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2002-2003 ANNUAL REPORT
RESULTS OF JUVENILE SALMONID DOWNSTREAM MIGRANT TRAPPING CONDUCTED ON FRESHWATER CREEK, 2003
PROJECT 2a6

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Northern California – North Coast Region

Steelhead Research and Monitoring Program
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ABSTRACT

Juvenile salmonid downstream migrant trapping was conducted at seven locations in the Freshwater Creek basin between March 14 and June 28, 2003. Pipe traps were deployed on McCready Gulch, Cloney Gulch, Graham Gulch, the upper main stem Freshwater Creek, South Fork, and Little Freshwater Creek. A fyke/pipe trap was fished on the lower main stem Freshwater Creek to provide i) basin wide estimate of salmonid migrants and ii) allow partitioning of salmonid production by sub-drainage. Based on trapping results, we were able to estimate the number of migrants for the period between May 9 and June 6. During this period we estimate that 3354 (SD 538) coho salmon (*Onchorhynchus kisutch*), and 2955 (SD 1045) Chinook salmon (*Onchorhynchus tshawytsha*) smolts emigrated from Freshwater Creek. Estimate of the number of coho and Chinook salmon migrants from March 14 to May 9 as well as other species and age classes were not possible due to low capture rates.

[1] Steelhead Research and Monitoring Program report, available from: Department of Fish and Game, 50 Ericson Court, Arcata California 95521 (707)825-4850

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INTRODUCTION

The California Department of Fish and Game (DFG) and National Oceanic and Atmospheric Administration ~ Fisheries (NOAA~Fisheries) recognize four key parameters for assessing the long term viability of salmonid populations. These parameters are; population size, population growth rate (productivity), population spatial structure, and life history diversity (McElhany et al. 2000). The Freshwater Salmonid Monitoring Project is designed to be a full life cycle monitoring station where the primary goals are to; 1)fill the data needs necessary to estimate these VSP parameters in one small basin, 2)provide the data necessary to interpret patterns in data gathered from less intensive abundance sampling on larger spatial scales, and 3) investigate the relationship between watershed and habitat conditions and abundance and distribution of animals.

The first goal is to estimate the four fundamental parameters used to assess population viability. Primarily, the focus is placed on estimating yearly abundance of adults and juveniles. A time series of this full life cycle abundance monitoring is then used to estimate both freshwater (summer and winter) and marine survival as well as the ratio of the number of recruits to the number of adults for a given brood year (productivity). Additionally, by following individual animals through space and time, we hope to define life history patterns as well as the spatial and temporal structure of the population(s).

The second goal is to define the relationships and sampling protocols necessary to appropriately gather data and interpret abundance sampling on larger spatial scales. For example, density dependant functions can make the interpretation of population trend from a time series of juvenile abundance unclear. Similarly, evaluating abundance data of adult spawners from carcasses, live fish, or redd counts remains ambiguous when variability in observation probability is unaccounted for between years or sites. By sampling at multiple life stages and using a permanent counting fence to enumerate adults, we strive to investigate both the dynamics of cohort abundance through time as well as investigate biases associated with adult and juvenile sampling techniques.

The third goal investigates habitat-fish productivity relationships and habitat restoration effectiveness. If survival between successive life stages and associated habitat and environmental conditions are monitored, this information can be used to target recovery actions which can be taken to improve survival at specific stages in the salmonids life cycle.

Life cycle monitoring in Freshwater Creek seeks to answer: 1) whether trends in coastal salmonid abundance are due to changes in freshwater and/or marine survival, 2) what is the spatial and temporal structure of Freshwater Creek salmonid populations (e.g. spawning group distribution and connectivity), 3) is survival at various life stages and habitat and environmental conditions correlated, and 4) what life stage or stages limiting adult production are conducive to efforts to improve survival.

This report summarizes the efforts to; 1) estimate smolt abundance on Freshwater Creek for the spring of 2003, 2) tag steelhead and Cutthroat for a full life history mark-recapture experiment. The estimates of emigrant abundance is intended to be used in conjunction with annual estimates of abundance of both adult and juvenile over-summer rearing abundance to achieve project goals.

Objectives

The Freshwater Creek downstream migrant program was initiated to; i) determine the yield of coho salmon and chinook salmon smolts as well as cutthroat and steelhead parr and smolts from Freshwater Creek basin, ii) determine the timing of outmigration of salmonids, iii) partition the basin yield of salmonids into that produced by tributaries and main stem areas, iv)serve as a tagging/recapture period for a full life history mark-recapture experiment of steelhead and cutthroat.

Study Area

The Freshwater Creek basin is located in Humboldt County between Eureka to the south and Arcata to the north. Freshwater Creek is a fourth order stream with a drainage area of approximately 9227 hectares (31 square miles) and drains into Humboldt Bay via the Eureka Slough. Elevations in the watershed range from 823 meters at the headwaters to sea level at the mouth. Main stem Freshwater Creek is approximately 23 km long, of which 14.5 km is anadromous fish habitat. Five main tributaries, Little Freshwater, Graham Gulch, Cloney Gulch, McCready Gulch and South Fork Freshwater each provide 2 to 4 km of anadromous fish habitat.

Annual rainfall amounts to approximately 150 cm in the headwaters and 100 cm near the mouth. The lower 6 km of Freshwater Creek is primarily cattle grazing land and is characterized by a low gradient, with limited riparian development. Levees confine the channel in this reach. Upstream of this section, the riparian community is much more highly developed, composed of willow (*Salix spp.),* alder (*Alnus rubra*), black cottonwood (*Populus trichocarpa*), blackberry (*Rubus ursinus*), salmonberry (*Rubus spectasbilis*), and other herbaceous plants. Bordering the riparian areas are forests of redwood (*Sequoia sempervirens*), Douglas-fir (*Psuedotsuga menziesii*), white fir (*Abies concolor*) and Sitka spruce (*Picea sitchensis*).

The fishery resources of the basin include three species of salmon, chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), and steelhead (*O. mykiss*). Occasionally, chum salmon (*O. keta*) are observed. Other fish present in the basin include Pacific lamprey (*Entosphenus tridentatus*), brook lamprey (*Lampreta pacifica*), cutthroat trout (*O. clarki*), and prickly and coast range sculpin (*Cottus asper, Cottus aleuticus*), and three spine stickleback (*Gasterosteus aculeatus*).

Amphibians and reptiles present include pacific giant salamanders (*Dicamptodon ensatus*), red legged frogs (*Rana boylii*), tailed frogs (*Ascaphus truei*) and western pond turtles (*Clemmys marmorata*).

Figure 1. Freshwater Creek Survey Locations

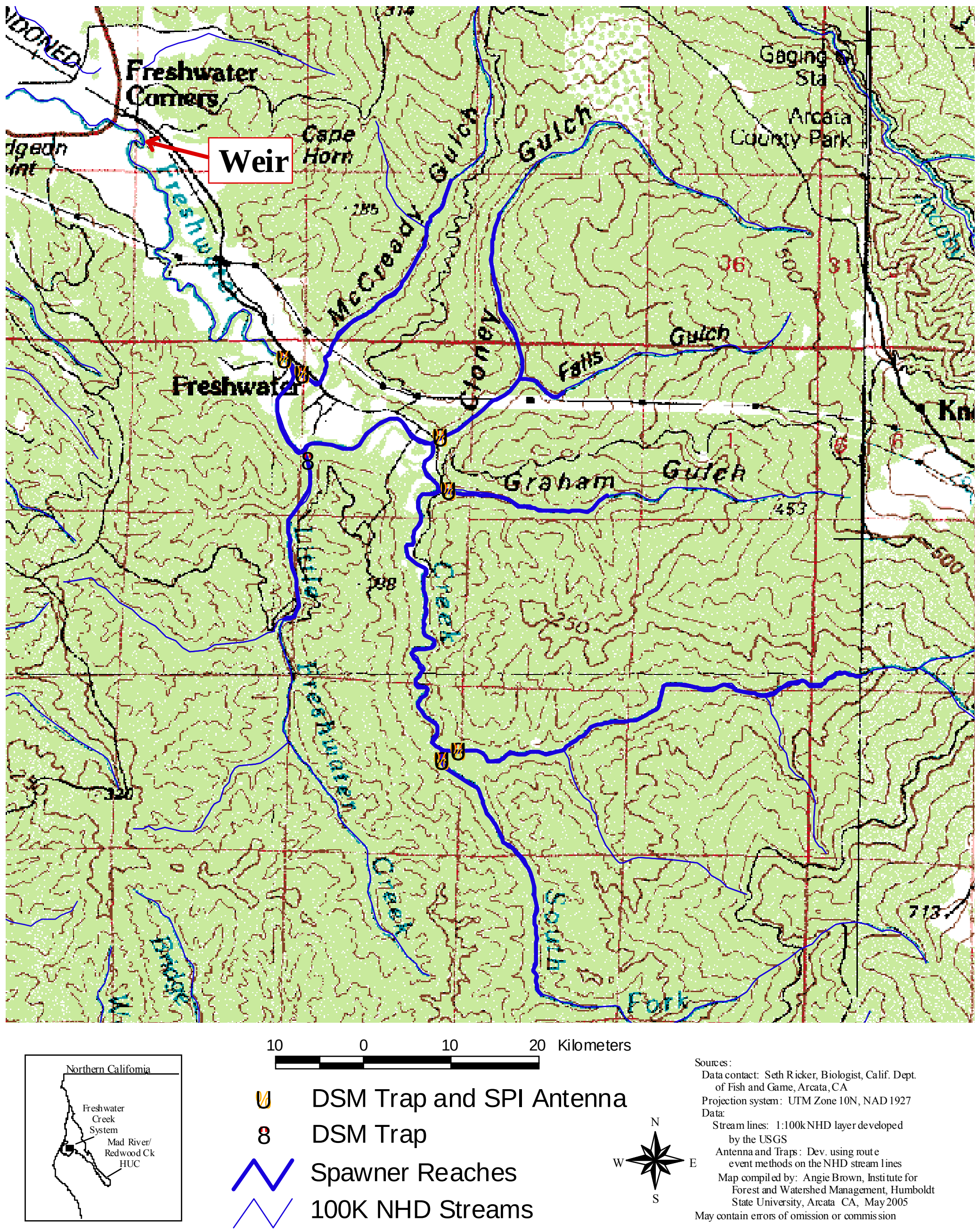

Figure 1. Freshwater Creek Basin, depicting relative location in Humboldt County, California and downstream migrant trap locations.

METHODS

Fish Capture

Seven downstream migrant traps were installed in the Freshwater Creek basin from March 14, 2003 through June 28, 2003. Pipe traps were deployed in each of the five major tributaries as well as the upper main stem Freshwater Creek above the confluence with the South Fork. The pipe traps were placed within 20-300m upstream of the confluence with the main stem of Freshwater Creek, at a pool tail out/ riffle crest. The six pipe traps consisted of a downstream "V" shaped rock and wooden pallet weir, which concentrated fish and water flow through a 10" PVC pipe. The pipes ran down a low gradient riffle and drained on to perforated inclined planes allowing water to pass through, while depositing fish into trap boxes. We also deployed a floating inclined plane trap (a.k.a. scoop trap) at the Lower Main-stem site (LMS) (Figure1). This floating trap consists of a 48" X 48" mouth narrowing to a 36" x 8" cod end which deposits into a live box. Water velocity pushes fish up the plane into the live box. The plane and box are buoyed by two 16' pontoon floats. Design, fabrication and deployment of this trap followed closely to the plans described by Todd (1994).

Abundance estimates

We estimated numbers of migrants at each trap using a single trap mark-recapture method. At least three days per week during the entire study, were designated as marking days. On these days, fish were anaesthetized with MS-222, measured for fork length, and marked by injecting either a small line of colored Visual Implant Elastomer (VIE) on both sides of the jaw (coho only). Each trap was designated a specific color, and was injected in the right jaw. Seven different mark colors on the left jaw were used to represent weekly stratified marking groups, so that estimates of the number of migrants could be separated when trap efficiencies varied. At the end of seven weeks the marking location cycle began again. All steelhead and cutthroat we given individually numbered Passive Integrated Transponder (PIT) tags, inserted into the body cavity (Prentice 1990). Chinook salmon smolts were marked with weekly VIE colors injected into the snout. Marked fish were held in a flow through live car up to 1 hour to check for handling and marking mortalities. Any mortality of marked fish prior to release were removed from the number of marks released. All marked fish were transported upstream of the trap one to three pool riffle sequences. Release sites upstream of the traps were chosen to provide cover and were rotated among three to five sites in an effort to avoid habituation of predators.

Each day, trapped fish were anaesthetized with MS-222, counted, checked for marks, and recaptures measured for fork length. Once processed, the fish were allowed to recover in flow through live cars and released downstream of the trap.

The mark-recapture data was analyzed separately for all age 1+, and 2+ and older steelhead and age 1+ coho salmon emigrants for each drainage. Numbers of age 0+ Chinook salmon smolts were estimated from at the lower main stem trap only. The mark-recapture data was analyzed using Darroch Analysis with Ranked Regression (DARR) to produce bounded estimates of abundance (Darroch 1961, Bjorkstedt pers. comm.). Briefly, this method is a temporally stratified mark-recapture experiment that estimates capture probability for each period accounting for the effects of migration on the pool of marked fish susceptible to capture during each period. This method does not require the assumption that all fish resume migration during the period during which they were released. Strata that contain problematic structure for Darroch (1961) analysis are combined to neighboring strata thereby reducing the rank of the data to the least possible extent to produce a dataset amenable to Darroch (1961) analysis (Bjorkstedt pers. Comm.).

Two types of PIT tags are used to identify juvenile salmonids. A small 11.5 mm Full Duplex (FDX) tag is implanted into fish >69mm <130mm. Thirty two millimeter tags are implanted in fish >129mm. This larger size and Half-Duplex (HDX) tag platform has the ability to be detected at a much larger range. Table X summarizes the number of fish tagged by species and tag type.

Age Determination

Age classes were determined with length frequencies. Two distinct modes of the frequency distribution were identified, and ages divided at the nadir of the frequency distribution. Age 1+ steelhead are considered <120 mm and age 2+ $\geq$ 120 mm (Figure 3).

The developmental stage of all captured and recaptured fish was determined by visual observation and consisted of three categories; parr, pre-smolt and smolt. Parr were characterized by well defined of parr marks, pre smolts exhibited partial silvering of the body and fading but still visible parr marks, and smolts exhibited total silvering of the body, no visible parr marks and blackening of the caudal fin tips.

RESULTS

Abundance Estimates

Estimation of fish passing the LMS trapping site was limited to age 1+ coho smolts and Chinook salmon, due to low sample sizes of captured fish and truncated trapping season. An estimated 3354 (538) age 1+ coho salmon and 2955 (1045) chinook smolts emigrated past the LMS site. All trap abundance estimates are displayed in Table 2. Young of the year (age 0+) captures for all traps are displayed in Table 2.

Trap Group / Age class	N(hat)	SD
Lower Main-stem		
Steelhead 1+	**85**	**NA**
Steelhead 2+	**9**	**NA**
Cutthroat 1+	**13**	**NA**
Cutthroat 2+	**25**	**NA**
Coho 1+	3354	538
Chinook	2955	1045
McCready G.		
Steelhead 1+	**2**	**NA**
Steelhead 2+	**7**	**NA**
Cutthroat 1+	**9**	**NA**
Cutthroat 2+	**58**	**NA**
Coho 1+	**40**	**NA**
Cloney G.		
Steelhead 1+	**117**	**NA**
Steelhead 2+	**53**	**NA**
Cutthroat 1+	**6**	**NA**
Cutthroat 2+	**42**	**NA**
Coho 1+	81	5
Graham G.		
Steelhead 1+	**12**	**NA**
Steelhead 2+	**11**	**NA**
Cutthroat 1+	**9**	**NA**
Cutthroat 2+	**10**	**NA**
Coho 1+	**23**	**NA**
Upper Main-stem		
Steelhead 1+	**22**	**NA**
Steelhead 2+	**17**	**NA**
Cutthroat 1+	**4**	**NA**
Cutthroat 2+	**10**	**NA**
Coho 1+	115	6
South Fork		
Steelhead 1+	**20**	**NA**
Steelhead 2+	**34**	**NA**
Cutthroat 1+	**5**	**NA**
Cutthroat 2+	**19**	**NA**
Coho 1+	17	4
Little Freshwater		
Steelhead 1+	**33**	**NA**
Steelhead 2+	**11**	**NA**
Cutthroat 1+	**18**	**NA**
Cutthroat 2+	**16**	**NA**
Coho 1+	63	6

Table 1. Abundance estimates (N(hat)), associated error (SD) of the estimate, of smolts and parr by species, age class and sub-drainage. BOLD indicates number of fish captured and is not an estimated total yield.

Table 2. Age 0+ (young of the year) catches for the seven downstream migrant traps in Freshwater Creek basin.

Age 0+ catches	McCready	Cloney	Graham	Upper Main	South Fork	Little Fresh	Lower Main
Coho	891	5605	749	2411	5183	648	4946
Steelhead	8	451	0	424	12	0	31
Chinook	12	525	0	347	0	1	1697

Table 3 Numbers and type of PIT tags given to juvenile steelhead and cutthroat trout.

Species	32mm	11.5mm
Steelhead	80	249
Cutthroat	96	90

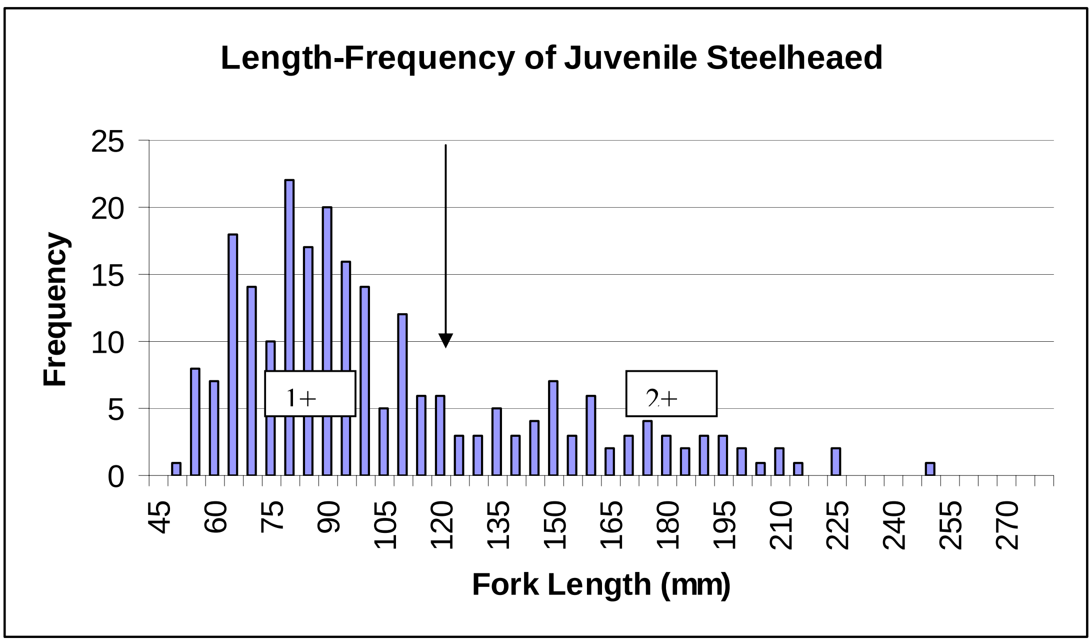

Figure 2. Length-frequency histogram of all captured steelhead at the LMS trap. Boxes indicate age classes and arrow depicts fork length used for age class delineation.

Migration Timing

Trapping commenced on March 3, 2002 during a period of low emigration. Thereafter, a peak in migration began April 11, and sporadic catches continues through May 15, 2002(Figures 3,4,5).

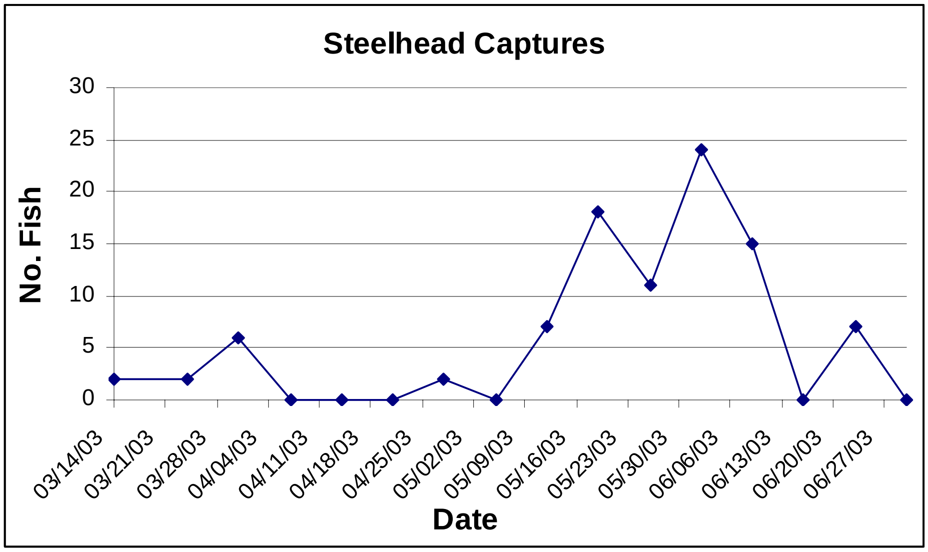

Figure 3. Timing of steelhead emigration at the LMS trap.

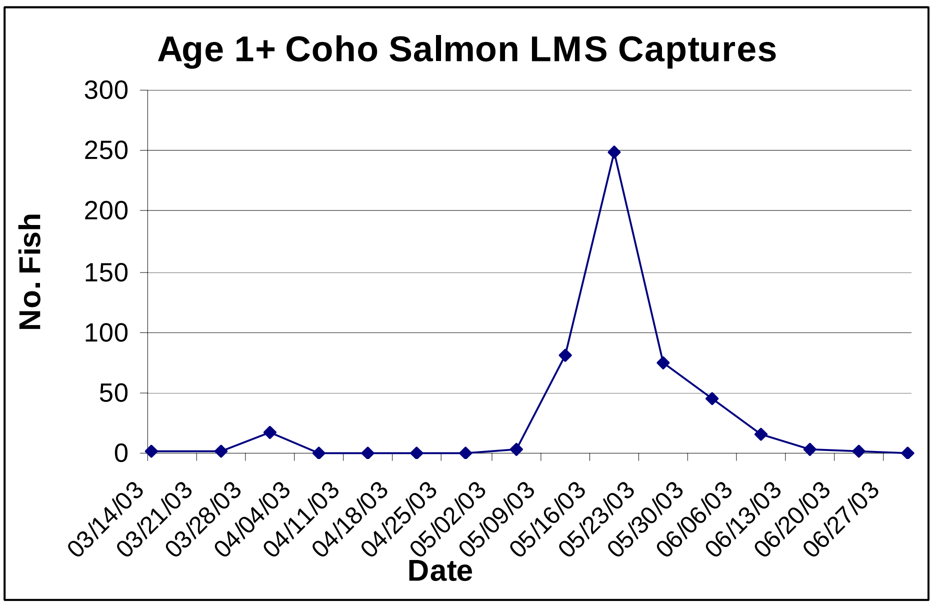

Figure 4. Timing of coho salmon captures at the LMS trap.

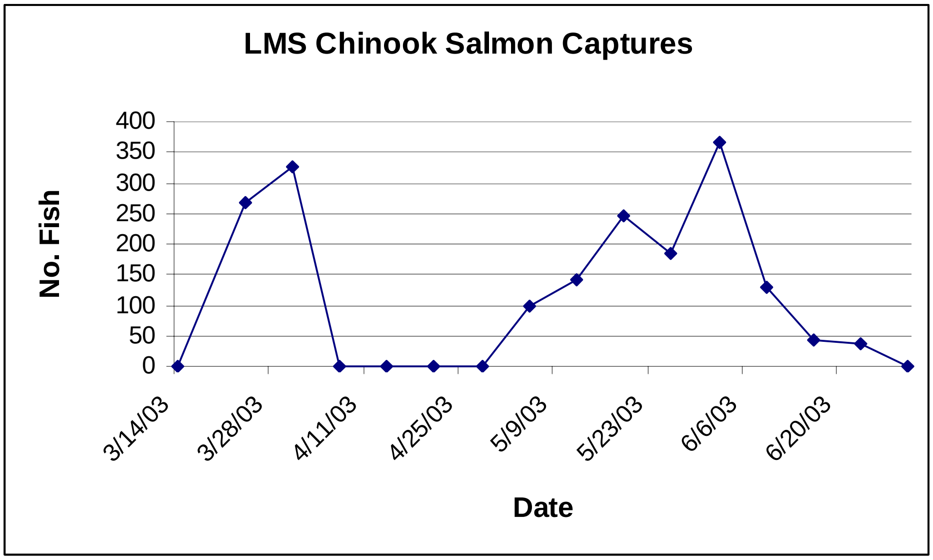

Figure 5. Timing of chinook salmon captures at the LMS trap.

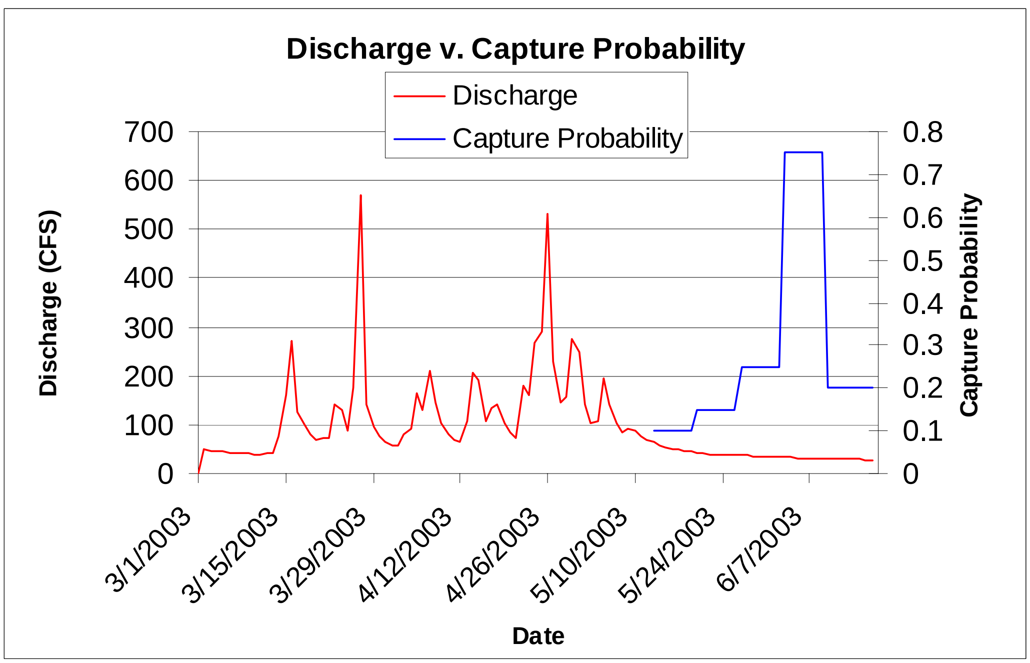

Figure 6 Hydrograph of Freshwater Creek stream discharge during DSM Trapping season, and associated capture probabilities of Coho Salmon smolts at the LMS trap.

Length of Steelhead and Coho Salmon

Steelhead. The median fork length of steelhead from tributary creeks ranged from 84 mm from the Cloney Gulch to 157mm for McCready Gulch (Figure 7).

Coho Salmon. Median sizes of coho salmon captured at the tributary traps ranged from 86mm in Cloney Gulch to 97mm from the upper main-stem (Figure 8).

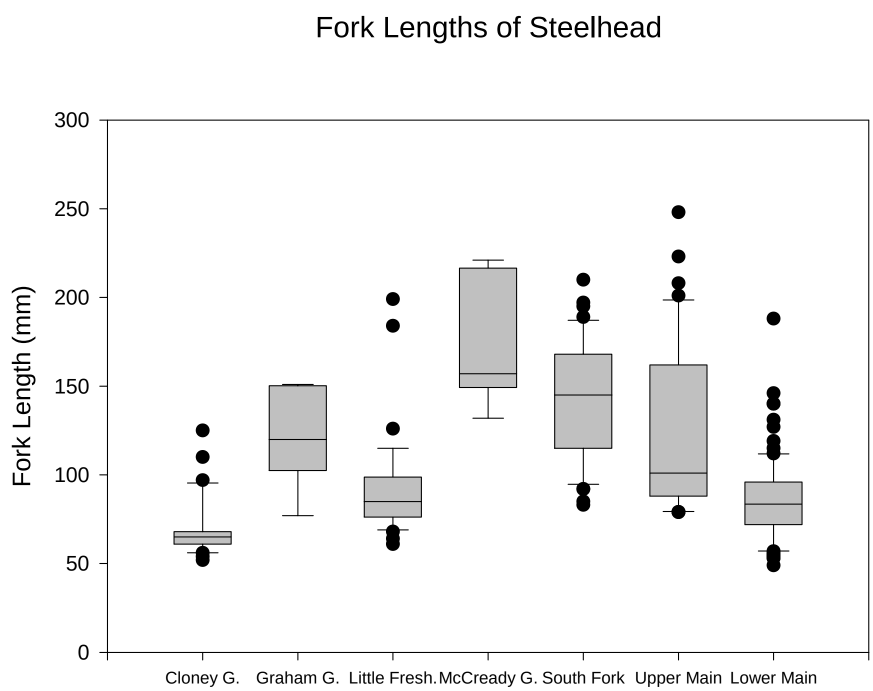

Figure 7. Comparison of fork lengths of measured steelhead from each tributary trap. Box plots depict 25th, 50th, and 75th percentiles, whiskers depict 10th and 90th percentiles and points indicate outliers.

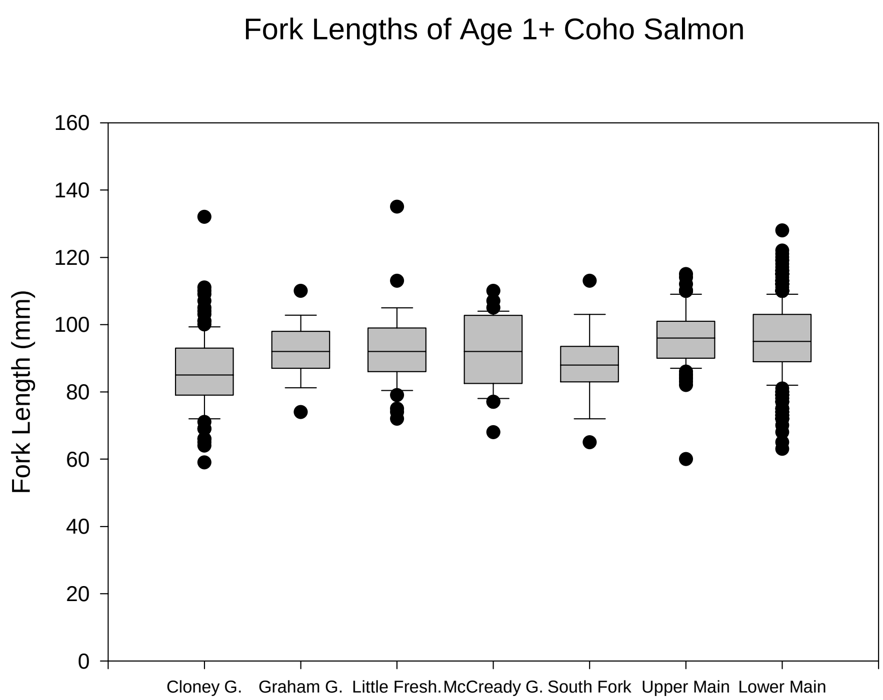

Figure 8. Comparison of fork lengths of systematically measured coho salmon smolts captured at each trap. Box plots depict 25th, 50th, and 75th percentiles, whiskers depict 10th and 90th percentiles and points indicate outliers.

DISCUSSION

Yield of Smolts and Parr

Estimates of the number if salmonid migrants were difficult this season. Traps could not be safely be fished continuously nor efficiently enough to estimate emigrant fish numbers until week nine of the study. It is unknown how wetter than average spring months effect the timing and magnitude of spring salmonid emigration and therefore difficult to approximate what portion of the yield was estimated. If timing alone of the past two seasons' salmonid emigration is used for comparison, it is likely nearly 50% percent of the coho and 60-90% of steelhead parr and smolts respectively are not represented in this season's abundance estimates or catches.

Age 0+ Captures

The occurrence of young -of-the-year (YOY) coho salmon fry in all of the tributaries indicates successful adult spawning presence in all anadromous reaches. The drastic reduction from the previous year in absolute numbers captured at the LMS trap indicates either decreased survival of eggs or reduced escapement of spawners.

RECOMMENDATIONS

Rainfall records indicate this spring's rainfall patterns although above average, are not entirely uncommon. The inability of our current trapping technique to successfully estimate the number of salmonids recruited to the ocean fishery, severely limits the utility of smolt trap estimates, as produced in this effort, in population dynamics models. We recommend life-long individual PIT tags be used for all smolts captured and marked at the migrant traps. This tagging technique will allow marked fish to be identified throughout the life cycle and mark-recapture experiments to be conducted through adult spawning surveys (See Rept 1a1). In this way, yearly estimates of smolt abundance may be calculated once a cohort has returned to spawn.

In order to understand YOY emigration, smolt yield and environmental conditions, we must continue to estimate adult escapement along with smolt abundance, as well as measure independent variables we hypothesis to affect population response. We recommend habitat related, as well as hydrologic conditions be monitored as well as abundance.

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