UMATILLA BASIN NATURAL PRODUCTION

MONITORING AND EVALUATION

ANNUAL PROGRESS REPORT 1992-1993

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ABSTRACT

This report summarizes the activities of the Umatilla Basin Natural Production Monitoring and Evaluation Project from September 30, 1992 to September 29, 1993. This program was funded by Bonneville Power Administration and is managed under the Fisheries Piogram, Department of Natural Resources, Confederated Tribes of the Umatilla Indian Reservation.

Examinations of historical flow and water temperature records and current physical habitat, indicate that the streams in the Umatilla River Basin vary in condition from extremely poor to good. Reduced flows and high water temperatures prevented salmonid production in the lower Umatilla River below river mile 75 during the summer and early fall. This was also true in the lower reaches of many tributaries. Isolated springs provided limited refuges in the mid Umatilla River and lower Meacham Creek. Suitable habitat for salmonids was found in the upper reaches of the mainstem and tributaries.

Surveyors electrofished 25,810 m^2 and collected 4,143 naturally produced rainbow trout (*Oncoryhnchus mykiss)* and 295 hatchery rainbow trout. An estimated 84,747 natural rainbow trout and 2,141 hatchery rainbow trout/steelhead inhabited 367,429 m^2 of habitat in Buckaroo Creek, Boston Canyon Creek and Tributary, Line Creek and Meacham Creek where habitat surveys were conducted. Densities of natural rainbow trout ranged from 0 to $2/m^2$ in pools. Fifty one juvenile coho salmon *(0. kisutch)* were collected in Buckaroo Creek (Figure E-7). Other species of fish observed included *7905* dace (*Rhinichthys spp.),* 5995 sculpin (*Cottus spp.),* 1036 redside shiners (*Richardsonius balteatus),* 7 whitefish *(Prosopium williamsoni),* 62 squawfish *(Ptychocheilus oregonensis),* and 2 11 suckers *(Catostomus spp.*).

Surveyors enumerated 55 steelhead redds along 46.6 miles of stream. High flows during the spring made fish and redds difficult to see.

Two hundred twenty four spring chinook redds were enumerated and 463 carcasses were examined along 88.5 river miles. The adult spring chinook salmon to redd ratio was 3.8 to 1. There were approximately 2.5 redds/mile. Surveyors collected 365 snouts (59% of total) for coded wire tags. Approximately 75 % of the carcasses examined appeared to have spawned successfully. Spawning success was highest in the upper reaches of the Umatilla River (above river mile 80) and Meacham Creek (above river mile 6).

Between river mile 40 and 49 during the fall of 1992, surveyors observed 14 live fall chinook or coho salmon, enumerated 13 salmon redds and recovered data from 8 coho and 2 fall chinook carcasses. Below Three Mile Falls Dam workers observed 34 fall chinook and 6 coho salmon on redds, 16 fall chinook and 13 coho salmon (alive). They also examined 88 fall chinook and 22 coho carcasses.

The rotary screw trap operated 124.5 out of 148 days from March 12 through August 6, 1993 and captured 490 juvenile rainbow/steelhead with an overall trap efficiency rate of 7.9% (20 recaptured from 254 marked and released). Two hundred and forty nine juvenile chinook salmon were captured with an overall efficiency rate of 8.9% (17 recaptured out of 191 marked and released). Six bull trout were captured; none were marked and released in the 1992-93 contract year.

Harvest monitors logged 81 survey hours among five survey sections during the 84 hour Tribal spring chinook salmon season (six days, fourteen hours/day). They conducted 93 angler interviews and examined 59 adult spring chinook (Table A-3, Figure A-3). No anglers were observed during 10 hours of survey effort below Pendleton. An additional 45 chinook salmon were reported during telephone interviews for a reported total of 104 spring chinook salmon. Expanding the effort and catch rate data gathered during the survey produced a Tribal harvest estimate of 176 .

The limited scale analysis that was performed indicated that 60% of the steelhead smolts/presmolts were age 2+ and 40% age 3 + (150 mm mean length). The age 3 + fish had very poor first year growth. Scales and otoliths from a 390 mm bull trout (*Salvelinus confluentus*) indicated it was four years old. The fish had grown slowly during the first two growth periods and rapidly during the last two.

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INTRODUCTION

This ongoing project is funded by Bonneville Power Administration as directed by section 4(h) of the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (P.L. 96-501) and pursuant of measure 703 (F)(l)(b) of the Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program (NPPC 1987). This report summarizes work completed during the contract year September 30, 1992 through September 29, 1993. Work was conducted by the Fisheries Program, Department of Natural Resources, Confederated Tribes of the Umatilla Indian Reservation (CTUIR). This project is one of several sub-projects of the Umatilla River Basin Fisheries Restoration Plan (CTUIR 1984, Oregon Department of Fish and Wildlife, ODFW, 1986) orchestrated to rehabilitate salmon and steelhead runs; sub-projects include:

- Natural Production Monitoring and Evaluation (this project);
- Watershed Enhancement and Rehabilitation;
- Hatchery Construction and Operations;
- Satellite Facility Construction and Operations for Juvenile Acclimation and Release and Adult Holding and Spawning;
- Trapping and Hauling of Juvenile and Adult Salmonids Around De-watered Reaches Below Irrigation Diversions;
- Juvenile Passage Facility Construction and Operation;
- Juvenile Passage Facility Evaluations;
- Adult Passage Facility Construction and Operation;
- Adult Passage Facility Evaluations, and
- Flow Augmentation to Increase Instream Flows Below Irrigation Diversions.

The Umatilla River Basin Fisheries Recovery Master Plan identified the following three critical uncertainties that the Umatilla Basin Natural Production Monitoring and Evaluation project will address:

1) What is the observed natural production success and estimated natural production potential for each anadromous salmonid species in the Umatilla River Basin?

2) Will supplementation enhance summer steelhead?

3) What extent will supplementation impact the genetic diversity and life history characteristics of native steelhead and resident trout?

The Umatilla Basin Natural Production Monitoring and Evaluation program goal is to evaluate the implementation of the Umatilla Basin Fisheries Recovery Master Plan with respect to natural production, Tribal harvest, and genetic and ecological risk. Project objectives are listed below:

Objective 1. Estimate the amount of existing and potential spawning and rearing habitat for summer steelhead, spring and fall chinook salmon, and coho salmon.

Objective 2. Determine species distribution, composition, abundance and densities of salmonids throughout the Umatilla River Basin.

Objective 3. Determine natural spawning success, spawning habitat utilization, prespawning mortality and the number of redds per adult anadromous salmonid passed above Three Mile Falls Dam by species.

Objective 4. Estimate natural smolt production and survival rates of anadromous salmonids at various life history stages.

Objective 5. Estimate Tribal harvest of adult salmon and steelhead returning to the Umatilla River Basin.

Objective 6. Determine salmonid age and growth.

Objective 7. Determine the genetic and ecological effects of supplementation on native steelhead and resident trout (this objective was not directly addressed in 1992-93).

Objective 8. Determine if hatchery supplementation enhances production of natural steelhead (this objective was not directly addressed in 1992-93).

The approach to the Umatilla Basin Natural Production Monitoring and Evaluation plan includes three phases. Phase one includes collecting baseline data relating to life histories, distribution, abundance, survival, natural production, habitat and production potential of salmonids. Phase two involves intensive adaptive management and the development of a streamlined monitoring program to be developed and tested through completion of tasks in phase one. Phase three consists of risk containment monitoring where the monitoring program will be employed. The Umatilla Basin Natural Production Monitoring and Evaluation plan places emphasis on phase one for 1992-97 and consists of baseline data collection. Phases two and three are scheduled to begin in intensity in 1997 and 2004 respectively.

DESCRIPTION OF PROJECT AREA

Summer steelhead and spring chinook salmon were abundant in the Umatilla River prior to the 1900's. Irrigation and agricultural development throughout the basin in the early 1900's is believed to be the primary cause of the decline of steelhead and the extinction of spring chinook salmon (Bureau of Reclamation 1988). Since 1855, aquatic and riparian habitats have been degraded through irrigation diversions, water extractions, channelization, livestock grazing, logging, agriculture and urban development (NPPC 1987).

The Umatilla River Basin in northeast Oregon comprises 1,465,600 acres of the 6,400,000 acres of ceded CTUIR land (Appendix A, Figure A-l, A-2). The Umatilla River originates on the west slope of the Blue Mountains east of Pendleton and flows 115 miles in a northwesterly direction .to the Columbia River at river mile 289. The Umatilla River Basin, hydrologic unit number 17070103, has a drainage area of 2290 square miles. The mouth of the Umatilla River at Umatilla, Oregon is at approximately 270 feet elevation above mean sea level. The headwaters are as high as 4950 feet. Annual precipitation averages 10 inches/year at Umatilla to 50 inches/year in the headwaters (Taylor 1993).

The basin can be roughly divided into two physiographic regions. The lower river west of Pendleton has cut a low valley into a broad upland plain called the Deschutes-Umatilla Plateau. Parent geologic materials of the plain are dominated by multiple layers of middle Miocene basalt flows, specifically, the Wanapum and Grand Ronde Basalts, originating 14-17 million years ago. Basalt bedrock outcroppings are common in the river channel and act as hydraulic controls that delay the deepening of the river channel and valley floor. On top of the Miocene basalts are Pleistocene and Holocene loess, alluvial and glaciofluvial deposits (NPPC 1990, Walker and MacLeod 1991). Vegetation on the broad Deschutes-Umatilla Plateau include dryland crops and sagebrush-grass communities. Historically, deciduous trees were abundant in riparian areas on the valley floor; however, landuse practices over the last hundred years have cleared most of these areas for irrigated agricultural and urban uses. Approximately 70 percent of riparian areas in the Umatilla River Basin were reported to be in need of improvement (ODFW 1987).

The region east of Pendleton is dominated by foot hills and the Blue Mountains. The Blue Mountains were created by lifting, faulting and folding of a variety of volcanic, sedimentary and metamorphic rock. The middle Miocene basalt flows of the lower river are also the dominant parent material in the headwaters. The river and streams have cut steep-sided canyons into the layers of rock that form the higher elevations of the Blue Mountains. Exposed basalt fractures into blocks and plates while unexposed layers remain fairly impervious to water (Walker and MacLeod 1991). The combination of the steepness of the canyon walls and the impervious nature of the bedrock lends to poor ground water recharge (NPPC 1990) Stream hydrographs reflect this by displaying a flashy nature. High flows regularly occur during rain storms and snow melt conditions. Extreme low flows are common during summer and dry conditions (Appendix B, Figures B-l through B-13). This effect is less pronounced in the near pristine North Fork Umatilla Wilderness Area, apparently because of the lack of human disturbance, higher elevation of the headwaters, developed soils, large woody debris and climax plant communities. Vegetation distribution patterns upstream from Pendleton are typical for the Blue Mountains. Grasses and small shrubs dominate the drier, south facing slopes. Conifers dominate the north facing slopes, higher elevations and moderately wet areas.

MATERIALS AND METHODS

HABITAT EXAMINATIONS

Knowing the quality and quantity of salmonid spawning and rearing habitat provides an indication of the total natural production potential of the basin. The principal measurable factors influencing presence and abundance of salmonids are known and include stream flow, water temperature, water chemistry, cover, food and space. Monitoring habitat quality provides a baseline to monitor changes occurring seasonally as well as during watershed restoration or degradation. We examined historical flow and temperature data, and began monitoring temperatures intensively and inventorying aquatic habitat throughout the Umatilla River Basin. By combining habitat surveys with biological data, we can further refine our knowledge and understanding of not only what is currently and potentially available in the basin, but also of how measured habitat features correlate to salmonid distribution, abundance, growth and survival.

Flows

Historical stream flows were examined and plotted from U.S. Geological Survey flow records (Hubbard et al. 1993 and other U.S. Geological Survey flow data records obtained from, Suzanne Miller, personal communication, U.S. Geological Survey, Portland, 1993). Maximum, mean and minimum monthly flows for the entire period of record were reviewed and plotted to ascertain the range of flows that could be expected at various points throughout the basin. We examined flow data from the U.S. Geological Survey gages listed in Table B-l.

We also examined correlations between flows and the number of adult natural steelhead returning to the Umatilla River one, two and three years later for 27 years of flow and return records (1966 through 1992). The number of returning adult natural steelhead was compared to mean annual flows at the Umatilla and Gibbon gages. Comparisons were also made between adult returns and seasonal flows consisting of the mean flow of individual months or several months averaged together. The flow year and steelhead return years are designated differently by convention and can be confusing. The comparison between flows in water year 1990 (October 89 to September 90) and steelhead returns in 1992 (fall 1992 through spring 93) was denoted as a two year lag. However, the actual number of months between spring flows during juvenile emigration and when the adult steelhead actually returned to the river would have been closer to 30 and 36 months rather than 24. Correlation coefficients were calculated by using Pearson's product-moment correlation, with Bonferroni adjustments allowing for multiple tests (SYSTAT 1992).

Temperatures

CTUIR, ODFW, U.S. Forest Service and Bureau of Reclamation coordinated the deployment of 32 thermographs and four Hydromet stations in the Umatilla River Basin to maximize consistency and coverage without duplicating effort; data was shared by all cooperators as needed. Specifics of the location and deployment of these thermographs are summarized in Appendix C, Tables C-l through C-5. CTUIR thermographs were initialized in the lab and deployed in the field during the first week of May, 1993. Thermographs were sealed inside a water proof housing which was placed inside a small cage made of expanded steel. Steel chains or cables anchored the units to a large tree or boulder on the bank. Thermographs and cables were concealed to minimize the probability of tampering by the public. Photographs were taken and detailed descriptions of the location of each thermograph were written at the time of deployment. Detailed vicinity maps were drawn and 7.5' topographic maps were marked to indicate the instrument's location.

Thermographs were checked several weeks after deployment and all appeared to function properly. In July, 1993, temperature data was down-loaded from each unit's memory chip to a computer where it was stored and processed. Thermographs were cleaned, examined, tested and redeployed in July, 1993. Four thermographs failed diagnostic tests and were returned to the manufacturer. Temperature data from May, 1993, to July, 1993, was not recorded by three of the defective units. Defective units were shipped, repaired and re-deployed within three weeks. Two thermographs were de-watered as flows receded (Meacham Creek river mile 13 and Bobsled Creek). No additional problems were encountered with the thermographs when they were recovered in November, 1993.

Physical Habitat Surveys

Intensive Habitat surveys were conducted from June 24, to September 8, 1993. Two, two person habitat crews surveyed 26 stream miles on five streams (Table D-l A).

We used the valley reach classification and stream habitat inventory methodology developed by ODFW (Moore et al. 1993). ODFW's habitat survey method has both a large scale, stream reach approach, as well as a more detailed, micro-habitat, inventory approach. By using ODFW's existing design we gained the following advantages: the methodology was compatible to our needs, survey design work had already been developed and reviewed, ODFW assisted in training our crews, data entry and summary programs were written, and finally, habitat survey work performed by CTUIR was comparable to ODFW's or U.S. Forest Service's data without duplication of effort. Because of the intensity of these surveys, only a portion of the drainage was completed. The remaining streams in the basin will be surveyed in the next two years by CTUIR, ODFW and U.S. Forest Service; data will be shared between cooperators as needed.

Surveyors worked in an upstream direction and divided the stream into reaches on a larger scale and individual hydraulic habitat units on a smaller scale. Variables associated with the larger scale classification included landform, valley form, adjacent vegetation and the ratio of active channel width to valley floor width. Photographs, water temperature and flow classifications (high, medium or low) were taken at the start of each reach.

On a smaller scale, individual habitat units such as pools, riffles and glides were classified and measured. Crews recorded a number of variables at each unit including length, width, maximum depth, slope, aspect, woody debris, substrate, bank composition, bank stability and channel type. Every tenth unit was flagged to expedite relocation of habitat units during the habitat survey and later during biological sampling.

Riparian communities were inventoried and photographed every 30 habitat units. Inventories entailed extending a 30 m tape across the riparian zone perpendicular to the stream channel (Moore et al. 1993). These lateral belt transects were 5 m wide and broken into six, 10 m zones, three on each side of the channel. Within each zone the following characteristics were recorded; geomorphic surfaces such as flood plain, low terrace, high terrace, hill slope; percent slope; canopy closure; shrub cover; grass and forb cover; tree groups such as conifer or hardwood; tree count by breast height diameter class, and finally, any pertinent notes.

BIOLOGICAL SURVEYS

CTUIR conducted intensive biological sampling from August 23 to November 19, 1993 to obtain salmonid density estimates. Salmonid populations were intensively surveyed within the 26 miles of streams where physical habitat had been assessed. Streams were stratified into major reaches and individual habitat units previously identified during habitat surveys. Subsamples were selected based on the total number of units of each type and stratified throughout the entire length of the reach. Ten to 15 units of each unit type were sampled. Habitat unit types were subsampled up to a rate of up to 100% if less than 10 units of that type occurred within the reach. The percent of all habitat units subsampled ranged from 7.9% on Meacham Creek to 39.0% on a Boston Canyon Creek tributary (Tables D-1 A, E-l through E-7).

The selected habitat units were individually isolated with blocknets and electrofished. Care was taken to avoid startling the fish out of the habitat unit before the block nets were secured. Fish were captured and removed on successive electrofishing passes until a depletion rate of more than 50% between individual passes was achieved. A second pass was not attempted if no salmonids were captured or observed in the first pass. The same individual operated the electroshocker in as close to the same manner as possible and for the same number of seconds on each removal pass to maximize equality of effort between removal passes. Electroshocker control settings and the number of seconds of electron flow was recorded and kept consistent during each pass through a unit.

Salmonids were netted and placed in a livewell until the completion of each electrofishing pass. Non-salmonids were not collected but workers estimated the number observed during the first pass. After each pass, crews examined, identified and measured all salmonids to the nearest mm (fork lengths). An anaesthetic (Tricaine Methane-Sulfonate, MS222) was used occasionally depending on the situation to further reduce stress of captured salmonids. Scales were taken from a portion of the captured salmonids and placed in mylar or manilla envelopes. Scales were removed posterior to the dorsal fin, dorsal to the lateral line and anterior to the adipose fin.

Density estimates were calculated using a maximum-likelihood method (Van Deventer and Platts 1989) in conjunction with surface area measurements collected during physical habitat surveys. Density estimates for each habitat unit type were averaged and expanded for the total area of that habitat type within the survey reach. The density estimates for individual habitat types were summed together for the entire reach estimate.

Informal biological sampling was initially conducted at 15 various sites in the basin from January 26, 1993 through March 9, 1993. Sites were sampled to determine the seasonal presence or absence of salmonids during the winter months. Sample sites on the mainstem Umatilla River were at river miles 87.5, 86.5, 79.5, 75, 73, 71, 63.8, 5 1, 43 and 26.5. Other sites included Squaw Creek at river mile 4, Meacham Creek at river mile 2 and 5; a beaver dam at the mouth of Line Creek; and Pearson Creek at river mile 8.5. Workers electrofished a convenient area in an upstream direction without blocknets. The other aspects of the sampling and handling of salmonids was similar to that described above. Additional investigations were conducted to determine presence and absence of summer steelhead fry from June 8, 1993 to July 16, 1993. Fry were electrofished with a low amperage setting to minimize stress even though catch efficiency was reduced.

SPAWNING ESCAPEMENT SURVEYS

CTUIR conducted redd and carcass surveys throughout the basin for steelhead, spring chinook, fall chinook and coho salmon. The surveys provided an estimate of the number of completed redds and allowed the inspection and enumeration of carcasses. Examining carcasses yields coded wire tags, age, sex, length data, egg retention and an estimate of the proportion of successful and unsuccessful spawners by reach. Prespawning surveys were conducted to examine prespawning mortalities and to get a general idea of the number and location of adults in holding areas and how these factors change as the spawning season progressed.

Repeated surveys were conducted in reaches found to be important spawning areas in earlier years (1991, 1992). Other areas were only surveyed one to three times during the spawning season. To minimize stress to adults, debris jams and other holding areas were not probed. Each surveyor examined three to four river miles a day. They walked in a down-stream direction and wore polarized glasses to maximize fish observing capabilities. The majority of the surveys were conducted by two or three principle people. However, on wide reaches and during peak spawning times, additional surveyors worked in pairs to ensure adequate coverage. To maintain data quality and consistency, principal surveyors were paired with alternates.

Redds were marked with orange flagging. The date, species and the number of fish observed on the redd was written on the flagging. Attempts were made to place flags at least six feet above ground to minimize disturbance by livestock. For each observed redd, surveyors recorded in a data book the stream name, river mile, redd location and description, date and the specifics of any observed adults. All flagged redds were reviewed by our most experienced redd surveyor for consistency. The redd was not counted if it was judged to be incomplete. Judgement was based on size and shape of the redd, amount of rock moved and other factors.

Carcasses found during the survey were measured from the center of the eye to the end of the hypural plate (Mid-Eye to Hypural Plate or MEHP length) and fork length. MEHP length is the preferred method for measuring lengths of spawning salmon as tail erosion and the protrusion of the upper and lower jaws during spawning can make fork length measurements inconsistent. We described obvious injuries and attempted to determine the cause of death. Workers cut open the body cavity to determine sex, egg retention (females) and to estimate the degree of successful spawning completed before death (males). Approximately ten scales were sampled from two rows above the lateral line on the left side of the fish in a diagonal line between the posterior edge of the dorsal fin and the anterior edge of the anal fin. The tail of each corpse was removed to prevent resampling.

Surveyors also removed snouts to recover coded wire tags from carcasses with the appropriate fin clip(s) by removing the entire front portion of the head immediately anterior to the preopercle and above the lower jaw. For steelhead, a left or right pelvic fin clip indicated a coded wire tag and an adipose clip denoted hatchery origin. For salmon, an adipose clip signaled a coded wire tag and a pelvic clip identified it as a hatchery fish. However, not all hatchery salmon were clipped. Snouts were placed in plastic bags with a snout card number. The snout card number linked each snout and coded wire tag with the scales and other data collected. Coded wire tag snouts and accompanying data were sent to the ODFW, Mark Processing Center at Clackamas for extraction and reading of the tags. Return rates and related data from fish with coded wire tags are presented by Rowan (1994).

Steelhead

Steelhead redd and carcass surveys were conducted from April 7 through May 27, 1993. Surveyors walked 63.6 accumulated river miles, during 18 survey days and expended 26 man days of effort. Steelhead redd and carcass surveys were conducted along 46.6 river miles on streams listed in Table F-l. Steelhead surveys were not conducted in Birch Creek as ODFW conducts surveys there (Table F-10).

Spring Chinook Salmon

Spring chinook salmon redd and carcass surveys were conducted from June 23 to September 28, 1993. Surveyors walked 408.5 accumulated river miles, during 58 survey days and expended 180 man days of effort. Seventeen river reaches totaling 88.5 river miles were surveyed from one to 13 times (Table F-2). Areas where few or no redds have been observed in past years were surveyed only one to three times during the spawning season.

Fall Chinook and Coho Salmon

Fall chinook and coho salmon redd and carcass surveys were conducted from November 16 to December 17, 1992 (Table F-3). Surveyors walked an accumulated 30 river miles during 10 survey days and expended 30 man days of effort. Fall chinook and coho salmon redd and carcass surveys were conducted below Three Mile Falls Dam from river mile 1.5 to 4.0 and from river mile 40 to 49 near the Barnhart adult release area.

JUVENILE SALMONID TRAPPING

We employed a five foot diameter rotary screw trap (manufactured by E.G. Solutions, Inc.) to capture emigrating juvenile salmonids in the Umatilla River at river mile 79.5 near the Imeques C-mem-ini-kern Acclimation Facility. Trapping was stopped during repairs and high flow periods when debris loads were heavy. The trap was operated 124.5 of 148 days from March 12 to August 6, 1993 (Table G-l, Figure G-6). Trapping resumed in the fall, 1993, during the next contract year. The trap was monitored on a daily basis during moderate flows and twice a week during low flow and low catch periods. Accordingly, during high flows the trap was monitored throughout the day to remove debris and adjust the trap to changing flow conditions.

Data recorded includes the following: date, time, water temperature, the number captured (by species), fork length (mm, occasionally salmonids were enumerated by size class), marks, clips, number marked and released, atmospheric and flow conditions, and comments regarding the effectiveness of the trap. Scales were taken as described above from a sub-sample of captured salmonids. Workers gave salmonids a temporary mark by clipping a notch in the margins of the caudal fin. Three marks were used, upper caudal, lower caudal and both caudal fin clips.

Marked salmonids were released approximately one kilometer above the rotary trap to determine catch efficiencies. Usually, all captured salmonids were used for efficiency estimates, however, occasionally only 50 to 100 salmonids were marked and released if hundreds of a given species and age class had been captured. Marked salmonids that were recaptured were enumerated, measured and released approximately 50 yards below the trap. No containment trials were conducted in contract year 1992-93 to determine the rate of escape from the livewell. Escapement from the livewell was included in the overall trap efficiency rate estimates.

Assumptions of catch rate estimates include: marked and unmarked salmonids were actively migrating past the trap; once fish were downstream of the trap, they did not return to risk capture again; previously captured, handled and marked fish released upstream of the trap had an equal probability of capture as naive unmarked fish; recaptured fish escaped from the livewell at the same rate as naive fish, and finally, marks on recaptured fish were correctly recognized and recorded by samplers.

HARVEST MONITORING

CTUIR fisheries personnel monitored the Tribal harvest of adult spring chinook salmon in the Umatilla River during a six day season. Originally, the season consisted of three consecutive weekends (friday through sunday), specifically June 18-20, 25-27 and July 2-4, 1993. After the second weekend, CTUIR Fish and Wildlife Committee terminated the season because the target number of salmon had been harvested. The remaining salmon were allowed to spawn with the intent being to develop natural production in the basin. Harvest and escapement targets are derived just prior to the fishing season and are based on the number of returning adults observed at Three Mile Falls Dam.

A roving creel survey with nonuniform probability sampling was incorporated for harvest monitoring. In addition, a selective phone survey was conducted during and after the season to all known and presumed Tribal anglers. Tribal harvest of steelhead, fall chinook salmon and coho salmon was not monitored during the fall, winter and spring of 1992-93.

The harvest area was divided into five sections, each with an estimated probability of use based on observations made in earlier years by Tribal enforcement and creel survey personnel (Table A-2). All days were given the same probability of sampling. Each day was broken up into two shifts, 0600 to 1300 and 1300 to 2000 hours. However, the friday morning shift was given a probability of sample of 0.30 and the evening shift a rating of 0.70. During weekends the probability given was 0.50 for both morning and evening shifts.

Surveyors conducted instantaneous counts on the initial trip up the stream and conducted interviews on the return trip back down the reach. This procedure was changed after the first three days. For the last three days of the season, instantaneous counts were combined with interviews because surveyors reported that some anglers appeared to leave after the instantaneous counts were made to avoid interviews.

Creel surveyors recorded the date, section number, start and end time of each trip, the current time and river mile where anglers were observed, the number of fisherman in the group, a description of the anglers' and their name(s) if possible. Automobile license plate numbers were also recorded as well as the time fisherman started fishing, the total hours fished, if the fishing trips were completed and the number of salmon caught that day. Interviewers also asked fishermen how many salmon they had caught to date for the entire season, the number of fish caught that season but had already been reported in an earlier interview, the location where salmon were caught on earlier trips, and finally, the names of other anglers that had caught salmon that season.

The telephone survey was conducted during and after the second week of the salmon season and was combined with person to person contact for those anglers without phones. We contacted salmon anglers that had been interviewed during the 1993 creel surveys, as well as others that were known to have fished but not interviewed, or reported by others to have fished. Surveyors asked how many salmon each angler caught, the number of fish reported during interviews, and the names of other anglers that might have also caught salmon.

Numerous survey strategies presented in the current literature were examined and included a punch card system, check stations, airplane flights, walking and floating surveys, post season phone surveys and roving creel surveys (Malvestuto et al. 1978, Malvestuto 1983). Options for the survey design were discussed with enforcement and/or creel personnel from CTUIR, ODFW and Idaho Department of Fish and Game. Problems and strengths associated with each method were identified. CTUIR selected a non-uniform probability stratified-random roving creel design in conjunction with an informal phone survey. CTUIR judged that this combination would give the best information per unit effort while maintaining positive public relations with Tribal fisherman. Furthermore, the surveys on the ground allowed the examination of harvested fish and the collection of coded wire tags, fork lengths, marks, tags, punches, scales, etc. Enforcement personnel also desired the presence of surveyors along the streams to minimize poaching and harassment of salmon. Combining the phone survey with the roving creel survey appeared to be the best combination of methods.

The punch card, check stations, or formal randomized phone survey techniques were judged inappropriate as they would most likely be interpreted as infringements on Tribal fishing rights. Such methods would create compliance problems and generate negative public relations between the Tribal Fisheries Program and Tribal members. Effectiveness of the aerial counts would require concurrent evaluations by ground surveys. A cooperative effort to evaluate aerial surveys is currently being explored by CTUIR, ODFW and Oregon State Police for the potential 1995 spring chinook salmon fishery.

AGE AND GROWTH

Scales were taken from a subsample of captured juveniles and adult carcasses as described above. Approximately 10 scales were removed per fish. Juvenile scales were mounted between acetate slides in preparation to be read with microprojection at 72x and 42x. Adult scales were pressed onto acetate sheets. Ages will be determined using the number of annuli in the anterior circuli field. Each scale will be read by an apprentice and veteran scale reader. Scale reading, analysis and summarization was not performed during the contract year 1992-93 because the microprojector was not available until after the end of the contract year.

GENETIC SAMPLING

Individual juvenile rainbow trout (n=402) were collected for genetic samples by electrofishing from 13 of 14 locations throughout the Umatilla River Basin in October and November, 1992 (Table A-4). From each location, workers collected 23-75 juvenile rainbow trout longer than 70 mm with optimum sizes of 100 to 120 mm (fork length). Trout were kept alive and transported to the raceways at Minthorn Springs Acclimation Facility near Pendleton where groups were kept separated in labeled minnow traps. Fish were killed and placed on wax paper just before freezing in ODFW's super cold freezer (-80 C) in La Grande, Oregon. In January, 1993, frozen samples were packed in dry ice and transported to Oregon State University's super cold freezer. Currens and Schreck (1993) at Oregon State University analyzed numerous allozyme, mitochondrial DNA and meristic characteristics.

STEELHEAD SUPPLEMENTATION EVALUATIONS

The evaluation of supplementation efforts on summer steelhead stocks was not directly addressed in the 1992-93 contract year. However, we did compare lengths and densities of natural rainbow/steelhead trout collected in streams with and without an abundance of juvenile hatchery steelhead trout.

RESULTS AND DISCUSSION

HABITAT INVESTIGATIONS

Flows

The flow characteristics of the basin have important influences on natural salmonid production potential in the basin. Climate, geology and watershed conditions are the main factors influencing the hydrograph. Unlike spring creeks, stream flows in the Umatilla River Basin follow the climate with low flows in summer and early fall and higher flows during freshets and snow melt. Historical flows recorded by U.S. Geological Survey gages throughout the basin indicate that summer flows are low in both relatively wet and dry years (Figures B-l through B-4). In contrast, winter and spring flows are highly variable. For example, August mean monthly flows for Meacham Creek during 18 years of record ranged from 8.5 cfs (1986) to 19.6 cfs (1976). February mean monthly flows ranged from 27.1 cfs (1977) to 950 cfs (1985) (Figure B-2). In Meacham Creek, spring daily mean flows are often more than 160 times summer daily mean flows (1950 cfs on April 4, 1993 to 12 cfs on October 2, 1993; Figure B-5). We observed similar flow patterns for other streams throughout the basin with and without gages (Figures B-6 through B-13).

Mean annual flows are similar in the Umatilla River near Gibbon, Meacham Creek and the South Fork Walla Walla River, but the annual hydrographs are drastically different. The South Fork Walla Walla River is in an adjacent basin to the north of the Umatilla system (Figure A-l). Peak flows in Meacham are five times greater than peak flows in the South Fork Walla Walla River, while base flows are ten times lower. The hydrograph of the Umatilla River near Gibbon is intermediate with peak flows that are only three times higher and base flows two times lower than the South Fork Walla Walla River (Figures B-4, B-8, B-9 and B-10). Topography and geology are very similar in both drainages. Landuse practices, however, are markedly different as Meacham Creek has been heavily grazed, logged and roaded while the South Fork Walla Walla River Basin has not.

Optimum summer flows for the natural production of salmonids (in relation to channel size) can never occur in the Umatilla River Basin under the current conditions. Summer flows are critically insufficient for optimal salmonid rearing and are considered a primary limiting factor. Many reaches are dry or puddled during the summer. Rearing habitat is greatly reduced during the summer months regardless of winter precipitation. Even though the variation between summer flows during wet and dry years is relatively small, the differences are important in regard to water temperatures. Flow is a major physical factor governing instream temperatures (Brown 1983). Temperatures in the puddled and low flow reaches often exceed state water standards and are lethal to salmonids. For example, in 1992, the maximum annual recorded water temperature was 26.8 C (80.4 F) and occurred August 13 (river mile 5.25) at flows of 9.4 cfs (river mile 1.4) (10.5 cfs mean monthly flow). In 1993, however, the maximum recorded temperature was 23.8 C (75 F) on August 3 and flows were 21 cfs (20.7 cfs mean monthly flow).

The geologic features in the basin play a significant roll in determining flows and the suitability of salmonid rearing habitat. During the summer months, salmonids utilize the upper one to two thirds of the tributaries. The upper reaches are characterized by steeper gradients (4 to 6%) with trees and adjacent steep hillsides that shade the stream. The steeper gradient and associated high stream-power scours the channel down to bedrock during peak runoff. The bedrock just below the streambed maintains the water table in the channel throughout the year. Pools with bedrock substrate (or bedrock just under the substrate) persist during periods of zero flow and provide refuges for trout. The shade provided by the dense riparian canopy and steep canyon walls prevent water temperatures from becoming excessive.

The lower reaches of the tributaries have lower gradients (1 to 2% slope) which reduces stream power and the capacity of the stream to carry bedload. The result is a depositional area with deep alluvial deposits. The water flowing over these depositional areas (influent reaches) percolates into the porous alluvium (vadose) and the channel often goes dry during low flow periods. The lower reaches that do have flow in the summer are not typically shaded by trees or adjacent hill sides sufficient to keep temperatures below lethal limits for salmonids. For example, at river mile 56, daily maximum water temperatures exceeded 26.6 C (80 F) for 48 days in 1991 and for 10 days in 1993 (Figure C-6).

Un-weathered parent geologic materials underlying much of the Umatilla River Basin are fairly impervious to water (Wanapum and Grand Ronde Basalts, Walker and MacLeod 1991, NPPC 1990). Precipitation generally runs off and does not percolate rapidly into the ground as in some basalt formations.

Combining the geologic and climatic features of the basin with the landuse practices of the last century has produced the large annual fluctuations of stream flow and temperatures currently observed. It is well documented that removing vegetation through livestock grazing, road building and logging can change the percentage of precipitation that percolates into the ground water or runs off into streams and rivers (Bohn and Buckhouse 1985, 1986, Bohn 1986, Brown 1983). Nobel (1965) found that only 2% of 2.44 inches of rain that fell on a well vegetated hillside (60-75% vegetated) was lost to surface runoff. During the same thunderstorm, 73% of the precipitation was lost to surface runoff in a nearby overgrazed area of similar slope where only 10% of the soil was covered with vegetation.

Losing precipitation immediately from the basin through runoff as currently occurs in the Umatilla River Basin not only reduces the summer base flows but also increases the peak flows. Large runoff events in combination with bank stability determines channel morphology and size. In the Umatilla River Basin, artificial channelization, livestock grazing and natural conditions have worked in concert to develop streams with erodible banks and wide channels that move laterally across the flood plain during high flows (Meacham Creek). In contrast, streams with relatively stable flows, narrow stream channels and well developed riparian vegetation communities are prime salmonid rearing areas (South Fork Walla Walla River, North Fork Umatilla River). When uplands are well vegetated, precipitation does not immediately runoff but percolates into the ground water and is released slowly into the stream channel through springs and seeps, so stream flows are more stable (Bohn and Buckhouse 1985, 1986, Bohn 1986, Brown 1983). Healthy riparian communities stabilize stream banks and force erosional energies downward to develop deeper and narrower channels with undercut banks. Thick riparian vegetation holds the soils and streambanks during peak flows and forces flood flows to spread out over the flood plain and drop suspended sediments that enrich the soil. Stream energy is dissipated and water has time to seep into the ground to recharge bank storage and the water table. The ground water stored during high spring flows are released slowly all summer to add to the base flow. Bank storage and ground water recharge occurs only on a limited basis in systems that have extensive channelization and flood plain levees.

In the Umatilla River Basin and the North Fork Walla Walla River, logging in the headwaters, channelizing streams, grazing livestock and clearing riparian areas have combined with the natural geologic features and climate to increase instability of stream banks and accentuate both peak and low flows. The result is poor salmonid habitat that typically features wide, shallow and unstable stream channels, extreme low summer flows and high water temperatures, and little or no riparian vegetation to provide cover or shade the stream. It is not coincidental that excellent flows and temperatures occur only in drainages that have had minimal human impacts (North Fork Umatilla River, North Fork Meacham Creek, South Fork Walla Walla River) while summer flows and temperatures are marginal or unsuitable in adjacent drainages with extensive human influences (North Fork Walla Walla River, Mainstem Meacham Creek, Mainstem Umatilla River). The relationship between human activities and water quantity and quality has long been recognized (Marsh 1864, Sears 1935 and 1971).

In addition to juvenile rearing, flows play an important roll in salmonid migration in the lower Umatilla and Columbia Rivers. Several revealing correlations were found between mean annual ($r=0.913$) and spring flows ($r=0.869$) at the Umatilla gage (river mile 2) and the number of returning natural adult steelhead two years later from 1981 to 1993 (Figures B- 14 and B- 15). Adult returns prior to 198 1 were not correlated to flows because counts were considered to be rough estimates (Jim Phelps, ODFW, personal communication). Furthermore, the correlation before 1981 fit better with a three year and a two year lag from 198 1. on (Figures B-l 6, B-l 7). The cause of this change in the relationship is unknown.

The flow/fish relationship may change during the next several years due to the affects of the new bypass facilities, increased trap and haul capabilities, and flow augmentation (phases I and II). Flows affecting passage of adults has been examined and discussed by Volkman (1993).

Temperatures

Selected stream temperature profiles collected throughout the Umatilla River Basin are listed in graphic form in Appendix C. Temperatures in the headwaters were suitable for salmonid rearing throughout the year. For example, at river mile 13 on Meacham Creek, temperatures never exceeded 20 C (68 F; Figure C-4, period of record July 20 - Nov 1, 1993). However, temperatures in Meacham Creek at river mile 2 were often in excess of 20 C (68 F) from mid June through the first of September, 1993 (Figure C-2). In the winter, rearing temperatures are more favorable in the lower reaches than the upper reaches were stream temperatures were often below 7 C (45 F).

In several locations, a spring or cool tributary will infuse enough cool water into a reach to provide suitable flows and temperatures for several hundred feet to several miles in a reach that otherwise would be too warm for salmonids in the summer. The North Fork Meacham Creek is an example of this. In 1993, Meacham Creek was dry above the mouth of the North Fork (river mile 15). Meacham Creek from river mile 15 down to river mile 6 had flows and temperatures suitable for the holding and spawning of spring chinook salmon. In warmer and drier years, such as in 1992, temperatures suitable for chinook did not extend as far down.

Furthermore, the lack of a riparian overstory along many reaches in the Umatilla River Basin does not provide shade to the stream during summer months. Direct solar radiation and total water volume play the greatest roles in stream temperature dynamics (Brown 1983). Removing large trees from stream areas has been shown to increase maximum stream temperatures in a test stream from a maximum of 15.6 (60 F) before logging to **30 (86** F) after logging while control reaches had no significant changes (Figures C-l 1 and C-12, from Brown and Krygier, 1970). The wide, shallow, unshaded pools and glides typical of much of the Umatilla River Basin function as efficient solar energy collectors. Water temperatures become unsuitable for salmonids below river mile 70 in the Umatilla River, below river mile 6 in Meacham Creek and in the lower ends of many of the smaller tributaries.

Physical Habitat Survevs

Physical habitat survey data collected in contract year 1992-93 is summarized in Appendix D. As additional data is collected and compiled in following years, detailed comparisons and analyses will be conducted. The general condition of the habitat in the five streams surveyed ranged from poor to good (Table D-1B). Buckaroo Creek was in the poorest condition followed by Meacham Creek, Boston Canyon Creek, Boston Canyon Creek Tributary, with Line Creek in the best condition. All the streams had low flows during the survey period with puddled and dry reaches. Dry reaches composed 3% of the area in Line Creek and ranged up to 44% in Buckaroo Creek. Pool area ranged from 10.8% of the total area of the stream in Boston Canyon Creek up to 35.6% in Meacham Creek (see Tables in Appendix D). Substrates were composed primarily of boulders, cobbles and gravel. Embeddedness of larger substrates by fines was less than 10% in all reaches. Percent open sky ranged from 10 to 60 percent with anything less than 20% considered good. All five streams were deficient in woody debris with less than 4 pieces/lOOm; more than 20 pieces/lOOm is considered good. Almost all of the rapid over boulder habitat units in Line Creek and Boston Canyon Creek were mistakenly classified by the surveyors as riffles. Many of the units would have been classified as pocketwater habitat had there been such a designation in the methodology. Lacking the pocket water classification, surveyors chose either the rapid over boulder or the riffle designations.

An effort was made to survey most of the habitat usable by salmonids. However, smaller streamlets and the upper reaches of streams were not surveyed even though they may provide some habitat to salmonids seasonally.

An indication of the future rehabilitation potential of degraded reaches in the Umatilla River Basin and how they might respond to watershed restoration efforts can be derived by examining both pristine and degraded watersheds in the area. Consider the mainstem of Meacham Creek in contrast to the more pristine North Fork Umatilla River, North Fork Meacham Creek, and South Fork Walla Walla River where stream channel morphology as well as temperature and flow profiles are suitable for salmonid rearing throughout the summer and fall (Figures C-l, C-5, C-8, C-9). The headwaters of these drainages are fairly pristine; mature riparian plant communities shade and stabilize the stream. They give the best indication of what the mainstem Meacham Creek and other subbasins could become if rehabilitated. Flow regimes are also more suitable to salmonid rearing in the adjacent pristine watersheds as observed by field personnel in the North Fork Umatilla and North Fork Meacham Creek and recorded by U.S. Geological Survey gages in the South Fork Walla Walla River. In 83 years of record, the peak monthly flows in the South Fork Walla Walla River were only 7 times base mean monthly flows. Specifically, 76 cfs (October 1988) is the minimum mean monthly flow for the 63 year period of record; 569 cfs (May 1948) is the maximum recorded mean monthly flow (Figure B-4). This contrasts strongly with the wide changes in discharge observed in the mainstem Meacham Creek as discussed earlier (Figures B-2, B-5).

BIOLOGICAL SURVEYS

Surveyors electrofished 25,810 m^2 and collected 4,143 natural rainbow trout and 295 hatchery rainbow trout. An estimated 84,747 natural rainbow trout and 2,141 hatchery rainbow trout/steelhead inhabited 367,429 m^2 of habitat in Buckaroo Creek, Boston Canyon Creek and Tributary, Line Creek and Meacham Creek where habitat surveys were conducted. Densities of natural rainbow trout ranged from 0 to $2/m^2$. Mean densities in surveyed plunge pools of Boston Canyon Creek were 2.01 natural rainbow trout/m' and 0.5 hatchery rainbow trout/m'. Lateral scour pools in Line creek had a mean density of 1.97 natural rainbow trout/m'. Weighted average density of natural rainbow trout among all watered units ranged from **0.08** in Buckaroo Creek to **0.88** in Line Creek (0.75 in Boston Canyon Creek, 0.19 in Boston Canyon Creek Tributary and 0.23 in Meacham Creek). Fifty one juvenile coho salmon were collected in Buckaroo Creek (Figure E-7). Other species of fish observed during electrofishing were not intentionally collected but the total number observed during the first pass was recorded. Surveyors observed 592 dace and 615 sculpin in Buckaroo Creek; 354 sculpin and one redside shiner in Boston Canyon Creek; 129 sculpin and 15 dace in Line Creek, and 7298 dace, 5026 sculpin, 1035 redside shiners, 7 whitefish, 62 squawfish and 211 suckers in Meacham Creek. Data summaries of electrofishing efforts are plotted and tabled in Appendix E (see Table D-l A also). As additional data is collected and compiled in following years, additional comparisons and analysis will be conducted.

Emergent rainbow/steelhead fry were first observed and captured on June 9, 1993 in Squaw Creek. In late June, large numbers of emergent fry were observed in the upper Umatilla River (river mile 84-90), North Fork of Meacham Creek and Meacham Creek (river mile 6-12). Few fry were observed in the North Fork Umatilla River and Umatilla River (river mile 67.5 to 73.5). No fry were observed during the spring below Three Mile Falls Dam where fall chinook and coho salmon were observed spawning the previous fall.

SPAWNING ESCAPEMENT SURVEYS

Major tributaries known to be utilized by spawning adult salmon and steelhead include Birch Creek, Squaw Creek, Meacham Creek and the North and South Forks of the Umatilla River (Figure A-2). Steelhead tend to use these and other tributaries, while spring chinook salmon use the mainstem and larger tributaries in the upper reaches where water temperatures are sufficiently cool in late summer and early fall. Fall chinook and coho salmon generally use the lower river. However, coho have been observed higher in the basin in tributaries such as Squaw Creek and Buckaroo Creek.

Steelhead

Steelhead redd and carcass surveyors enumerated 51 redds/46.6 miles, observed 50 live steelhead and recovered data from 7 steelhead carcasses (Table F-l). The low redd counts do not reflect a poor return as 1,913 steelhead were counted at Three Mile Falls Dam during the 1992-93 return season (1,297 natural and 616 hatchery). Marginal conditions for observing redds persisted throughout the spring of 1993 which makes comparisons to previous years infeasible. Redds marked before high flows in early May were indistinguishable during subsequent surveys. The majority of spawning likely occurred before and during the high water period. ODFW observed only 14 redds in Birch Creek after high flows in early May. Consequently, ODFW surveyors also postulated that most redds were unrecognizable after high flows (Table F-l 0).

High flows often prevent or limit the effectiveness of steelhead spawning surveys as occurred in the spring of 1993. Nevertheless, steelhead spawning surveys will be intensively conducted when conditions allow.

The known disposition of the 1,913 steelhead follows; 220 steelhead were taken for broodstock. 72 hatchery adults were sacrificed to recover the coded wire tags for ODFW research objectives (Zimmerman and Duke 1993). A total of 1621 summer steelhead were available for harvest and natural spawning (455 hatchery, 1166 natural).

Spring Chinook Salmon

Surveyors enumerated 224 spring chinook salmon redds (2.53 redds/mile) and examined 463 carcasses in 88.5 river miles in the Umatilla River Basin between June 23 and September 28, 1993 (Tables F-2 through F-5, Figures F-l through F-5). The 224 observed redds is a minimum estimate of the total redds produced by an estimated 861 adults for a adults/redd ratio of 3.8 to 1. Efforts were concentrated in areas where the majority of spawning occurred and the viability of redds was probable. An unknown number of adults could also have left the Umatilla River Basin after being counted at Three Mile Falls Dam.

The known disposition of the 1221 spring chinook counted at Three Mile Falls Dam was as follows: 153 were sacrificed for coded wire tag recoveries for ODFW research (Rowan 1994); 12 were Three Mile Falls Dam trap mortalities, nine were released at Three Mile Falls Dam; 1047 were hauled and released at river miles 42.2, 71.0, 79.5, or 87.0 (Zimmerman and Duke, 1993); an estimated 176 were harvested by Tribal anglers; a minimum of 15 were harvested by sport anglers (Mike Hayes, ODFW, personal communication 1994); surveyors examined 338 carcasses that had spawned successfully; 125 prespawning mortalities (67 females, 51 males and 7 unknown); leaving 402 unaccounted for.

The 463 spring chinook carcasses indicated that an average of 75.4% (205) of the 272 adult female spring chinook salmon had successfully completed spawning. An average of 72.3 % (133) of the 184 male carcasses inspected appeared to have spawned successfully. The sex of seven prespawning mortalities was not determined. The 463 carcasses found represented 38% of the 1205 adult spring chinook salmon trapped at Three Mile Falls Dam and 54% of the 865 salmon that were allowed to attempt natural spawning. The 865 adults produced 224 redds which gives an overall survival to spawning percentage of 52% (assuming that 50% of the adults were females). The discrepancy between the overall rate of 50% and the rate indicated by the carcass surveys (73%) is easily understood for the following three reasons: the fate of 402 salmon was unaccounted for; not all redds and carcasses were observed, and the exact ratio of male to females was probably not 50% (58 % of examined carcasses were female).

The percentage of carcasses indicating successful spawning was variable and highest in the upper drainage where water temperatures were coolest (Table F-5 and Figures C-6 through C-8). On the mainstem Umatilla River, survival through spawning was 81.3 % between river mile 80 and 90, 75 % from river mile 79 to 80, 52% from river mile 70 to 79 and 0% from river mile 59.5 to 70. Survival through spawning was 93.1% in the North Fork Umatilla River (Figure F-l). On Meacham Creek a similar pattern was observed, 91.7% survival upstream from river mile 6 to river mile 15 and 53.2% from the mouth to river mile 6 (Figure F-2). Data from four Meacham Creek thermographs reveal that maximum stream temperatures during the summer were 24 C (75 F) at river mile 2 and 5.25. At river mile **13** the maximum temperature was **20** C **(68** F) and only 18.8 C **(66 F)** in the North Fork Meacham Creek (Figures C-2 through C-5). To maximize survival to spawning, adult salmon trapped and hauled upstream should be released above river mile 80 rather than at river mile 42. This will increase the probability that fish will hold and spawn in the upper reaches where the habitat is suitable and cool temperatures help minimize prespawning mortalities.

The estimated cause of death of 125 prespawning mortalities included six with gaff wounds and one illegally harvested salmon abandoned on the bank. The remaining 116 apparently died of disease as the carcasses had either severe gill erosion, patches of heavy mucus on the gills or extensive body fungus. It appears that columnaris (*Flexibacter columnaris)* is an important pathogen in the lower and warmer reaches. Fresh, moribund prespawning spring chinook were not collected for pathological analysis to confirm columnaris, however evidence indicates that the probability is high. Water temperatures are known to influence the outbreaks of columnaris. Outbreaks seldom occur at water temperatures below 12.7 C (55 F) and may be severe at temperatures over 18.3 C (65 F; U.S. Fish and Wildlife Service 1982). Warmer water temperatures found in the lower reaches (as discussed in the preceding paragraph) also correlated well to the occurrence of prespawning mortalities with severe gill erosion and patches of heavy mucus on the gills.

Warm water temperatures weakened adult spring chinook salmon to the point that successful spawners constructed atypically small redds in the Umatilla River below river mile 79 and the lower six miles of Meacham Creek. Distinguishing between test digs and actual redds in these reaches was difficult. The number of carcasses and the percent indicating successful spawning in combination with the number of redds may be a better measure of spawning success in these marginal areas.

We measured both fork length and MEHP lengths on each carcass. MEHP length is taken to maintain consistency in length measurements as caudal fins erode and kypes extend during spawning season. Plotting the two measurements from each carcass indicates that for a given MEPH length, the difference in fork length can vary from 50 to 200 mm (Figure F-4, F-5). This difference is enough to place adults of the same MEHP length in different age categories based on fork length. While MEPH length measurements are accurate to a range of about 5 mm, the consistency of length is not confounded by the differential erosion of the caudal fin and the growth of the kype. Accordingly, MEHP length is the preferred measurement to accompany scales taken from carcasses and to evaluate the age composition of successful spawners using length criteria. As scale analysis is completed, we will examine relationships between size, age and successful spawning.

Surveyors collected 356 snouts from adipose fin-clipped salmon carcasses on the spawning grounds for 59% of the 603 coded wire tag fish examined at Three Mile Falls Dam and released in the river for harvest and spawning. Coded wire tag recovery data is reported by Rowan (1994).

Fall Chinook and Coho Salmon

Surveyors observed 14 live salmon, enumerated 13 salmon redds and recovered data from 8 coho and 2 fall chinook carcasses between river mile 40 and 49 during the fall of 1992. Below Three Mile Falls Dam workers observed 34 fall chinook and 6 coho salmon on redds, 16 fall chinook and 13 coho prespawning (living) salmon, and examined 88 fall chinook and 22 coho carcasses (Table F-6 through F-9 and Figure F-6, F-7).

The data suggests that better spawning and rearing conditions exist above Pendleton and that transporting fall chinook and coho adults captured at Three Mile Falls Dam to the mouth of Meacham Creek may enhance the restoration of natural runs. This is currently being done with some spring chinook with success. Furthermore, salvaging adults from below Three Mile Falls Dam and transporting them to more suitable spawning areas may also enhance natural production. Water quality and quantity inadequacies below Three Mile Falls Dam appear to prevent viable natural production even though hundreds of fall chinook and coho have spawned there in years past. No fry or fingerlings have been observed below Three Mile Falls Dam during biological surveys in the spring and early summer.

JUVENILE SALMONID TRAPPING

The rotary screw trap operated 124.5 out of 148 days from March 12 through August 6, 1993 and captured 490 juvenile rainbow/steelhead with an overall trap efficiency rate of 7.9% (20 recaptured from 254 marked and released). Two hundred and forty nine juvenile chinook salmon were captured with an overall efficiency rate of 8.9% (17 recaptured out of 191 marked and released). Six bull trout were captured; none were marked and released in the 1992-93 contract year (Appendix G).

Several uncertainties affect the evaluation of trap data regarding naturally produced smolts emigrating from the upper Umatilla River which include: wide day to day variation in trap catch rates (0 to 38.5%); the unknown number of salmonids passing the trap during the 23.5 days the trap was not operated, and the unknown proportion of the rainbow/steelhead that were presmolted emigrants or resident fish. Length frequencies of juvenile steelhead and rainbow trout captured in the lower river are very different from those caught in the rotary screw trap at river mile 79.5 (Figure G-l, G-**8).** Furthermore, smolts that had moved below the trap site during the previous fall and winter would not have been available for trapping after March 12 during spring emigration.

Trapping was conducted at river mile 79.5 because most of the redds in past years have had been found upstream of the site while hundreds of thousands of hatchery fish are annually released just below the site. In addition, water quality is unsuitable for summer rearing of salmonids not far below the site. We postulated that by trapping at river mile 79.5 naturally produced emigrants could be successfully estimated without subjecting recently released hatchery fish to the additional stress associated with trapping and handling. Trapping in the lower river would require continual monitoring during hatchery releases to prevent the trap from becoming inundated with fish and causing unnecessary stress to both hatchery and natural production smolts. After examining the results, it appears that trapping in both the mid and lower river will be required to effectively estimate the number of naturally produced smolts emigrating from the Umatilla River Basin.

HARVEST

Surveyors logged 81 survey hours among five survey sections during the 84 hour Tribal spring chinook salmon season (six days, fourteen hours/day). They conducted 93 angler interviews and examined 59 adult spring chinook (Table A-3, Figure A-3). No anglers were observed during 10 hours of survey effort below Pendleton in sections 4 and 5. An additional 45 chinook salmon were reported during telephone interviews for a reported total of 104 spring chinook salmon. Expanding the effort and catch rate data produced a similar estimate of 176.

The post season telephone survey was effective because of the relatively small number of Tribal anglers, the localized area of their residence, the short season and the reception of Tribal angers to the non-intrusive techniques and questions of the telephone interviews.

During the design and execution of the roving creel survey with nonuniform probability sampling, it was understood that the survey would produce a minimum estimate of effort and harvest because of an unknown probability of not seeing an unknown proportion of the fishermen. Furthermore, meaningful error bounds on the harvest estimate were not calculated because of the short length of the season (84 hours), the heterogeneity of angler effort between survey reaches and times, the small sample size from each category, and finally, the fact that most of the anglers interviewed had not completed their fishing trip. Complete angler trips provide the best estimate of catch per unit effort as many anglers fish until they catch one or two salmon and then go home. Traditionally catch per unit effort calculations are normally based on interviews with anglers who had completed their fishing trip for the day (Malvestuto 1983).

AGE AND GROWTH

Limited scale reading, analysis and summarization was performed during 1992-93 contract period because the microprojector was not available until 1993-94. However, it was determined from the few scales examined that growth rates for juvenile steelhead are slow. Three year old rainbow are often less than 160 mm in fork length. As expected, steelhead scales examined from adults indicated that juvenile steelhead spend two or three years in fresh water before entering the ocean. Scale analysis of 15 juvenile steelhead with silvery external appearance indicated that 60% were age 2+ and 40% were age 3 + (150 mm mean length). The age 3+ smolts had very poor first year growth. Scales and otoliths from a 390 mm bull trout indicated it was four years old. The fish had grown slowly during the first two growth periods and rapidly during the last two.

GENETIC SAMPLING

Currens and Schreck (1993) found significant differences in allozyme frequencies between trout from different tributaries; however, cluster analysis revealed only marginal geographic patterns. McKay and East Birch Creek trout were clearly genetically separate from trout collected from the rest of the drainage. They found strong evidence (allozyme, mtDNA and meristic characteristics) that the native stocks in McKay and East Birch Creek had hybridized with hatchery stocks introduced into those systems. For the remaining populations, the significant differences in allozyme frequencies without strong geographical pattern of differentiation in allozyme or mtDNA results indicates that either:

1) differences represent minor localized population differences among resident and anadromous populations, or
2) allozyme and haplotype frequencies developed through random events associated with small breeding populations and/or populations

founded by only a few individuals. This could be tested by examining cohort-to-cohort variations in fish from the same locations (Currens and Schreck 1993).

Additional work by Currens during the summer of 1994 will test for variations between cohorts by resampling populations from the same locations as done in the fall of 1992.

STEELHEAD SUPPLEMENTATION EVALUATIONS

The evaluation of steelhead supplementation effects on natural summer steelhead stocks in the Umatilla River Basin was not directly addressed in the 1992-93 contract year. However, in Boston Canyon Creek, the number of natural juvenile steelhead/rainbow trout over 75 mm in length appears to have been impacted by juvenile hatchery steelhead. While overall densities of natural salmonids were similar in Boston Canyon and Line Creeks (Tables E-2, E-5), few natural trout over 75 mm were collected in Boston Canyon Creek. However, natural salmonids up to 150 mm were regularly encountered in Line Creek and Meacham Creek. Compare length frequency histograms of juvenile rainbow trout from three adjacent streams, Boston Canyon Creek, Line Creek and Meacham Creek (Figures E-2 through E-4). Furthermore, juvenile rainbow trout from 50-75 mm in length were in markedly better physical condition in Line Creek than Boston Canyon Creek. Displacement of natural trout by hatchery trout has been observed in other systems and would-explain the lack of natural trout over 75 mm in Boston Canyon Creek (Vincent 1987). Significant residualization of juvenile hatchery steelhead appears to be limited to Boston Canyon Creek and is presumably a consequence of the acclimation facility located at the mouth.

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APPENDICES

APPENDIX A
General and Miscellaneous Tables and Figures

Table A- 1. Umatilla River Spring Chinook Salmon Harvest Plan (TMD = Three Mile Falls Dam).

NUMBER OF ADULTS COUNTED AT TMD	TRIBAL HARVEST	NON-TRIBAL HARVEST	PRESPAWNING MORTALITY	SPAWNING ESCAPEMENT
<500	0	0	1/2 the run	1/2 the run
500	50	50	200	200
750	75	75	300	300
1000	100	100	400	400
1250	125	125	500	500
1500	150	150	600	600
1750	175	175	700	700
2000+	10%	10%	40%	40%

Table A-2. Non-uniform probability Rates by Section for the Roving Creel Survey for Monitoring the Spring Chinook Salmon Fishery, 1993.

SECTION NUMBER	PROBABILITY RATING	SECTION DESCRIPTION	SECTION LENGTH (MILES)
1	0.45	Umatilla River, RM 79 to 90 and South Fork Umatilla River RM 1 to 4	15
2	0.35	Meacham Creek, RM 0 to 11	11
3	0.10	Umatilla River, RM 55 to 79	24
4	0.05	Umatilla River, RM 55 to 23	32
5	0.05	Umatilla River, RM 0 to 23	23
Total	1.00		105

Table A-3. Summary of the Spring Chinook Salmon Tribal Fishery, 1993.

	SECTION 1	SECTION 2	SECTION 3	TOTAL
Anglers Counted	32	68	3	103
Anglers Interviewed	27	63	3	93
Hours of Angler Effort Reported During Interviews	17	257	19:30	293:30
Number of Salmon Examined in Creel	1	52	3	56
Hours Surveyed	27:11	30:54	13:00	
Total Hours During Season	84	84	84	
Surveyed Hours/ Total Hours	0.3236	0.3679	0.1548	
Expanded Angler Effort Estimate (hours)	62:16	754:00	125:58	
Estimated Catch Per Unit Effort	0.0588	0.2023	0.1538	
Estimated Harvest For the Season	4	153	19	176

Table A-4. Summary of Juvenile Rainbow/Steelhead Collected for Genetic Samples form the Umatilla Basin, Fall 1992.

STREAM	REACH WHERE FISH WERE CAPTURED	DATE SAMPLED	DATE FROZEN	NUMBER COLLECTED
N. Fork Umatilla River	Mouth to RM 1	11/17/92	11/19/92	75
Buck Creek	Mouth to RM 1	11/18/92	11/19/92	25
Thomas Creek	Mouth to RM 1.6	11/05/92	11/06/92	24*
S. Fork Umatilla River	RM 3 to 4	11/18/92	11/19/92	25
Camp Creek	RM 0.3 to 1.3	11/23/92	12/02/92	23
N. Fork Meacham Creek	RM 0.2 to 1.2	11/24/92	12/02/92	24
Upper Meacham Creek	RM 17 to 30	11/05/92	11/06/92	24
Squaw Creek	RM 0 to 6	10/26/92	10/28/92	58
McKay Creek	RM 25 to 26	11/30/92	12/02/92	24
E. Birch Creek	RM 10.5 to 12.5	11/06/92	11/06/92	25
Pearson Creek	RM 0 to 6	10/27/92	10/28/92	25
W. Birch Creek	RM 5 to 7	10/27/92	10/28/92	25
Mainstem Butter Creek	RM 51 to 55	11/16/92	11/19/92	25
Wild Horse Creek	RM 20 to 30	11/20/92	—	0
				402

* one of these was collected 11/23/93.

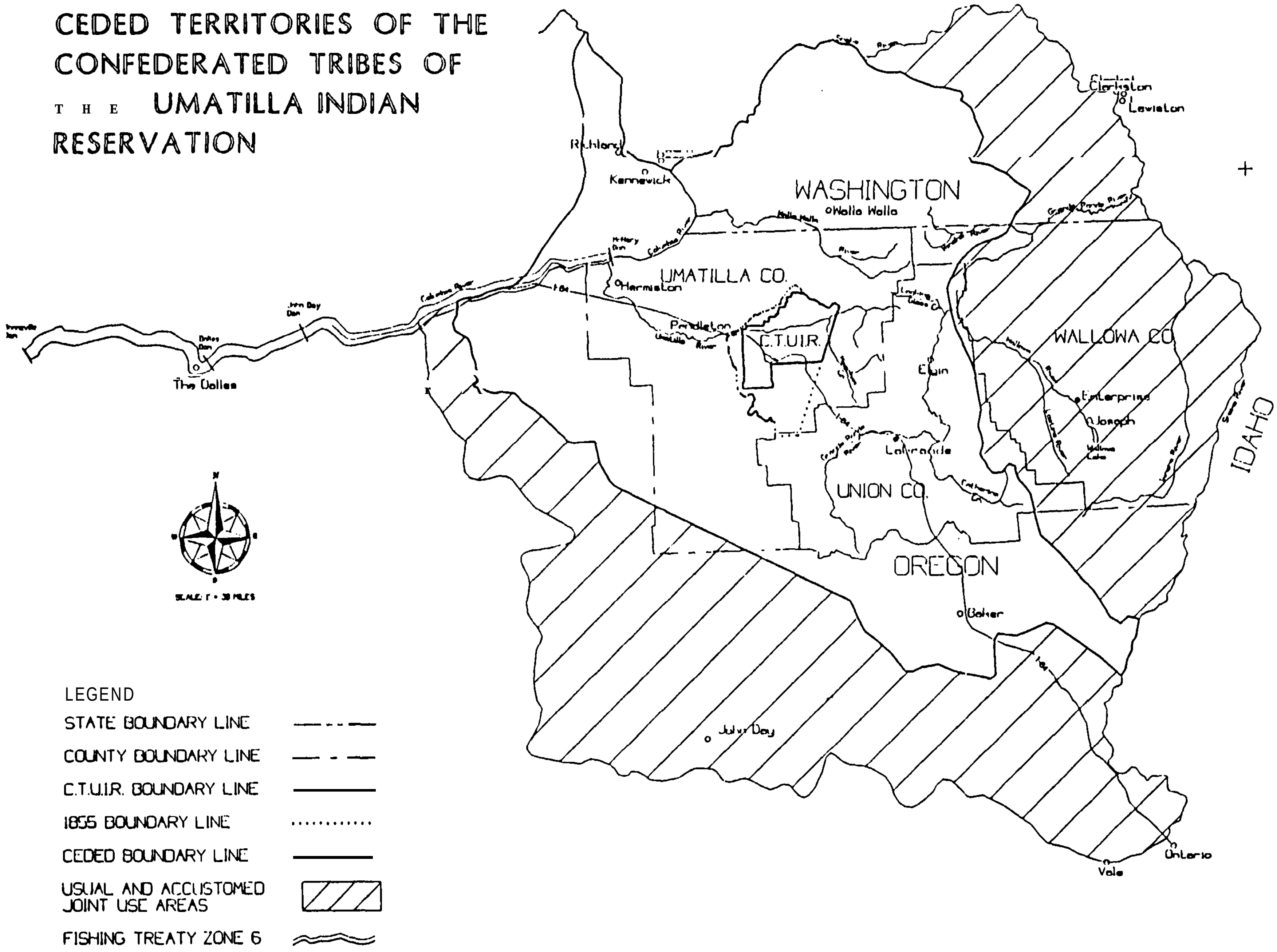

Figure A-l. Map of Reservation and Ceded Lands of the Umatilla Indian Reservation in Northeast **Oregon** and Southeast Washington.

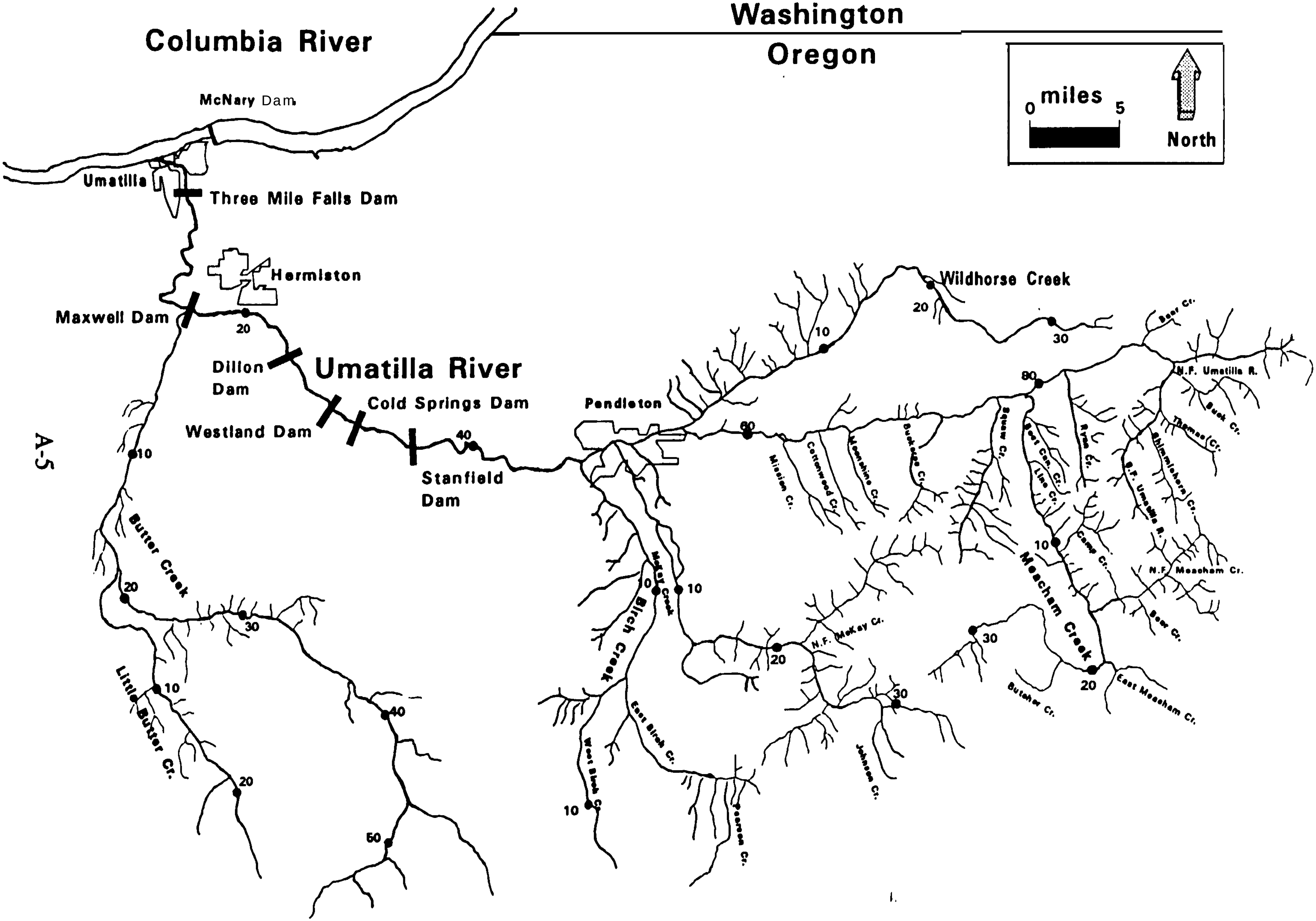

Figure A-2. Map of the Umatilla River Basin with River Miles Denoted.

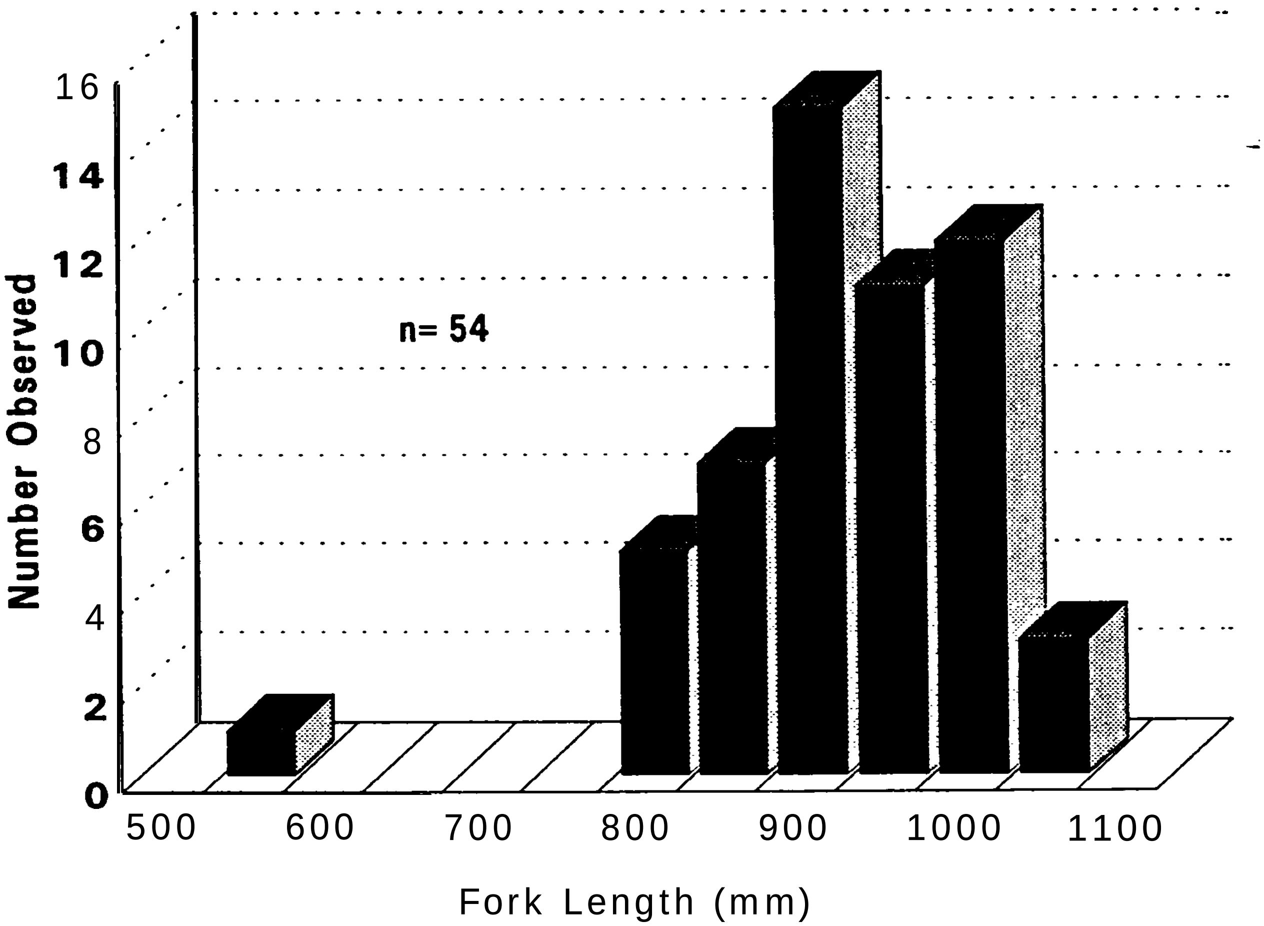

Figure A-3. Length Frequency of Spring Chinook Salmon Harvested During the Tribal Fishery, 1993 (93HARVST.CH3).

APPENDIX B
Historical Flows in the Umatilla River Basin

Table B-l. U.S. Geological Survey Flow Gages in the Umatilla River Basin.

GAGE NAME AND LOCATION	RIVER MILE	PERIOD OF RECORD
Umatilla River above Meacham Creek	83.1	1933 to Present
Umatilla River at Cayuse	67.0	1969 to 1975
Umatilla River at Pendleton	55.2	1934 to Present
Umatilla River at Yoakum	37.7	1904 to Present
Umatilla River near Umatilla	2.1	1903 to Present
Meacham Creek near Gibbon	1.5	1929 to Present
Moonshine Creek near Mission	1.1	1991 to Present
Cottonwood Creek near Mission	1.3	1991 to Present
Patawa Creek near Pendleton	2.9	1991 to Present
Butter Creek near Pine City	28.5	1928 to 1989
East Birch Creek near Pilot Rock	4.3	1968-1973
McKay Creek near Pilot Rock	10.5	1921-1989

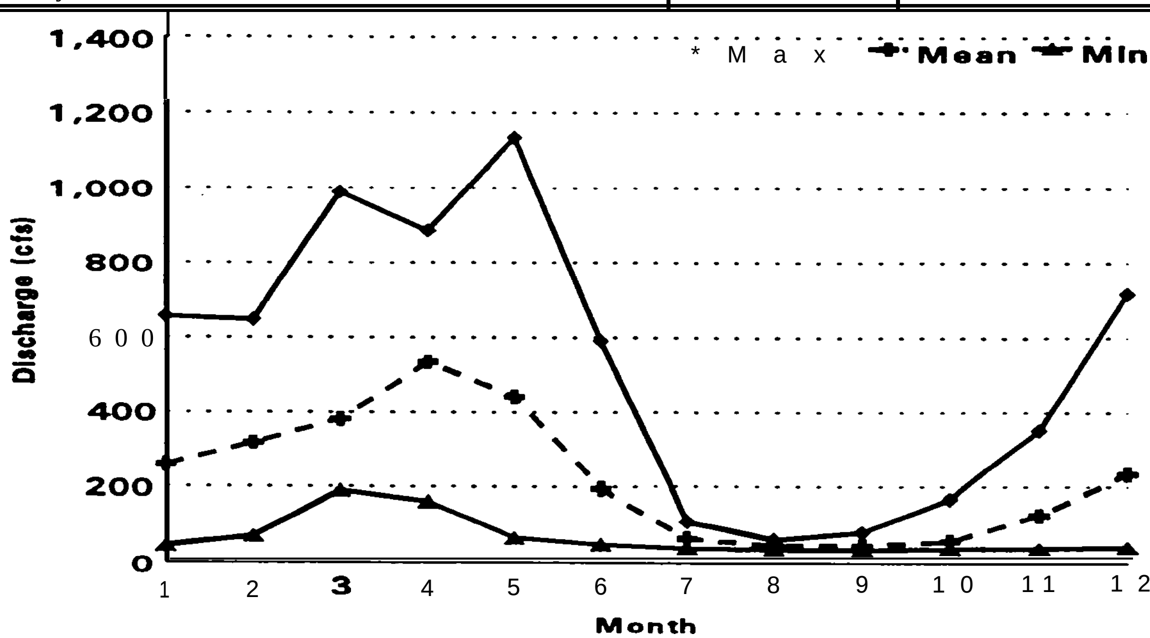

Figure B-l. Maximum, Mean and Minimum of the Average Monthly Flows of the Umatilla River Recorded by the USGS Gage at River Mile 81 from 1933 to 1992 (UMTMMFLW.CH3).

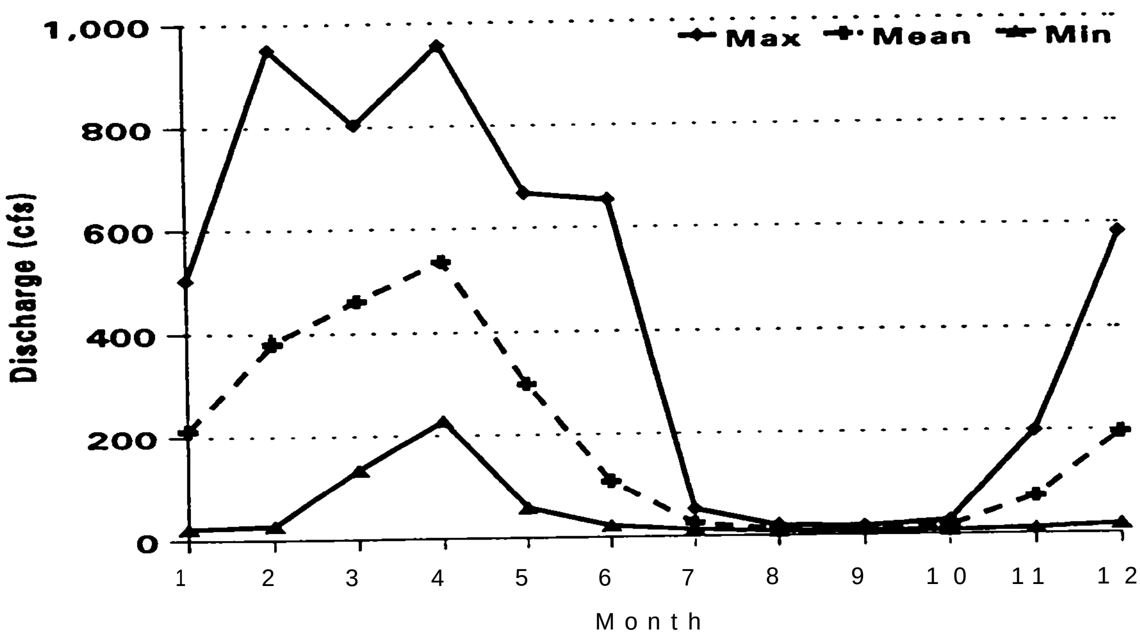

Figure B-2. Maximum, Mean and Minimum of the Average Monthly Flows of Meacham Creek Recorded by the USGS Gage at River Mile 1.4 from 1975 to 1992 (MMCG.CH3).

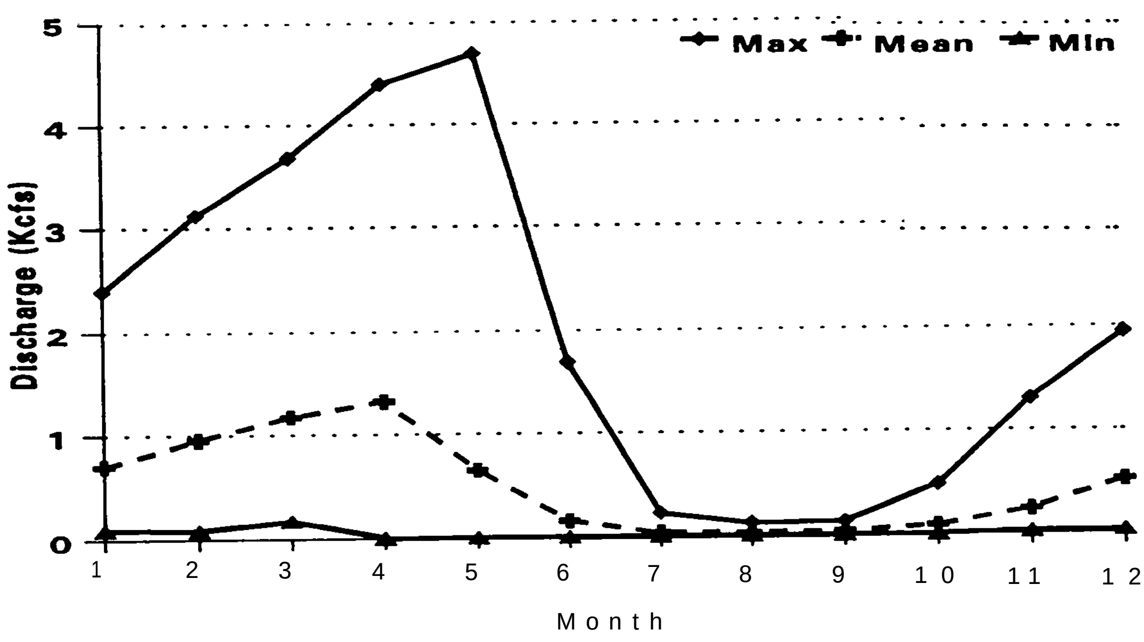

Figure B-3. Maximum, Mean and Minimum of the Average Monthly Flows of the Umatilla River Recorded by the USGS Gage at River Mile 1.2 from 1904 to 1992 (URU.CH3).

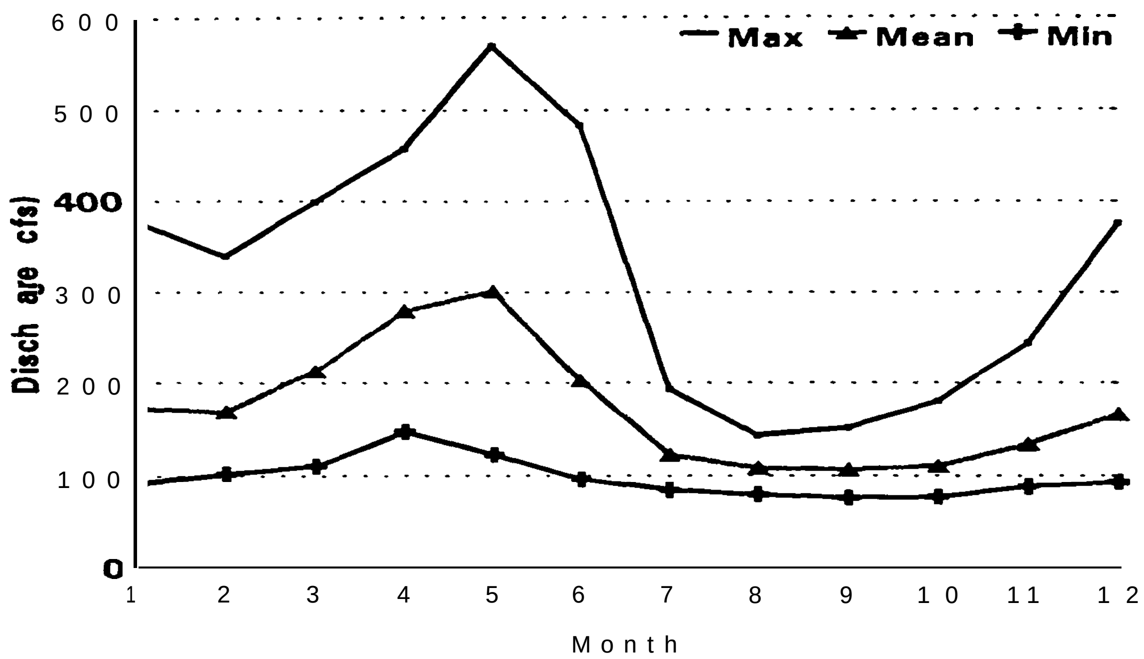

Figure B-4. Maximum, Mean and Minimum of the Average Monthly Flows of the South Fork **Walla Walla** River Gage Recorded by the USGS Gage at River Mile 8.7 from 1904 to 1992 **(SFMAXMIN.CH3).**

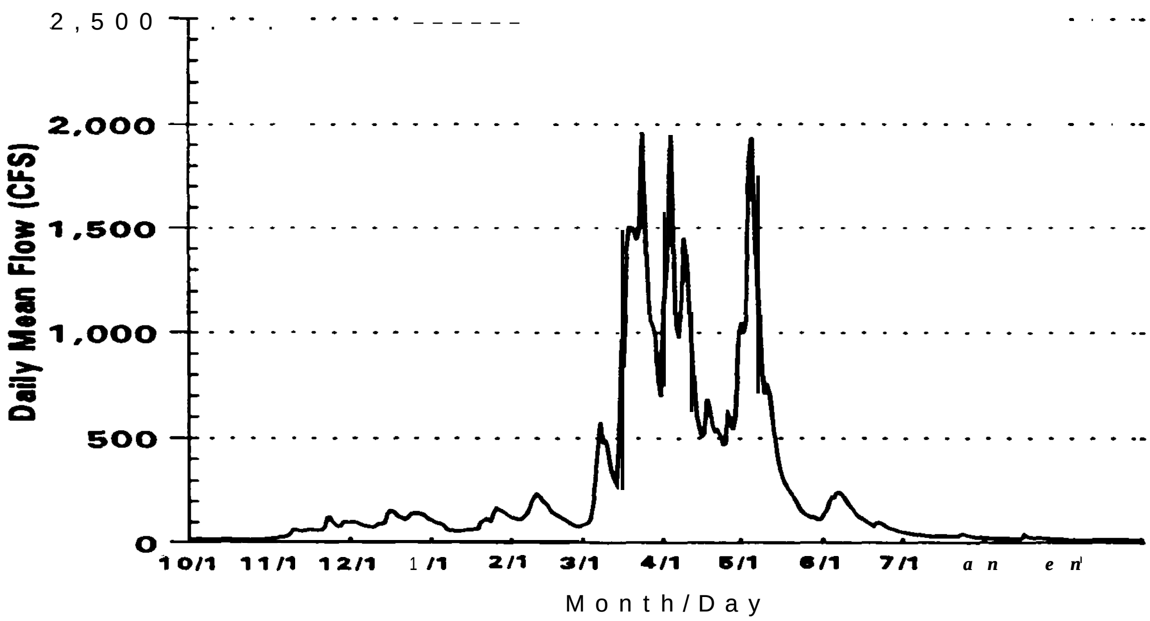

Figure B-5. **Mean** Daily Flows of Meacham Creek Recorded by the USGS Gage at River Mile 1.4 from October 1992 through September 1993 **(M93FLOW.CH3).**

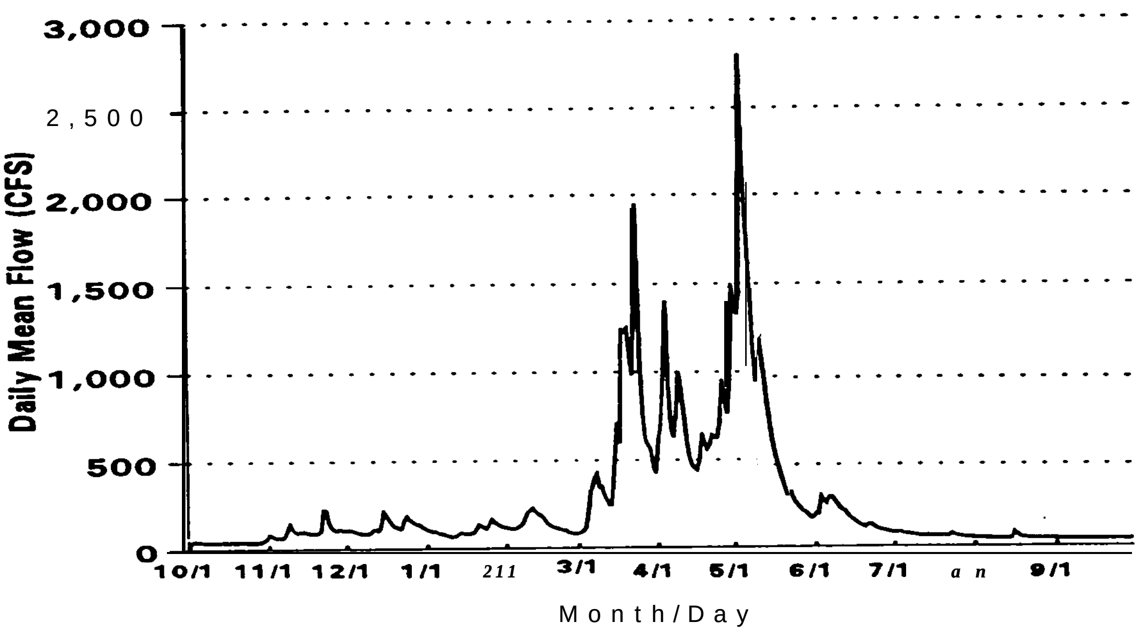

Figure B-6. Mean Daily Flow of the Umatilla River Recorded by the USGS Gage at River Mile 81 from October 1992 through September 1993 (U93FLOW.CH3).

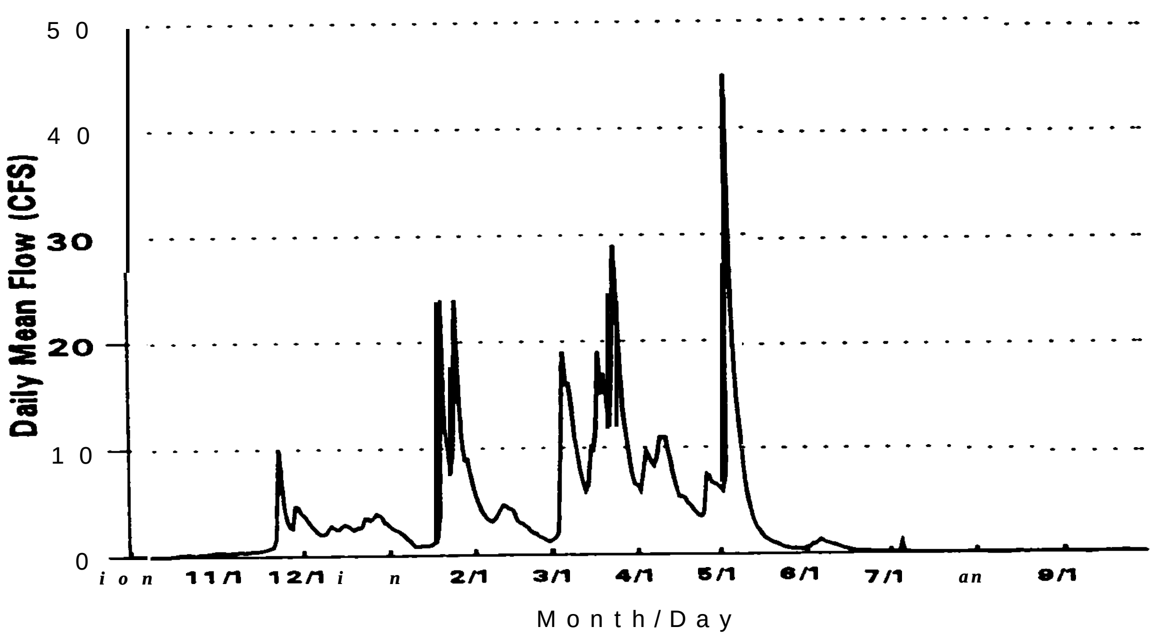

Figure B-7. Mean Daily Flow of Moonshine Creek Recorded by the USGS Gage at River Mile 1.1 from October 1992 through September 1993 (MOO93FLO.CH3).

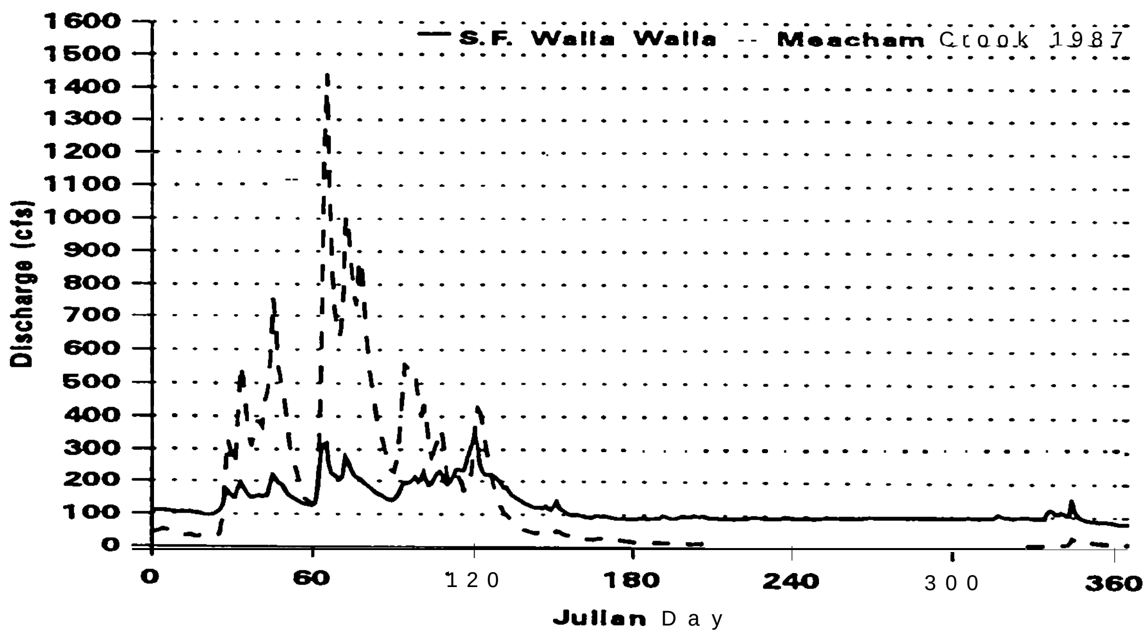

Figure B-8. Comparison of Mean Daily Flows of the South Fork of the **Walla Walla** River (RM 8.7) and Meacham Creek **(RM 1.4),** 1987 **(SFWWDAY.CH3).**

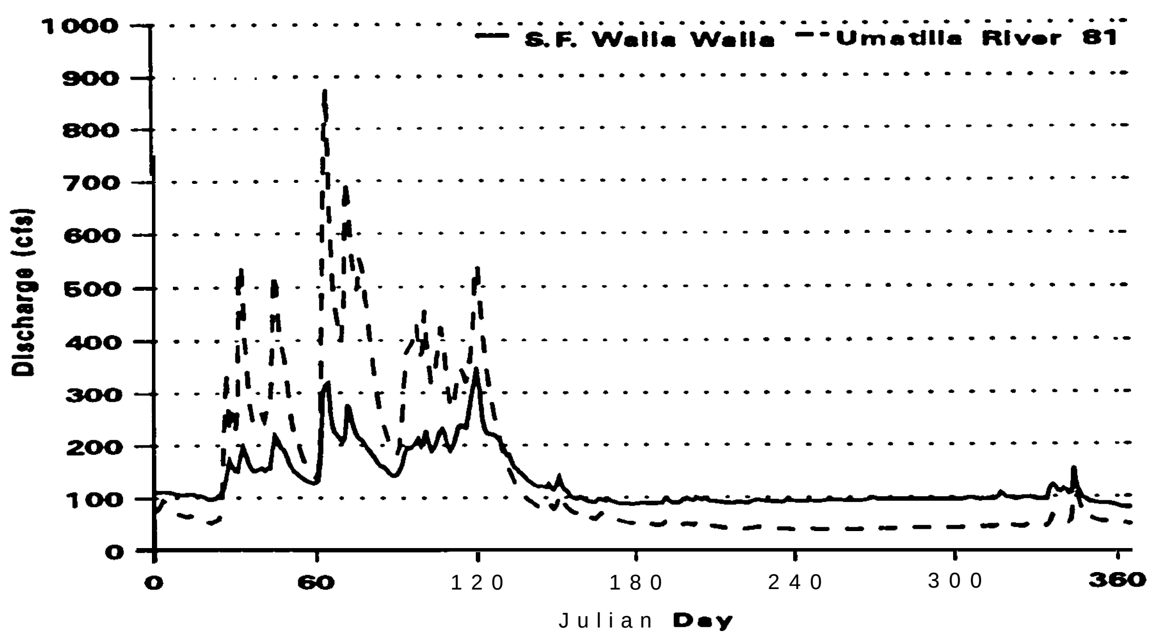

Figure B-9. **Comparison** of Mean Daily Flows of the South Fork of the **Walla Walla** River **(RM** 8.7) and the Umatilla River **(RM 81),** 1987 **(SFWWDAY.CH3).**

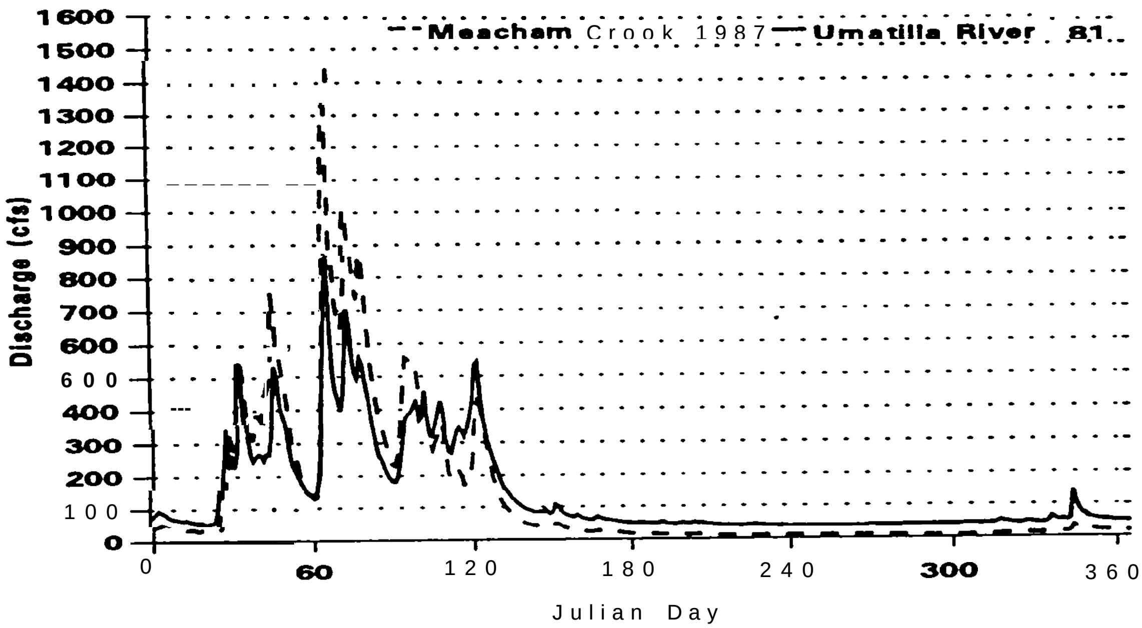

Figure B-10. Comparison of **Mean** Daily Flows of the Umatilla River **(RM** 81) and **Meacham Creek (RM** 1.4). 1987 **(SFWWDAY.CH3).**

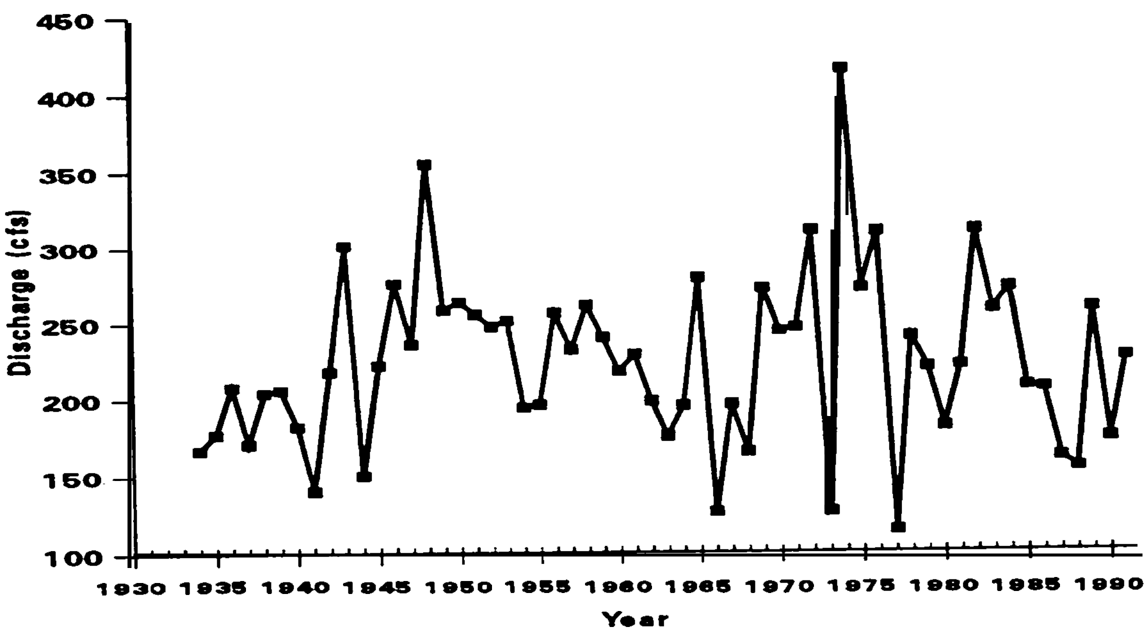

Figure B-11. Mean **Annual** Flow of the Umatilla River near Gibbon (RM 81) from 1933 to 1992 **(UMFLOWGB.CH3).**

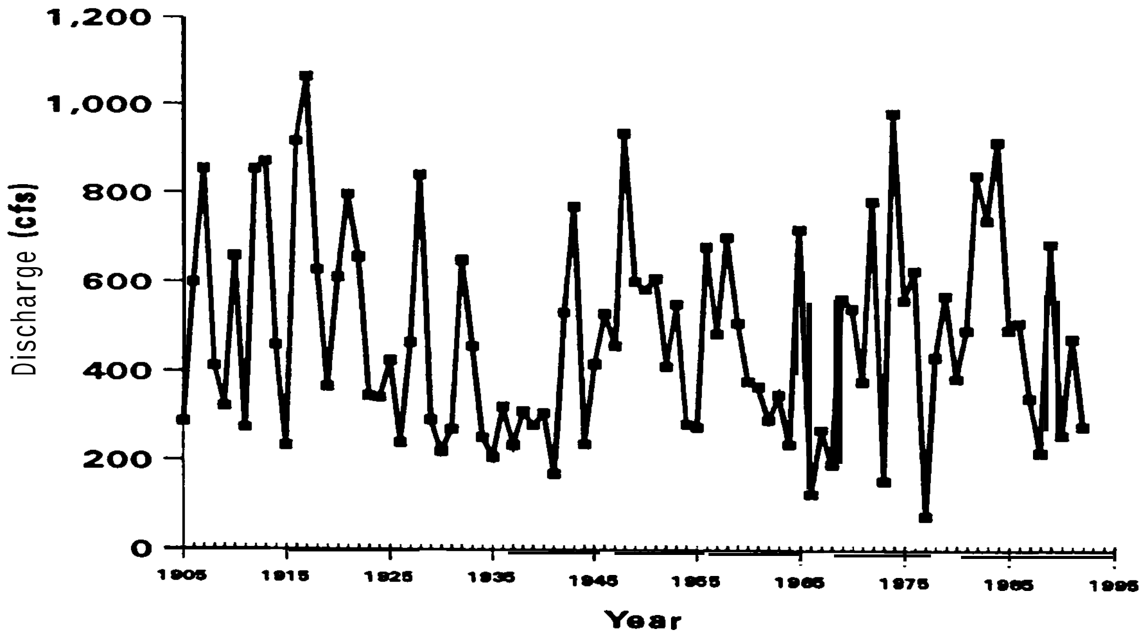

Figure B-12. Mean Annual Flow of the Umatilla River Near Umatilla (RM 1.2) from 1904-1993 (UMATUTFL.CH3)

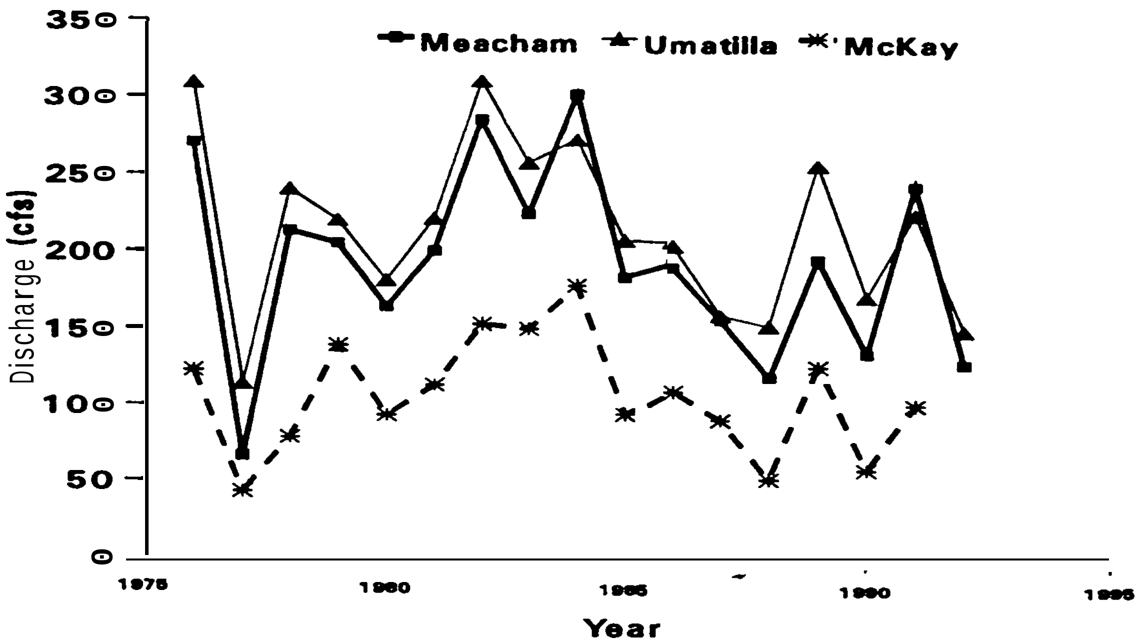

Figure B-13. Comparison of Mean Annual Flows from Meacham Creek (RM 1.4), Umatilla River (RM 81) and North Fork McKay Creek (RM 0.1; MEACHFLOW.CH3)

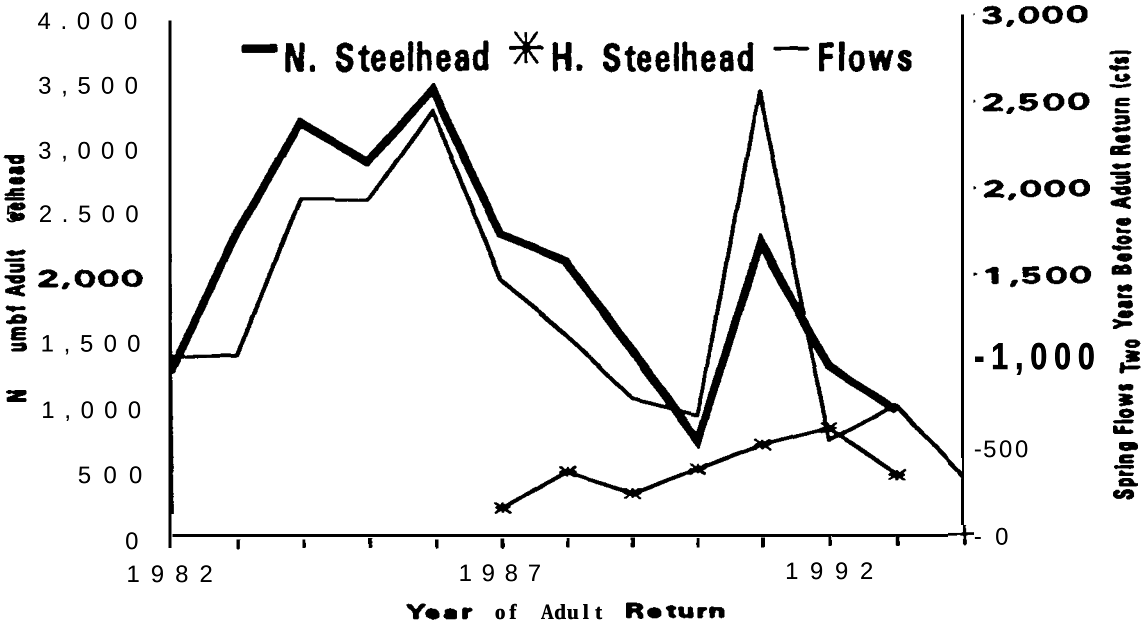

Figure B-14. Adult Steelhead Returns Compared to tbe Average of April and March Mean Monthly Flows (cfs) at Umatilla Gage (RM 1.2) Two Years Prior to the Adult Return from 1982 to 1994 **(STSFLW3.CH3)**

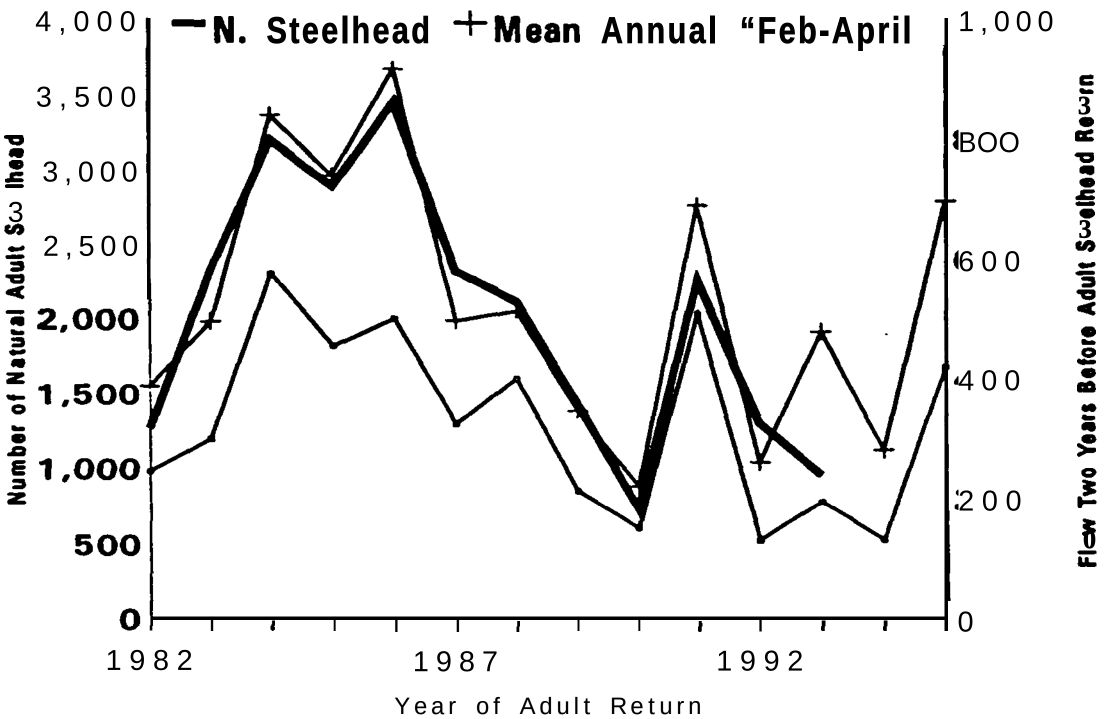

Figure B-15. Adult Steelhead Returns Compared to the Mean Annual Flows and the Average of February, March and April **Mean Monthly** Flows (cfs) at Umatilla Gage (RM 1.2) Two Years Prior to the Adult Return from 1982 to 1994 **(STSFLW2.CH3)**

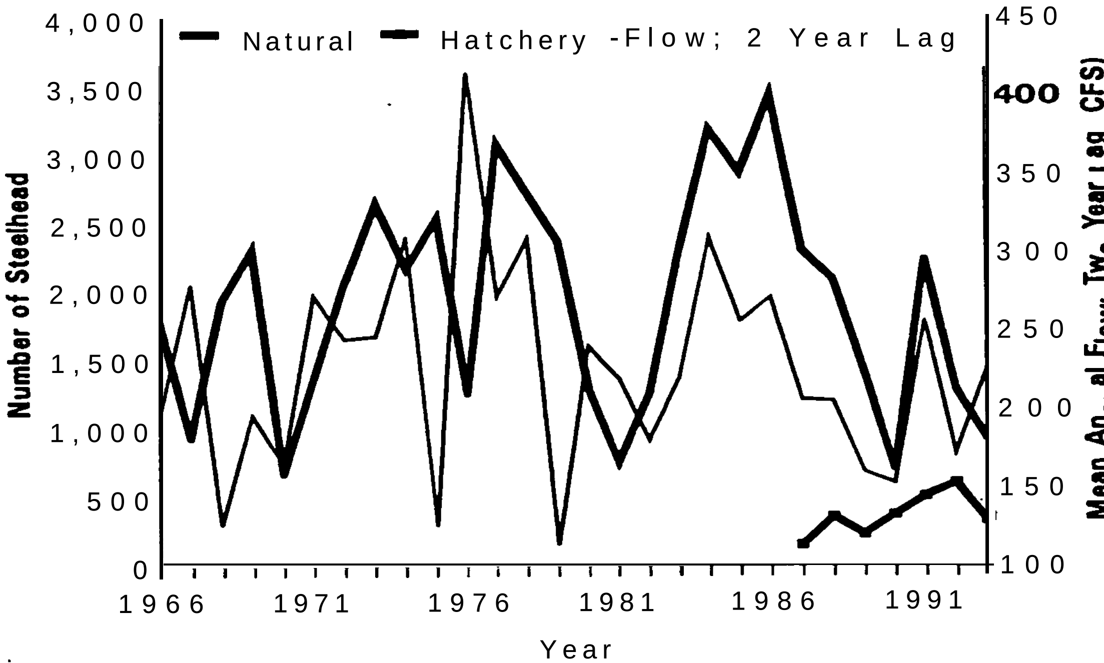

Figure B-16. Adult **Steelhead** Returns Compared to the Mean Annual Flows (cfs) at Umatilla Gage (RM 1.2) Two Years Prior to the Adult Return from 1966 to 1994 **(STHDRTN2.CH3)**

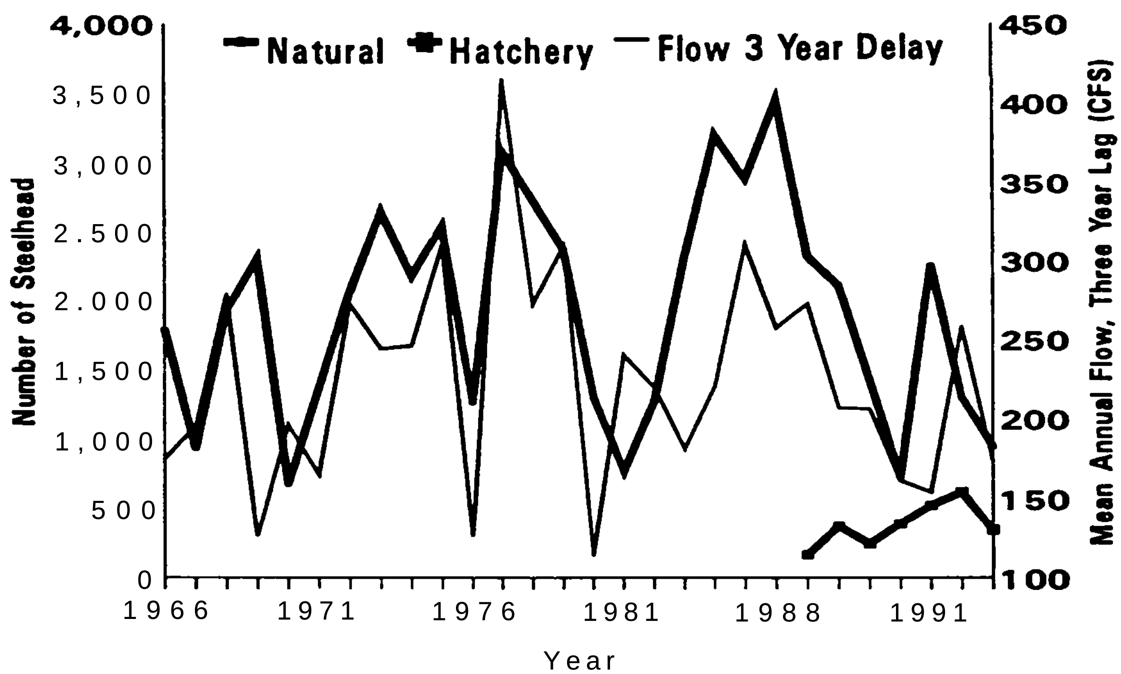

Figure B-17. Adult **Steelhead** Returns Compared to the **Mean Annual** Flows (cfs) at Umatilla Gage **(RM** 1.2) Three Years Prior to the Adult Return from 1966 to 1994 **(STHDRTN3.CH3)**

APPENDIX C
Thermograph Locations and Recorded Temperatures

Table C-1. Thermographs in the Umatilla River.

LOCATION	AGENCY	RIVER MILE	DEPLOYMENT PERIOD	THERMOGRAPH TYPE
Umatilla River at Three Mile Falls Dam	CTUIR	3.7	All Year	Temp-Mentor
Umatilla River (at Three Mile Falls Dam)	USBR	3.7	Proposed	Hydromet
Umatilla River (at Maxwell Canal @ new gage)	USBR	15	All Year	Hydromet
Umatilla River (near Dillon Canal, at gage 0310)	USBR	24	All Year	Hydromet
Umatilla River (near Feed Canal, at gage 0290)	USBR	28	All Year	Hydromet
Umatilla River (near Yoakum, at gage 0260)	USBR	37	All Year	Hydromet
Umatilla River (Near Rieth)	CTUIR	49	All Year	RTM2000
Umatilla River (Near Pendleton, at gage 0210)	USBR	55.2	Proposed	Hydromet
Umatilla River (Near ODFW Office)	CTUIR	56	All Year	Temp-Mentor
Umatilla River	CTUIR	78.5	All Year	Temp-Mentor
Umatilla River	CTUIR	79	All Year	Temp-Mentor
Umatilla River (at USGS Gage)	CTUIR	81.7	All Year	Temp-Mentor
Umatilla River (Below mouth of N. and S. Forks)	USFS	89.5	Feb.-Dec.	Temp-Mentor
Minthorn Springs (Near Umatilla RM 65)	CTUIR	In Springs	All Year	Temp-Mentor
Buckaroo Creek	CTUIR	2	All Year	Temp-Mentor
Squaw Creek	CTUIR	2	All Year	Temp-Mentor
Little Squaw Creek	CTUIR	0.1	All Year	Temp-Mentor
Ryan Creek	CTUIR	1.3	All Year	RTM2000
N.Fork Umatilla River	USFS	0.1	June-Oct.	Temp-Mentor
S.Fork Umatilla River	USFS	0.1	Feb.-Dec.	Temp-Mentor
S.Fork Umatilla River	USFS	6	June-Oct.	Temp-Mentor
Shimmiehorn	USFS	0.1	June-Oct.	Temp-Mentor

Table C-2. Thermographs in Meacham Creek Drainage.

LOCATION	AGENCY	RIVER MILE	DEPLOYMENT PERIOD	THERMOGRAPH TYPE
Meacham Creek	CTUIR	2	All Year	Temp-Mentor
Meacham Creek	CTUIR	5.25	All Year	Temp-Mentor
Meacham Creek	CTUIR	13	All Year	RTM2000
Meacham Creek	ODFW	31.5	April-Oct.	Temp-Mentor
Meacham Creek	ODFW	32.5	April-Oct.	Temp-Mentor
Bonifer Pond (near Meacham C. RU 2.5)	CTUIR	In Pond	All Year	Temp-Mentor
Camp Creek	CTUIR	0.6	All Year	RTM2000
N.F. Meacham	ODFW	0.1	All Year (Began 5/94)	Hobo
N.F. Ueacham	USFS	2	June-Oct.	Temp-Mentor
East Meacham	CTUIR	0.1	All Year	RTM2000
Butcher Creek	CTUIR	1	All Yedr	RTM2000

Table C-3. Thermographs in Wildhorse Creek Drainage

LOCATION	AGENCY	RIVER MILE	DEPLOYMENT PERIOD	THERMOGRAPH TYPE
Wildhorse Creek (Mouth)	CTUIR	0	All Year	Temp-Mentor
Wildhorse Creek (Below new project)	CTUIR	9.5	Proposed, All Year	Temp-Mentor
Wildhorse Creek (Above new project)	CTUIR	11	Proposed, All Year	Temp-Mentor
Wildhorse Creek (Near Adams)	ODFW	13	AU Year	Temp-Mentor
Wildhorse Creek (Headwaters)	CTUIR	26	All Yar	Temp-Mentor

Table C-4. Thermographs in the Walla Walla River Basin

LOCATION	AGESCY	RIVER MILE	DEPLOYMENT PERIOD	THERMOGRAPH TYPE
Walla Walla River	CTUIR	8	All Year	Temp-Mentor
Walla Walla River	CTUIR	47	All Yur	Temp-Mentor
S.F. Walla Walla	CTUIR	0.5	All Year	RTM2000
S.F. Walla Walla	CTUIR	7.	All Year	Temp-Mentor
S.F. Walla Walla	CTUIR	20	All Year	RTM2000
Elbow Creek (S.F. Walla Walla)	ODFW	0.1	New 5/94	HOBO
Burnt Cabin Creek (S.F. Walla Walla)	CTUIR	0.1	All Year	RTM2000
Reser Creek (S.F. Walla Walla)	CTUIR	0.1	All Yur	RTM2000
N.F. Walla Walla	CTUIR	0.1	All Year	Temp-Mentor
N.F.' Walla Walla	ODFW	6	New 5/94	HOBO
N.F. Walla Walla	ODFW	12	New 5/94	HOBO
Pine Creek	ODFW	20.5	New 5/94	Temp-Mentor
Pine Creek	ODFW	29	New 5/94	Temp-Mentor

Table C-S Thermographs in Bir:h Creek, Butter Creek, and Willow Creek Drainages.

LOCATION	AGESCY	RIVER MILE	DEPLOYMENT PERIOD	THERMOGRAPH TYPE
Birch Creek	ODFW	3.5	April-Oct.	Temp-Mentor
Birch Creek (near Sparks)	ODFW	6.5	April-Oct.	Temp-Mentor
East Birch Creek	ODFW	0.5	April-Oct.	Temp-Mentor
Westgate Canyon (East Birch Creek)	ODFW	0.75	April-Oct.	Temp-Mentor
Pearson Creek	ODFW	4	New 5/94	Hobo
West Birch Creek	ODFW	2	New 4/94	Hobo
West Birch Creek	ODFW	15	New 4/94	Hobo
Butter Creek	ODFW	51	New 5/94	Hobo
Little Buner Creek (Near Gurdane)	ODFW	7	New 5/94	Hobo
Little Butter Creek (Near Lena)	ODFW	19.5	New 5/94	Hobo
Willow Creek	ODFW	61	New 5/94	Hobo
Willow Creek	ODFW	77.5	New 5/94	Hobo
Rhea Creek	ODFW	16.7	New 5/94	Hobo
Rhu Creek	ODFW	35	New 5/94	Hobo

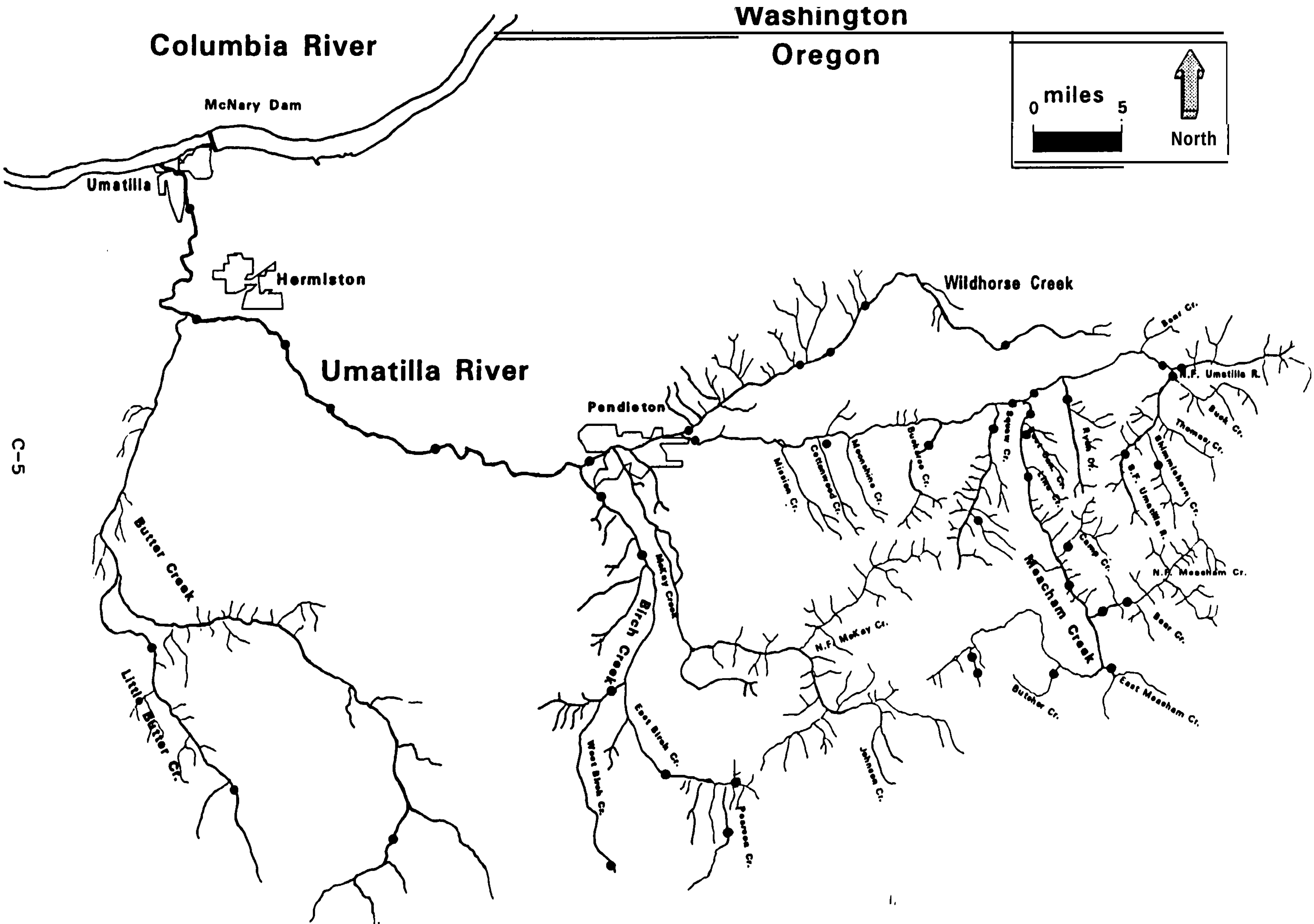

Figure C-l. Map of Thermograph Locations in the Umatilla River Basin.

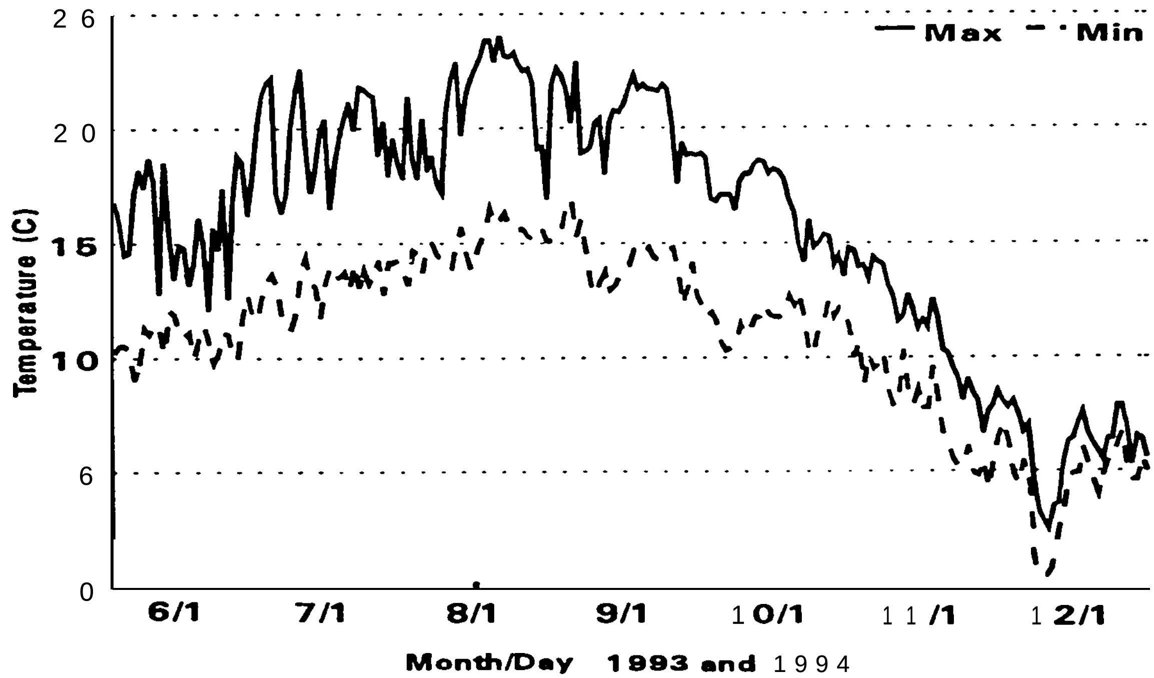

Figure C-2. Maximum and Minimum Temperatures Recorded in Meacham Creek, RM 2, May through December 1993 (MEACHRM2.CH3).

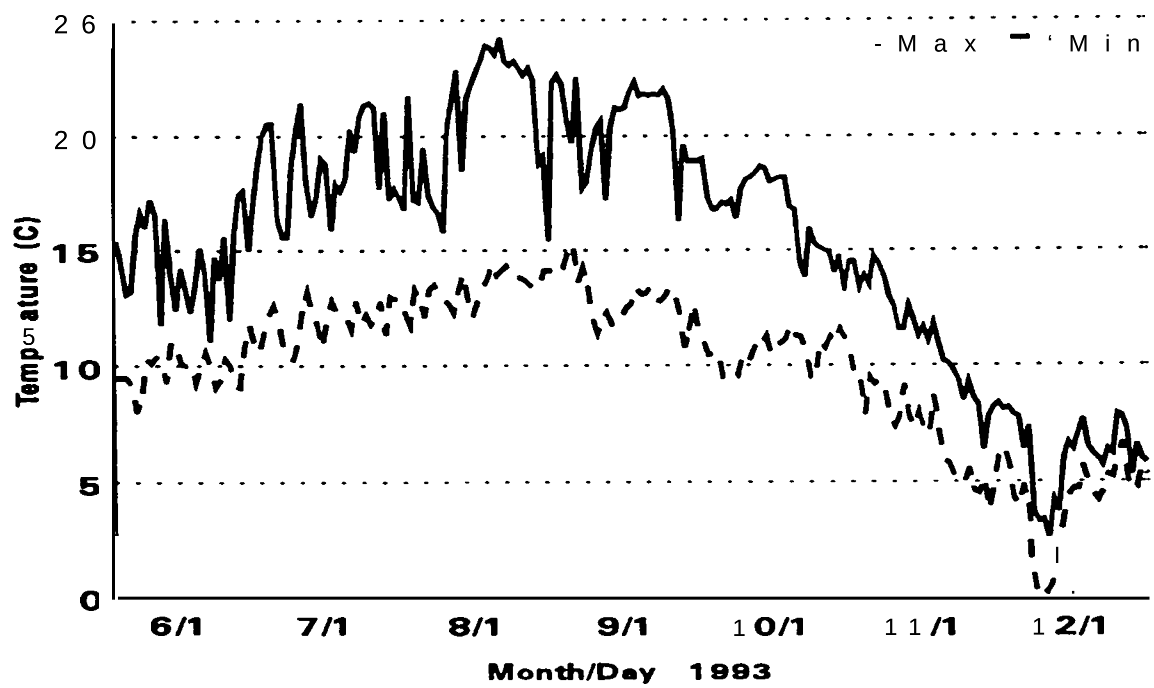

Figure C-3. The Maximum and Minimum Temperatures Recorded in Meacham Creek, RM 5.25. May through December, 1993 (MECHTP5.CH3).

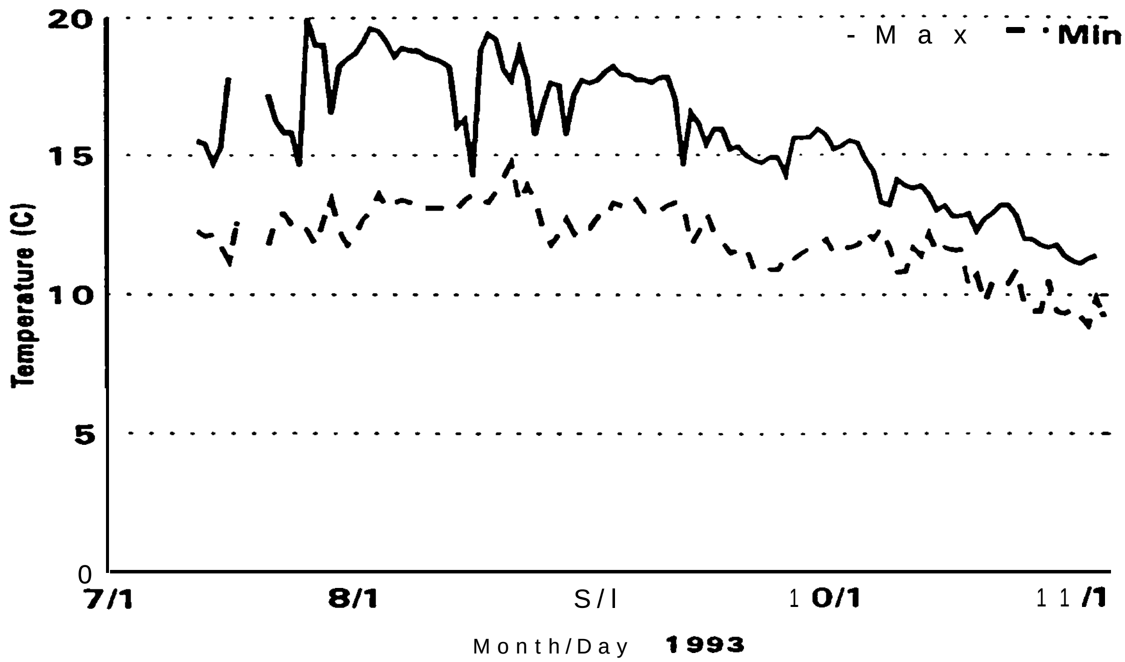

Figure C-4. Maximum and Minimum Temperatures Recorded in Meacham Creek, RM 13. July through October. 1993 (ME13TP93.CH3).

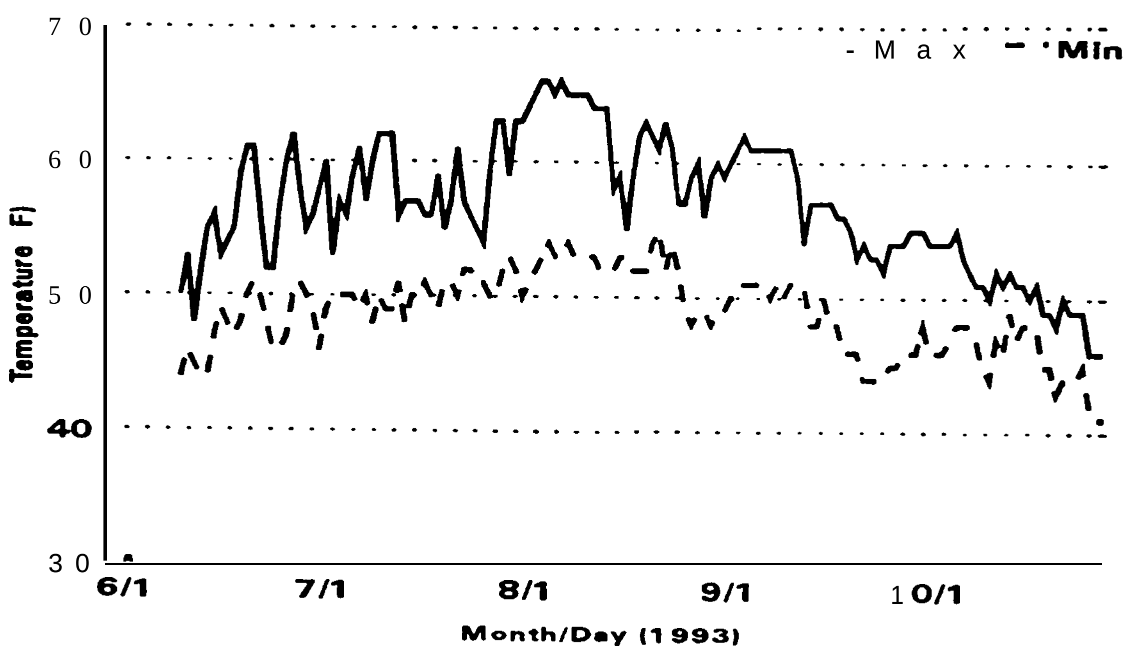

Figure C-5. The Maximum and Minimum Temperatures Recorded in the North Fork of Meacham Creek. RM 2, May through October, 1993 (NFMEACTP.CH3).

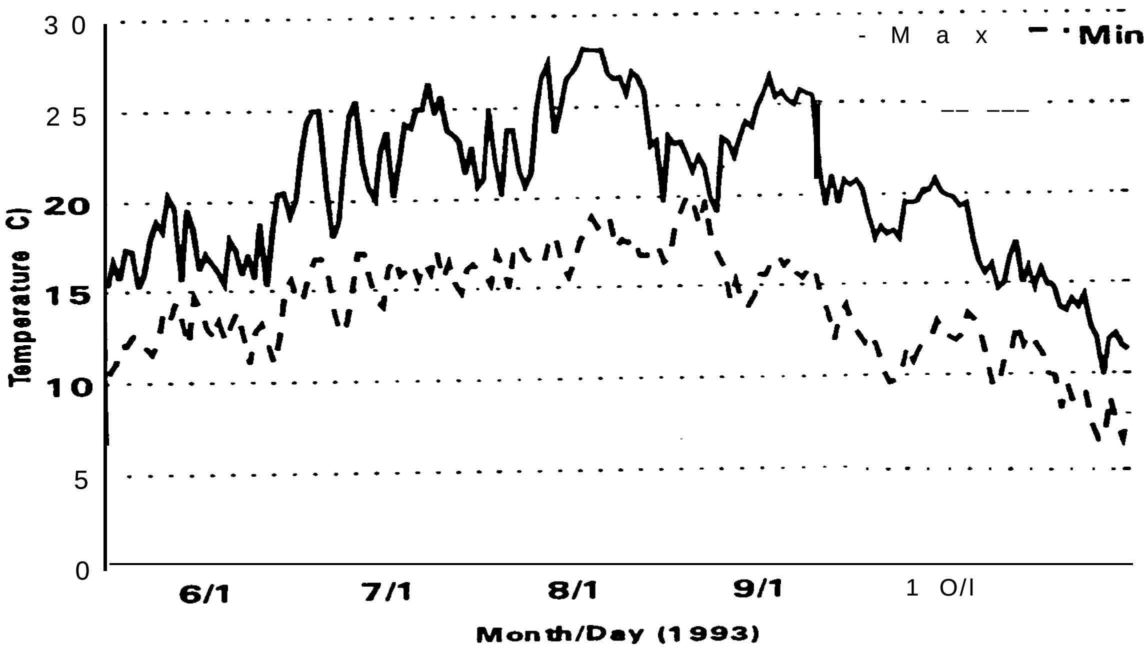

Figure C-6. Maximum and Minimum Temperatures Recorded in the Umatilla River, RM56, May through October 1993 (UM93TP56.CH3).

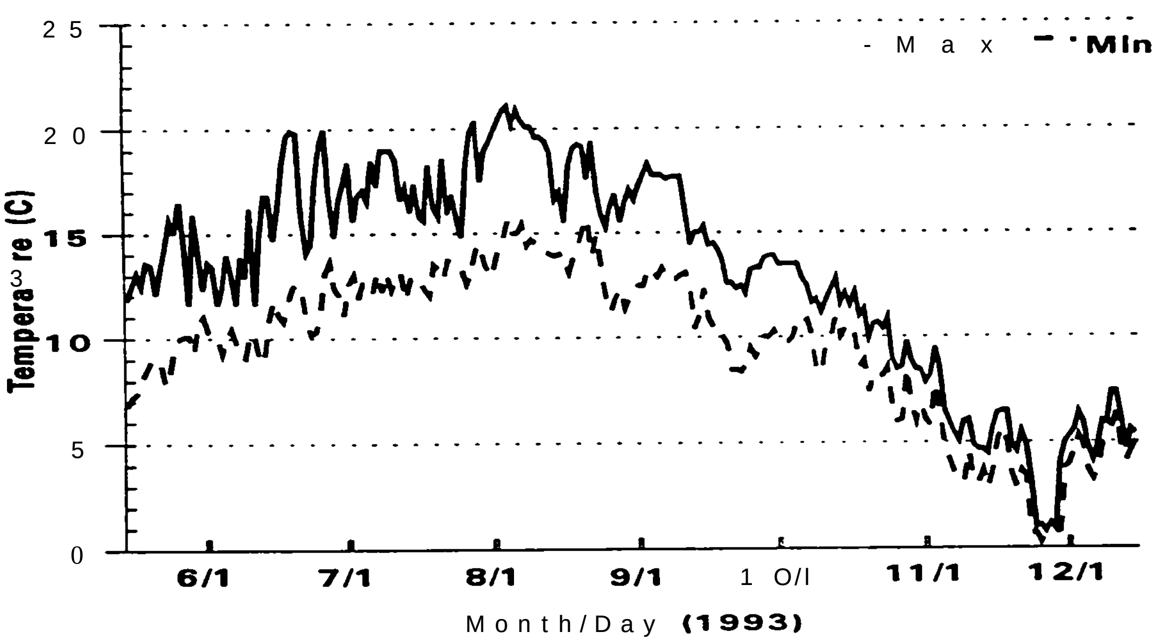

Figure C-7. The Maximum and Minimum Temperatures Recorded in the Umatilla River, RM 79, May through December, 1993 (UM93RM79.CH3).

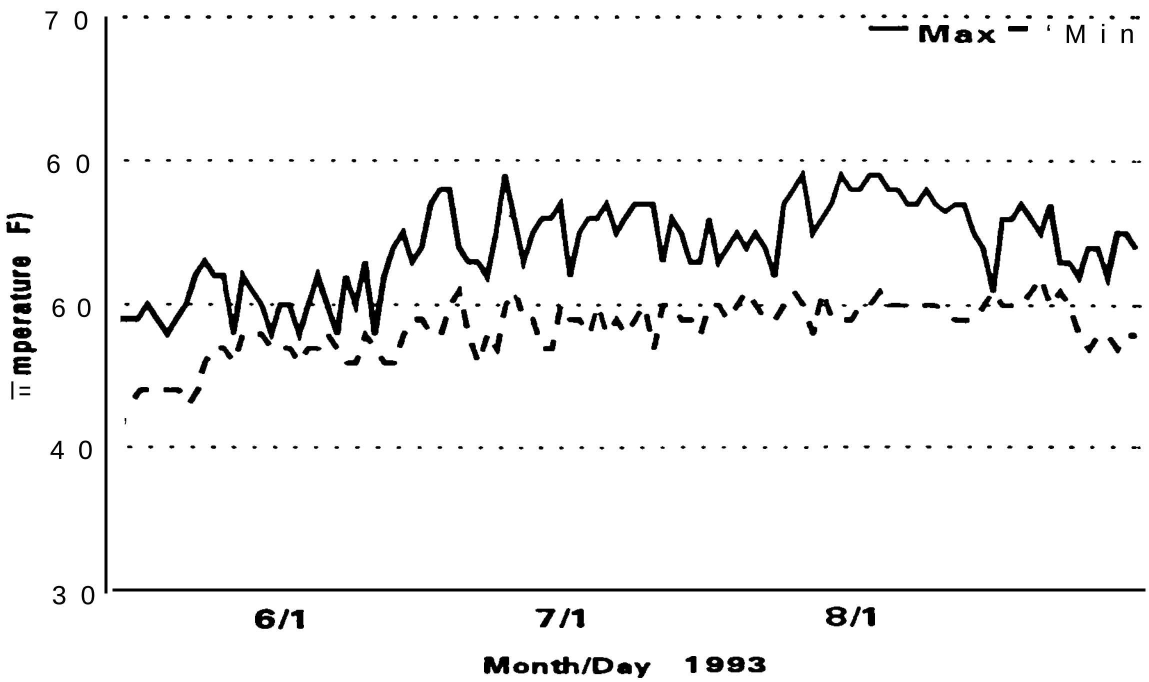

Figure C-8. The Maximum and Minimum Temperatures Recorded in the North Fork of the Umatilla River, **RM** 6. May through August, 1993 **(NFUM93TP.CH3).**

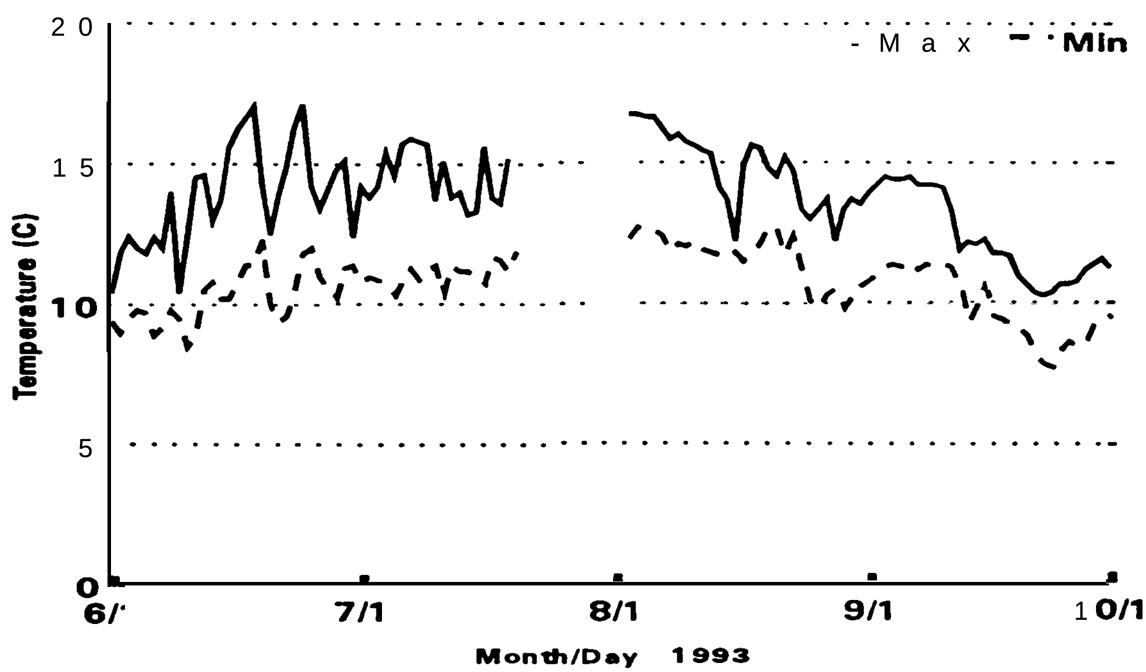

Figure C-9. The Maximum and Minimum Temperatures Recorded in the South Fork of the **Walla Walla** River, **RM** 0.5, May through October, 1993 **(SFW193TP.CH3).**

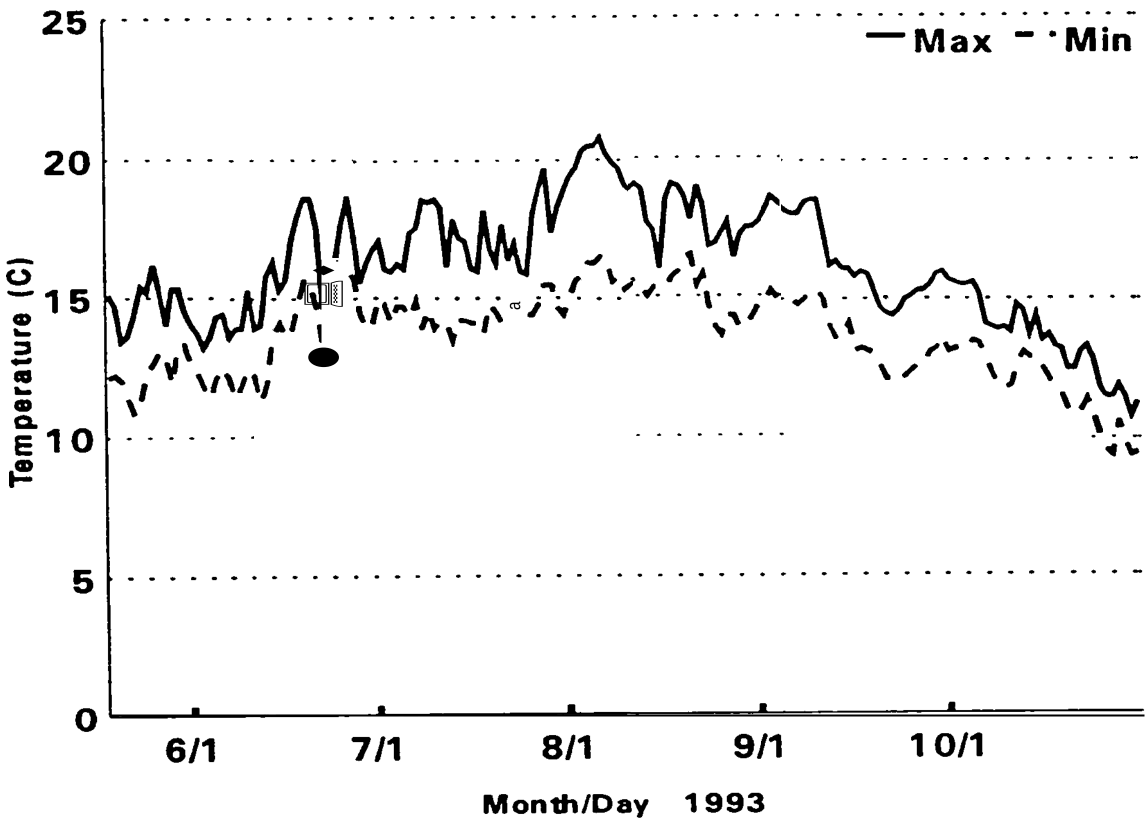

Figure C-10. Maximum and Minimum Temperatures Recorded in the N.F. Walla Walla River, RM 0.2, May through October 1993 (NFWW93TP.CH3)

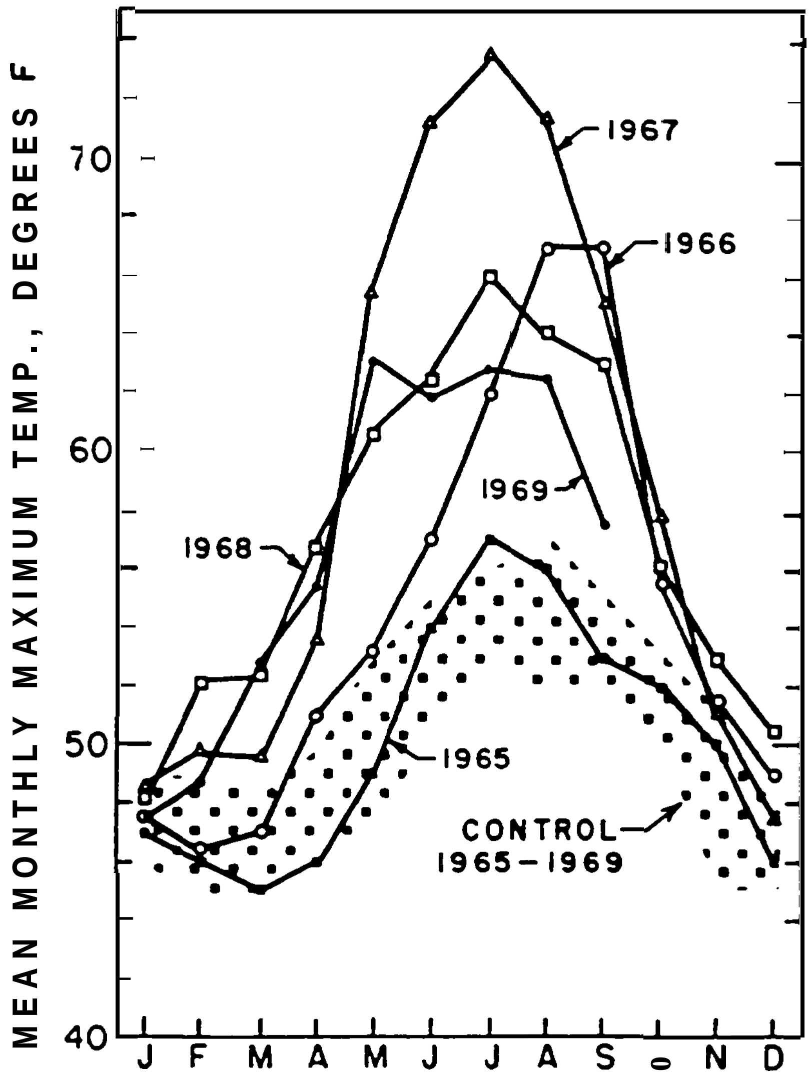

Figure C-11. Mean Monthly Maximum Temperatures for the Clearcut and Uncut Control Watersheds Before (1965), During (1966), and After (1967-1969) logging (After Brown and Krygier, 1970).

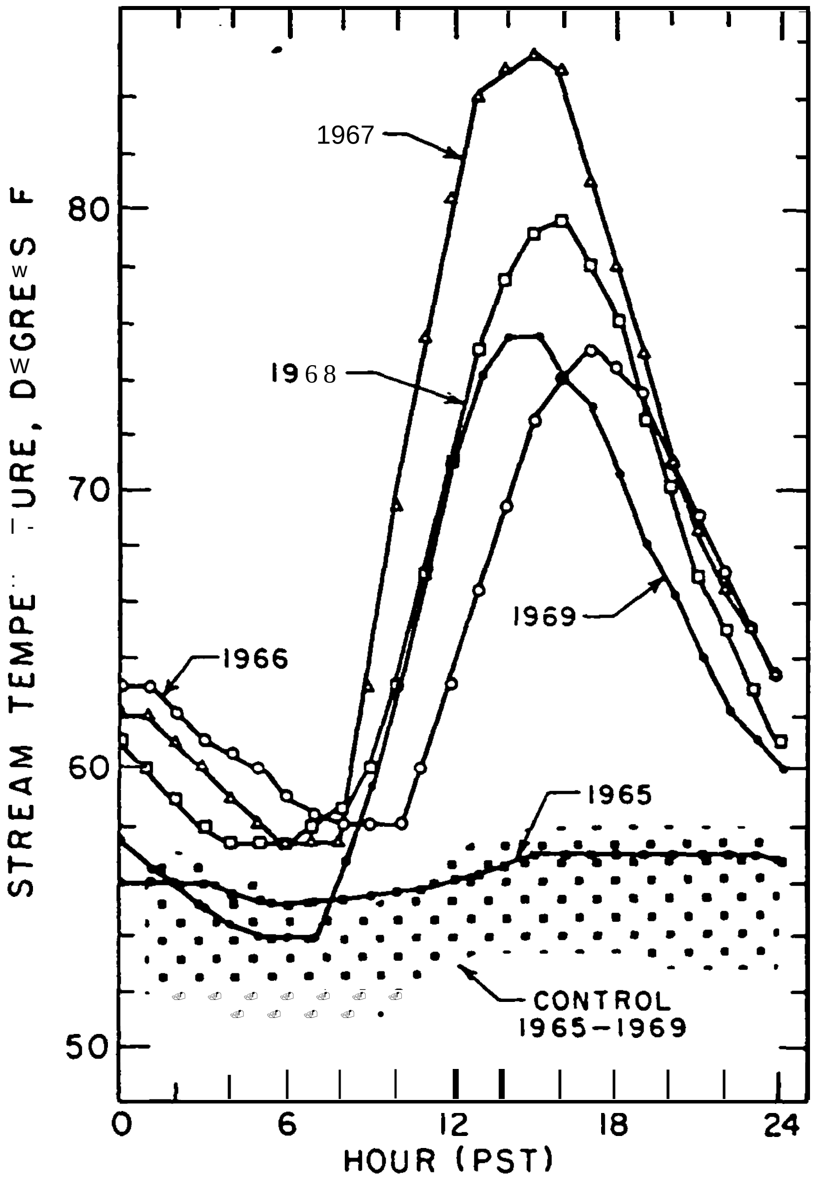

Figure C-12. The **Temperature** Pattern on the Days of the Annual Maximum **Recorded** on the **Clearcut and Uncut** Control Watersheds Before **(1965),** During (1966). and After (1967-1969) logging **(After Brown** and **Krygier,** 1970).

APPENDIX D
physical Habitat Survey Data Summary **Tables.**

Table D-IA. The Number of Miles of Habitat Surveyed, Number of Habitat Units, and the Number and Percent of Units Electrofished.

Stream	Number of Miles Surveyed	Total Number of Units	Number of units Electrofished	Percent of Units Electrofished
Meacham Creek	15	700	55	7.9
Buckaroo Creek	6	700	58	8.3
Line Creek	2	450	53	11.8
Boston Canyon Creek.	2	396	69	17.9
Boston Canyon Tributary	1	23	9	39.0
Total	26	2259	244	10.8

Table D-1B. Summary of Habitat Quality Rankings from Habitat Survey Data, 1993.

MEASURED HABITAT FEATURE	H. BITAT QUALITY RA KING CRITERIA			RANKING OF HABITAT FEATURE/n				
	Poor	Fair	Good	Buckaroo Creek	Boston Canyon Creek	Boston Canyon Creek Tributary	Line Creek	Meacham Creek
Pool Area (%)	$n<10$	$10<n<35$	$n>35$	Fair/18.9	Fair/10.8	Fair/10.8	Fair114.9	Good/35.6
Dry Channel Area (%)	$n>10$	$10>n>0$	$n=0$	PoorM4.2	Fair/37.6	Fair/3.0	Fair/S .6	Poor/14.2
Width/Depth (riffles)	$n>30$	$30>n>10$	$n<10$	Poor/60	Fair/19.1	Poor/54.7	Fair/26.0	Poor/49.0
Fines (%)	$n>20$	$20>n>8$	$n<8$	Good/6	Good/*	Good/*	Good/*	Good/7
Open Sky (%)	$n>50$	$50>n>20$	$n<20$	Fair/44	Good/16	Good/10	Good/11	Poor/60
Canopy Closure (%)	$n<35$	-	$n>35$	Poor/30	Good/38	Good/*	Good/42	Poor/32
Woody Debris (pieces, #/100m)	$n<10$	$10<n<20$	$n>20$	Poor/2.5	Poort2.4	Poor/*	Poor13.4	Poor/1.6
Woody Debris (volume. $m^3/100m$)	$n<20$	$20<n<30$	$n>30$	Poor/2.0	Poor/2.4	Poor/*	Poor/5.5	Poor/1.8

* numerical data unavailable

Table D-2. Habitat Inventory Summary for Buckaroo Creek, Valley, Channel. and Wood Summary, Survey Date, June 1993.

Valley and Channel Summary

Valley Characteristics (Percent Reach Length)

Narrow Valley Floor		Broad Valley Floor	
Steep V-shape	0	Constraining Terraces	48
Moderate V-shape	0	Multiple Terraces	0
Open V-shape	0	Wide Floodplain	29

Valley Width Index avg: 5.3 range: 2.0-20.0

Charnel Morphology (Percent Reach Length)

Constrained		Unconstrained	
Hillslope	0	Single Channel	29
Bedrock	0	Multiple Channel	0
Terrace	33	Braided Channel	0
Alt. Terrace/Hill	41		
Landuse	0		

Channel Characteristics

Type	Length	Area	Dry Units
Primary	12,225	74,352	240
Secondary	157	739	7

Channel Dimensions

Wetted Surface		Active Channel		First Terrace	
Width	5.8	Width	6.2	Width	9.9
Depth	0.16	Height	0.6	Height	0.8
W:D	60.0				

Stream Flow Type: LF Water Temp: 0.0-63.0

Avg. Unit Gradient: 4.1 Habitat Units/100m: 5.6

Riprian, Sank, and Wood Summary

Land Use: LG/LT Riparian Vrg.: 15-30C/G

Bank Stability

bank Class	Percent Reach Lenoth
Non-Erodible	5.7
Vegetation stabilized	69.1
Boulder-cobble	11.1
Actively Eroding	14.1

Undercut Banks

Unit Average: 1.36%

Open Sky (% of 180)

Unit Average:

Range:

Large Woody Debris

. Average Complexity Score: 1.3

Pieces	309	Volume(m3)	250
Pieces/100m	2.5	Volume/100m	2.0

Table D-3. Habitat Inventory Summary for Buckaroo Creek, Habitat Unit Summarv, **Survey** Date. June 1993.

HABITAT DETAIL

Habitat Type	Number Units	Total Length (m)	Avg Width (II.1	Avg Depth (m)	Total Area (m2)	Large boulders (#>0.5m)	Substrate Percent Wetted Area S/D	Snd	Grvl	Cbbl	Bldr	Bdrk
	1	9	6.2	0.10	55	2	0	10	20	60	10	0
CASCADE/BEDROCK	1	15	3.5	0.15	51	0	0	0	10	0	10	60
CASCADE/BOULDERS	20	452	3.1	0.14	1,440	93	0	2	17	LO	41	1
DRY CHANNEL	111	3,005	6.7	O.CO	21,565	130	0	4	38	49	8	0
DCY UNITS	60	1,221	4.1	0.00	5,163	148	0	6	25	50	19	0
POOL-BACKWATER	1	3	6.2	0.70	18	2	10	10	33	LO	10	3
POOL-ISOLATED	2	4	0.9	0.25	3	3	45	5	10	LO	0	0
POOL-LATERAL SCOUR	120	1,593	6.3	0.37	10,338	103	2	8	LO	41	3	6
POOL-PLUNGE	9	147	5.0	80.46		10	6	11	41	34	4	4
POOL-STRAIGHT SCOUR	48	410	6.0	0.25	2,682	71	3	8	39	43	5	3
POOL-TRENCH	6	62	5.4	0.48	328	1	2	10	28	15	0	45
PUDDLED CHANNEL	75	1,227	4.9	0.11	6,457	141	1	5	28	54	12	0
RAPID/BEDROCK	11	117	5.6	0.15	676	9	2	0	5	13	4	77
RAPID/BOULDERS	14	204	5.3	0.11	1,062	94	1	2	21	44	31	0
RIFFLE	183	3,454	6.1	0.11	21,220	481	1	4	29	57	8	1
RIFFLE W/ POCKETS	18	480	6.3	0.19	2,966	102	2	2	27	54	14	1
STEP/BEDROCK	4	7	6.6	0.19	66	0	0	3	20	3	25	50
STEP/BOULDERS	6	13	5.0	0.50	98	13	5	0	18	50	27	0
STEP/COBBLE	2	1	4.0	0.30	2	0	0	5	35	50	10	0
STEP/LOG	6	3	4.3	o.ba	13	0	2	5	38	47	8	0
STEP/STRUCTURE	1	1	9.7	0.03	5	0	0	10	30	60	0	0
Total:	700	12,422	5.8	0.16	75,092	1357 Avg:	1	5	32	48	10	4

HABITAT SUMMARY

Habitat Group	NO. Units	Total Length (m)	Avg Width (m)	Avg fepth (m)	Wetted Area (m2)	Percent	Large Number	Boulders #/100m2	Wood Class
Damned & BW Fools	3	6	2.7	0.40	21	0.03	2	9.43	2.3
Scour Pools	183	2,208	6.2	0.34	14191	18.90	185	1.30	1.3
Glides	0	0	.	.	0	0.00	0	0.00	.
Riffles	201	3,933	6.1	0.12	24206	32.23	583	2.41	1.2
Rapids	25	321	5.5	0.13	1738	2.31	103	5.93	1.2
Cascades	21	467	3.1	0.14	1491	1.99	90	6.03	1.3
Step/Falls	19	24	5.2	0.44	lab	0.24	13	7.07	1.3
Small Streams (SS)	0	0	.	.	0	0.00	a	0.00	.
Dry	247	5,453	5.5	0.03	33206	4i.22	419	1.26	1.3

Table D-4. Habitat Inventory Summary for Buckaroo Creek, Stream Summary, Survey Date, June 1993.

STREAM SUMMARY — Buckaroo Creek

Number Units	Total Length (m)	Avg Width (m)	Avg Depth (m)	Total Area (m2)	Substrate Percent Wetted Area S/O	Sand	Grvl	Cbbl	Bldr	bdrk	Total Large Boulder
700	12,422	5.8	0.16	75,092	1	5	32	48	10	4	1,357

Habitat Group	Wetted Area (m2)	Percent
Scour Fool	14,191	i8.9
Backwater Fools	21	**. ·
Cl ide	0	0.0
Riffle	24,206	32.2
Rtpid	1,738	2.3
Cascade	1,491	2.0
Step	184	0.2
Dry	33,206	44.2

Table D-5. Habitat Inventory Summary for Buckaroo Creek, Ripariaa Summary, Survey Date, June 1993.

RIPARIAN ZONE VEGETATION SUMMARY

Reach 0 is represented by 27 transects

Predominant landform in each zone

	Zone 1 0-10 meters	Zone 2 10-20 meters	zone 3 20-30 meters
Hillslope	18	46	53
High terrace	69	44	40
Lou terrace	13	9	a
Floodplain	0	0	0
Wetland/meadow	0	0	0
Stream channel	0	0	0
Roadbed/Railroad	0	0	0
Riprap	0	0	0
Surface slope (%)	11	17	19

Canon closure and ground cover

	tone 1 O-10 meters (%)	Zone 2 10-20 meters (%)	Zone 3 20-30 meters (%)
Canopy closure	30	25	28
Shrub cover	47	41	43
Grass/forb cover	46	54	50

Average number of trees in a 5-meter wide band

Diameter	Zone 1 0-10 meters		Zone 2 10-20 meters		Zone 3 20-30 meters		Zones 1-3 0-30 meters	
class (cm)	Conifer	Hardwood	Conifer	Hardwood	Conifer	Hardwood	Conifer	Hardwood
3-15cm	2.4	4.0	2.0	2.6	1.0	4.0	5.4	10.6
15-30cm	0.5	0.3	0.3	0.9	0.2	0.6	1.0	1.8
30-50cm	0.1	0.1	0.3	0.1	0.6	[illegible]	1.0	0.2
50-90cm	[illegible]	[illegible]	[illegible]	[illegible]	0.1	0.1	0.2	0.2
>90cm	[illegible]	[illegible]	[illegible]	[illegible]	0.0	0.0	0.0	[illegible]
Total/100m²	3.1	4.6	2.6	3.5	2.0	4.7	2.5	4.3

Table D-6. Habitat Inventory Summary for Boston Canyon Creek, Valley, Channel, and Wood Summary, Survey Date, July 1993.

Valley and Channel Summary

Valley Characteristics (Percent Reach Length)

Narrow Valley Floor		Broad Valley Floor	
Steep V-shape	47	Constraining Terraces	3
Moderate V-shape	22	Multiple Terraces	27
Open V-shape	0	Wide Floodplain	0

Valley Width Index avg: 3.3 range: 1.0-10.0

Channel Morphology (Percent Reach Length)

Constrained		Unconstrained	
Hillslope	69	Single Channel	27
Bedrock	0	Multiple Channel	0
Terrace	3	Braided Channel	0
Alt. Terrace/Hill	0		
Landuse	0		

Channel Characteristics

Type	Length	Area	Dry Units
Primary	4,170	10,784	55
Secondary	221	575	5

Channel Dimensions

Wetted Surface		Active Channel		First Terrace	
Width	2.4	Width	5.0	Width	7.9
Depth	0.17	Height	0.7	Height	0.9
W:D ●	**.*				

Stream Flow Type: DR Water Temp: 0.0-56.0

Avg. Unit Gradient: 5.9. Habitat Units/100m: 8.8

Riparian, Eank, and Wood Summary

Land Use: LG/ Riptrian Veg.: C15-30/5

Eank Stability

Eank Class	Fercent Reach Lencth
Non-Erodible	17.0
Vegetation Sttbilized	27.8
Eoulder-cobble	51.3
Actively Eroding	3.9

Undercut Etnks

Unit Average: 0.82%

Open Sky (% of 180)

Unit Average: 16

Range: O-78

Large Woody Debris

Average Complexity Score: 1.1

Pieces	100	Volume(m^3)	w
Pieces/100m	2.4	Volume/100m	2.4

Table D-7. Habitat Inventory Summary for Boston Canyon Creek, Habitat Unit Summary, Survey Date, July 1993.

HABITAT DETAIL

Habitat Type	Number Units	Total Length (m)	Avg Width (m)	Avg Depth (m)	Total Area (m^2)	Large Boulders (#>0.5m)	Substrate Percent Wetted Area S/O	Snd	Grvl	Cbbl	Bldr	Bdrk
CASCADE/BEDROCK	1	2	1.1	0.05	2	0	0	0	0	0	0	100
DRY UNITS	45	1,055	3.9	0.00	3,957	1274	2	5	30	51	12	0
GLIDE	2	24	3.0	0.22	70	9	10	35	25	30	0	0
PML-BEAVER DAM	1	3	2.6	0.40	7	2	10	20	30	30	10	0
PWL-ISOLATED	2	3	1.6	0.33	8	2	85	10	5	0	0	0
POOL-LATERAL SCOUR	36	145	2.1	0.31	307	122	9	13	23	38	4	13
POOL-PLUNGE	25	75	2.8	0.36	. 210	98	8	13	23	32	12	13
POOL-STRAIGHT SCOUR	64	301	2.3	0.31	705	335	8	14	26	33	6	12
POOL-TRENCH	1	3	2.1	0.35	7	1	10	10	10	0	0	70
PUDDLED CHANNEL	15	180	1.6	0.08	312	85	7	11	26	44	6	7
RIFFLE	169	2,570	2.1	0.11	5,692	3248	3	10	27	47	10	3
STEP/BEDROCK	2	2	1.2	0.05	2	0	0	0	0	5	0	95
STEP/BOULDERS	15	25	2.0	0.09	62	58	11	16	24	32	18	0
STEP/LOG	7	3	5.1	0.13	19	12	6	11	39	37	7	0
Total:	385	4,391	2.4	0.17	11,358	5246	Avg: 6	11	26	41	9	7

HABITAT SUMMARY

Habitat Group	No. Units	Total Length (m)	Avg Width (m)	Avg Depth (m)	Wetted Area (m^2)	Wetted Area Percent	Large Boulders Number	Large Boulders #/100m^2	Wood Class
Damned & BW Pools	3	6	1.9	0.33	15	0.13	4	26.85	1.0
Scour Pools	126	524	2.3	0.32	1229	10.82	556	45.25	1.1
Glides	2	24	3.0	0.22	70	0.61	9	12.89	1.0
Riffles	169	2,570	2.1	0.11	5692	50.11	3248	57.07	1.0
Rapids	0	0	.	.	0	0.00	0	0.00	.
Cascades	1	2	1.1	0.05	2	0.02	0	0.00	1.0
Step/Falls	24	30	2.8	0.09	83	0.73	70	84.54	1.4
Small Streams (SS)	0	0	.	.	0	0.00	0	0.00	.
Dry	60	1,235	3.3	0.02	4268	37.58	1359	31.04	1.2

Table D-8. Habitat Inventory Summary for Boston Canyon Creek, Stream Summary, Survey Date, July 1993.

STREAM SUMMARY Boston Canyon Creek

Number Units	Total Length (m)	Avg Width (m)	Avg Depth (m)	Total Area (m^2)	Substrate Percent Wetted Area S/O	Sand	Grvl	Cbbl	Bldr	Bdrk	Total Large Boulder
385	4,391	2.4	0.17	11,358			26	41	9	7	5,246

Habitat Group	Wetted Area (m^2)	Percent
Scour Fool	1,229	i0.8
Backwater Pccls	15	0.1
Glide	70	0.6
Riffle	5,692	50.1
Rapid	0	0.0
Cascade	2	[illegible]
Step	83	0.7
Dry	4,268	37.6

Table D-9. Habitat Inventory Summary for Boston Canyon Creek, Riparian Summary, Survey Date, July 1993.

RIPARIAN ZONE VEGETATION SUMMARY

'Reach 0 is represented by 17 transects

Predwinant landform in each zone

	Zone 1 O-10 meters	Zone 2 10-20 meters	Zone 3 20-30 meters
Hillslope	32	44	65
High terrace	9	12	12
Lou terrace	59	44	24
Floodplain	0	0	0
Wetland/meadow	0	0	0
Stream channel	0	0	0
Roadbed/Railroad	0	0	0
Riprap	0	0	0
Surface slope (%)	34	35	47

Canopy closure and ground cover

	Zone 1 O-10 meters (%)	Zone 2 10-20 meters (%)	zone 3 20-30 meters (%)
Canopy closure	38	39	43
Shrub cover	56	56	59
Grass/forb cover	3s	38	34

Average number of trees in a S-meter wide band

Diameter	Zone 1 O-10 meters		Zone 2 10-20 meters		Zone 3 20-30 meters		zones 1-3 D-30 meters	
class (cm)	Conifer	Hardwood	Conifer	Hardwood	Conifer	Hardwood	Conifer	Hardwood
3-15cm	0.4	1.1	0.7	0.9	0.8	1.3	1.9	3.3
15-30cm	0.1	0.1	0.7	0.0	0.8	0.0	1.6	0.1
30-50cm	0.5	0.0	0.4	0.1	0.3	0.3	1.2	0.4
SO-9Dcm	0.1	0.0	0.4	0.0	0.2	0.0	0.7	0.0
>90cm	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0
Total/100m²	1 . 1	1.1	2.3	1.0	2.1	1.6	1.8	1.2

Table D-10. Habitat Inventory Summary for Boston Canyon Creek Tributary, Valley, Channel, and Wood Summary, Survey Date, July 1993.

Valley and Channel Summary

Valley Characteristics (Percent Reath Length)

Narrow Valley Floor		Broad Valley Floor	
Steep V-shape	0	Constraining Terraces	0
Moderate V-shape	100	Multiple Terraces	0
Open V-shape	0	Wide Floodplain	0

Valley Width Index avg: 2.0 range: 1.0-3.0

Channel Morphology (Percent Reach Length)

Constrained		Unconstrained	
Hillslope	100	Single Channel	0
Bedrock	0	Multiple Channel	0
Terrace	0	Braided Channel	0
Alt. Terrace/Hill	0		
Landuse	0		

Channel Characteristics

Tvpe	lenoth	Area	Drv Units
Primary	86	180	0
Secondary	CI	23	1

Channel Dimensions

Wetted Surface		Active Channel		First Terrace	
Width	2.0	Width	3.4	Width	7.6
Depth	0.11	Height	0.7	Height	0.5
W:D	54.7				

Stream Flow Type: LF Uater Temp: 55.0-55.0
Avg. Unit Gradient: 8.5 Habitat Units/100m: 11.8

Riparian, Bank, and Uood Summary

Land Use: LG/ Riparian Veg.: 15-30C/S

Bank Stability

Sank Class	Percent Reach Length
Non-Erodible	10.5
Vegetation Stabilized	22.8
Boulder-cobble	66.6
Actively Eroding	0.0

Undercut Banks

Unit Average: 0.00%

Open Sky (% of 180)

Unit Average: 10
Range: O-24

Large Woody Debris

Average Complexity Score: 1.0

Pieces	0	Volume(m^3)	0
Pieces/100m	0.0	Volume/100m	0.0

Table D-l 1. Habitat Inventory Summary for Boston Canyon Creek Tributary, Habitat Unit Summary, Survey Date, July 1993.

HABITAT DETAIL

Habitat Type	Number Units	Total Length (m)	Avg Uidth (m)	Avg Depth (m)	Total Area (m^2)	Large Boulders (#>0.5m)	Substrate Percent Uetted Area S/O	Snd	Grvl	Cbbl	Bldr	Bdrk
POOL-LATERAL SCOUR	2	6	1.4	0.21	8	0	0	0	0	0	0	100
POOL-STRAIGHT SCOUR	4	13	1.1	0.18	1:	1	17	20	27	35	0	1
PUDDLED CHANNEL	1	13	0.5	0.03	6	0	0	10	SD	co	0	0
RIFFLE	8	96	2.7	0.07	176	9	8	16	26	30	1	19
Total:	15	127	2.0	0.11	204	10	Avg: 9	15	25	28	1	24

HABITAT SUMMARY

Habitat Group	No. Units	Total Length (m)	Avg Width (m)	Avg Cepth (m)	Wetted Area (m^2)	Percent	Large Boulders Number	#/100m^2	Uood Class
Dammed & BY Pools	0	0	.	.	0	0.00	0	0.00	.
Scour Pools	6	18	1.2	0.19	22	10.75	1	4.57	1.0
Glides	0	0	.	.	0	0.00	0	0.00	.
Riffles	8	96	2.7	0.07	176	86.16	9	5.13	1.0
Rapids	0	0	.	.	0	0.00	0	0.00	.
Cascades	0	0	.	.	0	0.00	0	0.00	.
Step/Falls	0	0	.	.	0	0.00	0	0.00	.
Small Streams (SS)	0	0	.	.	0	0.00	0	0.00	.
Dry	1	13	0.5	0.03	6	3.09	0	0.00	1.0

Table D-12. Habitat Inventory Summary for Boston Canyon Creek Tributary, Stream Summary, Survey Date, July 1993.

STREAM SUMMARY   Boston Canyon Creek Tributary

Number Units	Total length (m)	Avg Uidth (m)	Avg Depth (m)	Total Area (m^2)	Substrate Percent Wetted Area S/O	Sand	Grvl	Cbbl	Bldr	Bdrk	Total large Boulder
15	127	2.0	0.11	204			25	28	1	21	10

Habitat Group	Vetted Area (m^2)	Percent
Scour Pool	22	10.8
Backwater Fools	0	0.0
Glide	0	0.0
Riffle	176	86.2
Rapid	0	0.0
Cascade	0	0.0
Step	0	0.0
Dry	6	3.1

Table D-14. Habitat Inventory Summary for Line Creek, Valley, Channel, and Wood Summary, Survey Date, July 1993.

Valley and Channel Summary

Valley Characteristics (Percent Reach length)

Narrow Valley Floor		Broad Valley Floor	
Steep V-shape	95	Constraining Terraces	5
Moderate V-shape	0	Multiple Terraces	0
Open V-shape	0	Uide Floodplain	0

Valley Width Index avg: 2.8 range: 1.0-40.0

Channel Morphology (Percent Reach Length)

Constrained		Unconstrained	
Hillslope	95	Single Channel	S
Bedrock	0	Multiple Channel	0
Terrace	0	Braided Channel	0
Alt. Terrace/Hill	0		
Landuse	0		

Channel Characteristics

Type	Length	Area	Dry Units
Primary	2,803	3,929	2
Secondary	63	52	0

Channel Dimensions

Wetted Surface		Active Chamel		First Terrace	
Uidth	1.5	Uidth	3.9	Uidth	9.3
Depth	0.13	Height	0.5	Height	1.2
W:D	26.0				

Stream Flow Type: LF
Uater Temp: 54.0-59.0
Avg. Unit Gradient: 9.0
Habitat Units/100m: 15.7

Riparian, Bank, and Wood Summary

Land Use: LT/ST
Riparian Veg.: D5-15/S

Bank Stability

Bank Class	Percent Reach length
Non-Erodible	3.8
Vegetation Stabilized	2.5
Boulder-cobble	93.6
Actively Eroding	3.1

Undercut Banks
Unit Average: 0.20%

Open Sky (% of 180)
Unit Average: 11
Range: O-84

Large Woody Debris

Average Complexity Score: 1.3

Pieces	96	Volume(m^3)	153
Pieces/100m	3 . 4	Volume/100m	5.5

Table D-15. Habitat Inventory Summary for Line Creek, Habitat Unit Summary, Survey Date, July 1993.

HABITAT DETAIL

Habitat Type	Number Units	Total length (m)	Avg Uidth (m)	Avg Depth (m)	Total Area (m^2)	Large Boulders (#>0.5m)	Substrate Percent Vetted Area S/O	Snd	Grvl	Cbbl	Bldr	6drk
CASCADE/BOULDERS	1	2	1.0	0.05	2	6	0	0	0	40	CO	0
DRY UNITS	2	37	4.9	0.00	223	0	5	20	55	20	0	0
POOL-BEAVER DAM	1	1	2.1	0.25	3	1	10	10	10	70	0	0
POOL-ISOLATED	1	4	4.2	0.25	16	0	100	0	0	0	0	0
POOL-LATERALSCOUR	47	120	1.3	0.25	157	60	14	23	33	29	1	3
POOL-PLUNGE	44	102	1.9	0.34	194	64	16	24	32	24	4	1
POOL-STRAIGHT SCOUR	67	160	1.5	0.26	243	95	12	23	28	32	4	1
RIFFLE	231	2,405	1.3	0.05	3,084	955	7	15	36	38	3	1
STEP/BEDROCK	1	2	2.3	0.05	S	0	0	0	0	0	0	100
STEP/BOULDERS	37	25	1.6	0.05	43	143	11	18	41	24	4	2
STEP/COBBLE	4	1	1.2	0.04	2	1	5	20	63	13	0	0
STEP/LOG	14	5	1.6	0.04	8	11	13	18	43	26	0	0
Total:	450	2,866	1.5	0.13	3,981	1336	Avg:10	18	34	33	3	1

HABITAT SUMMARY

Habitat Group	NO. Units	Total Length (m)	Avg Uidth (m)	Avg Depth (m)	Uetted Area (m^2)	Area Percent	large Boulders Number	Boulders #/100m^2	Uood Class
Damned & BW Pools	2	5	3.2	0.25	19	0.48	1	5.24	1.0
Scour Pools	158	382	1.6	0.28	594	14.92	219	36.86	1.0
Glides	0	0	.	.	3	0.00	0	0.00	.
Riffles	231	2,405	1.3	0.05	3084	77.47	955	30.96	1.0
Rapids	0	0	.	.	0	0.00	0	0.00	.
Cascades	1	2	1.0	0.05	2	0.04	6	250.00	2.3
Step/Falls	56	35	1.6	0.05	58	1.57	155	265.41	1.1
Small Streams (SS)	0	0	.	.	0	3.00	0	0.00	.
Dry	2	37	4.9	0.00	223	5.60	0	0.00	1.0

Table D-16. Habitat Inventory Summary for Line Creek, Stream Summary, Survey Date, July 1993.

STREAM SUMMARY Line Creek

Number Units	Total Length (m)	Avg Width (m)	Avg Depth (m)	Total Area (m^2)	Substrate Percent Wetted Area S/O	Sand	Grvl	Cbbl	Bldr	Bdrk	Total Large Boulder
450	2,866	1.5	0.13	3,981			34	33	3	1	1,336

Habitat Group	Wetted Area (m^2)	Percent
Scour Pool	594	14.9
Backwater Pools	19	0.5
Glide	0	0.0
Riffle	3,084	77.5
Rapid	0	0.0
Cascade	2	0.1
Step	58	1.5
Dry	223	5.6

Table D-17. Habitat Inventory Summary for Line Creek, Riparian Summary, Survey Date, July 1993.

RIPARIAN ZONE VEGETATION SUMMARY

Reach 0 is represented by 20 transects

Predominant landform in each zone

	Zone 1 0-10 meters	zone 2 10-20 meters	zone3 20-30 meters
Hillslope	53	70	87
tiigh terrace	0	0	0
Lou terrace	48	30	13
Floodplain	0	0	0
Wetland/meadow	0	0	0
Stream channel	0	0	0
Rcadbed/Railrcad	0	0	0
Riprap	0	0	0
Surface slcpe (%)	40	53	64

Canopy closure and ground cover

	zone1 0-10 meters (%)	Zone 2 10-20 meters (%)	zone3 20-30 meters (%)
Canopy closure	42	44	46
Shrub cover	69	71	73
Grass/forb cover	26	24	22

Average number of trees in a S-meter wide band

Diameter class (cm)	Zone 1 O-10 meters Conifer	Hardwood	zone 2 10-20 meters Conifer	Hardwood	Zone 3 20-30 meters Conifer	Harduood	Zones 1-3 3-33 meters Conifer	Harduood
3-15cm	0.2	2.3	0.3	1.8	0.3	1.4	3.8	5.4
15-30cm	0.2	0.6	0.2	0.2	0.6	0.3	1.0	1.0
30-50cm	0.5	0.1	0.3	0.1	0.6	0.0	1.4	0.2
so-9ocm	0.2	0.0	0.3	0.0	0.1	0.0	0.5	0.0
>90cm	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.0
Total/100m^2	1.1	3.0	1.0	2.0	1.6	1.6	1.2	2.2

Table D-18. Habitat Inventory Summary for **Meacham** Creek, Valley, **Channel, and** Wood Summary, Survey Date, July 1993.

Valley and Channel Summary

Valley Characteristics (Percent Reach Length)

Narrow Valley Floor		Broad Valley Floor	
Steep V-shape	0	Constraining Terraces	0
Moderate V-shape	0	Multiple Terraces	100
Open V-shape	0	Wide Floodplain	0

Valley Width Index avg: 10.7 range: 6.0-20.0

Channel Morphology (Percent Reach Length)

Constrained		Unconstrained	
Hillslope	0	Single Channel	100
Bedrock	0	Multiple Channel	0
Terrace	0	Braided Chaml	0
Alt. Terrace/Hill	0		
Landuse	0		

Channel Characteristics

Type	Length	Area	Dry Units
Primary	25,824	325,195	18
Secondary	5,263	31.794	26

Chaml Dimensions

Wetted Surface		Active Channel		First Terrace	
Uidth	10.1	Width	21.8	Width	35.5
Depth	0.41	Height	0 . 5	Height	1 .1
W:D	• [illegible]. •				

Stream Flow Type: LF   Water Tap: 0.0-74.0

Avg. Unit Gradient: 1.3   Habitat Units/100m: 2.3

Riparian, Bank, and Wood Summary

Land Use: HG/ST   Riparian Veg.: C30-50/D

Bank Stability

Bank Class	Percent Reach Length
Non-Erodible	6.2
Vegetation Stabilized	17.8
Boulder-cobble	31.1
Actively Eroding	44.9

Undercut Banks

Unit Average: 0.88%

Open Skv (% of 180)

Unit Average: 60

Range: Q-130

Large Woody Debris

Average Complexity Score: 1.2

Pieces	412	Volume(m^3)	476
Pieces/100m	1 . 6	Volume/100m	1.8

Table D-19. Habitat Inventory Summary for Meacham Creek, Habitat Unit Summary, Survey Date, July 1993.

HABITAT DETAIL

Habitat Type	Number Units	Total Length (m)	Avg Width (m)	Avg Depth (m)	Total Area (m^2)	Large Boulders (#>0.5m)	Substrate Percent Wetted Area S/O	Snd	Grvl	Cbbl	Bldr	Bdrk
	1	SC	10.0	0.30	541	0	0	10	30	60	0	0
DRY UNITS	31	2,747	12.2	0.00	46,942	366	D	4	36	41	19	0
GLIDE	8	465	14.0	0.41	6,348	19	4	7	43	43	3	0
POOL-ISOLATED	2	22	3.9	0.68	88	16	5	10	so	30	5	0
POOL-LATERALSCOUR	246	8,993	i0.2	0.70	103,630	699	3	8	52	31	6	1
POOL-PLUNGE	4	104	10.3	0.93	1,218	21	0	8	so	28	13	3
POOL-STRAIGHTSCOUR	6 2	1,925	10.6	0.45	22,372	184	1	5	44	41	9	0
PUDDLED CHANNEL	13	927	3.9	0.17	3,858	43	16	6	35	33	9	0
RAPID/BEDROCK	3	170	8.5	0.43	1,816	5	0	0	17	20	7	57
RAPID/BOULDERS	30	974	9.3	0.25	9,611	269	0	1	24	40	34	1
RIFFLE	258	12,196	9.8	0.20	130,314	684	2	4	40	46	8	0
RIFFLE W/ POCKETS	34	2,489	11.6	0.36	29,993	617	0	1	26	SO	22	0
STEP/BEDROCK	1	1	a.9	0.30	10	1	0	10	70	20	0	0
STEP/BOULDERS	3	9	11.8	0.37	114	22	3	0	37	43	0	17
STEP/COBBLE	4	17	7.2	0.80	137	0	0	02377		0		0
Total:	700	31,088	10.1	0.41	356,989	2946	Avg: 2	5	43	40	9	1

HABITAT SUMMARY

Habitat Group	No. Units	Total Length (m)	Avg Width (m)	Avg Depth (m)	Wetted Area (m^2)	Percent	Large Boulders Number	#/$100m^2$	Wood Class
Damned & BW Pools	2	22	3.9	0.68	88	0.02	16	18.20	2.0
Scour Pools	312	11,019	10.3	0.65	127219	35.64	904	0.71	1.3
Glides	8	465	14.0	0.41	6348	1.78	19	0.30	1.0
Riffles	292	14,654	10.0	0.22	160306	44.91	1301	0.81	1.1
Rapids	33	1,143	9.3	0.27	11427	3.20	274	2.40	1.1
Cascades	0	0	.	.	0	0.00	0	0.00	.
Step/Falls	8	27	9.2	0.58	260	0.07	23	8.84	1.0
Small Streams (SS)	0	0	.	.	0	0.00	0	0.00	.
Dry	44	3,674	9.8	0.05	50800	16.23	409	0.81	1.1

Table D-20. Habitat Inventory Summary for Meacham Creek, Stream Summary, Survey Date, July 1993.

STREAM SUMMARY Meacham Creek

Number Units	Total Length (m)	Avg Width (m)	Avg Depth (m)	Total Area (m^2)	Substrate Percent Wetted Area S/O	Sand	Grvl	Cbbl	Bldr	Bdrk	Total Large Boulder
700	31,088	10.1	0.41	356,989	2	5	43	40	9	1	2,946

Habitat Group	Wetted Area (m^2)	Percent
scour Pool	127,219	35.6
Backwater Pools	88	**.*
Glide	6,348	1.8
Riffle	160,306	44.9
Rapid	11,427	3.2
Cascade	0	0.0
Step	260	0.1
Dry	50,800	14.2

Table D-21. Habitat Inventory Summary for Meacham Creek, Riparian Summary, Survey Date, July 1993.

Reach 0 is represented by 24 transects

Predominant landform in each zone

	zone 1 O-10 meters	zone2 10-20 meters	zone3 20-30 meters
Hillslope	8	12	14
High terrace	58	56	58
Lou terrace	34	32	28
Floodplain	0	0	0
Wetland/meadow	0	0	0
Stream channel	0	0	0
Roadbed/Railroad	0	0	0
Riprap	0	0	0
Surface slope (%)	6	9	8

Canopy closure and ground cover

	Zone 1 O-10 meters (%)	Zone 2 10-20 meters (%)	zone3 20-30 meters (%)
Canopy closure	32	2s	28
Shrub cover	26	24	27
Grass/forb cover	32	33	35

Average number of trees in a S-meter wide band

	zone 1 O-10 meters		Zone 2 10-20 meters		Zone 3 20-30 meters		zones I-3 O-33 meters	
Diameter class (cm)	Conifer	Hardwood	Conifer	Hardwood	Conifer	Hardwood	Conifer	Hardwood
3-15cm	2.6	4.0	1.9	2.7	2.1	3.6	6.6	10.2
15-30cm	0.8	0.6	0.3	1.0	0.8	0.7	2.0	2.3
30-50cm	0.5	0.2	0.3	0.1	0.5	0.2	1.2	0.5
SO-90cm	0.1	**.*	[illegible]	[illegible]	0.3	0.0	0.1	5.1
>90cm	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
Total/100m²	4.0	4.8	2.5	3.9	3.4	4.3	3.3	4.4

APPENDIX E
Biological Survey Data Summary Tables and Figures

Table E-l. Buckaroo Creek, Electrofishing Catch Summary, Natural Rainbow Trout, 1993.

HABITAT UNIT TYPE	NUMBER OF UNITS	TOTAL SURFACE AREA OF ALL UNITS	TOTAL AREA E. RSHED	PERCENT OF TOTAL AREA SAMPLED	MEA!! DENSITY FISH/M²	EST. NO. OF FISH BY UNIT TYPE
Back Water	1	17.9	17.9	100	1.44605	26
Cascade /Boulders	20	1440	187.9	13.0	0	0
Lateral Pool	120	10338	701.2	6.8	0.23402	2419
Puddled Pool	76	6457	270.4	4.2	0	0
Plunge Pool	9	843	141.2	88.6	0.14786	125
Riffle	183	21220	545.4	2.6	0.00675	143
Riffle with Pockets	18	2986	791.0	26.5	0.06434	192
Rapid over Bedrock	11	676	237.6	35.1	0.40045	271
scour Pool	48	2682	415.5	15.5	0.28592	767
Trench Pool	6	328	181.3	55.3	0.05578	18
TOTALS		46988	4095.7			3961

Table E-2. Boston Canyon Creek, Electrofishing Catch Summary, Natural Rainbow Trout. 1993.

HABITAT UNIT TYPE	NUMBER OF UNITS	TOTAL SURFACE AREA OF ALL UNITS	TOTAL AREA E. FISHED	PERCENT OF TOTAL AREA SAMPLED	MEAN DENSITY FISH/M²	EST. NO. OF FISH BY UNIT TYPE
Glide	2	70	19.8	28.3	0.40400	28
Isolated Pool	2	8	4	50	0	0
Lateral Pool	36	307	123.6	40.3	0.68495	210
Puddled Pool	15	312	76.9	24.6	0.10579	33
Plunge Pool	25	210	85.7	40.8	2.01148	422
Riffle	169	5692	358.9	6.3	0.67883	3864
Scour Pool	64	705	193.8	27.S	1.39948	987
Trench Pool	1	6.9	6.9	100.0	0.72200	5
TOTALS		7311	866.0			5550

Table E-3. Boston Canyon Creek, Electrofishing Catch Summary, Hatchery Rainbow Trout. 1993.

HABITAT UNIT TYPE	NUMBER OF UNITS	TOTAL SURFACE AREA OF ALL UNITS	TOTAL AREA E. FISHED	PERCENT OF TOTAL AREA SAMPLED	MEAN DENSITY FISH/M^2	EST. NO. OF FISH BY UNIT TYPE
Glide	2	70	19.8	28.3	0.30300	21
Isolated Pool	2	8	4	50	0	0
Lateral Pool	36	307	123.6	40.3	0.34618	106
Puddled Pool	15	312	76.9	24.6	0	0
Plunge Pool	25	210	85.7	40.8	0.52800	111
Riffle	169	5692	358.9	6.3	0.10300	586
scour Pool	64	705	193.8	27.5	0.41800	295
Trench Pool	1	6.9	6.9	100	0.72200	5
TOTALS		7311	866.0			1124

Table E-4. Boston Canyon Creek Tributary. Electrofishing Catch Summary, Natural Rainbow Trout, 1993.

HABITAT UNIT TYPE	NUMBER OF UNITS	TOTAL SURFACE AREA OF ALL UNITS	TOTAL AREA E. FISHED	PERCENT OF TOTAL AREA SAMPLED	MEAN DENSITY FISH/M^2	EST. NO. OF FISH BY UNIT TYPE
Lateral Pool	2	9.1	9.1	100.0	0	0
Puddled Pool	1	6.3	6.3	100.0	0.31700	2
Riffle	8	176	42.2	24.0	0.19339	34
Scour Pool	4	14	12.2	87.2	0.22870	3
TOTALS		204	69.9			39

Table E-5. Line Creek, Electrofishing Catch Summary, Natural Rainbow Trout, 1993.

HABITAT UNIT TYPE	NUMBER OF UNITS	TOTAL SURFACE AREA OF ALL UNITS	TOTAL AREA E. FISHED	PERCENT OF TOTAL ARE.4 SAMPLED	MEAN DENSITY FISH/M²	EST. SO. OF FISH BY UNIT TYPE
Lateral Pool	47	157	45.8	29.2	1.969401	309
Puddled Pool	44	194	75.8	39.0	1.485225	288
Rime	231	3084	141.3	4.6	0.740155	2283
scour Pool	67	243	63.7	26.2	1.563007	380
TOTALS		3678	326.7			3260

Table E-6. Meacham Creek, Electrofishing Catch Summary, Natural Rainbow Trout. 1993.

HABITAT UNIT TYPE	NUMBER OF UNITS	TOTAL SURFACE AREA OF ALL UNITS	TOTAL AREA E. FISHED	PERCENT OF TOTAL AREA SAMPLED	MEAN DENSITY FISH/M²	EST. SO. OF FISH BY UNIT TYPE
Glide	8	6348	1954.8	38.8	0.09148	581
Isolated Pool	2	88	66.4	75.5	0.03000	3
Lateral Pool	246	103630	2842.4	2.7	0.25296	26214
Paddled Pool	13	3858	243.8	6.3	0.21324	823
Plunge Pool	4	1218	1218	100.0	0.08991	110
Rapids over Boulders	30	9611	1502.4	15.6	0.27289	2623
Riffle	258	130314	4381.5	3.4	0.21008	27376
Riffle With Pockets	34	29993	4111.6	13.7	0.29088	8724
Rapid over Bedrock	3	1816	213.8	11.8	0.20600	374
scour Pool	62	22372	3917.9	17.5	0.22843	5110
TOTALS		309248	20452.1			71937

Table E-7. Meacham Creek, Electrofishing Catch Summary, Hatchery Rainbow Trout, 1993.

HABITAT UNIT TYPE	NUMBER OF UNITS	TOTAL SURFACE AREA OF ALL UNITS	TOTAL AREA E. FISHED	PERCENT OF TOTAL AREA SAMPLED	MEAN DENSITY FISH/M²	EST. NO. OF FISH BY UNIT TYPE
Glide	8	6348	1954.8	30.8	0.01951	124
Isolated Pool	2	88	66.4	75.5	0.04500	4
Lateral Pool	246	103630	2842.4	2.7	0.00539	559
Puddled Pool	13	3858	243.8	6.3	0.00000	0
Plunge Pool	4	1218	1218	100.0	0.03138	38
Rapids over Boulders	30	9611	1502.4	15.6	0.00794	76
Riffle	258	130314	4381.5	3.4	0.00046	59
Riffle With Pockets	34	29993	4111.6	13.7	0.00340	102
Rapid over Bedrock	3	1816	213.8	11.8	0.01900	35
Scour Pool	62	22372	3917.9	17.5	0.00087	19
TOTALS		309248	20452.1			1017

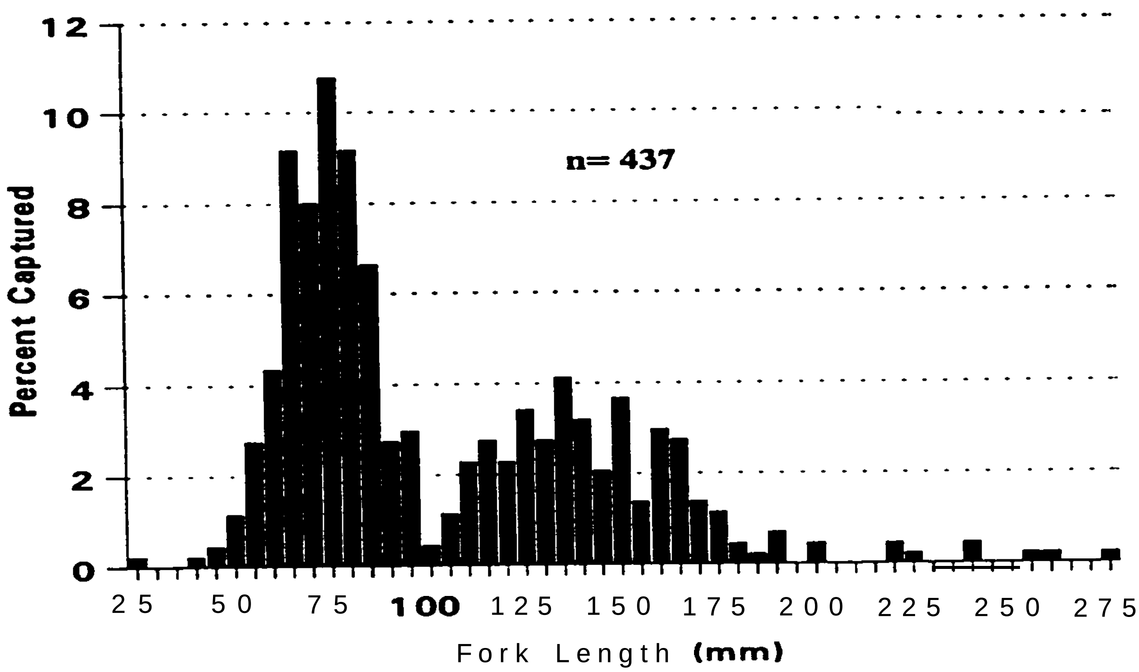

Figure E-l. **Length** Frequency Histogram of Natural Rainbow Trout Collected in Buckaroo Creek, 1993. **(BN93BUCK.CH3)**

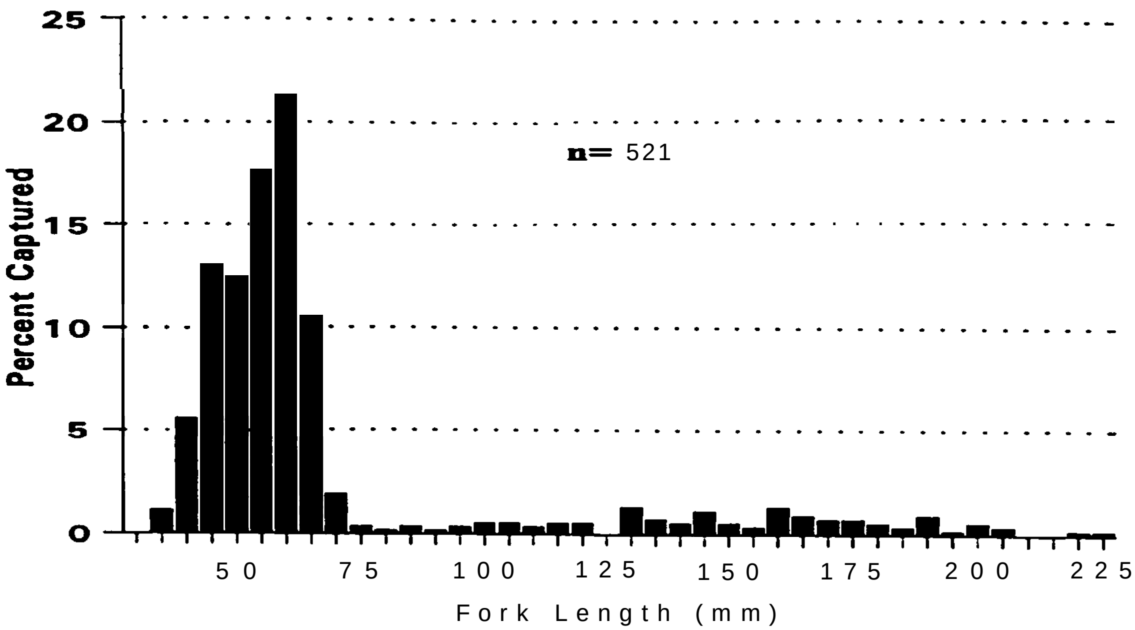

Figure E-2. Length Frequency Histogram of Natural Rainbow Trout Collected in Boston Canyon Creek, 1993.
(BN93BOSC.CH3)

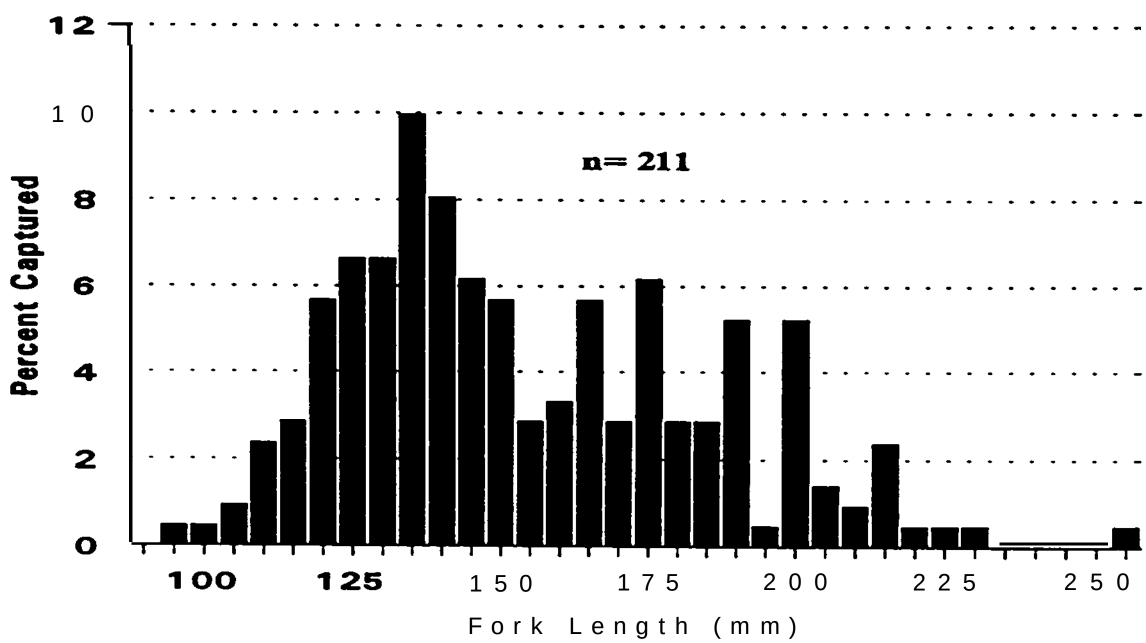

Figure E-3. Length Frequency Histogram of Hatchery Rainbow Trout Collected in Boston Canyon Creek, 1993.
(BH93BOSC.CH3)

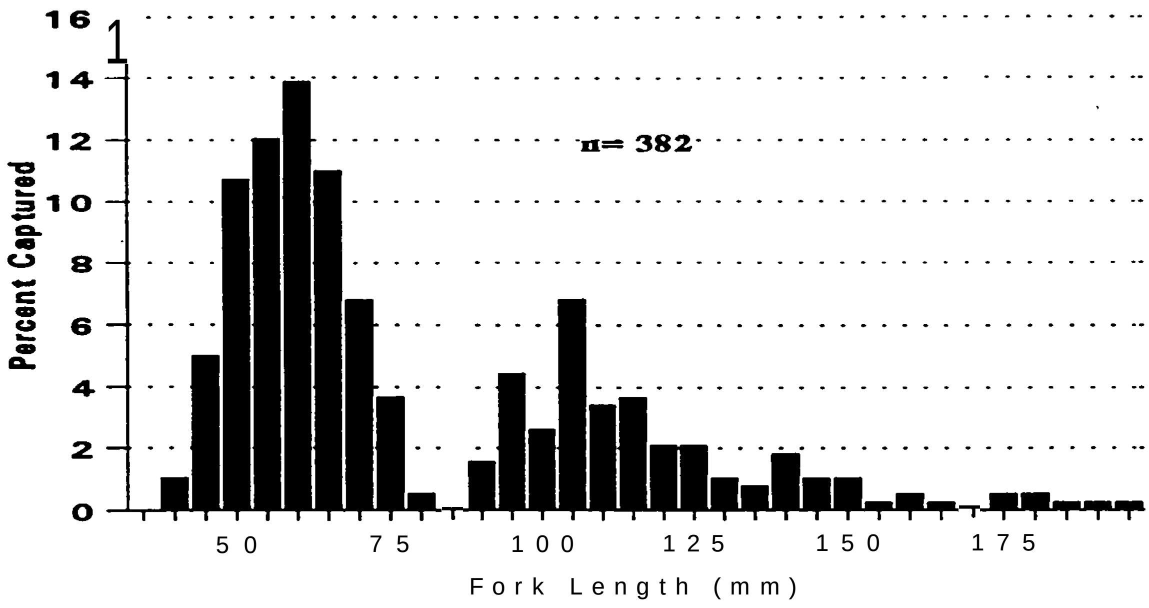

Figure E-4. Length Frequency Histogram of Natural Rainbow Trout Collected in Line Creek, 1993.
(BN93LINE.CH3)

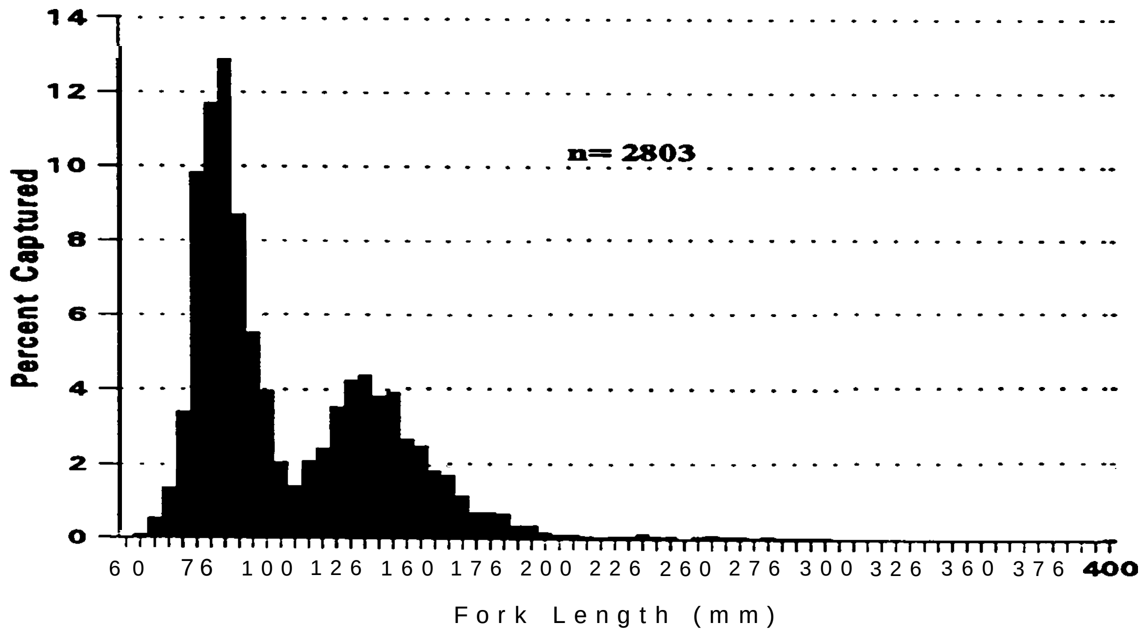

Figure E-5. Length Frequency Histogram of Natural Rainbow Trout Collected in **Meacham** Creek. 1993.
(BN93MEAC.CH3)

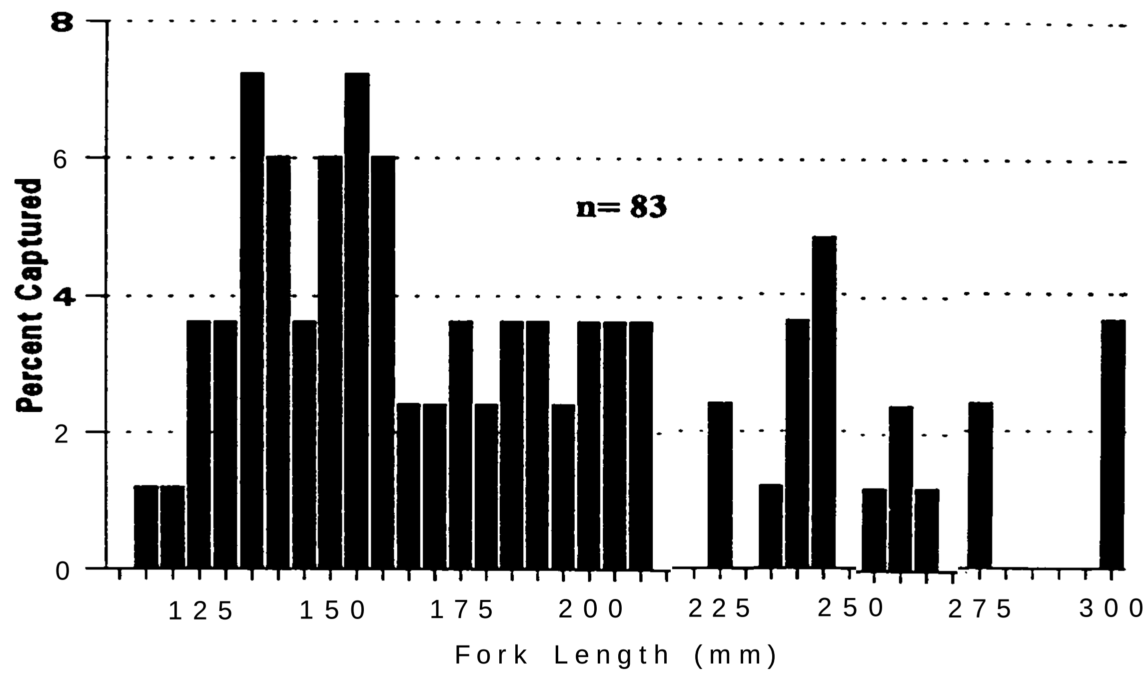

Figure E-6. Length Frequency Histogram of Hatchery Rainbow Trout Collected in Meacham Creek, 1993. **(BH93MEACH.CH3)**

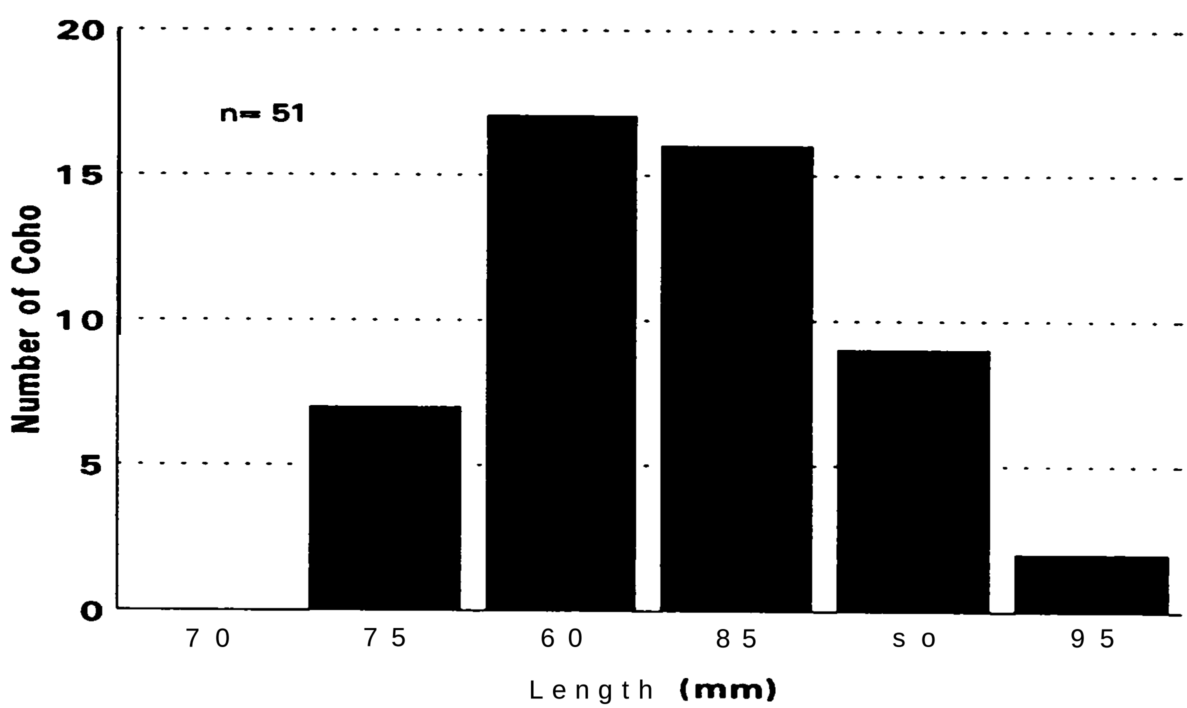

Figure E-7. Length Frequency Histogram of Juvenile Coho Salmon in Buckaroo Creek, 1993. **(BUCKCOHO.CH3).**

APPENDIX F
Spawning Survey Data for 1992-1993

ible F-l. Summarv of Summer Steelhead Redd Surveys. 1993.

STREAM	REACH	DATE	MILES SURVEYED	# NEW REDDS	STEELHEAD OBSERVED	CARCASSES EXAMINED
squaw Creek	Mouth to RM 4	04/07/93	4	1	3	0
	Mouth to RM 4	04/27/93	4	3	IO	0
	Mouth to RM 4	05/12/93	4	0	0	1
	RM 4 to RM 7	04/27/93	3	5	2	0
	RM 4 to RM 7	05/12/93	3	1	3	0
Boston Canyon C.	Mouth to RM 1	04/14/93	1	4	7	0
	Mouth to RM 1	05/10/93	1	2	0	0
Buckaroo Creek	Mouth to RM 3	04/20-21/93	3	5	4	0
	Mouth to RM 3	05/11/93	3	I	0	I
Camp Creek	Mouth IO RM 2	04/28/93	2	7	3	0
	Mouth to RM 2	05/14/93	2	0	1	0
Meacham Creek	Near RM 2	04/29/93	0.5	I	5	0
	Mouth to RM 3	05/24/93	3	0	0	0
	RM 3 to RM 6.4	05/24/93	3.4	3	2	0
	RM 6.4 to RM 11	05/24/93	4.6	0	0	1
	RM 11 to RM 14	05/26/93	3	2	1	0
	RM 14 to RM 17	05/26/93	3	1	0	1
N. F. Meacham	Mouth to RM 3	05/27/93	3	3	1	0
Duncan Springs C.	MoutbtoRM0.1	05/26/93	0.1	1	0	0
S. F. Umatilla	Mouth IO RM 4	05/20-21/93	4	8	4	0
Thomas Creek	Mouth to RM 1	05/21/93	1	0	0	0
Pearson Creek	Mouth to RM 8	05/17-18/93	8	3	4	1
TOTAL			46.6/63.6*	51	50	5

Table F-2. Summary of Spring Chinook Salmon Redd Surveys, 1993.

STREAM	REACH	DATE	MILES SURVEYED	NEW REDDS	CHINOOK OBSERVED	CARCASSES EXAMINED
North Fork, Umatilla River	RM o-3	7/16/93	3	0	3	1
		8/03/93	3	2	4	0
		8/17/93	3	6	10	5
		8/24/93	3	10	20	7
		8/30/93	3	5	11	7
		9/8/93	3	4	3	8
		9/14/93	3	0	0	1
Subtotal			3/21*	27	51	29
umatilla River	RM 83.5-89.5	6/23/93	6	0	5	1
		7/9/93	6	0	8	0
		7/27/93	6	0	19	2
		8/10/93	6	1	16	4
		8/19/93	6	5	24	6
		8/24/93	6	9	40	2
		8/30/93	6	5	44	17
		9/7/93	6	10	11	41
		9/14/93	6	9	0	17
Subtotal			6/54*	39	167	90
Umatilla River	RM 76.7-83.5	6/25/93	6.8	0	8	7
		7/12/93	6.8	0	23	4
		7/23/93	6.8	0	15	3
		8/4/93	6.8	0	64	6
		8/11/93	6.8	0	35	3
		8/18/93	6.8	3	25	9
		8/26/93	6.8	9	42	9
		9/1/93	6.8	16	46	21
		9/9/93	6.8	22	12	63
		9/14/93	6.8	15	8	41
		9/23/93	6.8	3	8	5
		9/24/93	6.8	1	0	5
		9/28/93	6.8	1	0	6
Subtotal			6.8/88.4*	70	286	175
Umatilla River	RM 73.5-76.7	6/26/93	3.2	0	0	0
		7/13/93	3.2	0	1	0
		7/28/93	3.2	0	5	3
		8/9/93	3.2	0	7	1
		8/27/93	3.2	0	8	3
		9/9/93	3.2	13	8	19
		9/15/93	3.2	3	3	12
Subtotal			3.2/22.4*	16	32	38
Umatilla River	RM 70.5-73.5	7/1/93	3	0	15	1
		7/13/93	3	0	17	0
		7/28/93	3	0	9	1
		8/13/93	3	0	13	0
		8/27/93	3	0	12	3
		9/13/93	3	4	8	9
		9/24/93	3	5	0	5
Subtotal			3/21*	9	74	19

Table F-2. Continued: Summary of Spring Chinook Salmon Redd Surveys 1993.

STREAM	REACH	DATE	MILES SURVEYED	# NEW REDDS	CHINOOK OBSERVED	CARCASSES EXAMINED
Umatilla River	RM 67.5-70.5	7/1/93	3	0	0	1
		7/20/93	3	0	0	0
		7/28/93	3	0	1	0
		8/27/93	3	0	3	0
		9/13/93	3	0	0	0
Subtotal			3/15*	0	4	1
Umatilla River	RM 63.8-67.5	7/6/93	3.7	0	0	0
		7/20/93	3.7	0	0	0
		9/16/93	3.7	0	0	0
Subtotal			3.7/11.1*	0	0	0
Umatilla River	RM 59.5-63.8	7/6/93	4.3	0	1	2
		7/29/93	4 3	0	0	1
		8/13/93	4.3	0	0	1
		9/21/93	4.3	0	1	1
Subtotal			4.3/17.2*	0	2	5
Umatilla River	RM 55.4-59.5	7/7/93	4.1	0	0	0
		7/29/93	4.1	0	0	0
Subtotal			4.1/8.2*	0	0	0
Umatilla River	RM 52.7-55.4	7/7/93	2.7	0	1	0
Umatilla River	RM 50.5-52.7	7/30/93	2.2	0	0	0
Umatilla River	RM 40.5-50.5	7/8/93	10	0	1	0
Meacham Creek	RM 0-6	6/28/93	6	0	5	0
		7/21/93	6	0	27	1
		8/2/93	6	0	34	1
		8/20/93	6	0	37	6
		8/31/93	6	3	41	5
		9/10/93	6	11	17	22
		9/16/93	6	7	6	13
		9/28/93	6	1	[illegible]	[illegible]
Subtotal			6/48*	[illegible]	167	48
Meacham Creek	RM 6-12	6/29/93	6	0	8	0
		7/22/93	6	0	23	1
		8/12/93	6	0	20	2
		8/31/93	6	8	31	7
		9/10/93	6	20	7	31
		9/13/93	6	2	0	4
		9/20/93	6	1	0	10
		9/22/93	6	3	[illegible]	[illegible]
Subtotal			6/48*	34	89	55
Meacham Creek	RM 12-3NF	6/30/93	6	0	6	0
		8/25/93	6	1	15	0
		9/13/93	6	4	4	1
		9/22/93	6	2	0	3
Subtotal			6/24*	7	25	8
Meacham Creek	RM 15-30	8/6/93	15	0	0	0
Umatilla River South Fork	RM o-3.5	7/27/93	3.5	0	0	0
GRAND TOTAL			88.5/411.7*	224	a99	471

Table F-3. Disposition of Umatilla River Spring Chinook Salmon above Three Mile Falls Dam, 1989-1993.

	1989	1990	1991	1992	1993
Total Observed at TMD	164	2190	1330	464	1221
Chinook Sacrificed at TMD	36	26	234	200	165
Chinook Taken For Brood Stock	0	200	0	0	0
Number Released Above TMD	131	1964	1096	264	1047
Number Released at TMD					9
Number of Adipose Clipped Fish Released Above TMD	3	685	480	127	603
Estimated Harvest Above TMD	?	?	?	CLOSED	191
Number of Chinook Sampled on Spawning Grounds	6	272	264	79	463
Percent Recovered (all chinook)	4.6	13.8	24.1	29.9	53.5
Number of Add. Clipped Chinook Recovered	0	83	136	39	356
Percent Recovered (ad. clipped)	0	12.1	28.3	30.7	59.0
Prespawning Mortalities Examined	0	0	88	22	125
Spawned Out Carcasses Examined	0	0	130	48	338
Redds Observed	14	289	144	59	224

Table F-4. Umatilla River Spring Chinook Salmon Redd Distributions, 1989-1993.

YEAR	1989	1990	1991	1992	1993
Total Number of Redds Observed	14	289	144	59	224
RIVER SECTION	NUMBER OF REDDS OBSERVED / PERCENT BY REACH				
North Fork Umatilla River	0 / 0	68 / 23.5	13 / 9.0	10 / 16.9	27 / 12.1
River Mile 86 to 89.5	14 / 100	174 / 60.3	21 / 14.6	13 / 22.0	25 / 11.2
River Mile 83 to 86			29 / 20.1	15 / 25.4	14 / 6.5
River Mile 80 to 83	0 / 0		26 / 18.1	13 / 22.0	31 / 13.8
River Mile 78.9 to 80	0 / 0		20 / 13.9	6 / 10.2	39 / 17.4
River Mile 76.7 to 78.9	0 / 0	36 / 12.5			
River Mile 73.6 to 76.7	0 / 0		0 / 0	0 / 0	25 / 11.1
River Mile 70.0 to 73.6	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
River Mile 67.5 to 70.0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
River Mile 63.8 to 67.5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
River Mile 63.8 to 59.5	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Meacham Creek (RM 1-15)	0 / 0	11 / 3.7	35 / 14.3	1 / 1.7	63 / 28.1

Table F-5. Summary of Successful Spawning by Reach of Spring Chinook Salmon Based on Examination of Carcasses, 1993.

RIVER REACH	SUCCESSFUL SPAWNERS		PRESPAWNING MORTALITIES			PERCENT SUCCESSFUL SPAWNING
	FEMALES	MALES	FEMALES	MALES	SEX UNKNOWN	
North Fork (0-3)	21	6	1	1	0	93.1
RM 86.3 to 89.5	20	13	2	8	0	76.6
RM 83.6 to 86.3	21	18	2	4	1	84.8
RM 80 to 83.6	37	21	6	6	1	81.7
RM 78.9 to 80	19	17	5	6	1	75.0
RM 76.7 to 78.9	19	12	21	6	2	51.7
RM 73.5 to 76.7	15	9	8	4	0	66.7
RM 70 to 73.5	6	4	4	2	1	58.8
RM 59.5 to 70	0	0	6	0	0	0
Meacham 0-3	10	8	6	2	0	69.2
Meacham 3-6	5	2	6	7	1	33.3
Meacham 6-9.8	21	17	0	5	0	88.4
Meacham 9.8-15	11	6	0	0	0	100.0
TOTAL	205	133	67	51	7	

Table F-6. Umatilla River Fall Chinook and Coho Salmon Adult Escapment Surveys, 1992.

REACH	DATE	OBSERVED LIVE FISH			RECOVERED CARCASSES			REDDS
		CHF	COHO	UNKOWN	CHF	COHO	UNKNOWN	
RM 47-49	11/17/92		11					5
	12/9/92							1
RM 47-45	11/17/92					3		4
	12/09/92				1	2	1	1
RM 45-43	11/18/92			3				
	12/11/92				1	3		
RM 40-43	1201192							1
RM 1.3-3.7	11 IOU92	2	2					
	11/16/92	29	17		2	4		21
	11/25/92				16	1		19
	12/01/92	19			39	4		
	12/07/92				24	9		
	12/14/92				7	4		
TOTAL		50	30	3	90	30	1	52

Table F-7. Minimun Estimate of Fall Chinook Salmon and Coho Salmon Adult Returns to the Umatilla River, 1989-1992

YEAR	ADULTS ENUMERATED AT THREE MILE DAM	ADULTS FOUND BELOW THREE MILE DAM	TOTAL	PERCENT SAMPLED BELOW DAM
COHO				
1989	4108	44	4152	1.1%
1990	410	2	412	0.5%
1991	1732	107	1839	5.8%
1992	355	22	377	5.8%
CHINOOK				
1989	279	89	368	24.2%
1990	333	110	443	24.8%
1991	522	16	538	3.0%
1992	238	85	323	26.3%

Table F-8. Fall Chinook and Coho Salmon Escapement Surveys, 1989-1992

YEAR	MILES SURVEYED	REDDS	OBSERVED LIVE FISH				RECOVERED CARCASSES			
			CHF	COHO	UNKNOWN	TOTAL	CHF	COHO	UNKNOWN	SUM
ABOVE THREE MILE FALLS DAM										
1989	32.5	92	5	30	0	35	20	37	10	67
1990	42.8	50	19	3	11	33	12	6	1	19
1991	29.0	18	12	15	1	28	5	11	1	17
1992	9.0	12	0	11	3	14	2	8	1	11
BELOW THREE MILE FALLS DAM										
1989	2.5		8	4	15	27	92	52	17	161
1990	2.5	-	15	9	11	35	120	5	8	133
1991	2.5	-	16	68	0	84	16	107	1	124
1992	2.5	40	50	19	0	69	88	22	0	110

Table F-9. Fall Chinook and Coho Salmon Released Above Three Mile Falls Dam, 1989-1992.

YEAR	FALL CHINOOK		COHO	
	ADULTS	JACKS	ADULTS	JACKS
1989	192	78	580	52
1990	168	89	364	450
1991	166	18	1385	91
1992	36	51	342	168

Table F-10. Summary of the Oregon Department of Fish and Wildlife's 1993 Steelhead Spawning Ground Surveys.

STREAM	DATE	MILE	LIVE	DEAD	REDDS	REDDS/MILE
UMATILLA BASIS						
East Birch Creek	May 20	4.5	2	0	II	2.4
West Birch Creek	June 1	4.5	0	0	3	0.7
Total Umatilla Basin			2	0	14	1.3
WALLA WALW BASIS						
North Fork Walla Walla	June 7	3.0	0	0	4	1.3
Cousc Creek	June 9	4.0	0	0	7	1.8
Mill Creek, OR/WA Border IO Watershed Dam	June 11	4.0	0	0	4	1.0
Mill Creek. Watershed Dam to OR/WA Border	June 11	1.5	0	0	I	0.7
Total Walla Walla Basin		12.5	0	0	16	1.3

- **Note. Most redds constructed before high flows were believed IO be unrecognizable after early May.**

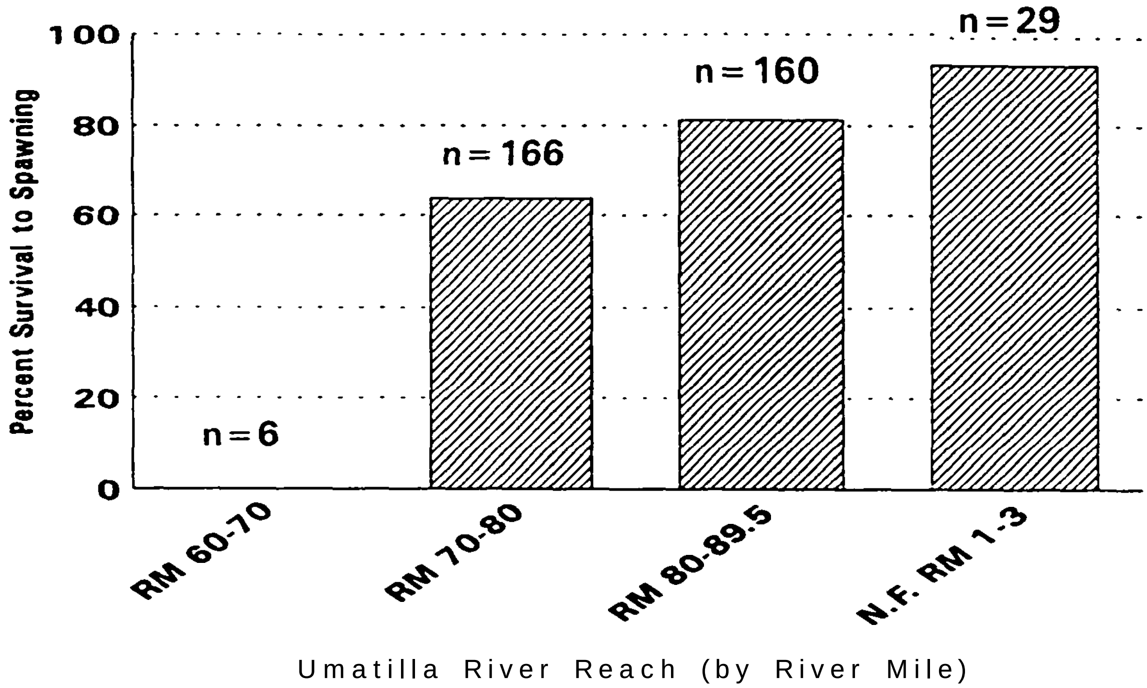

Figure F-l. Survival to Spawning (Based on Examination of Carcasses) of Adult Spring Chinook Salmon in Four Different Reaches of the Umatilla River, 1993.

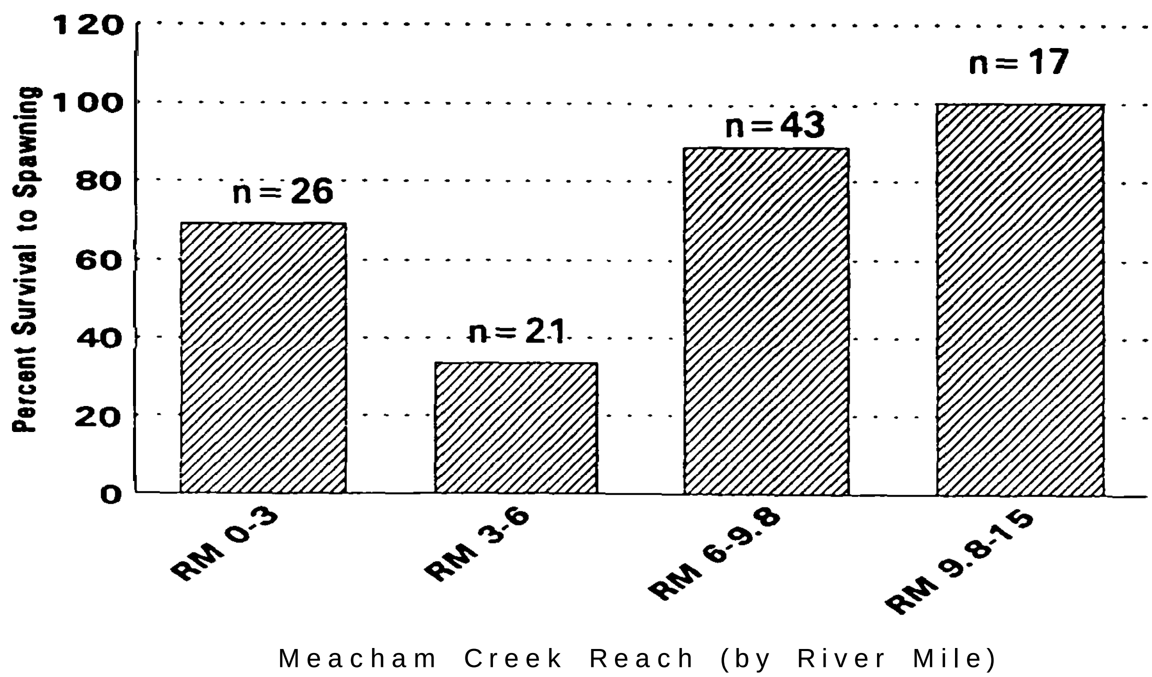

Figure F-2. Survival to Spawning (Based on Examination of Carcasses) of Adult Spring Chinook Salmon in Four Different Reaches of Meacham Creek, 1993.

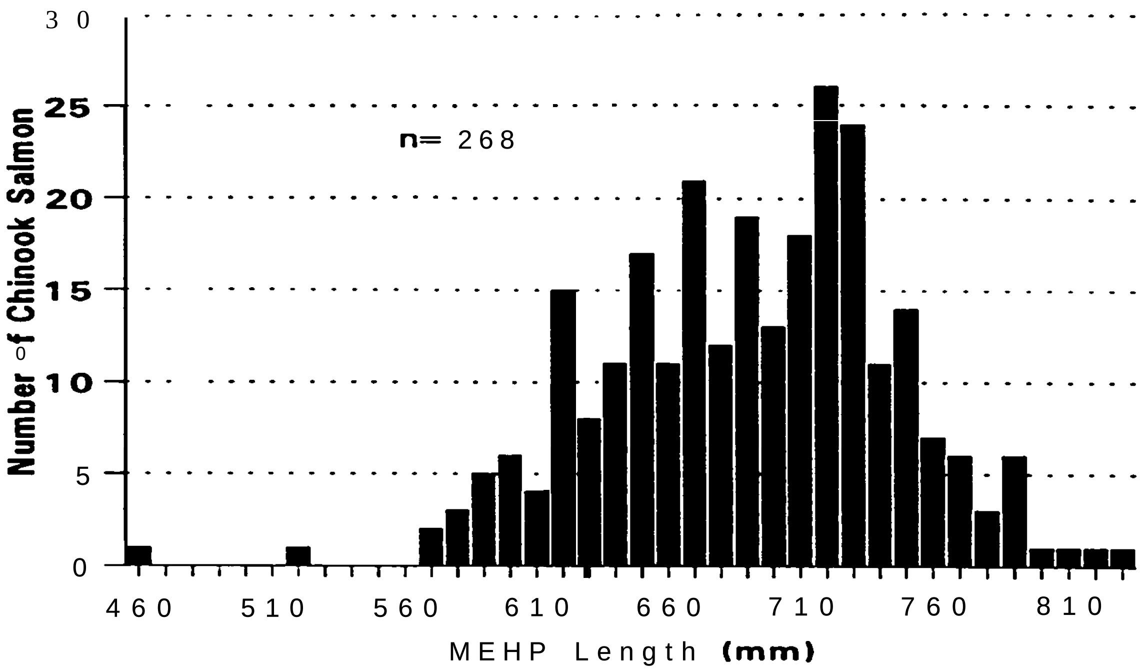

Figure F-3. MEHP Lengths of Adult Spring Chinook Salmon Examined During Spawning Surveys, 1993. **(93CHESC2.CH3)**

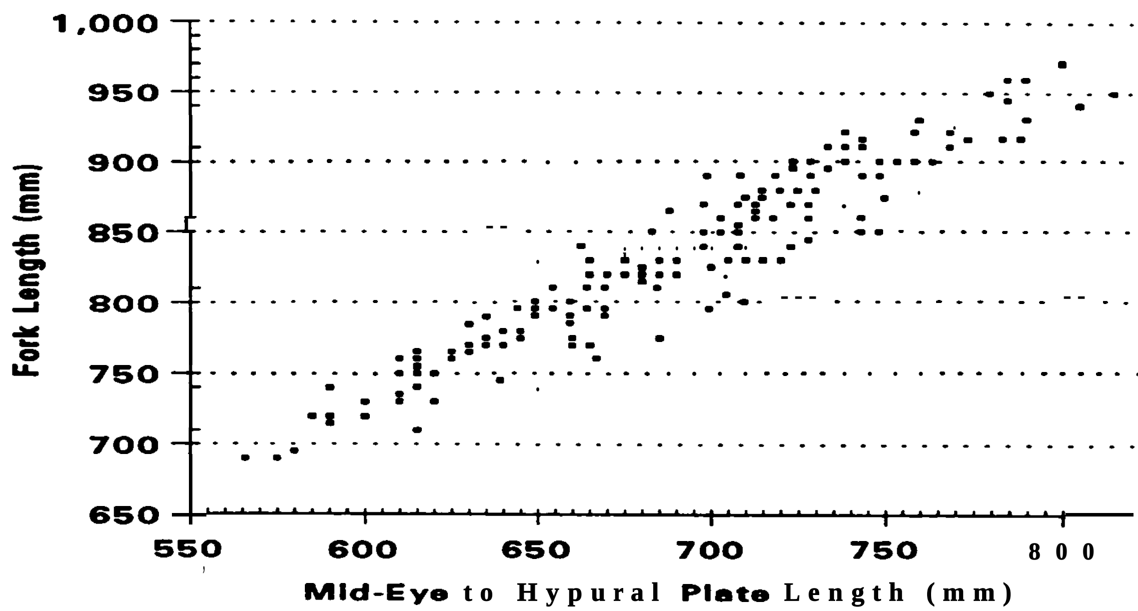

Figure F-4. Female Spring Chinook Salmon **Length Measurements,** MEHP Length Plotted Against Fork Lengths From Individual Carcasses Examined During Spawning Surveys, 1993. **(MEHP93SE.CH3)**

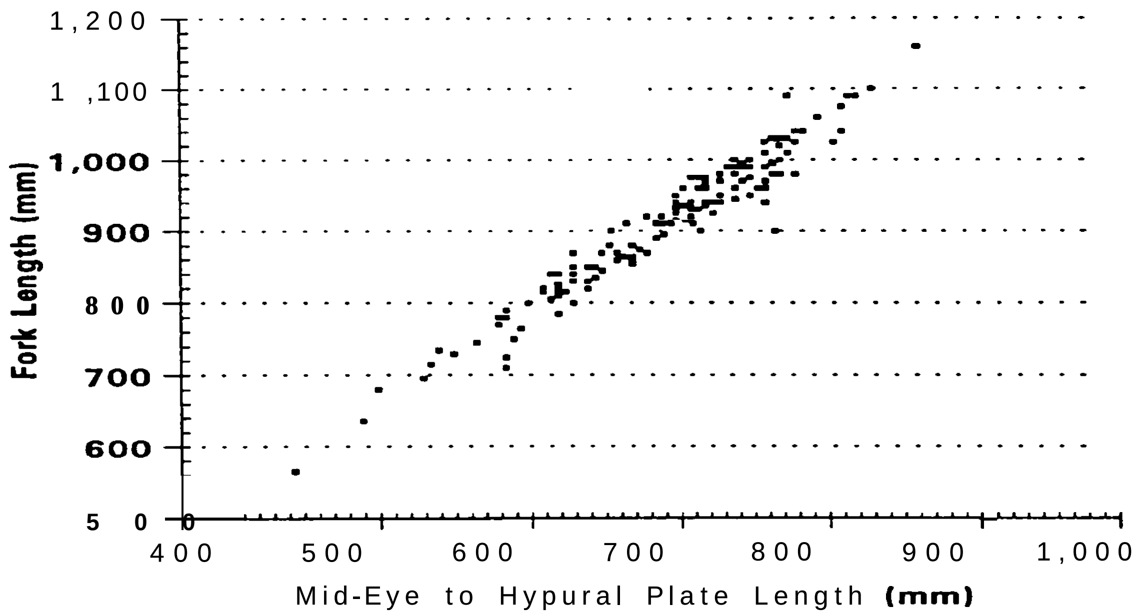

Figure F-S. Male Spring Chinook Salmon Length Measurements, MEHP Length Plotted Against Fork Lengths From Individual Carcasses Examined During Spawning Surveys, 1993. **(93UMCESC.CH3)**

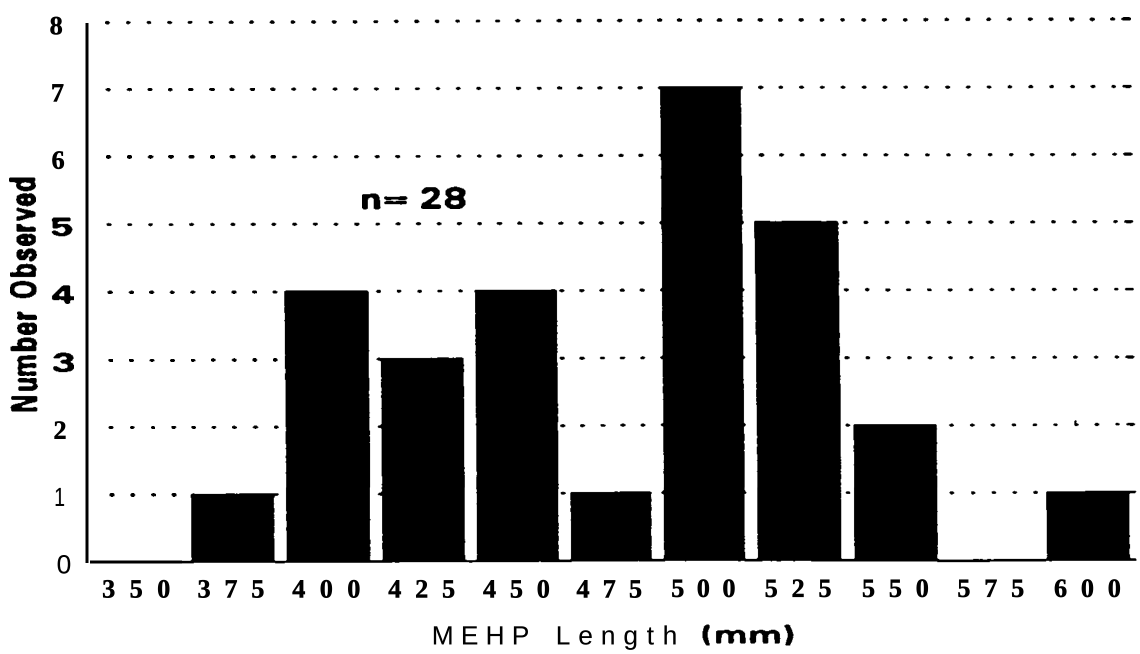

Figure F-6. MEHP Lengths of Adult Coho Salmon Examined During Spawning Surveys, Fall of 1992. **(COHO92LG.CH3)**

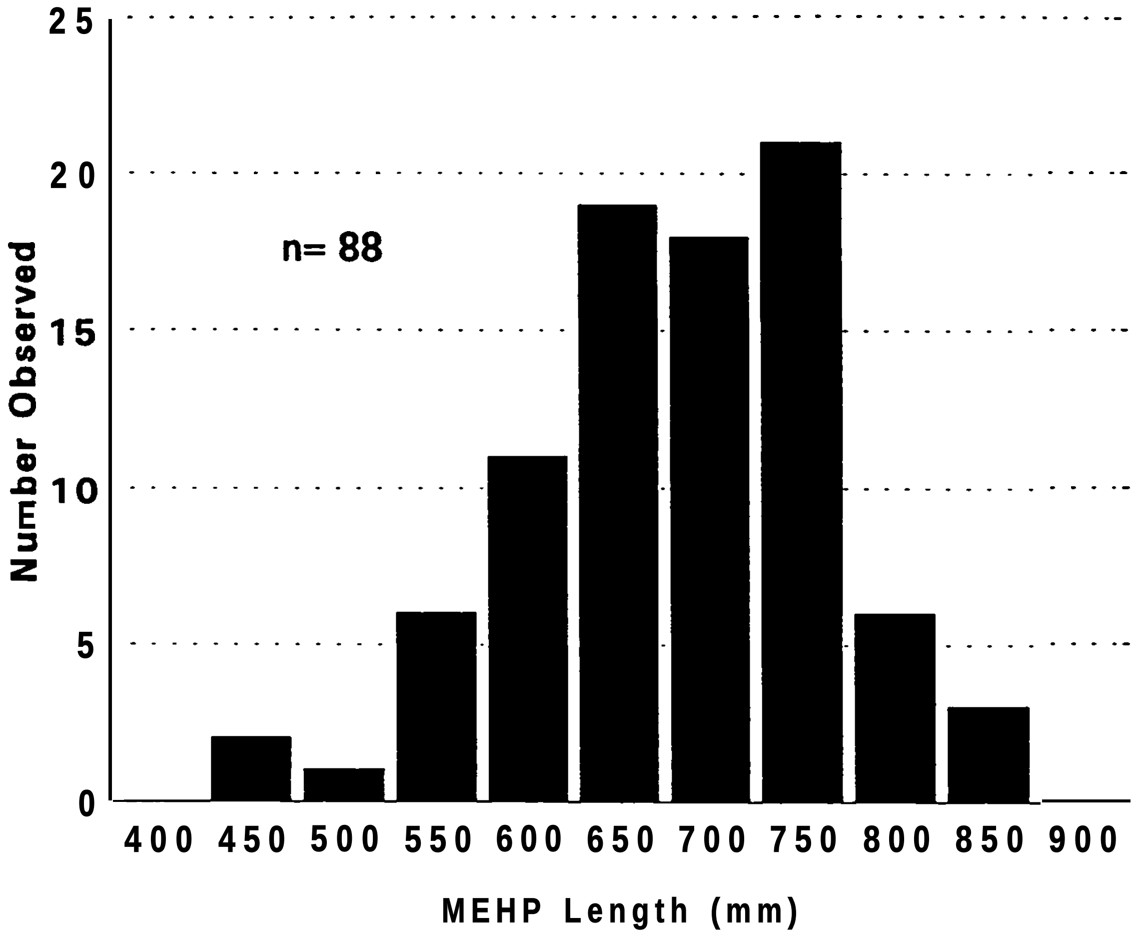

Figure F-7. MEHP Lengths of Adult Fall Chinook Salmon Examined During Spawning Surveys, Fall of 1992 (FCH92LG.CH3).

APPENDIX G
Rotary Screw Trap Tables and Figures

Table G-l. Summary of Trap Catch Data, 1993.

	TOTAL CATCH BY MONTH						TOTAL
	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	
Number of Trapping Hours (total)	269.5 (480)	529 (720)	611.5 (744)	718 (720)	720 (744)	144 (144)	2992 (4152)
Jv. Chinook Jv. RBT/STS Bull Trout	101 163 0	22 198 2	6 103 0	66 20 4	49 6 0	3 0 0	247 490 6
Shinners Suckers Dace Sculpin Squaw Fish	27 3 1210 27 6	15 8 2422 89 8	29 20 241 28 14	15 6 36 2 8	12 2 49 10 9	1 0 7 0 6	99 39 3965 156 , 51
GRAND TOTAL							5053

Table G-2. Summary of Bull Trout Observations in the Umatilla River Basin, 1992 **through 1994.**

STREAM / LOCATION	DATE(s)	LENGTH(s) mm	METHOD
Meacham Creek (RM 1.5)	December '93 to June '94	120+	Trap
Umatilla Trap (RM 79.5)	April '93 to June '94	120+	Trap
Coyote Creek, North Fork Umatilla Tributary	April '94	125	Electro.
N.F. Umatilla (RM .75)	November '92	265	Electro.
N.F. Umatilla (RM 3)	August '93	140	Mort.
Buck Creek, South Fork Umatilla Tributary	May '92	160	Electro.
Umatilla (RM 80)	June '94	390	Mort. *
Umatilla (RM 78.5)	June ,93	150	Electro.
Squaw Creek (RM 1)	October '92	210	Electro.
Squaw Creek (RM 7)	July '94	~150	Observ.
Meacham Creek (RM 1-9)	August '92	270	Mort.

* Angling related mortality; hooks in gills.

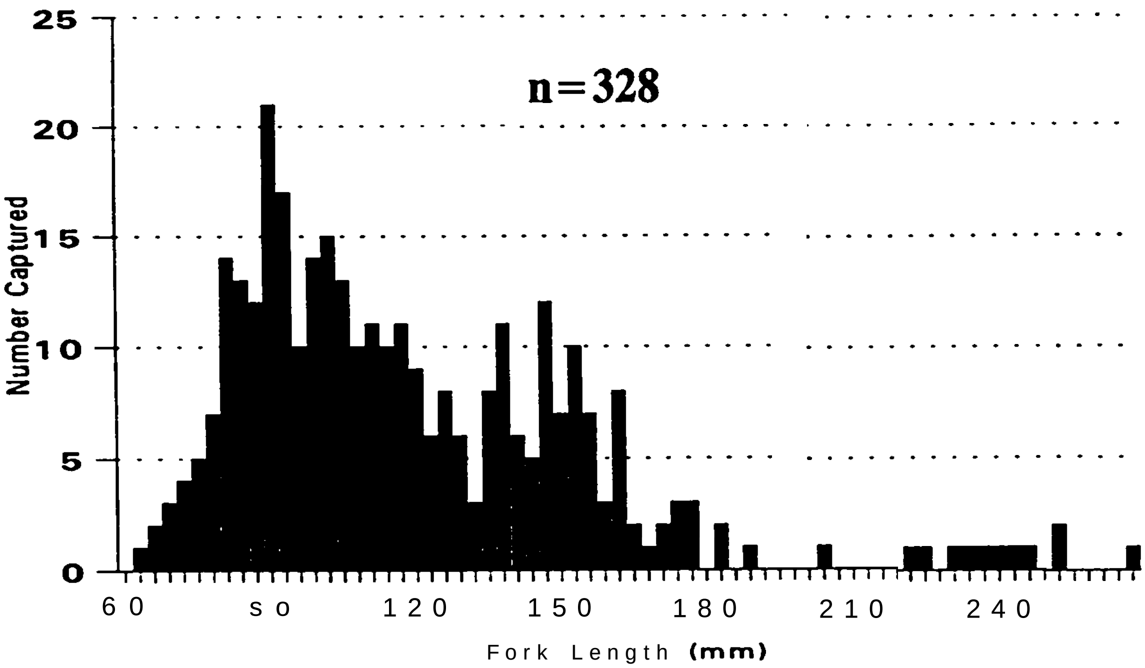

Figure G-l. Length Frequency Histogram of Rainbow Trout Captured by the Rotary Screw Trap in the Umatilla River (RM 79.5) from March to August 8, 1993. **(STSU93Q3.CH3)**

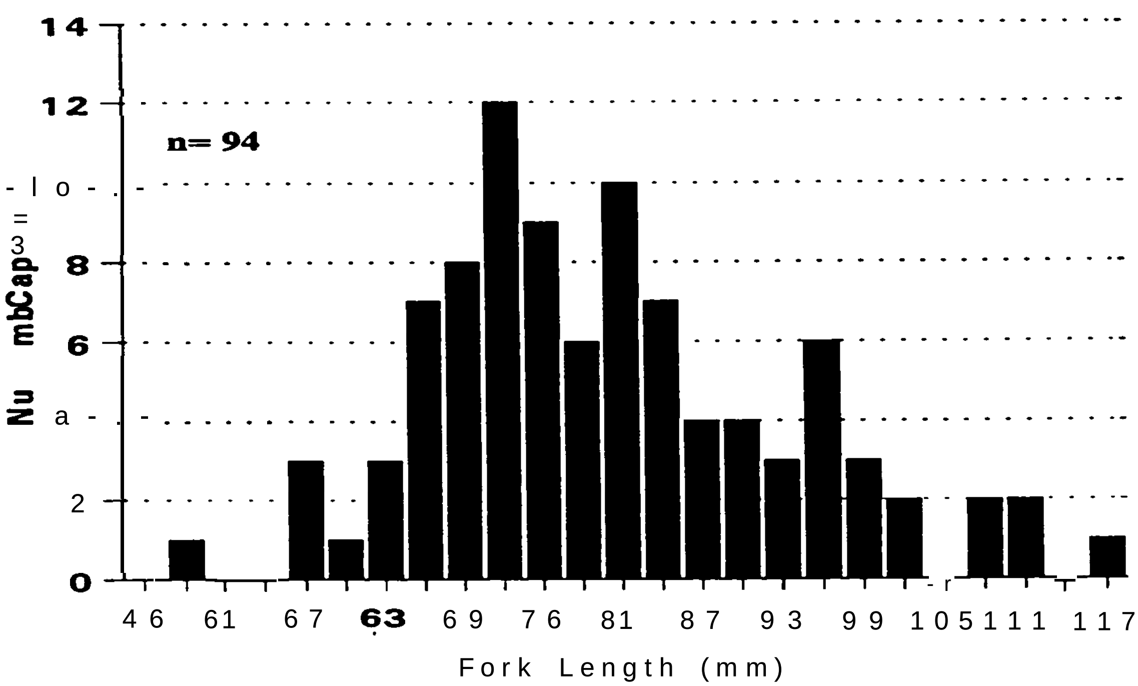

Figure G-2. Length Frequency Histogram of Juvenile Chinook Salmon Captured by the Rotary Screw Trap in the Umatilla River (RM 79.5) from March to June 1993. **(CHSU93Q3.CH3)**

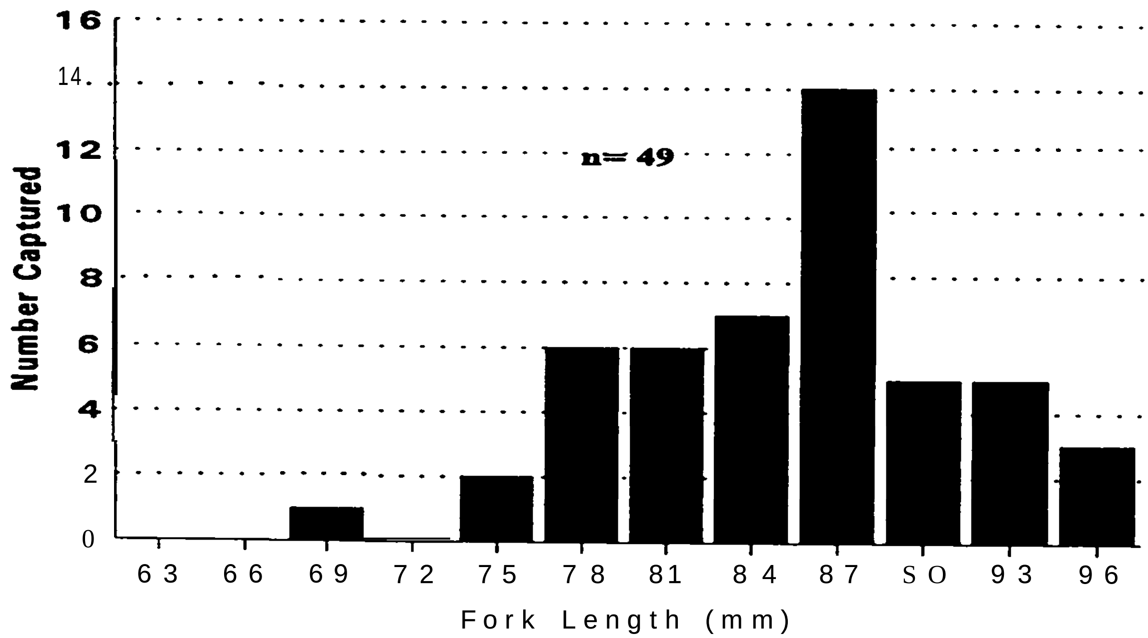

Figure G-3. Length Frequency Histogram of Juvenile Chinook Salmon Captured by the Rotary Screw Trap in the Umatilla River **(RM 79.5)** from July to August 8, 1993. **(CHSU93Q4.CH3)**

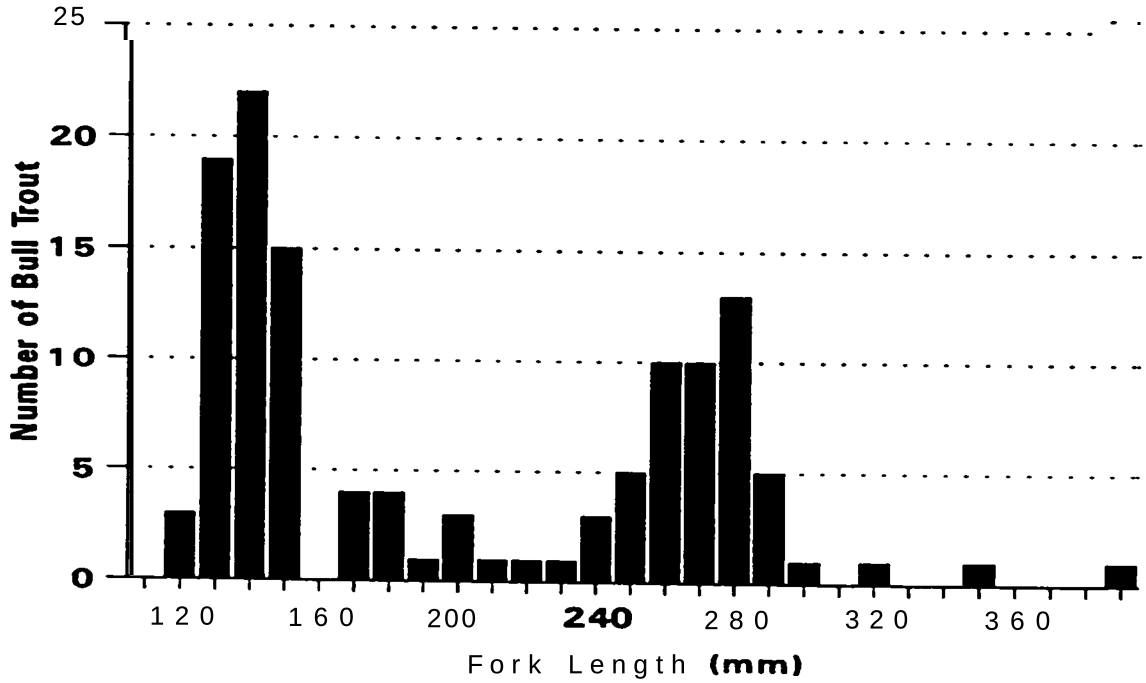

Figure **G-4.** Length Frequency Histogram of Bull Trout Captured by **Electrofishing** or Trapping From May 1992 to June 1994, **n** = 134. **(BTFVS#.CH3)**

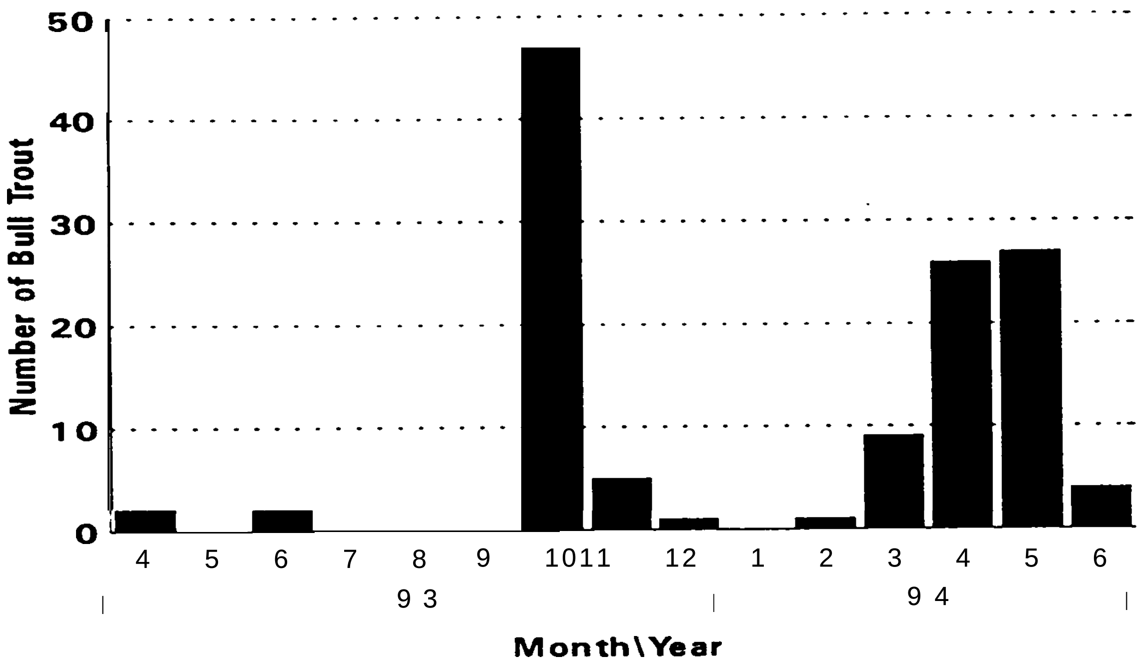

Figure G-5. Time Frequency Histogram of Bull Trout Captured by Electrofishing and/or Trapping from April 1992 through June 1994, n = 134. (BT493694.CH3)

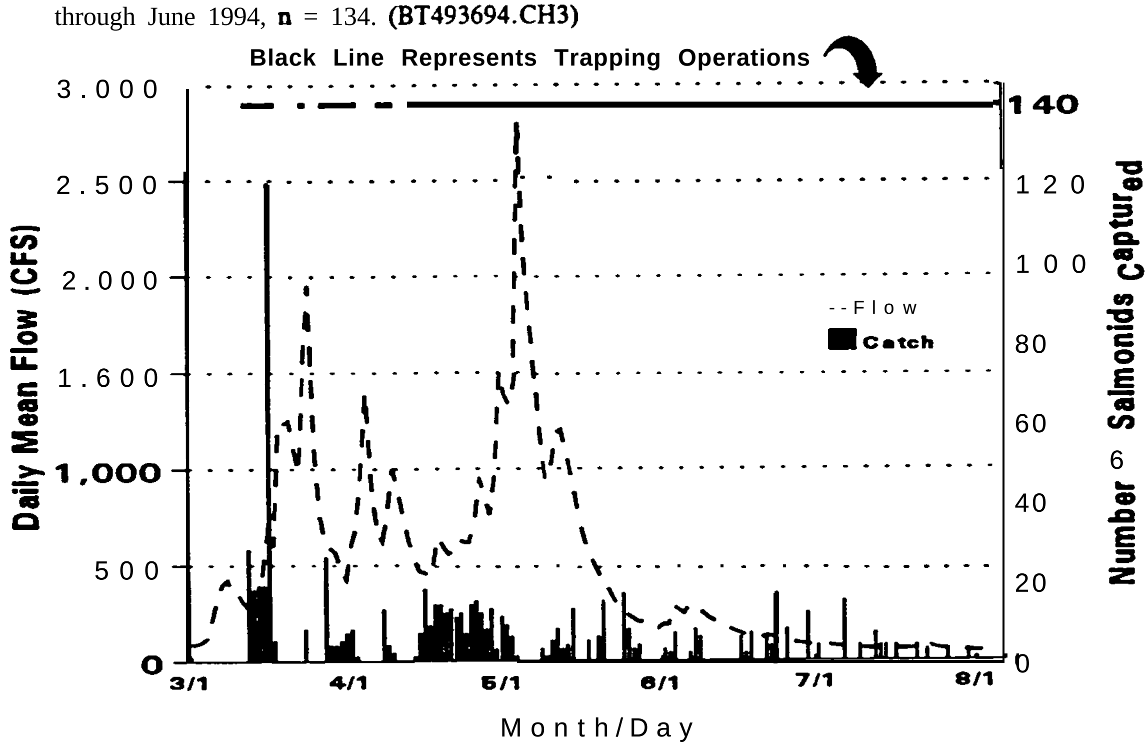

Figure G-6. Summary of Flows (Dotted Line), Catch (Histogram) and Trapping Days (Horizontal Bar at the Top of the Chart) of the Rotary Screw Trap in the Umatilla River (RM 79.5) from March to August 8, 1993 (Gaps in Line at the Top of the Graph Represent Days the Trap did not Operate; U93FLOW2.CH3)

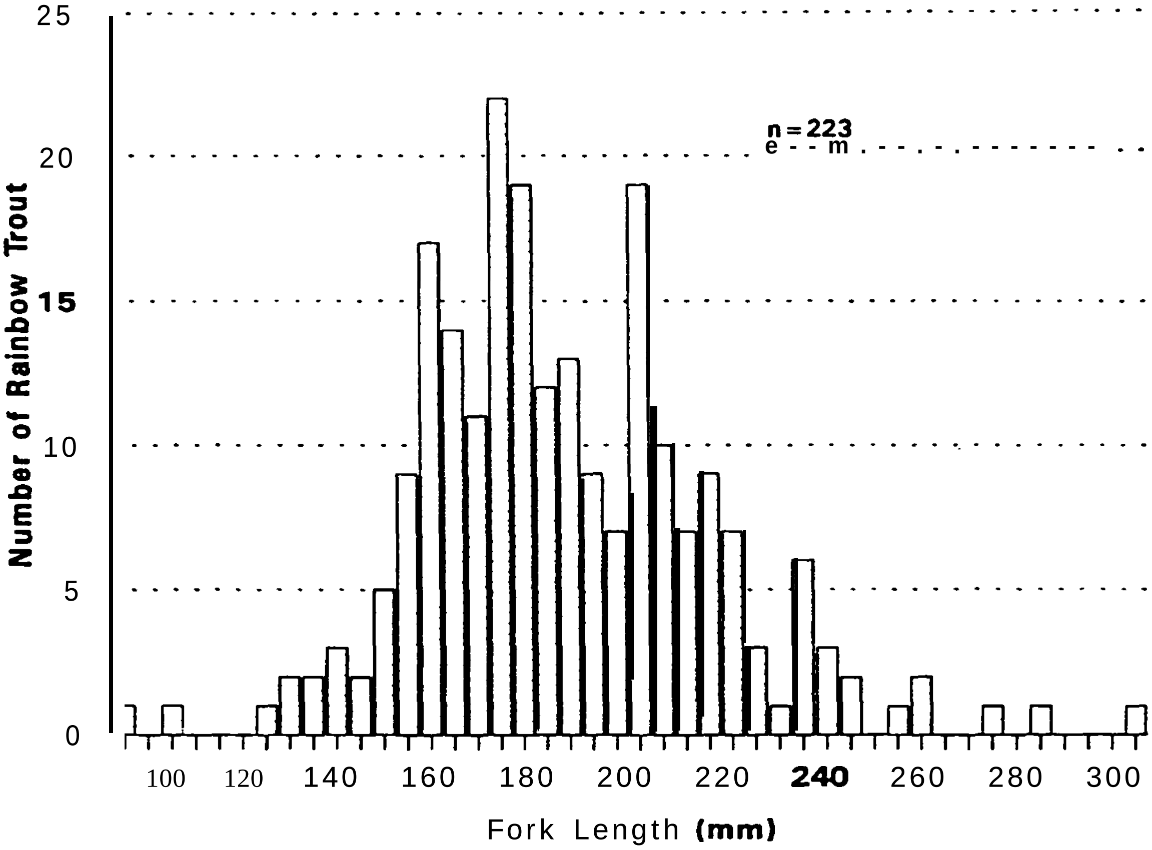

Figure G-7. Length Frequency Histogram of Juvenile Steelhead Captured at Westland Diversion Dam (Rowan, 1990 and Personal Communication).

APPENDIXH

Table H-l. Summary of Landmarks and Their Associated River Miles, Umatilla River Basin.

LOCATION/LANDMARK	RM	LOCATION/LANDMARK	RM
Three Mile Falls Dam	3.7	Gibbon Railroad Yard	78.4
Horse Ranch	5	Mouth Of Meacham Creek	79.0
Tree Farm	5.5	Fred Gray's Bridge	80.0
House on Bluff	7.4	London Bridge	80.8
South Park Bridge	8.8	Reservation Boundary--Ryan Creek	81.8
Boyd's Return	9	Emmit Williams Place	82.0
Boyd's Dam	10.2	Larson's Driveway	83.5
Lookinglass Road	11.3	Stage Coach Stop House	84.7
Maxwell Dam	15.2	Bar M Driveway	86.0
Simplot	17	Lower Bar M	87.0
Stanfield Bridge	23	Bear Creek	87.1
I-84 Bridge	24.2	Old Silver Building	87.5
Dillon Dam	24.6	Corporation Hole	88.5
Echo Bridge	26.3	Umatilla Mainstem Forks	89.5
Westland Dam	27.2	North Fork Umatilla River	O-10
Coldsprings Dam	28.2	Coyote Creek	2.5
Stanfield Dam	32.4	Woodward Creek	5.7
Yoakum	37	South Fork Umatilla River	O-10
Barnhart Bridge	42.2	Buck Creek	0.5
Forth's Diversion	46.9	Thomas Creek	3.3
Mouth of Birch Creek	48.3	Shimmiehom Creek	4.6
PGG Building	51	Meacham Creek	O-36
ODFW, Receiver Site #4	56	Boston Canyon Creek	2.2
Pendleton Ready Mix	57	Bonifer Acclimation Site	2.3
Mission Bridge	59.5	Line Creek	5.0
Minthorn Springs	64.5	Camp Creek	10.9
Cayuse Railroad Bridge	67.0	Duncan	12.0
Cayuse Highway Bridge	67.5	East Meacham Creek	18.5
Louie Dick's Fence	70.0	Butcher Creek	21.5
Thomhollow Railroad Bridge	71.0	Meacham	30.0
Badger Comer	71.8	North Fork Meacham Creek	o-9.5
Thomhollow Highway Bridge	73.5	Bear Creek	18.0
Weathers's Place	74.5	Pot Creek	21.0
Mouth of Squaw Creek	76.7		