for future recruitment of large woody debris. Poor future recruitment condition was defined as an acre having fewer than 12 standing trees greater than 12" diameter at breast height (dbh); 'good' as 12 to 15 such trees, and 'excellent' as greater than 15 recruitable trees per acre.

Biological sampling was conducted by two person dive teams at sample units. Depending on stream size, single or paired divers used the equivalent of a "two-pass" method beginning at the lower end of each dive unit and enumerating fish in the unit by mask-and-snorkel direct observation. Salmonids were classified by species and age-class (0+, 1+ or older juveniles, and adults). The presence of other species was noted. This method was calibrated against electrofishing results as described by Hankin and Reeves (1989). Divers consistently under counted fish in low gradient riffle, high gradient riffle, and cascade habitats (Types 1, 2, and 3) where generally only 25% of the fish present were seen. An average of 66% of fish present in Run, Step-Run, and Pocket Water habitats (Types 15, 16, and 21) were observed by divers. Approximately 71% of fish present in pool habitat types were observed by divers.

Extremely long dive units were encountered with sufficient frequency to warrant subsampling; pool habitats were not subsampled. The following subsampling criteria were developed by project biologists: the sample unit had to be greater than 60 m in length and contain relatively homogeneous habitat throughout. One-third of the unit (lower, middle, or upper third) was randomly selected by using coins or dice, and that section was biologically sampled. The next time a long dive unit of the same habitat type was encountered, one of the two remaining thirds was randomly selected and sampled. At the third such occurrence, the remaining

Mask and Snorkel Direct Observation.

third of that unit was sampled. A tally system was utilized to track subsampling efforts for each study area.

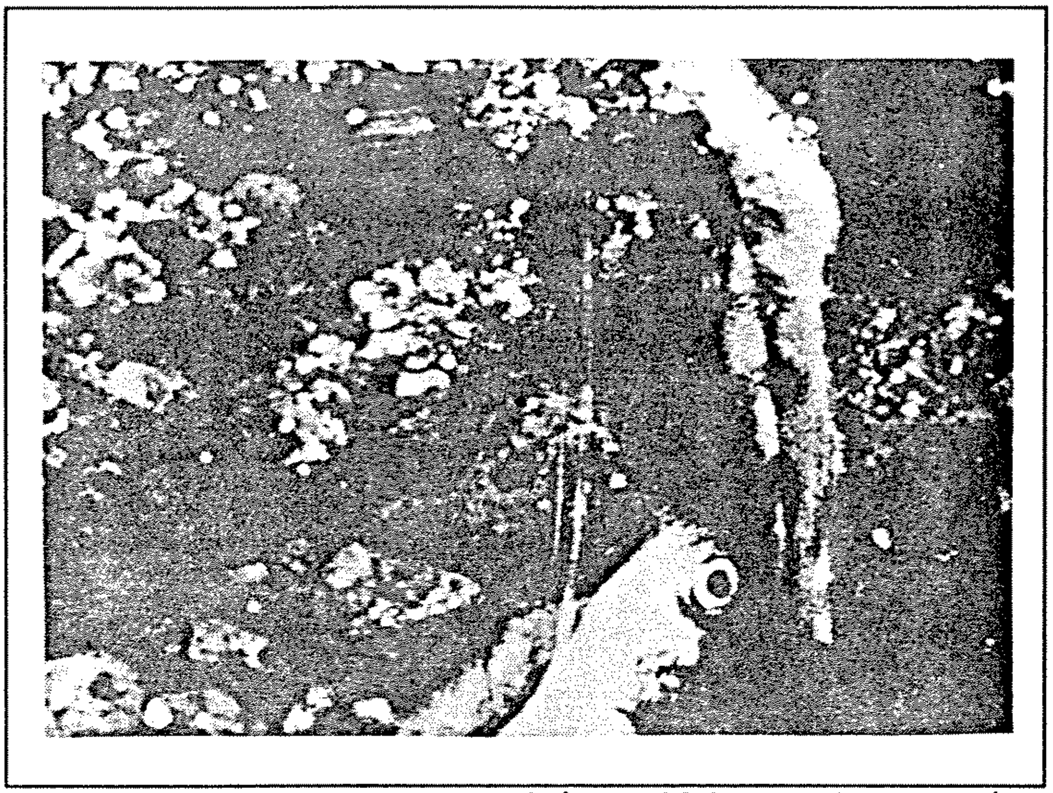
Due to adverse diving conditions in Yreka Creek, removal method electrofishing estimator was used to obtain biological information. For this process, a sampling frequency of 12.5% was utilized in each habitat type due to additional time and crewpersons required for sampling. Salmonids were enumerated as per direct observation methods previously described. Additional biotic information obtained through electrofishing included fork length of each salmonid and number of individuals of each non-salmonid species captured.

Mean densities of observed salmonids by age-class and species were calculated for both area and volume of each habitat type. Estimated densities were derived for each habitat type by applying the appropriate factor based on results of electrofishing calibration (eg: where 25% of fish were observed, observed densities were multiplied by four; where 66% of the fish were observed, observed densities were multiplied by 1.6; where 71% of the fish were observed, observed densities were multiplied by 1.4). Estimated densities were used in performing all analyses and interpreting results.

Habitat specific "utilization coefficients" were calculated using the formula described by Bisson et al. (1982) to "relate the fraction of the population found within a particular habitat type to the relative abundance of that habitat type" in the study area. The formula used is identical to that referenced in spawning ground evaluation methods, except, numbers of juvenile fish per unit area or volume were substituted for number of redds per unit area. Coefficients were calculated for utilization of habitat types based on both volume and area.

Spawning habitat adequacy was addressed by establishing how many redds could be accommodated in available habitat (at base flow). Total estimated "standing crop" of yearling steelhead was assumed to survive over the winter to smolt the following spring/summer at a 40% rate (Everest and Sedell, 1983). Five percent (5%) of those smolts were assumed to survive to adulthood and become "maiden" (or first time) spawners (Everest and Sedell, 1983). Unpublished California Department of Fish and Game steelhead scale analysis reports have indicated that Klamath River steelhead spawning runs are composed of about 60% maiden spawners and 40% repeat spawners (Hopelain, unpublished). Using the above process it is possible to determine if enough spawning habitat is located in each study area to accommodate progeny theoretically reared by that habitat. We did not have similar tools available to assess adequacy of chinook or coho habitat, because early life history information for those races endemic to the study areas is not available.

RESULTS, DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS



Emergent Salmon Fry Trapped in Redd by Sand, Location Unknown.

SUMMARY ALL STUDY AREAS

Results and Discussion

Roughly 58,000 m^2 of suitable salmon and/or steelhead spawning habitat was present under summer base flow conditions during the study period. Average chinook redd surface area (4.6 m2; n= 520) and average steelhead redd surface area (1.5 m^2; n= 194) were not significantly different (p=0.05) between study areas or between habitat types within study areas. Roughly 12600 chinook redds and 38600 steelhead redds could be accommodated by existing suitable habitat under base flow conditions, disregarding any territorial needs of either species. Spawning habitat in Nordheimer, Shackleford/Mill, and Yreka Creeks was not accessible to chinook during 1988 due to low fall flows. As a result, about 41,198 m^2 of spawning habitat, which could accommodate 8960 redds, was accessible to chinook.

A total of 2174 chinook redds were counted in all study areas during fall 1988 (Appendix B). Several study areas or reaches of particular study areas are apparently overutilized and others may be underutilized. Chinook spawning began in mid-September in the Salmon subbasin study areas and concluded by late November in all subbasins. Mid Klamath study areas influenced by presence of Iron Gate hatchery chinook stocks displayed compressed spawning periods. Wild chinook stock dominance (assumed in those study areas without rearing pond programs) is indicated by a longer spawning period and more even temporal distribution of spawning, in Salmon and Scott subbasins. Spawning ground evaluation results in Shasta River were complicated by increased flows and poor visibility early in the study period.

Chinook of hatchery origin spawned predominantly in slow velocity run (Type 15) associated habitats in all mid-Klamath subbasin study areas. Conversely, wild stock spawners in Salmon, Scott, and Shasta subbasins concentrated their spawning in higher velocity low gradient riffle (Type 1) associated habitats.

Coho salmon spawning (a total of 2 coho redds) was observed in Mid Klamath subbasin study areas during the study period. Juvenile coho were observed in several tributaries in summer of 1989, indicating that at least some spawning occurred between December 1988 and March 1989 in these streams.

A total of 757 steelhead redds were counted in all study areas during spring 1989. Steelhead spawning began in mid-February in the South Fork Salmon and Elk Creek study areas and concluded in mid May in all subbasins. Due to high flows which occurred in March, some study areas were not counted in the first part of that month. Persistent high, turbid flow conditions in Scott and Shasta

Rivers made wading very hazardous and viewing conditions extremely difficult, so attempts to conduct counts on those two study areas were abandoned after early March.

Habitat types used by steelhead for spawning varied between study areas; no spawning was noted in step run (Type 16) associated habitats. Heavy spawning occurred in run (Type 15) associated spawning habitats. Crew observations indicate that steelhead spawning is more "bank oriented" than chinook spawning, which occurs in or near the thalweg of these small rivers.

Salmonid rearing habitat conditions in the study areas are quite variable. Generally poor conditions prevail in Shasta River, Yreka Creek, and Shackleford/Mill Creek study areas. Water quantity and quality conditions reach critical or lethal levels in those study areas during summer months. High water temperatures observed in Shasta River (31°C), Scott River (25°C), and Indian Creek (24°C) may be either lethal or sub-lethal to juvenile salmonids rearing there.

A total of 2,430,596 m^2 of habitat area (1,332,413 m^3) was evaluated during the study period. While all natural and enhanced habitat types were represented, six habitat types dominated (Appendix B). Run and low gradient riffle (Types 15 and 1, respectively) dominate habitat surface area and volume (Appendix B). About 25% of the habitat units were sampled for additional physical and biological parameters; that effort resulted in sampling about 18.4% of the surface area and 19.7% of the habitat volume.

Everest and Sedell (1984), pointed out the complexity of assessing habitat use to determine what features may "limit" fish production. We agree that it may not be possible, based on data collected in this project, to draw absolute conclusions. We believe that evidence is provided which suggests gross habitat shortcomings as well as relationships between fish use and habitat features. **We feel that apparently all components of stream habitat are important during some freshwater life history phase for salmonids encountered during this study.**

There were observed differences between fish "density" (#fish/unit area or volume) based on the method of calculation chosen. Calculating "density" by surface area (# fish/sq.meter) generally results in a lower estimate for shallow water habitats than for deep water habitats. This approach alone could lead to improper interpretation of relative habitat value. For this reason **we chose to display results using both methods of calculation. We assumed that highest value habitats would display higher than average "estimated density" by both methods of calculation. We further assumed that those habitats which stood out using the above process of elimination, would be reflected by positive utilization coefficients.**

Using the above process, we have found that habitat use between study areas is quite different but some trends do begin to appear. **Sample size in some instances was small (fewer than 10 units sampled), and in those instances caution must be used in interpretation of utilization coefficients.**

Young of the year steelhead, chinook, and coho were generally found in slower velocity habitat types or associated with slower velocity areas of other habitats. This is probably a direct result of swimming capability which is related to fish body length; the smaller the fish, the slower its swimming speed (Reiser and Bjornn, 1979). Steelhead fry selected for margins of low gradient riffle and lateral scour pools (Types 1,10, and 11) and slow velocity habitats including secondary channel pool and backwater pools (Types 4,6,and 7). Fry were observed especially in those areas with an abundance of organic cover (large or small wood accumulations).

We observed chinook fry in their natal streams until October (freshwater rearing habitat may play an important role in determining survival to smolt). Reeves (in press) observed similar rearing behavior in populations of Elk River chinook in coastal Oregon. Chinook fry selected slower velocity habitats or areas including low gradient riffle margins, backwater pools, lateral scour pools, corner pools, and enhanced deflectors (Types 1,5,10,11,12,22, and 31).

Coho fry selected margins of low and high gradient riffles, backwater pools, lateral scour pools, enhanced weirs, enhanced deflectors, and enhanced pockets (Types 1,2,5,10,30,31, and 32).

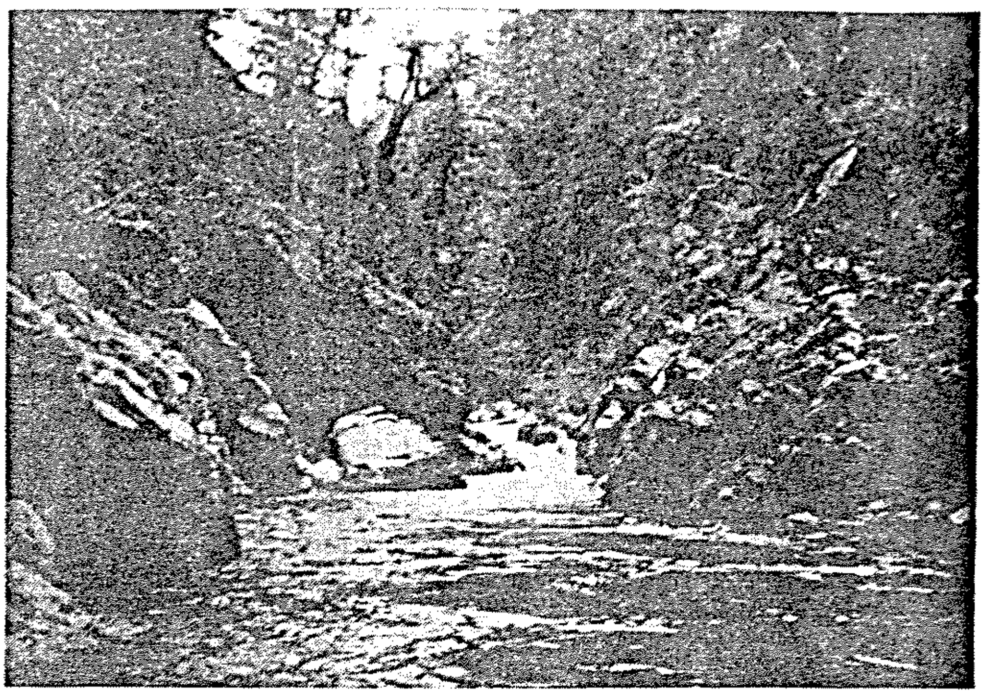
Steelhead, chinook, and coho fry showed a strong affinity for complex cover within their rearing area. A mix of boulders, live vegetation, and woody debris provided cover.
Steelhead 1+ (yearling and older juveniles) selected moderately high velocity habitats (or in some instances slow velocity habitats with an abundance of cover) with cover and/or suitable holding habitat nearby. Steelhead 1+ were found in all habitat types, but selected for low and high gradient riffles, secondary channel pools, backwater pools, and lateral scour pools (Types 1,2,4,6,7,10,and 11) as supported by positive utilization coefficients (Appendix B).

Much of the study area lacks one or more features necessary to meet potential winter habitat criteria. Large woody debris was found primarily in association with backwater pools, plunge pools, lateral scour pools, and glides (Types 7,9,10, and 14). Large wood provided cover to an average of less than 10% of the habitat surface area. Much of the existing potential winter cover is provided by large boulders; large woody debris is scarce in nearly all study areas, including wilderness study areas that have not been influenced by man.

Present available spawning area can accommodate a maximum of 38600 steelhead redds. Based on rearing habitat available in the study areas in 1989, estimated steelhead standing crops should result in an adult escapement which would produce about 6400 redds (Appendix B).

Some of the study areas may serve as "spawning areas" for fish which rear to smolt elsewhere. In several instances more spawning was observed than could be attributed to the rearing potential of a particular study area. These conditions were observed in Shackleford/Mill Creek and Yreka Creek study areas. Additional habitat information may clarify the role(s) played by study area rearing and spawning habitats.

SALMON SUBBASIN



Main Channel Pool Habitat, Salmon Subbasin.

South Fork Salmon River

Results and Discussion

An estimated 7,175 m^2 of suitable salmon and steelhead spawning habitat was available in the study area which could accommodate a maximum of 1560 chinook redds and 4800 steelhead redds. A total of 334 chinook redds were counted in the study area during fall 1988 (Appendix C). Habitats artificially manipulated with instream structures (Types 30, 31, and 32) were selectively used by chinook spawners as evidenced by high positive utilization coefficients (Appendix C). Natural habitats selected for spawning were low and high gradient riffles (Types 1 and 2); slower velocity glides, runs, and step runs (Types 14, 15, and 16) were used less than average. Chinook spawning began in mid-September, peaked through October, and concluded in early November. There was no evidence of a distinguishable second influx of spawners during the study period, indicating that fall and spring run chinook spawning period overlaps in this study area.

No coho salmon spawning was observed and juvenile coho were not seen in summer 1989, indicating that the study area was not used by coho during the contract period.

Forty-nine steelhead redds were observed in the study area in spring 1989. Shortly after surveys were begun in early March stormy conditions and high turbid flows made redd observation difficult until early April. Bright substrate resulted from those high flows, making redd identification difficult even after water clarity improved and flows subsided. Habitats artificially manipulated with instream structures (Types 30, 31, and 32) were selectively used by steelhead spawners as evidenced by high positive utilization coefficients (Appendix C). Bank associated structures, enhanced deflectors and pockets (Types 31 and 32), were especially heavily used relative to their availability. Margin areas associated with runs (Type 15) and high gradient riffle (Type 2) habitats were also selected for spawning. High gradient riffle (Type 2) associated spawning habitat was limited in the study area (only 58 m^2) which may lead to a false impression of that habitat's overall importance. Low gradient riffle, glides, and step runs (Types 1,14, and 16) were used less than average or not at all. Steelhead spawning began in mid-February and concluded in late April (Appendix C).

A total of 209,782 m^2 of habitat area (97,282 m^3) was evaluated during the study period. Eighteen of the twentyfive natural and enhanced habitat types were represented, backwater pools associated with roots or logs, trench pools, plunge pools, lateral scour pools associated with roots or logs, and dammed pools (Types 6,7,8,9,10,11, and 13 respectively) were absent from the study area. Low gradient riffle and run (Types 1 and 15, respectively) composed the bulk of the habitat by both surface area and volume (Appendix C).

Over 27% of the total habitat units (and units of each habitat type) were sampled for additional physical and biological parameters, resulting in sampling of about 20.6% of the surface area and 23.3% of the habitat volume.

Steelhead fry selected margins of low and high gradient riffle, secondary channel pool, backwater pool, and edgewater habitats (Types 1,2,4,5, and 18, respectively) as evidenced by positive utilization coefficients. Chinook fry selected for slower velocity habitats or areas including low gradient riffle, glides, lateral scour pool, and enhanced weir habitats (Types 1,14,20, and 30). (Coho fry were found so infrequently, that it is likely they were misidentified by crew members; only 9 fish were identified as coho juveniles in the entire study area.) Where complex cover was available, it was dominated by boulders which frequently provided over half of the available cover.

Steelhead 1+ juveniles, selected for moderately high velocity habitats (or in some instances slow velocity habitats with an abundance of cover) with cover and/or suitable holding habitat nearby. Steelhead 1+ were found in all habitat types present in the study area except backwater pools and enhanced deflectors (Types 5 and 31, respectively). They utilized low and high gradient riffles, cascades, secondary channel pools, glides, and enhanced weir habitats selectively (Types 1,2,3,4,14, and 30 respectively). All of these habitats were either relatively deep (>0.3m) or swift, had abundant sunlight (<10% shade), and were within or immediately preceded by habitats characterized by high food production (riffles). Whitewater, bedrock, boulders, wood debris, and live vegetation provided cover in these habitats. Except for secondary channel pool habitat where cover was very limited, high standing crops were associated with diversity of cover.

Much of the study area lacks features necessary to provide potentially suitable winter rearing habitat. Naturally occurring large woody debris was found primarily in association with runs, step runs, channel confluence pool, lateral scour pool, and corner pool habitats (Types 15,16,19,20,and 22). It was also found where it had been placed in association with enhanced pocket habitat (Type 32) and along the margins of low and high gradient riffles (Types 1 and 2), however those habitats are most likely not well suited to providing winter refuge due to their relatively high winter velocities. Large wood provided cover to less than 10% of the habitat surface area. Much of the potential winter cover is provided by large boulders and cobble in slower velocity habitat types. Roughly 85% of the habitat within the study area (Appendix C) experiences high or marginally high water velocity during the winter months and may therefore be unsuitable for winter rearing purposes.

Present available spawning area can accommodate about 4800 steelhead redds. Based on rearing habitat available in the study area in 1989, estimated steelhead standing crops should result in an adult escapement which would produce about 265 redds (Appendix C). Available spawning area is more than adequate to accommodate adults which would be produced by the rearing habitat under 1989 conditions.

Summary and Conclusions

Observed marginal summer water temperature conditions result from the broad, unvegetated floodplain. The poor riparian area is a problem affecting rearing habitat quality in the "Petersburg" reach and downriver areas. Lack of deep pools due to the mobile nature of the stream bed in this reach probably influences rearing and spawning conditions. Lack of potential winter rearing habitat, particularly cover in slow velocity areas, may affect the number of juvenile fish that survive from fry to 1+ and from 1+ to smolt. Steelhead spawning area is more than adequate to accommodate adults which could be produced by the rearing habitat available during the study period.

The principle non-habitat related problem in the study area found during this period was poaching of adult fish.

Recommendations

1) Revegetate riparian and floodplain areas with native species of deciduous and coniferous vegetation.

2) Restore suitable accumulations of woody cover in slow velocity habitats and evaluate effectiveness for steelhead and coho winter rearing.

3) Control fish poaching through aggressive enforcement and education.

4) Stabilize existing pools in aggraded reach of South Fork Salmon River to prevent further pool filling.

North Fork Salmon River

Results and Discussion

An estimated 7,764 m^2 of suitable salmon and steelhead spawning habitat was available in the study area, which could accommodate about 1680 chinook redds and 5160 steelhead redds. Over 90% of the available spawning habitat is associated with glides and runs (Types 14 and 15). Wild chinook spawners in the Salmon subbasin used very little glide and run habitat. Conversely, very little (about 4%) available spawning habitat was associated with low gradient riffle (Type 1; Appendix D).

Forty-nine chinook redds were counted in the study area during fall 1988 (Appendix D). Redds were smaller on average (1.5 m^2) than those observed in other study areas. This may indicate that chinook spawners here were constructing multiple redds, since the fish here were about equal in size to those seen in other study areas. Habitat type selected for spawning was low gradient riffle (Type 1); slower velocity glides, runs, and step runs (Types 14, 15, 16) were used less than average or went unused. Low gradient riffle was used at a highly disproportionate level and had a spawner utilization coefficient of 17.6 (Appendix D). Though it made up only 4% of the available spawning habitat, it received 76% of the total spawning use. Small redd size (multiple redds) was probably a result of patchy distribution of available gravels within low gradient riffles. Crews did not observe any redd superimposition. Chinook spawning began in early October, peaked through October, and concluded in late November.

Coho salmon spawning was not observed. Juvenile coho were not seen in summer 1989, indicating that the study area was not used by coho during the contract period.

Sixteen steelhead redds were observed in the study area in spring 1989. Flow and observation conditions similar to those described for South Fork Salmon were encountered on the North Fork. Low gradient riffles were selected for spawning at a level disproportionate to their availability. Margin areas of glides and runs (Types 14 and 15) were also selected for spawning. No spawning was observed until mid April and none was observed after early May (Appendix D).

A total of 215,613 m^2 of summer habitat area (123,398 m^3) was evaluated during the study period. Fifteen of the twenty-five natural and enhanced habitat types were represented; secondary channel pools, backwater pools associated with roots or logs, lateral scour pools associated with roots, logs, and boulders, and dammed pools (Types 4,6,7,10,11,12, and 13 respectively) were absent from the study area. Main channel pool, run, and step run (Types 17,15, and 16, respectively) composed over 60% of the habitat by both surface area and volume (Appendix D).

Over 24% of total habitat units and units within a habitat type were sampled for additional physical and biological parameters. However, that effort resulted in sampling about 20.8% of the surface area and 20.3% of the habitat volume.

Steelhead fry selected low and high gradient riffle and backwater pool habitats (Types 1,2, and 5 respectively). Chinook and Coho fry were found so infrequently that their utilization of habitat type could not be assessed. Chinook and coho standing crops are probably limited by the number of adult spawners using limited quality spawning habitat available to them.

Steelhead 1+ juveniles selected for relatively high velocity habitats associated with an abundance of cover provided by boulders and whitewater. Steelhead 1+ were found in all habitat types present in the study area. They selected deep plunge pool habitat (Type 9), however that habitat made up only a fraction of the total habitat available (Appendix D). A comparatively (relative to other study areas) high estimated standing crop of 1+ steelhead was noted in all habitats except glide, channel confluence pool, and lateral scour pool (Types 14, 19, and 20). Inspection of raw data indicates that average embeddedness is about 4% in this study area which may partially explain high standing crops observed. Further, substrate in the study area contains a greater percentage of boulders than that of other study areas. This may lead to favorable year-round rearing conditions by providing less embedded interstices and cover for juvenile fish. Whitewater, bedrock, boulders, wood debris, and live vegetation provided cover, though its abundance was limited to a small percentage of the surface area.

Naturally occurring large woody debris was found consistently associated with glide, run, step run, and main channel pool habitats (Types 14,15,16,and 17). Potential winter cover is provided by large boulders and cobble in slower velocity habitat types. Roughly 66% of the habitat within the study area (Appendix D) experiences high or marginally high water velocity during the winter months and may be unsuitable for winter rearing purposes.

Present available spawning area can accommodate 5160 steelhead redds. Based on rearing habitat available in the study area in 1989, estimated steelhead standing crops should result in an adult escapement which would produce about 420 redds (Appendix D). Spawning habitat is adequate to accommodate more spawners than rearing habitat could produce under 1989 conditions.

Entrapment of additional suitable spawning gravels in existing low gradient riffle habitat may benefit chinook spawning success. Low numbers of chinook that escape to use this habitat may be a result of non-habitat related or off site problems.

Summary and Conclusions

Marginal summer water temperature conditions resulting from the broad, unvegetated floodplain and riparian area is a problem affecting rearing habitat quality in the "flat" reach and downriver areas. Much of the downriver habitat (due to channel aspect and lack of suitable riparian vegetation) experiences high summer water temperatures. Though potential winter habitat conditions in this study area may be less than optimum, high standing crops of juvenile steelhead were observed. Suitable spawning habitat for chinook salmon is found only in small patches, which resulted in construction of multiple redds during the study period. Additional spawning gravel accumulation in low gradient riffles could result in better distribution of spawners and prevent superimposition of redds if increased numbers of fish escape to spawn here in future years. Access to the habitat by adult spawners may be more critical than existing habitat conditions. Steelhead spawning area is more than adequate to accommodate adults which could be produced by the rearing habitat available during the study period.

The principle non-habitat related problem found here during this period was poaching of adult fish. Some carcasses were stripped of roe and discarded on the banks.

Recommendations

1) Provide adequate, stable spawning areas for chinook and evaluate effectiveness.

2) Control fish poaching through aggressive enforcement and education.

Nordheimer Creek

Results and Discussion

An estimated 634 m^2 of suitable salmon and steelhead spawning habitat was available in the study area, which could accommodate a maximum of 140 chinook redds and 424 steelhead redds.
Only 1 chinook redd was counted in the study area during fall 1988. The redd was located in glide (Type 14) habitat immediately downstream from the fish ladder. Chinook spawning did not occur until very late in November following an increase in flows. Access to the stream was restricted by low flows over a broad alluvial fan at the mouth of the creek.

No coho salmon spawning was observed and juvenile coho were not seen in summer 1989, indicating that the study area was not used by coho during 1988 and 1989.

Thirty-seven steelhead redds were observed in the study area in spring 1989. Flow and observation conditions similar to those described for South Fork Salmon were encountered on Nordheimer Creek. Spawning habitat associated with runs (Type 15) was used by most of the spawners, but resultant utilization coefficients were not exceptionally high. Spawning was first observed in mid-March and concluded in late April. No late spawning was observed in this study area, similar to observations in other Salmon subbasin study areas (Appendix E).

A total of 52,030 m^2 of habitat area (24,619 m^3) was evaluated during the study period. Thirteen of the twenty-five habitat types were represented; secondary channel pools, backwater pools associated with roots, logs, and boulders, lateral scour pools associated with roots or boulders, dammed pools, edgewater, channel confluence pool, and enhanced weirs, deflectors, and pocket habitats (Types 4,5,6,7,11,12,13,18,19,30,31, and 32 respectively) were absent from the study area. Low gradient riffle (Type 1) dominated the habitat by surface area, but main channel pool (Type 17) contained most habitat volume (Appendix E).

Seventeen percent of the habitat units were sampled for additional physical and biological parameters. This resulted in sampling about 21.9% of the surface area and 22.6% of the habitat volume.

Steelhead fry selected run, step run, and pocket water habitats (Types 15, 16, and 21 respectively). No chinook or coho fry were observed during the study period.
Steelhead 1+ juveniles were found in all habitat types present in the study area. They selected relatively high velocity low

gradient riffle, trench pool, pocket water, and corner pool habitats (Types 1,8,21, and 22 respectively). These habitats were relatively deep (>0.4m), had abundant sunlight (<20% shade), and were within or immediately preceded by habitats characterized by high food production (riffles). Whitewater, bedrock, boulders, wood debris, and live vegetation provided cover in these habitats, though it was limited to less than 20% of the surface area. High standing crops were found where cover was diverse.

Large woody debris was found in higher velocity habitats, except occasional debris jams in main channel pool and corner pool habitats (Types 17 and 22). However, wood provided cover to less than 10% of the habitat surface area. Potential winter cover is provided by large boulders and cobble in slower velocity habitat types. Roughly 84% of the habitat within the study area (Appendix E) experiences high or marginally high water velocity during the winter months and may be unsuitable for winter rearing.

Available spawning area can accommodate a maximum of 424 steelhead redds. Based on rearing habitat available in the study area in 1989, estimated steelhead standing crops should result in an adult escapement which would produce 38 redds (Appendix E). Spawning habitat is adequate to accommodate more adult steelhead than the rearing habitat could produce under 1989 conditions.

Summary and Conclusions

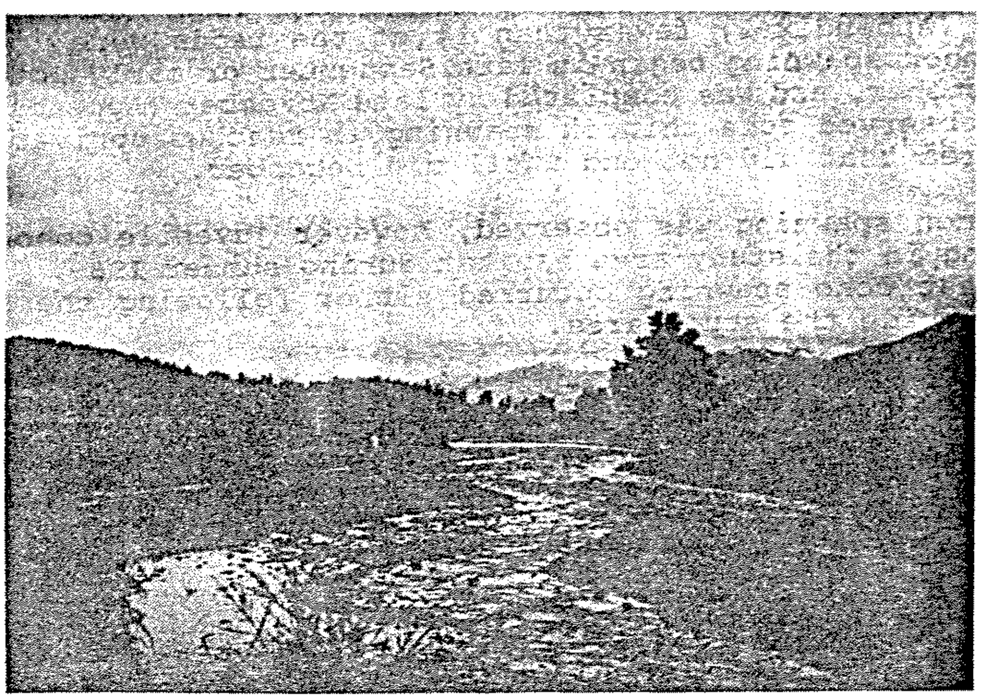
Streambed instability from aggradation during the flood of 1964, persists as a problem in the lower kilometer of this study area. The unstable stream bed in this area results in partial or complete blockage of access to the study area for adult chinook salmon in some flow years. Though the condition corrects itself as flows increase, suitable habitat is often inaccessible to chinook. Lack of potential winter rearing habitat conditions, particularly cover in slow velocity areas, may affect the number of juvenile fish that survive to smolt. Steelhead spawning area is more than adequate to accommodate adults which could be produced by the rearing habitat available during the study period.

Recommendations

1) Restore suitable accumulations of woody cover in slow velocity habitats and evaluate effectiveness for steelhead and coho winter rearing.

2) Correct flow related chinook migration problem at mouth.

SCOTT SUBBASIN



Spring 1989 Floodplain of Shackleford Creek, Scott Subbasin.

Scott River

Results and Discussion

An estimated 6630 m^2 of suitable salmon and steelhead spawning habitat was available in the study area, which could accommodate a maximum of 1440 chinook redds and 4420 steelhead redds.

Crews observed 804 chinook redds in the study area during fall 1988. No redd superimposition was observed, though some higher quality gravel beds were crowded with redds. Spawning was observed in heavily sedimented gravels. Low gradient riffles and runs (Types 1 and 14) were selected for spawning. Though high gradient riffle (Type 2) habitat has a relatively high utilization coefficient (Appendix F) fewer than 1% of the redds were located there. Chinook spawning began in late September or early October, peaked in October, and was completed by late November (Appendix F). The author observed some chinook spawning in reaches upriver from the study area that did not end until mid December.

No coho salmon spawning was observed, however juvenile coho were found rearing in the study area habitat during summer 1989. This indicates that coho spawning occurred either following the study period or outside the study area.

Steelhead spawning was not observed in the study area due to high flows which resulted in dangerous wading and poor observation conditions. Following the first few attempts to count steelhead redds in the study area, later efforts were abandoned.

A total of 579,310 m^2 of summer habitat area (367,287 m^3) was evaluated during the study period. Eighteen of twenty-five habitat types were represented. Backwater pools associated with roots or logs, lateral scour pools associated with roots, edgewater, and enhanced weir, deflector, and pocket (Types 6,7,11,18,30,31, and 32 respectively) were absent from the study area. Glide, low gradient riffle, and run, (Types 14,1,and 15 respectively) dominated the habitat by both surface area and volume (Appendix F).

Over 28% of the total habitat units were sampled for additional physical and biological parameters, which resulted in sampling about 23% of the surface area and 24% of the habitat volume. Backwater pool formed by boulders, trench pool, and dammed pool habitats (Types 5,8, and 13 respectively) were present but were not sampled for additional parameters. However, only eight units of those habitats were present in the study area (total of 462 units), representing less than 1% of the total available habitat.

Chinook fry were found in the margins of high gradient riffles, lateral scour pools, pocket water, and corner pool habitats (Types 2,10,21, and 22 respectively). Coho fry were restricted to margins of low and high gradient riffles (Types 1 and 2).

Steelhead fry selected margins of high gradient riffles, secondary channel pool, lateral scour pool, step run, and pocket water habitats (Types 2,4,10,16, and 21 respectively; Appendix F).

Steelhead 1+ juveniles selected for relatively high velocity habitats and slower velocity areas with an abundance of cover provided by bedrock, boulders, whitewater, or organic debris. Though steelhead 1+ were found in all habitat types present, they selected low and high gradient riffle, cascade, secondary channel pool, plunge pool, lateral scour pool, step run, channel confluence pool, and pocket water habitat (Types 1,2,3,4,9,10,12,16,19, and 21 respectively).

Large woody debris was not found in the study area. This is possibly a result of man's influence (logging, debris removal, and channel clearing) in and adjacent to the river. Potential winter cover is provided by large boulders and cobble in slower velocity habitat types, however heavy sedimentation may limit its usefulness. Useful over-winter habitat may be provided by dense mats of sedge on lower bars within winter channel and side channel areas.

Present available spawning area can accommodate a maximum of 4420 steelhead redds. Based on rearing habitat available in the study area in 1989, estimated steelhead standing crops should result in an adult escapement which would produce about 1260 redds (Appendix F). Spawning habitat is adequate to accommodate more adult steelhead than the rearing habitat could produce under 1989 conditions.

Summary and Conclusions

Lack of suitable summer flows, high summer water temperatures, and massive quantities of sandy sediment are major factors influencing salmon and steelhead habitat utilization in this study area. Poor summer flows, as a result of heavy water withdrawal on agricultural lands, influence the quantity of habitat available for rearing purposes. Warm summer water temperatures result from riparian conditions above the study area. Riparian conditions and channel aspect in the "canyon" reach also contribute to warm temperatures. High embeddedness of low gradient riffle habitat (the most desirable chinook spawning habitat in this study area) has a negative influence on egg incubation and fry emergence success. Spawning areas which had clean substrate conditions experienced heavy chinook spawning use, however those substrate conditions are the exception in this study area. High embeddedness in slower velocity habitats, potentially most suitable for winter rearing purposes, may seriously inhibit over winter rearing in those areas.

Steelhead spawning area is more than adequate to accommodate adults which would be produced by the rearing habitat available during the study period.

"Whitehouse rapids" a cascade located approximately 200 m upstream from the mouth of Tompkins Creek, may delay upstream migration of chinook salmon, however it does not block migration.

Recommendations

1) Augment flow or regulate water withdrawal to provide water for summer rearing and chinook spawning migration access.

2) Revegetate riparian and floodplain areas with native species of deciduous and coniferous vegetation (fence or control grazing as necessary).

3) Restore suitable accumulations of woody cover in slow velocity habitats and evaluate effectiveness for steelhead and coho winter rearing.

4) Modify seasonal migration barrier at Whitehouse rapids.

5) Place prototype velocity control structures in low gradient riffle spawning habitats to reduce embeddedness and prevent further deposition of sandy sediments.

Shackleford/Mill Creeks

Results and Discussion

An estimated 14925 m^2 of suitable salmon and steelhead spawning habitat was available in the study area, which could accommodate a maximum of 3200 chinook redds and 10,000 steelhead redds. No chinook spawning was observed in this study area, because it was dry at the confluence with Scott River until late December. The author has observed heavy chinook spawning in this study area in previous years when flow conditions allowed access into the habitat.

No coho spawning was observed in the study area because of the above mentioned fish access problem. No coho juveniles were observed in the study area during rearing habitat assessment in summer 1989.

Two hundred seventy-nine (279) steelhead redds were observed in spring 1989 (Appendix G). Flow and observation conditions were better in this study area during the steelhead season than in other study areas. This is most likely because infiltration rates are very high in the surrounding agricultural land, reducing the amount of surface runoff. Low gradient riffle and run (Type 1 and 15) associated spawning habitat was used most extensively by steelhead spawners. Spawning was first observed in mid March, peaked in April and was completed by early May (Appendix G). Some spawning was observed in the heads ditches.

A total of 112,754 m^2 of habitat area (52,092 m^3) was evaluated during the study period. Sixteen of the twenty-five natural and enhanced habitat types were represented; backwater pools associated with boulders, plunge pool, dammed pool, step run, lateral scour pools associated with bedrock, pocket water, and enhanced weir, deflector, and pocket (Types 5,9,13,16,20, 21,30,31, and 32 respectively) were absent from the study area. Run and low gradient riffle (Types 14 and 1 respectively) dominated the habitat surface area and volume (Appendix G).

Over 23% of the habitat units were sampled for additional physical and biological parameters, which resulted in sampling about 17% of the surface area and 15% of the habitat volume. Channel confluence pools (Type 19) were present but were not sampled for additional parameters, however only one unit of that type was present (total of 227 units) representing less than 1% of the total available habitat.

Steelhead fry selected margins of low gradient riffles and lateral scour pool habitats (Types 1 and 10 respectively).

Chinook and coho fry were absent from the study area, because adults had no spawning access.

Steelhead 1+ juveniles selected low gradient riffle habitat, though they were found in all habitat types present in the study area except cascades.

Large woody debris was found in trench pool, lateral scour pool, and edgewater habitat types. Potential winter cover is provided by large boulders, cobble, live vegetation, and woody debris. Undercut banks were more common in this study area than in others, possibly adding to the suitability of potential winter rearing habitat.

High densities of steelhead juveniles were observed during biological sampling which took place several weeks after physical assessment. At that time heavy water diversion and withdrawal reduced the total amount of habitat available in the stream. It is not possible to estimate standing crop of the study area because of this habitat reduction. Much of the study area was dried up by mid summer.

It is likely that just a remnant of the observed standing crop was able to migrate upstream and survive the summer. Employees of CDFG were actively trapping and transferring juvenile steelhead to the Scott River at the time biological sampling was being conducted.

Summary and Conclusions

No rearing habitat is available through much of the area during summer months because virtually all water is diverted for agricultural uses. Unrestricted livestock grazing has resulted in serious loss of woody riparian vegetation and collapse of streambanks. Steelhead spawning in ditches and at ditch inlets which are being maintained may seriously affect survival of those eggs and fry. Steelhead spawning area is more than adequate to accommodate adults produced by the rearing habitat available during the study period. Poaching of adult steelhead was noted and is a problem in this area.

Recommendations

1) Augment flow or regulate water withdrawal to provide water for summer rearing and chinook spawning migration access.

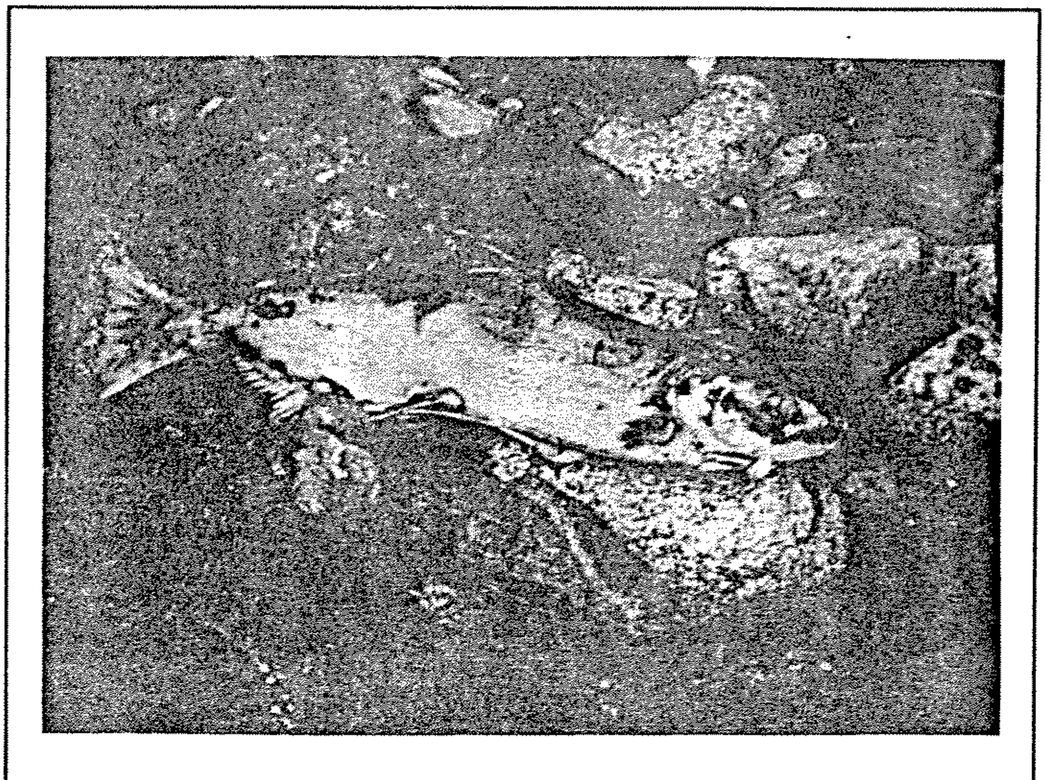
2) Revegetate riparian and floodplain areas with native species of deciduous and coniferous vegetation (fence or control grazing as necessary).

3) Stabilize eroding streambanks by natural methods.

4) Control fish poaching through aggressive enforcement and education.

5) Screen ditch inlets and regulate instream maintenance to reduce likelihood of damage to steelhead spawning.

SHASTA SUBBASIN



Chinook Salmon Carcass, Fall 1988.

Shasta River

Results and Discussion

An estimated 2690 m^2 of suitable salmon and steelhead spawning habitat was available in the study area, which could accommodate a maximum of 584 chinook redds and 1792 steelhead redds.

Crews observed 479 chinook redds in this heavily spawned study area during fall 1988. No redd superimposition was observed, though higher quality gravel beds were crowded with redds. Low gradient riffles and runs (Types 1 and 14) were selected for spawning. Though high gradient riffle (Type 2) habitat was also selected, fewer than 1% of the redds were located in those areas which provided little spawnable surface. Though 46% of the available spawning grounds in the study area were associated with artificially enhanced weir habitats (Type 30) less than 7% of the chinook spawning occurred there. A similar negative chinook spawning response (negative utilization coefficient) was evidenced in other study areas with enhanced weir habitat. Some enhanced weir habitats displayed the opposite result. Chinook spawners selected to spawn on weirs instead of other suitable habitat. Chinook spawning began in late September or early October and was completed in the study area by late October (Appendix H). Though peak spawning occurred in early October, some later spawning may have gone unobserved due to poor visibility. Determining a temporal peak in spawning activity is not possible for this study period.

No coho salmon spawning was observed. However, juvenile coho were observed rearing in study area habitat during summer 1989. This indicates that coho spawning occurred either following the study period or outside the study area.

No steelhead redds were observed in the study area. High flows and turbid water resulted in dangerous wading and poor observation conditions. Following the first few attempts to count steelhead spawning in the study area, later efforts were abandoned.

A total of 152,738 m^2 of habitat area (95,372 m^3) was evaluated during the study period. Nine of the twenty-five habitat types were represented. Cascades, secondary channel pool, backwater pools, trench pool, plunge pool, lateral scour pool, edgewater, channel confluence pool, pocket water, and enhanced deflector and pocket (Types 3,4,5,6,7,8,910,11,12,18,19,20,21,31, and 32 respectively) were absent from the study area. Slow velocity glide and run habitat (Types 14 and 15 respectively) dominated the habitat surface area and volume (Appendix H).

Over 24% of the habitat units were sampled for additional physical and biological parameters. This resulted in sampling about 17.6% of the surface area and 19.4% of the habitat volume. Water quality conditions were poor during biological sampling. Most of the salmonids observed were close to or located in the bubble curtain of habitats sampled. Salmonids were not observed in the upper 6 km. of the study area. Lethal water temperature and dissolved oxygen conditions (D. Maria, personal communication) are the primary causes. Water temperatures of 31°C were observed by crew members several times during mid-July 1989. Centrarchids were observed as frequently or more frequently than salmonids, especially in the upper study area. It is likely that severe mortality of salmonids occurs frequently during summer months if conditions observed in 1989 are typical.

Steelhead, chinook, and coho fry were seen so infrequently that a discussion of their distribution within utilized areas is not possible. Lack of fish observation may be a result of poor water clarity conditions as well as clumped fish distribution.

Steelhead 1+ juveniles selected for turbulence associated with low gradient riffle and corner pool habitats (Types 1 and 22). Steelhead 1+ were found in all habitat types present in the study area except high gradient riffles (Appendix H).

Large woody debris was almost entirely lacking in the study area, possibly as a result of man's activities in the watershed similar to the situation in Scott River. Live vegetation and some small woody debris accumulations were common in slower velocity habitats. Shade was almost entirely absent from the study area. Slow velocity habitats dominate the study area (91%). In combination with cover features noted above, these habitats may provide some suitable winter rearing.

Present available spawning area can accommodate a maximum of 1792 steelhead redds. Based on rearing habitat available in the study area in 1989, estimated steelhead standing crops should result in an adult escapement which would produce about 48 redds (Appendix H). Spawning habitat is adequate to accommodate more adult steelhead than rearing habitat could produce under 1989 conditions.

Summary and Conclusions

Riparian areas in the "Valley" reach impacted by unrestricted grazing results in an absence of shade and extreme summer water temperatures. Temperatures are extreme and water quality conditions are poor. It is surprising that salmonids were able to survive in habitats downstream. Lethal water temperature and dissolved oxygen conditions were noted (or reported to us) on several occasions during the summer survey period. These conditions probably influence habitats in the Klamath River, making them less suitable for summer rearing of juvenile salmonids. Artificially enhanced weir spawning habitats were used at a disproportionately low rate by spawning chinook salmon. Steelhead spawning area is more than adequate to accommodate adults which would be produced by the rearing habitat available during the study period.

Recommendations

1) Augment flow or regulate water withdrawal to provide water for summer rearing and chinook spawning migration access.

2) Revegetate riparian and floodplain areas with native species of deciduous and coniferous vegetation (fence or control grazing as necessary).

3) Provide adequate, stable spawning areas for chinook and steelhead and evaluate effectiveness.

4) Investigate apparent lack of chinook salmon spawning on weirs.

Yreka Creek

Results and Discussion

An estimated 270 m^2 of suitable spawning habitat was available in the study area, which could accommodate a maximum of 180 steelhead redds. The amount of this spawning habitat suitable for chinook use is much less, limited to the lower reach of stream when it is accessible.

No chinook spawning was observed in this study area, due to low discharge conditions during the study period. Chinook spawning has been observed in previous years in the lower several kilometers of the study area by employees of CDFG. No juvenile chinook were observed rearing in the study area in summer 1989, confirming the absence of chinook spawning noted above.

No coho spawning or rearing coho juveniles were observed in the study area during the spawning or rearing habitat assessment study periods.

One hundred seventy-seven (177) steelhead redds were observed in the study area in spring 1989 (Appendix I), suggesting that nearly all available steelhead spawning habitat was utilized. Flow and observation conditions were considerably better in this study area during the steelhead season than in other parts of the subbasin, because runoff and turbidity conditions were generally limited to short periods directly related to storm events. Low gradient riffle and run (Type 1 and 15) associated spawning habitat was selected by steelhead spawners. The spawnable habitat provided by weirs in the study area was not utilized by steelhead during the study period. Spawning was first observed in mid March, peaked in April and was completed by early May (Appendix I).

A total of 50,460 m^2 of habitat area (15,005 m^3) was evaluated during the study period. Only eight of twenty-five habitat types were represented. Glide, run, and low gradient riffle (Types 14,15, and 1 respectively) composed 99% of the habitat by both surface area and volume (Appendix I).

Over 52% of the study area (35% of the volume) was dewatered between completion of physical assessment and biological sampling. This resulted in drying up 215 of the original 402 habitat units. Most dewatered habitat was in the "Forest" reach, located on agricultural land upstream from Yreka Junction shopping center.

About 12% of the 187 habitat units present during biological sampling period, were sampled by electrofishing for biological parameters, which resulted in sampling about 14.5% of the surface area and 9.9% of the habitat volume.

Steelhead fry selected margins of high gradient riffles, main channel pool, and enhanced weir habitats (Types 2,17, and 30 respectively). Those habitats represented only about 1% of the total habitat volume available at the time of sampling. Chinook and coho fry were absent from the study area because adults had no spawning access.

Steelhead 1+ juveniles selected high gradient riffle habitats, and they were found only in low and high gradient riffle and glide habitats in the study area (Appendix I). Potential winter cover is provided by live vegetation and woody debris.

Present available spawning area can accommodate a maximum of 180 steelhead redds. Based on rearing habitat available in the study area in 1989, estimated steelhead standing crops should result in an adult escapement which would produce about 7 redds (Appendix I). Spawning habitat is adequate to accommodate more adult steelhead than the rearing habitat could produce under 1989 conditions. All of the available spawning area was heavily used in the study period by steelhead, suggesting that the progeny may rear in habitats elsewhere.

Summary and Conclusions

Garbage and water pollution in the "Municipal" reach are problems which complicate marginal summer rearing conditions in this part of the study area. Poor riparian conditions upstream result from unrestricted livestock grazing. The deteriorated riparian condition has led to collapse of streambanks, channel aggradation, poor stream shade, and unsuitable summer rearing conditions. These poor conditions may not play a major role in fish rearing however, because this area is dry as a result of water diversion during the period when those influences would be greatest. Steelhead spawning area is more than adequate to accommodate adults which would be produced by the rearing habitat available during the study period.

<u>Recommendations</u>

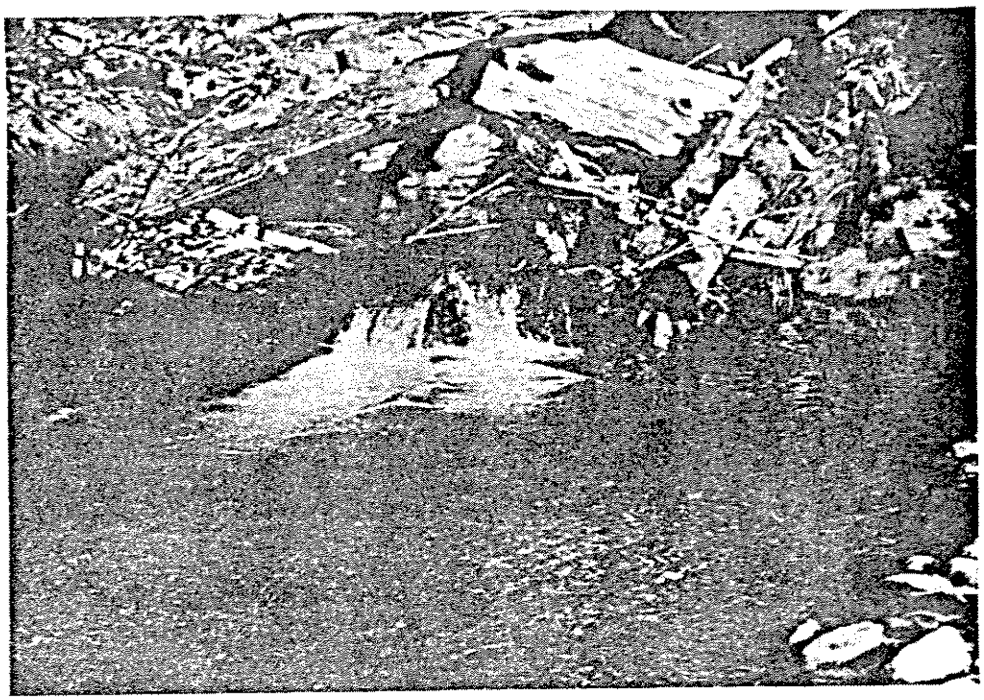
1) Augment flow or regulate water withdrawal to provide water for summer rearing and chinook spawning migration access.

2) Revegetate riparian and floodplain areas with native species of deciduous and coniferous vegetation (fence or control grazing as necessary).

3) Stabilize eroding streambanks by natural methods.

4) Remove garbage and control contamination.

MID-KLAMATH SUBBASIN



Plunge Pool Associated With Large Organic Debris.

Elk Creek

Results and Discussion

An estimated 342 m^2 of suitable spawning habitat was available in the study area, which could accommodate a maximum of 76 chinook redds and 228 steelhead redds. Suitability of this spawning habitat is questionable because much of it was associated with suction dredge tailing deposits and was very unstable. As a result of gravel instability, much spawnable surface was lost between the time chinook spawning ground surveys were conducted in fall 1988 and physical habitat was assessed in summer 1989. Because of this problem, it is not possible to determine chinook spawner habitat utilization coefficients. This should point out however that destabilization of existing spawning habitats may be a critical problem.

Crews observed 97 chinook redds in the study area during fall 1988, however approximately 80% of the redds associated with suction dredge tailings were completely lost when flows rose over the winter, washing away the unstable gravels. No redd superimposition was observed, though higher quality gravel beds were crowded with redds. Low gradient riffles and runs (Types 1 and 15) were selected by spawning chinook. Chinook spawning began in mid October, peaked in early November, and was completed in the study area by late November (Appendix J). Nearly 90% of the spawning occurred in the first two weeks of November.

Several coho were observed spawning in the study area following chinook use. Use of the habitat by coho is also supported by presence of juvenile coho during the summer rearing habitat evaluation.

Sixty-six (66) steelhead redds were observed in the study area in spring 1989 (Appendix J). Shortly after surveys were begun in late February, stormy conditions and high turbid flows made redd observation very difficult until early April. Bright substrate resulted from those high flows, making redd identification difficult even after water clarity improved and flows subsided. Glide and run (Type 14 and 15) associated spawning habitat was selected by steelhead spawners. The spawnable habitat provided by enhanced weirs (Type 30) in the study area was also selected by steelhead during the study period as evidenced by utilization coefficient (Appendix J). Spawning was first observed in late February, peaked in mid April, and was completed by mid May (Appendix J). Based on observation of early spawning and presence of adult fish in summer months, the study area probably serves as summer steelhead holding, spawning, and rearing habitat. Observation of steelhead spawning extending well into May indicates that "winter-run" steelhead also use this study area.

A total of 329,641 m^2 of summer habitat area (232,861 m^3) was evaluated during the study period. Nineteen of twenty-five habitat types were represented; secondary channel pools, backwater pools associated with roots and logs, lateral scour pools associated with logs, edgewater, and enhanced deflector habitats (Types 4,6,7,10,18,and 31 respectively) were absent from the study area. Low gradient riffle and run (Types 1 and 15) dominated the habitat surface area, but lateral scour pool (Type 12) contained the most habitat volume (Appendix J).

Nearly 28% of the habitat units were sampled for additional physical and biological parameters, which resulted in sampling about 25.4% of the surface area and habitat volume.

Steelhead fry selected margins of low and high gradient riffle habitats (Types 1 and 2).

Chinook fry used margins of low gradient riffles, but also selected backwater pool and lateral scour pool habitats (Types 5 ,11, and 12 respectively). Coho fry used the same habitats as chinook, but also selected a single dammed pool (Type 13) close to woody debris and live vegetation.

Steelhead 1+ juveniles were found in all habitat types present in the study area, but selected low and high gradient riffles, cascades, and lateral scour pools (Types 1,2,3, and 11 respectively). All of these habitats were swift, relatively deep (>0.4m), had abundant sunlight (<32% shade), and were within or immediately preceded by habitats characterized by high food production (riffles). Whitewater, bedrock, boulders, wood debris, and live vegetation provided cover it was often limited to less than 20% of the surface area. The habitat with highest utilization coefficient (Appendix J), lateral scour pool associated with roots, had a high percentage (about 17%) of the unit covered by large woody debris.

Large woody debris was found in slower velocity habitats, where it provided cover to less than 10% of the habitat surface area. Potential winter cover is provided by large boulders and cobble in slower velocity habitat types within the study area. Roughly 88% of the habitat within the study area (Appendix J) experiences high or marginally high water velocity during the winter months and may be unsuitable for winter rearing.

Present available spawning area can accommodate a maximum of 228 steelhead redds. Based on rearing habitat available in the study area in 1989, estimated steelhead standing crops should result in an adult escapement which would produce about 242 redds (Appendix J). Spawning habitat is not adequate to accommodate adult steelhead that the rearing habitat could produce under 1989 conditions.

Summary and Conclusions

This study area may not have adequate spawning areas available to support the adult fish produced by the rearing habitat. However, tributary spawning habitat may be adequate to seed rearing habitat within the study area. Limited spawning areas available suffer from instability as a result of dredging activity. Observed spawning gravel instability results in poor egg and alevin survival to emergence. Spawner use of enhanced weir habitat was high, indicating that increased spawning habitat restoration may be effective. Potential winter rearing habitat is possibly at a premium in this stream. 90% of the available habitat experiences high water velocities and is probably not suitable for winter use. Slow velocity habitats present had accumulations of woody debris available to provide winter rearing habitat.

Non-habitat related problems include the effect of suction dredging which occurs before July 1, when eggs of late spawning steelhead are still incubating. The extent and severity of this problem are unknown.

Recommendations

1) Restore suitable accumulations of woody cover in slow velocity habitats and evaluate effectiveness for steelhead and coho winter rearing.

2) Provide adequate, stable spawning areas for chinook and steelhead and evaluate effectiveness.

Indian Creek

Results and Discussion

An estimated 2400 m^2 of suitable spawning habitat was available in the study area, which could accommodate a maximum of 520 chinook redds and 1600 steelhead redds.

Crews observed 206 chinook redds in the study area during fall 1988. No redd superimposition was observed, though higher quality gravel beds were crowded with redds. Crowding of spawning areas was especially evident in near rearing ponds operated by CDFG, indicating that some of these fish may be pond returnees. Low gradient riffles and runs (Types 1 and 15) were selected for spawning. Similar to findings in the Shasta River, enhanced weir and deflector/pocket (Types 30, 31, and 32) associated spawning areas received disproportionately low chinook use (Appendix K). Chinook spawning began in early October, peaked in mid October, and was completed in the study area by late October (Appendix K). About 75% of the spawning occurred in the last two weeks of October.

Crews observed 2 coho redds in the study area during fall 1988, following chinook use. Additional adult coho were observed holding in the study area, however they had not spawned before the end of the spawning study period. Use of the habitat by coho is supported by presence of juvenile coho during the summer rearing habitat evaluation.

Forty-one (41) steelhead redds were observed in the study area in spring 1989 (Appendix K). Shortly after surveys were begun in late February, stormy conditions and high turbid flows made redd observation difficult. Bright substrate resulted from those high flows, making redd identification difficult even after water clarity improved and flows subsided. Habitats artificially manipulated with instream structures (Types 30, 31, and 32) were selected by steelhead spawners. Bank associated structures, enhanced deflectors and pockets (Types 31 and 32), were especially heavily used relative to their availability. Run (Type 15) habitat was most extensively selected by steelhead spawners. Spawning was first observed in mid March, peaked in late April, and was completed by mid May (Appendix K). Observation of steelhead spawning extending well into May suggests that "winter-run" steelhead use this study area.

A total of 362,599 m^2 of summer habitat area (177,031 m^3) was evaluated during the study period. Twenty-one of the twenty-five habitat types were represented; secondary channel pools, backwater pools associated with roots or logs, and edgewater habitats (Types 4,6,7, and 18 respectively) were absent from the study area. Step run, run, and low gradient riffle (Types 16,15,and 1) dominated the

habitat surface area, but main channel pool (Type 17) contained substantial habitat volume (Appendix K).
Over 26% of the habitat units were sampled for additional physical and biological parameters, which resulted in sampling about 15.4% of the surface area and 16.2% of the habitat volume.
Steelhead fry selected margin areas of low and high gradient riffles and step runs (Types 1,2, and 16 respectively). Chinook fry selected margins of low gradient riffle, backwater pool formed by boulders, plunge pool, lateral scour pool with roots, and enhanced pocket habitats (Types 1,5,9,11, and 32 respectively) for summer rearing. Coho fry selected the same habitats as chinook, but also used habitats associated with dammed pools and enhanced weirs (Types 13 and 30) extensively. Coho showed a noticeable affinity to live vegetation and woody debris cover types.

Steelhead 1+ juveniles were found in all habitat types present in the study area except backwater pools and lateral scour pools associated with roots or logs (Types 5, 10, and 11). They selected low and high gradient riffle, cascade, plunge pool, dammed pool, step run, and enhanced pocket habitats (Types 1,2,3,9,13,16, and 32 respectively). These habitats were deep, except cascades (>0.3m), had abundant sunlight (<15% shade), and were within or immediately preceded by habitats characterized by high food production (riffles). Whitewater, bedrock, boulders, wood debris, and live vegetation provided cover. Plunge pools and dammed pools were scarce in the study area and hence were not responsible for rearing a great percentage of the estimated steelhead standing crop.

Large woody debris was found in higher velocity habitats, except debris jams found in with lateral scour pool habitats (Types 10 and 11), where it provided cover to only a small percentage of the habitat surface area. Potential winter cover is provided by live vegetation, large boulders, and cobble associated with the limited number (19%) of slower velocity habitat types within the study area. Over 80% of the habitat within the study area (Appendix K) experiences high or marginally high water velocity during the winter months and may be unsuitable for winter rearing.

Present available spawning area can accommodate a maximum of 1600 steelhead redds. Based on rearing habitat available in the study area in 1989, estimated steelhead standing crops should result in an adult escapement which would produce about 180 redds (Appendix K). Spawning habitat is adequate to accommodate more adult steelhead than the rearing habitat could produce under 1989 conditions.

<u>Summary and Conclusions</u>

Desirable chinook spawning habitats were crowded with adult spawners, particularly near rearing ponds. Prior attempts to provide additional spawning area received disproportionately little chinook use during the study period, but received heavy use by steelhead spawners. Steelhead spawning area is more than adequate to accommodate adults which could be produced by rearing habitat available during the study period. Shade conditions are locally fair to poor in parts of the study area. Combined with the aspect of the stream, this leads to water temperatures less than optimal for juvenile fish rearing in summer months. Water quality conditions may continue to be adversely affected by residual heavy metal concentrations and disposal of sewer leachates in the stream. Though mass wasting into the "West Branch" reach was noted as common, deposition of sediments was not apparent as a problem downstream. Potential winter rearing habitat is in scarce, because over 80% of the available habitat experiences high water velocities in winter. Slow velocity habitats present did not have accumulations of woody debris available to provide winter rearing habitat conditions.

Non-habitat related problems include: the possible effect of suction dredging which occurs before July 1, when eggs of late spawning steelhead are still incubating, and poaching of adult salmon during the spawning period (based on reports from previous seasons).

<u>Recommendations</u>

1) Revegetate riparian and floodplain areas with native species of deciduous and coniferous vegetation.

2) Restore suitable accumulations of woody cover in slow velocity habitats and evaluate effectiveness for steelhead and coho winter rearing.

3) Provide adequate, stable spawning areas for chinook and steelhead and evaluate effectiveness.

4) Control fish poaching through aggressive enforcement and education.

5) Investigate apparent lack of chinook salmon spawning on weirs.

Grider Creek

Results and Discussion

An estimated 5660 m^2 of suitable steelhead spawning habitat was available in the study area, which could accommodate 3760 steelhead redds. Chinook salmon could only access the lower 9.1 km (5.6 mi) of habitat which provides 4500 m^2 of spawning area, which could accommodate a maximum of 980 chinook redds.

Crews observed 66 chinook redds in the study area during fall 1988. No redd superimposition was observed, though higher quality gravels associated with low and high gradient riffle (Types 1 and 2) habitats were crowded with redds. The highest spawner utilization coefficients during this study occur in low and high gradient riffle associated spawning habitats within this study area (Appendix L), values of 44 and 63, respectively. Much of the early spawning took place in the lower few kilometers of the study area because access to upstream habitats was temporarily blocked by a log jam until flows rose in mid October. Chinook spawning began in early October, peaked in early November, and was completed in the study area by late November (Appendix L).

No coho salmon spawning was observed, however juvenile coho were observed rearing in the study area habitat during summer 1989, indicating that coho spawning occurred either following the study period or outside the study area.

Thirty-six (36) steelhead redds were observed in the study area in spring 1989 (Appendix L). Shortly after surveys were begun in early March, stormy conditions and high turbid flows made redd observation very difficult until late that month. Bright substrate resulted from those high flows, making redd identification difficult even after water clarity improved and flows subsided. Spawning habitat associated with low and high gradient (Type 1 and 2) riffles was selected by steelhead spawners. Spawning was first observed in late March, peaked in mid April, and was completed by early May (Appendix L).

A total of 167,894 m^2 of habitat area (53,786 m^3) was evaluated during the study period. Twenty of the twenty-five habitat types were represented; backwater pools associated with roots, edgewater, channel confluence pool, and enhanced deflector and pocket habitats (Types 6,18,19,31 and 32 respectively) were absent from the study area. Step run, run, and high gradient riffle (Types 16,15, and 2) dominated the habitat surface area and volume (Appendix L).

Over 24% of the habitat units were sampled for additional physical and biological parameters, which resulted in sampling about 13.8% of the surface area and 13.9% of the habitat volume.

Steelhead fry selected slow velocity habitats associated with secondary channel pools, backwater pools with logs, glides and enhanced weirs, and also margins of high velocity habitats associated with lateral scour pools with roots or boulders, and step runs (Types 4,7,14,30,11,20, and 16 respectively). Chinook fry used nearly all slower velocity habitat that was available in the study area (Types 12,13,14,17,20,21,22, and 30) for summer rearing. Coho fry selected only two habitat types in the study area, runs and corner pools (Types 15 and 22). Coho showed an affinity for areas with live vegetation and woody debris cover types.

Steelhead 1+ juveniles were found in all habitat types present in the study area except backwater pools formed by boulders (Type 5). They selected backwater pools formed by logs, plunge pools, lateral scour pools formed by roots or boulders, and runs (Types 7,9,11,20, and 15 respectively). Most of these habitats, except runs, were relatively scarce in the study area and probably were not responsible for rearing significant numbers of 1+ steelhead to smolt. All of these habitats had abundant sunlight (<15% shade) and were within or immediately preceded by habitats characterized by high food production (riffles). Whitewater, bedrock, boulders, wood debris, and live vegetation provided cover in these habitats. Backwater pool with logs (Type 7) was the only habitat type found where fewer than 5 types of cover were available in the same unit, however use of that type was high probably because of the dominance of woody debris.

This stream is relatively high gradient, and therefore has very limited low velocity habitat available during most of the water year. Large woody debris was found in higher velocity habitats, except debris jams found in association with backwater pool and dammed pool habitats (Types 5 and 13), where it provided cover to a great percentage of the habitat surface area. Potential winter cover is provided by large boulders and cobble associated with the extremely few (7%) slower velocity habitat types within the study area. Roughly 93% of the habitat within the study area (Appendix L) experiences high or marginally high water velocity during the winter months and may therefore be unsuitable for winter rearing purposes.

Present available spawning area can accommodate a maximum of 3760 steelhead redds. Based on rearing habitat available in the study area in 1989, estimated steelhead standing crops should result in an adult escapement which would produce about 226 redds (Appendix L). Spawning habitat is adequate to accommodate more adult steelhead than the rearing habitat could produce under 1989 conditions.

<u>Summary and Conclusions</u>

Desirable chinook spawning areas, low and high gradient riffles, were crowded with adult spawners. Steelhead spawning area is more than adequate to accommodate adults which could be produced by the rearing habitat available during the study period. Though chinook salmon had difficulty accessing spawning grounds early in the season because of a log jam, it allowed passage when flows increased. Chinook salmon only utilize the lower 9.1 km of habitat, though there was not a migration barrier noted within that area. Potential winter rearing habitat is very limited in this steep gradient study area, where nearly 95% of the available habitat experiences high winter water velocities. Only several slow velocity habitats present had accumulations of woody debris available to provide winter rearing habitat conditions.

Recommendations

1) Restore suitable accumulations of woody cover in slow velocity habitats and evaluate effectiveness for steelhead and coho winter rearing.

2) Provide adequate, stable spawning areas for chinook and steelhead and evaluate effectiveness.

Beaver Creek

Results and Discussion

An estimated 8270 m^2 of suitable spawning habitat was available in the study area, which would accommodate a maximum of 5520 steelhead redds. Chinook salmon could only access the lower 12.4 km (7.7 mi) of habitat which provides an estimated m^2 of spawning habitat, enough to accommodate chinook redds.

Crews observed 138 chinook redds in the study area during fall 1988. Run (Type 15) spawning habitat was used most heavily by chinook, however that use was not disproportionate to its availability. Low gradient riffle (Type 1) habitat was selected by spawning chinook, as evidenced by the positive utilization coefficient. Nearly 24% of the available spawning habitat is associated with by weirs, however it's use was disproportionately low (Appendix M). Chinook spawning began in early October, peaked in late October and concluded by early November (Appendix M).

No coho salmon spawning was seen, but juvenile coho were observed rearing in the study area in summer 1989, indicating that coho spawning occurred either following the study period or outside the study area.

Fifty-seven (57) steelhead redds were observed in the study area in spring 1989 (Appendix M). Run (Type 15) habitat was used extensively by steelhead spawners, however not disproportionate to it's availability. Habitat enhanced by artificial structures was heavily used, in relation to its availability. Spawning was first observed in mid March, peaked in early April, and was completed by early May (Appendix M). April high flows made accurate observations impossible, and attempts were abandoned until later that month.

A total of 190,417 m^2 of summer habitat area (72,008 m^3) was evaluated during the study period. Seventeen of the twenty-five habitat types were represented; secondary channel pools, backwater pools, trench pools, edgewater, corner pools, and enhanced pocket habitats (Types 4,5,6,7,8,18,22, and 32 respectively) were absent from the study area. Step run, run, and low gradient riffle (Types 16,15, and 1) dominated the habitat surface area and volume (Appendix M). Pool and glide habitats made up only about 13% of the total stream area.

A catastrophic debris torrent which began in the headwaters meadow area below Mt. Ashland occurred in August 1989, resulted in extreme turbidity and habitat damage throughout the study area. Physical habitat conditions had already been assessed but biological sampling had only occurred on about 11% of the habitat units. Attempts to complete sampling after this event were unsuccessful due to persistent turbidity and poor direct observation conditions. Due to these circumstances, it is not reasonable to discuss juvenile fish habitat utilization, however sampling results are summarized in Appendix M.

Large woody debris was found primarily in lateral scour pools (Types 10 and 11). Woody debris was otherwise absent from the study area. Potential winter cover is provided by large boulders and cobble associated with the few (10%) slower velocity habitat types in the study area. Roughly 90% of the study area habitat (Appendix M) experiences high or marginally high water velocity during winter months.

Present available spawning area can accommodate a maximum of 5520 steelhead redds. Based on rearing habitat available in the study area in 1989, estimated steelhead standing crops should result in an adult escapement which would produce about 113 redds (Appendix M). Spawning habitat is adequate to accommodate more adult steelhead than the rearing habitat could produce under 1989 conditions.

Summary and Conclusions

Several cascades in the near Bumblebee Creek (12.4 km^2 (7.7 mi^2) created flow related barriers to chinook spawners during the study period. Attempts to provide additional spawning area received disproportionately little use during the study period by chinook spawners, but heavy use by steelhead spawners. Damage to habitat within the study area, after physical assessment of habitat conditions, by a debris torrent was severe. Nearly the entire study area was affected by sediment deposition. Chinook spawning and over winter rearing conditions for steelhead are potentially the most seriously affected habitats. Steelhead spawning area is more than adequate to accommodate adults which could be produced by the rearing habitat available during the study period. Slower velocity pool and glide habitats were scarce in the study area, probably making winter rearing habitat a valuable commodity. Though woody debris was found in lateral scour pool habitats (and probably adds to that habitat's desirability in summer months), wood accumulations were scarce in the entire study area. Low velocity habitat types made up only about 10% of the available stream habitat, hence winter rearing conditions may be harsh in the study area.

Recommendations

1) Restore suitable accumulations of woody cover in slow velocity habitats and evaluate effectiveness for steelhead and coho winter rearing.

2) Modify seasonal migration barrier.

3) Investigate apparent lack of chinook salmon spawning on weirs.

4) Evaluate physical effects of catastrophic debris torrent on habitat. Take corrective actions as appropriate to expedite natural recovery of habitat.

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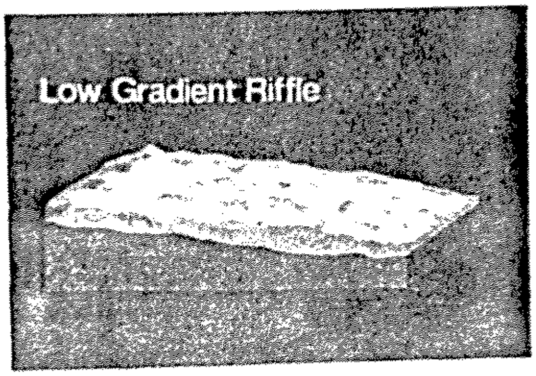
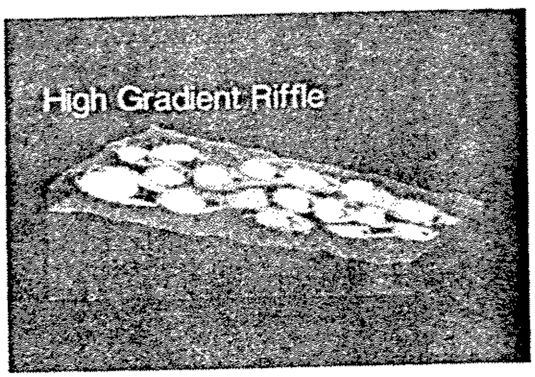
APPENDIX A. HABITAT TYPES



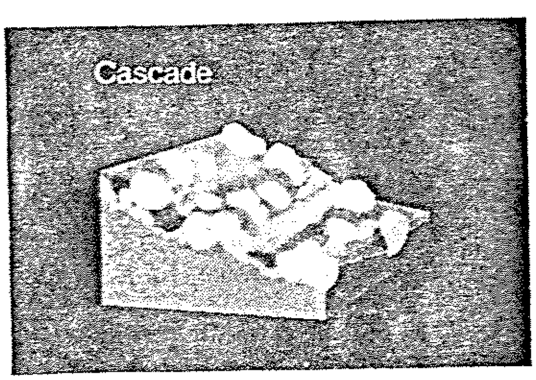
1--Low Gradient Riffles "LGR"

Shallow reaches with swiftly flowing, turbulent water with some partially exposed substrate. Gradient < 4%, substrate is usually cobble dominated.



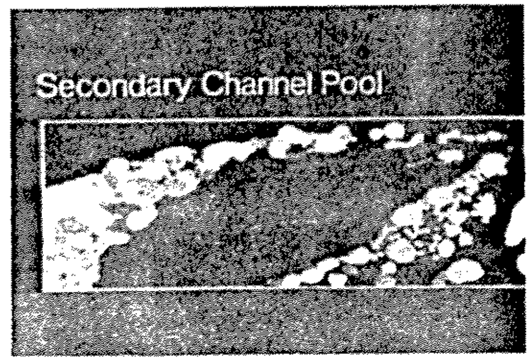
2--High Gradient Riffles "HGR"

Steep reaches of moderately deep, swift, and very turbulent water. Amount of exposed substrate is relatively great. Gradient is > 4%, and substrate is boulder dominated.



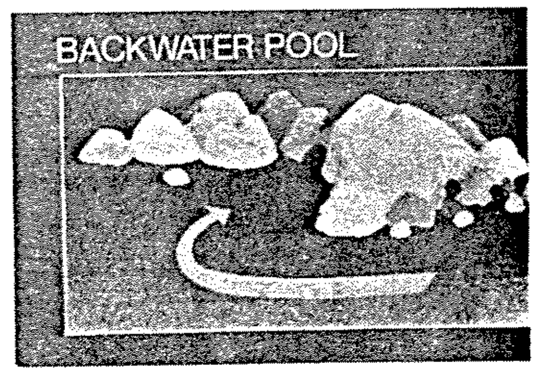
3--Cascade "CAS"

The steepest riffle habitat, consists of alternating small waterfalls and shallow pools. Substrate is usually bedrock and boulders.



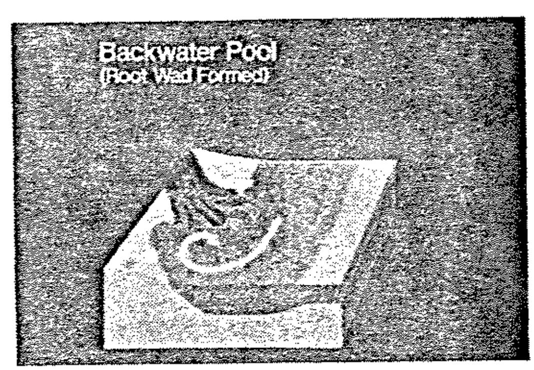
4--Secondary Channel Pool "SCP"

Pools formed outside of the average wetted channel. During summer these pools will dry up or have very little flow. Mainly associated with gravel bars and may contain sand and silt substrates.

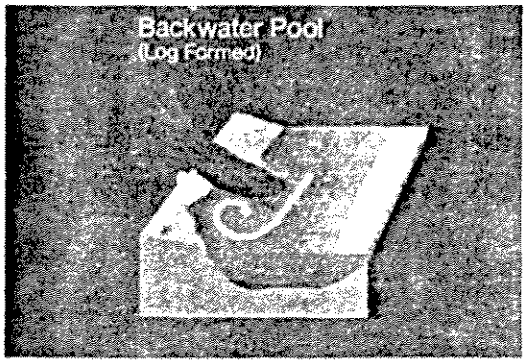


5--Backwater Pool "BWP"
Boulder Formed

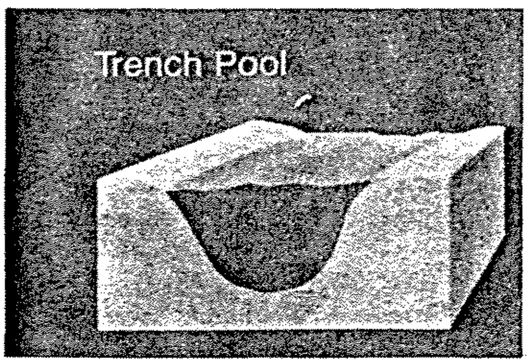
Found along channel margins and caused by eddies around obstructions such as boulders, rootwads, or woody debris. These pools are usually shallow and are dominated by fine-grain substrates. Current velocities are quite low.



6--Backwater Pool "BWP"
Root Wad Formed

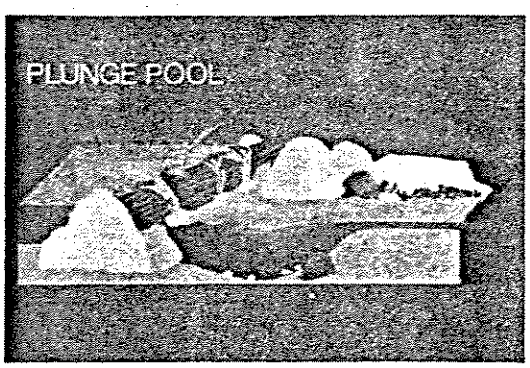


7--Backwater Pool "BWP"
Log Formed



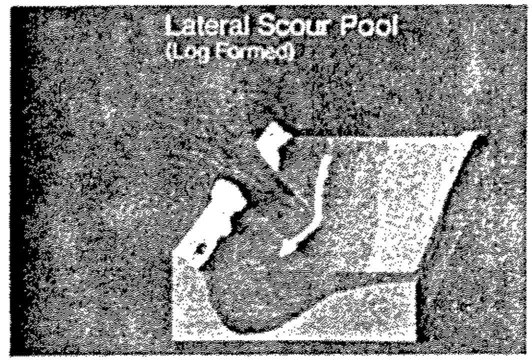
8--Trench Pool "TRP"

Long, generally deep pools in a stable substrate. Channel cross sections are typically U-shaped with a coarse grained bottom flanked by bedrock walls. Current velocities are the swiftest of any pool type and the direction of flow is uniform.



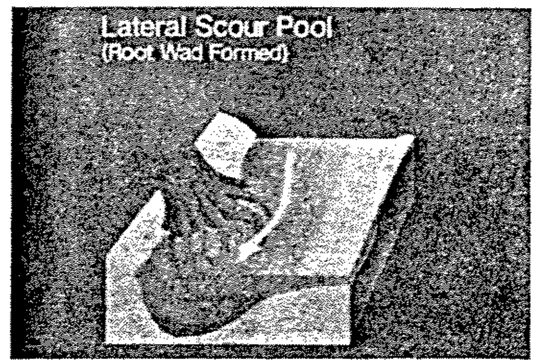
9--Plunge Pool "PLP"

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.

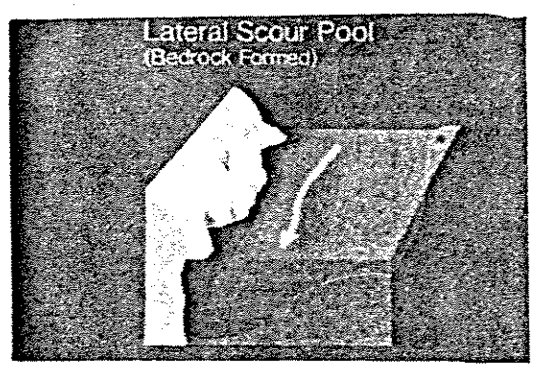


10--Lateral Scour "LSP" Log Formed

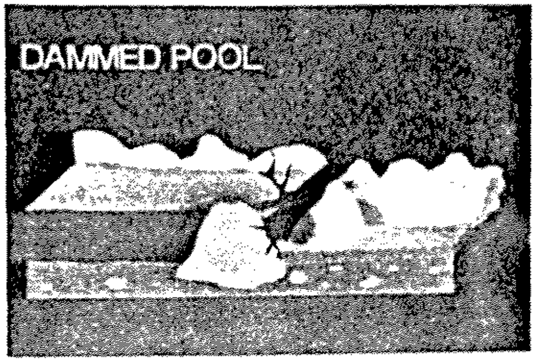
Formed by flow impinging against one streambank or against a partial channel obstruction. The associated scour is confined to <60% of wetted channel width. Channel obstructions include rootwads, woody debris, boulders, and bedrock.



11-- Lateral Scour Pool "LSP"
Root Wad Formed

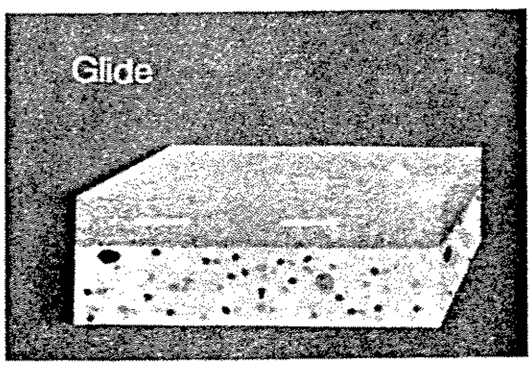


12--Lateral Scour Pool "LSP"
Bedrock Formed



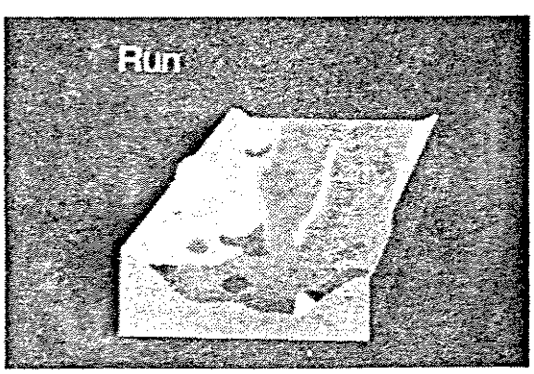
13--Dammed Pool "DPL"

Water impounded from a complete or nearly complete channel blockage (debris jams, rock landslides or beaver dams). Substrates tend toward smaller gravels and sand.



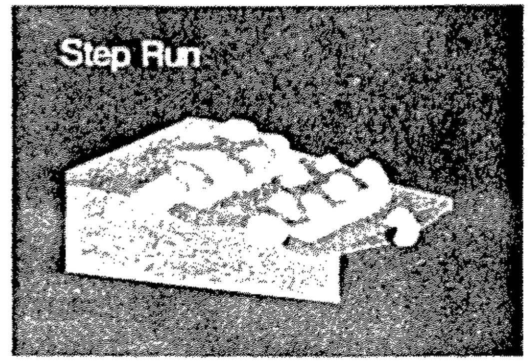
14—Glides "GLD"

A wide shallow pool flowing smoothly and gently, with low to moderate velocities and little or no surface turbulence. Substrates usually consist of cobble, gravel and sand.



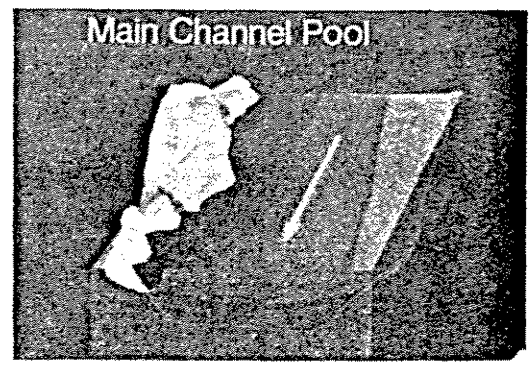
15--Run "RUN"

Swiftly flowing reaches with little surface agitation and no major flow obstructions. Often appears as flooded riffles. Typical substrates are gravel, cobble and boulders.



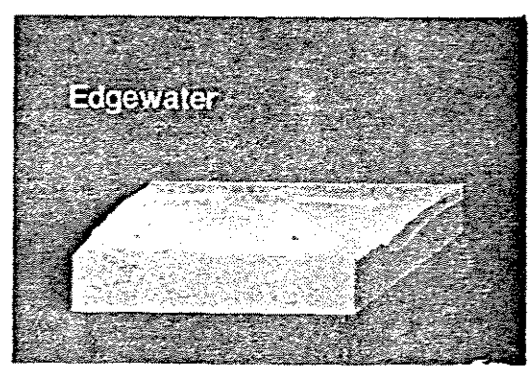
16--Step Run "SRN"

A sequence of runs separated by short riffle steps. Substrates are usually cobble and boulder dominated.



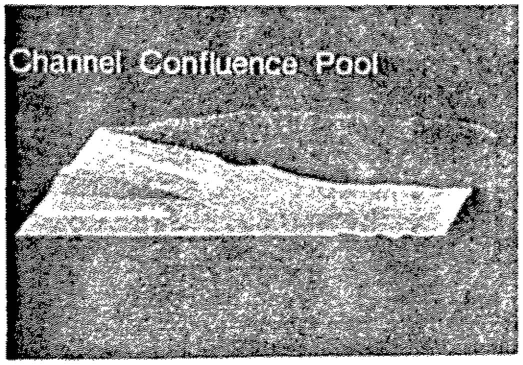
17--Main Channel Pool "MCP"

Large pools often associated with one bank and a bend in the stream. The scour hole encompasses more than 60% of the wetted channel. Water velocity is slow, and the substrate is highly variable.



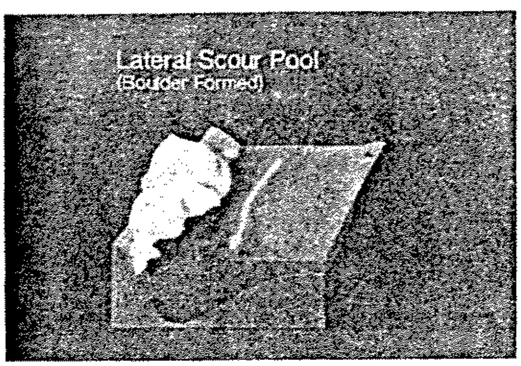
18--Edgewater "EGW"

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.



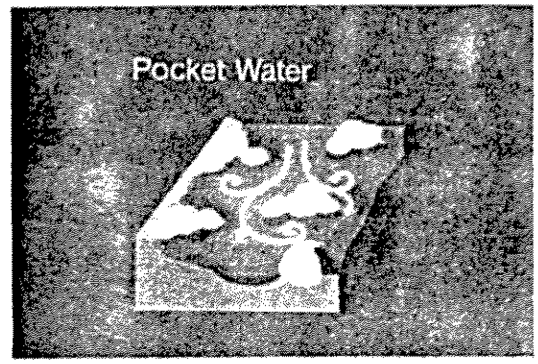
19--Channel Confluence Pool "CCP"

Large pools formed at the confluence of two or more channels. Scour can be due to plunges, lateral obstructions or down-scour at the channel intersections. Velocity and turbulence are usually greater than those in other pool types.



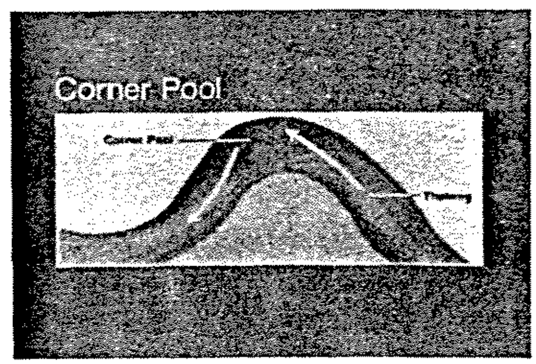
20--Lateral Scour Pool "LSP"
Boulder Formed

Formed by flow impinging against boulders that create a partial channel obstruction. The associated scour is confined to <60% of wetted channel width.



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.

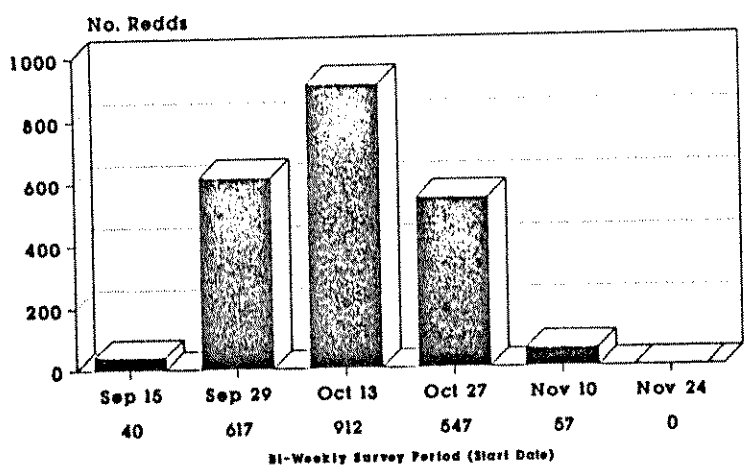


22--Corner Pool "CRP"

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.

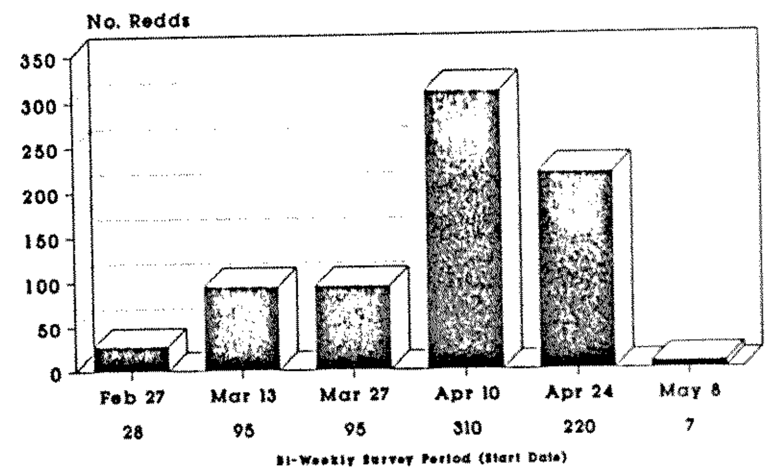
APPENDIX B. HABITAT CONDITION AND USE - ALL STUDY AREAS

Spawning Period
Chinook



All Study Area Streams

Spawning Period
Steelhead



All Study Area Streams 1989

Relationship between spawning and rearing habitat for steelhead in all 1989 study areas of Salmon, Scott, Shasta, and mid-Klamath Subbasins combined.

Parameter	Numbers
Steelhead spawning area/pair	1.5 m^2
Steelhead spawning area in study area	58000 m^2
Redds accom. w/out superimposition	38667 redds
Total spawning population (1.5 males/female)	96667 spawners
Estimated 1+ steelhead standing crop	236,474 juveniles
Estimated 2+ smolts (40% survival)	94,590 smolts
Expected adult maiden return (5%)	4729 adults
Estimated maiden redds @ 2.5 fish/redd	1892 maiden redds
Est. total redds (60% maiden;40% repeat)	3152 total redds

CONCLUSION: Present spawning area is adequate to seed the rearing habitat available in the study area under 1989 conditions.

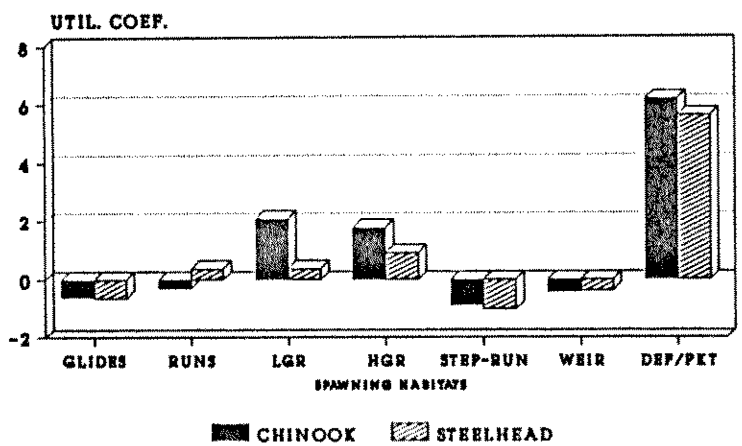
All Study Area Streams
Spawning Ground Utilization

	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	DEFL/PCKT	TOTAL
Spawning Area m^2	15141	24798	8648	235	3250	4227	283	56581
Percent Spawning Area	27	44	15	0	6	7	0	
Chinook Redds	245	690	1021	25	19	96	78	2174
Steelhead Redds	79	454	158	6	0	36	25	758
Chinook Redd Density	0.0162	0.0278	0.1181	0.1062	0.0058	0.0227	0.2757	0.0384
Steelhead Redd Density	0.0052	0.0183	0.0183	0.0255	0.0000	0.0085	0.0884	0.0134

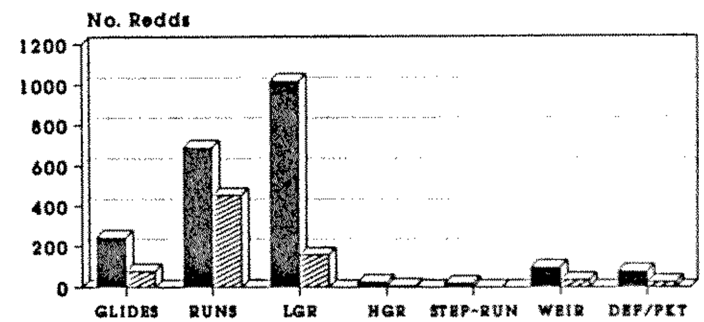
Utilization Coefficients

	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	DEFL/PCKT
Chinook Util Coef	-0.5789	-0.2758	2.0728	1.7650	-0.8478	-0.4089	6.1763
Steelhead Util Coef	-0.6105	0.3666	0.3638	0.9033	-1.0000	-0.3642	5.5968

Spawner Utilization
All Study Area Streams 1988-89



Redds by Habitat Type
All Study Area Streams



	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	DEF/PKT
Chinook	245	690	1021	25	19	96	78
Steelhead	79	454	158	6	0	36	25

1988 - 1989

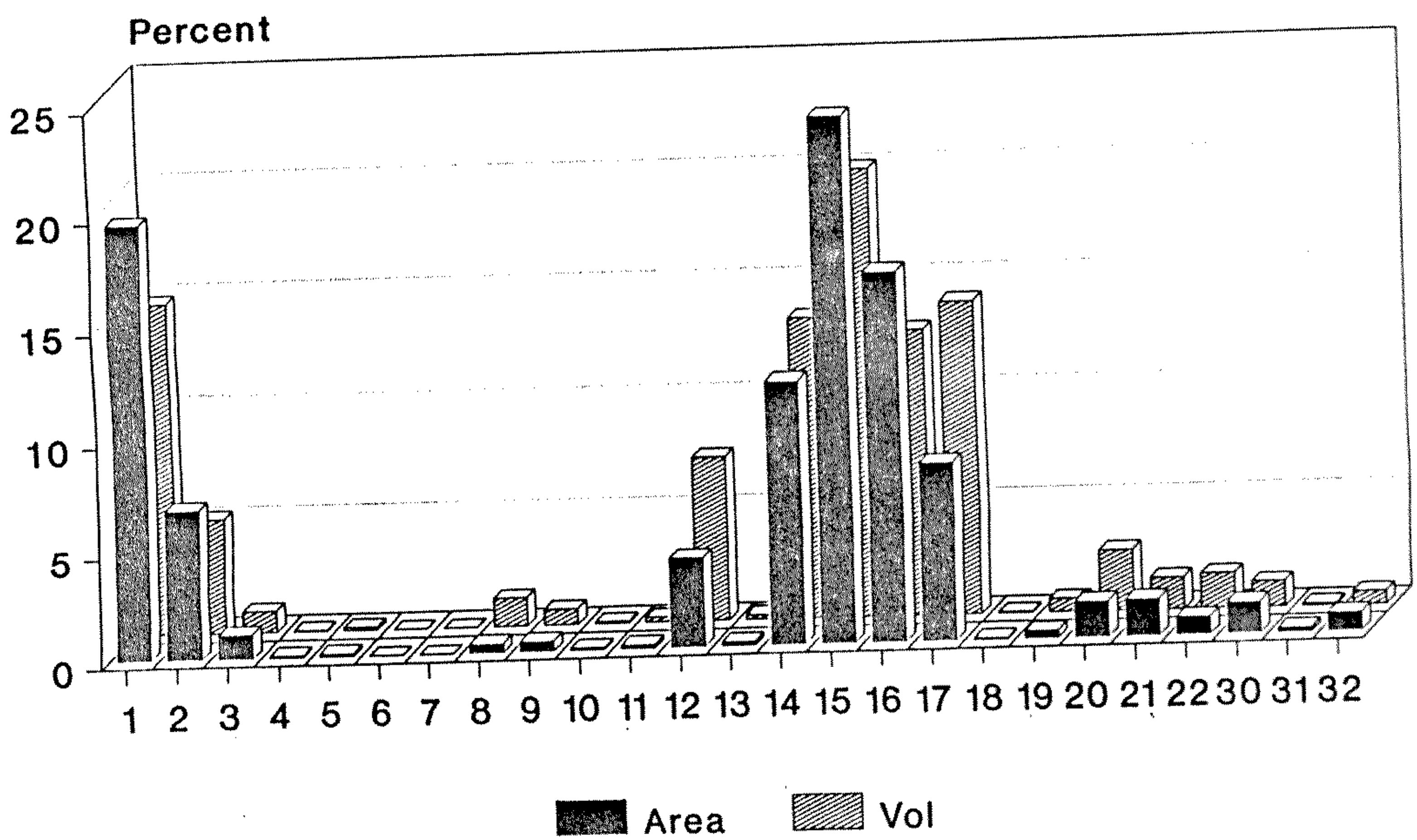
All Study Area Streams
Physical Data Summary

HABITAT TYPE	NO. UNITS	LENGTH m	AREA m^2	VOLUME m^3	AVG LENGTH m	AVG WIDTH m	AVG DEPTH m	AVG VOLUME m^3	STREAM AREA %	STREAM VOL %	EMBEDD %	FINES %	GRAVEL %	COBBLE %	BOULDER %	BEDROCK %	SPAWN AREA m^2
1	860	39112	474580	195597	45.5	10.6	0.34	227.70	20	15	9.3	10	17	33	37	4	8648
2	612	15634	164126	68534	25.5	9.5	0.36	112.17	7	5	6.7	4	7	31	52	7	235
3	132	2563	25890	12590	19.6	8.2	0.44	133.94	1	1	6.5	9	7	15	48	20	2
4	9	172	1562	447	19.1	6.6	0.56	49.66	0	0	53.3	45	9	4	38	5	1
5	14	258	3086	1660	18.5	8.1	0.67	118.55	0	0	15.8	29	3	3	23	42	3
6	1	8	36	27	7.9	4.6	0.76	27.30	0	0	20.0	90	10				
7	2	20	85	33	10.1	4.4	0.38	16.56	0	0	2.3	20	80				0
8	25	883	9523	17073	35.3	7.6	1.27	711.35	0	1	17.7	27	10	20	21	23	34
9	127	1404	10584	9238	11.1	6.6	0.64	73.32	0	1	12.1	19	11	21	33	16	191
10	23	309	1890	1095	13.4	5.4	0.50	47.61	0	0	14.0	24	20	30	23	3	29
11	33	534	3640	2851	16.2	6.5	0.71	86.41	0	0	8.0	24	17	41	18		61
12	271	8031	99506	98994	29.6	10.4	0.90	368.01	4	8	7.0	14	13	33	30	9	997
13	26	385	3950	2602	14.8	7.3	0.56	100.09	0	0	6.4	34	27	12	19	8	41
14	444	21034	289554	178327	47.4	10.1	0.50	401.64	12	14	13.7	32	24	21	21	2	10707
15	1091	55576	574834	264974	51.0	9.4	0.42	243.54	24	20	9.3	15	27	30	26	3	23340
16	691	45574	403733	169611	66.0	8.3	0.38	245.46	17	13	5.1	11	13	25	43	8	3250
17	405	14440	197547	185738	35.7	11.5	1.02	467.85	8	14	11.0	29	14	18	22	17	3029
18	7	117	1000	628	16.6	8.7	0.64	89.73	0	0	8.3	34	17	25	18	6	3
19	28	697	8176	7784	24.9	10.2	0.76	288.29	0	1	10.1	26	14	16	31	13	268
20	185	3618	38959	36767	19.6	8.3	0.79	198.74	2	3	17.2	31	12	21	19	16	615
21	74	3108	40479	19339	42.0	12.0	0.46	261.34	2	1	8.7	13	7	24	51	5	843
22	62	1847	19250	21369	29.8	9.2	1.08	344.66	1	2	10.8	16	18	23	31	12	1131
30	44	3038	34319	15450	69.1	11.0	0.40	351.14	1	1	5.8	16	31	24	28	0	4227
31	7	382	4253	1237	54.6	11.5	0.32	176.73	0	0	18.4	18	18	35	30		70
32	20	1438	20035	7859	71.9	13.5	0.37	392.96	1	1	8.5	7	13	43	37		213

All Study Area Streams
Cover Data Summary

HABITAT	NO. UNITS	COVER %	UNDERCUT %	SWD %	LWD %	TERR_VEG %	WT_WATER %	BOULDERS %	BDRK_LEDG %	SHADE %
1	859	35	3	1	0	8	45	41	2	5
2	612	55	1	1	1	4	54	39	2	6
3	131	67					67	27	6	2
4	9	12					20		80	3
5	14	36			2		27	2	69	4
6	1	40	1		2		57	14	26	65
7	2	12		6	45	6	39	3		23
8	25	16	3	1	1	4	27	37	27	1
9	127	30	5	10	25	25	30	5		8
10	23	17	1	1	25	11		60	2	10
11	33	22	5	1	5	10	24	49	5	10
12	271	18	1	1	1	5	32	54	6	8
13	26	22	5		0	4	25	34	31	6
14	444	20			11	11	55	18	5	3
15	1090	20	4			12	44	35	5	5
16	691	30		1		4	44	51		5
17	405	17			0	5	32	7	56	3
18	7	11					30	70		10
19	27	23				9	32	59		4
20	185	18								6
21	74	43								5
22	62	19								9
30	44	24								3
31	7	30								4
32	20	34								1

Habitat Distribution
All Study Area Streams



All Study Area Streams
Biological Data Summary

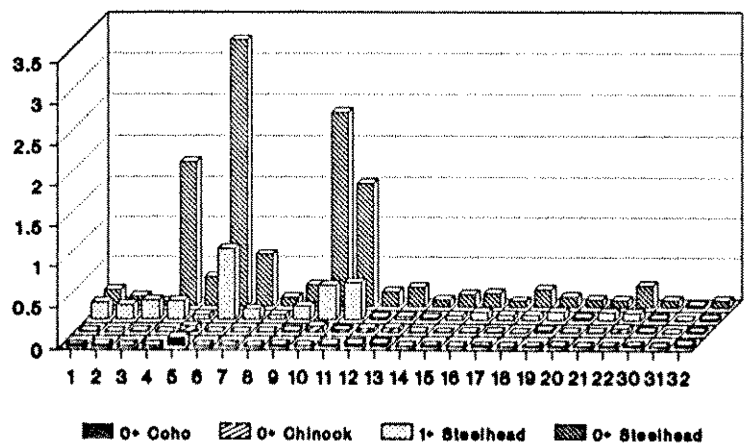
Observed Fish by Habitat Type

HABITAT	# UNITS	0+ STHD	1+ STHD	0+ KING	0+ COHO	TOTAL VOLUME m^3	TOTAL AREA m^2	OBSERVED VOLUME m^3	OBSERVED AREA m^2
1	189	37354	15926	2106	792	195597	474580	34045	77698
2	149	9248	5542	586	442	68534	164126	13218	31720
3	18	726	1178	140	0	12590	25890	3157	5125
4	6	729	90	0	0	447	1562	222	408
5	8	148	22	34	47	1660	3086	540	486
6	1	69	18	0	0	27	36	19	25
7	1	21	4	0	0	33	85	8	40
8	7	194	100	0	0	17072	9523	2350	1762
9	32	547	331	45	13	9238	10584	2840	2487
10	9	1760	304	68	0	1095	1890	477	885
11	13	1336	388	32	16	2851	3640	581	1050
12	67	3269	540	1137	498	98994	99506	19742	21324
13	8	112	17	31	16	2602	3950	277	557
14	77	4245	1090	396	27	178326	289554	29425	48207
15	222	21654	5573	1046	490	264974	574834	48284	105396
16	143	11407	4350	665	141	169611	403733	27123	50493
17	97	2728	2127	441	103	185738	197547	40837	42506
18	4	141	42	0	0	628	1000	345	647
19	12	468	366	156	9	7784	8176	4129	4326
20	44	1160	366	173	72	36767	38959	10392	14111
21	18	1396	1006	226	3	19339	40479	6106	11488
22	25	2017	630	498	27	21369	19250	10276	9101
30	12	718	169	123	83	15450	34319	3953	7955
31	2	24	3	0	0	1237	4253	207	690
32	10	690	143	174	190	7859	20035	4025	7843

All Study Area Streams
Estimated Fish Densities

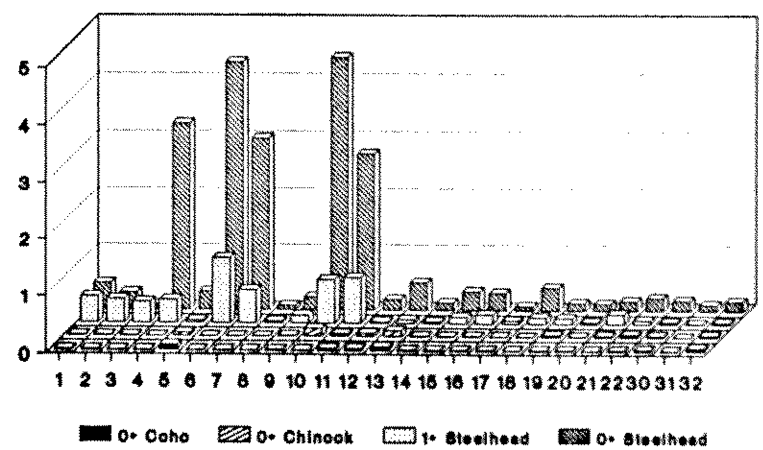
HABITAT	Per m^2 0+ STHD	1+ STHD	0+ KING	0+ COHO	Per m^3 0+ STHD	1+ STHD	0+ KING	0+ COHO
1	0.481	0.205	0.027	0.010	1.097	0.468	0.062	0.023
2	0.292	0.175	0.018	0.014	0.700	0.419	0.044	0.033
3	0.142	0.230	0.027	0.000	0.230	0.373	0.044	0.000
4	1.788	0.220	0.000	0.000	3.277	0.402	0.000	0.000
5	0.303	0.044	0.070	0.097	0.273	0.040	0.063	0.087
6	2.728	0.717	0.000	0.000	3.624	0.952	0.000	0.000
7	0.531	0.101	0.000	0.000	2.521	0.480	0.000	0.000
8	0.110	0.056	0.000	0.000	0.082	0.042	0.000	0.000
9	0.220	0.133	0.018	0.005	0.192	0.117	0.016	0.005
10	1.988	0.343	0.077	0.000	3.689	0.637	0.143	0.000
11	1.272	0.369	0.030	0.015	2.301	0.668	0.055	0.028
12	0.153	0.025	0.053	0.023	0.166	0.027	0.058	0.025
13	0.201	0.031	0.056	0.029	0.404	0.061	0.112	0.058
14	0.088	0.023	0.008	0.001	0.144	0.037	0.013	0.001
15	0.205	0.053	0.010	0.005	0.448	0.115	0.022	0.010
16	0.226	0.086	0.013	0.003	0.421	0.160	0.025	0.005
17	0.064	0.050	0.010	0.002	0.067	0.052	0.011	0.003
18	0.218	0.064	0.000	0.000	0.409	0.120	0.000	0.000
19	0.108	0.084	0.036	0.002	0.113	0.089	0.038	0.002
20	0.082	0.026	0.012	0.005	0.112	0.035	0.017	0.007
21	0.122	0.088	0.020	0.000	0.229	0.165	0.037	0.001
22	0.222	0.069	0.055	0.003	0.196	0.061	0.048	0.003
30	0.090	0.021	0.015	0.010	0.182	0.043	0.031	0.021
31	0.034	0.004	0.000	0.000	0.113	0.014	0.000	0.000
32	0.088	0.018	0.022	0.024	0.171	0.036	0.043	0.047

Estimated Fish Densities
All Study Area Streams



Fish Per Cu. M.

Estimated Fish Densities
All Study Area Streams

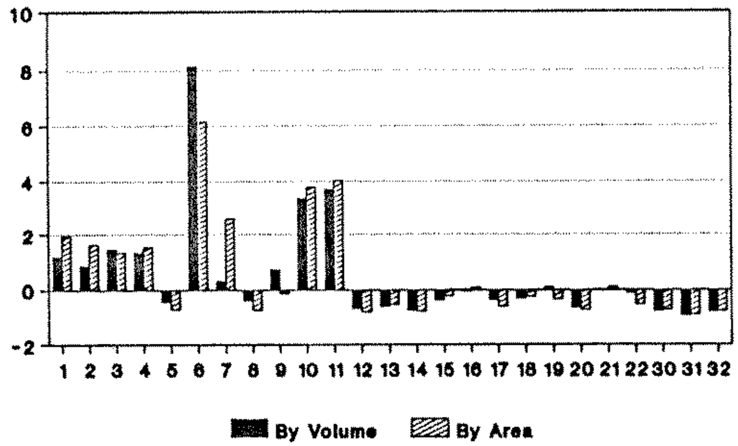


Fish Per Sq. M.

All Study Area Streams
Utilization Coefficients

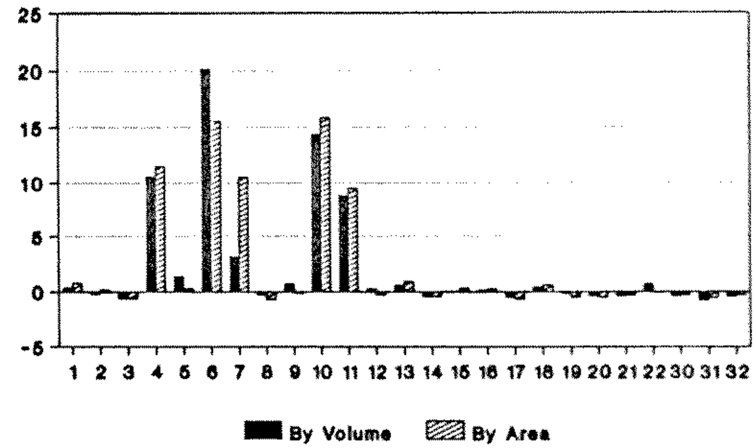
HABITAT	Area 0+ STHD	1+ STHD	0+ KING	0+ COHO	Volume 0+ STHD	1+ STHD	0+ KING	0+ COHO
1	1.10	1.27	0.50	0.53	1.82	2.05	1.01	1.06
2	0.27	0.93	0.02	1.10	0.80	1.73	0.44	1.96
3	-0.38	1.54	0.51		-0.41	1.43	0.44	
4	6.81	1.43			7.42	1.62		
5	0.32	-0.51	2.86	13.53	-0.30	-0.74	1.05	6.70
6	10.92	6.94			8.32	5.20		
7	1.32	0.12			5.48	2.13		
8	-0.52	-0.37			-0.79	-0.72		
9	-0.04	0.47	0.00	-0.21	-0.51	-0.24	-0.48	-0.60
10	7.69	2.80	3.25		8.48	3.15	3.63	
11	4.56	3.09	0.68	1.29	4.92	3.35	0.79	1.44
12	-0.33	-0.72	1.95	2.51	-0.57	-0.82	0.87	1.23
13	-0.12	-0.66	2.07	3.32	0.04	-0.60	2.64	4.11
14	-0.62	-0.75	-0.55	-0.92	-0.63	-0.76	-0.56	-0.92
15	-0.10	-0.41	-0.45	-0.30	0.15	-0.25	-0.30	-0.10
16	-0.01	-0.05	-0.27	-0.58	0.08	0.04	-0.20	-0.54
17	-0.72	-0.45	-0.43	-0.64	-0.83	-0.66	-0.65	-0.78
18	-0.05	-0.29			0.05	-0.22		
19	-0.53	-0.06	0.99	-0.69	-0.71	-0.42	0.23	-0.81
20	-0.64	-0.71	-0.32	-0.23	-0.71	-0.77	-0.46	-0.39
21	-0.47	-0.03	0.09	-0.96	-0.41	0.07	0.20	-0.95
22	-0.03	-0.23	2.02	-0.55	-0.50	-0.60	0.58	-0.77
30	-0.61	-0.76	-0.15	0.56	-0.53	-0.72	0.01	0.85
31	-0.85	-0.95			-0.71	-0.91		
32	-0.62	-0.80	0.23	2.64	-0.56	-0.77	0.41	3.18

Utilization Coefficients
1+ Steelhead



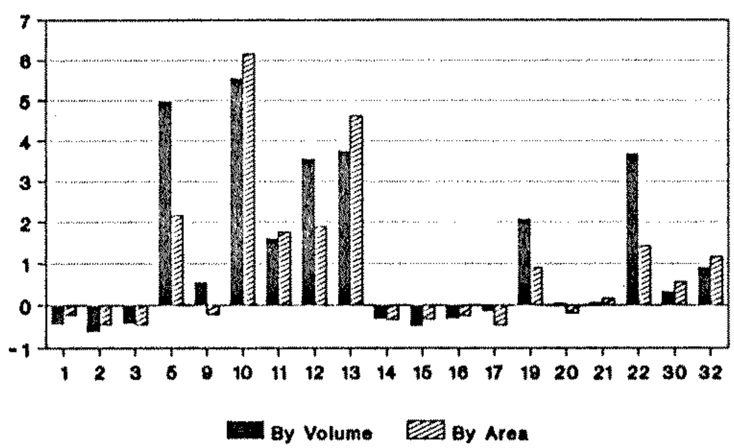
All Study Area Streams

Utilization Coefficients
0+ Steelhead



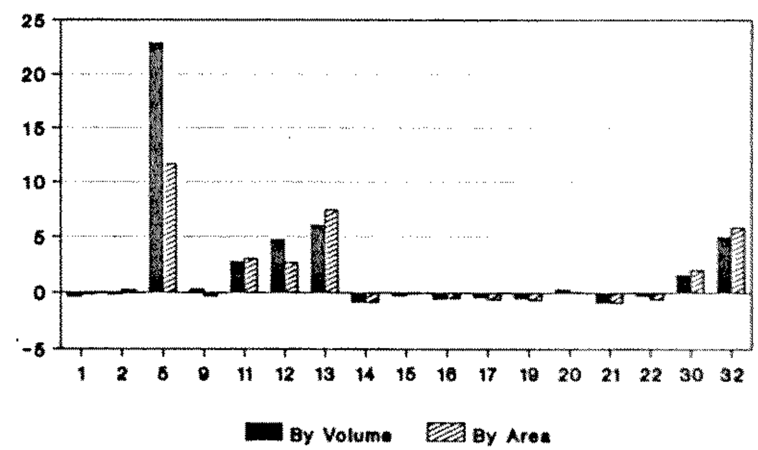
All Study Area Streams

Utilization Coefficients
0+ Chinook



All Study Area Streams

Utilization Coefficients
0+ Coho

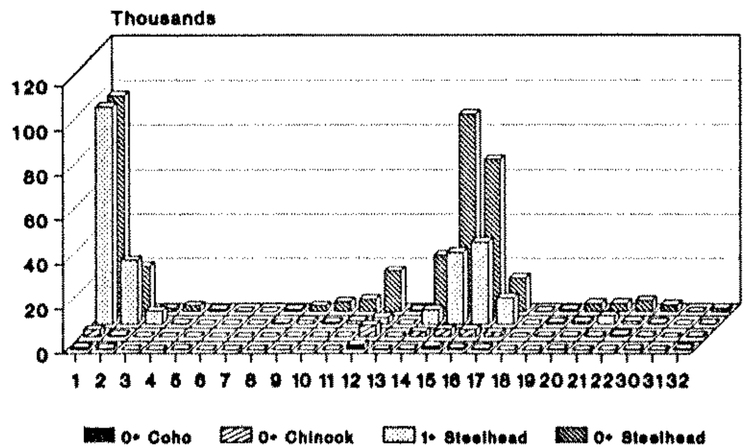


All Study Area Streams

All Study Area Streams
Estimated Standing Crop

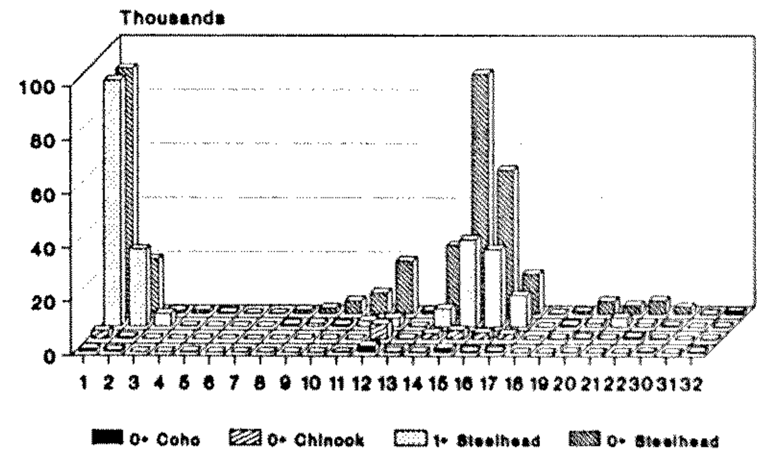
	Area				Volume			
HABITAT	0+ STHD	1+ STHD	0+ KING	0+ COHO	0+ STHD	1+ STHD	0+ KING	0+ COHO
1	228158	97276	12863	4838	214610	91500	12100	4550
2	47852	28676	3032	2287	47949	28734	3038	2292
3	3668	5951	707	0	2896	4698	558	0
4	2793	343	0	0	1465	180	0	0
5	936	136	216	298	453	66	105	144
6	99	26	0	0	99	26	0	0
7	45	9	0	0	84	16	0	0
8	1046	538	0	0	1406	723	0	0
9	2326	1409	192	55	1777	1077	146	42
10	3758	649	145	0	4039	698	156	0
11	4631	1345	111	55	6562	1906	157	79
12	15252	2520	5306	2324	16390	2708	5701	2497
13	794	120	220	113	1052	160	291	150
14	25494	6544	2376	162	25724	6603	2397	164
15	118099	30394	5707	2670	118831	30582	5742	2687
16	91209	34778	5316	1126	71333	27199	4157	880
17	12676	9885	2047	476	12405	9674	2004	466
18	218	64	0	0	257	76	0	0
19	883	691	295	17	881	689	294	17
20	3203	1010	476	199	4104	1295	610	255
21	4919	3543	795	11	4421	3185	715	10
22	4266	1331	1053	57	4194	1309	1036	56
30	3095	729	531	356	2805	661	481	322
31	145	18	0	0	140	18	0	0
32	1761	365	444	485	1346	279	340	371
TOTAL	577326	228352	41831	15531	545222	214060	40028	14983

Estimated Standing Crop
All Study Area Streams



Derived From Fish Per Cu. M.

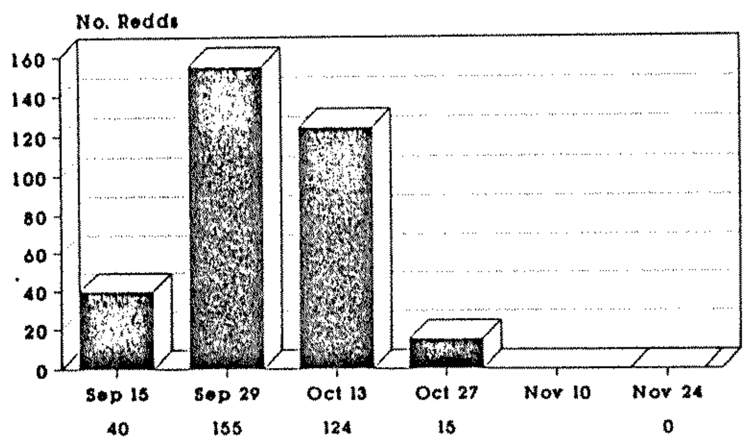
Estimated Standing Crop
All Study Area Streams



Derived From Fish Per Sq. M.

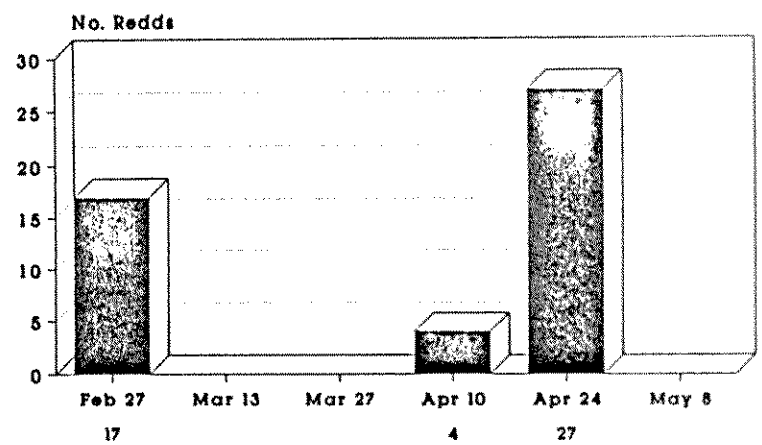
APPENDIX C. HABITAT CONDITION AND USE - SOUTH FORK SALMON RIVER

Spawning Period
Chinook



South Fork Salmon River 1988

Spawning Period
Steelhead



South Fork Salmon River 1989

Relationship between spawning and rearing habitat for steelhead in South Fork Salmon River, 1989.

Parameter	Numbers
Steelhead spawning area/pair	1.5 m^2
Steelhead spawning area in study area	7175 m^2
Redds accom. w/out superimposition	4783 redds
Total spawning population (1.5 males/female)	11958 spawners
Estimated 1+ steelhead standing crop	8622 juveniles
Estimated 2+ smolts (40% survival)	3449 smolts
Expected adult maiden return (5%)	172 adults
Estimated maiden redds @ 2.5 fish/redd	69 maiden redds
Est. total redds (60% maiden;40% repeat)	115 total redds

CONCLUSION: Present spawning area is adequate to seed the rearing habitat available in the study area under 1989 conditions.

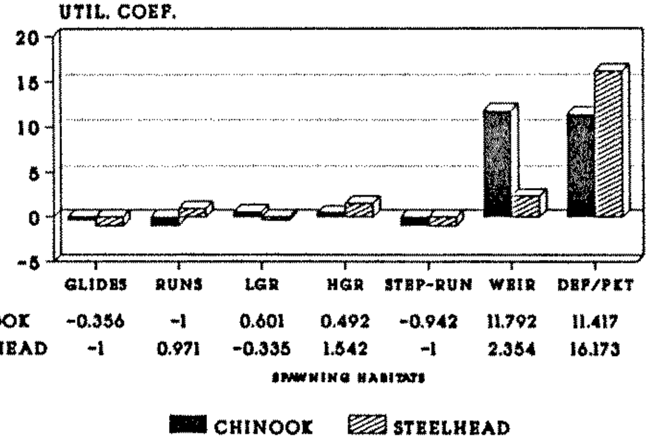
South Fork Salmon River
Spawning Ground Utilization

	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	DEFL/PCKT	TOTAL
Spawning Area m^2	2303	1709	2200	58	742	44	119	7175
Percent Spawning Area	32	24	31	1	10	1	2	
Chinook Redds	69	0	164	4	2	26	69	334
Steelhead Redds	0	23	10	1	0	1	14	49
Chinook Redd Density	0.0300	0	0.0745	0.0694	0.0027	0.5955	0.5780	0.0465
Steelhead Redd Density	0	0.0135	0.0045	0.0174	0	0.0229	0.1173	0.0068

Utilization Coeffiecients

	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	DEFL/PCKT
Chinook Util Coef	-0.3563	-1.0000	0.6012	0.4919	-0.9421	11.7921	11.4169
Steelhead Util Coef	-1.0000	0.9707	-0.3345	1.5423	-1.0000	2.3537	16.1729

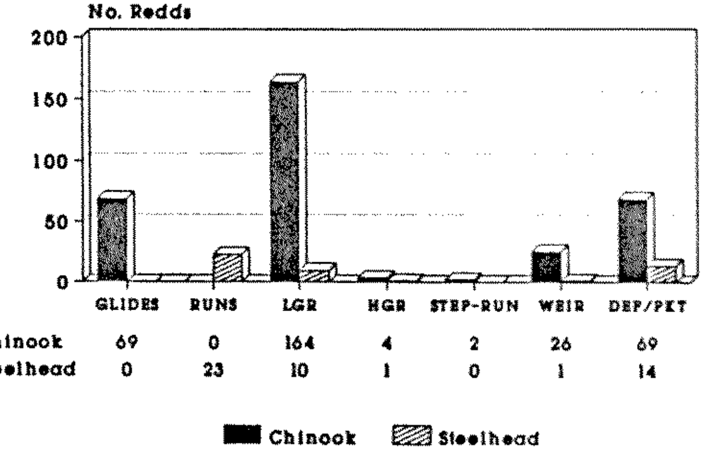
Spawner Utilization
South Fork Salmon River 1988-89



	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	DEF/PKT
CHINOOK	-0.356	-1	0.601	0.492	-0.942	11.792	11.417
STEELHEAD	-1	0.971	-0.335	1.542	-1	2.354	16.173

SPAWNING HABITATS

Redds by Habitat Type
South Fork Salmon River 1988-89



	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	DEF/PKT
Chinook	69	0	164	4	2	26	69
Steelhead	0	23	10	1	0	1	14

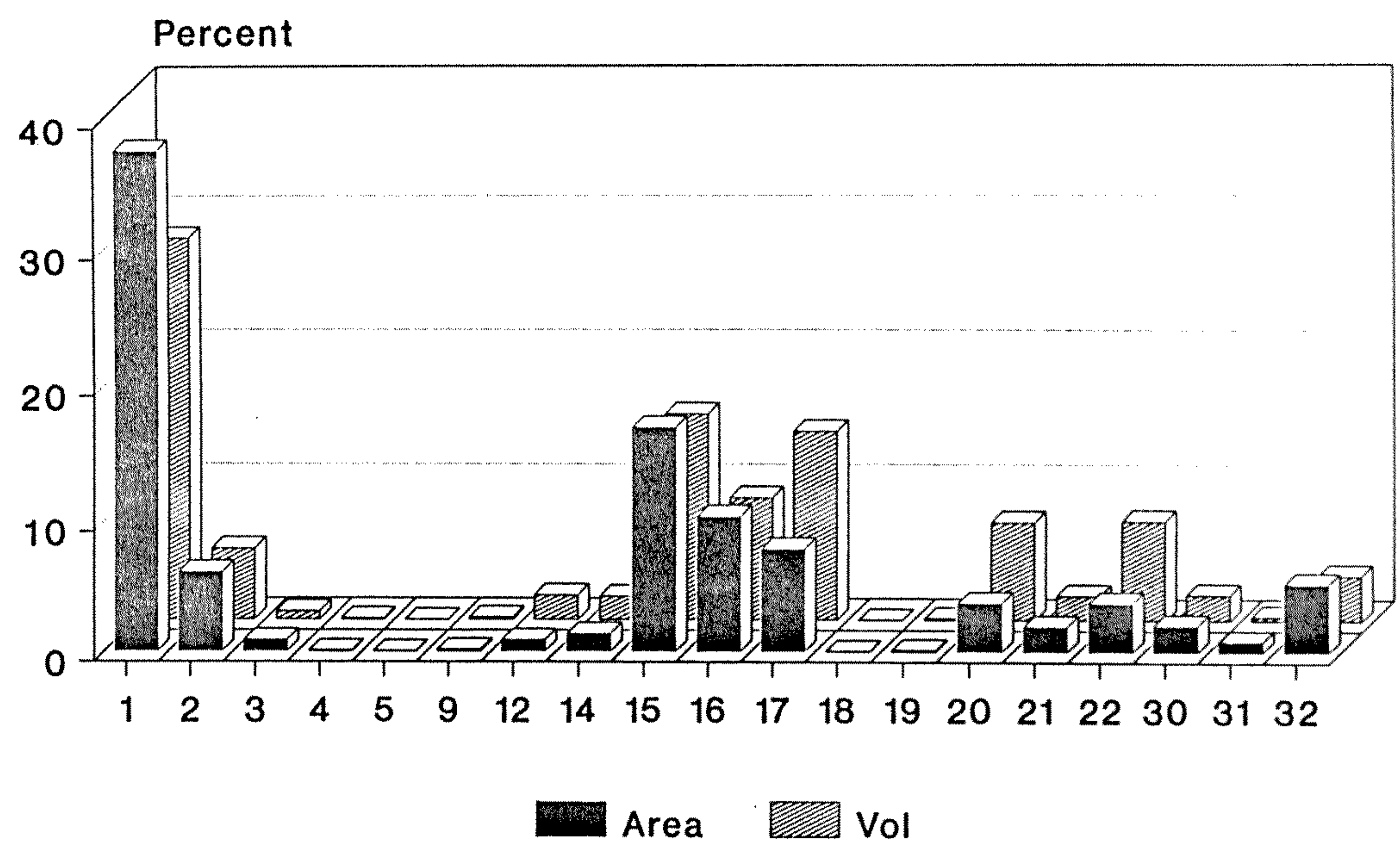
South Fork Salmon River
Physical Data Summary

HABITAT TYPE	NO. UNITS	LENGTH m	AREA m^2	VOLUME m^3	AVG LENGTH m	AVG WIDTH m	AVG DEPTH m	AVG VOLUME m^3	STREAM AREA %	STREAM VOL %	EMBEDD %	FINES %	GRAVEL %	COBBLE %	BOULDER %	BEDROCK %	SPAWN AREA m^2
1	103	6598	78826	27691	64.1	11.5	0.36	268.85	38	28	5.8	14	22	29	31	4	2200
2	41	1116	12920	5307	27.2	10.8	0.42	129.43	6	5	12.4	6	15	28	38	12	58
3	7	201	1929	619	28.7	9.2	0.46	103.21	1	1	20.3	10	10	27	26	26	0
4	1	37	134	81	36.6	3.7	0.61	80.64	0	0	10.0	40	10	20	10	20	0
5	1	21	26	6	21.4	1.2	0.24	6.27	0	0	10.0	30	30	30	10		0
9	1	37	279	168	36.6	7.6	0.61	168.00	0	0	30.0	20	20	10	20	30	0
12	8	202	1946	1855	25.2	9.5	0.93	231.88	1	2	4.0	21	19	29	20	11	123
14	6	222	2950	1760	37.1	11.9	0.58	293.34	1	2	13.1	18	27	24	24	6	567
15	3	3064	35367	14984	48.6	11.5	0.44	237.85	17	15	8.7	13	28	29	19	11	1383
16	22	1905	21540	8943	86.6	10.1	0.47	406.49	10	9	6.5	17	26	19	28	10	742
17	46	1404	16528	13730	30.5	11.2	0.80	298.47	8	14	7.6	13	19	19	25	24	1071
18	1	7	45	23	7.3	6.1	0.52	22.85	0	0	10.0	50	10		20	20	2
19	2	41	186	134	20.3	10.7	0.73	134.06	0	0	20.0	30	30	30	10		28
20	24	740	7963	7255	30.8	10.6	1.18	302.28	4	7	8.9	12	17	26	14	31	307
21	8	373	4181	1860	46.6	10.6	0.45	232.51	2	2	17.9	10	10	14	50	16	19
22	23	753	7995	7318	32.7	10.6	1.00	318.16	4	8	8.8	19	29	19	17	17	635
30	12	298	4349	1957	24.9	14.4	0.42	163.08	2	2	15.1	20	30	25	25		44
33	3	106	1731	339	35.3	14.1	0.26	112.94	1	0	20.0	30	20	30	20		13
32	14	731	11165	3420	52.2	14.3	0.31	244.29	5	4	14.3	19	25	32	24		106

South Fork Salmon River
Cover Data Summary

HABIAT	NO. UNITS	COVER %	UNDERCUT %	SWD %	LWD %	TERR_VEG %	WT_WATER %	BOULDERS %	BDRK_LEDG %	SHADE %
1	103	30	0	4	1	12	25	52	6	7
2	41	38		2	2	5	33	51	7	6
3	7	37		2			43	45	10	6
4	1	10						40	60	0
5	1	10						44	56	50
9	1	30					10	40	50	20
12	8	13				0	9	46	45	7
14	6	11					1	77	22	0
15	63	19	0	2	1	16	6	58	16	6
16	22	35		1	1	12	14	52	19	8
17	46	21	4	1	0	6	8	34	48	6
18	1	0								80
19	2	20		20	20	20	20	20		0
20	24	19	3	2	1	1	11	21	62	10
21	8	53				4	22	62	12	17
22	23	21	4		1	2	17	40	37	10
30	12	25		3		3	19	61	14	0
31	3	39			1	11	7	81		0
32	14	34	0	4	8	8	10	69	0	0

Habitat Distribution
SFk Salmon River



South Fork Salmon River
Biological Data Summary

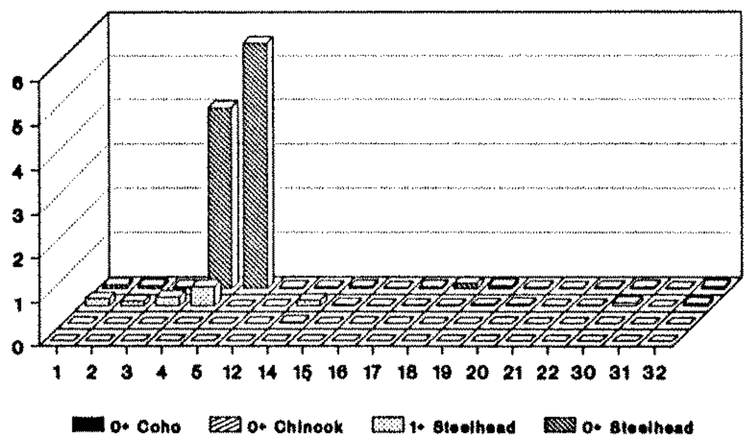
Observed Fish by Habitat Type

HABITAT	# UNITS	0+ STHD	1+ STHD	0+ KING	0+ COHO	TOTAL VOLUME m^3	TOTAL AREA m^2	OBSERVED VOLUME m^3	OBSERVED AREA m^2
1	25	950	800	46	0	27691	78826	4544	12264
2	12	246	174	8	2	5307	12920	1521	3250
3	1	2	4	0	0	619	1929	19	48
4	1	137	15	0	0	81	134	34	56
5	1	35	0	0	0	6	26	6	26
12	3	18	5	3	0	1855	1946	609	651
14	2	9	32	9	0	1760	2950	229	533
15	14	244	113	0	0	14984	35367	3292	8051
16	6	72	36	10	0	8943	21540	2156	4572
17	13	163	78	14	1	13730	16527	3697	4721
18	2	24	5	0	0	23	45	180	379
19	2	15	7	0	0	134	186	182	292
20	6	98	102	12	0	7255	7963	2275	1619
21	2	26	14	0	0	1860	4181	777	1700
22	7	68	43	0	0	7318	7994	1667	1986
30	3	46	71	5	0	1957	4349	848	1506
31	1	3	0	0	0	339	1731	95	352
32	4	33	35	0	0	3420	11165	539	1228

South Fork Salmon
Estimate Fish Densities

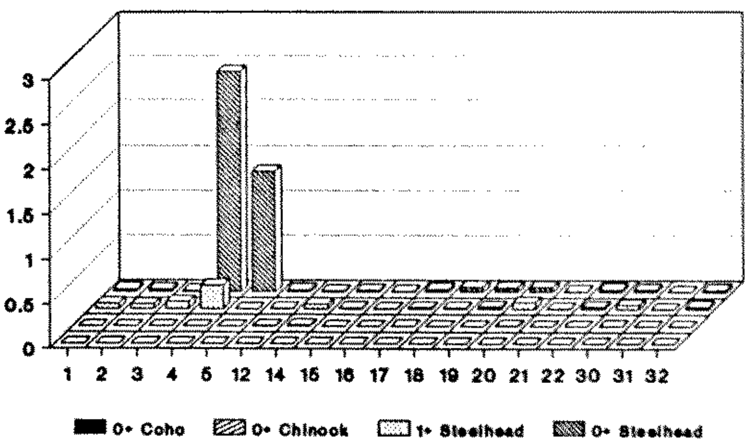
	Area				Volume			
HABITAT	0+ STHD	1+ STHD	0+ KING	0+ COHO	0+ STHD	1+ STHD	0+ KING	0+ COHO
1	0.077	0.065	0.004	0.000	0.209	0.176	0.010	0.000
2	0.076	0.054	0.002	0.001	0.162	0.114	0.005	0.001
3	0.042	0.083	0.000	0.000	0.106	0.213	0.000	0.000
4	2.455	0.269	0.000	0.000	4.077	0.446	0.000	0.000
5	1.344	0.000	0.000	0.000	5.580	0.000	0.000	0.000
12	0.028	0.007	0.005	0.000	0.030	0.007	0.005	0.000
14	0.017	0.059	0.016	0.000	0.039	0.137	0.037	0.000
15	0.030	0.014	0.000	0.000	0.074	0.034	0.000	0.000
16	0.016	0.008	0.002	0.000	0.033	0.017	0.004	0.000
17	0.034	0.016	0.003	0.000	0.044	0.021	0.004	0.000
18	0.062	0.013	0.000	0.000	0.131	0.028	0.000	0.000
19	0.051	0.022	0.000	0.000	0.082	0.036	0.000	0.000
20	0.060	0.063	0.007	0.000	0.043	0.045	0.005	0.000
21	0.016	0.008	0.000	0.000	0.034	0.018	0.000	0.000
22	0.034	0.021	0.000	0.000	0.041	0.026	0.000	0.000
30	0.030	0.047	0.003	0.000	0.054	0.084	0.006	0.000
31	0.007	0.000	0.000	0.000	0.026	0.000	0.000	0.000
32	0.026	0.028	0.000	0.000	0.060	0.065	0.000	0.000

Estimated Fish Densities
South Fork Salmon River



Fish Per Cu. M.

Estimated Fish Densities
South Fork Salmon River



Fish Per Sq. M.

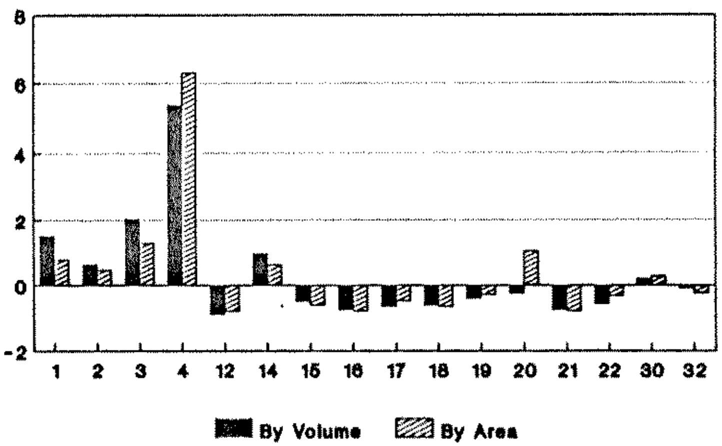
South Fork Salmon River
Utilization Coefficients

HABITAT	Area 0+ STHD	1+ STHD	0+ KING	0+ COHO	Volume 0+ STHD	1+ STHD	0+ KING	0+ COHO
1	0.53	0.84	0.54		1.17	1.61	1.18	
2	0.50	0.51	0.01	9.64	0.68	0.69	0.13	10.92
3	-0.18	1.35			0.10	2.15		
4	47.56	6.59			41.29	5.61		
5	25.58				56.87			
12	-0.45	-0.80	0.89		-0.69	-0.89	0.06	
14	-0.67	0.67	5.56		-0.59	1.03	7.00	
15	-0.40	-0.60			-0.23	-0.49		
16	-0.69	-0.78	-0.14		-0.65	-0.75	-0.04	
17	-0.32	-0.54	0.18	0.83	-0.54	-0.69	-0.21	0.23
18	0.23	-0.63			0.36	-0.59		
19	0.02	-0.37			-0.14	-0.47		
20	0.19	0.77	1.92		-0.56	-0.34	0.09	
21	-0.69	-0.77			-0.65	-0.74		
22	-0.33	-0.40			-0.58	-0.62		
30	-0.40	0.33	0.37		-0.44	0.24	0.27	
31	-0.86				-0.73			
32	-0.48	-0.19			-0.37	-0.04		

South Fork Salmon River
Estimated Standing Crop

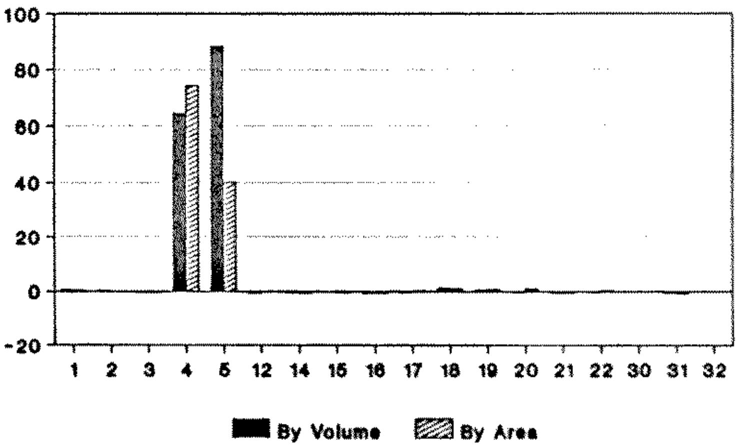
HABITAT	Area 0+ STHD	1+ STHD	0+ KING	0+ COHO	Volume 0+ STHD	1+ STHD	0+ KING	0+ COHO
1	6106	5142	296	0	5789	4875	280	0
2	978	692	32	8	858	607	28	7
3	80	161	0	0	66	132	0	0
4	329	36	0	0	329	36	0	0
5	35	0	0	0	35	0	0	0
12	54	13	9	0	55	14	9	0
14	50	174	47	0	69	242	65	0
15	1072	496	0	0	1111	513	0	0
16	339	170	45	0	299	149	40	0
17	569	271	47	2	604	288	50	2
18	3	1	0	0	3	1	0	0
19	10	4	0	0	11	5	0	0
20	480	499	57	0	311	324	37	0
21	65	33	0	0	63	33	0	0
22	272	171	0	0	296	187	0	0
30	131	205	14	0	105	164	12	0
31	12	0	0	0	9	0	0	0
32	295	318	0	0	206	222	0	0
TOTAL	10880	8387	547	10	10219	7790	521	9

Utilization Coefficients
1+ Steelhead



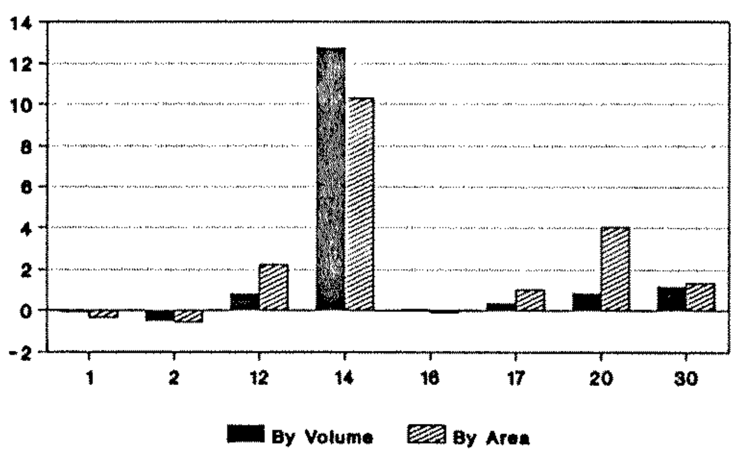
South Fork Salmon River

Utilization Coefficients
0+ Steelhead



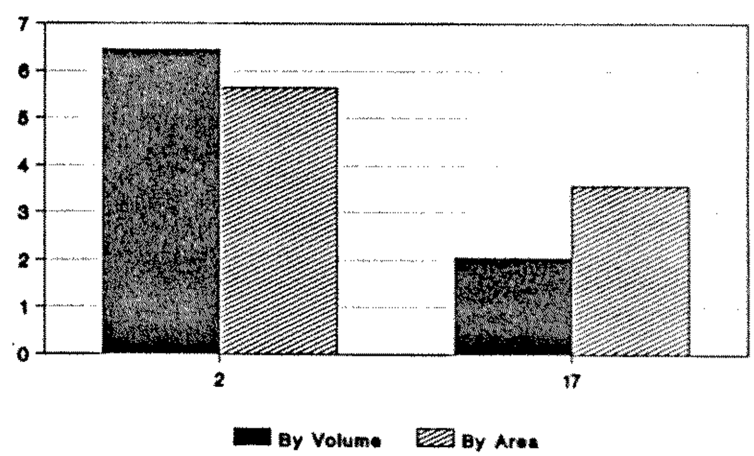
South Fork Salmon River

Utilization Coefficients
0+ Chinook



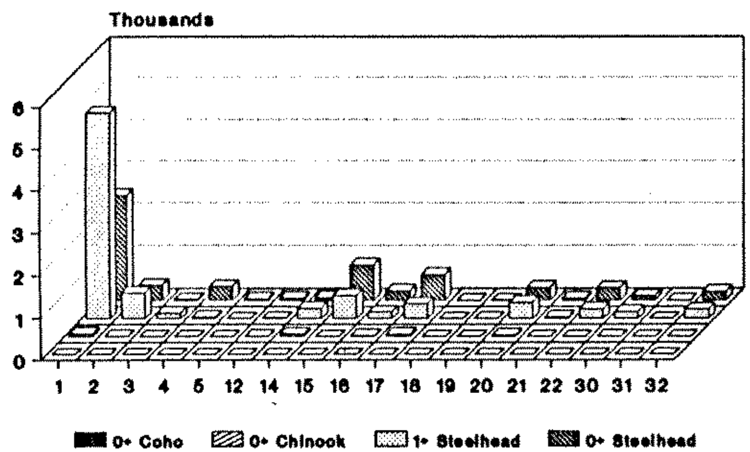
South Fork Salmon River

Utilization Coefficients
0+ Coho



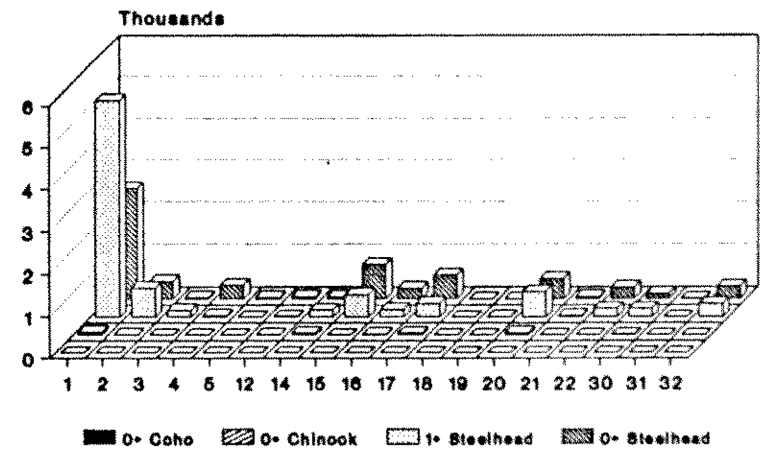
South Fork Salmon River

Estimated Standing Crop
South Fork Salmon River



Derived From Fish Per Cu. M.

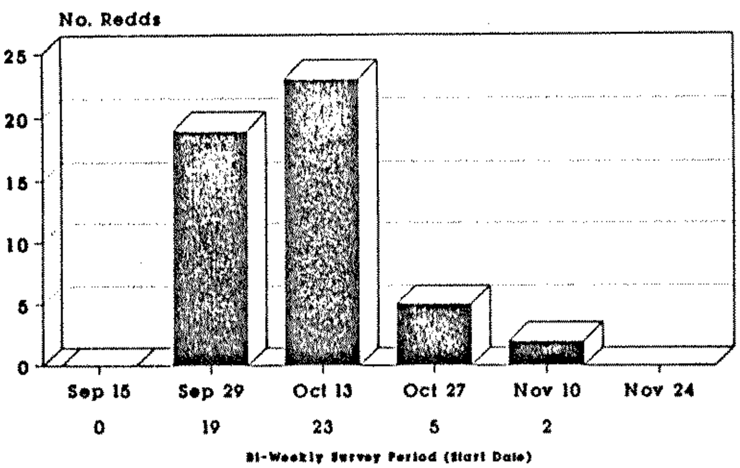
Estimated Standing Crop
South Fork Salmon River



Derived From Fish Per Sq. M.

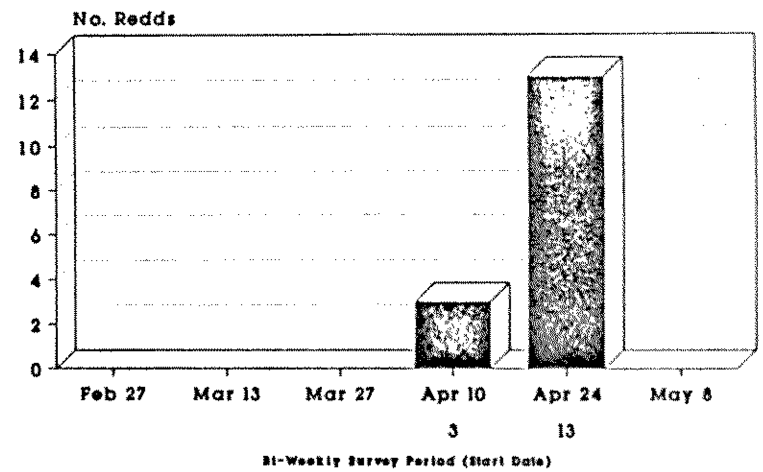
APPENDIX D. HABITAT CONDITION AND USE - NORTH FORK SALMON RIVER

Spawning Period
Chinook



North Fork Salmon River 1988

Spawning Period
Steelhead



North Fork Salmon River 1989

Relationship between spawning and rearing habitat for steelhead in North Fork Salmon River, 1989.

Parameter	Numbers
Steelhead spawning area/pair	1.5 m^2
Steelhead spawning area in study area	7764 m^2
Redds accom. w/out superimposition	5176 redds
Total spawning population (1.5 males/female)	12940 spawners
Estimated 1+ steelhead standing crop	90072 juveniles
Estimated 2+ smolts (40% survival)	36029 smolts
Expected adult maiden return (5%)	1801 adults
Estimated maiden redds @ 2.5 fish/redd	720 maiden redds
Est. total redds (60% maiden;40% repeat)	1201 total redds

<u>CONCLUSION:</u> <u>Present spawning area is adequate to seed the rearing habitat available in the study area under 1989 conditions.</u>

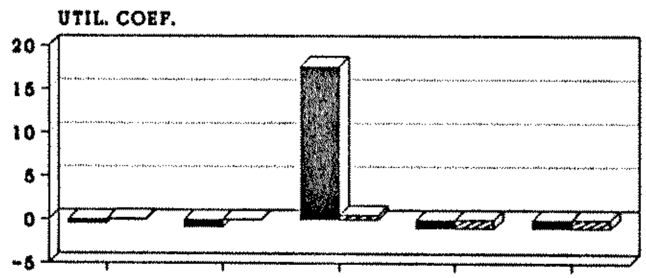
North Fork Salmon River
Spawning Ground Utilization

	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	DEFL/PCKT	TOTAL
Spawning Area m^2	2316	4829	314	22	283			7764
Percent Spawning Area	30	62	4	0	4	0	0	
Chinook Redds	8	4	37	0	0	0	0	49
Steelhead Redds	5	10	1	0	0	0	0	16
Chinook Redd Density	0.0035	0.0008	0.1177	0	0			0.0063
Steelhead Redd Density	0.0022	0.0021	0.0032	0	0			0.0021

Utilization Coefficients

	GLIDES	RUNS	LGR	HGR	STEP-RUN
Chinook Util Coef	-0.4526	-0.8688	17.6479	-1.0000	-1.0000
Steelhead Util Coef	0.0477	0.0048	0.5435	-1.0000	-1.0000

Spawner Utilization
North Fork Salmon River 1988-89

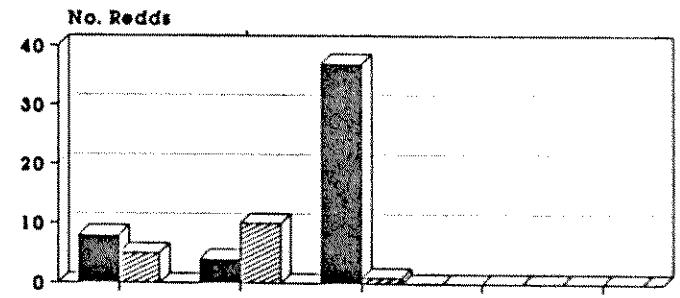


	GLIDES	RUNS	LGR	HGR	STEP-RUN
CHINOOK	-0.453	-0.869	17.648	-1	-1
STEELHEAD	0.048	0.005	0.543	-1	-1

SPAWNING HABITATS

CHINOOK STEELHEAD

Redds by Habitat Type
North Fork Salmon River 1988-89



	GLIDES	RUNS	LGR	HGR	STEP-RUN
Chinook	8	4	37	0	0
Steelhead	5	10	1	0	0

Chinook Steelhead

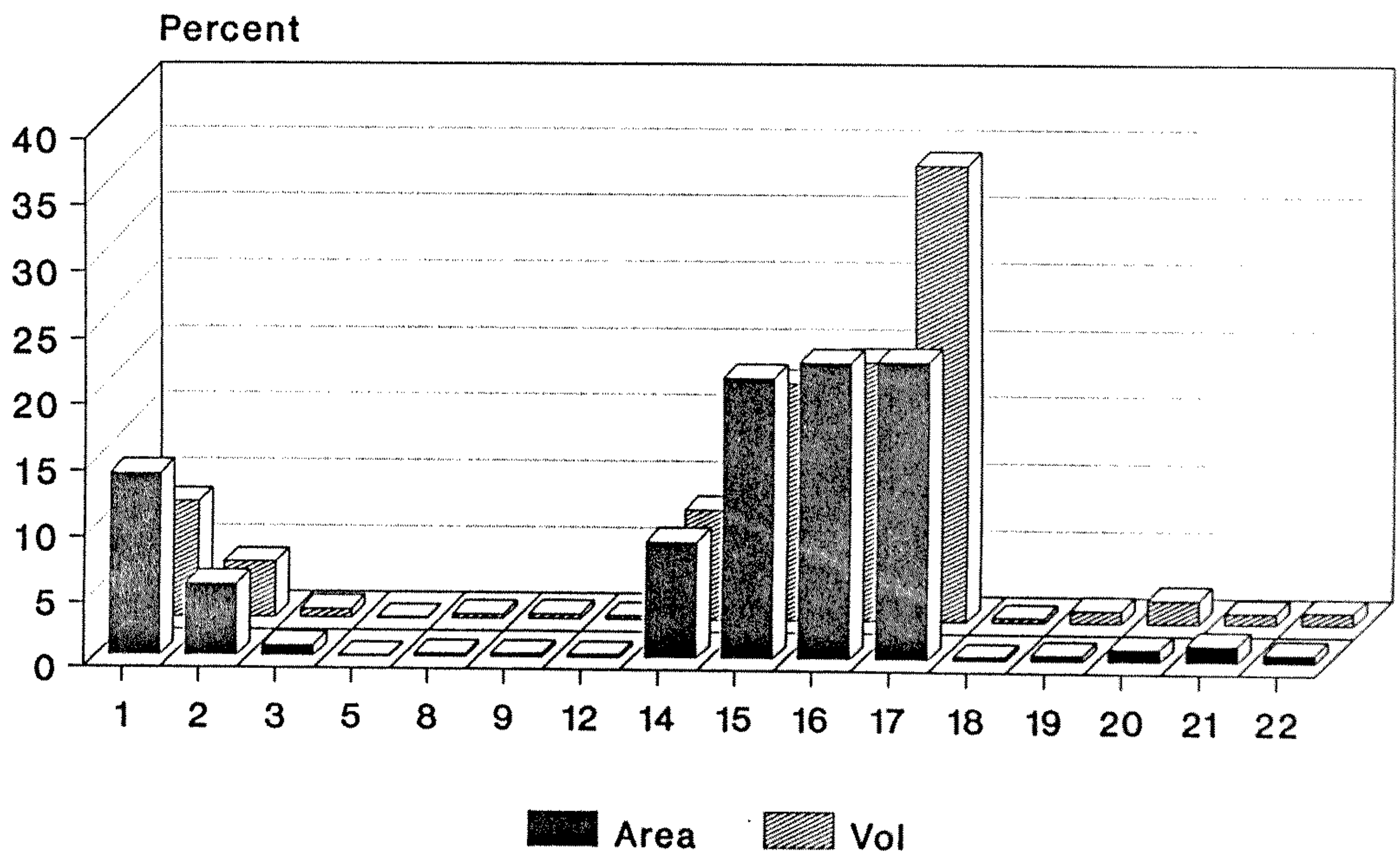
North Fork Salmon River
Physical Data Summary

HABITAT TYPE	NO. UNITS	LENGTH m	AREA m^2	VOLUME m^3	AVG LENGTH m	AVG WIDTH m	AVG DEPTH m	AVG VOLUME m^3	STREAM AREA %	STREAM VOL %	EMBEDD %	FINES %	GRAVEL %	COBBLE %	BOULDER %	BEDROCK %	SPAWN AREA m^2
1	81	2909	30015	10899	35.9	10.0	0.36	134.56	14	9	2.8	6	17	34	42	1	314
2	47	1245	11981	5297	26.5	8.9	0.42	112.69	6	4	2.4	3	10	31	46	11	22
3	15	247	1828	837	16.4	7.2	0.43	55.81	1	1	3.3	3	14	31	40	11	0
5	3	34	128	93	11.2	3.1	0.54	31.02	0	0	55.7	49	20	5	10	17	2
8	3	71	525	437	23.5	6.9	0.92	145.57	0	0	18.7	10	15	15	15	45	26
9	5	71	605	510	14.2	7.9	0.92	102.01	0	0	3.1	8	10	20	60	2	6
12	3	48	507	356	15.9	10.3	0.64	118.74	0	0	0.0		10	10	70	10	6
14	41	1480	19302	10329	36.1	12.4	0.52	251.93	9	8	2.5	18	23	27	23	9	1839
15	99	3916	45979	22119	39.6	10.5	0.58	223.42	21	18	4.1	17	25	28	26	4	4624
16	74	4080	48506	24189	55.1	10.7	0.47	326.88	22	20	3.4	8	13	25	40	14	283
17	87	3670	48698	42419	42.2	11.4	1.03	493.25	23	34	6.7	33	16	16	18	17	440
18	4	69	566	455	17.3	8.5	0.80	113.73	0	0	8.3	5	25	40	25	5	1
19	3	80	1019	1251	26.7	12.2	1.23	417.06	0	1	0.0	20			10	70	0
20	11	222	2188	2268	20.2	8.6	1.00	206.14	1	2	8.4	20	9	17	40	14	7
21	6	231	2857	1085	38.5	11.8	0.41	180.88	1	1	0.9	3	10	40	47		198
22	7	170	1416	1212	24.2	8.4	1.76	173.07	1	1	15.4	20	12	25	37	5	33

North Fork Salmon River
Cover Data Summary

HABITAT	NO. UNITS	COVER %	UNDERCUT %	SWD %	LWD %	TERR_VEG %	WT_WATER %	BOULDERS %	BDRK_LEDG %	SHADE %
1	81	24		0	0	5	22	71	2	3
2	47	38		2	3	2	38	53	1	3
3	15	37		1	1		52	45	1	5
5	3	10						21	79	45
8	3	20					8	80	12	0
9	5	24					30	60	11	0
12	3	10				4	5	77	14	2
14	41	11	0	2	6	11	1	53	27	2
15	99	17		2	3	12	3	74	7	3
16	74	26		1	1	6	13	68	12	2
17	87	11		1	1	3	1	26	68	1
18	4	12				8		33	59	3
19	3	28				13	9	52	26	0
20	11	12				1	3	21	76	2
21	6	39				5	30	64	1	2
22	7	9			0	10	6	66	17	31

Habitat Distribution
North Fork Salmon River



North Fork Salmon River
Biological Data Summary

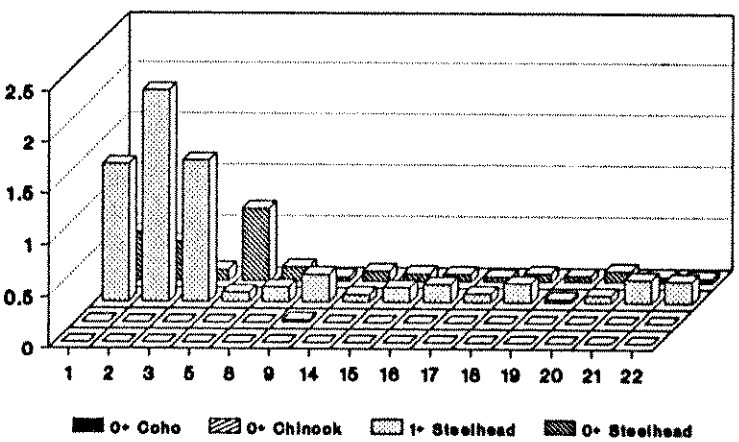
Observed Fish by Habitat Type

HABITAT	# UNITS	0+ STHD	1+ STHD	0+ KING	0+ COHO	TOTAL VOLUME m^3	TOTAL AREA m^2	OBSERVED VOLUME m^3	OBSERVED AREA m^2
1	19	1342	1600	12	0	10899	30015	1711	4807
2	11	420	958	0	2	5297	11981	1273	1859
3	4	28	146	0	0	837	1828	213	426
5	2	58	8	0	0	93	128	72	82
8	1	23	23	0	0	437	525	148	164
9	2	7	39	4	0	510	605	101	147
14	10	332	245	2	0	10329	19302	1704	3336
15	23	787	986	3	0	22118	45979	4669	11874
16	17	602	982	3	0	24189	48506	4916	9573
17	22	545	888	3	8	42419	48698	8705	10543
18	1	16	35	0	0	455	566	136	189
19	1	22	12	0	0	1251	1019	610	338
20	2	48	32	0	0	2268	2188	382	449
21	1	26	70	0	0	1085	2857	237	525
22	2	18	91	0	0	1211	1416	215	429

Fish Densities

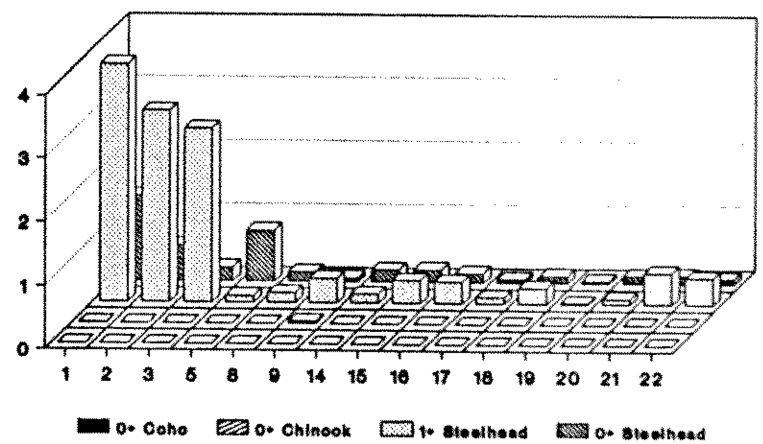
	Area				Volume			
HABITAT	0+ STHD	1+ STHD	0+ KING	0+ COHO	0+ STHD	1+ STHD	0+ KING	0+ COHO
1	0.279	0.333	0.002	0.000	0.784	0.935	0.007	0.000
2	0.226	0.515	0.000	0.001	0.330	0.753	0.000	0.002
3	0.066	0.343	0.000	0.000	0.131	0.684	0.000	0.000
5	0.703	0.092	0.000	0.000	0.798	0.104	0.000	0.000
8	0.141	0.141	0.000	0.000	0.156	0.156	0.000	0.000
9	0.047	0.265	0.027	0.000	0.069	0.385	0.039	0.000
14	0.100	0.073	0.001	0.000	0.195	0.144	0.001	0.000
15	0.066	0.083	0.000	0.000	0.169	0.211	0.001	0.000
16	0.063	0.103	0.000	0.000	0.122	0.200	0.001	0.000
17	0.052	0.084	0.000	0.001	0.063	0.102	0.000	0.001
18	0.085	0.183	0.000	0.000	0.117	0.253	0.000	0.000
19	0.064	0.034	0.000	0.000	0.035	0.019	0.000	0.000
20	0.106	0.071	0.000	0.000	0.124	0.084	0.000	0.000
21	0.050	0.133	0.000	0.000	0.111	0.294	0.000	0.000
22	0.042	0.212	0.000	0.000	0.084	0.423	0.000	0.000

Estimated Fish Densities
North Fork Salmon River



Fish Per Cu. M.

Estimated Fish Densities
North Fork Salmon River



Fish Per Sq. M.

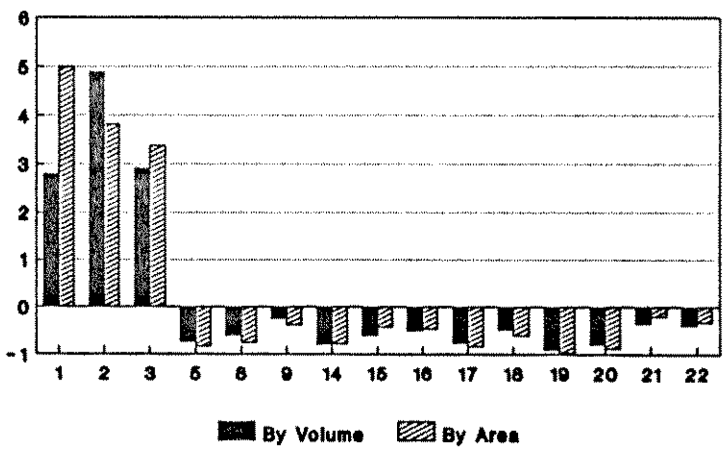
North Fork Salmon River
Utilization Coefficients

HABITAT	Area 0+ STHD	1+ STHD	0+ KING	0+ COHO	Volume 0+ STHD	1+ STHD	0+ KING	0+ COHO
1	1.92	1.44	3.08		3.61	2.84	5.42	
2	1.37	2.77		3.81	0.94	2.09		2.94
3	-0.31	1.51			-0.23	1.81		
5	6.36	-0.33			3.69	-0.57		
8	0.47	0.03			-0.09	-0.36		
9	-0.50	0.94	43.31		-0.59	0.58	35.14	
14	0.04	-0.46	-0.02		0.14	-0.41	0.07	
15	-0.31	-0.39	-0.56		-0.01	-0.13	-0.37	
16	-0.34	-0.25	-0.45		-0.28	-0.18	-0.40	
17	-0.46	-0.38	-0.54	2.39	-0.63	-0.58	-0.68	1.31
18	-0.11	0.34			-0.31	0.04		
19	-0.33	-0.75			-0.79	-0.92		
20	0.11	-0.48			-0.27	-0.66		
21	-0.47	-0.03			-0.35	0.21		
22	-0.56	0.55			-0.51	0.73		

Estimated Standing Crop

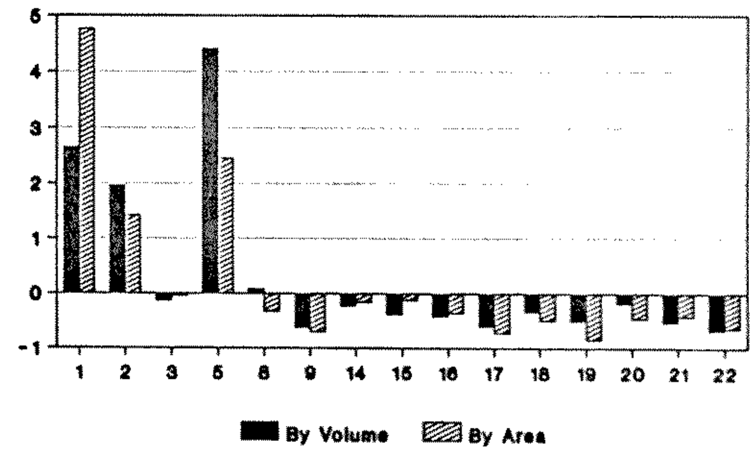
HABITAT	Area 0+ STHD	1+ STHD	0+ KING	0+ COHO	Volume 0+ STHD	1+ STHD	0+ KING	0+ COHO
1	8379	9990	75	0	8548	10192	76	0
2	2707	6175	0	13	1748	3987	0	8
3	120	626	0	0	110	573	0	0
5	90	12	0	0	74	10	0	0
8	74	74	0	0	68	68	0	0
9	29	160	16	0	35	196	20	0
14	1921	1417	12	0	2012	1485	12	0
15	3048	3820	12	0	3729	4673	15	0
16	3048	4978	16	0	2960	4834	16	0
17	2515	4099	14	37	2653	4325	15	39
18	48	103	0	0	53	115	0	0
19	65	35	0	0	44	24	0	0
20	231	156	0	0	282	190	0	0
21	144	379	0	0	121	319	0	0
22	59	300	0	0	101	512	0	0
TOTAL	22478	32323	145	50	22540	31500	154	47

Utilization Coefficients
1+ Steelhead



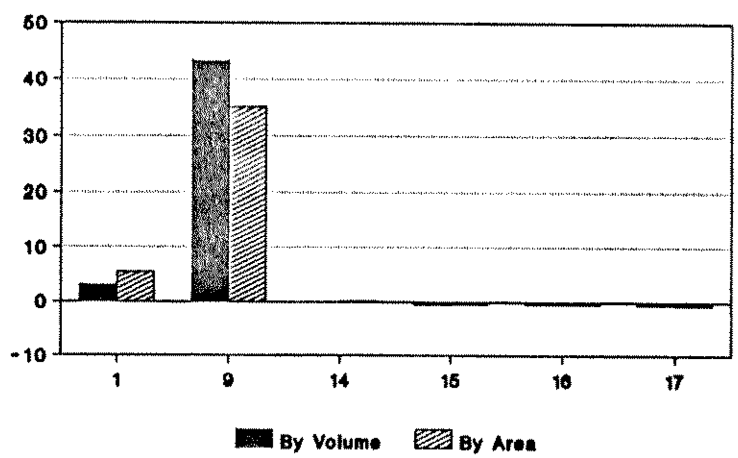
North Fork Salmon River

Utilization Coefficients
0+ Steelhead



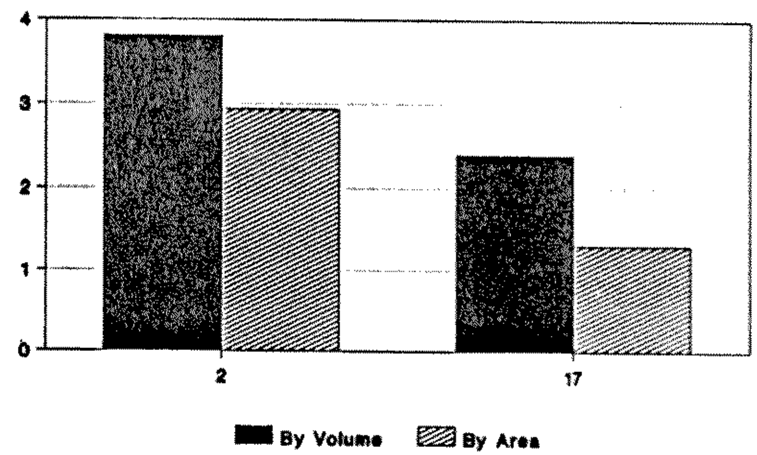
North Fork Salmon River

Utilization Coefficients
0+ Chinook



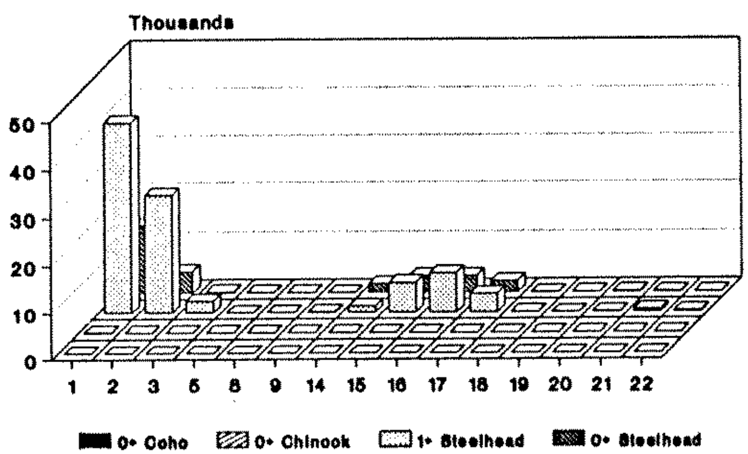
North Fork Salmon River

Utilization Coefficients
0+ Coho



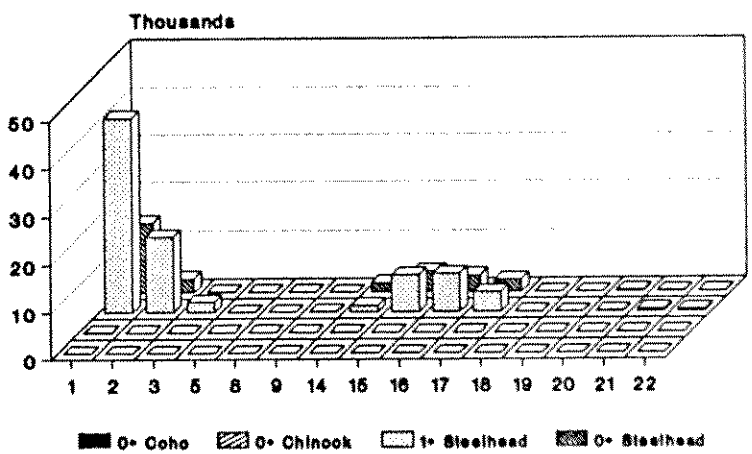
North Fork Salmon River

Estimated Standing Crop
North Fork Salmon River



Derived From Fish Per Cu. M.

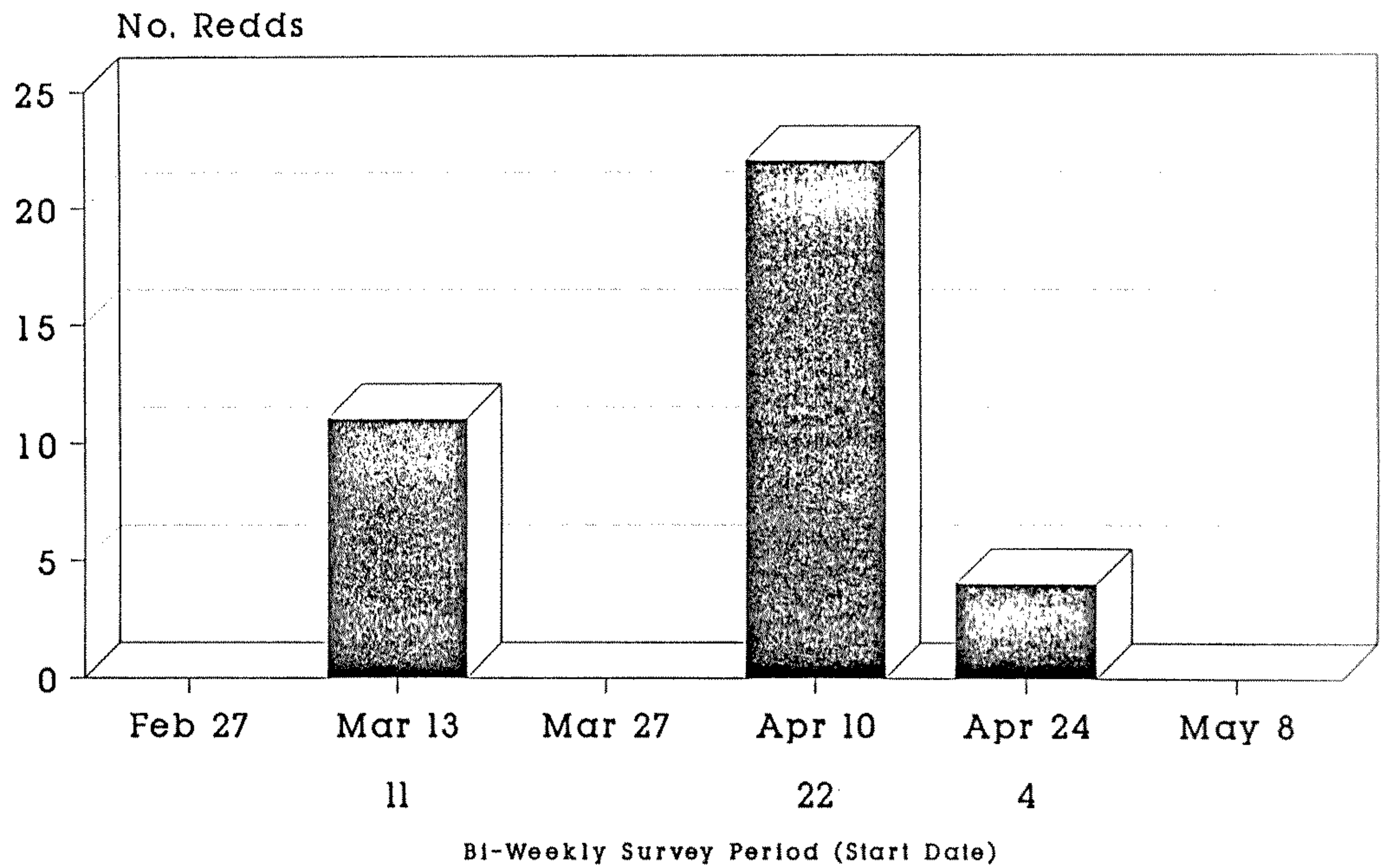
Estimated Standing Crop
North Fork Salmon River



Derived From Fish Per Sq. M.

APPENDIX E. HABITAT CONDITION AND USE - NORDHEIMER CREEK

Spawning Period
Steelhead



Nordheimer Creek 1989

Relationship between spawning and rearing habitat for steelhead in Nordheimer Creek, 1989.

Parameter	Numbers
Steelhead spawning area/pair	1.5 m^2
Steelhead spawning area in study area	634 m^2
Redds accom. w/out superimposition	423 redds
Total spawning population (1.5 males/female)	1057 spawners
Estimated 1+ steelhead standing crop	3049 juveniles
Estimated 2+ smolts (40% survival)	1220 smolts
Expected adult maiden return (5%)	61 adults
Estimated maiden redds @ 2.5 fish/redd	24 maiden redds
Est. total redds (60% maiden;40% repeat)	40 total redds

<u>CONCLUSION:</u> <u>Present spawning area is adequate to seed the rearing habitat available in the study area under 1989 conditions.</u>

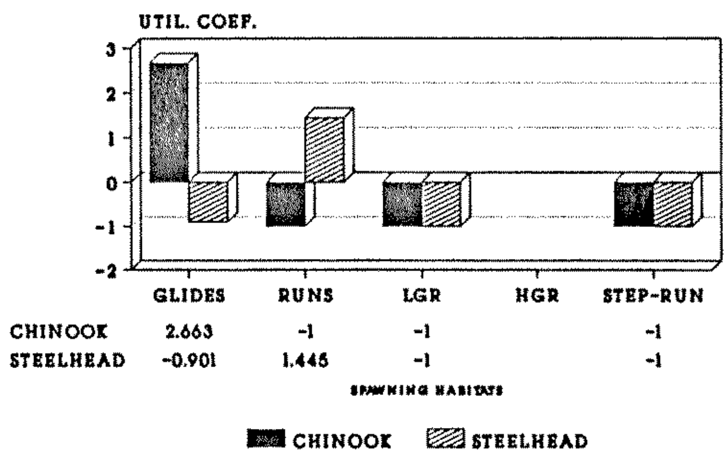
Nordheimer Creek
Spawning Ground Utilization

	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	DEFL/PCKT	TOTAL
Spawning Area m^2	173	245	70	0	145			634
Percent Spawning Area	27	39	11	0	23	0	0	
Chinook Redds	1	0	0	0	0	0	0	1
Steelhead Redds	1	35	0	1	0	0	0	37
Chinook Redd Density	0.0058	0	0		0			0.0016
Steelhead Redd Density	0.0058	0.1427	0		0			0.0583

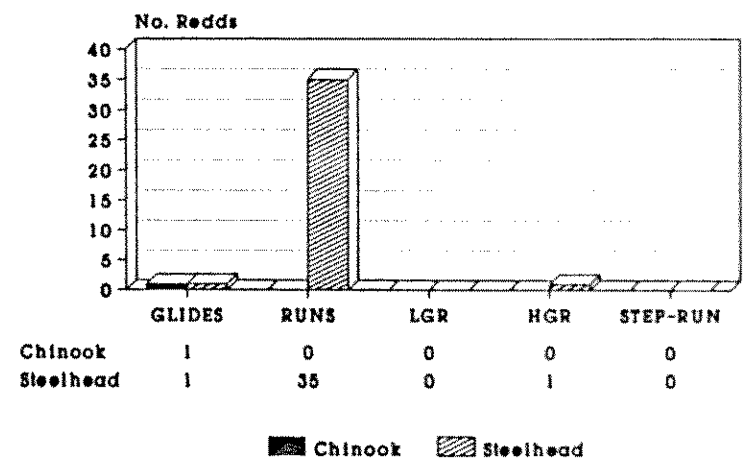
Uitilization Coefficients

	GLIDES	RUNS	LGR	HGR	STEP-RUN
Chinook Util Coef	2.6626	-1	-1		-1
Steelhead Util Coef	-0.9010	1.4453	-1		-1

Spawner Utilization
Nordheimer Creek 1988-89



Redds by Habitat Type
Nordheimer Creek 1988-89



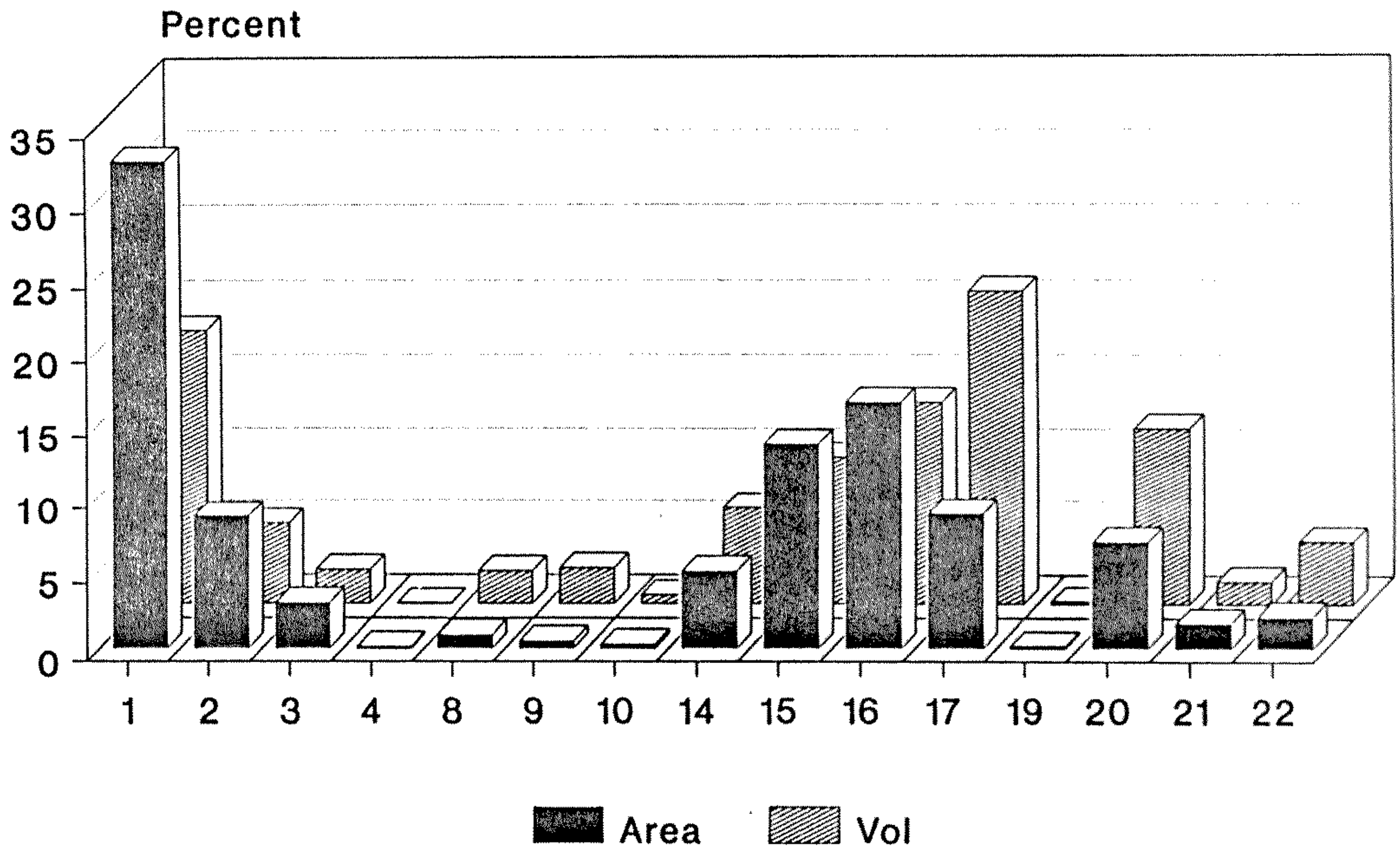
Nordheimer Creek
Physical Data Summary

HABITAT TYPE	NO. UNITS	LENGTH m	AREA m^2	VOLUME m^3	AVG LENGTH m	AVG WIDTH m	AVG DEPTH m	AVG VOLUME m^3	STREAM AREA %	STREAM VOL %	EMBEDD %	FINES %	GRAVEL %	COBBLE %	BOULDER %	BEDROCK %	SPAWN AREA m^2
1	99	2302	16976	4566	23.2	6.8	0.28	46.12	33	19	6.3	11	17	38	31	2	70
2	41	597	4476	1310	14.6	7.1	0.29	31.95	9	5	3.2	6	15	35	34	9	0
3	26	327	1478	544	12.6	4.2	0.30	20.93	3	2	4.0		4	9	66	21	2
4	2	18	39	7	8.8	2.1	0.18	3.51	0	0	26.8	10	10	50	30		0
8	7	108	445	529	15.4	4.0	1.04	75.51	1	2	13.5	12	13	34	20	21	1
9	2	32	232	576	16.2	6.9	2.09	287.74	0	2	14.5	30	20	20		30	1
10	1	22	132	139	21.7	6.1	1.07	139.16	0	1	15.0	20	30	25		25	0
14	24	452	2571	1586	18.8	5.7	0.61	66.08	5	6	7.1	15	31	22	15	16	91
15	61	1022	7115	2458	16.8	6.0	0.39	40.30	14	10	7.3	20	26	34	11	8	141
16	37	1368	8571	3363	37.0	6.5	0.41	90.90	16	14	2.7	7	25	32	26	9	145
17	36	685	4594	5220	19.0	6.5	1.06	145.01	9	21	11.2	22	16	18	18	27	73
19	1	11	52	39	11.3	4.6	0.76	38.85	0	0	15.0	5	25	20	30	20	1
20	28	528	3591	2943	18.9	6.3	0.77	105.10	7	12	14.2	17	29	18	13	23	103
21	9	129	816	368	14.3	6.5	0.45	40.89	2	1	3.6	1	10	18	58	14	1
22	9	179	1034	1018	19.9	5.7	0.96	113.14	2	4	19.8	13	26	19	17	25	8

Nordheimer Creek
Cover Data Summary

HABITAT	NO. UNITS	COVER %	UNDERCUT %	SWD %	LWD %	TERR_VEG %	WT_WATER %	BOULDERS %	BDRK_LEDG %	SHADE %
1	99	38	0	6	3	9	32	50	1	11
2	41	57		3	2	2	41	51	1	9
3	26	69		1	2	0	57	37	3	7
4	2	37		2		13		85		44
8	7	19					14	41	45	0
9	2	22			4		46	31	19	14
10	1	30		40	40				20	20
14	24	16			0	2	4	76	18	6
15	61	19		9	0	9	14	55	12	9
16	37	30	0	3	1	3	32	56	4	6
17	36	19	1	9	7	6	11	39	27	8
19	1	20					25	40	35	35
20	28	17		4		7	7	37	45	8
21	9	45		1	1		34	59	6	16
22	9	31		9	9		11	30	42	12

Habitat Distribution
Nordheimer Creek



Nordheimer Creek
Biological Data Summary

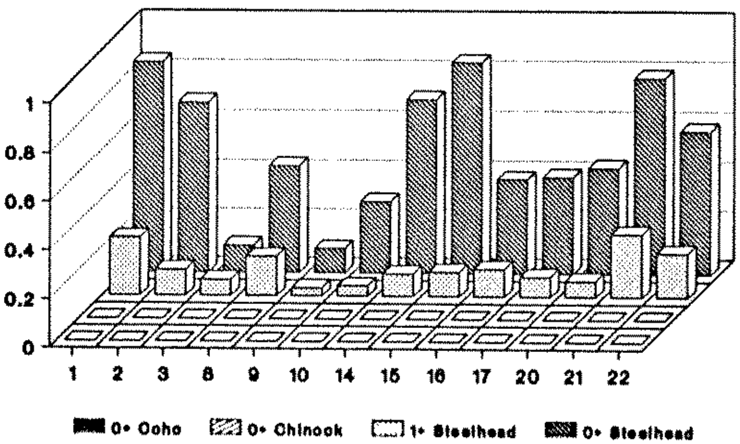
Observed Fish by Habitat Type

HABITAT	# UNITS	0+ STHD	1+ STHD	0+ KING	0+ COHO	TOTAL VOLUME m^3	TOTAL AREA m^2	OBSERVED VOLUME m^3	OBSERVED AREA m^2
1	19	2396	284	0	0	4566	16976	1192	4390
2	7	244	16	0	0	1310	4476	150	733
3	2	8	2	0	0	544	1478	30	79
8	1	32	12	0	0	529	445	72	119
9	1	51	14	0	0	575	232	504	167
10	1	41	5	0	0	139	132	139	132
14	4	220	29	0	0	1586	2571	310	410
15	11	726	60	0	0	2458	7114	637	2400
16	4	206	42	0	0	3363	8571	398	783
17	7	480	83	0	0	5220	4594	1210	1007
20	6	323	41	0	0	2943	3591	743	880
21	1	28	6	0	0	368	816	26	63
22	2	88	23	0	0	1018	1034	150	216

Fish Densities

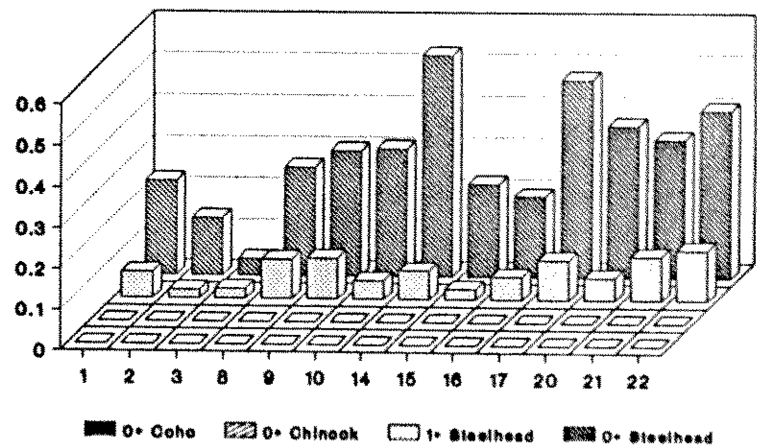
	Area				Volume			
HABITAT	0+ STHD	1+ STHD	0+ KING	0+ COHO	0+ STHD	1+ STHD	0+ KING	0+ COHO
1	0.546	0.065	0.000	0.000	2.010	0.238	0.000	0.000
2	0.333	0.022	0.000	0.000	1.628	0.107	0.000	0.000
3	0.101	0.025	0.000	0.000	0.266	0.066	0.000	0.000
8	0.265	0.097	0.000	0.000	0.439	0.160	0.000	0.000
9	0.305	0.084	0.000	0.000	0.101	0.028	0.000	0.000
10	0.310	0.038	0.000	0.000	0.295	0.036	0.000	0.000
14	0.535	0.071	0.000	0.000	0.707	0.093	0.000	0.000
15	0.303	0.025	0.000	0.000	1.140	0.094	0.000	0.000
16	0.263	0.054	0.000	0.000	0.516	0.106	0.000	0.000
17	0.476	0.082	0.000	0.000	0.397	0.068	0.000	0.000
20	0.367	0.047	0.000	0.000	0.434	0.055	0.000	0.000
21	0.446	0.102	0.000	0.000	1.058	0.242	0.000	0.000
22	0.405	0.104	0.000	0.000	0.585	0.150	0.000	0.000

Estimated Fish Densities
Nordheimer Creek



Fish Per Cu. M.

Estimated Fish Densities
Nordheimer Creek



Fish Per Sq. M.

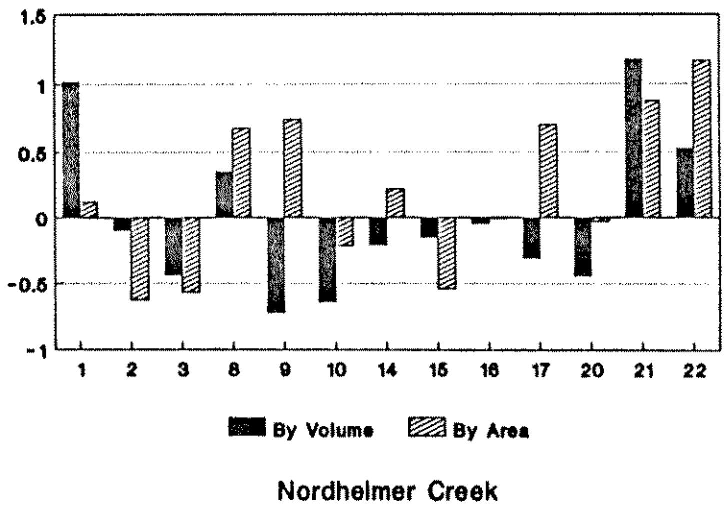
Nordhiemer Creek
Utilization Coefficients

HABITAT	Area 0+ STHD	1+ STHD	0+ KING	0+ COHO	Volume 0+ STHD	1+ STHD	0+ KING	0+ COHO
1	-0.01	-0.06			0.78	0.70		
2	-0.40	-0.68			0.44	-0.24		
3	-0.82	-0.63			-0.76	-0.53		
8	-0.52	0.41			-0.61	0.14		
9	-0.45	0.22			-0.91	-0.80		
10	-0.44	-0.45			-0.74	-0.74		
14	-0.03	0.03			-0.37	-0.33		
15	0.37	-0.09			1.52	0.68		
16	0.19	0.98			0.14	0.90		
17	-0.14	0.20			-0.65	-0.51		
20	-0.34	-0.32			-0.62	-0.61		
21	1.02	2.72			1.34	3.31		
22	-0.27	0.52			-0.48	0.07		

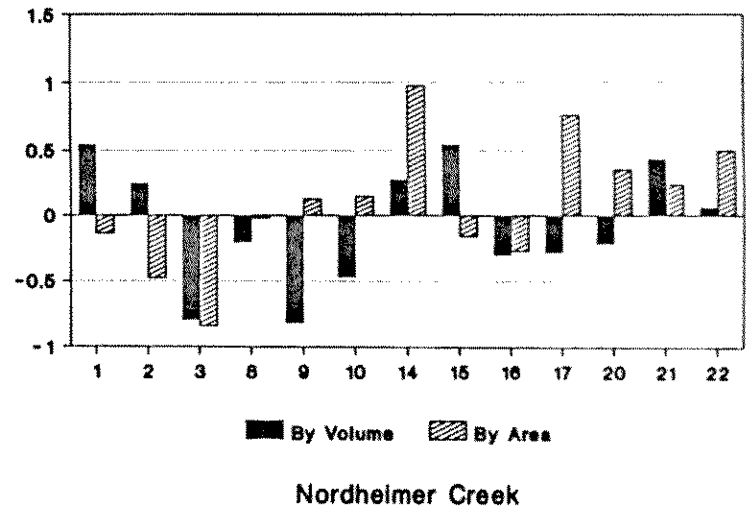
Estimated Standing Crop

HABITAT	Area 0+ STHD	1+ STHD	0+ KING	0+ COHO	Volume 0+ STHD	1+ STHD	0+ KING	0+ COHO
1	9266	1098	0	0	9178	1088	0	0
2	1490	98	0	0	2133	140	0	0
3	149	37	0	0	145	36	0	0
8	118	43	0	0	232	85	0	0
9	71	19	0	0	58	16	0	0
10	41	5	0	0	41	5	0	0
14	1375	182	0	0	1121	148	0	0
15	5383	445	0	0	7004	579	0	0
16	5628	1161	0	0	4341	895	0	0
17	2189	376	0	0	2071	356	0	0
20	1316	167	0	0	1277	162	0	0
21	909	208	0	0	974	223	0	0
22.	419	108	0	0	595	153	0	0
TOTAL	28353	3947	0	0	29170	3885	0	0

Utilization Coefficients
1+ Steelhead



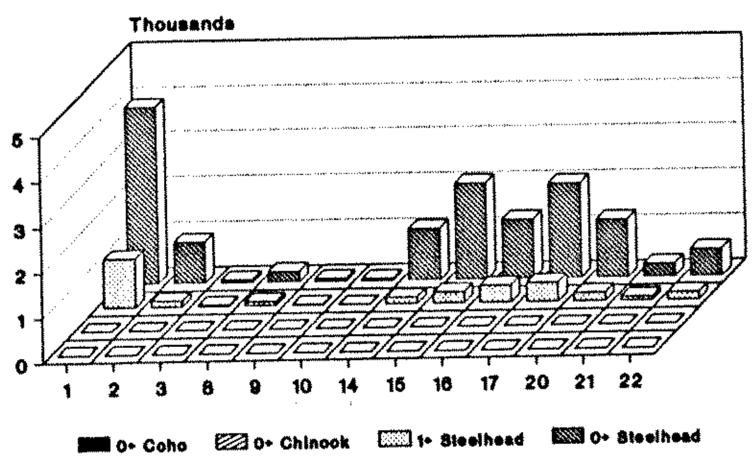
Utilization Coefficients
0+ Steelhead



0+ Chinook were not observed in this system.

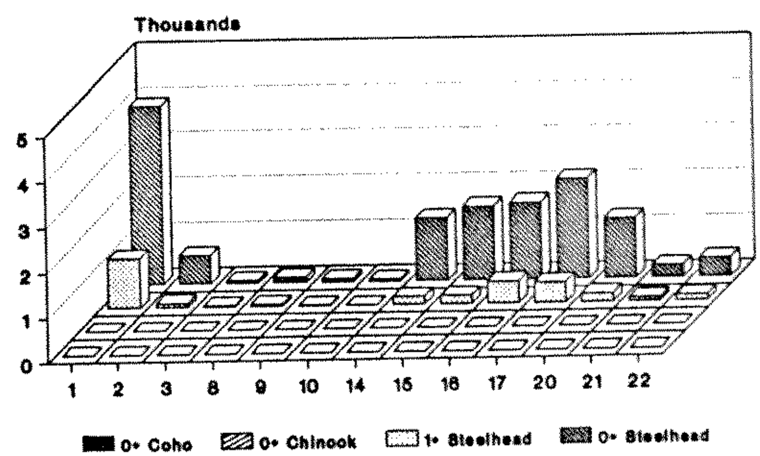
0+ Coho were not observed in this system.

Estimated Standing Crop
Nordheimer Creek



Derived From Fish Per Cu. M.

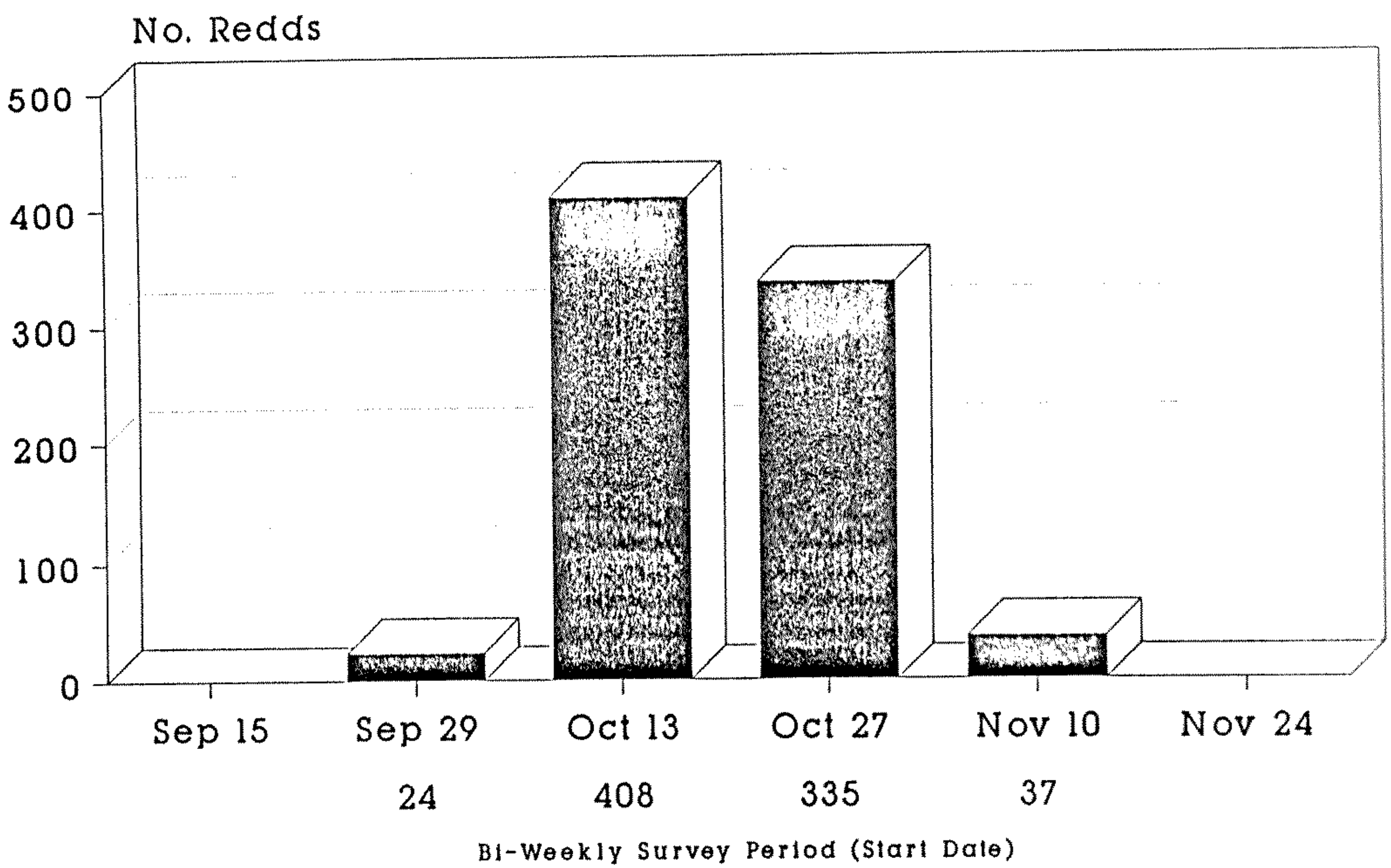
Estimated Standing Crop
Nordheimer Creek



Derived From Fish Per Sq. M.

APPENDIX F. HABITAT CONDITION AND USE - SCOTT RIVER

Spawning Period
Chinook



Scott River 1988

Relationship between spawning and rearing habitat for steelhead in Scott River, 1989.

Parameter	Numbers
Steelhead spawning area/pair	1.5 m^2
Steelhead spawning area in study area	6630 m^2
Redds accom. w/out superimposition	4420 redds
Total spawning population (1.5 males/female)	11050 spawners
Estimated 1+ steelhead standing crop	95489 juveniles
Estimated 2+ smolts (40% survival)	38196 smolts
Expected adult maiden return (5%)	1910 adults
Estimated maiden redds @ 2.5 fish/redd	764 maiden redds
Est. total redds (60% maiden;40% repeat)	1273 total redds

CONCLUSION: Present spawning area is not adequate to seed the rearing habitat available in the study area under 1989 conditions.

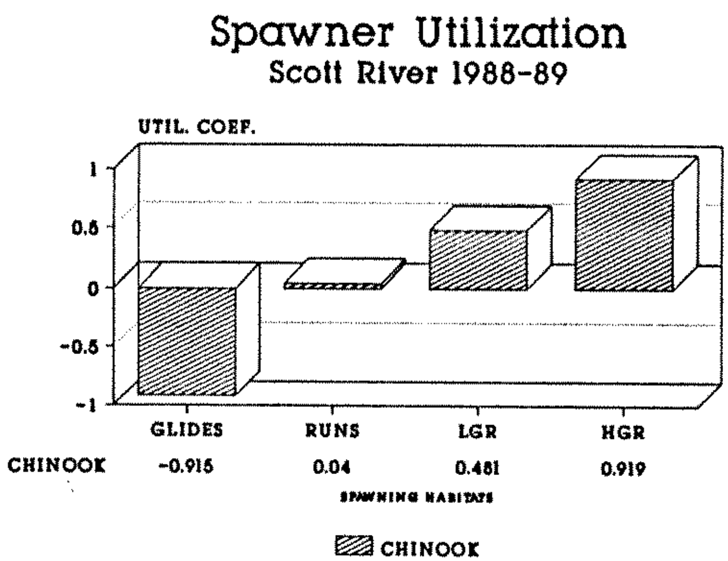
Scott River
Spawning Ground Utilization

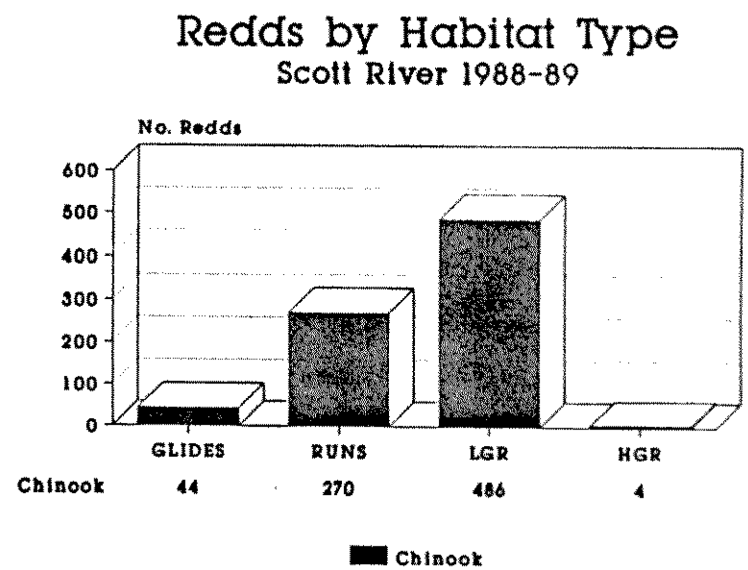
	GLIDES	RUNS	LGR	HGR	STEP-RUN	TOTAL
Spawning Area m^2	3854	1626	1020	8	122	6630
Percent Spawning Area	58	25	15	0	2	
Chinook Redds	44	270	486	4	0	804
Steelhead Redds[1]						
Chinook Redd Density	0.0114	0.1661	0.4764	0.4784	0	0.1213
Steelhead Redd Density[1]						

Utilization Coefficients

	GLIDES	RUNS	LGR	HGR	STEP-RUN
Chinook Util Coef	-0.9059	0.3696	2.9281	2.9449	-1
Steelhead Util Coef[1]					

[1] Due to high flows, no steelhead spawning data was collected.


Spawner Utilization
Scott River 1988-89
UTIL. COEF.
1
0.5
0
-0.5
-1
GLIDES
RUNS
LGR
HGR
CHINOOK
-0.915
0.04
0.481
0.919
SPAWNING HABITATS
CHINOOK


Redds by Habitat Type
Scott River 1988-89
No. Redds
600
500
400
300
200
100
0
GLIDES
RUNS
LGR
HGR
Chinook
44
270
486
4
Chinook

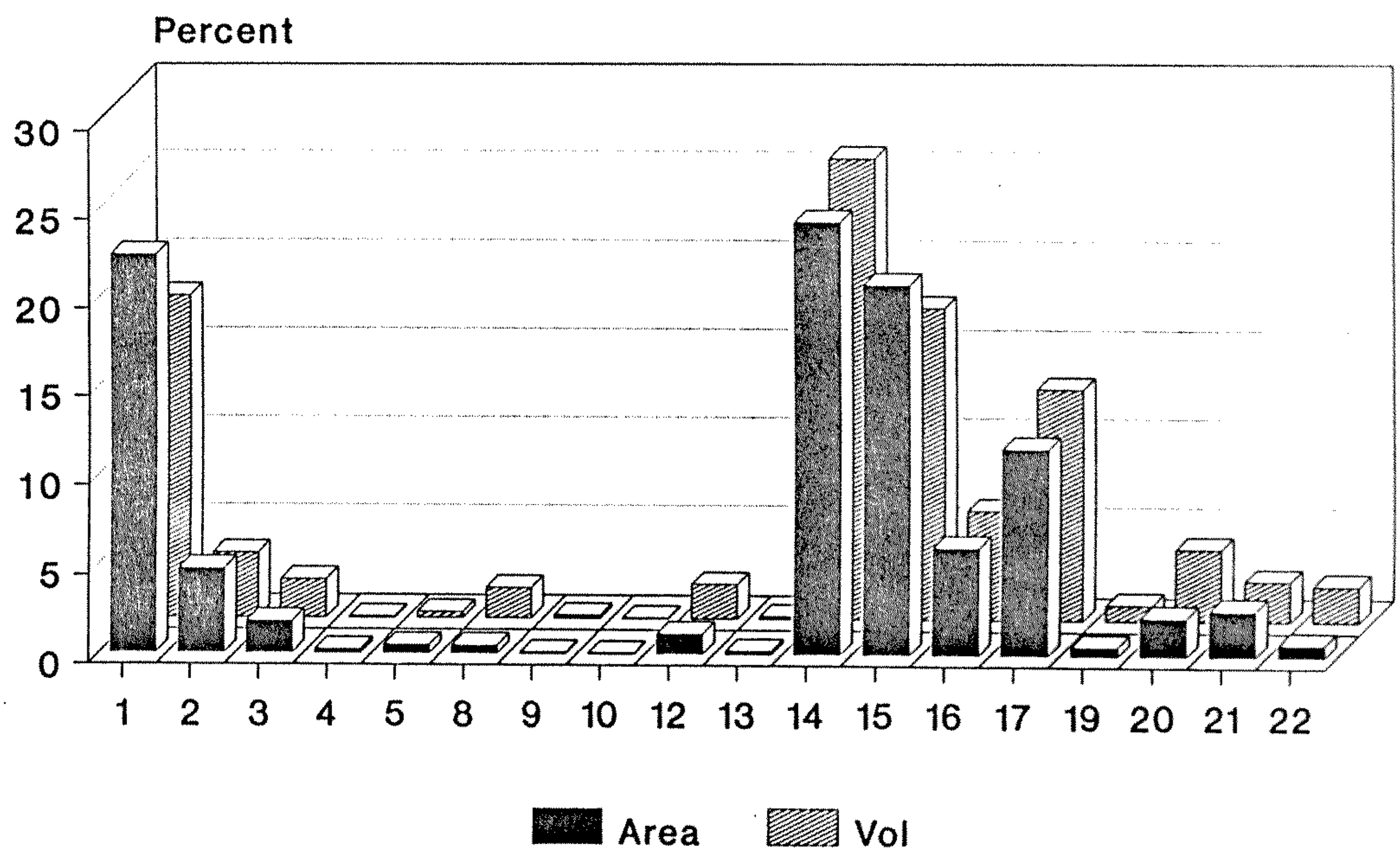
Scott River
Physical Data Summary

HABITAT TYPE	NO. UNITS	LENGTH m	AREA m^2	VOLUME m^3	AVG LENGTH m	AVG WIDTH m	AVG DEPTH m	AVG VOLUME m^3	STREAM AREA %	STREAM VOL %	EMBEDD %	FINES %	GRAVEL %	COBBLE %	BOULDER %	BEDROCK %	SPAWN AREA m^2
1	76	5672	131248	68107	74.6	21.5	0.52	896.15	22	18	19.6	16	9	24	45	6	1020
2	43	1698	27631	13596	39.5	16.2	0.59	316.19	5	4	20.3	9	5	29	50	7	8
3	19	669	10389	8127	35.2	13.6	0.68	451.50	2	2	10.6	12	7	11	49	21	0
4	4	92	1256	294	23.0	10.1	0.76	73.50	0	0	58.4	47	5		46	2	0
5	5	167	2739	1361	33.5	15.9	0.65	272.22	0	0	14.6	27	1	1	26	46	1
8	2	178	2718	6431	88.9	16.0	2.59	3215.52	0	2	50.3	40	5	20	15	20	0
9	1	23	424	651	23.2	18.3	1.56	651.17	0	0	95.0	75	5		10	10	4
10	1	34	286	173	33.6	8.5	0.61	172.48	0	0	30.0	10	20	40	30		14
12	9	384	6693	7314	42.7	15.7	2.27	812.67	1	2	2.4	21	9	10	50	11	318
13	1	55	1010	547	55.2	18.3	0.55	547.34	0	0							9
14	68	5463	142418	97368	80.3	23.9	0.75	1431.87	24	26	22.6	34	24	17	24	1	2845
15	93	5564	121534	65807	59.8	19.5	0.62	723.16	21	18	24.2	21	8	27	40	4	1269
16	41	2321	34959	22864	56.6	14.3	0.64	557.67	6	6	12.3	13	5	10	69	3	122
17	64	3357	67580	48722	52.5	19.2	0.98	812.03	12	13	18.9	35	8	14	30	13	771
19	5	215	3103	3398	43.0	14.1	1.06	679.61	1	1	15.4	32	8	6	43	12	153
20	9	636	12664	15090	70.7	19.2	1.20	1676.69	2	4	32.5	57	5	11	9	19	1
21	17	881	15103	8464	51.8	18.4	0.56	497.87	3	2	14.1	23	6	18	50	3	356
22	4	220	4021	7486	55.1	15.3	1.77	1871.48	1	2	16.3	15	9	10	55	10	84

Scott River
Cover Data Summary

HABITAT	NO. UNITS	COVER %	UNDERCUT %	SWD %	LWD %	TERR_VEG %	WT_WATER %	BOULDERS %	BDRK_LEDG %	SHADE %
1	76	38	0	0		4	26	63	6	1
2	43	49		1	0	1	36	56	7	1
3	19	82					52	37	11	0
4	4	13						78	22	0
5	5	39				6	30	31	34	0
8	2	17						21	79	0
9	1	50				10	60	30		5
10	1	5					50	50		10
12	9	9	0	0		1	3	87	8	0
13	1	40					30	70		
14	68	21	0	0		4		83	12	0
15	93	23	0	0		3	7	82	7	1
16	41	29				3	23	71	2	0
17	64	20				1	4	45	51	1
19	5	23				0	19	73	8	3
20	9	18		1		5	8	25	62	2
21	17	33		1		1	23	72	4	1
22	4	16				10	1	61	28	0

Habitat Distribution
Scott River



Scott River
Biological Data Summary

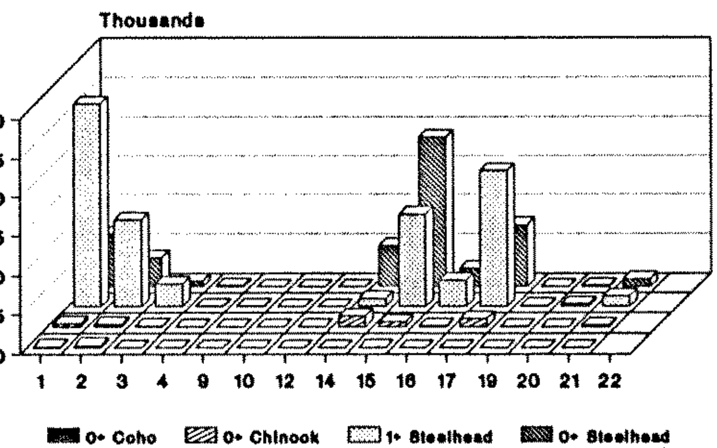
Observed Fish by Habitat Type

HABITAT	# UNITS	0+ STHD	1+ STHD	0+ KING	0+ COHO	VOLUME m^3	AREA sq m	VOLUME m^3	AREA sq m
1	18	591	968	64	17	68107	131248	10126	15589
2	10	462	578	72	58	13596	27631	2848	5858
3	7	152	240	35	0	8127	10389	2611	3998
4	1	66	35	0	0	294	1256	97	107
9	1	18	100			651	424	651	424
10	1	102	163	68		172	286	172	286
12	3		116		0	7314	6693	909	1934
14	20	876	180	227	0	97367	142418	18212	26229
15	27	1626	704	62	4	65807	121534	16219	35561
16	15	1106	1121	81	0	22864	34959	6691	10583
17	15	420	776	57	0	48722	67580	12536	13789
19	2	70	214	117		3398	3104	2602	2495
20	4	37	71			15090	12664	5264	7844
21	4	559	517	128	0	8464	15103	3598	6013
22	3	310	24	416	0	7486	4021	5478	3213
Total	131	6395	5807	1327	75	367,287	579,310	88,014	133,923

Fish Densities

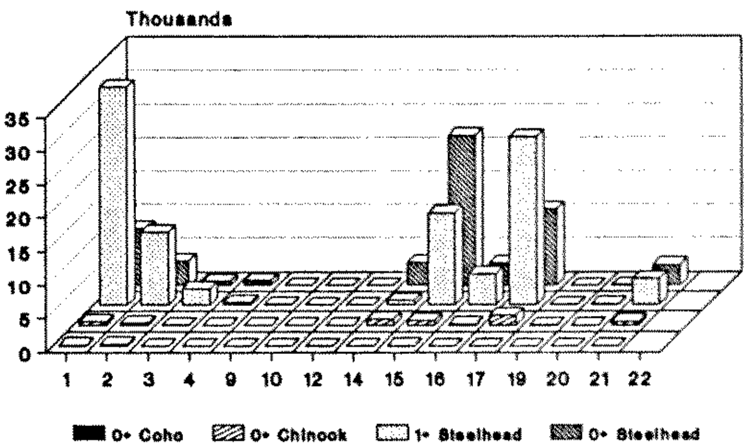
	Area				Volume			
HABITAT	0+ STHD	1+ STHD	0+ KING	0+ COHO	0+ STHD	1+ STHD	0+ KING	0+ COHO
1	0.038	0.062	0.004	0.001	0.058	0.096	0.006	0.002
2	0.079	0.099	0.012	0.010	0.162	0.203	0.025	0.020
3	0.038	0.060	0.009	0.000	0.058	0.092	0.013	0.000
4	0.617	0.327	0.000	0.000	0.683	0.362	0.000	0.000
9	0.041	0.236	0.000	0.000	0.027	0.154	0.000	0.000
10	0.356	0.567	0.237	0.000	0.591	0.942	0.394	0.000
12	0.000	0.060	0.000	0.000	0.000	0.128	0.000	0.000
14	0.033	0.007	0.009	0.000	0.048	0.010	0.012	0.000
15	0.046	0.020	0.002	0.000	0.100	0.043	0.004	0.000
16	0.105	0.106	0.008	0.000	0.165	0.168	0.012	0.000
17	0.030	0.056	0.004	0.000	0.033	0.062	0.005	0.000
19	0.028	0.086	0.047	0.000	0.027	0.082	0.045	0.000
20	0.005	0.009	0.000	0.000	0.007	0.013	0.000	0.000
21	0.093	0.086	0.021	0.000	0.155	0.144	0.036	0.000
22	0.096	0.007	0.129	0.000	0.057	0.004	0.076	0.000

Estimated Standing Crop
Scott River



Derived From Fish Per Cu. M.

Estimated Standing Crop
Scott River



Derived From Fish Per Sq. M.

Scott River
Biological Data Summary

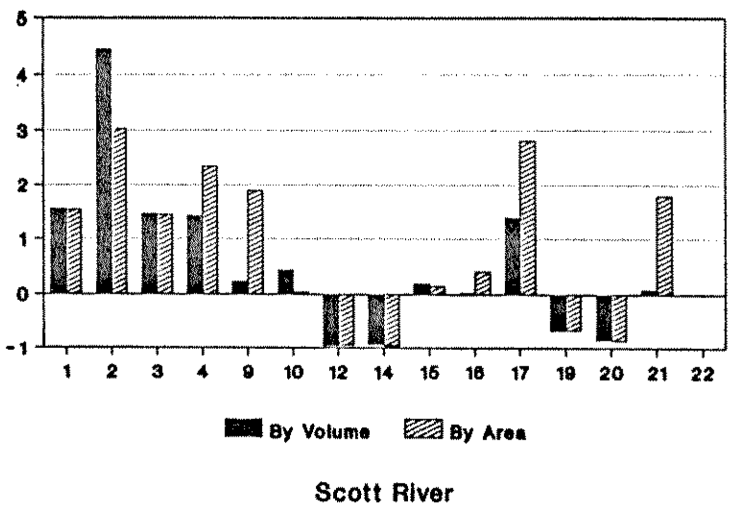
Utilization Coefficients

HABITAT	Area 0+ STHD	1+ STHD	0+ KING	0+ COHO	Volume 0+ STHD	1+ STHD	0+ KING	0+ COHO
1	-0.21	0.43	-0.59	0.86	-0.20	0.45	-0.58	0.88
2	0.65	1.28	0.23	15.75	1.23	2.08	0.67	21.64
3	-0.20	0.38	-0.11		-0.20	0.39	-0.11	
4	11.93	6.55			8.41	4.49		
9	-0.14	4.44			-0.63	1.33		
10	6.46	12.09	23.00		7.14	13.29	25.20	
12		0.38				0.93		
14	-0.30	-0.84	-0.13		-0.34	-0.85	-0.17	
15	-0.04	-0.54	-0.83	-0.81	0.38	-0.34	-0.75	-0.72
16	1.19	1.44	-0.23		1.28	1.54	-0.20	
17	-0.36	0.30	-0.58		-0.54	-0.06	-0.70	
19	-0.41	0.98	3.74		-0.63	0.25	1.99	
20	-0.90	-0.79			-0.90	-0.80		
21	0.95	0.98	1.15		1.14	1.18	1.36	
22	1.02	-0.83	12.08		-0.22	-0.93	4.04	

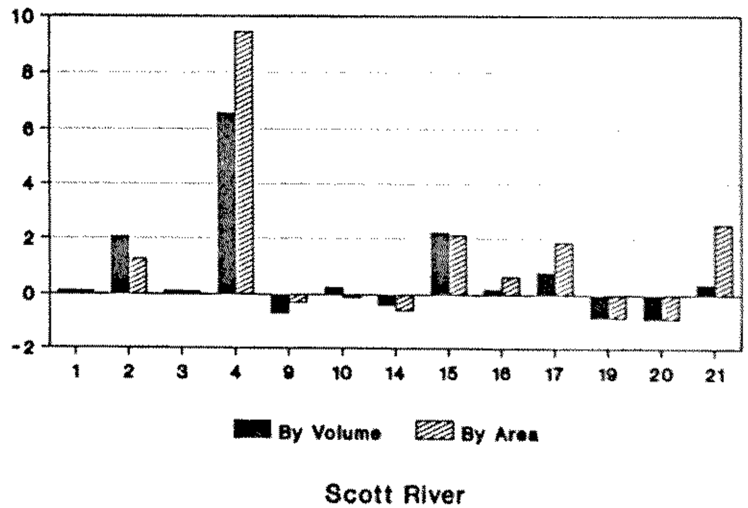
Estimated Standing Crop

HABITAT	Area 0+ STHD	1+ STHD	0+ KING	0+ COHO	Volume 0+ STHD	1+ STHD	0+ KING	0+ COHO
1	4972	8146	535	143	3972	6507	427	114
2	2179	2726	337	271	2205	2759	341	274
3	395	622	91	0	473	745	109	0
4	775	411	0	0	201	107	0	0
9	18	100	0	0	18	100	0	0
10	102	163	68	0	102	163	68	0
12	0	401	0	0	0	933	0	0
14	4756	977	1230	0	4683	962	1211	0
15	5557	2404	210	14	6597	2854	250	16
16	3653	3703	268	0	3779	3830	277	0
17	2056	3803	279	0	1630	3016	222	0
19	87	266	146	0	91	280	153	0
20	59	114	0	0	105	202	0	0
21	1404	1297	321	0	1315	1215	301	0
22	388	29	520	0	424	32	568	0
TOTAL	26401	25164	4005	428	25596	23706	3926	405

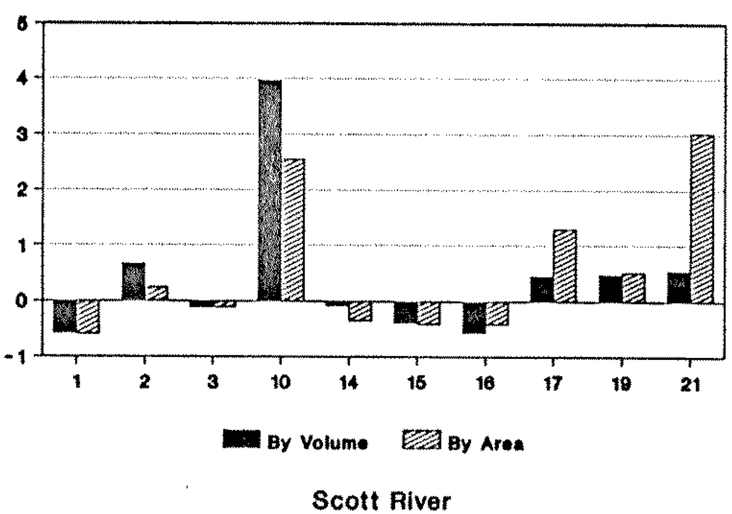
Utilization Coefficients
1+ Steelhead



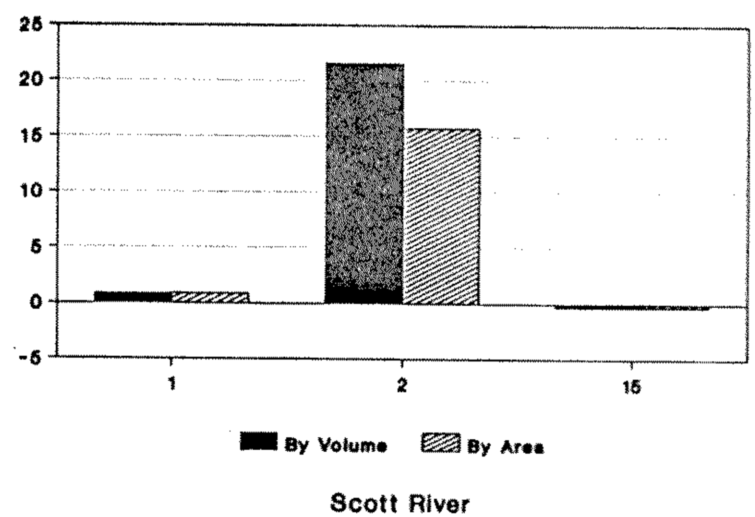
Utilization Coefficients
0+ Steelhead



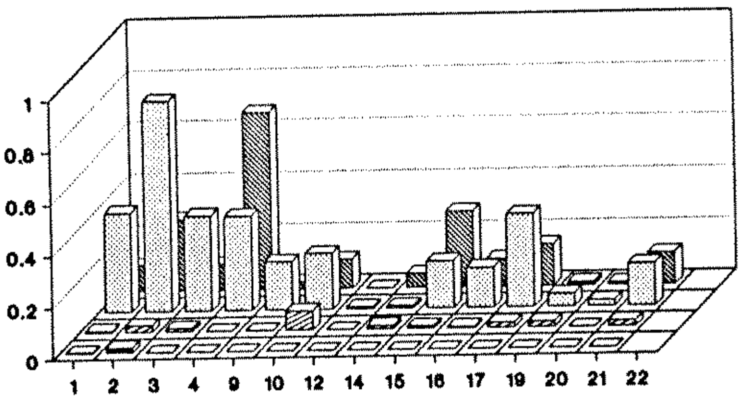
Utilization Coefficients
0+ Chinook



Utilization Coefficients
0+ Coho

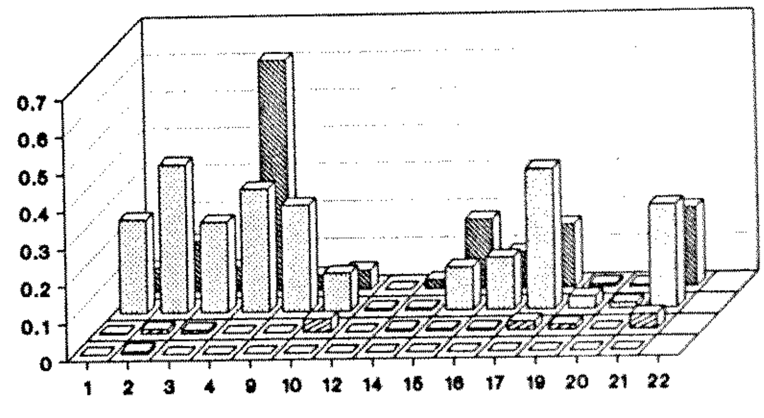


Estimated Fish Densities
Scott River



Fish Per Cu. M.

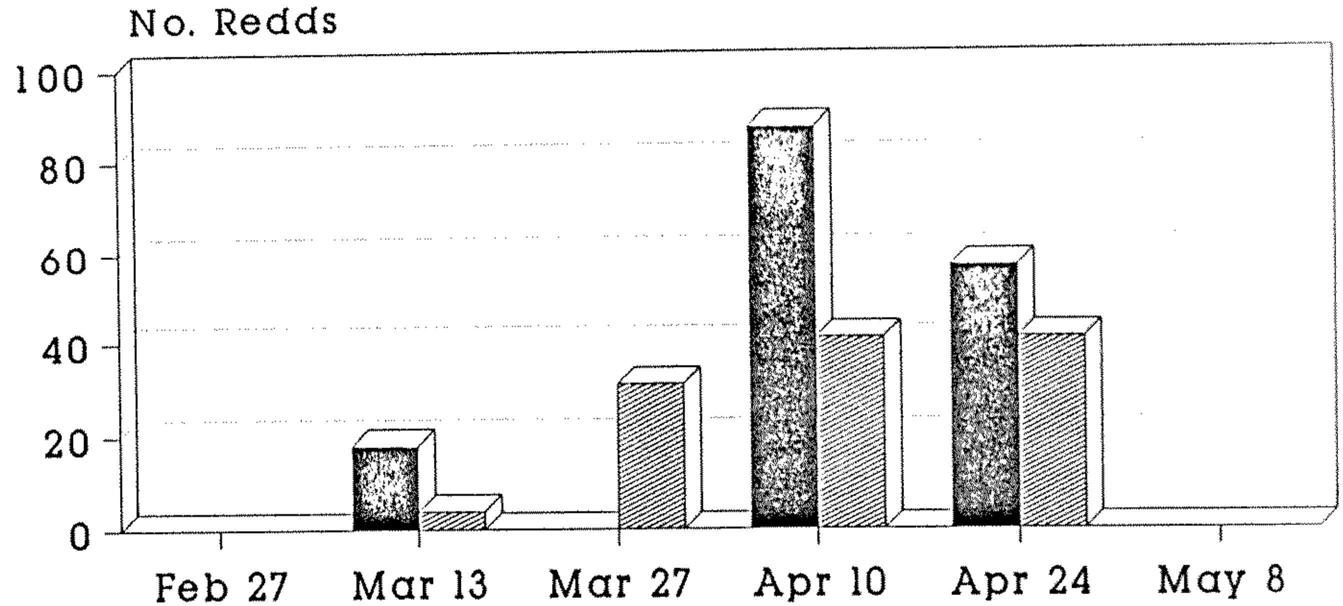
Estimated Fish Densities
Scott River



Fish Per Sq. M.

APPENDIX G. HABITAT CONDITION AND USE - SHACKLEFORD/MILL CREEKS

Spawning Period
Steelhead



	Feb 27	Mar 13	Mar 27	Apr 10	Apr 24	May 8
Shackleford		18		87	57	
Mill		4	31	41	41	

Bi-Weekly Survey Period (Start Date)

Shackleford   Mill

Shackleford / Mill Creeks 1989

Relationship between spawning and rearing habitat for steelhead in Shackleford/Mill Creeks, 1989.

Parameter	Numbers
Steelhead spawning area/pair	1.5 m^2
Steelhead spawning area in study area	14925 m^2
Redds accom. w/out superimposition	9950 redds
Total spawning population (1.5 males/female)	24875 spawners
Estimated 1+ steelhead standing crop	46595 juveniles
Estimated 2+ smolts (40% survival)	18638 smolts
Expected adult maiden return (5%)	932 adults
Estimated maiden redds @ 2.5 fish/redd	373 maiden redds
Est. total redds (60% maiden;40% repeat)	621 total redds

CONCLUSION: Present spawning area is adequate to seed the rearing habitat available in the study area under 1989 conditions.

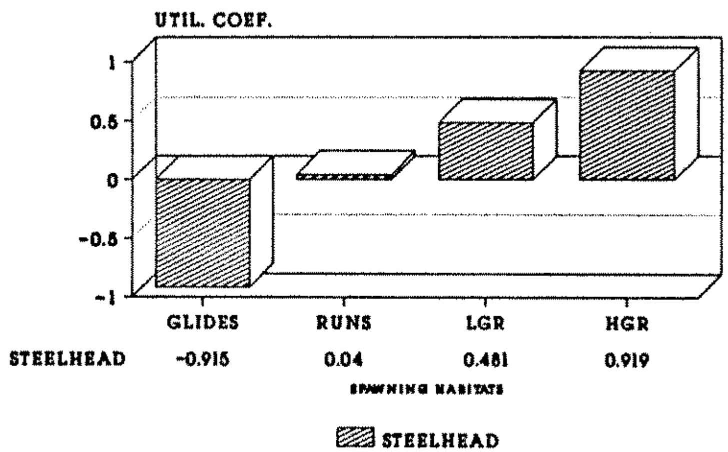
Shackleford / Mill Creeks
Spawning Ground Utilization

	GLIDES	RUNS	LGR	HGR	STEP-RUN	TOTAL
Spawning Area m^2	2511	8385	3973	56		
Percent Spawning Area	17	56	27	0	0	
Chinook Redds	0	0	0	0	0	0
Steelhead Redds	4	163	110	2	0	279
Chinook Redd Density	0	0	0	0	0	
Steelhead Redd Density	0.0016	0.0194	0.0277	0.0359		

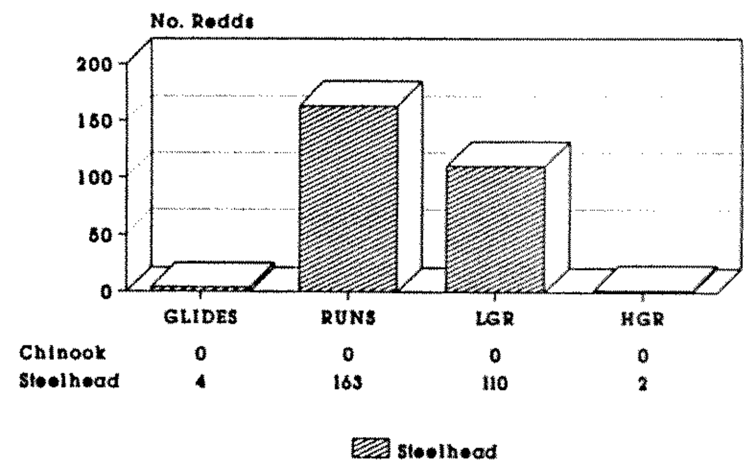
Utilization Coefficients

	GLIDES	RUNS	LGR	HGR	STEP-RUN	TOTAL
Chinook Util Coef						
Steelhead Util Coef	-0.9148	0.0399	0.4810	0.9195		

Spawner Utilization
Shackford / Mill Creeks 1988-89



Redds by Habitat Type
Shackleford / Mill Creeks 1988-89



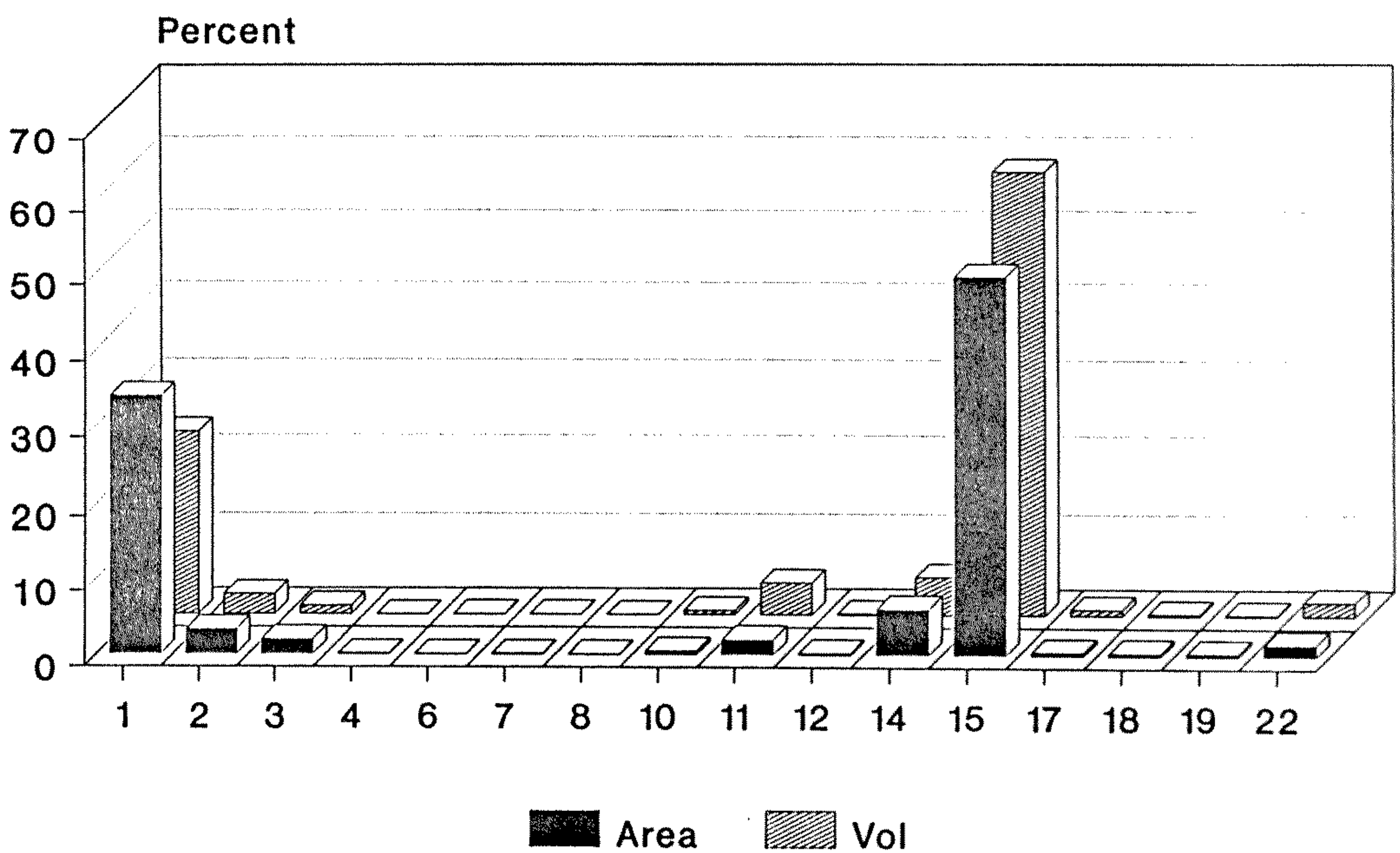
Shackleford/Mill Creeks
Physical Data Summary

HABITAT TYPE	NO. UNITS	LENGTH m	AREA m^2	AVG VOLUME m^3	AVG LENGTH m	AVG WIDTH m	AVG DEPTH m	VOLUME m^3	STREAM AREA %	STREAM VOL %	EMBEDD %	FINES %	GRAVEL %	COBBLE %	BOULDER %	BEDROCK %	SPAWN AREA m^2
1	65	5303	38220	12461	81.6	7.7	0.32	191.71	34	24	2.4		54	46			3973
2	6	407	3650	1403	67.9	9.4	0.32	233.89	3	3	0.4	15	70	15			56
3	2	165	2190	593	82.5	10.7	0.27	296.67	2	1	0.4	5	64	31			
4	1	14	53	24	14.3	3.7	0.46	23.69	0	0	20.0	5	5	10	10	70	1
6	1	8	36	27	7.9	4.6	0.76	27.30	0	0	20.0	8	5	20	7	60	
7	1	13	46	25	12.5	3.7	0.55	24.80	0	0		3	6	32	38	20	
8	1	8	22	18	7.9	2.7	0.85	18.35	0	0	5.0	20	278	192	10	0	
10	5	102	516	293	20.3	5.1	0.52	58.50	0	1	5.1	12	11	36	31	9	8
11	16	290	2224	2231	18.1	7.4	0.99	139.43	2	4	2.5		5	45	45	5	52
12	1	21	209	88	20.7	10.1	0.43	87.96	0	0	10.0	5	14	34	46	1	1
14	24	1339	6783	2669	55.8	5.1	0.29	111.21	6	5	3.3	5	8	44	39	4	2083
15	85	8311	55900	30595	97.8	6.9	0.34	359.94	50	59	4.6	4	10	36	37	13	8385
17	3	60	442	437	19.9	7.6	1.03	145.54	0	1	3.8						4
18	2	40	390	150	20.0	10.2	0.38	75.17	0	0	8.0						
19	4	55	333	108	13.6	6.0	0.29	27.05	0	0	5.5						57
22	10	258	1741	970	25.8	6.5	0.54	97.02	2	2	7.3						368

Shackleford / Mill Creeks
Cover Data Summary

HABITAT	NO. UNITS	% COVER	% UNDERCUT	% SWD	% LWD	% TERR_VEG	% WT_WATER	% BOULDERS	% BDRK_LEDG	% SHADE
1	65	9				100				2
2	6	37		7	7	86				
3	2		12	9	8	71				4
4	1	5		44		56				5
6	1	40	22			78				65
7	1	10								
8	1	20								
10	5	11								13
11	16	17								3
12	1	10								
14	24	13								3
15	85	10								4
17	3	14								
18	2	12								12
19	4	3								3
22	10	14								11

Habitat Distribution
Shackleford / Mill Creeks



Shackleford / Mill Creeks
Biological Data Summary

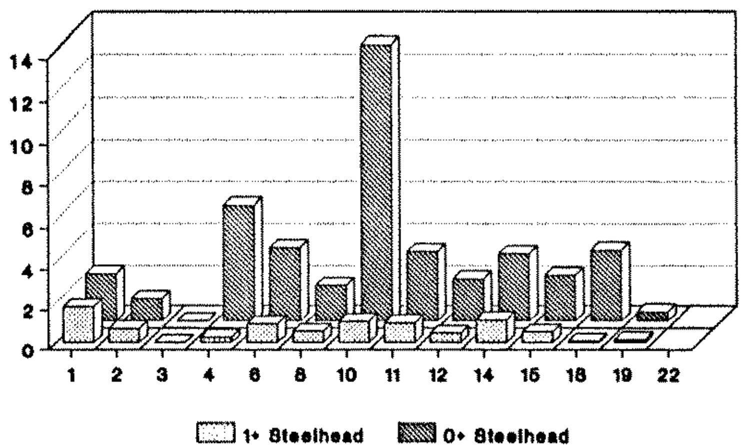
Observed Fish by Habitat Type

HABITAT	# UNITS	0+ STHD	1+ STHD	0+ KING	0+ COHO	TOTAL VOLUME m^3	TOTAL AREA m^2	OBSERVED VOLUME m^3	OBSERVED AREA m^2
1	13	15676	5128	0	0	12461	38220	2840	7456
2	1	86	24	0	0	1403	3650	33	222
3	1	0	0	0	0	593	2190	18	65
4	2	272	14	0	0	24	52	48	159
6	1	69	18	0	0	27	36	19	25
8	1	63	21	0	0	18	22	36	42
10	2	1590	130	0	0	293	516	120	297
11	6	1160	340	0	0	2231	2224	338	542
12	1	197	46	0	0	88	209	94	223
14	2	1457	509	0	0	2669	6783	437	1141
15	17	9005	1534	0	0	30595	55899	2973	7791
18	1	102	2	0	0	150	390	29	80
19	1	247	86	0	0	108	333		
22	4	1408	317	0	0	970	1741	549	884

Fish Densities

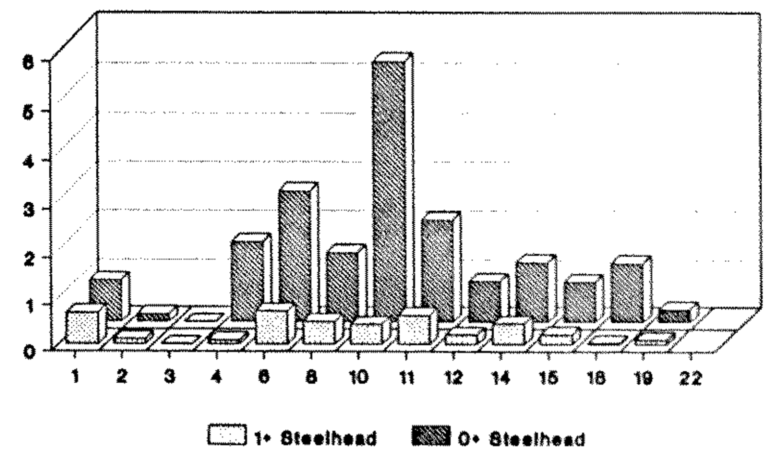
	Area				Volume			
HABITAT	0+ STHD	1+ STHD	0+ KING	0+ COHO	0+ STHD	1+ STHD	0+ KING	0+ COHO
1	2.102	0.688	0.000	0.000	5.520	1.806	0.000	0.000
2	0.387	0.108	0.000	0.000	2.568	0.717	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	1.707	0.085	0.000	0.000	5.621	0.280	0.000	0.000
6	2.728	0.717	0.000	0.000	3.624	0.952	0.000	0.000
8	1.486	0.495	0.000	0.000	1.762	0.587	0.000	0.000
10	5.359	0.437	0.000	0.000	13.215	1.076	0.000	0.000
11	2.138	0.627	0.000	0.000	3.432	1.006	0.000	0.000
12	0.880	0.204	0.000	0.000	2.089	0.484	0.000	0.000
14	1.277	0.446	0.000	0.000	3.335	1.164	0.000	0.000
15	1.156	0.197	0.000	0.000	3.029	0.516	0.000	0.000
18	1.269	0.025	0.000	0.000	3.513	0.069	0.000	0.000
22	1.592	0.358	0.000	0.000	2.565	0.577	0.000	0.000

Estimated Fish Densities
Shackleford / Mill Creeks



Fish Per Cu. M.

Estimated Fish Densities
Shackleford / Mill Creeks



Fish Per Sq. M.

Shackleford / Mill Creeks

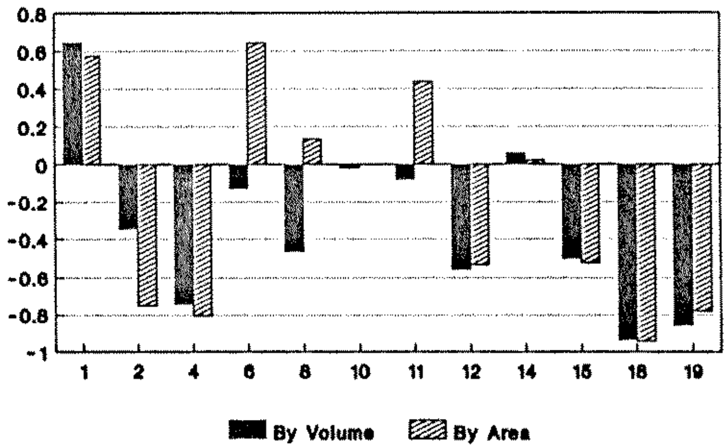
Utilization Coefficients

	Area				Volume			
HABITAT	0+ STHD	1+ STHD	0+ KING	0+ COHO	0+ STHD	1+ STHD	0+ KING	0+ COHO
1	0.27	0.59			0.33	0.67		
2	-0.77	-0.75			-0.38	-0.34		
4	0.03	-0.80			0.35	-0.74		
6	0.65	0.66			-0.13	-0.12		
8	-0.10	0.15			-0.58	-0.46		
10	2.24	0.01			2.18	-0.01		
11	0.29	0.45			-0.17	-0.07		
12	-0.47	-0.53			-0.50	-0.55		
14	-0.23	0.03			-0.20	0.07		
15	-0.30	-0.54			-0.27	-0.52		
18	-0.23	-0.94			-0.16	-0.94		
22	-0.04	-0.17			-0.38	-0.47		

Estimated Standing Crop

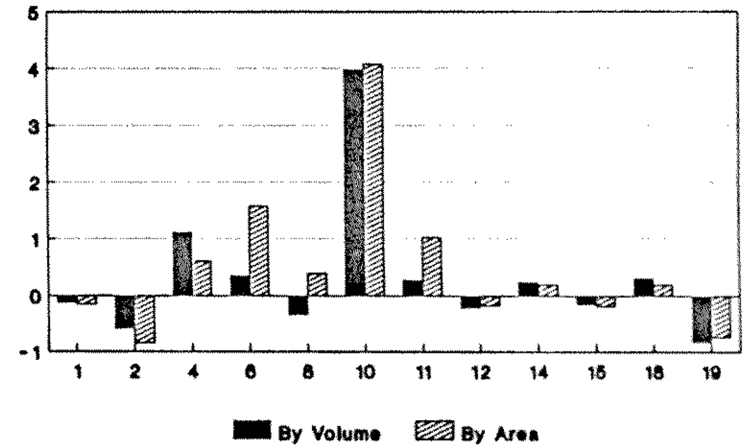
	Area				Volume			
HABITAT	0+ STHD	1+ STHD	0+ KING	0+ COHO	0+ STHD	1+ STHD	0+ KING	0+ COHO
1	80357	26287	0	0	68789	22503	0	0
2	1411	394	0	0	3604	1006	0	0
3	0	0	0	0	0	0	0	0
4	90	4	0	0	133	7	0	0
6	99	26	0	0	99	26	0	0
8	32	11	0	0	32	11	0	0
10	2768	225	0	0	3866	315	0	0
11	4755	1394	0	0	7656	2244	0	0
12	184	43	0	0	184	43	0	0
14	8658	3022	0	0	8902	3107	0	0
15	64605	11009	0	0	92671	15791	0	0
18	495	10	0	0	528	10	0	0
22	2772	623	0	0	2488	559	0	0
TOTAL	166225	43046	0	0	188952	45621	0	0

Utilization Coefficients
1+ Steelhead



Shakcleford / Mill Creeks

Utilization Coefficients
0+ Steelhead

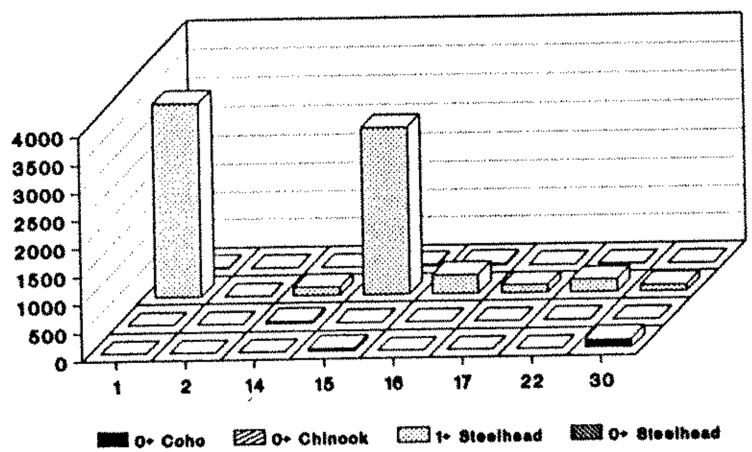


Shakcleford / Mill Creeks

0+ Chinook were not observed in this system.

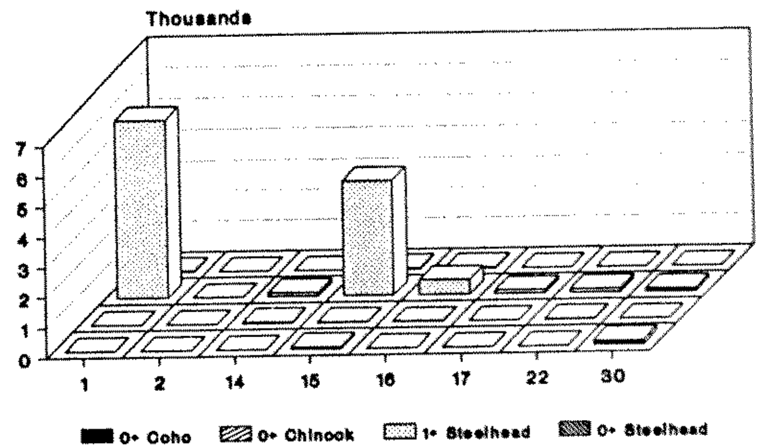
0+ Coho were not observed in this system.

Estimated Standing Crop
Shasta River



Derived From Fish Per Cu. M.

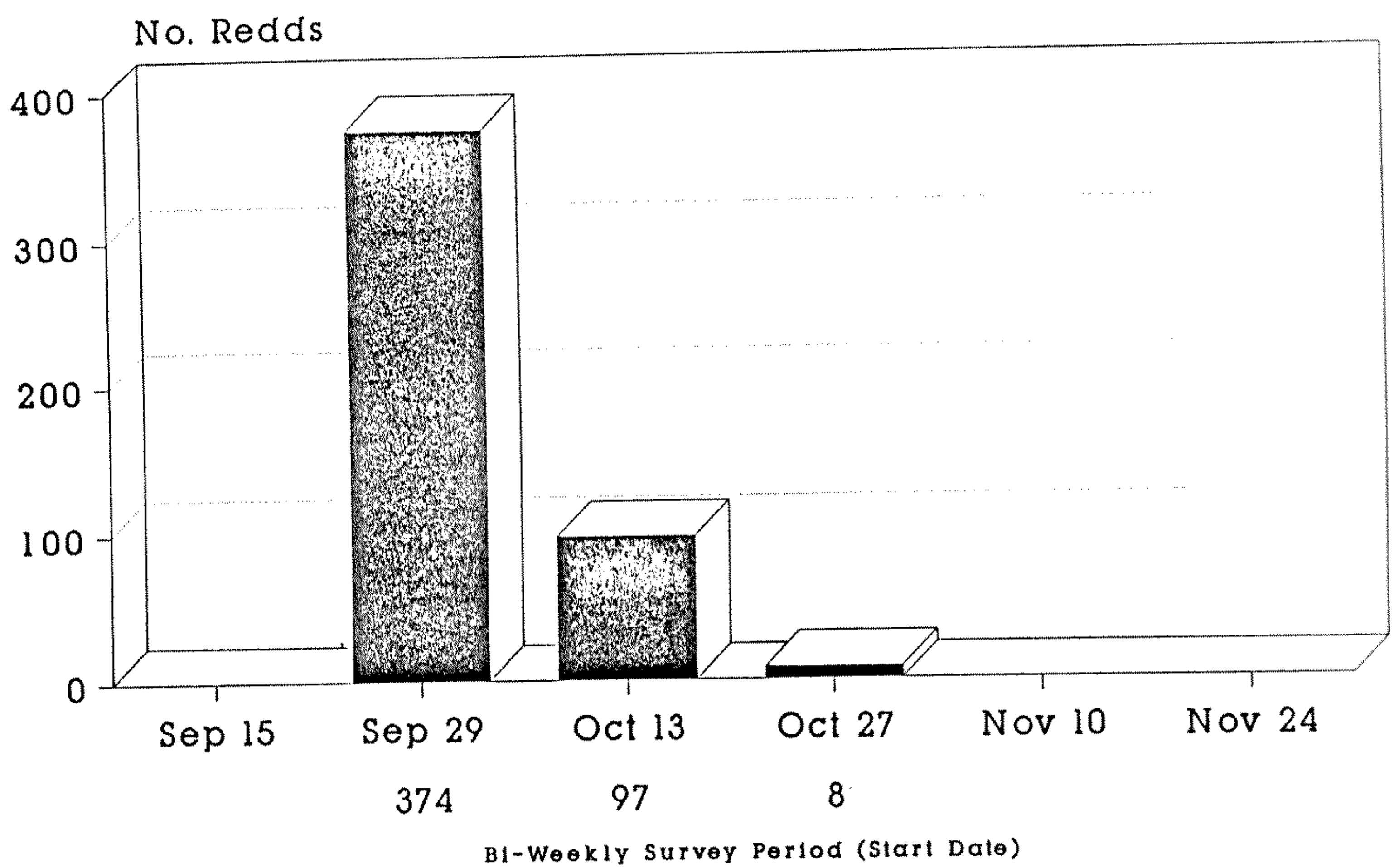
Estimated Standing Crop
Shasta River



Derived From Fish Per Sq. M.

APPENDIX H. HABITAT CONDITION AND USE - SHASTA RIVER

Spawning Period
Chinook



Shasta River 1988

Relationship between spawning and rearing habitat for steelhead in Shasta River, 1989.

Parameter	Numbers
Steelhead spawning area/pair	1.5 m^2
Steelhead spawning area in study area	2690 m^2
Redds accom. w/out superimposition	1799 redds
Total spawning population (1.5 males/female)	4497 spawners
Estimated 1+ steelhead standing crop	10629 juveniles
Estimated 2+ smolts (40% survival)	4252 smolts
Expected adult maiden return (5%)	213 adults
Estimated maiden redds @ 2.5 fish/redd	85 maiden redds
Est. total redds (60% maiden;40% repeat)	142 total redds

CONCLUSION: Present spawning area is adequate to seed the rearing habitat available in the study area under 1989 conditions.

Shasta River
Spawning Ground Utilization

	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	DEFL/PCKT	TOTAL
Spawning Area m^2	164	635	295	2	344	1248	0	2688
Percent Spawning Area	6	24	11	0	13	46		
Chinook Redds	24	201	220	2	0	32	0	479
Steelhead Redds[2]	0	0	0	0	0	0	0	0
Chinook Redd Density	0.1468	0.3165	0.7447	1.0764	0	0.0256	0	0.1782
Steelhead Redd Density	0	0	0	0	0	0	0	0

Utilization Coefficients

	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	DEFL/PCKT
Chinook Util Coef	-0.1764	0.7759	3.1784	5.0397	-1.0000	-0.8561	
Steelhead Util Coef							

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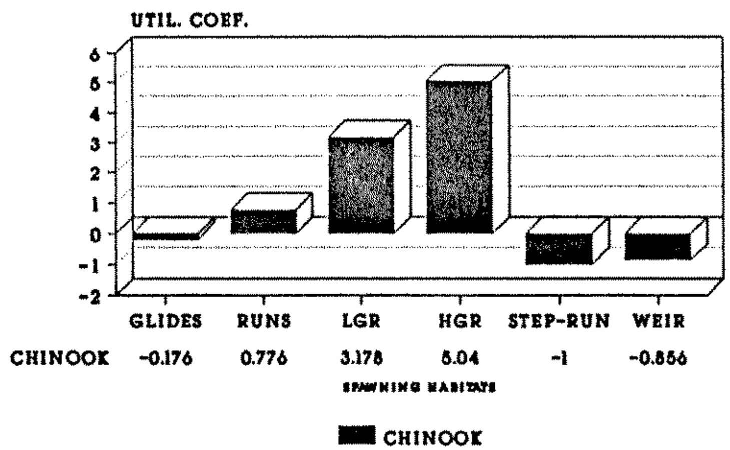
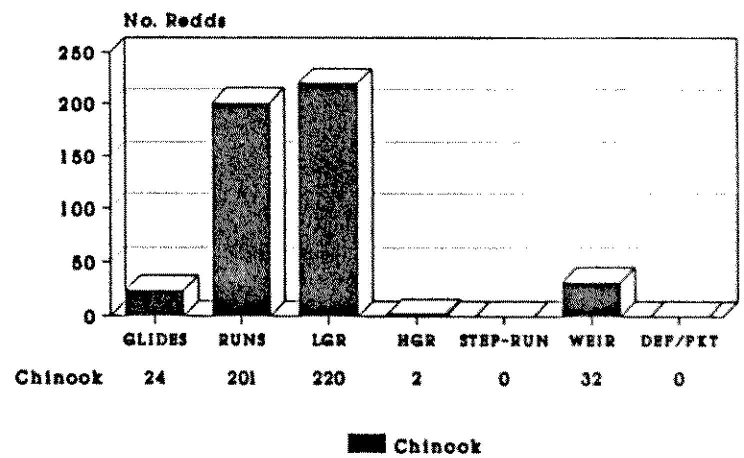
[2]Due to high flow conditions, steelhead spawning data was not collected.

Spawner Utilization
Shasta River 1988-89



Redds by Habitat Type
Shasta River 1988-89



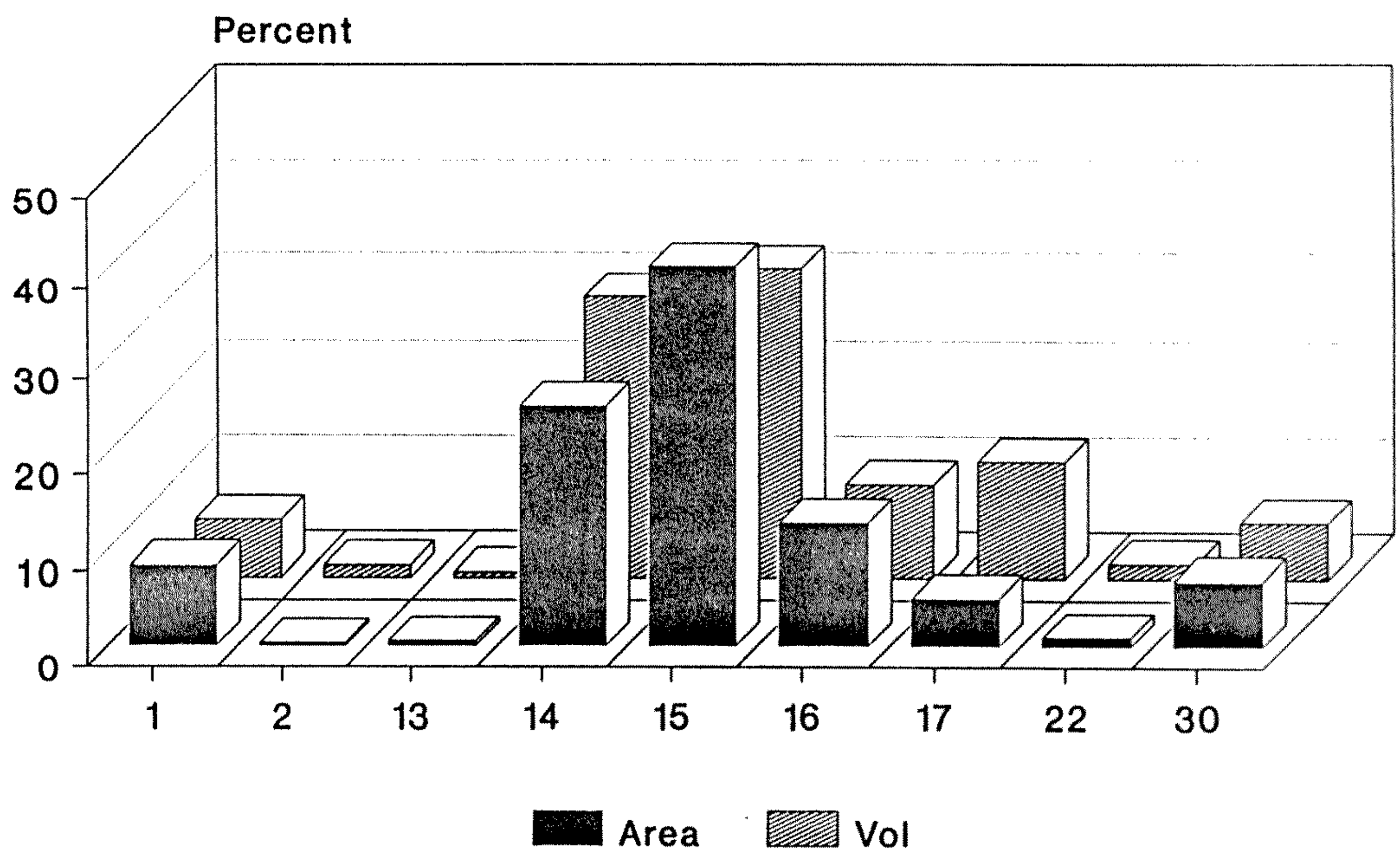
Shasta River
Physical Data Summary

HABITAT TYPE	NO. UNITS	LENGTH m	AREA m^2	VOLUME m^3	AVG LENGTH m	AVG WIDTH m	AVG DEPTH m	AVG VOLUME m^3	STREAM AREA %	STREAM VOL %	EMBEDD %	FINES %	GRAVEL %	COBBLE %	BOULDER %	BEDROCK %	SPAWN AREA m^2
1	24	1203	12726	5734	50.1	10.3	0.43	238.92	8	6	5.0	14	26	12	28	20	295
2	3	100	419	1219	33.2	4.1	2.33	406.18	0	1	18.2	10	10	10	10	60	2
13	1	60	725	546	59.5	12.2	0.76	546.00	0	1		60	40				3
14	41	3332	38104	28490	81.3	11.2	0.87	694.87	25	30	1.5	52	28	13	6	1	164
15	52	4852	61617	31473	93.3	10.8	0.50	605.25	40	33	5.1	29	45	11	12	3	635
16	27	2280	19615	9285	84.5	8.0	0.49	343.89	13	10	6.3	18	26	17	24	15	344
17	13	782	7652	11547	60.2	9.2	1.56	888.21	5	12	5.5	35	12	6	16	31	0
22	3	101	1423	1466	33.8	14.7	1.04	488.71	1	2	0.0	10	20		10	60	0
30	4	779	10457	5612	194.7	12.2	0.53	1403.01	7	6	0.7	20	20	30	30		1248

Shasta River
Cover Data Summary

HABITAT	NO. UNITS	COVER %	UNDERCUT %	SWD %	LWD %	TERR_VEG %	WT_WATER %	BOULDERS %	BDRK_LEDG %	SHADE %
1	24	30	3	8	0	17	12	38	21	1
2	3	0								0
13	1	10				100				
14	41	26	15	24	2	26	11	14	9	1
15	52	24	3	5		11	2	52	27	1
16	27	23	9	10		16	5	30	30	2
17	13	22				2		18	80	0
22	3	20	8			16		8	68	3
30	4	21		1		41	9	49		0

Habitat Distribution
Shasta River



Shasta River
Biological Data Summary

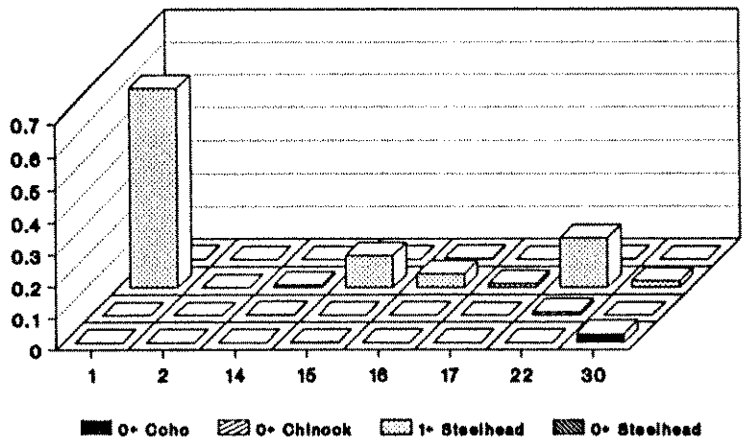
Observed Fish by Habitat Type

HABITAT	# UNITS	0+ STHD	1+ STHD	0+ KING	0+ COHO	TOTAL VOLUME m^3	TOTAL AREA m^2	OBSERVED VOLUME m^3	OBSERVED AREA m^2
1	8	4	381	0	0	5734	12726	2500	3171
2	1	0	0	0	0	1219	419	73	242
14	10	0	36	11	0	28490	38104	4913	7894
15	12	5	361	2	11	31473	61617	6191	9557
16	4	3	24	1	0	9285	19615	952	1422
17	2	0	25	0	0	11547	7652	2399	1836
22	2	1	66	6	0	1466	1423	509	807
30	2	0	20	0	29	5612	10457	995	1978

Shasta River
Fish Densities

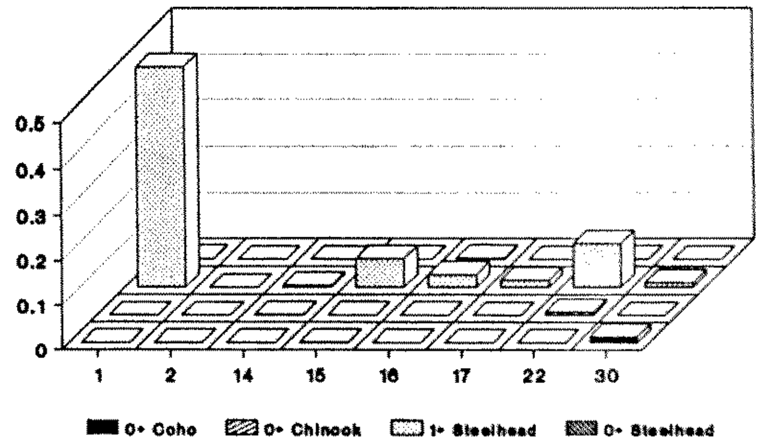
HABITAT	Area 0+ STHD	1+ STHD	0+ KING	0+ COHO	Volume 0+ STHD	1+ STHD	0+ KING	0+ COHO
1	0.001	0.120	0.000	0.000	0.002	0.152	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	0.000	0.004	0.001	0.000	0.000	0.007	0.002	0.000
15	0.001	0.038	0.000	0.001	0.001	0.058	0.000	0.002
16	0.002	0.017	0.000	0.000	0.003	0.025	0.001	0.000
17	0.000	0.013	0.000	0.000	0.000	0.010	0.000	0.000
22	0.001	0.081	0.007	0.000	0.002	0.129	0.011	0.000
30	0.000	0.010	0.000	0.014	0.000	0.020	0.000	0.029

Estimated Fish Densities
Shasta River



Fish Per Cu. M.

Estimated Fish Densities
Shasta River



Fish Per Sq. M.

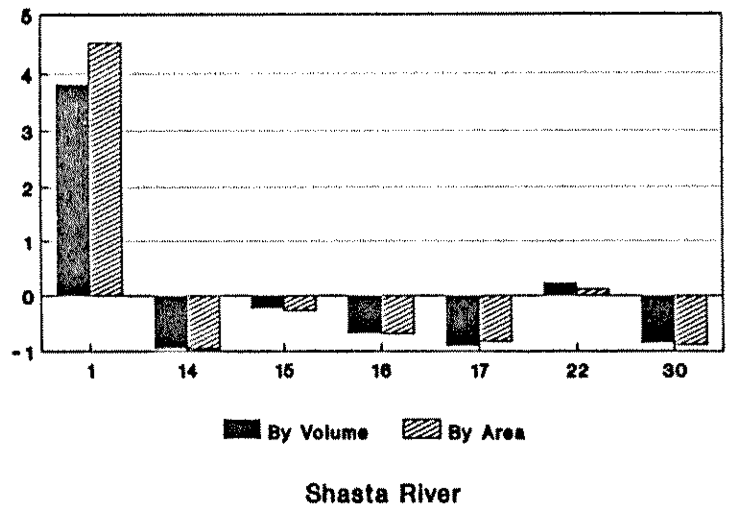
Shasta River
Utilization Coefficients

HABITAT	Area 0+ STHD	1+ STHD	0+ KING	0+ COHO	Volume 0+ STHD	1+ STHD	0+ KING	0+ COHO
1	1.61	2.55			1.28	2.10		
14		-0.87	0.99			-0.85	1.20	
15	0.08	0.12	-0.77	-0.22	0.15	0.19	-0.75	-0.17
16	3.37	-0.51	-0.47		3.49	-0.50	-0.46	
17		-0.61				-0.79		
22	1.57	1.40	9.19		1.80	1.62	10.12	
30		-0.70		8.82		-0.59		12.44

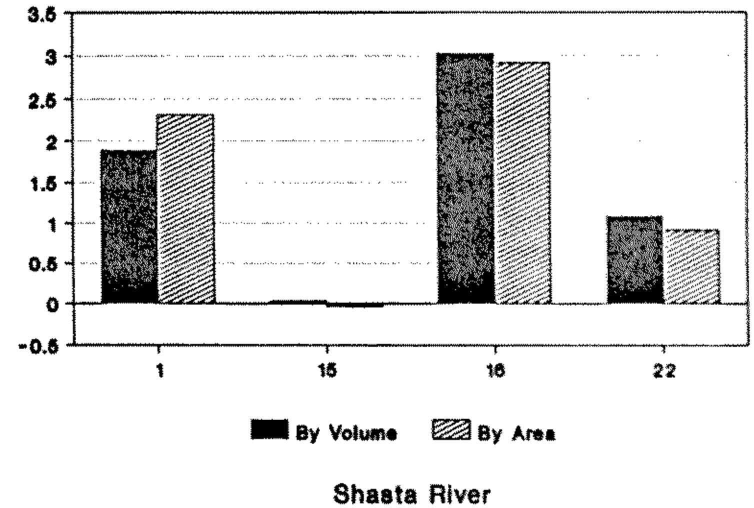
Shasta River
Estimated Standing Crop

HABITAT	Area 0+ STHD	1+ STHD	0+ KING	0+ COHO	Volume 0+ STHD	1+ STHD	0+ KING	0+ COHO
1	16	1529	0	0	9	874	0	0
14	0	171	51	0	0	206	61	0
15	32	2328	10	71	25	1835	8	56
16	41	324	7	0	29	229	5	0
17	0	102	0	0	0	118	0	0
22	2	116	10	0	3	189	16	0
30	0	106	0	151	0	113	0	161
TOTAL	91	4676	77	222	67	3563	89	217

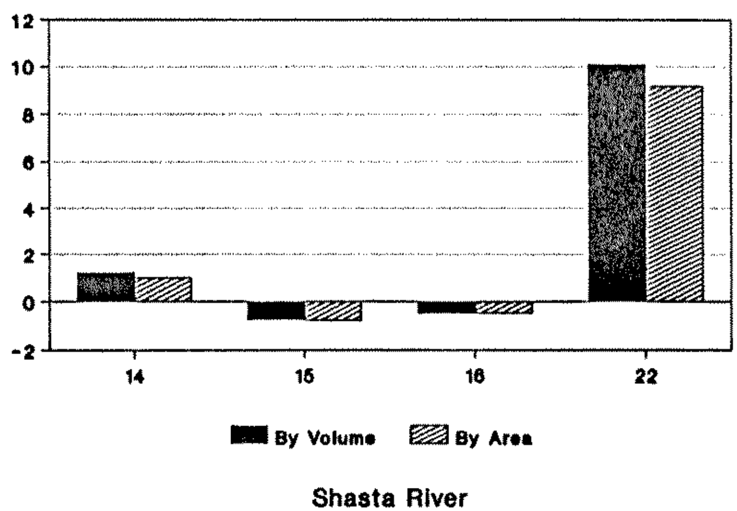
Utilization Coefficients
1+ Steelhead



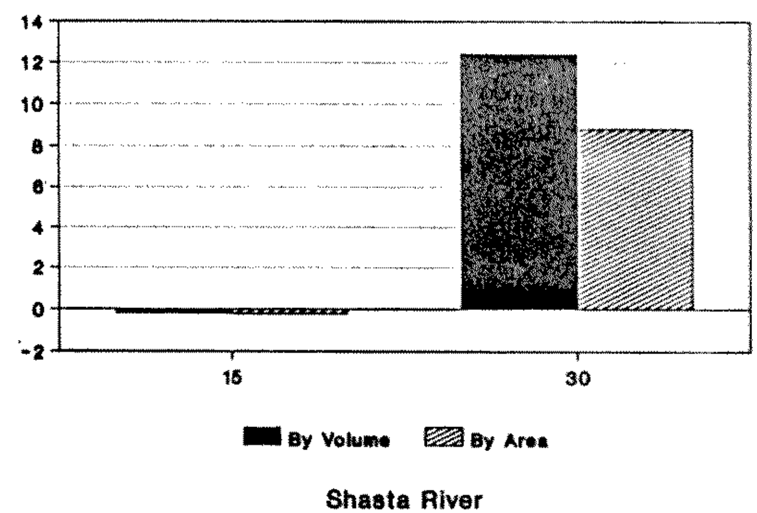
Utilization Coefficients
0+ Steelhead



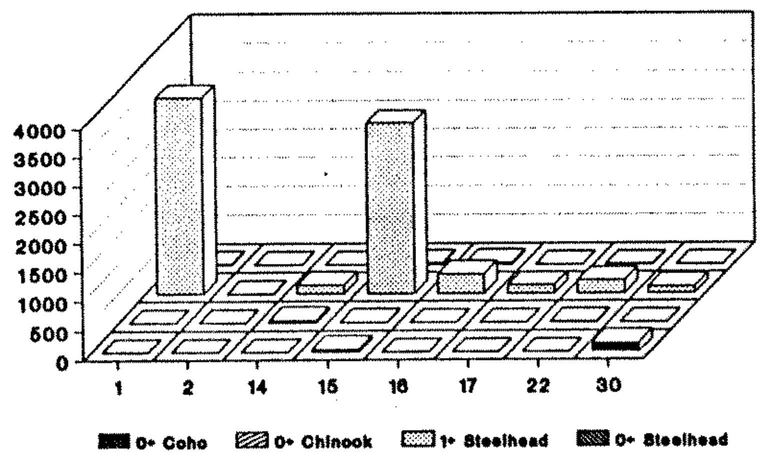
Utilization Coefficients
0+ Chinook



Utilization Coefficients
0+ Coho

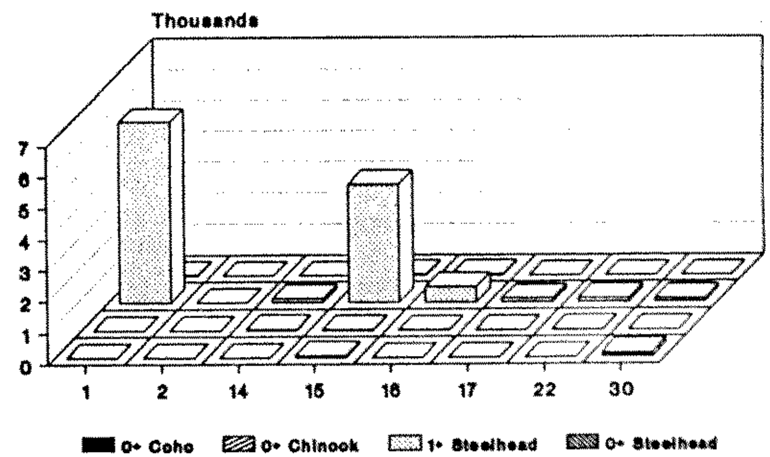


Estimated Standing Crop
Shasta River



Derived From Fish Per Cu. M.

Estimated Standing Crop
Shasta River

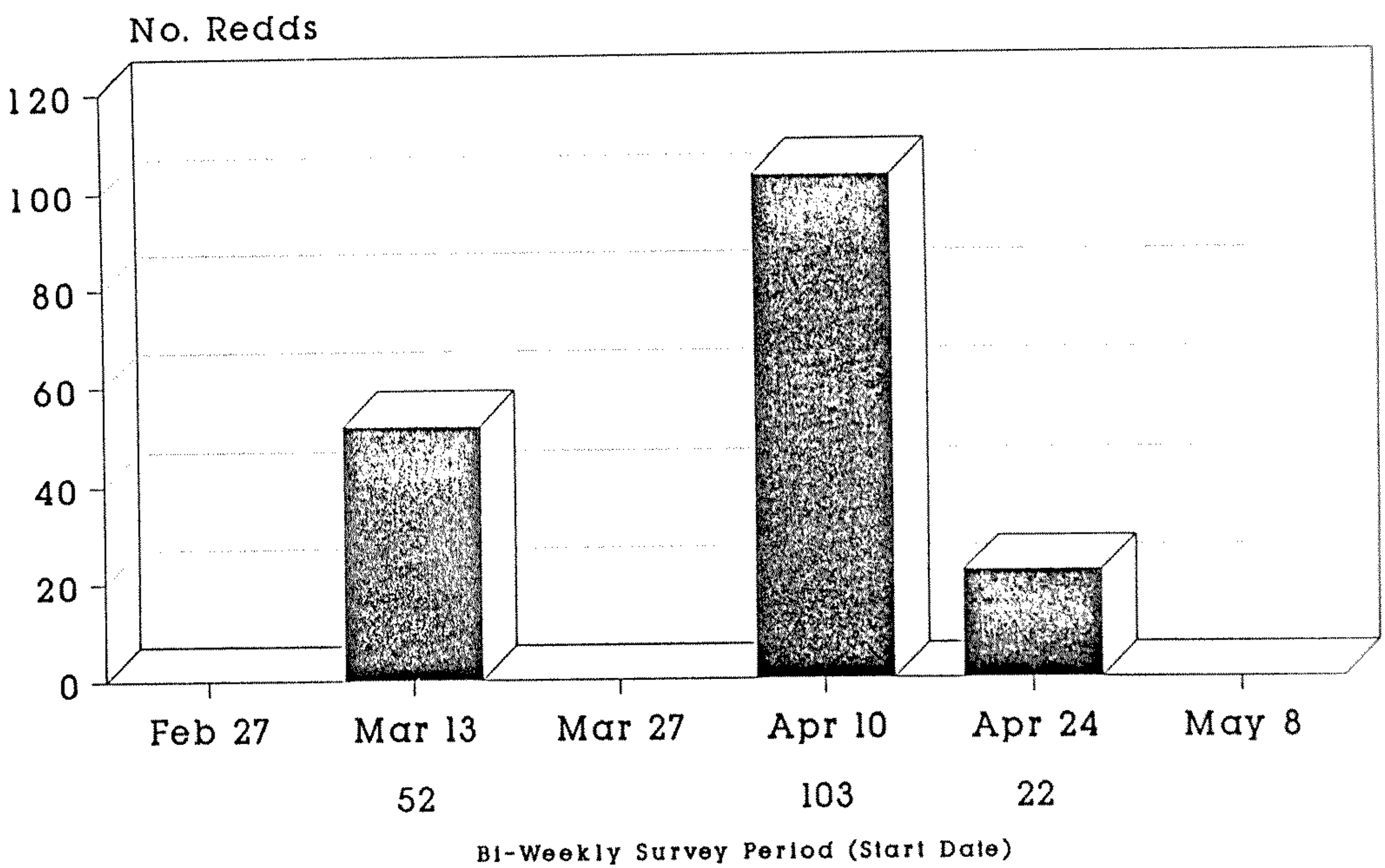


Derived From Fish Per Sq. M.

APPENDIX I. HABITAT CONDITION AND USE - YREKA CREEK

Spawning Period

Steelhead



Yreka Creek 1989

Relationship between spawning and rearing habitat for steelhead in Yreka Creek, 1989.

Parameter	Numbers
Steelhead spawning area/pair	1.5 m^2
Steelhead spawning area in study area	270 m^2
Redds accom. w/out superimposition	180 redds
Total spawning population (1.5 males/female)	450 spawners
Estimated 1+ steelhead standing crop	516 juveniles
Estimated 2+ smolts (40% survival)	206 smolts
Expected adult maiden return (5%)	10 adults
Estimated maiden redds @ 2.5 fish/redd	4 maiden redds
Est. total redds (60% maiden;40% repeat)	7 total redds

<u>CONCLUSION:</u> <u>Present spawning area is adequate to seed the rearing habitat available in the study area under 1989 conditions.</u>

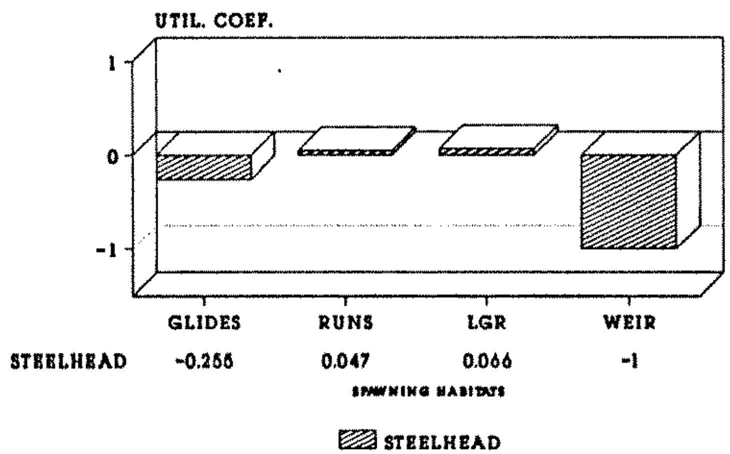
Yreka Creek
Spawning Ground Utilization

	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	TOTAL
Spawning Area m^2	41	190	37	0	0	1	269
Percent Spawning Area	15	71	14	0	0	0	
Chinook Redds	0	0	0	0	0	0	0
Steelhead Redds	20	131	26	0	0	0	177
Chinook Redd Density	0	0	0	0	0	0	0
Steelhead Redd Density	0.4904	0.6885	0.7014				0.6579

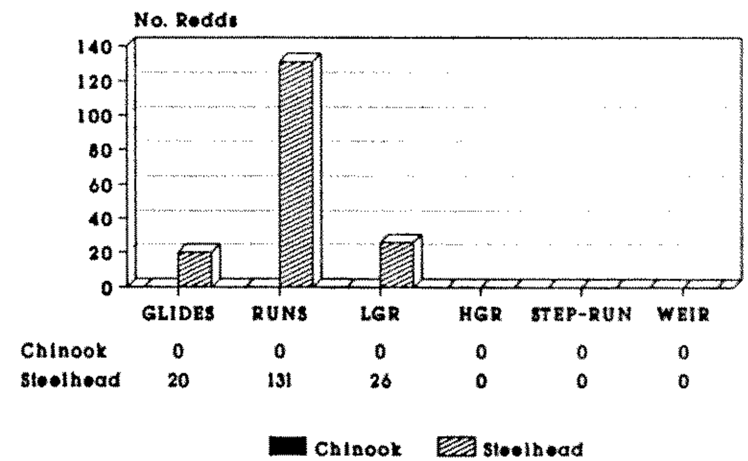
Utilization Coefficients

	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	TOTAL
Chinook Util Coef							
Steelhead Util Coef	-0.2546	0.0466	0.0662			-1.00	.6579

Spawner Utilization
Yreka Creek 1988-89



Redds by Habitat Type
Yreka Creek 1988-89

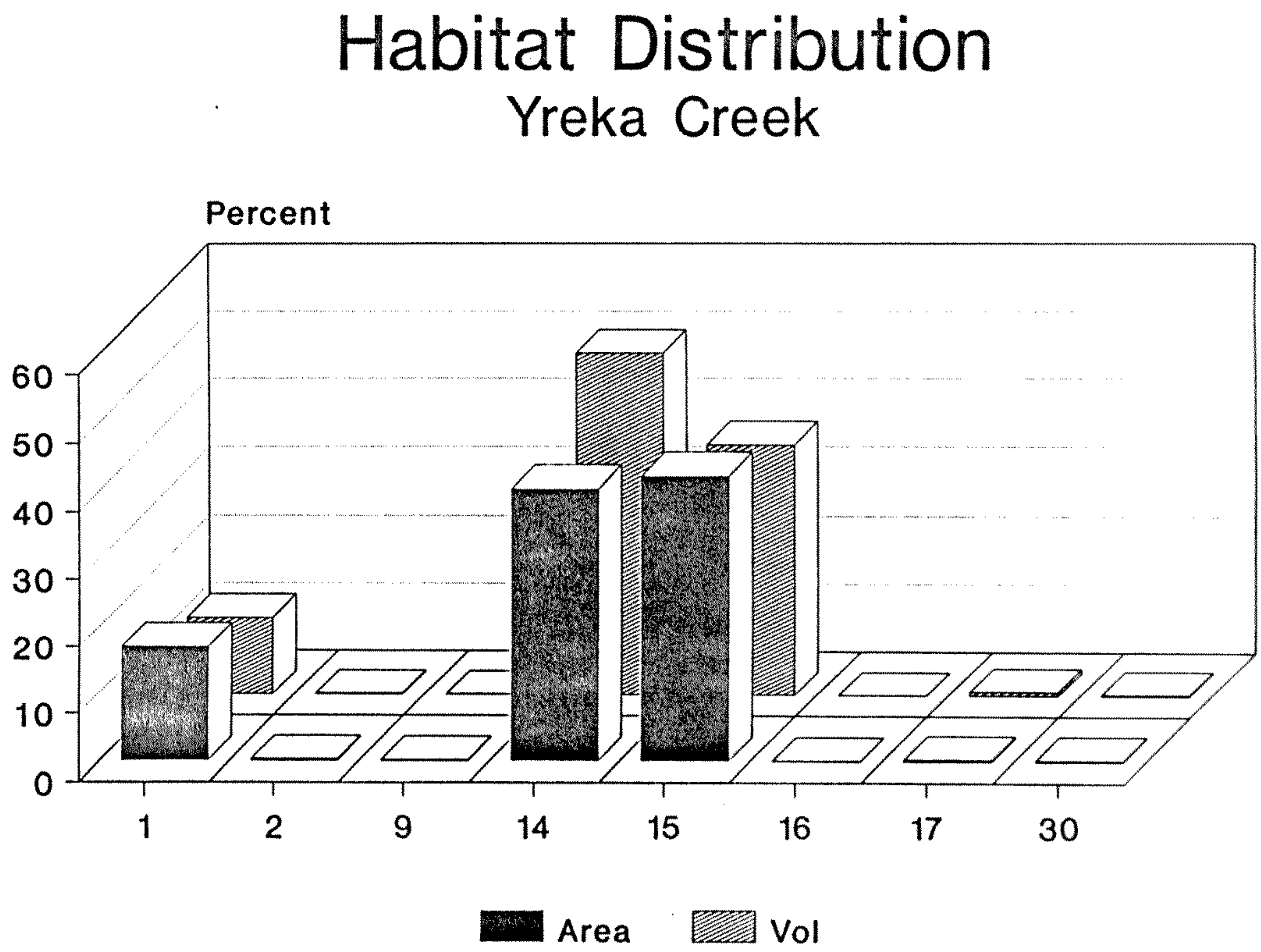


Yreka Creek
Physical Data Summary

HABITAT TYPE	NO. UNITS	LENGTH m	AREA m^2	VOLUME m^3	AVG LENGTH m	AVG WIDTH m	AVG DEPTH m	AVG VOLUME m^3	STREAM AREA %	STREAM VOL %	EMBEDD %	FINES %	GRAVEL %	COBBLE %	BOULDER %	BEDROCK %	SPAWN AREA m^2
1	67	2068	8539	1734	30.9	3.8	0.20	26.27	17	12	10.5	12	32	33	22	1	37
2	2	38	106	26	18.9	2.7	0.23	12.80	0	0	27.5		7	31	28	35	0
9	1	14	34	14	13.7	2.4	0.43	14.11	0	0	0.0	80	20				0
14	166	4970	20309	7566	29.9	3.6	0.34	45.58	40	50	6.0	48	27	17	7	1	36
15	157	7678	21227	5534	48.9	2.9	0.21	35.25	42	37	3.9	34	38	19	9	0	190
16	1	15	18	3	14.6	1.2	0.15	2.69	0	0							0
17	2	24	134	94	12.0	5.3	0.69	47.18	0	1	3.5	74	6			20	5
30	1	12	93	34	12.2	7.6	0.37	33.60	0	0	20.0	10	30	40	20		1

Cover Data Summary

HABITAT	NO. UNITS	COVER %	UNDERCUT %	SWD %	LWD %	TERR_VEG %	WT_WATER %	BOULDERS %	BDRK_LEDG %	SHADE %
1	66	33	12	31	32	22	1	1	1	25
2	2	19		4	18	16	20	20	20	19
9	1	10	80	20						40
14	166	41	47	27	17	7	1	1	1	24
15	157	34	34	38	19	9	0	0	0	17
16	1	20								
17	2	60	53	4			14	14	14	9
30	1	30	10	30	40	20				0


Habitat Distribution
Yreka Creek
Percent
60
50
40
30
20
10
0
1
2
9
14
15
16
17
30
Area
Vol

Yreka Creek
Biological Data Summary

Fish by Habitat Type

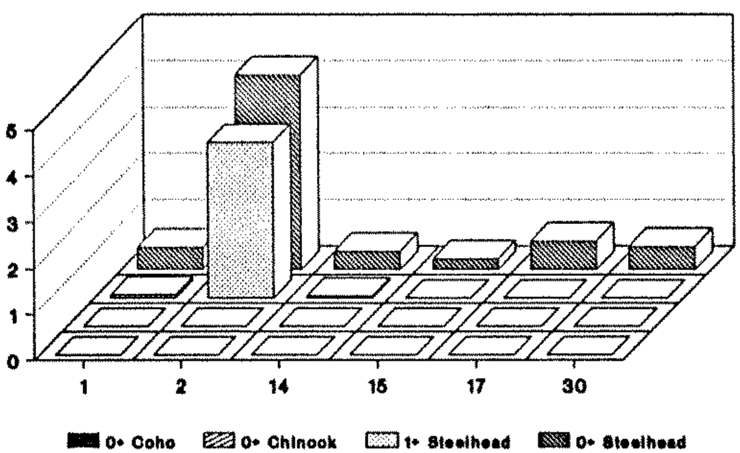
HABITAT	# UNITS	0+ STHD	1+ STHD	0+ KING	0+ COHO	TOTAL VOLUME m^3	TOTAL AREA m^2	OBSERVED VOLUME m^3	OBSERVED AREA m^2
1	6	102	15	0	0	1734	8539	209	953
2	1	25	20	0	0	26	105	6	33
14	8	161	18	0	0	7566	20309	400	1169
15	5	77	0	0	0	5534	21227	316	1218
17	1	15	0	0	0	94	133	24	40
30	1	17	0	0	0	34	93	34	93

Yreka Creek
Estimated Fish Densities

	Area				Volume			
HABITAT	0+ STHD	1+ STHD	0+ KING	0+ COHO	0+ STHD	1+ STHD	0+ KING	0+ COHO
1	0.107	0.016	0.000	0.000	0.489	0.072	0.000	0.000
2	0.759	0.607	0.000	0.000	4.204	3.363	0.000	0.000
14	0.138	0.015	0.000	0.000	0.402	0.045	0.000	0.000
15	0.063	0.000	0.000	0.000	0.243	0.000	0.000	0.000
17	0.371	0.000	0.000	0.000	0.616	0.000	0.000	0.000
30	0.183	0.000	0.000	0.000	0.506	0.000	0.000	0.000

Estimated Fish Densities

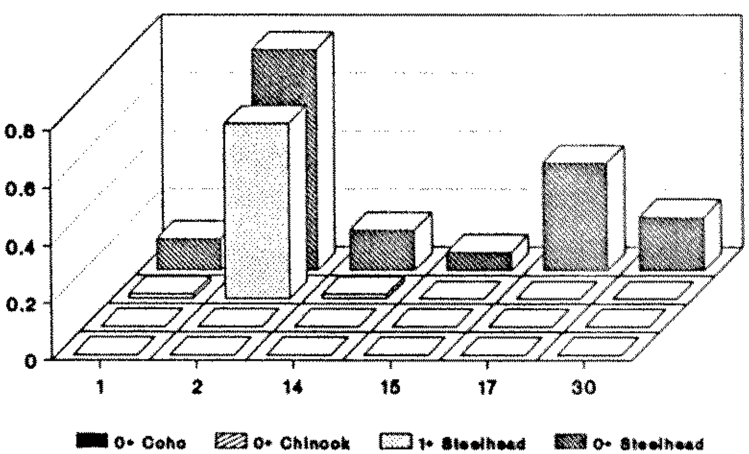
Yreka Creek



Fish Per Cu. M.

Estimated Fish Densities

Yreka Creek



Fish Per Sq. M.

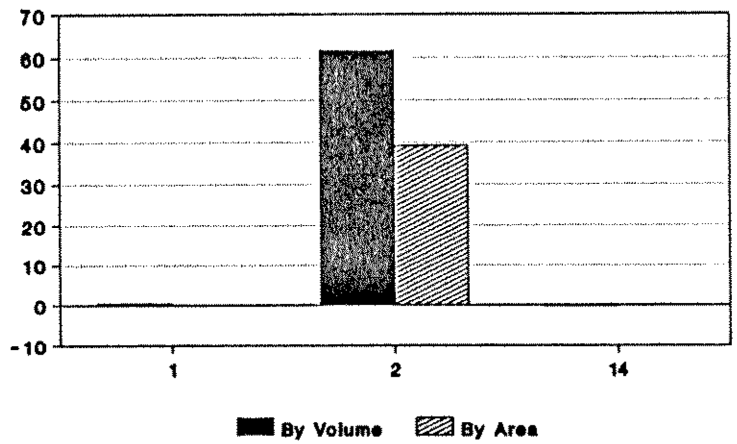
Yreka Creek
Utilization Coefficients

HABITAT	Area 0+ STHD	1+ STHD	0+ KING	0+ COHO	Volume 0+ STHD	1+ STHD	0+ KING	0+ COHO
1	-0.05	0.04			0.22	0.34		
2	5.71	39.18			9.47	61.76		
14	0.22	0.02			0.00	-0.16		
15	-0.44				-0.39			
17	2.27				0.53			
30	0.61				0.26			

Estimated Standing Crop

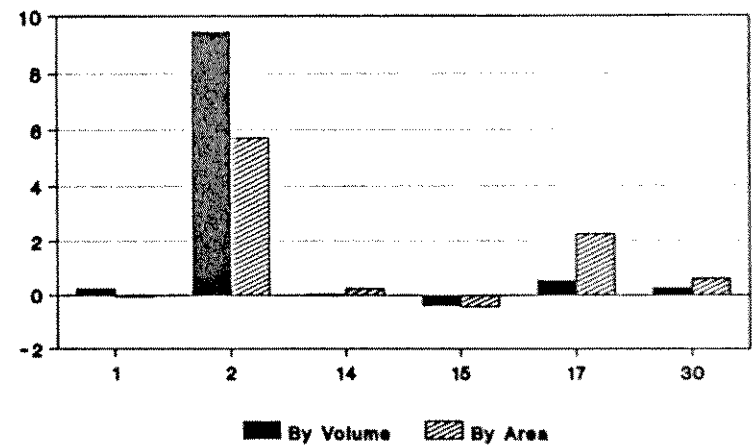
Area HABITAT	0+ STHD	1+ STHD	0+ KING	0+ COHO	Volume 0+ STHD	1+ STHD	0+ KING	0+ COHO
1	914	134	0	0	847	125	0	0
2	80	64	0	0	108	86	0	0
14	2798	313	0	0	3043	340	0	0
15	1342	0	0	0	1348	0	0	0
17	49	0	0	0	58	0	0	0
30	17	0	0	0	17	0	0	0
TOTAL	5200	511	0	0	5421	551	0	0

Utilization Coefficients
1+ Steelhead



Yreka Creek

Utilization Coefficients
0+ Steelhead

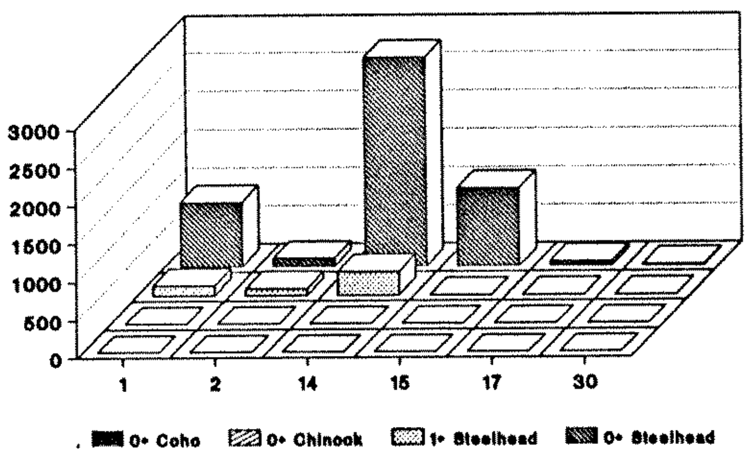


Yreka Creek

0+ Chinook were not observed in this system.

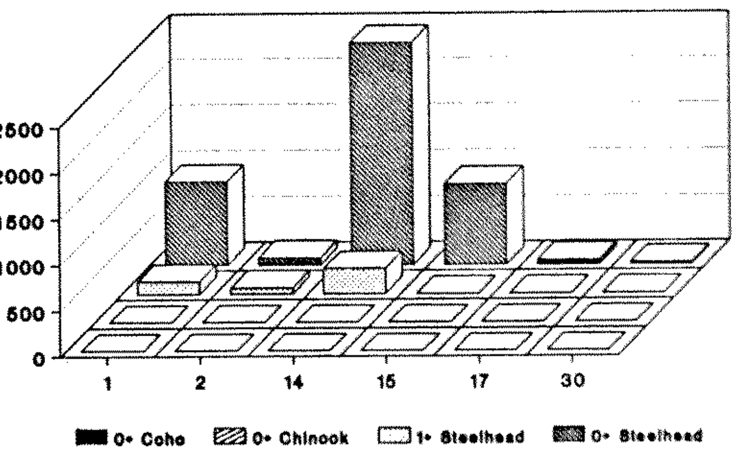
0+ Coho were not observed in this system.

Estimated Standing Crop
Yreka Creek



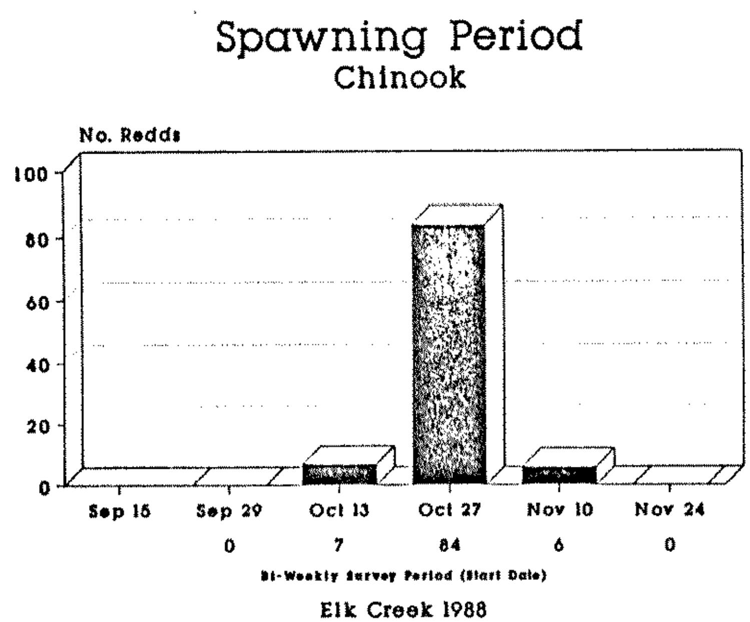
Derived From Fish Per Cu. M.

Estimated Standing Crop
Yreka Creek

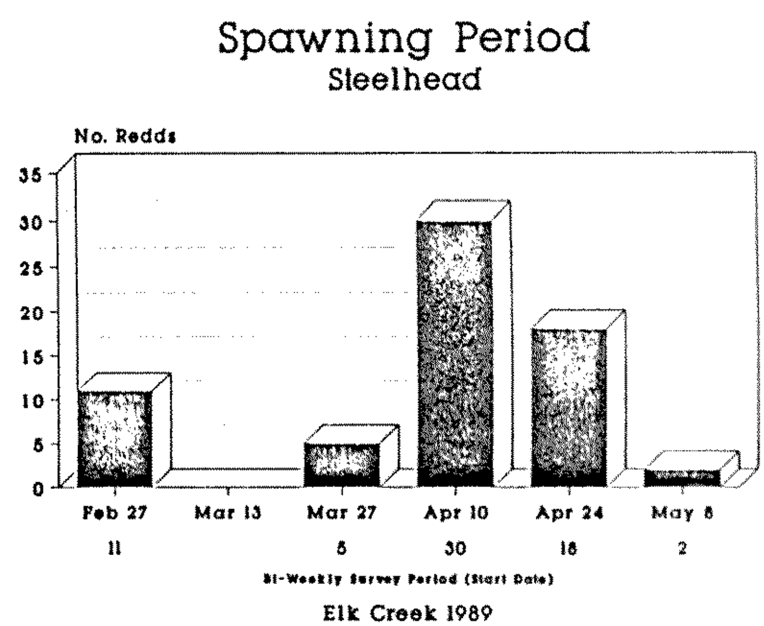


Derived From Fish Per Sq. M.

APPENDIX J. HABITAT CONDITION AND USE - ELK CREEK



Spawning Period
Chinook
No. Redds
100
80
60
40
20
0
Sep 15
Sep 29
Oct 13
Oct 27
Nov 10
Nov 24
0
7
84
6
0
Bi-Weekly Survey Period (Start Date)
Elk Creek 1988



Spawning Period
Steelhead
No. Redds
35
30
25
20
15
10
5
0
Feb 27
Mar 13
Mar 27
Apr 10
Apr 24
May 8
11
5
30
18
2
Bi-Weekly Survey Period (Start Date)
Elk Creek 1989

Relationship between spawning and rearing habitat for steelhead in Elk Creek, 1989.

Parameter	Numbers
Steelhead spawning area/pair	1.5 m^2
Steelhead spawning area in study area	343 m^2
Redds accom. w/out superimposition	229 redds
Total spawning population (1.5 males/female)	572 spawners
Estimated 1+ steelhead standing crop	18567 juveniles
Estimated 2+ smolts (40% survival)	7427 smolts
Expected adult maiden return (5%)	371 adults
Estimated maiden redds @ 2.5 fish/redd	149 maiden redds
Est. total redds (60% maiden;40% repeat)	248 total redds

<u>CONCLUSION:</u> <u>Present spawning area is not adequate to seed the rearing habitat available in the study area under 1989 conditions.</u>

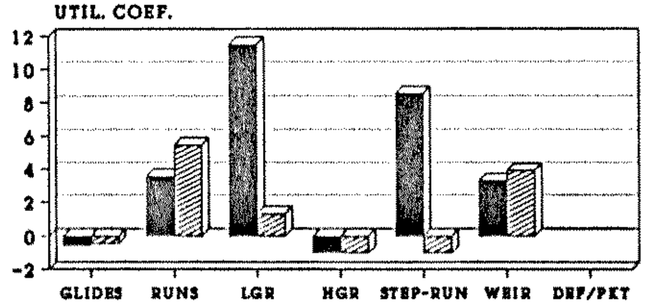
Elk Creek
Spawning Ground Utilization

	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	DEFL/PCKT	TOTAL
Spawning Area m^2	174	18	5	55	1	6	0	259
Percent Spawning Area	67	7	2	21	0	2	0	
Chinook Redds	27	31	24	0	4	9	2	97
Steelhead Redds	24	30	3	0	0	7	2	66
Chinook Redd Density	0.1554	1.7112	4.6971	0.0000	3.588	1.6146		0.3749
Steelhead Redd Density	0.1382	1.6560	0.5871	0.0000	0.0000	1.2558		0.2551

Utilization Coefficient

	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR
Chinook Util Coef	-0.5855	3.5644	11.5286	-1.0000	8.5704	3.3067
Steelhead Util Coef	-0.4584	5.4918	1.3017	-1.0000	-1.0000	3.9230

Spawner Utilization
Elk Creek 1988-89

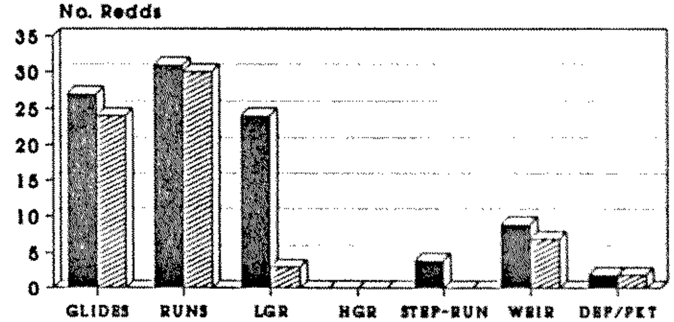


	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	DEP/PKT
CHINOOK	-0.585	3.564	11.529	-1	8.57	3.307	
STEELHEAD	-0.458	5.492	1.302	-1	-1	3.923	

SPAWNING HABITATS

CHINOOK STEELHEAD

Redds by Habitat Type
Elk Creek 1988-89



	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	DEP/PKT
Chinook	27	31	24	0	4	9	2
Steelhead	24	30	3	0	0	7	2

Chinook Steelhead

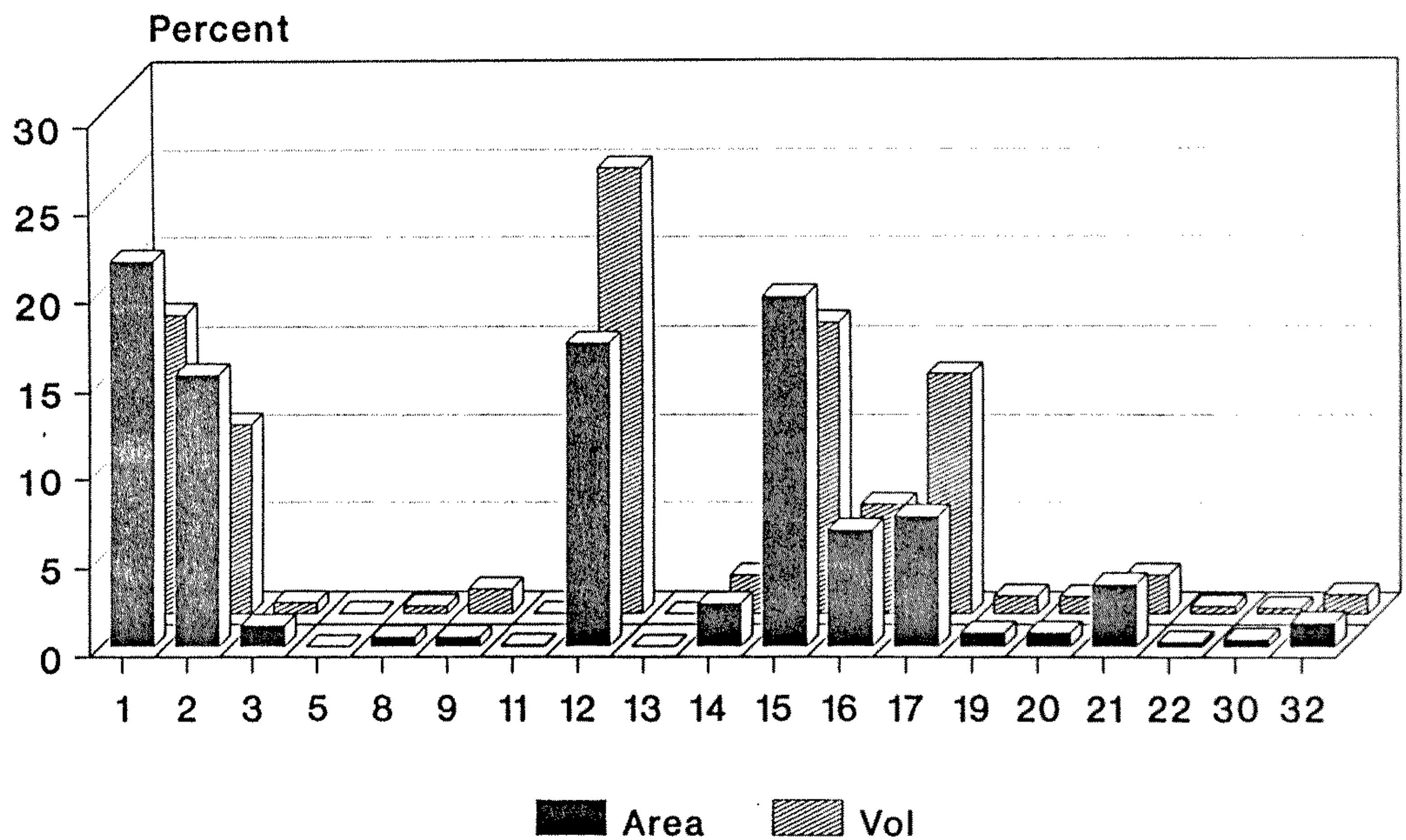
Elk Creek
Physical Data Summary

HABITAT TYPE	NO. UNITS	LENGTH m	AREA m^2	VOLUME m^3	AVG LENGTH m	AVG WIDTH m	AVG DEPTH m	AVG VOLUME m^3	STREAM AREA %	STREAM VOL %	EMBEDD %	FINES %	GRAVEL %	COBBLE %	BOULDER %	BEDROCK %	SPAWN AREA m^2
1	111	4854	71760	39360	43.7	14.1	0.50	354.60	22	17	7.5	4	6	41	46	3	5
2	134	4113	50745	24956	30.7	12.1	0.46	187.64	15	11	2.7	1	2	34	56	6	55
3	22	406	3941	1507	19.3	8.7	0.57	115.94	1	1	0.5			22	74	4	0
5	1	9	42	84	9.2	4.6	2.04	84.42	0	0		5	5	10	10	70	0
8	4	142	1841	1082	35.6	12.1	0.97	360.64	1	0	3.0	8	5	20	7	60	5
9	8	151	1815	3262	19.0	11.9	1.78	407.77	1	1	10.7	3	6	32	38	20	2
11	3	43	266	112	14.4	5.6	0.47	37.35	0	0	10.6	1	1	75	23		0
12	121	4267	56634	58673	35.3	12.3	1.02	484.90	17	25	9.0	12	11	36	31	9	77
13	1	8	29	16	7.9	3.7	0.55	15.72	0	0	25.0		5	45	45	5	0
14	8	415	8116	5093	51.9	19.3	0.60	636.65	2	2	6.3	5	14	34	46	1	2
15	131	4889	65089	38336	37.6	12.4	0.61	294.89	20	16	7.2	5	8	44	39	4	11
16	39	1999	21589	14316	51.2	10.0	0.65	367.08	7	6	7.8	4	10	36	37	13	1
17	61	1963	24214	31646	32.2	11.9	1.33	518.79	7	14	6.8	13	11	27	26	24	171
19	6	190	2629	2391	31.6	13.3	0.93	398.45	1	1	6.6	15	17	37	30		0
20	11	235	2621	2294	21.4	10.6	0.86	208.56	1	1	14.7	7	8	48	30	7	3
21	14	928	11649	5188	66.3	12.5	0.48	370.58	4	2	2.7	5	4	33	50	7	4
22	4	91	780	1054	22.8	7.1	1.47	263.37	0	0	11.1	11	8	42	25	13	0
30	1	101	1381	832	100.7	13.7	0.61	831.60	0	0	20.0	5	15	40	40		6
32	2	307	4500	2659	153.7	14.6	0.59	1329.35	1	1		5	5	45	45		0

Elk Creek
Cover Data Sumary

HABITAT	NO. UNITS	COVER %	UNDERCUT %	SWD %	LWD %	TERR_VEG %	WT_WATER %	BOULDERS %	BDRK_LEDG %	SHADE %
1	111	44	3	1	0	8	45	41	2	10
2	134	66	1	1	1	4	54	39	2	7
3	22	90					67	27	6	5
5	1	5					20		80	4
8	4	19			2		27	2	69	3
9	8	43	1		2		57	14	26	2
11	3	38		6	45	6	39	3		32
12	121	21	3	1	1	4	27	37	27	11
13	1	99	5	10	25	25	30	5		98
14	8	6	1	1	25	11		60	2	1
15	131	20	5	1	5	10	24	49	5	14
16	39	34	1	1	1	5	32	54	6	6
17	61	20	5		0	4	25	34	31	5
19	6	26			11	11	55	18	5	0
20	11	30	4			12	44	35	5	7
21	14	59		1		4	44	51		3
22	4	25			0	5	32	7	56	7
30	1	10					30	70		15
32	2	39				9	32	59		

Habitat Distribution
Elk Creek



Elk Creek
Biological Data Summary

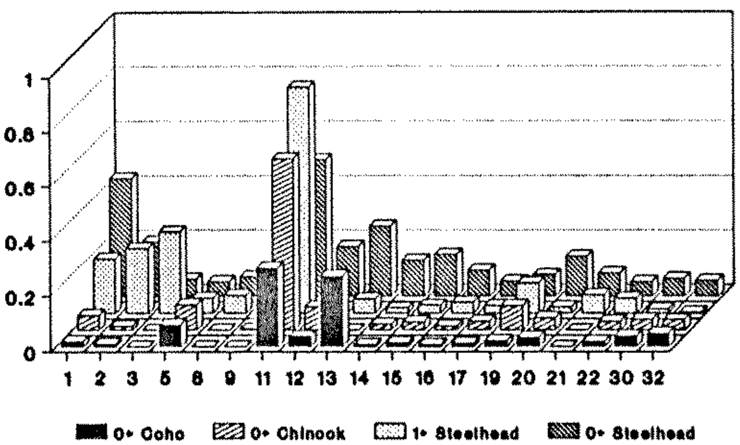
Observed Fish by Habitat Type

HABITAT	# UNITS	0+ STHD	1+ STHD	0+ KING	0+ COHO	TOTAL VOLUME cu m	TOTAL AREA m^2	HABITAT	OBSERVED VOLUME cu m	OBSERVED AREA m^2
1	31	7656	1472	1584	560	39360	71760	1	7564	16994
2	35	2152	1076	268	184	24956	50745	2	4631	9989
3	1	24	48	0	0	1507	3941	3	163	318
5	2	16	14	28	25	84	42	5	314	219
8	2	32	29	0	0	1082	1841	8	470	493
9	4	43	25	3	0	3262	1815	9	879	537
11	2	16	22	20	9	112	266	11	32	63
12	30	2170	205	977	451	58673	56633	12	12087	11440
13	1	6	1	0	6	16	29	13	24	44
14	3	59	8	10	3	5093	8116	14	457	893
15	33	2539	320	594	307	38336	65089	15	12533	18941
16	12	739	211	133	75	14316	21589	16	5967	5952
17	17	361	168	199	76	31646	24213	17	6598	5092
19	2	29	34	32	8	2391	2629	19	375	549
20	5	267	34	81	61	2294	2620	20	1858	4070
21	3	64	35	0	0	5188	11649	21	578	1189
22	3	50	42	29	18	1053	780	22	945	776
30	1	63	14	38	38	832	1381	30	983	1632
32	2	151	7	97	127	2659	4500	32	2617	4414

Fish Densities

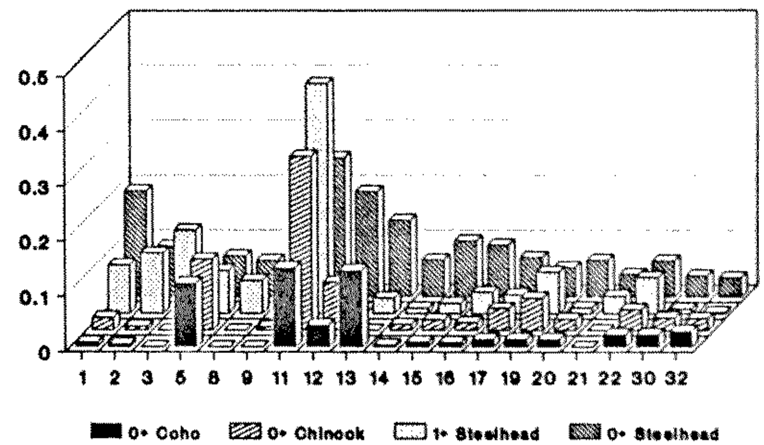
	Area				Volume			
HABITAT	0+ STHD	1+ STHD	0+ KING	0+ COHO	0+ STHD	1+ STHD	0+ KING	0+ COHO
1	0.451	0.087	0.093	0.033	1.012	0.195	0.209	0.074
2	0.215	0.108	0.027	0.018	0.465	0.232	0.058	0.040
3	0.075	0.151	0.000	0.000	0.147	0.295	0.000	0.000
5	0.073	0.064	0.128	0.114	0.051	0.045	0.089	0.080
8	0.065	0.059	0.000	0.000	0.068	0.062	0.000	0.000
9	0.080	0.047	0.006	0.000	0.049	0.028	0.003	0.000
11	0.253	0.348	0.316	0.142	0.500	0.688	0.625	0.281
12	0.190	0.018	0.085	0.039	0.180	0.017	0.081	0.037
13	0.138	0.023	0.000	0.138	0.254	0.042	0.000	0.254
14	0.066	0.009	0.011	0.003	0.129	0.018	0.022	0.007
15	0.134	0.017	0.031	0.016	0.203	0.026	0.047	0.025
16	0.124	0.035	0.022	0.013	0.124	0.035	0.022	0.013
17	0.071	0.033	0.039	0.015	0.055	0.025	0.030	0.012
19	0.053	0.062	0.058	0.015	0.077	0.091	0.085	0.021
20	0.066	0.008	0.020	0.015	0.144	0.018	0.044	0.033
21	0.054	0.030	0.000	0.000	0.111	0.061	0.000	0.000
22	0.064	0.054	0.037	0.023	0.053	0.044	0.031	0.019
30	0.039	0.009	0.023	0.023	0.064	0.014	0.039	0.039
32	0.034	0.002	0.022	0.029	0.058	0.003	0.037	0.049

Estimated Fish Densities
Elk Creek



Fish Per Cu. M.

Estimated Fish Densities
Elk Creek



Fish Per Sq. M.

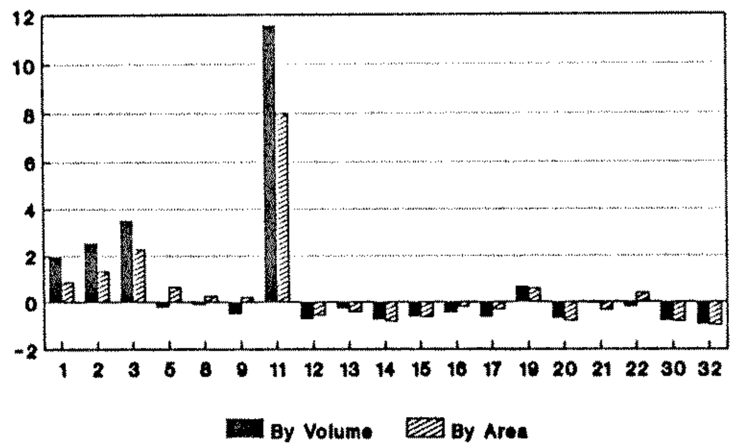
Elk Creek
Utilization Coeffiecients

HABITAT	Area 0+ STHD	1+ STHD	0+ KING	0+ COHO	Volume 0+ STHD	1+ STHD	0+ KING	0+ COHO
1	1.29	0.92	0.90	0.41	2.64	2.05	2.02	1.24
2	0.10	1.39	-0.45	-0.21	0.67	2.65	-0.16	0.20
3	-0.62	2.35			-0.47	3.62		
5	-0.63	0.42	1.61	3.90	-0.82	-0.30	0.29	1.42
8	-0.67	0.31			-0.76	-0.03		
9	-0.59	0.03	-0.89		-0.82	-0.55	-0.95	
11	0.29	6.72	5.46	5.11	0.80	9.79	8.03	7.53
12	-0.04	-0.60	0.74	0.69	-0.35	-0.73	0.17	0.13
13	-0.30	-0.49		4.92	-0.09	-0.33		6.71
14	-0.66	-0.80	-0.77	-0.86	-0.54	-0.73	-0.68	-0.80
15	-0.32	-0.62	-0.36	-0.30	-0.27	-0.60	-0.32	-0.26
16	-0.37	-0.21	-0.54	-0.46	-0.55	-0.44	-0.68	-0.62
17	-0.64	-0.27	-0.20	-0.36	-0.80	-0.60	-0.56	-0.65
19	-0.73	0.37	0.19	-0.37	-0.72	0.42	0.23	-0.35
20	-0.67	-0.81	-0.59	-0.36	-0.48	-0.71	-0.37	0.00
21	-0.73	-0.34			-0.60	-0.05		
22	-0.67	0.20	-0.24	0.00	-0.81	-0.30	-0.56	-0.42
30	-0.80	-0.81	-0.52	0.00	-0.77	-0.78	-0.44	0.17
32	-0.83	-0.96	-0.55	0.23	-0.79	-0.96	-0.47	0.47

Estimated Standing Crop

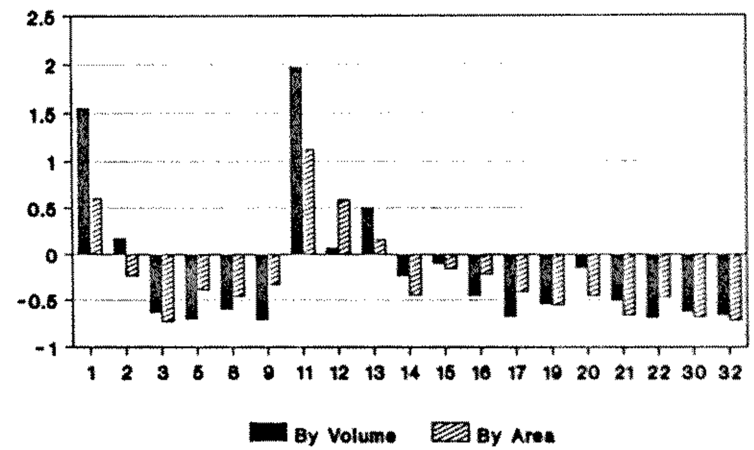
	Area				Volume		AREA	
HABITAT	0+ STHD	1+ STHD	0+ KING	0+ COHO	0+ STHD	1+ STHD	0+ KING	0+ COHO
1	32328	6216	6689	2365	39840	7660	8243	2914
2	10932	5466	1361	935	11597	5799	1444	992
3	297	594	0	0	222	444	0	0
5	3	3	5	5	4	4	8	7
8	120	108	0	0	74	67	0	0
9	145	85	10	0	160	93	11	0
11	67	92	84	38	56	77	70	32
12	10743	1015	4837	2233	10533	995	4742	2189
13	4	1	0	4	4	1	0	4
14	536	73	91	27	658	89	111	33
15	8726	1100	2040	1056	7767	979	1816	940
16	2681	766	482	273	1773	507	319	180
17	1717	799	946	361	1731	806	954	365
19	139	163	153	38	185	217	204	51
20	172	22	52	39	330	42	100	75
21	627	345	0	0	574	316	0	0
22	50	42	29	18	56	47	32	20
30	53	12	32	32	53	12	32	32
32	154	7	99	129	153	7	99	129
TOTAL	69495	16908	16911	7553	75772	18160	18186	7963

Utilization Coefficients
1+ Steelhead



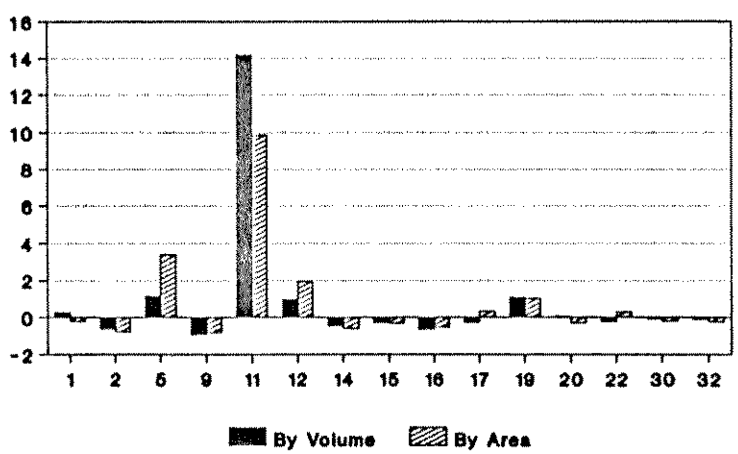
Elk Creek

Utilization Coefficients
0+ Steelhead



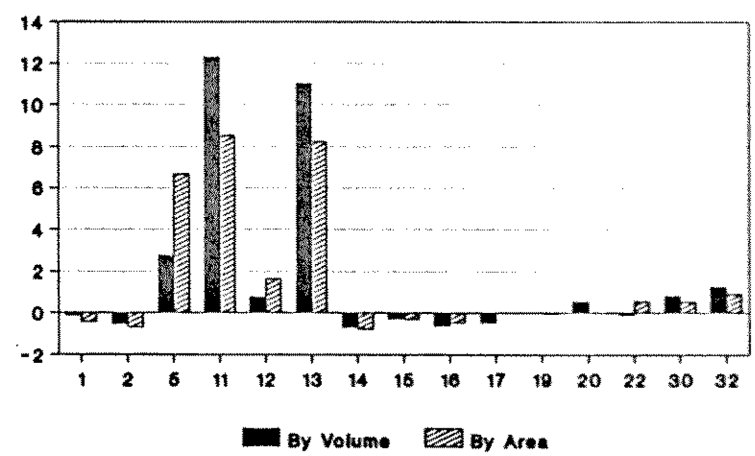
Elk Creek

Utilization Coefficients
0+ Chinook



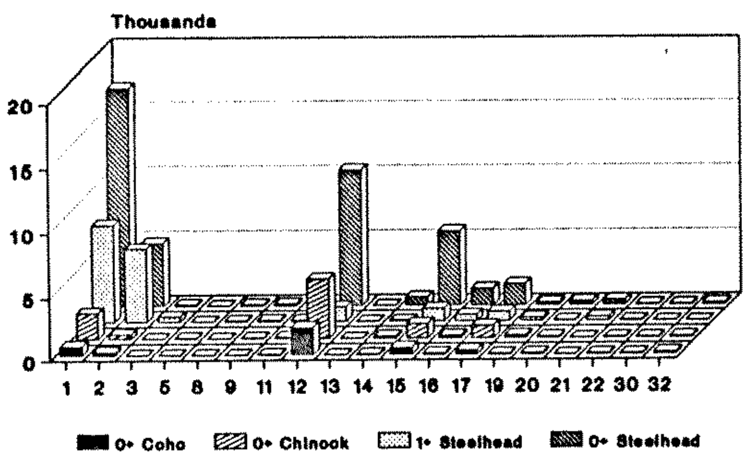
Elk Creek

Utilization Coefficients
0+ Coho



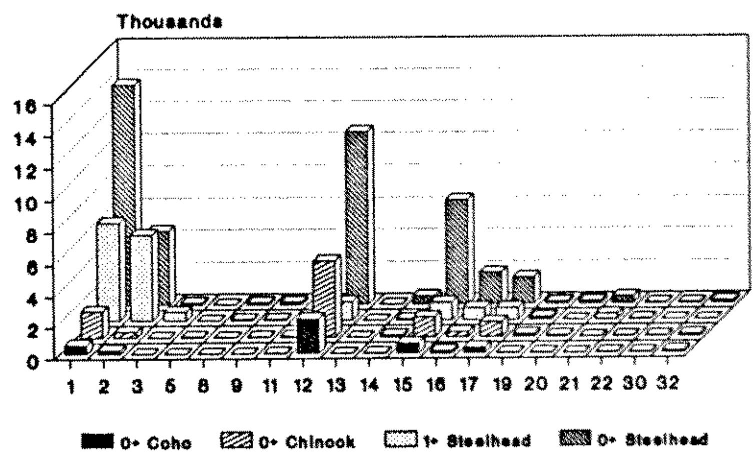
Elk Creek

Estimated Standing Crop
Elk Creek



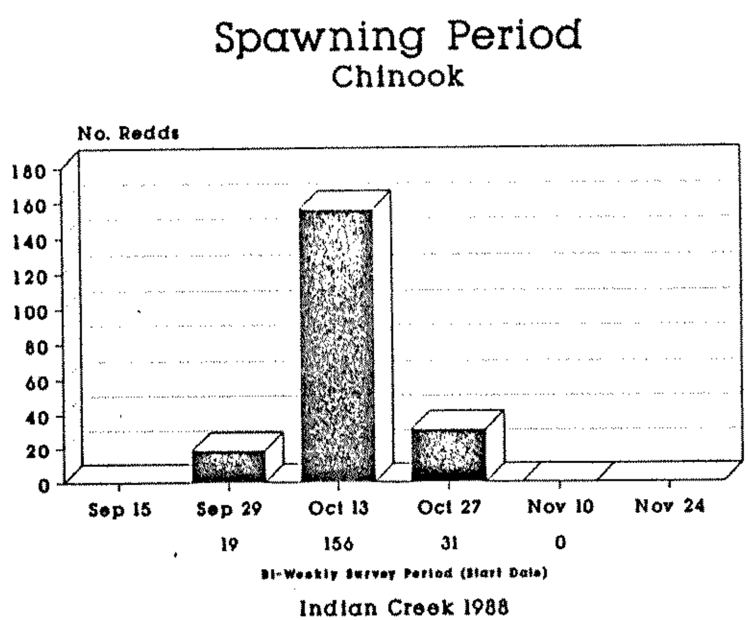
Derived From Fish Per Cu. M.

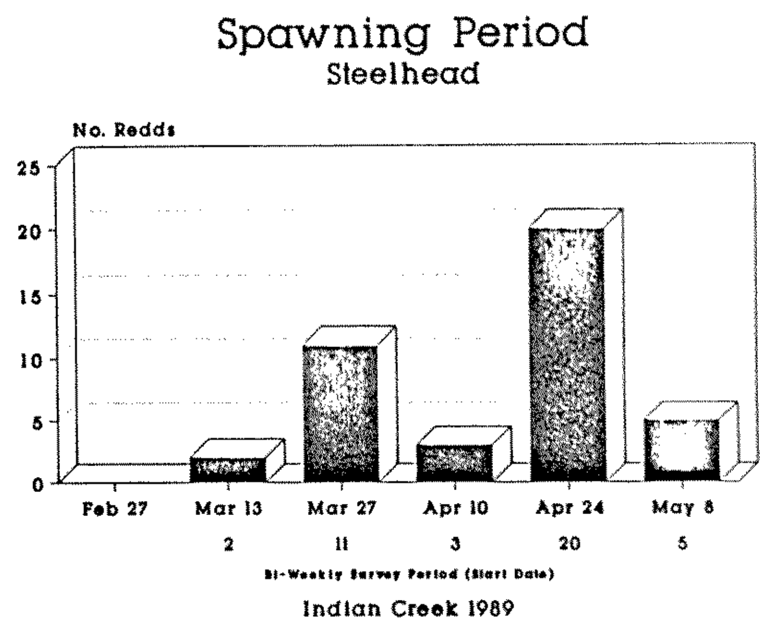
Estimated Standing Crop
Elk Creek



Derived From Fish Per Sq. M.

APPENDIX K. HABITAT CONDITION AND USE - INDIAN CREEK


Spawning Period
Chinook
No. Redds
180
160
140
120
100
80
60
40
20
0
Sep 15
Sep 29
Oct 13
Oct 27
Nov 10
Nov 24
19
156
31
0
Bi-Weekly Survey Period (Start Date)
Indian Creek 1988


Spawning Period
Steelhead
No. Redds
25
20
15
10
5
0
Feb 27
Mar 13
Mar 27
Apr 10
Apr 24
May 8
2
11
3
20
5
Bi-Weekly Survey Period (Start Date)
Indian Creek 1989

Relationship between spawning and rearing habitat for steelhead in Indian Creek, 1989.

Parameter	Numbers
Steelhead spawning area/pair	1.5 m^2
Steelhead spawning area in study area	2400 m^2
Redds accom. w/out superimposition	1600 redds
Total spawning population (1.5 males/female)	4000 spawners
Estimated 1+ steelhead standing crop	14195 juveniles
Estimated 2+ smolts (40% survival)	5678 smolts
Expected adult maiden return (5%)	284 adults
Estimated maiden redds @ 2.5 fish/redd	114 maiden redds
Est. total redds (60% maiden;40% repeat)	189 total redds

CONCLUSION: Present spawning area is adequate to seed the rearing habitat available in the study area under 1989 conditions.

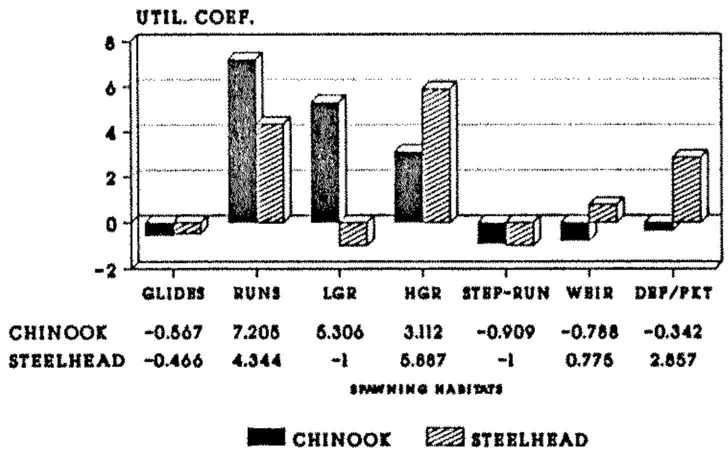
Indian Creek
Spawning Ground Utilization

	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	DEFL/PCKT	TOTAL
Spawning Area m^2	1543	154	48	9	387	166	107	2413
Percent Spawning Area	64	6	2	0	16	7	4	
Chinook Redds	57	108	26	3	3	3	6	206
Steelhead Redds	14	14	0	1	0	5	7	41
Chinook Redd Density	0.0369	0.7003	0.5382	0.3510	0.0078	0.0181	0.0562	0.0854
Steelhead Redd Density	0.0091	0.0908	0.0000	0.1170	0.0000	0.0302	0.0655	0.0170

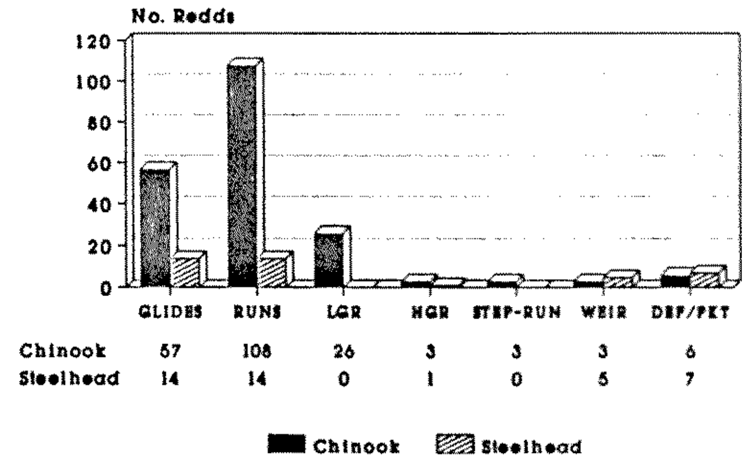
Utilization Coefficients

	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	DEFL/PCKT
Chinook Util Coef	-0.5672	7.2049	5.3056	3.1123	-0.9091	-0.7880	-0.3420
Steelhead Util Coef	-0.4659	4.3439	-1.0000	5.8873	-1.0000	0.7749	2.8569

Spawner Utilization
Indian Creek 1988-89



Redds by Habitat Type
Indian Creek 1988-89



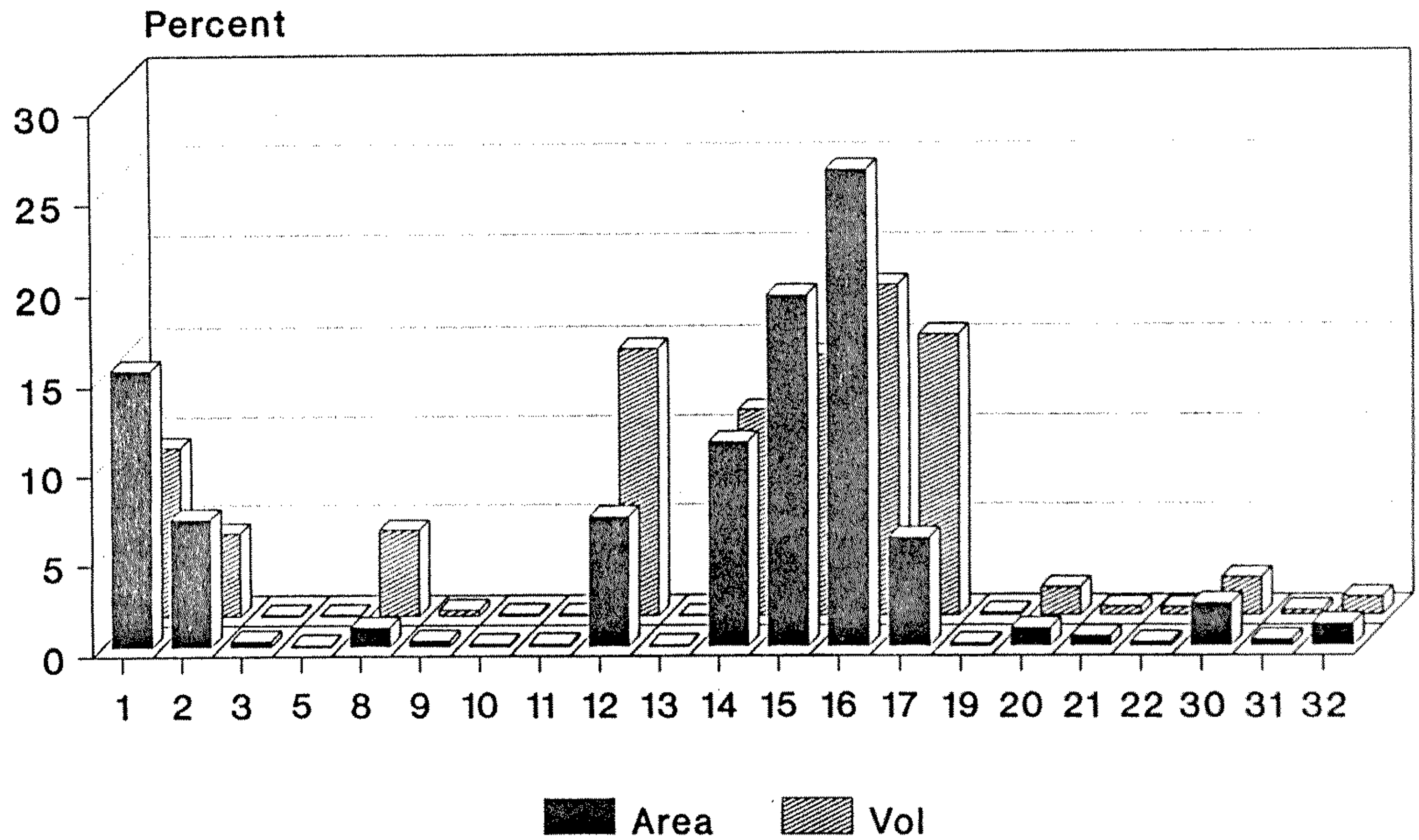
Indian Creek
Physical Data Summary

HABITAT TYPE	NO. UNITS	LENGTH m	AREA m^2	VOLUME m^3	AVG LENGTH m	AVG WIDTH m	AVG DEPTH m	AVG VOLUME m^3	STREAM AREA %	STREAM VOL %	EMBEDD %	FINES %	GRAVEL %	COBBLE %	BOULDER %	BEDROCK %	SPAWN AREA m^2
1	114	4707	55855	16628	41.3	11.6	0.28	145.86	15	9	4.4	6	11	41	39	3	48
2	116	2725	25497	8051	23.5	8.6	0.27	69.41	7	5	2.2	2	8	31	53	7	9
3	11	99	1035	86	9.0	10.5	0.16	17.28	0	0							0
5	3	23	138	109	7.5	5.5	0.60	36.30	0	0	8.4	55	15	20	10		0
8	5	323	3763	8382	64.7	9.5	1.72	1676.37	1	5	2.7	19	19	19	38	6	0
9	22	172	1012	568	7.8	5.4	0.52	25.80	0	0	11.1	5	12	34	39	10	9
10	3	47	331	174	15.7	5.8	0.50	57.92	0	0	4.5	14	20	37	29		1
11	5	82	382	183	16.5	4.7	0.50	36.55	0	0	10.0	5	20	50	25		0
12	56	2002	25841	26369	35.8	11.0	0.93	488.31	7	15	3.2	17	17	37	24	5	261
13	6	28	134	62	4.6	4.5	0.44	10.30	0	0	8.4	9	11	27	54		0
14	38	2442	40949	20246	64.3	15.5	0.46	532.79	11	11	8.4	15	18	39	26	2	1332
15	150	5751	70315	25694	38.3	10.2	0.37	171.29	19	15	3.5	6	12	46	35	2	95
16	145	10717	95332	32307	73.9	8.3	0.31	222.80	26	18	2.7	8	11	35	41	5	387
17	40	1660	21489	27666	41.5	11.7	1.20	728.04	6	16	6.4	19	24	31	15	11	209
19	5	61	441	217	12.1	6.4	0.45	43.34	0	0	11.0	9	18	43	31		2
20	33	440	3509	2714	13.3	6.5	0.65	82.25	1	2	6.8	7	25	36	27	5	39
21	6	148	1867	828	24.7	9.9	0.41	137.98	1	0	4.8	2	8	33	57		20
22	1	60	725	786	59.5	12.2	1.10	786.24	0	0	5.0		5	70	20	5	0
30	8	792	8438	3687	99.0	9.5	0.45	460.83	2	2	3.2	3	21	36	39	1	166
31	2	159	1175	495	79.5	7.5	0.43	247.55	0	0							0
32	4	39 9	4371	1780	99.7	10.1	0.47	445.08	1	1	2.6	2	17	46	35		107

Indian Creek
Cover Data Sumary

HABITAT	NO. UNITS	COVER %	UNDERCUT %	SWD %	LWD %	TERR_VEG %	WT_WATER %	BOULDERS %	BDRK_LEDG %	SHADE %
1	114	43	0	1	0	7	42	49	1	4
2	116	61	0	1	0	7	44	46	1	6
3	11	54		3	3	1	54	37	2	
5	3	9		9		10		16	64	26
8	5	12					5	23	72	0
9	22	29			3	4	29	53	12	11
10	3	24			22	16	16	46		7
11	5	58	1	46	9	5	15	25		22
12	56	15		0	0	18	4	29	48	3
13	6	24		9	6	13	15	58		12
14	38	16	0	1	2	19	1	68	9	2
15	150	19	0	1	0	10	7	76	5	3
16	145	32	0	1	1	7	24	62	3	5
17	40	15	0	1	0	16	2	34	47	2
19	5	16	2	2		6	18	71		28
20	33	17	0	1	0	3	16	59	21	8
21	6	29		0	0	2	6	91		10
22	1	10						20	80	0
30	8	40		1		12	18	67	1	2
31	2	33					20	80		
32	4	29		6	1	15	11	67		6

Habitat Distribution
Indian Creek



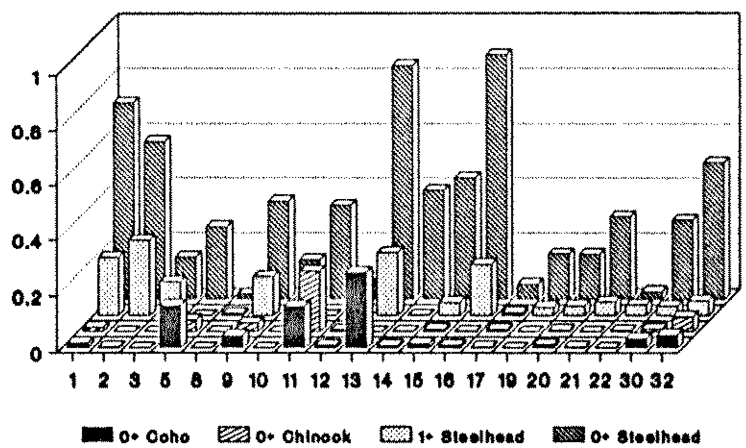
Indian Creek
Biological Data Summary
Observed Fish by Habitat Type

HABITAT	# UNITS	0+ STHD	1+ STHD	0+ KING	0+ COHO	TOTAL VOLUME m^3	TOTAL AREA m^2	OBSERVED VOLUME m^3	OBSERVED AREA m^2
1	28	3960	480	144	164	16628	55855	2358	8478
2	32	2476	492	4	24	8051	25497	1841	5960
3	1	36	12	0	0	86	1035	103	85
5	2	38	0	6	22	109	138	145	153
8	1	30	11	0	0	8382	3763	1589	894
9	6	103	33	9	13	568	1012	290	449
10	2	25	0	0	0	174	331	178	340
11	1	16	0	10	7	183	382	47	121
12	15	375	100	38	47	26369	25841	5153	5573
13	2	32	7	0	10	62	134	38	73
14	10	805	6	4	17	20246	40949	2043	4919
15	40	2195	165	51	94	25694	70315	3738	9698
16	34	3301	472	11	45	32306	95332	2789	7819
17	9	253	41	38	17	27666	21489	4696	4208
19	3	32	5	0	0	217	441	197	380
20	9	146	26	5	11	2714	3509	904	1268
21	4	227	26	0	3	828	1867	571	1131
22	1	19	22	3	0	786	725	680	628
30	2	126	15	4	15	3687	8438	441	976
32	3	431	46	47	40	1780	4371	869	2201

Estimated Fish Densities

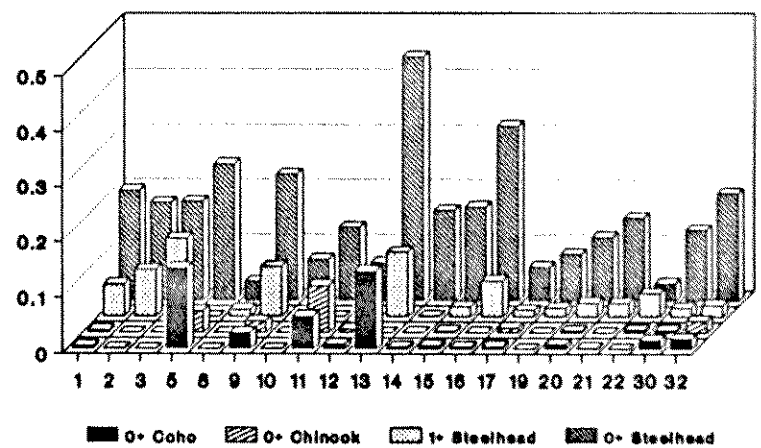
HABITAT	Area 0+ STHD	1+ STHD	0+ KING	0+ COHO	Volume 0+ STHD	1+ STHD	0+ KING	0+ COHO
1	0.467	0.057	0.017	0.019	1.679	0.204	0.061	0.070
2	0.415	0.083	0.001	0.004	1.345	0.267	0.002	0.013
3	0.422	0.141	0.000	0.000	0.350	0.117	0.000	0.000
5	0.248	0.000	0.039	0.143	0.262	0.000	0.041	0.152
8	0.034	0.012	0.000	0.000	0.019	0.007	0.000	0.000
9	0.229	0.073	0.020	0.029	0.355	0.114	0.031	0.045
10	0.074	0.000	0.000	0.000	0.140	0.000	0.000	0.000
11	0.133	0.000	0.083	0.058	0.339	0.000	0.212	0.148
12	0.067	0.018	0.007	0.008	0.073	0.019	0.007	0.009
13	0.441	0.096	0.000	0.138	0.849	0.186	0.000	0.265
14	0.164	0.001	0.001	0.003	0.394	0.003	0.002	0.008
15	0.226	0.017	0.005	0.010	0.587	0.044	0.014	0.025
16	0.422	0.060	0.001	0.006	1.184	0.169	0.004	0.016
17	0.060	0.010	0.009	0.004	0.054	0.009	0.008	0.004
19	0.084	0.013	0.000	0.000	0.163	0.025	0.000	0.000
20	0.115	0.020	0.004	0.009	0.161	0.029	0.006	0.012
21	0.201	0.023	0.000	0.003	0.398	0.045	0.000	0.006
22	0.030	0.035	0.005	0.000	0.028	0.032	0.004	0.000
30	0.129	0.015	0.004	0.015	0.286	0.034	0.009	0.034
32	0.196	0.021	0.021	0.018	0.496	0.053	0.054	0.046

Estimated Fish Densities
Indian Creek



Fish Per Cu. M.

Estimated Fish Densities
Indian Creek



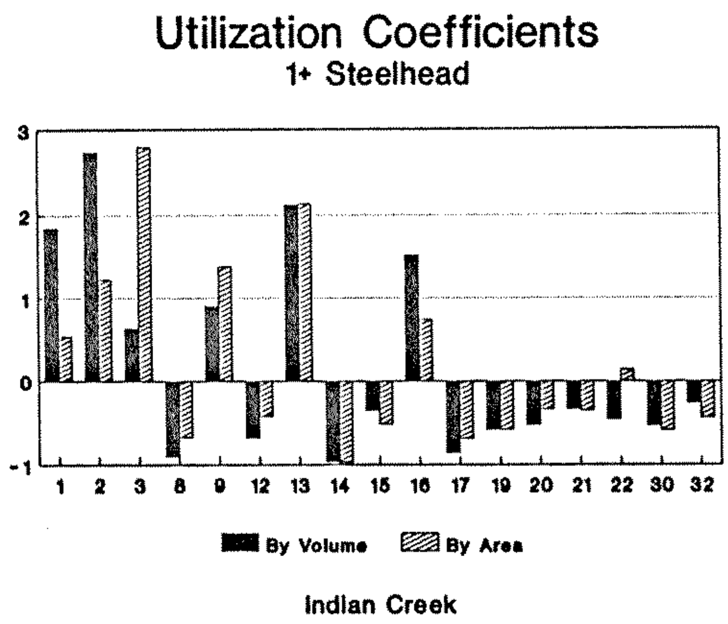
Fish Per Sq. M.

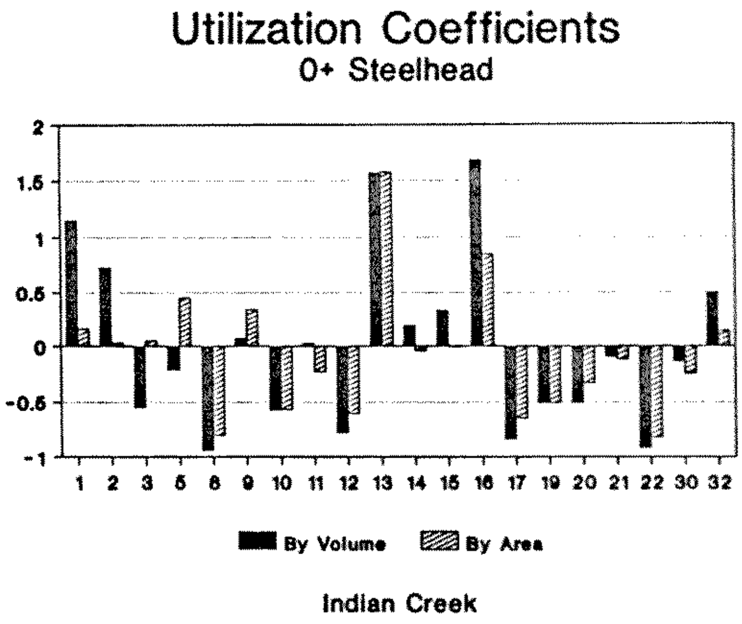
Indian Creek
Utilization Coeffiecient

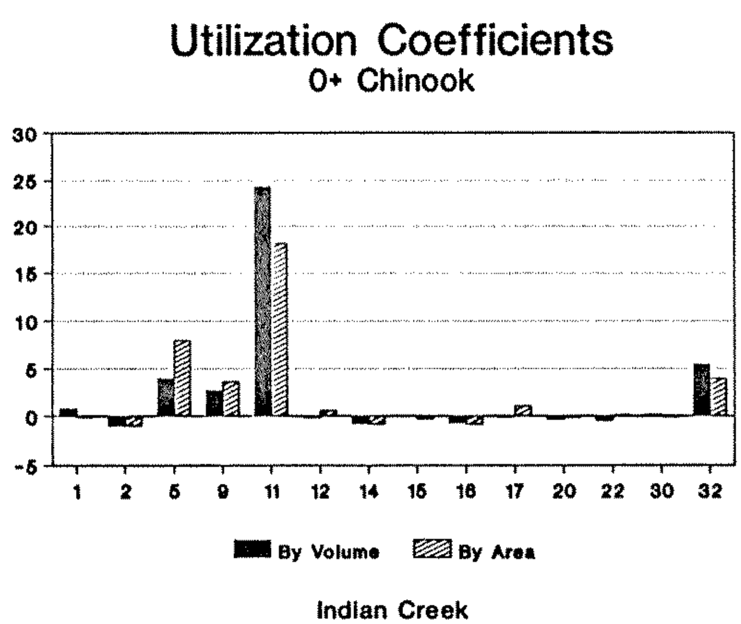
HABITAT	Area 0+ STHD	1+ STHD	0+ KING	0+ COHO	Volume 0+ STHD	1+ STHD	0+ KING	0+ COHO
1	0.77	0.60	1.51	1.02	2.29	1.98	3.68	2.77
2	0.57	1.33	-0.90	-0.58	1.64	2.91	-0.83	-0.29
3	0.60	2.97			-0.31	0.71		
5	-0.06		4.78	13.99	-0.49		2.17	7.21
8	-0.87	-0.65			-0.96	-0.90		
9	-0.13	1.08	1.96	2.02	-0.30	0.66	1.38	1.43
10	-0.72				-0.73			
11	-0.50		11.27	5.07	-0.34		15.23	7.04
12	-0.75	-0.49	0.01	-0.12	-0.86	-0.72	-0.44	-0.51
13	0.67	1.73		13.41	0.66	1.72		13.37
14	-0.38	-0.97	-0.88	-0.64	-0.23	-0.96	-0.85	-0.55
15	-0.14	-0.52	-0.22	0.02	0.15	-0.35	0.05	0.37
16	0.60	0.71	-0.79	-0.40	1.32	1.48	-0.69	-0.13
17	-0.77	-0.72	0.34	-0.58	-0.89	-0.87	-0.38	-0.80
19	-0.68	-0.63			-0.68	-0.63		
20	-0.56	-0.42	-0.42	-0.09	-0.68	-0.58	-0.58	-0.34
21	-0.24	-0.36		-0.70	-0.22	-0.34		-0.70
22	-0.89	-0.01	-0.29		-0.95	-0.53	-0.66	
30	-0.51	-0.57	-0.39	0.61	-0.44	-0.50	-0.30	0.84
32	-0.26	-0.41	2.16	0.90	-0.03	-0.22	3.14	1.49

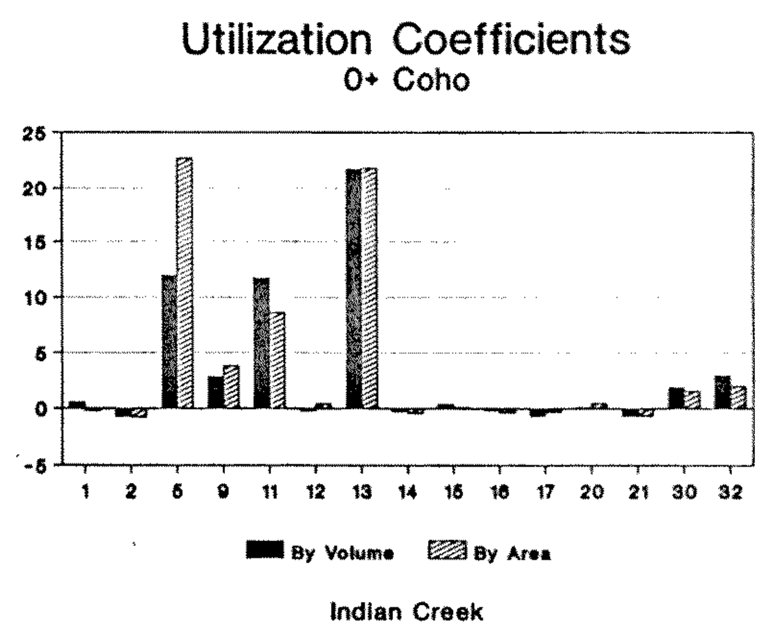
Indian Creek
Estimated Standing Crop

Area				Volume				
HABITAT	0+ STHD	1+ STHD	0+ KING	0+ COHO	0+ STHD	1+ STHD	0+ KING	0+ COHO
1	26090	3162	949	1080	27922	3385	1015	1156
2	10592	2105	17	103	10827	2151	17	105
3	436	145	0	0	30	10	0	0
5	34	0	5	20	29	0	5	17
8	126	46	0	0	158	58	0	0
9	232	74	20	29	201	65	18	25
10	24	0	0	0	24	0	0	0
11	51	0	32	22	62	0	39	27
12	1739	464	176	218	1919	512	194	240
13	59	13	0	18	52	11	0	16
14	6702	50	33	142	7977	59	40	168
15	15916	1195	371	684	15089	1133	352	649
16	40243	5755	137	546	38241	5468	130	519
17	1292	209	194	87	1490	242	224	100
19	37	6	0	0	35	6	0	0
20	404	72	14	30	438	78	15	33
21	375	42	0	5	330	37	0	5
22	22	25	3	0	22	25	3	0
30	1090	130	35	130	1054	126	33	126
32	856	91	93	79	883	94	96	82
TOTAL	106320	13585	2080	3195	106787	13460	2182	3269

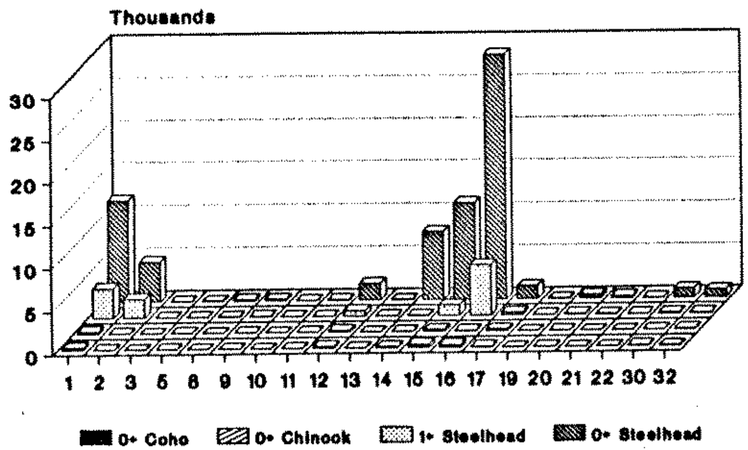

Utilization Coefficients
1+ Steelhead
3
2
1
0
-1
1 2 3 8 9 12 13 14 15 16 17 19 20 21 22 30 32
By Volume
By Area
Indian Creek


Utilization Coefficients
0+ Steelhead
2
1.5
1
0.5
0
-0.5
-1
1 2 3 5 8 9 10 11 12 13 14 15 16 17 19 20 21 22 30 32
By Volume
By Area
Indian Creek


Utilization Coefficients
0+ Chinook
30
25
20
15
10
5
0
-5
1 2 5 9 11 12 14 15 16 17 20 22 30 32
By Volume
By Area
Indian Creek

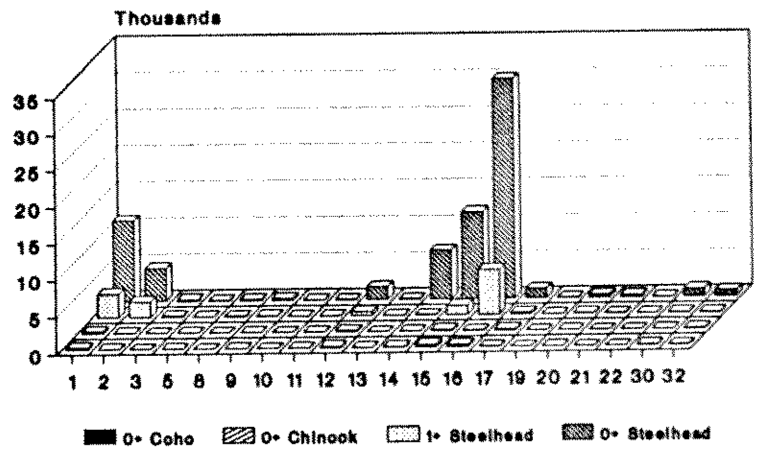

Utilization Coefficients
0+ Coho
25
20
15
10
5
0
-5
1 2 5 9 11 12 13 14 15 16 17 20 21 30 32
By Volume
By Area
Indian Creek

Estimated Standing Crop
Indian Creek



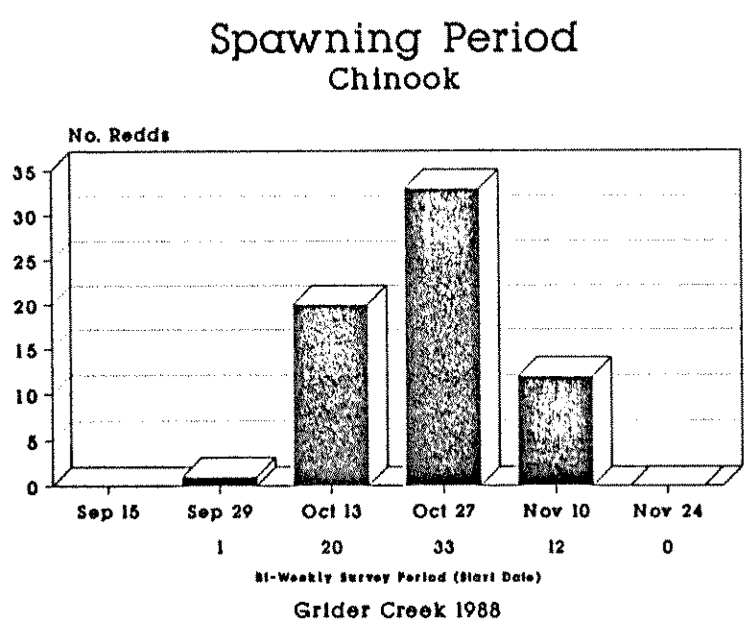
Derived From Fish Per Cu. M.

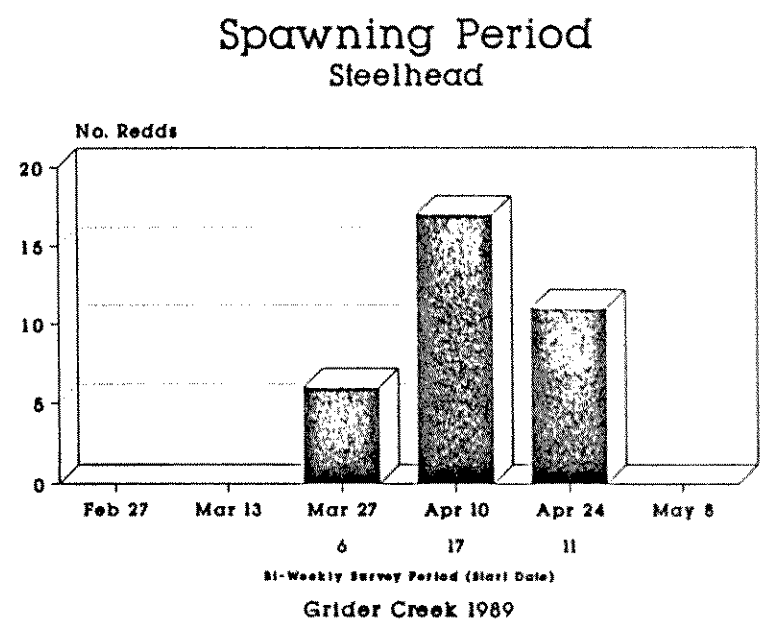
Estimated Standing Crop
Indian Creek



Derived From Fish Per Sq. M.

APPENDIX L. HABITAT CONDITION AND USE - GRIDER CREEK


Spawning Period
Chinook
No. Redds
35
30
25
20
15
10
5
0
Sep 15
Sep 29
Oct 13
Oct 27
Nov 10
Nov 24
1
20
33
12
0
Bi-Weekly Survey Period (Start Date)
Grider Creek 1988


Spawning Period
Steelhead
No. Redds
20
15
10
5
0
Feb 27
Mar 13
Mar 27
Apr 10
Apr 24
May 8
6
17
11
Bi-Weekly Survey Period (Start Date)
Grider Creek 1989

Relationship between spawning and rearing habitat for steelhead in Grider Creek, 1989.

Parameter	Numbers
Steelhead spawning area/pair	1.5 m^2
Steelhead spawning area in study area	5660 m^2
Redds accom. w/out superimposition	3773 redds
Total spawning population (1.5 males/female)	9433 spawners
Estimated 1+ steelhead standing crop	17997 juveniles
Estimated 2+ smolts (40% survival)	7199 smolts
Expected adult maiden return (5%)	360 adults
Estimated maiden redds @ 2.5 fish/redd	144 maiden redds
Est. total redds (60% maiden;40% repeat)	240 total redds

<u>CONCLUSION:</u> <u>Present spawning area is adequate to seed the rearing habitat available in the study area under 1989 conditions.</u>

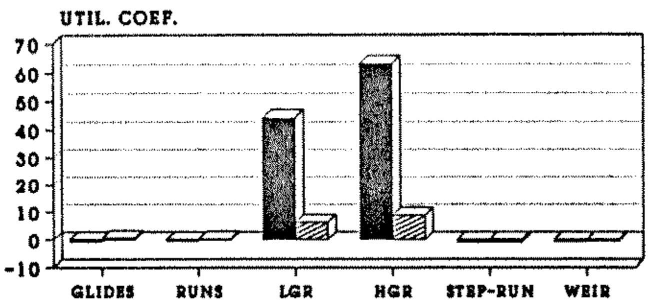
Grider Creek
Spawning Ground Utilization

	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	TOTAL
Spawning Area m^2	890	3287	44	16	663	762	5663
Percent Spawning Area	16	58	1	0	12	13	
Chinook Redds	3	24	23	12	1	2	66
Steelhead Redds	8	22	2	1	0	3	36
Chinook Redd Density	0.0034	0.0073	0.5279	0.7467	0.0015	0.0026	0.0117
Steelhead Redd Density	0.0090	0.0067	0.0459	0.0622	0.0000	0.0039	0.0064

Utilization Coefficients

	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR
Chinook Util Coef	-0.7109	-0.3736	44.2904	63.0599	-0.870	-0.7747
Steelhead Util Coef	0.4136	0.0526	6.2202	8.7869	-1.0000	-0.3806

Spawner Utilization
Grider Creek 1988-89

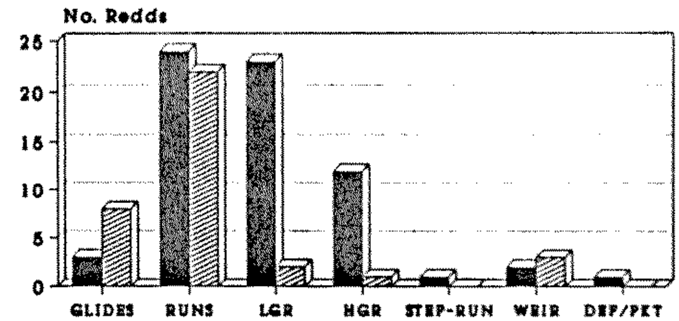


	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR
CHINOOK	-0.711	-0.374	44.29	63.06	-0.871	-0.775
STEELHEAD	0.414	0.053	6.22	8.787	-1	-0.381

SPAWNING HABITATS

CHINOOK STEELHEAD

Redds by Habitat Type
Grider Creek 1988-89



	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	DEP/PKT
Chinook	3	24	23	12	1	2	1
Steelhead	8	22	2	1	0	3	0

Chinook Steelhead

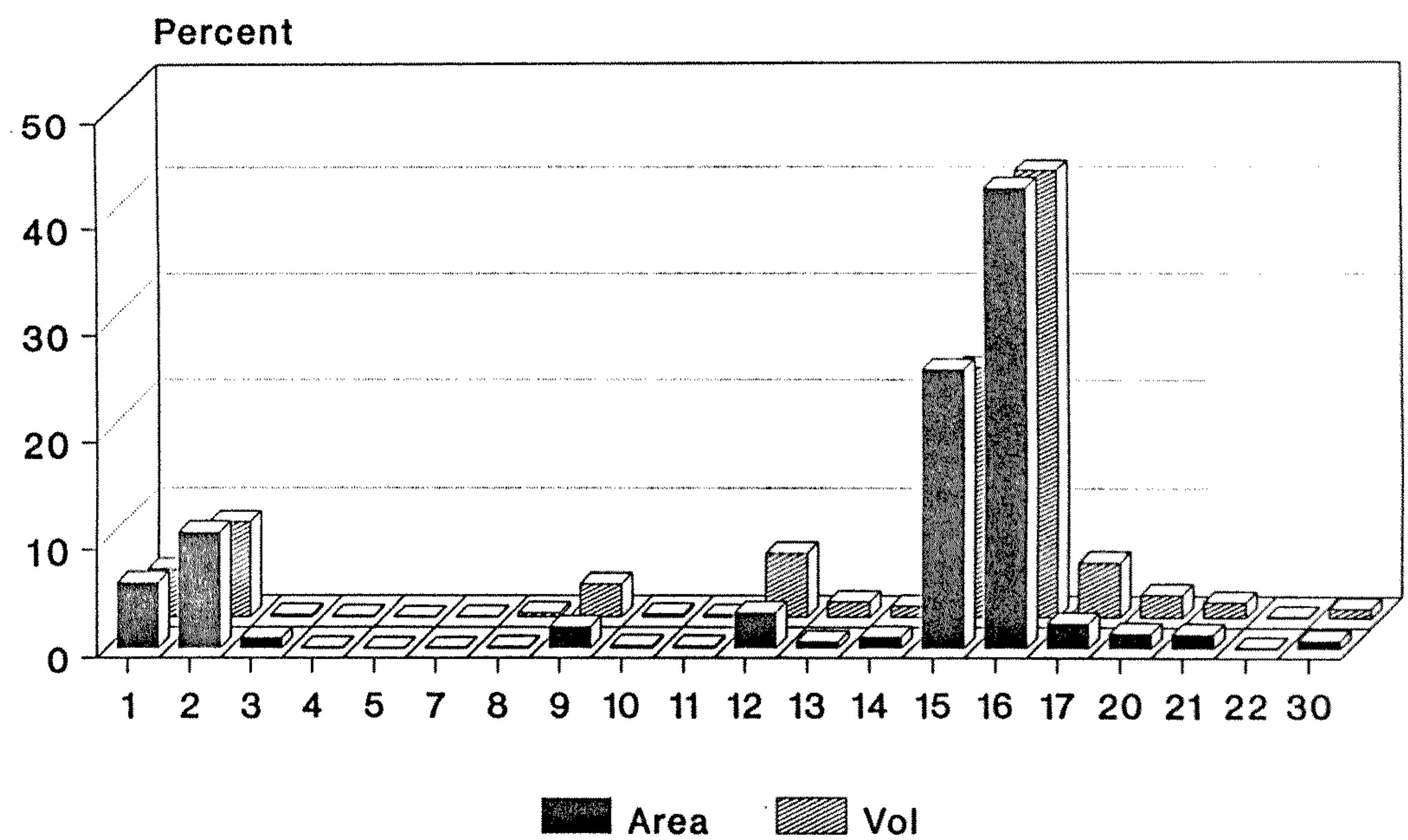
Grider Creek
Physical Data Summary

HABITAT TYPE	NO. UNITS	LENGTH m	AREA m^2	VOLUME m^3	LENGTH m	WIDTH m	DEPTH m	VOLUME m^3	STREAM AREA %	AVG STREAM AREA %	AVG STREAM VOL %	AVG EMBEDD %	AVG FINES %	GRAVEL %	COBBLE %	BOULDER %	BEDROCK %	SPAWN AREA m^2
1	57	1346	10268	2361	23.6	6.4	0.20	41.41	6		4	5.3	4	9	32	55		44
2	134	2549	17891	4687	19.0	6.4	0.23	34.98	11		9	5.9	2	8	27	59	3	16
3	19	249	1618	123	13.1	6.8	0.24	24.69	1		0	2.6	3	5	7	20	65	0
4	1	12	81	42	11.6	7.0	0.52	41.60	0		0	80.0	30	50			20	0
5	1	4	13	6	4.3	3.1	0.46	5.88	0		0	10.0				5	95	0
7	1	8	40	8	7.6	5.2	0.21	8.33	0		0	5.0	20	80				0
8	3	533	210	194	17.6	3.8	0.96	64.66	0		0	2.1		5	20	30	45	2
9	64	560	3428	1649	8.7	5.7	0.46	26.18	2		3	6.4	8	13	22	34	24	106
10	11	73	336	133	6.6	4.4	0.40	12.13	0		0	19.5	16	11	27	46		5
11	4	48	237	95	12.0	4.3	0.37	23.73	0		0	28.2	8	10	33	49		0
12	55	817	5690	3136	14.8	6.4	0.52	57.01	3		6	8.6	9	14	22	32	22	177
13	11	117	985	788	10.6	7.0	0.61	71.59	1		1	3.9	5	33	6	8	48	28
14	7	235	1789	566	33.5	7.0	0.31	80.91	1		1	9.5	9	36	33	22		658
15	106	5235	43429	12449	49.4	7.1	0.30	117.45	26		23	3.4	4	19	31	45	1	3218
16	174	10847	71962	22367	62.3	6.2	0.27	128.55	43		42	4.1	4	10	29	50	8	663
17	38	557	3936	2712	14.6	6.3	0.61	73.30	2		5	5.5	13	28	23	15	20	230
20	36	361	2365	1147	10.0	5.9	0.45	31.87	1		2	10.9	9	19	38	31	3	48
21	10	252	2219	786	25.2	8.4	0.31	78.59	1		1	5.2	5	8	15	72		22
22	1	15	116	60	15.3	7.6	0.52	59.50	0		0	40.0	15	15	30	40		2
30	2	133	1283	477	66.3	10.1	0.37	238.55	1		1	0.0		75	5	20		762

Grider Creek
Cover Data Summary

HABITAT	NO. UNITS	COVER %	UNDERCUT %	SWD %	LWD %	TERR_VEG %	WT_WATER %	BOULDERS %	BDRK_LEDG %	SHADE %
1	57	34		1	1	2	45	51		9
2	134	48	0	1	2	1	53	43	0	9
3	19	71				0	72	27	1	1
4	1	1		50				50		40
5	1	40					100			90
7	1	15		5	95					50
8	3	18			21		59	20		17
9	64	27		0	4	0	57	32	7	7
10	11	28		5	76	3	8	8		7
11	4	13	3	7	31	3	10	46		21
12	55	16		1	5	0	31	36	27	11
13	11	23		5	15	0	14	23	42	6
14	7	14	3	17		18		62	1	14
15	106	19	0	3	2	3	6	86	1	8
16	174	29	0	2	2	1	38	56	0	8
17	38	13		1	3	3	39	35	19	9
20	36	19		1	5	1	22	70	1	15
21	10	34		1	3	0	17	80		12
22	1	15		25				75		5
30	2	12				10	20	70		24

Habitat Distribution
Grider Creek



Grider Creek
Biological Data Summary

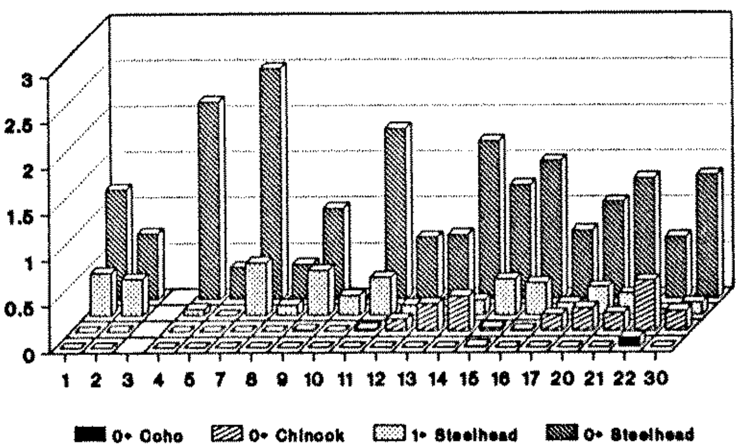
Observed Fish by Habitat Type

HABITAT	# UNITS	0+ STHD	1+ STHD	0+ KING	0+ COHO	TOTAL VOLUME m^3	TOTAL AREA m^2	OBSERVED VOLUME m^3	OBSERVED AREA m^2
1	14	418	69	1	0	2361	10267	590	2535
2	33	390	91	2	0	4687	17891	917	3741
3	1	5	2	0	0	123	1618	25	104
4	1	95	3	0	0	42	81	44	86
5	1	1	0	0	0	6	13	3	6
7	1	21	4	0	0	8	40	8	40
8	1	14	4	0	0	194	210	36	49
9	16	282	116	4	0	1649	3428	284	574
10	3	2	7	0	0	133	336	39	117
11	3	141	26	2	0	95	237	76	192
12	13	482	65	91	0	3136	5689	710	1265
13	4	74	9	31	0	788	985	105	274
14	3	225	21	49	0	566	1789	131	337
15	26	1351	300	51	22	12449	43429	1307	4523
16	38	2434	399	25	1	22367	71962	1942	6842
17	9	425	61	102	0	2712	3936	569	764
20	8	224	53	52	0	1147	2365	211	497
21	2	73	9	13	0	786	2219	67	223
22	1	56	4	45	9	60	116	83	162
30	1	422	40	69	0	477	1283	313	801

Fish Densities

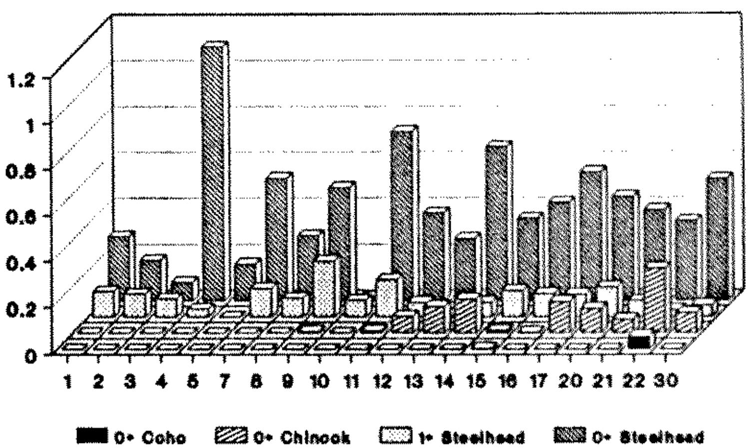
	Area				Volume			
HABITAT	0+ STHD	1+ STHD	0+ KING	0+ COHO	0+ STHD	1+ STHD	0+ KING	0+ COHO
1	0.165	0.027	0.000	0.000	0.709	0.117	0.002	0.000
2	0.104	0.024	0.001	0.000	0.425	0.099	0.002	0.000
3	0.048	0.019	0.000	0.000	0.200	0.080	0.000	0.000
4	1.106	0.035	0.000	0.000	2.160	0.068	0.000	0.000
5	0.162	0.000	0.000	0.000	0.358	0.000	0.000	0.000
7	0.531	0.101	0.000	0.000	2.521	0.480	0.000	0.000
8	0.283	0.081	0.000	0.000	0.392	0.112	0.000	0.000
9	0.492	0.202	0.007	0.000	0.992	0.408	0.014	0.000
10	0.017	0.060	0.000	0.000	0.051	0.178	0.000	0.000
11	0.735	0.136	0.010	0.000	1.859	0.343	0.026	0.000
12	0.381	0.051	0.072	0.000	0.679	0.092	0.128	0.000
13	0.270	0.033	0.113	0.000	0.705	0.086	0.295	0.000
14	0.668	0.062	0.145	0.000	1.724	0.161	0.375	0.000
15	0.299	0.066	0.011	0.005	1.034	0.230	0.039	0.017
16	0.356	0.058	0.004	0.000	1.253	0.205	0.013	0.001
17	0.557	0.080	0.134	0.000	0.747	0.107	0.179	0.000
20	0.451	0.107	0.105	0.000	1.061	0.251	0.246	0.000
21	0.328	0.040	0.058	0.000	1.095	0.135	0.195	0.000
22	0.346	0.025	0.278	0.056	0.676	0.048	0.543	0.109
30	0.527	0.050	0.086	0.000	1.347	0.128	0.220	0.000

Estimated Fish Densities
Grider Creek



Fish Per Cu. M.

Estimated Fish Densities
Grider Creek



Fish Per Sq. M.

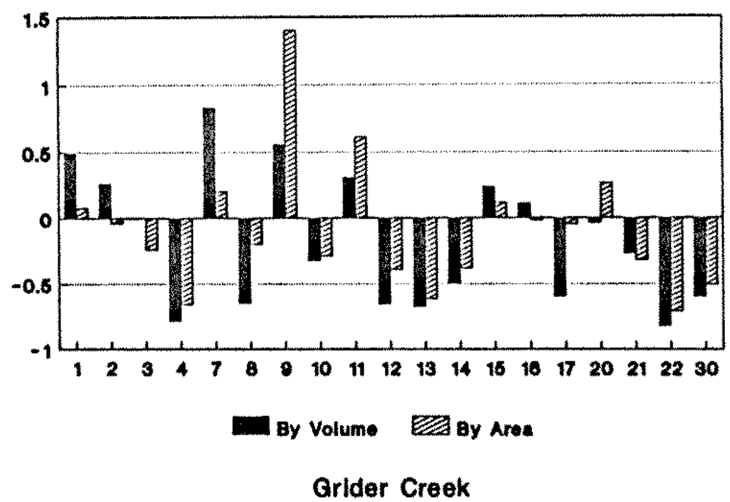
Grider Creek
Utilization Coefficients

HABITAT	Area 0+ STHD	1+ STHD	0+ KING	0+ COHO	Volume 0+ STHD	1+ STHD	0+ KING	0+ COHO
1	-0.47	-0.51	-0.98		-0.26	-0.32	-0.98	
2	-0.66	-0.56	-0.98		-0.56	-0.42	-0.97	
3	-0.84	-0.65			-0.79	-0.53		
4	2.58	-0.37			1.26	-0.60		
5	-0.48				-0.63			
7	0.72	0.82			1.64	1.79		
8	-0.08	0.46			-0.59	-0.35		
9	0.59	2.65	-0.70		0.04	1.37	-0.80	
10	-0.94	0.08			-0.95	0.03		
11	1.38	1.44	-0.55		0.94	0.99	-0.63	
12	0.24	-0.07	2.10		-0.29	-0.47	0.78	
13	-0.12	-0.41	3.88		-0.26	-0.50	3.10	
14	1.16	0.12	5.26		0.80	-0.06	4.21	
15	-0.03	0.20	-0.51	2.52	0.08	0.34	-0.46	2.93
16	0.15	0.05	-0.84	-0.89	0.31	0.19	-0.82	-0.88
17	0.80	0.44	4.75		-0.22	-0.38	1.49	
20	0.46	0.92	3.51		0.11	0.46	2.42	
21	0.06	-0.27	1.51		0.14	-0.22	1.71	
22	0.12	-0.55	10.98	39.20	-0.29	-0.72	6.55	24.33
30	0.71	-0.10	2.71		0.41	-0.26	2.06	

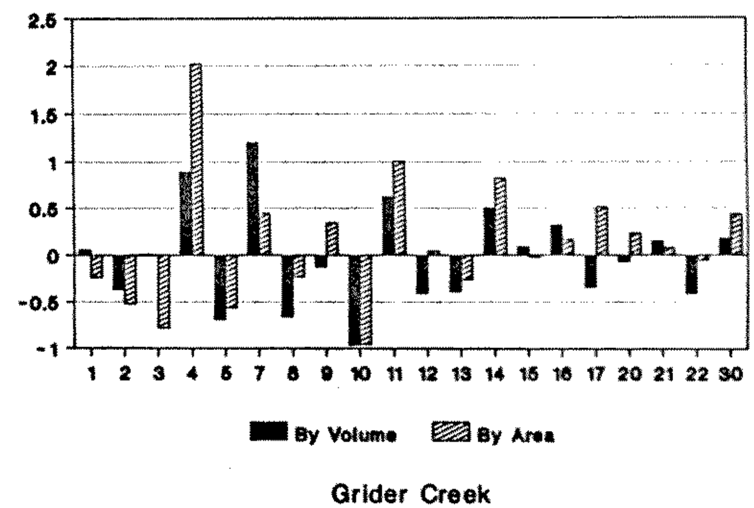
Grider Creek
Estimated Standing Crop

HABITAT	Area 0+ STHD	1+ STHD	0+ KING	0+ COHO	Volume 0+ STHD	1+ STHD	0+ KING	0+ COHO
1	1693	279	4	0	1672	276	4	0
2	1865	435	10	0	1994	465	10	0
3	78	31	0	0	25	10	0	0
4	90	3	0	0	90	3	0	0
5	2	0	0	0	2	0	0	0
7	21	4	0	0	21	4	0	0
8	59	17	0	0	76	22	0	0
9	1685	693	24	0	1637	673	23	0
10	6	20	0	0	7	24	0	0
11	174	32	2	0	176	33	3	0
12	2168	292	409	0	2129	287	402	0
13	266	32	111	0	555	67	232	0
14	1195	111	260	0	976	91	213	0
15	12973	2881	490	211	12873	2859	486	210
16	25599	4196	263	11	28031	4595	288	12
17	2190	314	526	0	2025	291	486	0
20	1066	252	247	0	1218	288	283	0
21	727	90	130	0	860	106	153	0
22	40	3	32	6	40	3	32	6
30	676	64	111	0	643	61	105	0
TOTAL	52574	9752	2619	228	55050	10157	2720	228

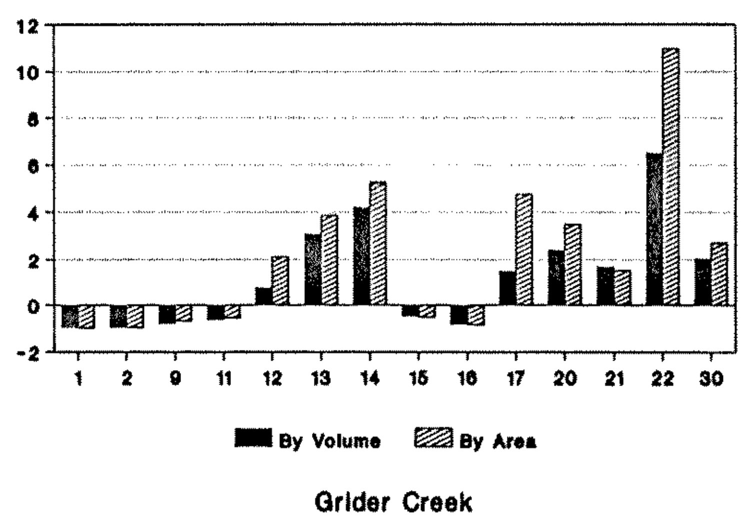
Utilization Coefficients
1+ Steelhead



Utilization Coefficients
0+ Steelhead

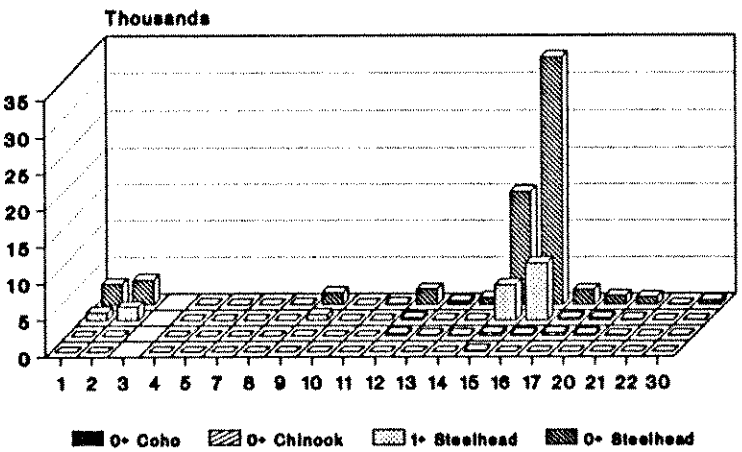


Utilization Coefficients
0+ Chinook



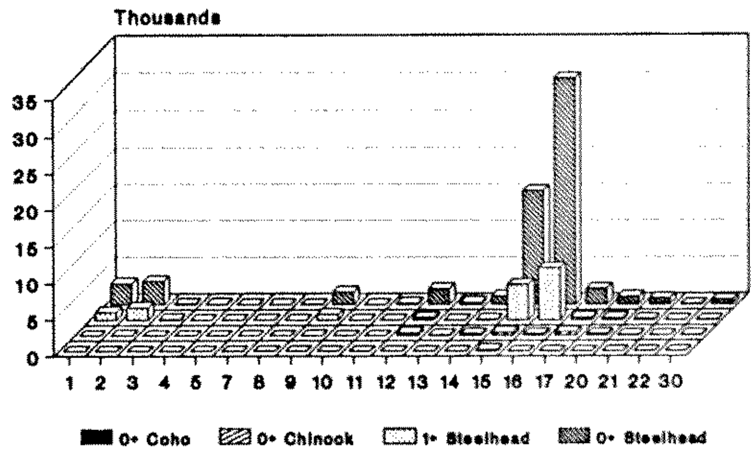
0+ Coho were not observed
in this system.

Estimated Standing Crop
Grider Creek



Derived From Fish Per Cu. M.

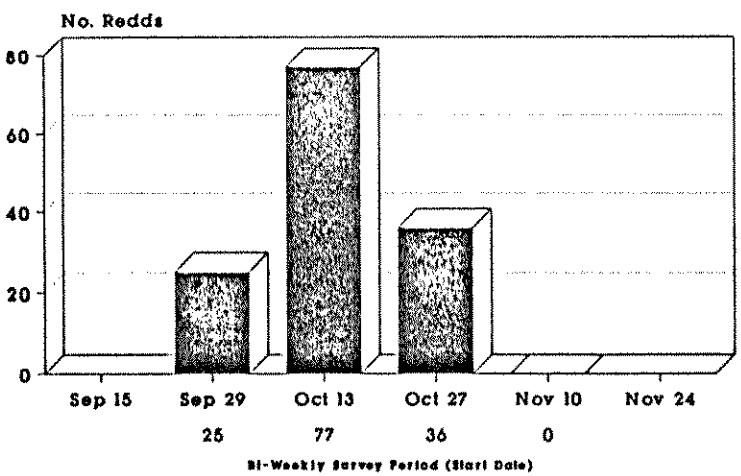
Estimated Standing Crop
Grider Creek



Derived From Fish Per Sq. M.

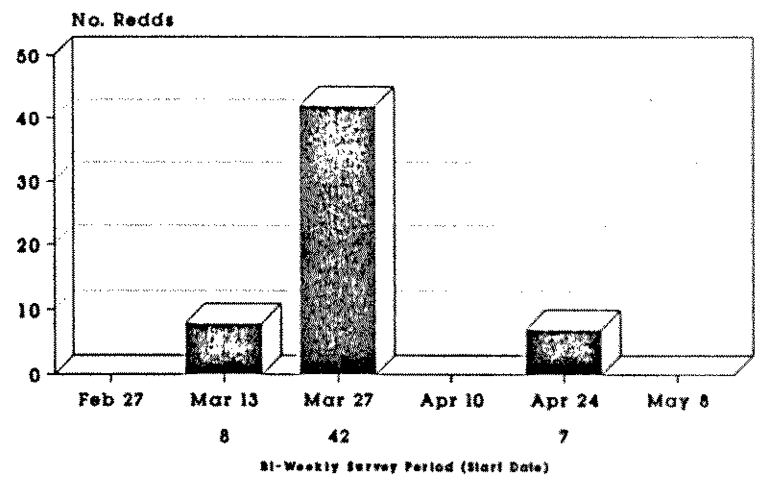
APPENDIX M. HABITAT CONDITION AND USE - BEAVER CREEK

Spawning Period
Chinook



Beaver Creek 1988

Spawning Period
Steelhead



Beaver Creek 1989

Relationship between spawning and rearing habitat for steelhead in Beaver Creek, 1989.

Parameter	Numbers
Steelhead spawning area/pair	1.5 m^2
Steelhead spawning area in study area	8270 m^2
Redds accom. w/out superimposition	5513 redds
Total spawning population (1.5 males/female)	13783 spawners
Estimated 1+ steelhead standing crop	9665 juveniles
Estimated 2+ smolts (40% survival)	3866 smolts
Expected adult maiden return (5%)	193 adults
Estimated maiden redds @ 2.5 fish/redd	77 maiden redds
Est. total redds (60% maiden;40% repeat)	129 total redds

<u>CONCLUSION:</u> <u>Present spawning area is adequate to seed the rearing habitat available in the study area under 1989 conditions.</u>

Beaver Creek
Spawning Ground Utilization

	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	DEFL/PCKT	TOTAL
Spawning Area m^2	1173	3718	640	10	562	2001	57	8161
Percent Spawning Area	14	46	8	0	7	25	1	
Chinook Redds	12	52	41	0	9	24	0	138
Steelhead Redds	3	26	6	0	0	20	2	57
Chinook Redd Density	0.0102	0.0140	0.0641	0.0000	0.0160	0.0120	0.0000	0.0169
Steelhead Redd Density	0.0026	0.0070	0.0094	0.0000	0.0000	0.0100	0.0353	0.0070

	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	DEFL/PCKT
Chinook Util Coef	-0.3948	-0.1729	2.7914	-1.0000	-0.0536	-0.2908	-1.0000
Steelhead Util Coef	-0.6337	0.0012	0.3433	-1.0000	-1.0000	0.4308	4.0531

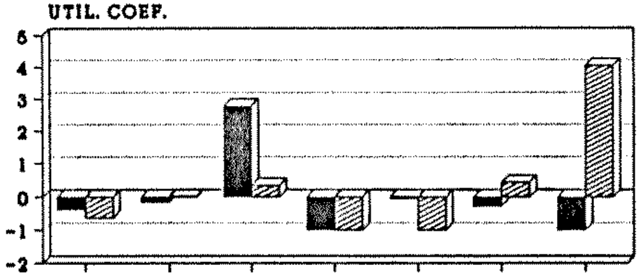
Beaver Creek
Physical Data Summary

HABITAT TYPE	NO. UNITS	LENGTH m	AREA m²	VOLUME m³	LENGTH m	WIDTH m	DEPTH m	VOLUME m³	STREAM AREA %	AVG STREAM VOL %	AVG EMBEDD %	AVG FINES %	GRAVEL %	COBBLE %	BOULDER %	BEDROCK %	SPAWN AREA m²
1	63	2150	20148	6055	34.1	9.0	0.28	96.11	11	8	4.9	11	15	31	43	0	640
2	45	1046	8810	2687	23.2	8.5	0.29	59.61	5	4	3.9	9	6	25	58	2	10
3	11	200	1483	152	18.2	7.3	0.43	38.05	1	0							0
9	23	343	2756	1840	14.9	7.8	0.64	80.01	1	3	7.9	29	8	17	45	1	64
10	2	30	288	1847	16.5	8.8	0.63	91.84	0	0	18.4	37	15	33	15		0
11	5	71	531	231	14.2	7.6	0.43	46.15	0	0	19.3	40	16	28	16		9
12	18	291	1988	1204	16.1	6.7	0.54	66.86	1	2	15.7	36	11	26	20	7	35
13	6	118	1068	644	19.7	8.5	0.57	107.34	1	1	18.5	20	10	27	43		0
14	21	684	6263	2653	32.6	8.3	0.39	126.35	3	4	5.3	17	17	40	26		1091
15	94	5294	47263	15525	56.3	8.3	0.35	165.15	25	22	7.5	16	14	30	39	0	3388
16	131	10042	81641	31974	76.7	7.8	0.35	244.08	43	44	5.5	20	10	22	43	5	562
17	15	279	2281	1545	18.6	8.0	0.63	102.99	1	2	13.9	27	10	21	41	1	54
19	2	45	414	246	22.4	9.0	0.59	123.04	0	0	15.3	30	28	30	12		28
20	33	455	4059	3057	13.8	8.8	0.83	92.62	2	4	7.5	28	16	18	39		106
21	4	166	1788	760	41.6	10.8	0.46	190.09	1	1	2.9	5	10	35	50		224
30	16	924	8318	2852	57.7	9.0	0.33	178.27	4	4	8.5	27	32	16	24		2001
31	2	117	1348	403	58.7	11.4	0.29	201.60	1	1	32.4	14	17	37	32		57

Beaver Creek
Cover Data Summary

HABITAT	NO. UNITS	COVER %	UNDERCUT %	SWD %	LWD %	TERR_VEG %	WT_WATER %	BOULDERS %	BDRK_LEDG %	SHADE %
1	63	44	0	1	0	5	44	51		7
2	45	64	0	1	1	2	53	40	2	5
3	11	84				2	74	23	1	
9	23	27		1	0		30	65	4	10
10	2	16		9	78		6	6		7
11	5	17	11	10	6	2	45	21	5	14
12	18	16	1	0	1		25	35	38	10
13	6	12	15	2	3	1	0	74	4	13
14	21	10		1	1	7	0	91	0	4
15	94	19	0	2	0	5	10	83	0	7
16	131	29		2	1	4	27	65	1	7
17	15	16		0	2	1	12	79	5	7
19	2	18					76	24		15
20	33	17	1	1	1	1	9	87	1	5
21	4	31				6	5	89		3
30	16	16	0			5	40	55		5
31	2	16					4	96		12

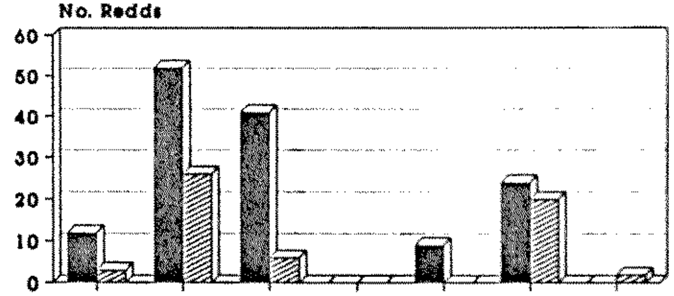
Spawner Utilization
Beaver Creek 1988-89



	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	DEF/PKT
CHINOOK	-0.395	-0.173	2.791	-1	-0.054	-0.291	-1
STEELHEAD	-0.634	0.001	0.343	-1	-1	0.431	4.053

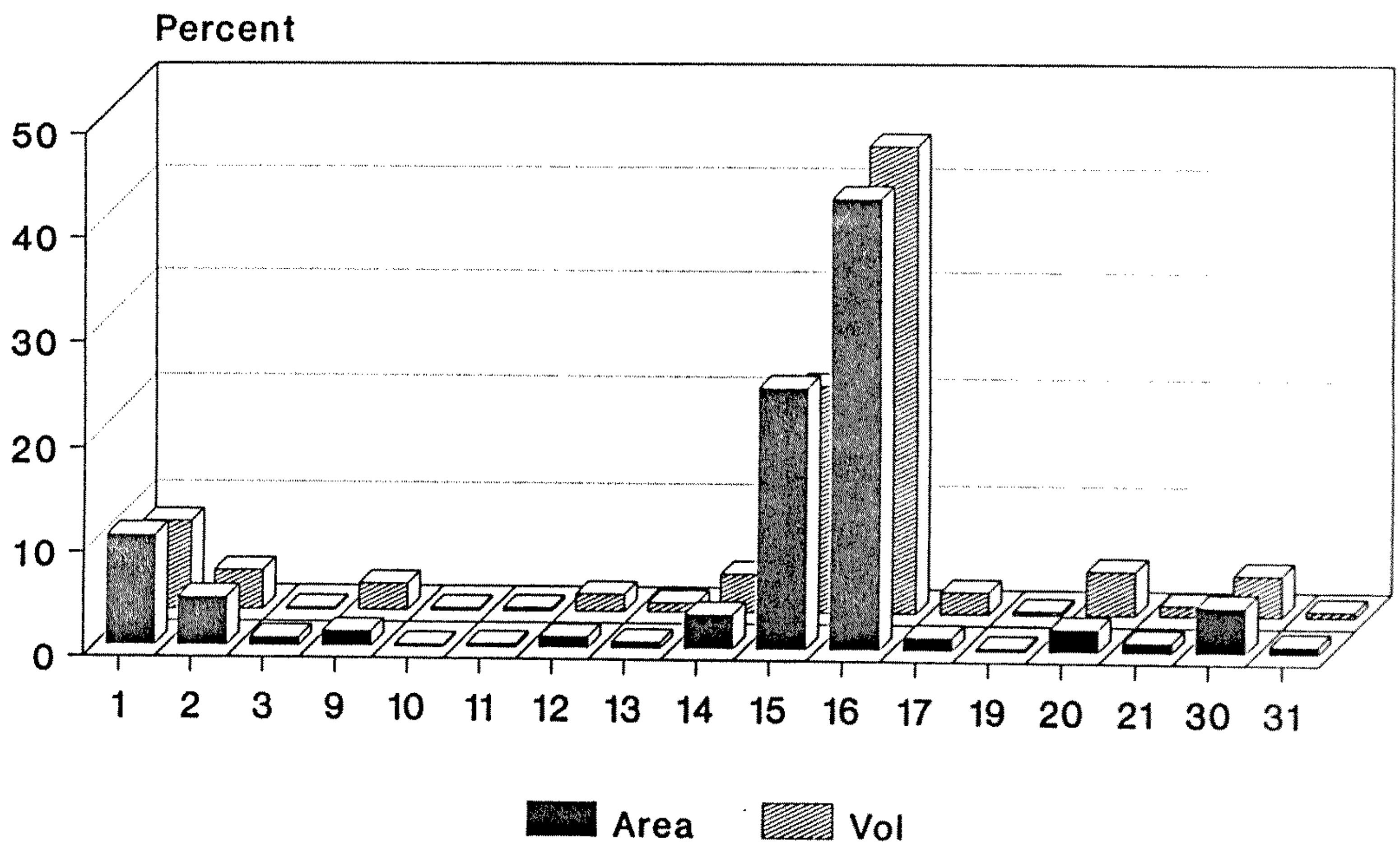
SPAWNING HABITATS

Redds by Habitat Type
Beaver Creek 1988-89



	GLIDES	RUNS	LGR	HGR	STEP-RUN	WEIR	DEF/PKT
Chinook	12	52	41	0	9	24	0
Steelhead	3	26	6	0	0	20	2

Habitat Distribution
Beaver Creek



Beaver Creek
Biological Data Summary

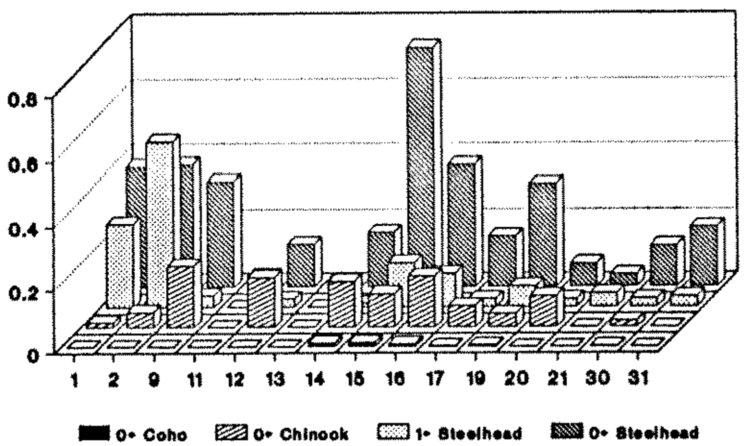
Observed Fish by Habitat Type

HABITAT	# UNITS	0+ STHD	1+ STHD	0+ KING	0+ COHO	TOTAL VOLUME m^3	TOTAL AREA m^2	HABITAT	OBSERVED VOLUME m^3	OBSERVED AREA m^2
1	7	752	224	56	0	6055	20148	1	852	2527
2	3	56	32	12	0	2683	8810	2	62	213
9	2	43	4	25	0	1840	2756	9	130	188
11	1	3	0	0	0	231	531	11	88	132
12	1	24	4	28	0	1204	1988	12	179	237
13	1	0	0	0	0	644	1068	13	111	167
14	5	101	7	85	7	2653	6263	14	589	1346
15	11	1261	166	216	29	15525	47263	15	1282	3493
16	11	666	128	336	19	31974	81641	16	1312	2946
17	2	67	9	28	1	1545	2281	17	419	546
19	1	53	9	7	1	246	413	19	165	273
20	3	17	5	23	0	3056	4059	20	235	377
21	1	13	14	0	0	760	1788	21	252	645
30	2	44	9	7	1	2852	8318	30	339	971
31	1	21	3	0	0	403	1348	31	112	339

Beaver Creek
Estimated Fish Densities

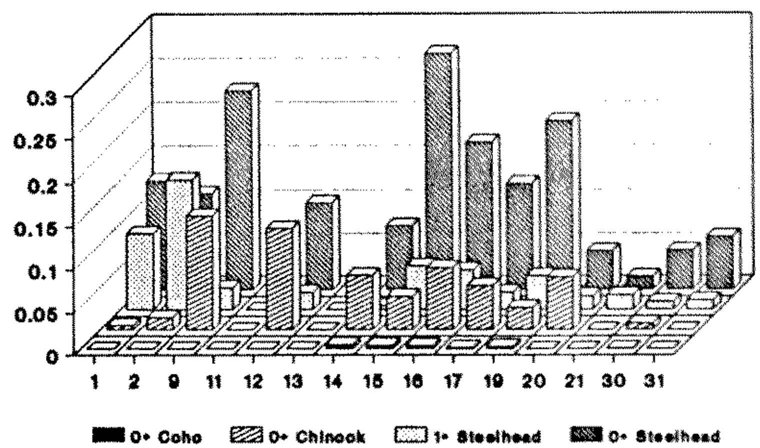
	Area				Volume			
HABITAT	0+ STHD	1+ STHD	0+ KING	0+ COHO	0+ STHD	1+ STHD	0+ KING	0+ COHO
1	0.298	0.089	0.022	0.000	0.883	0.263	0.066	0.000
2	0.264	0.151	0.056	0.000	0.900	0.514	0.193	0.000
9	0.229	0.021	0.133	0.000	0.330	0.031	0.192	0.000
11	0.023	0.000	0.000	0.000	0.034	0.000	0.000	0.000
12	0.101	0.017	0.118	0.000	0.134	0.022	0.157	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	0.075	0.005	0.063	0.005	0.172	0.012	0.144	0.012
15	0.361	0.048	0.062	0.008	0.983	0.130	0.168	0.022
16	0.226	0.043	0.114	0.007	0.507	0.098	0.256	0.015
17	0.123	0.016	0.051	0.002	0.160	0.021	0.067	0.002
19	0.194	0.033	0.026	0.004	0.322	0.055	0.043	0.006
20	0.045	0.013	0.061	0.000	0.072	0.021	0.098	0.000
21	0.020	0.022	0.000	0.000	0.051	0.057	0.000	0.000
30	0.045	0.009	0.007	0.001	0.130	0.027	0.021	0.003
31	0.062	0.009	0.000	0.000	0.187	0.027	0.000	0.000

Estimated Fish Densities
Beaver Creek



Fish Per Cu. M.

Estimated Fish Densities
Beaver Creek



Fish Per Sq. M.

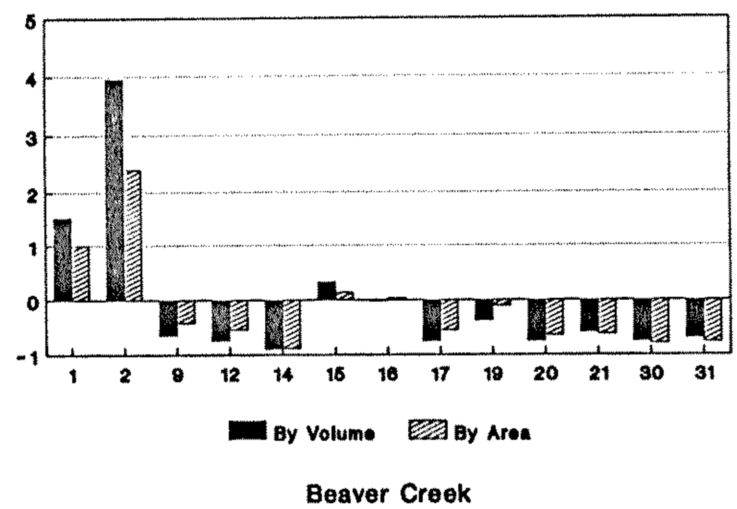
Beaver Creek
Utilization Coefficients

HABITAT	Area 0+ STHD	1+ STHD	0+ KING	0+ COHO	Volume 0+ STHD	1+ STHD	0+ KING	0+ COHO
1	0.37	1.08	-0.61		0.73	1.62	-0.51	
2	0.22	2.53	-0.01		0.77	4.13	0.44	
9	0.06	-0.50	1.33		-0.35	-0.69	0.43	
11	-0.90				-0.93			
12	-0.53	-0.61	1.06		-0.74	-0.78	0.17	
14	-0.65	-0.88	0.10	0.29	-0.66	-0.88	0.08	0.26
15	0.67	0.12	0.08	1.05	0.93	0.29	0.25	1.37
16	0.04	0.02	1.00	0.62	0.00	-0.03	0.91	0.55
17	-0.43	-0.61	-0.10	-0.54	-0.69	-0.79	-0.50	-0.75
19	-0.11	-0.23	-0.55	-0.09	-0.37	-0.46	-0.68	-0.36
20	-0.79	-0.69	0.07		-0.86	-0.79	-0.27	
21	-0.91	-0.48			-0.90	-0.43		
30	-0.79	-0.78	-0.87	-0.74	-0.75	-0.74	-0.85	-0.69
31	-0.71	-0.79			-0.63	-0.73		

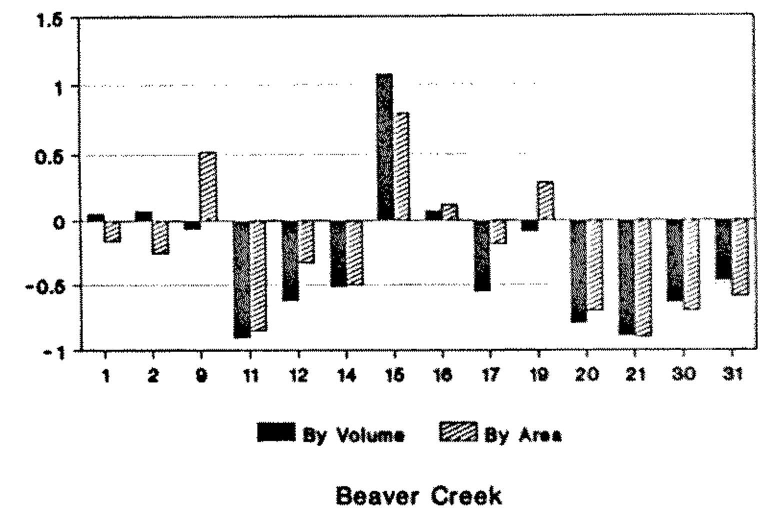
Estimated Standing Crop

HABITAT	Area 0+ STHD	1+ STHD	0+ KING	0+ COHO	Volume 0+ STHD	1+ STHD	0+ KING	0+ COHO
1	5996	1786	447	0	5346	1593	398	0
2	2322	1327	498	0	2415	1380	518	0
9	630	59	366	0	608	57	353	0
11	12	0	0	0	8	0	0	0
12	201	34	235	0	162	27	189	0
13	0	0	0	0	0	0	0	0
14	470	33	395	33	455	32	383	32
15	17062	2252	2923	390	15267	2015	2616	349
16	18446	3547	9312	532	16217	3119	8187	468
17	280	38	117	4	247	33	103	4
19	80	14	11	2	79	13	10	1
20	183	54	248	0	221	65	299	0
21	35	40	0	0	39	43	0	0
30	377	77	60	9	370	76	59	8
31	84	12	0	0	76	11	0	0
TOTAL	46178	9271	14610	969	41509	8463	13114	862

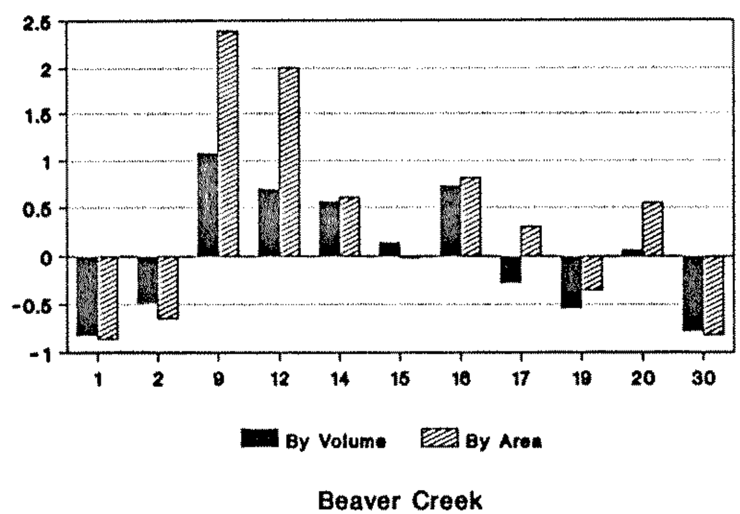
Utilization Coefficients
1+ Steelhead



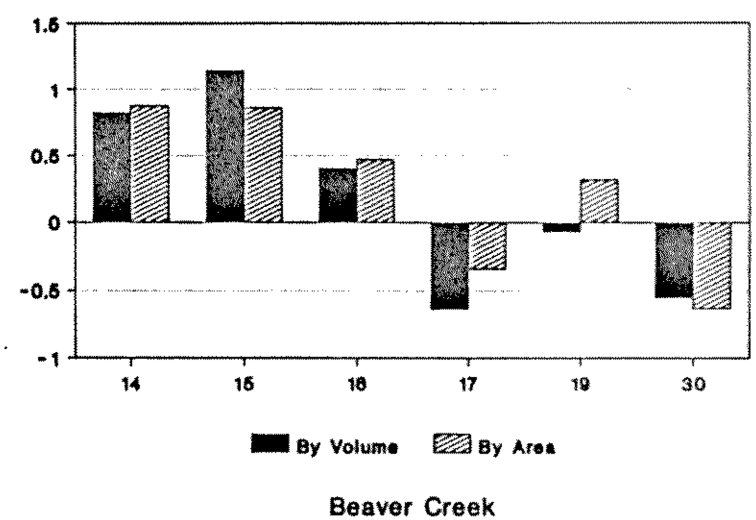
Utilization Coefficients
0+ Steelhead



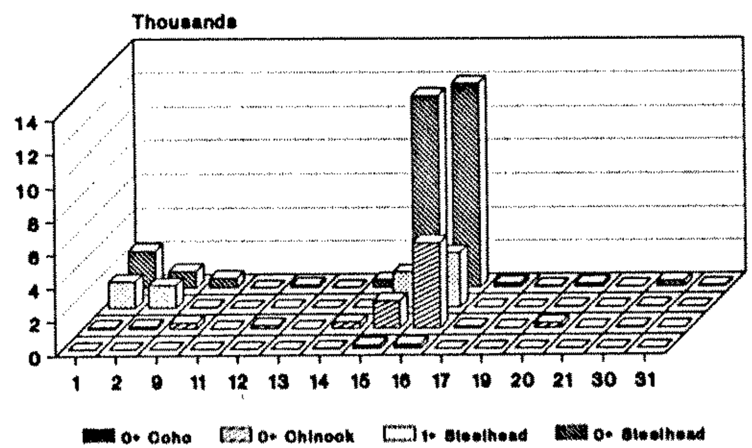
Utilization Coefficients
0+ Chinook



Utilization Coefficients
0+ Coho

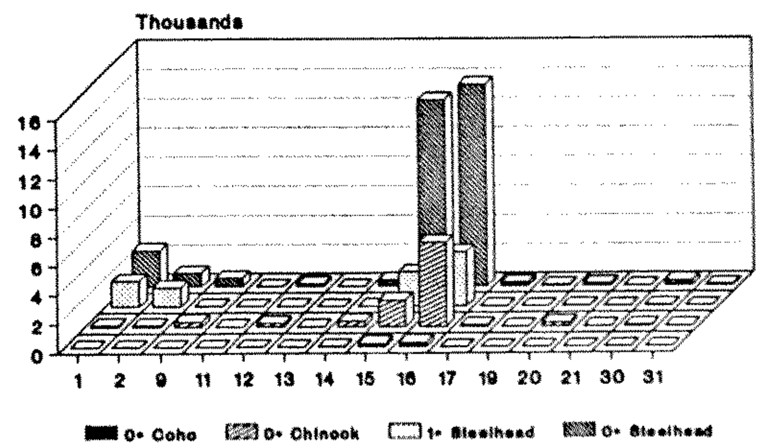


Estimated Standing Crop
Beaver Creek



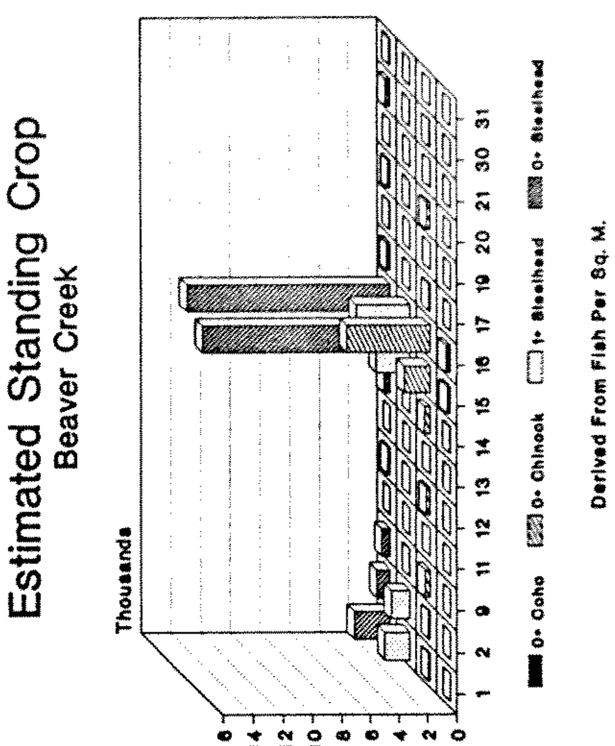
Derived From Fish Per Cu. M.

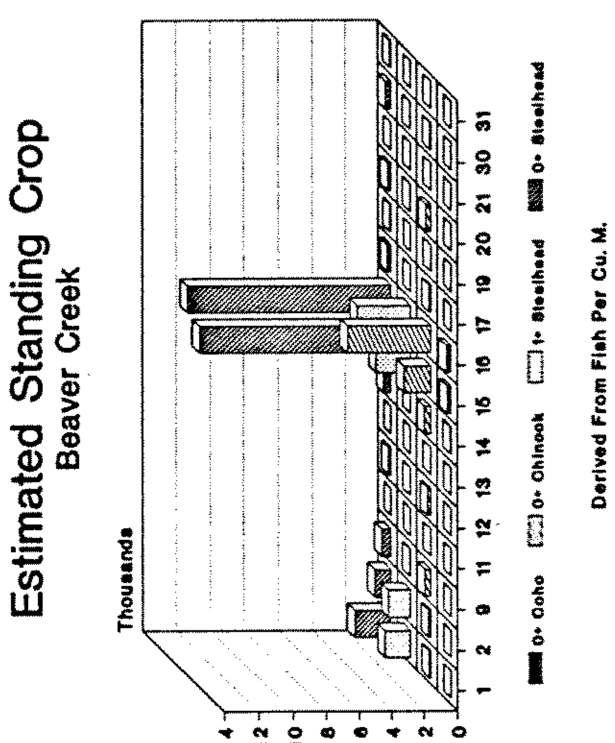
Estimated Standing Crop
Beaver Creek



Derived From Fish Per Sq. M.

APPENDIX N. SUMMARY OF EXPENDITURES





Project Total
150,349
17,798
30,574
198,721

d facilities.