U.S. Fish & Wildlife Service

Arcata Fisheries Data Series Report DS 2011-20

Juvenile Salmonid Monitoring On The Mainstem Trinity River At Willow Creek, California, 2008

William Pinnix, Nathan Harris, and Shane Quinn

U.S. Fish and Wildlife Service
Arcata Fish and Wildlife Office
1655 Heindon Road
Arcata, CA 95521
(707) 822-7201

With:
Yurok Tribal Fisheries Program
Box 196 Highway 96, Weitchpec Route
Hoopa, CA 95546
(530) 625-4130

April 2011

Funding for this study was provided by the U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office and the Trinity River Restoration Program.

The Arcata Fish and Wildlife Office Fisheries Program reports its study findings through two publication series. The **Arcata Fisheries Data Series** was established to provide timely dissemination of data to local managers and for inclusion in agency databases. The **Arcata Fisheries Technical Reports** publishes scientific findings from single and multi-year studies that have undergone more extensive peer review and statistical testing. Additionally, some study results are published in a variety of professional fisheries journals.

Key words: Trinity River, downstream migrant trapping, salmon, Chinook Salmon, Coho Salmon, Steelhead, abundance, juvenile salmon, rotary screw trap, emigration timing

The correct citation for this report is:

Pinnix, W.D., N.J. Harris, and S. Quinn. 2011. Juvenile Salmonid Monitoring on the Mainstem Trinity River at Willow Creek, California, 2008. U. S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata Fisheries Data Series Report Number DS 2011-20, Arcata, California.

TABLE OF CONTENTS

page

List of Tables iii

List of Figures iv

List of Appendices v

Introduction 2

Study Area 3

Methods 3
- Trap Operation 3
- Water Flow and Temperature Measurements 5
- Biological Sampling Procedures 6
- Hatchery and Natural Stocks Estimate 7
- Abundance Indices, Emigration Timing and Duration 8
- Migration Rate 9
- Population Estimation 10

Results 11
- Trap Operation 11
- Water Flow and Temperature Measurements 12
- Catch Totals 13
- Fork Lengths 15
- Abundance Indices, Emigration Timing and Duration 18
- Migration Rate 21
- Population Estimate 22

Summary 23
- Sampling Efforts 23
- Salmonid Biological Information 24
- Abundance Indices 24
- Chinook Salmon Population Estimation 25

Acknowledgements 26

Literature Cited 26

Appendices 28

LIST OF TABLES

page

Table 1. Julian week and corresponding first calendar date. 5

Table 2. Period and duration of spring/summer monitoring, and percent of time trapping was conducted during 2008 near Willow Creek (rkm 34), California, operated by the United States Fish and Wildlife Service, Arcata Fish and Wildlife Office and the Yurok Tribal Fisheries Program. Combined value is total number of days sampled with at least one trap. 12

Table 3. Juvenile salmonid catch totals for 2008 at the Trinity River rotary screw traps near Willow Creek (rkm 34), California, operated by the United States Fish and Wildlife Service, Arcata Fish and Wildlife Office and the Yurok Tribal Fisheries Program. Hatchery and natural catches for Chinook Salmon are estimated from coded wire tag expansions; age-1+ fish includes all juveniles 1 year old and older. 13

Table 4. California Department of Fish and Game, Trinity River Hatchery juvenile salmonid releases, 2008. 13

Table 5. Catch totals of non-target fish species captured at the Trinity River rotary screw trap, near Willow Creek (rkm 34), California, 2008. 15

Table 6. Juvenile salmonid abundance indices, Willow Creek trap site, 2008. 18

Table 7. Juvenile salmonid emigration duration and peak, Willow Creek trap site, 2008. Values represent Julian weeks. 18

Table 8. Juvenile salmonid maximum migration rate from Trinity River Hatchery to the rotary screw trap site near Willow Creek (rkm 34), California, operated by the United States Fish and Wildlife Service, Arcata Fish and Wildlife Office and the Yurok Tribal Fisheries Program, 2008. 21

Table 9. Chinook Salmon age-0 season total catch, numbers marked and recaptured, and season-wide marking and recapture rates, Willow Creek trap site, in 2008. 22

LIST OF FIGURES

page

Figure 1. Location of the Trinity River rotary screw trap site near Willow Creek (river kilometer 34), California, operated by the United States Fish and Wildlife Service, Arcata Fish and Wildlife Office and the Yurok Tribal Fisheries Program. 4

Figure 2. Mean daily discharge (ft^3/s) as recorded at Hoopa (HPA), California (US Geological Survey Water Resource gauge station #11-530000) and mean daily water temperature (^oC) during the 2008 sampling season at the Trinity River rotary screw trap site near Willow Creek (rkm 34), California. 12

Figure 3. Weekly mean fork lengths for age-0 (natural and hatchery combined) and natural age-1 Chinook salmon captured at the Trinity River rotary screw traps near Willow Creek (rkm 34), California, 2008. Error bars represent one standard deviation of the mean. 16

Figure 4. Weekly mean fork lengths for natural age-0, natural age-1, and hatchery coho salmon captured at the Trinity River rotary screw traps near Willow Creek (rkm 34), California, 2008. Error bars represent one standard deviation of the mean. 16

Figure 5. Weekly mean fork lengths for natural age-0, natural age-1, natural age-2, and hatchery Steelhead captured at the Trinity River rotary screw traps near Willow Creek (rkm 34), California, 2008. Error bars represent one standard deviation of the mean. 17

Figure 6. Weekly abundance indices for natural age-0 and hatchery age-0 Chinook salmon captured at the Trinity River rotary screw traps near Willow Creek (rkm 34), California, and mean daily discharge (ft^3/s) as recorded at Hoopa, California (US Geological Survey Water Resource streamgage station #11-530000), 2008. Please note differences in scale of axes. 19

Figure 7. Weekly abundance indices for natural age-0, natural age-1, and hatchery age-1 coho salmon captured at the Trinity River rotary screw traps near Willow Creek (rkm 34), California, and mean daily discharge (ft^3/s) as recorded at Hoopa, California (US Geological Survey Water Resource streamgage station #11-530000), 2008. Please note differences in scale of axes. 20

Figure 8. Weekly abundance indices for natural age-0, natural age-1+, and hatchery age-1 Steelhead captured at the Trinity River rotary screw traps near Willow Creek (rkm 34), California, and mean daily discharge (ft^3/s) as recorded at Hoopa, California (US Geological Survey Water Resource streamgage station #11-530000), 2008. Please note differences in scale of axes. 21

Figure 9. Comparison of trapping efficiency between night and day releases of marked juvenile Chinook salmon at the Trinity River rotary screw traps near Willow Creek (rkm 34), California, 2008. 23

LIST OF APPENDICES

page

Appendix 1. Trinity River at Willow Creek weekly Chinook salmon catches and abundance indices, 2008. NC = no clip, AD = adipose fin clip. 29

Appendix 2. Trinity River at Willow Creek weekly coho salmon catches and abundance indices, 2008. R-MAX = right maxillary clip. 30

Appendix 3. Trinity River at Willow Creek weekly Steelhead catches and abundance indices, 2008. AD = adipose fin clip. 31

Appendix 4. Trinity River at Willow Creek weekly Chinook salmon and coho salmon fork lengths, 2008. 32

Appendix 5. Trinity River at Willow Creek weekly Steelhead fork lengths, 2008..... 33

Appendix 6. Trinity River at Willow Creek weekly Chinook salmon population estimates, 2008. 34

Arcata Fisheries Data Series Report DS 2011-20

Juvenile Salmonid Monitoring on the Mainstem Trinity River at Willow Creek, California, 2008

William Pinnix[1], Nathan Harris[2], and Shane Quinn[2]

[1]*U. S. Fish and Wildlife Service, Arcata Fish and Wildlife Office*
1655 Heindon Road, Arcata, California 95521

[2]*Yurok Tribal Fisheries Program*
Box 196 Highway 96, Weitchpec Route
Hoopa, California 95546

Abstract. Juvenile salmonid emigration from the lower mainstem Trinity River has been monitored since 1988 with rotary screw traps used as the primary gear type since 1989. This report describes monitoring conducted in 2008; the traps fished for 155 days of the 170 possible trap days (91.2%) in 2008. Catch data were used to calculate abundance indices for juvenile Chinook Salmon (*Oncorhynchus tshawytscha*), Coho Salmon (*O. kisutch*), and Steelhead (*O. mykiss*), which were used to identify the duration and peak of outmigration. In addition, population estimates of age-0 juvenile Chinook Salmon were derived via an intensive mark-recapture procedure for periods when these could be implemented. The Bayesian time-stratified estimate of natural juvenile Chinook Salmon passing the Willow Creek trap site during the 2008 sampling period was 2,644,527 +/- 159,598 (95% CI) and the hatchery Chinook Salmon estimate was 372,444 +/- 33,699. The estimate of the date at which 80% of the juvenile Chinook Salmon population passed the Willow Creek trap site, as inferred from the flow based abundance index was Julian Week 28 (July 9-12), which met the Trinity River Restoration Program (TRRP) management target date of July 9. The estimate of the date at which 80% of the Steelhead smolt population passed the Willow Creek trap site, as inferred from the flow based abundance index, was Julian Week 21 (May 21), which met the TRRP management target date of May 22. The estimate of the date at which 80% of the natural Coho Salmon smolt population passed the Willow Creek trap site, as inferred brom the flow based abundance index was Julian Week 24 (June 11), which exceeded the TRRP management target date of June 4 by one week. Estimates of juvenile salmonid age, length frequency distributions, migration rates, and hatchery contributions are presented, along with catch data of other fishes.

INTRODUCTION

The Klamath and Trinity rivers once supported large runs of Chinook Salmon (*Oncorhynchus tshawytscha*), Coho Salmon (*O. kisutch*), and Steelhead (*O. mykiss*) that contributed to economically and culturally important tribal, ocean troll, and recreational fisheries. Declines in the Klamath Basin anadromous fish populations due to floods, water and land management, and fish harvest management (Klamath River Basin Fisheries Task Force 1991), led Congress to enact the Trinity River Basin Fish and Wildlife Restoration Act (PL 98-541) in 1984 and the Klamath River Basin Conservation Area Fishery Restoration Program (PL 99-552) in 1986. These Acts directed the Secretary of the Interior to take actions necessary to restore the fishery resources of the Klamath Basin, primarily by addressing restoration of freshwater habitat.

Past fishery investigations in the Basin have focused primarily on adult returns, due to harvest allocation and escapement objectives. Data on adult returns, however, provide an indirect measure of restoration efforts in the Basin because adult return data are affected by ocean mortality (both juveniles entering the ocean, and adult mortality), harvest at sea, and a number of other factors. Monitoring emigrating juvenile salmonid populations in conjunction with habitat availability data and suitability studies may permit for the evaluation of restoration efforts because these studies focus on the freshwater phase, which is directly affected by instream conditions.

Intermittent juvenile salmonid investigations have been conducted in the Klamath River Basin by the U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office since 1981 (USFWS 1982). In 1988, a substantial monitoring effort was undertaken in both the mainstem Klamath and Trinity rivers utilizing frame nets (USFWS 1989) and then rotary screw traps in 1989 (USFWS 1991). The purpose of this project was to monitor the abundance, timing, hatchery contribution, and biological parameters of emigrating anadromous salmonids in the mainstem Klamath and Trinity rivers. The effort on the Trinity River has continued since initiated in 1989 (USFWS 1991, 1992, 1994, 1998, 1999, 2001; Pinnix et al. 2007; Pinnix and Quinn 2008).

Information obtained from the salmonid outmigrant monitoring effort was critical in the development of salmonid outmigrant temperature components of the hydrographs recommended in the Trinity River Flow Evaluation (USFWS and Hoopa Valley Tribe 1999). One component of the restoration strategy employed by the Trinity River Restoration Program is to provide improved thermal regimes for rearing and emigrating juvenile salmonids. This objective is linked to the water temperature objectives for the lower Trinity River (USFWS and Hoopa Valley Tribe 1999, Table 5.11) and the timing of salmonid emigration (USFWS and Hoopa Valley Tribe 1999, Figure 5.46). Water-year specific hydrographs were developed to achieve optimum emigration temperatures throughout the majority of the spring/early summer outmigration period in normal and wetter years and marginal temperatures in dry and critically dry water years (USFWS and Hoopa Valley Tribe 1999, Appendix K). To evaluate the influence of the modified spring hydrographs on the salmonid production, including outmigration timing and the "health" of the outmigrants, the salmonid monitoring program implemented in the lower Trinity River was continued and expanded. Additionally, increases in spawning and

rearing habitat should result in increased production of healthier salmonids, which can be assessed through the information collected by the outmigrant monitoring program.

It is intended that this information will provide basic biological information that can be used by managers to evaluate the effectiveness of habitat restoration efforts, especially the new flow regimes recommended in the Record of Decision (USDOI 2000), in restoring the fishery resources of the Trinity River.

STUDY AREA

The Klamath River is the second largest river system in California, draining about 26,000 square kilometers (km^2) in California, and 14,400 km^2 in Oregon. The Trinity River is the largest tributary to the Klamath River, draining approximately 7,690 km^2 in California. Two dams, Iron Gate Dam on the Klamath River (river kilometer (rkm) 306) and Lewiston Dam on the Trinity River (rkm 144), are the upper limits of anadromous fish migration in the Basin. Two fish hatcheries, Iron Gate Hatchery (IGH) on the Klamath River and Trinity River Hatchery (TRH), were constructed to mitigate for losses of anadromous fish habitat upstream of Iron Gate and Lewiston dams.

Trinity River juvenile salmonid outmigrant trapping was conducted at the Riverdale Campground (rkm 34) near Willow Creek, California (WTC)(Figure 1). This location has been used since 1991 because the channel configuration is fairly consistent from year to year, and it has private access.

METHODS

Trap Operation

Outmigrant sampling was conducted by deploying one to three 2.44 m diameter rotary screw traps at the trapping site. In 2008, the first and second traps were installed on March 13, 2008, and the third trap installed on March 29, 2008. An effort was made to place rotary traps in the river early in the spring so that portions of the Coho Salmon and Steelhead smolt outmigration could be sampled, and prior to the emigration of age-0 Chinook Salmon so that emigration patterns and the relative abundance of natural and hatchery Chinook Salmon could be more fully evaluated.

Traps were anchored with 0.64 cm diameter aircraft cable to a series of steel fence stakes. One or two 0.1 x 0.15 x 6.0 m (4"x6"x10') beams were used to push the trap out from the bank. Cone revolutions were used to determine where and when the trap could be operated without inducing unnecessary risk to the trap. Traps were fished on the edge of the thalweg during high river discharge, and incrementally moved back into the thalweg as river discharge decreased. When deployed, the bottom of the cone was generally <1 m from the stream bottom. A sample day was defined as the time period between the setting of the trap one day and removal of captured fish approximately 24 hours later.

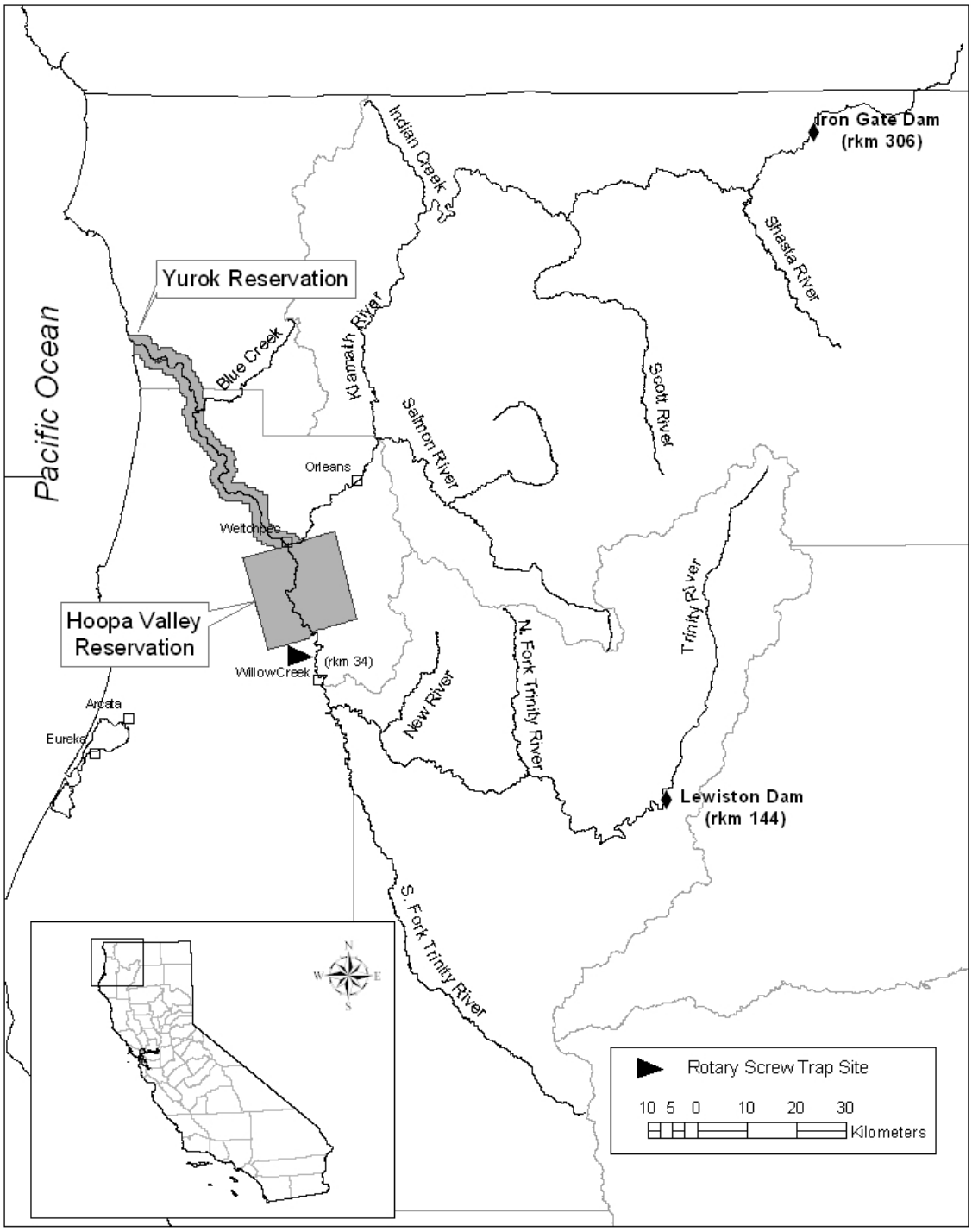

Figure 1. Location of the Trinity River rotary screw trap site near Willow Creek (river kilometer 34), California, operated by the United States Fish and Wildlife Service, Arcata Fish and Wildlife Office and the Yurok Tribal Fisheries Program.

This period encompassed all night hours, when the majority of juvenile salmonids emigrate. Trap checks usually occurred during late morning or early afternoon. During peak emigration periods, fish were removed from traps several times during the sampling day with the frequency dictated by water temperatures, fish numbers, and mortality rates.

Daily trap catch data were summarized by Julian week (JW), with the first day of JW 1 commencing on the first day of the year (Table 1). All JWs are seven days in length except the last JW of the year and the ninth JW during leap years, which are both eight days in length.

Table 1. Julian week and corresponding first calendar date.

Julian Week	Week beginning	Julian Week	Week beginning	Julian Week	Week Beginning
1	1/1	18	4/30	35	8/27
2	1/8	19	5/7	36	9/3
3	1/15	20	5/14	37	9/10
4	1/22	21	5/21	38	9/17
5	1/29	22	5/28	39	9/24
6	2/5	23	6/4	40	10/1
7	2/12	24	6/11	41	10/8
8	2/19	25	6/18	42	10/15
9	2/26	26	6/25	43	10/22
10	3/5	27	7/2	44	10/29
11	3/12	28	7/9	45	11/5
12	3/19	29	7/16	46	11/12
13	3/26	30	7/23	47	11/19
14	4/2	31	7/30	48	11/26
15	4/9	32	8/6	49	12/3
16	4/16	33	8/13	50	12/10
17	4/23	34	8/20	51	12/17
				52	12/24

Water Flow and Temperature Measurements

Normal cone operating depth was 1.07 m. Daily velocity measurements were taken directly in front of the cone as follows: the submerged portion of the cone was divided into three cells (right, center, left); within each cell, velocity was measured at 0.2 and 0.8 of the cone operating depth for 60 seconds using a General Oceanics® digital flowmeter (Model 2030) (General Oceanics, Inc. 1983). Mean water velocity (ft/s) was calculated for each cell. Each cell area (ft^2) was calculated, then multiplied by its corresponding mean water velocity (ft/s). The values for each cell were summed, yielding an estimate of volume of river discharge sampled (Qs) in cubic feet per second (ft^3/s). Discharge data from U.S. Geological Survey Water Resource gauge station at Hoopa (#11-530000 at rkm 19.9) on the Trinity River was used as a surrogate measure of mean daily river discharge (Q) at the trap site.

Water temperature data were collected using an Onset Stow Away Tidbit® temperature logger attached to the outside bottom edge of each trap live box. Water temperature was recorded once per hour for the entire sampling season. Mean daily water temperatures were calculated by averaging over 24-hour periods.

Biological Sampling Procedures

All juvenile fish captured were anesthetized with tricaine methanesulfonate (MS-222) prior to processing. Up to 30 individuals of each species and age class (based on size) were randomly subsampled (biosampled) from the daily catch. Biosampled salmonids were measured to the nearest mm fork length (FL), weighed by digital scale, and examined for external marks (stains, fin clips, tattoos), and physical irregularities. All captured salmonids that were not biosampled were tallied by species, size/age class and examined for external marks.

All anesthetized fish not retained were allowed to resuscitate in buckets of ambient river water before being released downstream of the trap. NovAqua® water conditioner was added to recovery buckets to help protect fish during handling, minimize infection, reduce stress and aid in recovery. Adult salmonids were not anesthetized. Fork lengths of adult salmonids were either measured or approximated before release. Any salmonid mortality in the live box was checked for a fin clip and, if included in the subsample, measured. If a salmonid escaped during netting or handling before it could be identified to species or checked for a hatchery mark (i.e. fin or maxillary clip), it was counted in the sample tally as an "unknown". Based on the probability of occurrence, unknown fish were redistributed into the most likely marked or unmarked species categories.

When present, daily subsamples of marked hatchery Chinook Salmon were collected. A missing adipose fin (ad-clip) was the external marker depicting Chinook Salmon with a coded wire tag (CWT) embedded in the snout. A maximum of five ad-clipped Chinook Salmon from each trap were collected daily and sacrificed for subsequent CWT retrieval. Collected fish were stored in a freezer until time of dissection. Occasionally, ad-clipped fish were also collected for disease sampling, after which the CWT's were removed.

Juvenile Chinook Salmon were classified as age-0 (young-of-year) or age-1, based on size and date of capture. Coho Salmon were classified as either age-0 or age-1; the latter of which were much larger in size, silvery, and lacked distinct parr marks. Steelhead were classified by age based on length-to-age analysis of scales collected from a subsample of Steelhead captured. Analysis of scale samples collected from unmarked Steelhead over the sampling season provided length-to-age relationships. Un-aged Steelhead were assigned an age based on the length-to-age relationship derived from aged samples.

Fish other than Chinook Salmon, Coho Salmon, or Steelhead were considered non-target species. Non-target fishes captured were identified to species (or genus in some cases), enumerated, and up to 30 specimens of each species were measured to FL. Total length (TL) was measured on species without a forked caudal fin.

Hatchery and Natural Stocks Estimate

The catch of Chinook Salmon, Coho Salmon, and Steelhead was partitioned into being either of hatchery or natural origin based on external marks, coded wire tag data, and hatchery marking rates. Hatchery release strategies for Chinook Salmon consist of fingerling (age-0) releases in the spring and yearling (age-1) releases in the fall. These two distinct release periods prompted the division of the trapping season into spring and fall monitoring periods. The spring monitoring period was designated as JW 1 through 39 and the fall period JW 40 through 52 in years when extended sampling was conducted. Hatchery reared Steelhead and Coho Salmon are typically volitionally released as smolts or yearling-plus (age-1) in early spring.

Chinook Salmon

All collected ad-clipped Chinook Salmon were passed through a magnetic field detector manufactured by Northwest Marine Technology® to determine the presence or absence of a CWT. The snout of each fish that registered positive for a tag was dissected until the CWT was recovered. If the tag was not recovered, the fish was considered an ad-clipped fish that had shed its tag. Recovered tags were decoded using a dissection microscope. Coded Wire Tag recoveries were summed by specific CWT code for each JW.

The number of CWT fish captured for each code was estimated by multiplying the number of CWT's recovered by an expansion factor (E) which accounts for all subsampling, CWT's that were lost during dissection, and unreadable tags. The expansion factor (E) was calculated using the formula:

$$E = (C/MS)(AD/H)(T/TR)$$

Where:
- C = Total # of Chinook Salmon captured,
- MS = Number of Chinook Salmon examined for ad-clips,
- AD = Number of ad-clipped Chinook Salmon observed,
- H = Number of ad-clipped Chinook Salmon collected,
- T = Number of collected ad-clipped Chinook Salmon with a CWT,
- TR = Total number of CWT's recovered and decoded after processing.

To account for unmarked hatchery fish in the catch over a JW, the expanded estimates for each CWT code were multiplied by a production multiplier (PM) specific to each CWT code. Each PM was calculated from hatchery release data (Pacific States Marine Fisheries Commission 2008), using the following formula:

$$PM = (\#\ Tagged + \#\ Poor\ Tagged + \#\ Unmarked)/\ \#\ Tagged$$

Where:
- # Tagged = The actual number of ad-clipped Chinook Salmon released with a CWT,
- # Poor Tagged = The number of ad-clipped Chinook Salmon that were tagged and shed the tag (No-Tags),
- # Unmarked = The number of unmarked Chinook Salmon in a release group.

The estimated contribution of hatchery Chinook Salmon attributable to a specific CWT code for a given JW, was calculated by the following formula:

$$\#\ Hatchery_{code(i)} = (\#\ recovered_{code(i)}) * (E_{JW}) * (PM_{code(i)})$$

The total weekly estimated hatchery contribution to the catch was the sum of all daily estimated hatchery Chinook Salmon attributable to CWT codes. The weekly contribution of naturally produced Chinook Salmon to the catch was estimated by subtracting the estimated hatchery contribution from the total weekly catch. Occasionally, the daily estimated hatchery contribution exceeded the total daily catch. In these instances, the estimated hatchery contribution was limited to the actual daily catch.

Towards the end of each emigration period, when catch rates were low, it is possible that juveniles of hatchery origin were captured but not represented by ad-clipped fish. If no hatchery fish captured within a given time period were marked, the hatchery contribution for that period could not be differentiated from the natural component. Thus, all fish captured during that period were considered of natural origin. The hatchery and natural stock estimates assume no differential mortality between tagged and untagged fish of the same release group, equal vulnerability to capture, and accurate estimates of the numbers of marked, unmarked, and poor tagged fish released from the hatchery. The estimate does not account for ad-clipped or non-ad-clipped hatchery fish removed from the river upstream during other juvenile monitoring operations.

Coho Salmon

All hatchery Coho Salmon released from TRH were marked with a right-maxillary clip (max-clip). The weekly contribution of naturally produced Coho Salmon to the catch was estimated by subtracting the catch of marked hatchery fish from the total catch.

Steelhead

All hatchery Steelhead released from TRH were marked with an ad-clip. The weekly contribution of naturally produced Steelhead to the catch was estimated by subtracting the catch of marked hatchery fish from the total catch.

Abundance Indices, Emigration Timing and Duration

A weekly flow-based abundance index for each age class of Chinook Salmon, Coho Salmon, and Steelhead was estimated for each JW based on catch-effort data. Daily abundance indices ($Index_{DC}$) for each species and development stage were calculated by the following equation:

$$Index_{DC} = Catch_{DC} / (Q_C/Q)$$

Where: $Catch_{DC}$ = Sum of daily catch of a species/life stage/age class from all traps

Q_C = Sum of discharge sampled (ft^3/s) by all traps
Q = Mean daily river discharge (ft^3/s) at Hoopa

Weekly abundance indices ($Index_{CJWi}$) were calculated for each JW using the following equation:

$$Index_{CJWi} = \sum Index_{DC} (nt_i/(\sum TD_i)$$

Where: nt_i = Number of days in the JW with at least one trap fishing
TD_i = Sum of the days in the JW

The estimated proportion of hatchery produced fish, based on catches of marked fish and marking rates, were used to apportion the abundance indices into production attributable to hatchery or natural production. The usefulness of this index as an estimator of abundance is contingent upon the assumptions that abundance are directly proportional to the percentage of river flow sampled and that individuals from a given species are equally susceptible to capture. The abundance index is not intended to represent a population estimate, but is used to compare relative abundance between weeks during the trapping season, and between years. The discharge as measured at the Hoopa, California US Geological Survey Water Resource streamgage station #11-530000 is assumed to be a suitable surrogate for flow at the trap site (Pinnix and Quinn, 2008).

Emigration duration is defined as beginning the first Julian week that a particular species and life stage are present in the catch and ending the last Julian week that a particular species is present in the catch. This definition applies strictly to the sampling period, and is potentially longer for species and life stages that are present prior to and after the sampling period. Emigration peaks are defined as the largest weekly abundance index for a particular species and life stage.

Abundance indices are greatly influenced by river discharge and one must use caution in comparing indices within or between years for absolute numbers of fish passing a site. However, abundance indices are generally thought to be adequate indicators of emigration timing and duration if sampling occurred in all weeks of the sampling period and encompasses the temporal duration of the outmigration based on the specific species and life stage.

For each species the date at which 80% of the flow based abundance index had passed the Willow Creek trap site, or 80% emigration date, was calculated. For Chinook Salmon, Coho Salmon, and Steelhead, the 80% emigration date was obtained from the flow based abundance index. The TRRP has chosen target dates for these values of July 9 (JW 28) for Chinook Salmon, May 22 (JW 21) for Steelhead, and June 4 (JW 23)(USFWS and Hoopa Valley Tribe 1999).

Migration Rate

Maximum migration rates for hatchery-produced salmonids were estimated by dividing the distance (rkm) traveled by the number of days elapsed between the initial hatchery

release date and initial capture date for specific CWT codes or marked fish. Due to potential delays in outmigration during volitional releases, mean migration rates were not calculated for volitional release groups. All hatchery releases in 2008 were volitional.

Population Estimation

An intensive mark-recapture sampling technique was employed to generate population estimates for natural and hatchery age-0 Chinook Salmon in 2008. Population estimates were generated using a Bayesian time-stratified spline-based method (Schwarz et al. 2009; hereafter Schwarz method) stratified by Julian week.

In 2008, juvenile Chinook Salmon were obtained from the TRH for the purpose of estimating trap efficiency early in the season when abundance of natural fish was too low to obtain sample sizes needed for accurate calculations of trap efficiency. During previous years, when abundance of natural fish was high enough to conduct mark-recapture estimates, paired mark-recapture efficiency tests were used to compare trap efficiency between natural and hatchery fish. However, in 2008, no comparison of natural vs. hatchery recapture rates was conducted due to low numbers of natural fish.

Population estimates were not calculated for Coho Salmon and Steelhead because too few Steelhead and Coho Salmon were captured to conduct mark-recapture population estimates.

Mark-Recapture Technique

A mark unique to each sampling week was applied to anesthetized individuals utilizing a BMX 1000 POW'R-Jet marking unit with photonic marking formula manufactured by NewWest Technologies®. The mark was made by subcutaneously injecting the photonic solution at the base of various fins specific to the color and fin mark designated for that week. After marking, the fish were allowed to recover in containers filled with river water that was aerated and iced to remain within 1.7°C of ambient river temperatures.

Upon recovery, marked fish were immediately transported upstream 0.4 km by boat and released into a large, still pool to mix with the population that had yet to pass the sampling site. Recaptures were identified and recorded during normal trapping operations, but were not counted as part of the catch for that day.

In the early portion of the sampling season juvenile Chinook Salmon from TRH were obtained for the purpose of estimating trap efficiency during high flows and/or low abundance of naturally producted fish. Fish to be marked and released were netted out of raceways at the TRH and soaked in an aeriated, buffered solution of Bismarck Brown ($0.03\ g\ l^{-1}$) for approximately 1 hour. Marked fish were then transported in bait tanks supplied with oxygen to the trap site. Fish were transported upstream 0.4 km by boat and released into a large, still pool to mix with the population that had yet to pass the sampling site. Recaptures were identified and recorded during normal trapping operations, but were not counted as part of the catch for that day.

Testing of Trap Efficiency Assumptions

As funding permits, evaluations assessing the assumptions utilized in various aspects of implementing mark-recapture trap efficiency estimates are conducted. All comparisons were tested using a paired t-test (Zar 1996).

Comparison of Day and Night Releases. Comparison of trapping efficiency between day and night releases of marked juvenile Chinook Salmon were conducted at the Willow Creek trap site during the spring emigration monitoring period in 2008. Roughly equal size groups of differentially marked juvenile Chinook Salmon were released from the same release site approximately 6 hours apart; day releases at approximately 16:00 and night releases at approximately 22:00.

Comparisons of Different Release Locations. A preliminary evaluation of variation in recapture rates of marked juvenile Chinook Salmon based on the distance between the release point and the traps was conducted in the early summer of 2008 at the Willow Creek trap site. Roughly equal size groups of differentially marked juvenile Chinook Salmon were released at approximately the same time from two separate locations: 1) the usual release point in a pool 0.4 km above the trap site, and 2) another pool one riffle downriver from the usual point approximately 0.25 km above the trap site.

RESULTS

Trap Operation

Trapping duration at the WCT was determined both by river conditions and funding levels. In years when the project was fully funded trapping was generally conducted from early spring (March-April) to late fall (November). In 2008, the project was funded only to operate during the spring/summer emigration period. Spring monitoring at the WCT was conducted from March 13 to August 29, a 170 day period (Table 2). The Willow Creek traps, in combination, were effectively fished for 155 days of the 170 possible trap days (91.2%) during the 2008 monitoring period (Table 2), while individual trap rates ranged from 89.4% to 91.2%. Consistent daily data collection was disrupted (flawed set) intermittently by large woody debris, high flows, and mechanical difficulties, but sampling occurred in each of the Julian weeks during the sampling period.

Table 2. Period and duration of spring/summer monitoring, and percent of time trapping was conducted during 2008 near Willow Creek (rkm 34), California, operated by the United States Fish and Wildlife Service, Arcata Fish and Wildlife Office and the Yurok Tribal Fisheries Program. Combined value is total number of days sampled with at least one trap.

Trap	Start-End dates	Days Trapped	Days possible	Trapping Rate
1	13 Mar – 29 Aug	155	170	91.2%
2	29 Mar – 29 Aug	140	154	90.9%
3	13 Mar – 29 Aug	152	170	89.4%
Combined	13 Mar – 29 Aug	155	170	91.2%

Water Flow and Temperature Measurements

Maximum daily discharge during the 2008 sampling period, as recorded at Hoopa, California US Geological Survey Water Resource gauge station #11-530000, was 10,600 ft^3/s and minimum daily discharge was 643 ft^3/s. Maximum mean daily water temperature during the 2008 sampling period, as recorded at the trap site, was 22.1 ^oC and minimum mean daily water temperature was 7.4 ^oC (Figure 2).

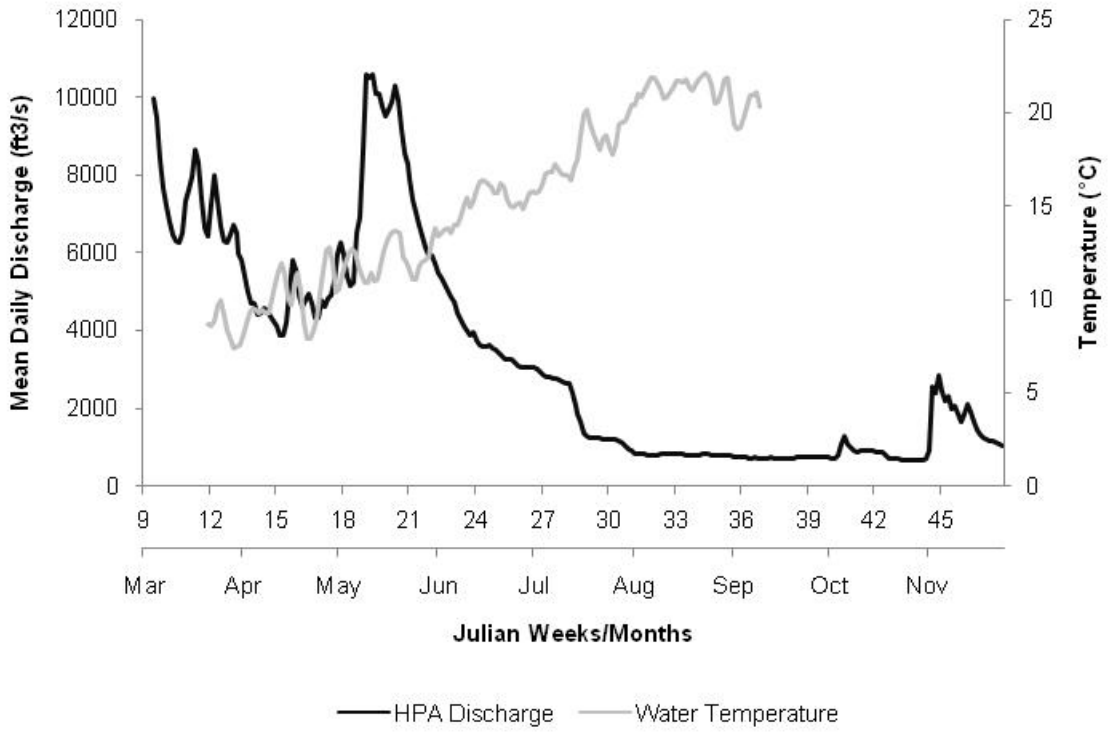

Figure 2. Mean daily discharge (ft^3/s) as recorded at Hoopa (HPA), California (US Geological Survey Water Resource gauge station #11-530000) and mean daily water temperature (^oC) during the 2008 sampling season at the Trinity River rotary screw trap site near Willow Creek (rkm 34), California.

Catch Totals

Chinook Salmon

Catches of Chinook Salmon in 2008 were predominately age-0 natural fish with a catch of 77,994 comprising 85.5% of the total age-0. A total of 13,204 hatchery age-0 fish were captured during the monitoring period, comprising 14.5% of the total catch. Additionally, seven age-1 Chinook Salmon were captured (Table 3, Appendix 1).

Natural age-0 Chinook Salmon were captured throughout the sampling period (mid-March through late August), and the majority of hatchery produced Chinook Salmon were captured from mid-June through early August (Appendix 1). Catches of age-0 Chinook Salmon during the first week of sampling indicate that emigration past the site had already begun, with an unknown number of fish migrating past the trap site prior to the initiation of sampling.

Table 3. Juvenile salmonid catch totals for 2008 at the Trinity River rotary screw traps near Willow Creek (rkm 34), California, operated by the United States Fish and Wildlife Service, Arcata Fish and Wildlife Office and the Yurok Tribal Fisheries Program. Hatchery and natural catches for Chinook Salmon are estimated from coded wire tag expansions; age-1+ fish includes all juveniles 1 year old and older.

Species	Hatchery	Natural Age-0	Natural Age-1+	Total	% Hatchery
Chinook Salmon	13,204	77,994	7	91,205	14.5
Coho Salmon	577	307	190	1,074	53.7
Steelhead	2,042	4,520	1,384	7,946	25.7

Trinity River Hatchery released over 2.5 million age-0 Chinook Salmon (spring- and fall-run) in the spring of 2008, including AD-clipped Coded Wire Tagged groups, representing 24.9% of released Chinook Salmon. The TRH released nearly 1.4 million age-1 Chinook Salmon in the fall of 2008. Fall releases, which occurred after trapping operations were ended, included AD-clipped Coded Wire Tagged groups, representing 24.0% of released Chinook Salmon (Table 4).

Table 4. California Department of Fish and Game, Trinity River Hatchery juvenile salmonid releases, 2008.

Species	Release Season	Number Released	Percentage AD-clipped/Marked	Release Dates
Chinook Salmon	Spring	2,546,833	24.9%	06/02/2008-06/12/2008
Chinook Salmon	Fall	1,391,312	24.0%	10/01/2008-10/14/2008
Coho Salmon	Spring	456,561	100%	03/17/2008-03/25/2008
Steelhead	Spring	772,514	100%	03/17/2008-03/27/2008

Coho Salmon

Catches of Coho Salmon during 2008 were predominately hatchery age-1 fish with a catch of 577, comprising 53.7% of the total catch. A total of 190 natural age-1 and 307 natural age-0 Coho Salmon were captured, comprising 17.7% and 28.6%, respectively, of the total catch (Table 3, Appendix 2).

The majority of age-1 Coho Salmon, both hatchery and naturally produced, were captured from early May through mid-June, though natural age-1 Coho Salmon were present in the catch from the start of trapping until the end of June. Trapping was initiated the week before the release of hatchery produced Coho Salmon, and catches of age-1 hatchery Coho Salmon did not occur until the second week of sampling. The majority of age-0 Coho Salmon were captured from mid-March through mid-July (Appendix 2).

Trinity River Hatchery released over 450,000 yearling Coho Salmon during March, 2008 (Table 4). All hatchery Coho Salmon were marked with a right maxillary clip and an adipose fin clip.

Steelhead

Catches of Steelhead during 2008 were predominately natural age-0 fish, with a catch of 4,520 comprising 56.9% of the total catch. A total of 1,284 natural age-1, 100 natural age-2, and 2,042 hatchery age-1 Steelhead were captured, comprising 16.2%, 1.3%, and 25.7% of the total catch, respectively (Table 3, Appendix 3).

Trapping was initiated the week before the release of hatchery produced Steelhead, and age-1 hatchery Steelhead first appeared during the second week of sampling. The majority of age-1 hatchery Steelhead were captured from late March through mid-June. Natural age-1+ Steelhead were captured throughout the sampling season, but catches were highest from early April through mid-June (Appendix 3). The majority of age-0 Steelhead were captured from mid-May through the end of August.

Trinity River Hatchery released over 770,000 yearling Steelhead during March of 2008 (Table 4). All hatchery Steelhead were marked with an adipose fin clip.

Non-Target Species

Lamprey ammocetes were the most common non-target fish captured during 2008. Other abundant species included suckers, speckled dace, and three-spine stickleback (Table 5).

Table 5. Catch totals of non-target fish species captured at the Trinity River rotary screw trap, near Willow Creek (rkm 34), California, 2008.

Common name	Species	Life stage	Catch(n)
Lamprey	*Entosphenus spp.*	Ammocete	3012
		Adult	175
	Lampetra spp.	Ammocete	12
		Adult	2
	Unknown	Ammocete	38
Sucker	*Catostomus spp.*		1137
Speckled dace	*Rhinichthys osculus*		611
Threespine stickleback	*Gasterosteus aculeatus*		190
Marbled sculpin	*Cottus klamathensis*		76
Golden shiner	*Notemigonus crysoleucas*		42
Coastrange sculpin	*Cottus aleuticus*		29
Prickly sculpin	*Cottus asper*		11
Green sturgeon	*Acipenser medirostris*		10
Brown trout	*Salmo trutta*		8
Sunfish	*Lepomis spp.*		6
Fathead minnow	*Pimephales promelas*		5
Chum salmon	*Oncorhynchus keta*		2
American shad	*Alosa sapidissima*		1
Tadpole frog			1
Crappie	*Pomoxis spp.*		1
Season Total			5368

Fork Lengths

Chinook Salmon

Mean FL of age-0 Chinook Salmon was fairly stable during the beginning of sampling in 2008 (Figure 3, Appendix 4) then increased noticeably in Julian weeks 23-26 with the arrival of hatchery fish. This sudden increase of approximately 10 mm in mean FL was sustained and gradually increased through the end of sampling (Figure 3).

Coho Salmon

Mean FL of age-0 Coho Salmon generally increased over the 2008 sampling season other than a temporary decrease during JW 18-20. Mean FL of natural age-1 Coho Salmon initially increased through April, and then was fairly stable for the remainder of the 2008 sampling season. Mean FL of hatchery age-1 Coho Salmon remained generally stable over the 2008 sampling season, ranging between 142 and 166 mm (Figure 4, Appendix 4).

Steelhead

Mean FL of age-0 Steelhead generally increased over the 2008 sampling season, though some deviations from this trend were seen in JW 20 and 35. Natural age-1 Steelhead mean FL increased to a peak in JW 23 before gradually dropping off, with an anomalous peak in JW 28 due to a small sample size. Natural age-2 fish generally decreased over the 2008 sampling season with some exceptions late in the season due to small sample sizes. Mean FL of hatchery age-1 generally maintained FL averages with a slight reduction through the season (Figure 5, Appendix 5).

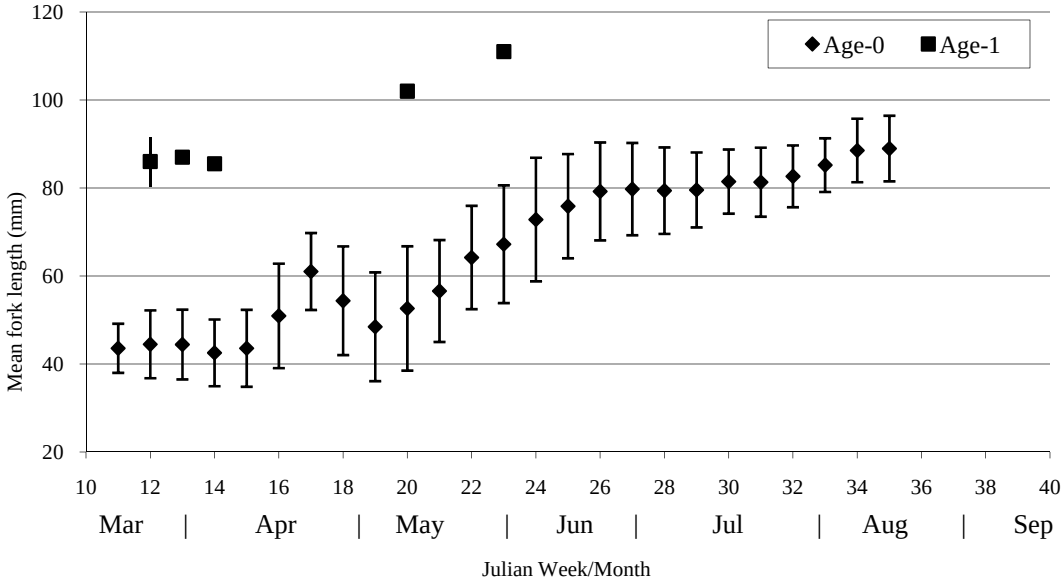

Figure 3. Weekly mean fork lengths for age-0 (natural and hatchery combined) and natural age-1 Chinook Salmon captured at the Trinity River rotary screw traps near Willow Creek (rkm 34), California, 2008. Error bars represent one standard deviation of the mean.

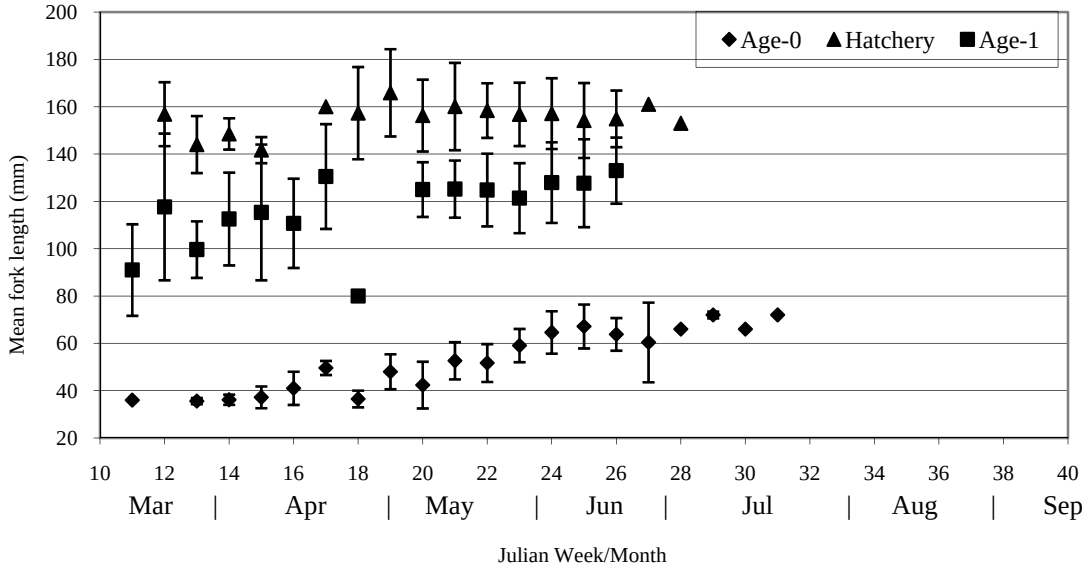

Figure 4. Weekly mean fork lengths for natural age-0, natural age-1, and hatchery Coho Salmon captured at the Trinity River rotary screw traps near Willow Creek (rkm 34), California, 2008. Error bars represent one standard deviation of the mean.

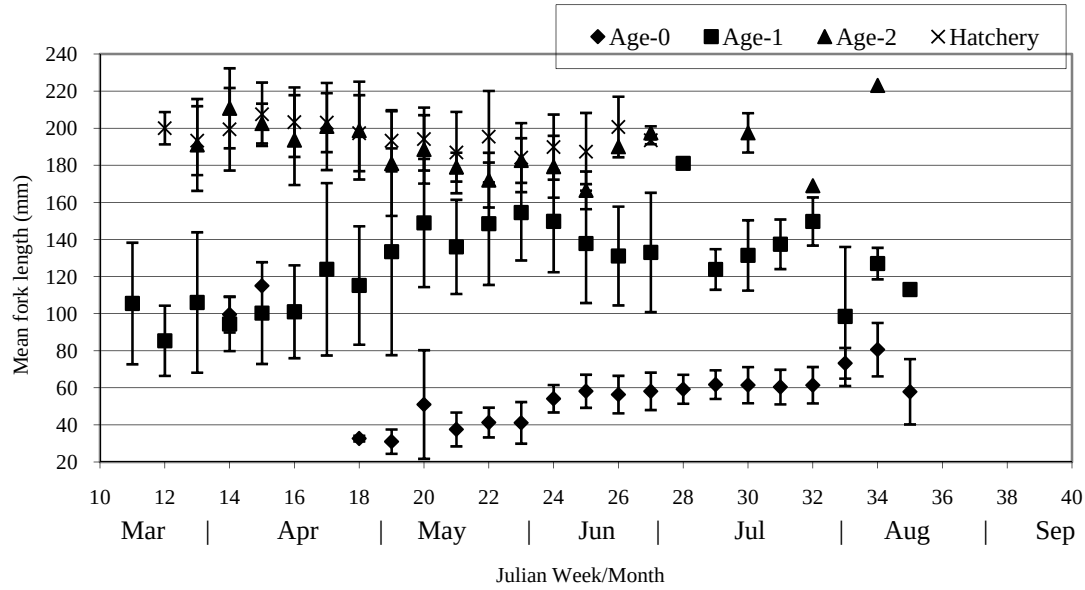

Figure 5. Weekly mean fork lengths for natural age-0, natural age-1, natural age-2, and hatchery Steelhead captured at the Trinity River rotary screw traps near Willow Creek (rkm 34), California, 2008. Error bars represent one standard deviation of the mean.

Abundance Indices, Emigration Timing and Duration

Chinook Salmon

Chinook Salmon were caught the first day trapping occurred, suggesting that juvenile Chinook Salmon were present before traps were installed. The 2008 total abundance index for natural age-0 Chinook Salmon was 909,415 (Table 6). Natural age-0 Chinook Salmon had one general emigration period, peaking JW 25 (Figure 6, Table 7, Appendix 1).

A total of seven natural age-1 Chinook Salmon were captured, so no peak could be determined, and the emigration duration should be interpreted with caution. The 2008 abundance index for natural age-1 Chinook Salmon was 192 (Table 6).

Emigration duration of hatchery age-0 Chinook Salmon was JW 23-35 with peaks in JW 27 and 30 (Table 7). Weekly abundance indices of hatchery age-0 Chinook Salmon picked up quickly following JW 23 when they first appeared, peaking above 20,000 in JW 27 and 30. The 2008 abundance index total for hatchery age-0 Chinook Salmon was 117,077 (Figure 6, Table 6, Appendix 1). The date of the 80% emigration of juvenile Chinook Salmon derived from the flow based abundance index was JW 28.

Table 6. Juvenile salmonid abundance indices, Willow Creek trap site, 2008.

Species	Natural Age-0	Natural Age-1+	Hatchery Age-0	Hatchery Age-1	Total
Chinook Salmon	909,415	192	117,077	N/A	1,026,684
Coho Salmon	5,725	3,394	N/A	19,454	28,573
Steelhead	47,932	25,854	N/A	53,083	126,869

Table 7. Juvenile salmonid emigration duration and peak, Willow Creek trap site, 2008. Values represent Julian weeks.

	Emigration Duration			Emigration Peak		
Species	Natural Age-0	Natural Age-1+	Hatchery	Natural Age-0	Natural Age-1+	Hatchery
Chinook Salmon	11-35	12-23	23-35	25	N/A	27/30*
Coho Salmon	11-31	11-26	12-28	19	20/24*	19
Steelhead	14-35	11-35	12-33	27	16	17/20*

*Multiple Peaks

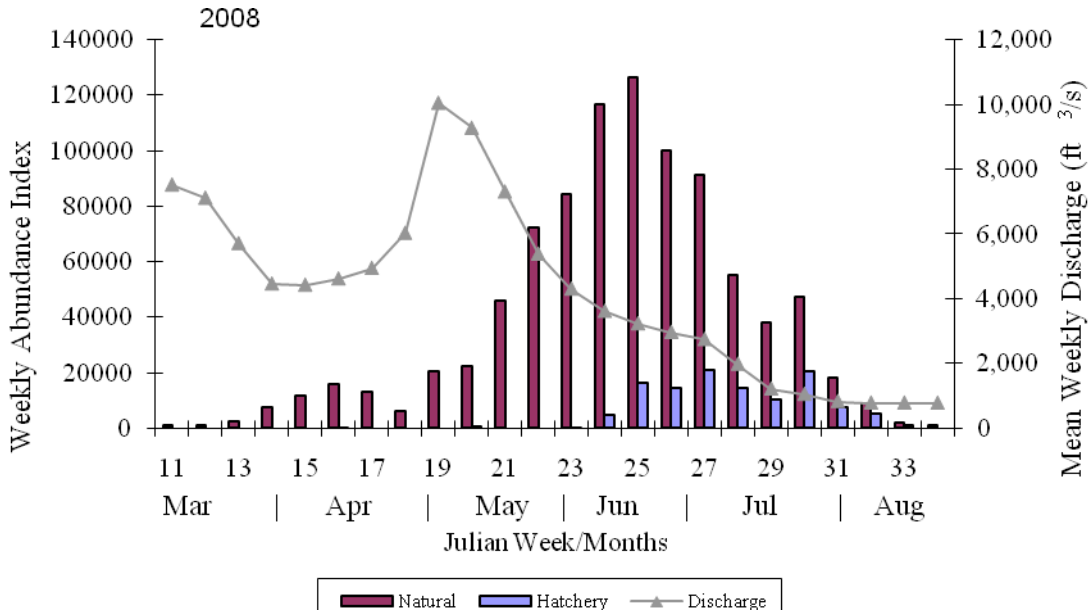

Figure 6. Weekly abundance indices for natural age-0 and hatchery age-0 Chinook Salmon captured at the Trinity River rotary screw traps near Willow Creek (rkm 34), California, and mean daily discharge (ft^3/s) as recorded at Hoopa, California (US Geological Survey Water Resource streamgage station #11-530000), 2008. Please note differences in scale of axes.

Coho Salmon

A single age-0 Coho Salmon was captured the first week of trapping, suggesting that age-0 Coho Salmon were present before traps were installed. The 2008 abundance index total for age-0 Coho Salmon was 5,725 (Table 6, Appendix 2). Natural age-0 Coho Salmon in 2008 had an extended emigration period from JW 11-31, with an abrupt peak in JW 13, followed by weeks of lower abundance before a much higher peak in JW 19 (Table 7, Figure 7, Appendix 2).

Natural age-1 Coho Salmon were caught the first day trapping occurred, suggesting that natural age-1 Coho Salmon were present before traps were installed. The 2008 abundance index for natural age-1 Coho Salmon was 3,394 (Table 6, Appendix 2). Emigration duration for natural age-1 Coho Salmon was JW 11-26 with an isolated peak in JW 13, and two higher peaks in JW 20 and 24 (Table 7, Figure 7, Appendix 2). The date of the 80% emigration of juvenile Coho Salmon smolts derived from the flow based abundance index was JW 24.

Hatchery age-1 Coho Salmon were not caught until the second week of trapping, suggesting that the hatchery age-1 Coho Salmon emigration period was adequately sampled. The 2008 abundance index total for hatchery age-1 Coho Salmon was 19,454 (Table 6). Emigration duration for hatchery age-1 Coho Salmon was JW 12-28 with two distinct emigration periods one from JW 12-15 peaking JW 12, and another from JW 17-28 peaking JW 19 (Figure 7, Table 7, Appendix 2).

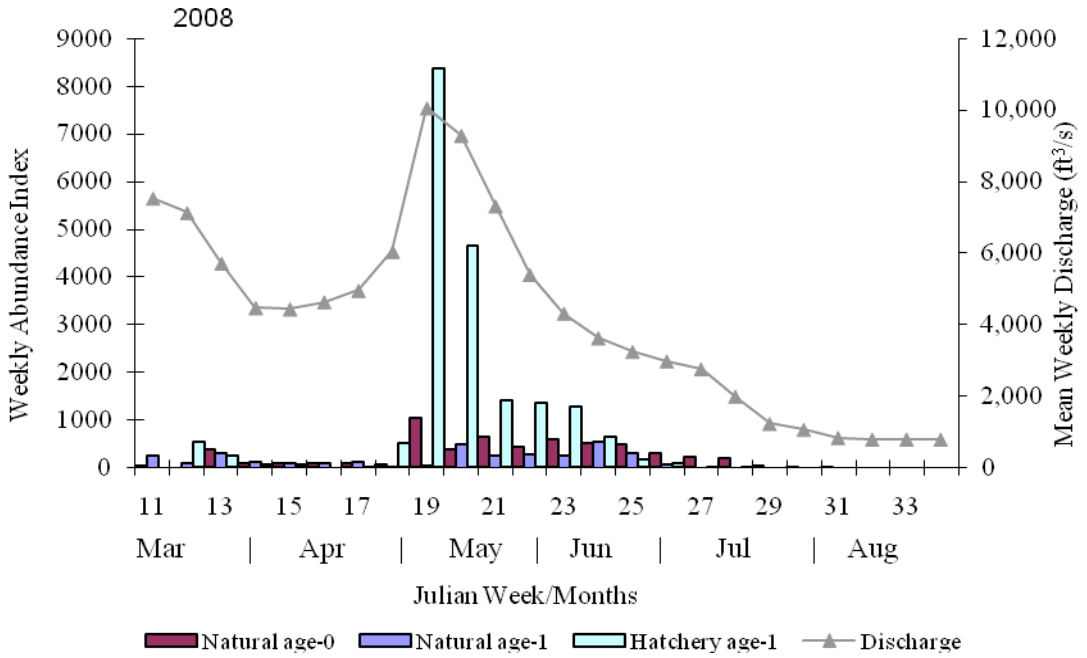

Figure 7. Weekly abundance indices for natural age-0, natural age-1, and hatchery age-1 Coho Salmon captured at the Trinity River rotary screw traps near Willow Creek (rkm 34), California, and mean daily discharge (ft^3/s) as recorded at Hoopa, California (US Geological Survey Water Resource streamgage station #11-530000), 2008. Please note differences in scale of axes.

Steelhead

Age-0 steelhead were not caught until the fourth week of trapping, suggesting that the initiation of their emigration period was adequately sampled. The 2008 abundance index total for age-0 steelhead was 47,932 (Table 6). A small number of age-0 steelhead appeared in JW 14 and 15, followed by zero captured in JW 16 and 17, prior to a sustained emigration during JW 18-35 peaking JW 27 (Table 7, Appendix 3). Age-0 steelhead had one emigration period (Figure 8), however, like age-0 Coho Salmon, age-0 steelhead are redistributing throughout the river for extended rearing.

Natural age-1+ steelhead were caught the first week trapping occurred, suggesting that natural age-1+ steelhead were present before traps were installed. The 2008 spring emigration abundance index total for natural age-1+ steelhead was 25,854. Natural age-1+ steelhead had one distinct emigration period (JW 11-35) peaking in JW 16 (Figure 8, Table 7, Appendix 3). The date of the 80% emigration of juvenile Steelhead smolts derived from the flow based abundance index was JW 21.

Hatchery age-1+ steelhead were not caught until the second week of trapping, suggesting that their emigration was adequately sampled. The 2008 spring emigration abundance index total for hatchery age-1+ steelhead was 53,083. The emigration duration of natural age-1+ steelhead had one distinct period (JW 12-33) with multiple peaks in JW 17 and 20 (Figure 8, Table 7, Appendix 3).

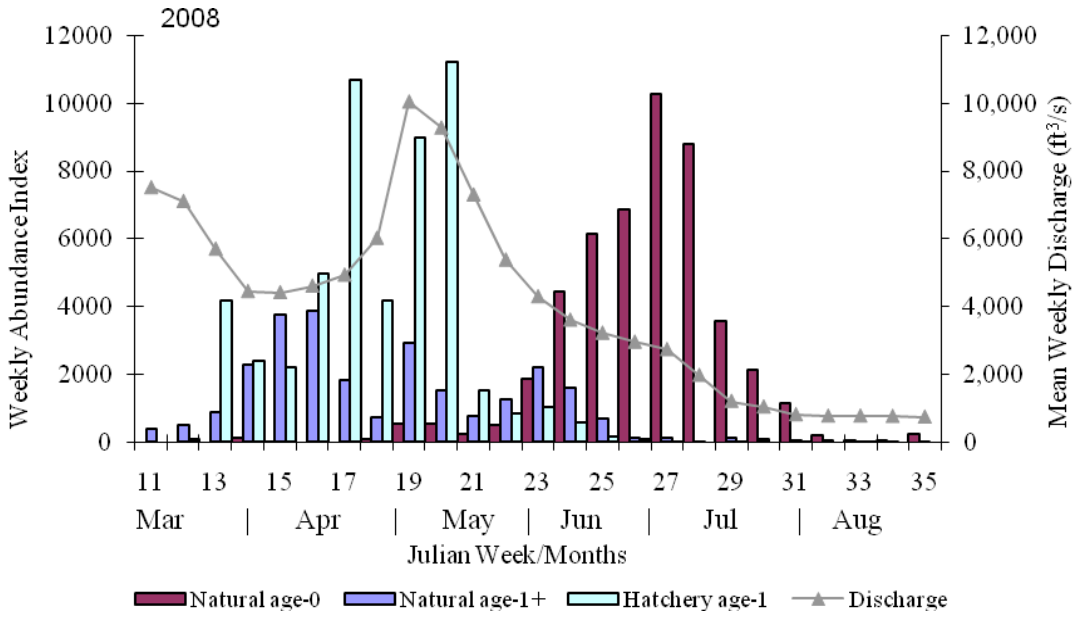

Figure 8. Weekly abundance indices for natural age-0, natural age-1+, and hatchery age-1 steelhead captured at the Trinity River rotary screw traps near Willow Creek (rkm 34), California, and mean daily discharge (ft^3/s) as recorded at Hoopa, California (US Geological Survey Water Resource streamgage station #11-530000), 2008. Please note differences in scale of axes.

Migration Rate

Chinook Salmon

Juvenile Chinook Salmon were released from TRH on June 2, 2008, and first captured at the trap site on June 8, 2008. The initial/maximum migration rate for hatchery Chinook Salmon calculated from the initial release date and first ad-clip captured was 24.0 rkm/day (Table 8).

Table 8. Juvenile salmonid maximum migration rate from Trinity River Hatchery to the rotary screw trap site near Willow Creek (rkm 34), California, operated by the United States Fish and Wildlife Service, Arcata Fish and Wildlife Office and the Yurok Tribal Fisheries Program, 2008.

Species	Date First Released	Date First Captured	# of Days	Maximum Migration Rate
Chinook Salmon	6/02/2008	6/08/2008	6	24.0 rkm/day
Coho Salmon	3/17/2008	3/21/2008	4	36.0 rkm/day
steelhead	3/17/2008	3/22/2008	5	28.8 rkm/day

Coho Salmon

Coho Salmon yearlings released from TRH on March 17, 2008, were first captured at the trap site on March 21, 2008. The migration rate calculated from the initial release date and first max-clip captured was 36.0 rkm/day (Table 8).

Steelhead

Steelhead yearlings released from TRH on March 17, 2008, were first captured at the trap site on March 22, 2008. The migration rate calculated from the initial release date and first ad-clip captured was 28.8 rkm/day (Table 8).

Population Estimate

Only age-0 Chinook Salmon were captured in quantities sufficient for conducting mark-recapture population estimates. Mark-recapture tests in 2008 were conducted during JW 19 and 20, and from JW 22 to JW 27. Season-wide marking rate was 17.0% (Table 9) with nearly 17,000 trap caught fish marked, and the recapture rate was 2.41% with 407 recaptures. The natural age-0 Chinook Salmon population estimate using the Schwarz method was 2,644,527+/- 159,598 (Appendix 6). The hatchery age-0 Chinook Salmon population estimate using the Schwarz method was 372,444 +/- 33,699 (Appendix 6).

Table 9. Chinook Salmon age-0 season total catch, numbers marked and recaptured, and season-wide marking and recapture rates, Willow Creek trap site, in 2008.

Catch	# Marked	Marking Rate	# Recaps	Recapture Rate
99,205	16,890	17.0%	407	2.41%

Testing of Trap Efficiency Assumptions

Comparison of Day and Night Releases. Comparison of trapping efficiency between day and night releases of marked juvenile Chinook Salmon indicated that night releases achieved significantly higher trap efficiencies ($p = 0.015$, $df = 2$, paired t-test), ranging from 1.02% to 3.28%, while day releases ranged from 0.55% to 2.64%. However, the efficiency of day and night releases were positively correlated ($r = 0.993$, $p = 0.018$; Figure 9).

Comparison of Close and Far Release sites. Comparison of trapping efficiency between a close and far (historic release location) release site showed no significant ($p = 0.375$, $df = 1$, paried t-test) difference in trapping efficiency depending on release site. Efficiency for close releases ranged from 1.8% to 4.4% and far releases ranged from 3.5% to 3.7%.

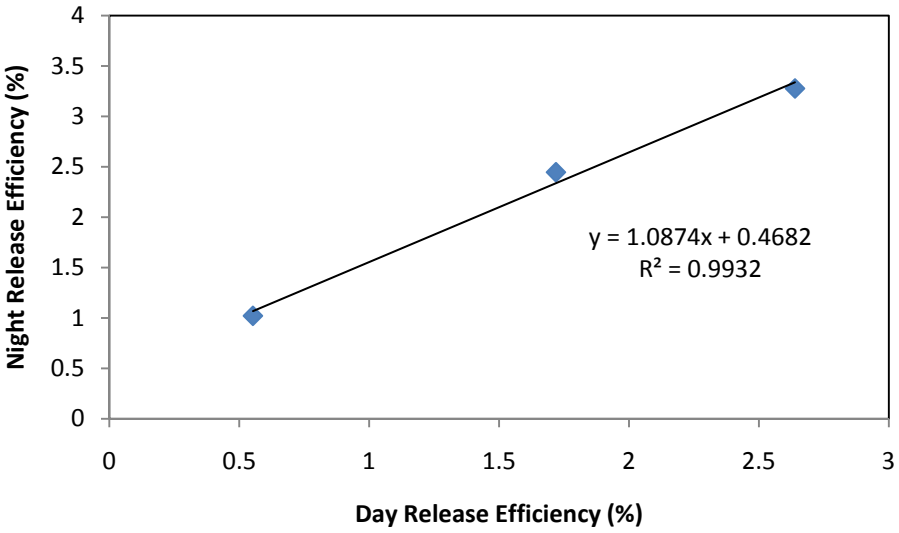

Figure 9. Comparison of trapping efficiency between night and day releases of marked juvenile Chinook Salmon at the Trinity River rotary screw traps near Willow Creek (rkm 34), California, 2008.

SUMMARY

Juvenile salmonid emigration from the mainstem Trinity River has been monitored at the Willow Creek site since 1989 with rotary screw traps. This data series report summarizes the outmigrant monitoring data collected in 2008 cooperatively by the Arcata Fish and Wildlife Office and Yurok Tribal Fisheries Program. It is intended that this information will provide basic biological information that can be used by managers to evaluate the effectiveness of habitat restoration efforts, especially the new flow regimes recommended in the Record of Decision, in restoring the fishery resources of the Trinity River.

Sampling Efforts

The utilization of multiple traps beginning in 2002 has improved the ability to generate population estimates due to greater capture efficiency at the site and prevents the loss of catch data for a day if one trap has a flawed set, typically due to being clogged with debris. It is recommended that multiple traps continue to be utilized at the lower Trinity River trap site. While trapping operations have been refined to operate the traps at higher flows (>12,000 ft^3/s), high and highly variable flows during the beginning of the trapping seasons create challenges in maintaining effective sampling.

Trapping was initiated in the second week of March to ensure that the early emigration peaks of natural Chinook Salmon, hatchery and natural Coho Salmon, and steelhead smolt were sufficiently sampled. It is important to initiate sampling as early as possible and continue as late as possible so that comparable data, especially similar time periods, are collected to allow between year comparisons in emigration timing (duration and peak)

and abundance. Additionally, it is important to point out that sampling a portion of the year (i.e. the spring/summer season), samples only a portion of the production and all estimates of production refer only to the sampling period.

Salmonid Biological Information

The Chinook Salmon population in the Trinity River is composed of both naturally produced and hatchery populations. The vast majority of juveniles during the spring/summer emigration period emigrate as age-0 fish, with the natural and hatchery emigration periods overlapping. Chinook Salmon were captured throughout the 2008 sampling season with the spring/summer emigration dominated by naturally produced fish comprising 88.6% based on abundance indices. By the final sampling week at the end of August only 100 Chinook Salmon were captured, the lowest total since mid-March.

The Coho Salmon population in the Trinity River is composed of both naturally produced and hatchery populations. The vast majority of Coho Salmon emigrate to the ocean as age-1 smolts while the emigration of age-0 fish is presumably a redistribution of rearing juveniles. Natural and hatchery produced age-1 Coho Salmon emigrated through the lower Trinity River beginning in mid-March through early July. Emigration of natural age-1 Coho Salmon may have occurred earlier but trapping was initiated in mid-March. Based on abundance indices, the age-1 Coho Salmon emigration is composed primarily of hatchery produced fish, comprising 68.1% of the total index in 2008.

The steelhead population in the Trinity River is composed of both tributary and mainstem spawning and rearing populations that exhibit highly variable juvenile life history patterns as well as a hatchery produced component. Steelhead were generally captured throughout the sampling season. Peaks in abundance occurred during the early portion of sampling effort, except for natural age-0 fish, which peaked during JW 27. The majority of age-1 or older natural steelhead emigrated by the end of June but maintained some presence in the catch to the middle of August, and natural age-1 fish persisted to the end of sampling. The majority of hatchery produced age-1 steelhead emigrated by the end of June. Steelhead mean length data was highly variable, most likely due to the various populations and races being sampled at the Willow Creek trapping site. Based on abundance indices, the age-1+ steelhead emigration is composed of more hatchery produced fish (41.8%) compared to naturally produced fish (20.4%).

Abundance Indices

The total spring season 2008 abundance index for age-0 natural, age-1 natural, and age-0 hatchery Chinook Salmon, age-0 and age-1 natural Coho Salmon, and all ages of natural and hatchery steelhead were within the range of values calculated since 1992 over comparable time periods (Table 6; USFWS 1992, 1994, 1998, 1999, 2001; Pinnix et al. 2007; Pinnix and Quinn 2008). Since natural age-0 Chinook Salmon were captured on the first day of trap operation in 2008, it is possible that a portion of the early spring natural age-0 Chinook Salmon emigrated prior to trap installation, leading to a slightly

lower abundance index. However, the first week's catch of nineteen fish was the lowest of all sampling weeks in actual catch, and the second lowest of all abundance indices.

Chinook Salmon Population Estimation

Since 2002, intensive mark-recapture efforts to estimate the size of the emigrating Chinook Salmon population, as well as estimate the precision of these estimates, were incorporated into trapping operations. Previous efforts to implement mark-recapture techniques into the trapping efforts were limited due to lack of sufficient funding. Abundance indices based on catches and the proportion of flow sampled by the trap(s) have been the quantification method employed for many years (USFWS 1991, 1994, 1995, 1998, 1999, and 2001) and are generally thought to be adequate indicators of emigration timing and duration if sampling occurred in all weeks of the sampling period. A shortcoming of the abundance indices is that they do not provide a measure of the accuracy of the indices and make inter-year comparisons questionable. Mark-recapture efforts employed since 2002 (Pinnix et al. 2007; Pinnix and Quinn 2008) indicate that precise population estimates can be obtained (95% confidence intervals ranging from +/- 8.9% to 54.9% of the estimate) depending on the proportion of the population marked (marking rate), and capture efficiency (recapture rate).

Low catches of Chinook Salmon early in the sampling season of 2008 precluded conducting mark-recapture efforts on natural age-0 Chinook Salmon during these periods, therefore the generated estimates only represent times when mark-recapture efforts were conducted. During the 2008 sampling season, marked hatchery Chinook Salmon were released to estimate capture efficiency early in the season. Utilizing the analysis tools developed for the TRRP and described in Schwarz et al. 2009 has greatly improved the ability to glean information from the population estimates. Not only are separate estimates for natural and hatchery fish generated, but many products are produced that allow interpretation of the precision and quality of the population estimates.

It appears that time of day can affect trap efficiency at the Willow Creek trap site, but in the 2008 effort the sample size was low, suggesting increased effort may yield a different result. In addition, the day releases were made during the late afternoon, not during morning hours, and it is unknown what effect earlier release might have on the relationship. It is recommended that the relationship between release times be investigated in future years. No significant difference in efficiency were detected based on release location, although the sample size was low (n=2). Future efforts will continue to test this aspect of the mark-recapture techniques.

ACKNOWLEDGEMENTS

Special thanks to Al Andreoli, for allowing access through his property at the Trinity River trap site.

The U.S. Fish and Wildlife Service and Yurok Tribe Fisheries Program acknowledges the following persons integral to the efforts of this project: Michael Long, Randy Brown, Nicholas Hetrick, Joe Polos, Mike Cunanan, Tim Hayden, and Dave Hillemeyer.

We also appreciate the contributions of the following individuals who worked as crew members on this project: Hank Alameda, Jeremy Alameda, Anthony Heacock, Anthony Scheiff, Aaron Johnson, and Tim Ulrich.

LITERATURE CITED

General Oceanics, Inc. 1983. Digital Flowmeter Manual. General Oceanics, Inc. Miami, FL. 13pp.

Klamath River Basin Fisheries Task Force. 1991. Long Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program. USFWS. Yreka, CA.

Pacific States Marine Fisheries Commission. 2008. Pacific salmonid coded wire tag release database. Regional Mark Processing Center, PSFMC. Gladstone, OR. http://www.rmpc.org (Dec. 2008)

Pinnix, W, J. Polos, A. Scheiff, S. Quinn, and T. Hayden. 2007. Juvenile Salmonid Monitoring on the Mainstem Trinity River at Willow Creek, California, 2001 - 2005. U. S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata Fisheries Data Series Report Number DS 2007-09, Arcata, California.

Pinnix, W.J., and S. Quinn. 2008. Juvenile Salmonid Monitoring on the Mainstem Trinity River at Willow Creek, California, 2006-2007. U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata Fisheries Data Series Report Number DS 2008-XX, Arcata, California.

Schwarz, C.J., D. Pickard, K. Marine and S.J. Bonner. 2009. Juvenile Salmonid Outmigrant Monitoring Evaluation, Phase II– December 2009. Final Technical Memorandum for the Trinity River Restoration Program, Weaverville, CA. 155 pp. + appendices.

USDOI (U.S. Department of the Interior). 2000. U.S. Department of the Interior (DOI). 2000. Record of Decision. Trinity River Mainstem Fishery Restoration Final Environmental Impact Statement/Environmental Impact Report. December 2000. 43pp.

USFWS (U.S. Fish and Wildlife Service). 1982. Annual Report of the Klamath River Fisheries Investigation Program, 1981. Fisheries Assistance Office. Arcata, CA. 131 pp.

USFWS (U.S. Fish and Wildlife Service). 1989. Juvenile Salmonid Production Monitoring. Annual Report of the Klamath River Fisheries Assessment Program, 1988. Fisheries Assistance Office, Arcata, CA. 25 pp.

USFWS (U.S. Fish and Wildlife Service). 1991. Klamath River Basin Juvenile Salmonid Fisheries Investigation. Annual Report of the Klamath River Fisheries Assessment Program, 1989. Coastal California Fishery Resource Office. Arcata, CA. 81 pp.

USFWS (U.S. Fish and Wildlife Service). 1992. Juvenile Salmonid Trapping on the Mainstem Trinity River at Willow Creek and the Klamath River at Big Bar. Annual Report of the Klamath River Fisheries Assessment Program, 1990. Coastal California Fishery Resource Office. Arcata, CA. 50 pp.

USFWS (U.S. Fish and Wildlife Service). 1994. Juvenile Salmonid Trapping on the Trinity and Klamath Rivers. Annual Report of the Klamath River Fisheries Assessment Program, 1991. Coastal California Fishery Resource Office. Arcata, CA. 58 pp.

USFWS (U.S. Fish and Wildlife Service). 1998. Juvenile salmonid monitoring on the mainstem Klamath River at Big Bar and mainstem Trinity River at Willow Creek, 1992-1995. Annual Report of the Klamath River Fisheries Assessment Program, 1992-95. Coastal California Fish and Wildlife Office. Arcata, CA. 97 pp.

USFWS (U.S. Fish and Wildlife Service). 1999. Juvenile salmonid monitoring on the mainstem Klamath River at Big Bar and mainstem Trinity River at Willow Creek, 1996. Annual Report of the Klamath River Fisheries Assessment Program. 1996. Coastal California Fish and Wildlife Office. Arcata, CA. 69 pp.

USFWS (U.S. Fish and Wildlife Service) and Hoopa Valley Tribe. 1999. Trinity River Flow Evaluation Study. Final Report. U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata CA and Hoopa Valley Tribe, Hoopa, CA. 513 pp.

USFWS (U.S. Fish and Wildlife Service). 2001. Juvenile salmonid monitoring on the mainstem Klamath River at Big Bar and mainstem Trinity River at Willow Creek, 1997-2000. Annual Report of the Klamath River Fisheries Assessment Program. 1997-2000. Arcata Fish and Wildlife Office. Arcata, CA. 55 pp.

Zar, J.H. 1996. Biostatistical Analysis. Prentice-Hall, Inc. 3rd edition. Upper Saddle River, New Jersey

APPENDICES

Appendix 1. Trinity River at Willow Creek weekly Chinook Salmon catches and abundance indices, 2008. NC = no clip, AD = adipose fin clip. Trap days sampled is the sum of the number of traps fishing by day (i.e. 3 traps x 7 days = 21 trap days).

		Mean	Trap	Weekly Chinook Catch					Weekly Chinook Index Totals				
Week	Julian	Daily	Days	Hatchery		Natural		Catch	Hatchery		Natural		Index
Starting	Week	Discharge	Sampled	NC	AD	Age-0	Age-1	Total	NC	AD	Age-0	Age-1	Total
03/12/08	11	7,530	10	0	0	19	0	19	0	0	928	0	928
03/19/08	12	7,125	14	0	0	27	2	29	0	0	833	60	893
03/26/08	13	5,715	18	0	0	130	1	131	0	0	2214	15	2,229
04/02/08	14	4,465	21	0	0	523	2	525	0	0	7417	28	7,445
04/09/08	15	4,430	15	0	0	595	0	595	0	0	11438	0	11,438
04/16/08	16	4,625	21	3	1	1,062	0	1,066	46	15	15813	0	15,874
04/23/08	17	4,950	15	0	0	548	0	548	0	0	13168	0	13,168
04/30/08	18	6,035	11	0	0	231	0	231	0	0	6147	0	6,147
05/07/08	19	10,060	14	0	0	230	0	230	0	0	20604	0	20,604
05/14/08	20	9,290	20	21	7	513	1	542	563	188	22373	74	23,198
05/21/08	21	7,315	12	0	0	1,270	0	1,270	0	0	45810	0	45,810
05/28/08	22	5,395	21	0	0	4,446	0	4,446	0	0	72399	0	72,399
06/04/08	23	4,310	21	12	4	6,080	1	6,097	157	52	84213	15	84,437
06/11/08	24	3,620	21	282	94	9,885	0	10,261	3,381	1,127	116773	0	121,281
06/18/08	25	3,235	21	1,098	366	11,623	0	13,087	12,122	4,041	126722	0	142,885
06/25/08	26	2,970	21	1,014	338	9,673	0	11,025	10,847	3,616	100072	0	114,535
07/02/08	27	2,750	18	1,290	430	7,802	0	9,522	15,560	5,187	91454	0	112,201
07/09/08	28	1,985	18	885	295	4,868	0	6,048	10,830	3,610	55333	0	69,773
07/16/08	29	1,220	21	1,179	393	5,931	0	7,503	7,637	2,546	37798	0	47,981
07/23/08	30	1,054	21	2,280	760	7,120	0	10,160	15,490	5,164	47283	0	67,937
07/30/08	31	829	21	1,017	339	3,314	0	4,670	5,695	1,898	18102	0	25,695
08/06/08	32	782	21	570	190	1,490	0	2,250	3,870	1,290	8711	0	13,871
08/13/08	33	784	21	159	53	316	0	528	877	293	1674	0	2,844
08/20/08	34	777	21	72	24	226	0	322	376	125	1142	0	1,643
08/27/08	35	754	9	21	7	72	0	100	355	119	994	0	1,468
Total			447	9,903	3,301	77,994	7	91,205	87,806	29,271	909,415	192	1,026,684

Appendix 2. Trinity River at Willow Creek weekly Coho Salmon catches and abundance indices, 2008. R-MAX = right maxillary clip.

Week Starting	Julian Week	Man Daily Discharge	Trap Days Sampled	Weekly coho catches				Weekly coho indices			
				Hatchery	Natural		Catch	Hatchery	Natural		Index
				R-MAX	Age-0	Age-1	Total	R-MAX	Age-0	Age-1	Total
03/12/08	11	7,530	10	0	1	4	5	0	42	258	300
03/19/08	12	7,125	14	19	0	3	22	546	0	89	635
03/26/08	13	5,715	18	13	20	19	52	262	384	321	967
04/02/08	14	4,465	21	4	6	9	19	57	87	134	278
04/09/08	15	4,430	15	3	5	5	13	60	98	97	255
04/16/08	16	4,625	21	0	6	7	13	0	87	104	191
04/23/08	17	4,950	15	1	5	4	10	18	95	120	233
04/30/08	18	6,035	11	15	2	1	18	522	63	22	607
05/07/08	19	10,060	14	105	12	1	118	8,376	1,043	46	9,465
05/14/08	20	9,290	20	122	10	14	146	4,641	382	500	5,523
05/21/08	21	7,315	12	38	18	7	63	1,397	641	252	2,290
05/28/08	22	5,395	21	85	27	17	129	1,367	441	273	2,081
06/04/08	23	4,310	21	91	42	19	152	1,278	593	264	2,135
06/11/08	24	3,620	21	55	42	46	143	648	504	541	1,693
06/18/08	25	3,235	21	15	44	28	87	164	490	310	964
06/25/08	26	2,970	21	9	28	6	43	94	292	63	449
07/02/08	27	2,750	18	1	19	0	20	12	223	0	235
07/09/08	28	1,985	18	1	10	0	7	12	193	0	205
07/16/08	29	1,220	21	0	5	0	5	0	35	0	35
07/23/08	30	1,054	21	0	3	0	3	0	22	0	22
07/30/08	31	829	21	0	2	0	2	0	10	0	10
08/06/08	32	782	21	0	0	0	0	0	0	0	0
08/13/08	33	784	21	0	0	0	0	0	0	0	0
08/20/08	34	777	21	0	0	0	0	0	0	0	0
08/27/08	35	754	9	0	0	0	0	0	0	0	0
Total			447	577	307	190	1,074	19,454	5,725	3,394	28,573

Appendix 3. Trinity River at Willow Creek weekly steelhead catches and abundance indices, 2008. AD = adipose fin clip.

		Man	Trap	Steelhead Weekly Catch					Steelhead Weekly Abundance Indices				
Week	Julian	Daily	Days	Hatchery		Natural		Catch	Hatchery		Natural		Index
Starting	Week	Discharge	Sampled	AD	Age-0	Age-1	Age-2+	Total	AD	Age-0	Age-1	Age-2+	Total
03/12/08	11	7,530	10	0	0	6	6	12	0	0	371	0	371
03/19/08	12	7,125	14	3	0	16	0	19	90	0	500	0	590
03/26/08	13	5,715	18	229	0	48	3	280	4,155	0	829	46	5,030
04/02/08	14	4,465	21	166	8	155	8	337	2,387	117	2,182	114	4,800
04/09/08	15	4,430	15	112	1	189	4	306	2,194	20	3,657	80	5,951
04/16/08	16	4,625	21	321	0	244	10	575	4,979	0	3,690	163	8,832
04/23/08	17	4,950	15	398	0	40	15	453	10,686	0	1,438	406	12,530
04/30/08	18	6,035	11	133	3	18	7	161	4,179	112	508	220	5,019
05/07/08	19	10,060	14	131	6	24	13	174	8,954	545	1,842	1,088	12,429
05/14/08	20	9,290	20	306	21	33	12	372	11,208	540	1,169	367	13,284
05/21/08	21	7,315	12	42	7	17	4	70	1,524	245	613	151	2,533
05/28/08	22	5,395	21	52	34	75	3	164	840	524	1,211	49	2,624
06/04/08	23	4,310	21	72	138	152	5	367	1,022	1,890	2,140	74	5,126
06/11/08	24	3,620	21	49	376	131	4	560	580	4,454	1,552	47	6,633
06/18/08	25	3,235	21	15	561	58	4	638	167	6,143	657	41	7,008
06/25/08	26	2,970	21	7	660	11	1	679	73	6,861	117	10	7,061
07/02/08	27	2,750	18	2	867	9	2	880	23	10,253	105	25	10,406
07/09/08	28	1,985	18	0	687	2	0	689	0	8,804	19	0	8,823
07/16/08	29	1,220	21	1	549	22	0	572	7	3,583	141	0	3,731
07/23/08	30	1,054	21	0	323	10	4	337	0	2,143	66	14	2,223
07/30/08	31	829	21	1	212	8	0	221	5	1,162	43	0	1,210
08/06/08	32	782	21	0	32	9	1	42	0	198	49	5	252
08/13/08	33	784	21	2	12	2	0	16	10	63	11	0	84
08/20/08	34	777	21	0	9	3	1	13	0	46	16	5	67
08/27/08	35	754	9	0	14	2	0	16	0	229	23	0	252
Total			447	2,042	4,520	1,284	100	7,946	53,083	47,932	22,949	2,905	126,869

Appendix 4. Trinity River at Willow Creek weekly Chinook Salmon and Coho Salmon fork lengths, 2008.

		Chinook*										Natural coho										Hatchery coho				
Week	Julian	Age-0					Age-1					Age-0					Age-1					Age-1				
Starting	Week	n	$\bar{X}$	min	max	SD	n	$\bar{X}$	min	max	SD	n	$\bar{X}$	min	max	SD	n	$\bar{X}$	min	max	SD	n	$\bar{X}$	min	max	SD
03/12/08	11	19	44	31	51	5.58	0	0	0	0	----	1	36	36	36	----	4	91	81	120	19.34	0	0	0	0	----
03/19/08	12	27	44	34	63	7.71	2	86	82	90	5.66	0	0	0	0	----	3	118	95	153	31.01	19	157	140	190	13.50
03/26/08	13	128	44	34	65	7.92	1	87	87	87	----	20	36	32	38	1.31	19	100	74	126	11.94	13	144	121	160	12.06
04/02/08	14	324	43	32	70	7.58	2	86	85	86	0.71	6	36	34	40	2.14	9	113	86	146	19.62	4	149	140	156	6.61
04/09/08	15	268	44	34	70	8.74	0	0	0	0	----	5	37	32	43	4.60	6	115	95	172	28.69	3	142	138	148	5.51
04/16/08	16	397	51	34	83	11.87	0	0	0	0	----	6	41	34	53	7.01	7	111	90	144	18.86	0	0	0	0	----
04/23/08	17	275	61	38	84	8.75	0	0	0	0	----	5	50	46	54	2.97	4	131	109	152	22.13	1	160	160	160	----
04/30/08	18	174	54	35	88	12.36	0	0	0	0	----	2	37	34	39	3.54	1	80	80	80	----	14	157	113	190	19.48
05/07/08	19	141	48	29	89	12.36	0	0	0	0	----	11	48	40	59	7.39	0	0	0	0	----	71	166	125	221	18.45
05/14/08	20	336	53	32	115	14.12	1	102	102	102	----	8	42	34	64	9.87	14	125	101	140	11.55	84	156	129	226	15.18
05/21/08	21	252	57	37	92	11.58	0	0	0	0	----	17	53	40	67	7.87	5	125	112	139	12.07	25	160	140	210	18.46
05/28/08	22	526	64	39	103	11.74	0	0	0	0	----	23	52	34	71	8.00	10	125	107	157	15.37	65	158	118	186	11.53
06/04/08	23	504	67	43	106	13.38	1	111	111	111	----	31	59	47	73	7.03	14	121	98	148	14.79	73	157	135	230	13.38
06/11/08	24	583	73	42	106	14.05	0	0	0	0	----	36	65	52	86	8.96	40	128	102	168	17.04	42	157	124	201	14.96
06/18/08	25	770	76	40	107	11.84	0	0	0	0	----	34	67	53	90	9.27	27	128	102	193	18.58	12	154	133	176	15.83
06/25/08	26	720	79	45	109	11.12	0	0	0	0	----	21	64	52	83	6.89	6	133	111	153	13.96	8	155	144	180	11.97
07/02/08	27	649	80	40	102	10.49	0	0	0	0	----	10	60	40	96	16.83	0	0	0	0	----	1	161	161	161	----
07/09/08	28	494	79	43	110	9.83	0	0	0	0	----	1	66	66	66	----	0	0	0	0	----	1	153	153	153	----
07/16/08	29	377	80	44	102	8.52	0	0	0	0	----	2	72	71	73	1.41	0	0	0	0	----	0	0	0	0	----
07/23/08	30	458	81	54	111	7.29	0	0	0	0	----	1	66	66	66	----	0	0	0	0	----	0	0	0	0	----
07/30/08	31	466	81	50	110	7.84	0	0	0	0	----	1	72	72	72	----	0	0	0	0	----	0	0	0	0	----
08/06/08	32	494	83	50	105	7.03	0	0	0	0	----	0	0	0	0	----	0	0	0	0	----	0	0	0	0	----
08/13/08	33	359	85	70	104	6.11	0	0	0	0	----	0	0	0	0	----	0	0	0	0	----	0	0	0	0	----
08/20/08	34	241	89	49	113	7.22	0	0	0	0	----	0	0	0	0	----	0	0	0	0	----	0	0	0	0	----
08/27/08	35	75	89	57	105	7.46	0	0	0	0	----	0	0	0	0	----	0	0	0	0	----	0	0	0	0	----

* Includes Hatchery Releases

Appendix 5. Trinity River at Willow Creek weekly steelhead fork lengths, 2008.

Week	Julian	Natural steelhead Age-0					Natural steelhead Age-1					Natural steelhead Age-2					Hatchery steelhead Age-1				
Starting	Week	n	$\overline{X}$	min	max	SD	n	$\overline{X}$	min	max	SD	n	$\overline{X}$	min	max	SD	n	$\overline{X}$	min	max	SD
3/5/08	10	0	0	0	0	----	0	0	0	0	----	0	0	0	0	----	0	0	0	0	----
3/12/08	11	0	0	0	0	----	6	106	75	157	32.79	0	0	0	0	----	0	0	0	0	----
3/19/08	12	0	0	0	0	----	16	85	44	127	18.93	0	0	0	0	----	3	200	194	210	8.72
3/26/08	13	0	0	0	0	----	48	106	54	219	37.86	3	191	163	210	24.76	203	193	100	238	18.58
4/2/08	14	9	100	80	113	9.67	154	94	58	179	14.61	8	211	181	243	21.55	165	199	95	280	22.27
4/9/08	15	1	115	115	115	----	153	100	61	246	27.42	4	203	194	218	10.72	107	208	160	248	17.08
4/16/08	16	0	0	0	0	----	168	101	57	225	25.03	10	194	162	238	24.22	272	203	98	252	18.75
4/23/08	17	0	0	0	0	----	35	124	72	234	46.49	15	201	152	249	23.47	186	203	155	253	15.88
4/30/08	18	3	33	31	34	1.53	15	115	89	190	31.92	7	199	175	253	26.39	110	197	113	248	20.49
5/7/08	19	5	31	26	42	6.56	13	133	69	230	55.75	13	181	148	240	28.21	92	193	148	230	16.47
5/14/08	20	6	51	32	110	29.27	22	149	77	210	34.59	12	189	162	233	18.43	147	194	153	230	16.99
5/21/08	21	7	38	29	55	9.11	8	136	104	167	25.37	4	179	170	186	7.79	24	187	97	211	21.93
5/28/08	22	26	41	25	54	8.03	53	148	74	200	33.02	3	172	155	181	14.73	34	195	159	298	24.64
6/4/08	23	115	41	27	65	11.20	124	154	93	208	25.82	5	183	163	194	12.03	56	184	140	234	18.61
6/11/08	24	285	54	27	98	7.40	92	150	95	193	27.38	4	179	162	195	16.68	36	190	146	233	17.54
6/18/08	25	356	58	22	106	8.95	53	138	77	209	32.05	4	167	157	178	10.15	10	187	155	224	20.94
6/25/08	26	412	56	24	96	10.11	10	131	100	175	26.63	1	190	190	190	----	6	201	185	230	16.34
7/2/08	27	390	58	27	94	10.10	9	133	90	188	32.19	2	198	195	200	3.54	2	194	192	195	2.12
7/9/08	28	288	59	28	81	7.80	1	181	181	181	----	0	0	0	0	----	0	0	0	0	----
7/16/08	29	165	62	43	89	7.72	6	124	110	137	10.94	0	0	0	0	----	0	0	0	0	----
7/23/08	30	117	61	36	89	9.75	5	131	105	155	18.96	2	198	190	205	10.61	0	0	0	0	----
7/30/08	31	101	60	41	97	9.35	5	137	114	148	13.37	0	0	0	0	----	0	0	0	0	----
8/6/08	32	17	61	36	77	9.81	7	150	138	176	12.97	1	169	169	169	----	0	0	0	0	----
8/13/08	33	8	73	57	85	8.26	2	99	72	125	37.48	0	0	0	0	----	0	0	0	0	----
8/20/08	34	5	81	61	97	14.40	2	127	121	133	8.49	1	223	223	223	----	0	0	0	0	----
8/27/08	35	8	58	40	90	17.63	1	113	113	113	----	0	0	0	0	----	0	0	0	0	----

Appendix 6. Trinity River at Willow Creek weekly Chinook Salmon population estimates, 2008.

Julian Week	Natural Chinook Pop Estimate Utot	Standard Deviation	Hatchery Chinook Pop Estimate Utot	Standard Deviation
11	994	785		
12	2,579	1,281		
13	6,199	2,734		
14	11,489	5,884		
15	15,529	5,911		
16	19,770	8,446		
17	20,943	6,119		
18	23,544	7,549		
19	28,407	5,184		
20	57,171	9,610		
21	82,709	22,283		
22	121,877	11,148		
23	202,787	20,759		
24	341,552	39,626	13,512	2,027
25	466,330	57,050	57,835	8,024
26	395,059	47,131	56,114	7,598
27	271,083	36,280	59,631	8,088
28	221,774	44,617	53,512	10,818
29	151,757	27,071	40,307	6,914
30	83,763	15,662	35,507	6,560
31	53,170	11,134	22,038	4,717
32	32,265	8,877	16,395	4,453
33	16,508	5,046	10,116	3,073
34	10,775	4,063	4,942	1,873
35	6,494	4,424	2,536	1,821
Total:	**2,644,527**	**33,699**	**372,444**	**33,699**