Mattole Salmon Group

Juvenile Salmonid Monitoring on the Mainstem Mattole River at Petrolia, CA
2009

FINAL REPORT

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Table of Contents

Table of Figures

Background

The Mattole Salmon Group (MSG) has been assessing salmonid populations and their limiting factors on the Mattole River as part of a watershed approach to native salmonid and aquatic habitat enhancement. One of the primary goals of the MSG is the recovery of native salmon and steelhead stocks to robust, self-perpetuating population levels. Considerable effort and expense has been devoted to the rehabilitation and recovery of natural systems, including native salmon and steelhead and their habitat. An integral component of watershed restoration is appropriate monitoring activities. The MSG has conducted downstream migrant trapping annually since 1985, in cooperation with Humboldt State University (HSU), the US Bureau of Land Management (BLM), the US Fish and Wildlife Service (USFWS), and the California Department of Fish and Game (DFG). Due to high levels of natural variability, monitoring population trends among the three resident salmonid species of the Mattole requires a long-term approach. The MSG intends to continue to conduct its current monitoring programs in partnership with state and federal agencies.

Introduction

The 2009 season marked the 24th consecutive year of the MSG's Juvenile Salmonid Migrant Monitoring program. The MSG has conducted annual population monitoring of juvenile salmonids (by downstream migrant trapping in spring and early summer) in the lower mainstem Mattole River since 1985 (using a fyke trap through 1996, and a 1.5 m rotary screw trap thereafter), in lower Bear Creek from 1997-2003 (pipe trap), in the middle mainstem Mattole near Ettersburg from 2001-2003 (pipe trap),in lower Squaw Creek in 2006 (pipe trap), and in the Lower North Fork Mattole River in 2008 and 2009. During the 2009 season, the MSG conducted juvenile salmonid monitoring on the lower mainstem Mattole River using a 1.5 m rotary screw trap on loan from the BLM. Data collected provides valuable information and insights on the timing of emigration, relative abundance, as well as the age and size of emigrating juvenile salmonids. Data also serve as an indicator of adult escapement, reproductive conditions, in-stream habitat quality and future recruitment to adult populations. To assess such factors, downstream migrant trapping needs to be conducted over multiple consecutive years, particularly for trend analysis purposes.

Materials and Methods

Trap Site

The 1.5m rotary screw trap was installed at river mile (RM) 3.9 on the lower mainstem Mattole River (Figure 1) during the 2009 sampling season. Landowners Dr. Richard Scheinman and Charles Gould permitted the MSG to install and operate the trap on their properties. The 2009 season was the fifth consecutive year that the MSG conducted juvenile monitoring at this particular location. Due to having one of the steepest riffles in the lower river and being downstream of all Chinook salmon bearing tributaries, the site continues to be a valuable location for the placement of a screw trap.

Figure 1 Mattole River 2009 downstream migrant trap location.

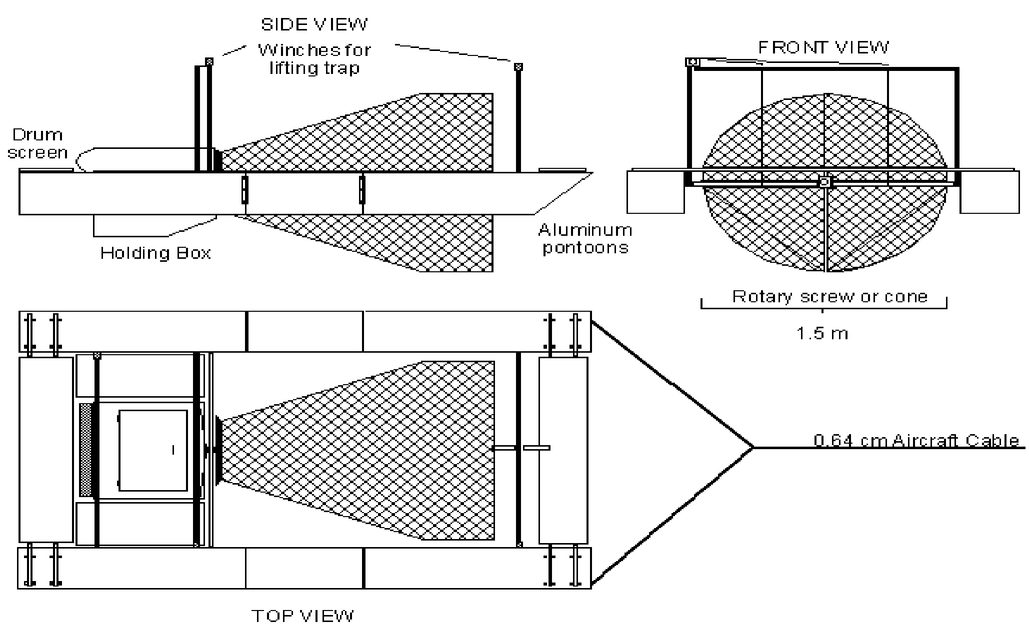
Trap Design and Operation

A rotary screw trap with a 1.5 m diameter cone was used for downstream migrant trapping (Figure 2). The trap was anchored with 0.64 cm diameter aircraft cable to a series of steel fence posts and large trees just upstream. A Z-rig anchor system was used to allow the trap to be positioned in the thalweg (or on the edge depending on river flows), as well as to pull it ashore for analyzing daily catches. Cone revolutions (revs) were used to determine where and when the trap could be operated without imparting unnecessary risk to trapped fish. Ideal cone revolutions for downstream migrant trapping range from a minimum of 3.3 revolutions per minute to a maximum of 12 revolutions per minute.

The trap was operated on the edge of the thalweg during higher river discharge, and incrementally moved back into the thalweg as the river discharge decreased. When deployed, the bottom of the cone is approximately 1m or less from the stream bottom. A sampling day was defined as the time period between the setting of the trap one day, and the removal of captured fish approximately 24 hours later. This period encompassed all night hours, when the majority of juvenile salmonids emigrate (Steel, 1999). Trap checks occurred each morning around 0800 hours.

River conditions ultimately determined what dates the trap was operated. An effort was made to install the rotary screw trap as early as possible in order to record as much of the Chinook salmon (*Oncorhynchus tshawytscha)* juvenile emigration as possible. This was done in order to get the most accurate data on emigration patterns and relative abundances of Chinook salmon, as well as coho salmon (*Oncorhynchus kisutch)* and steelhead (*Oncorhynchus mykiss)*. The MSG focused its efforts around the juvenile Chinook salmon run while collecting as much data as possible on the coho salmon and steelhead runs.

Figure 2 Rotary screw trap design.



Biological Sampling Procedures

During the 2009 season the rotary screw trap was operated 7 days a week, unless high stream flows or excessive water temperatures posed a risk to the survival of captured fish. According to the MSG's DFG-approved Downstream Migrant Monitoring QAQC Plan, fish were not handled when morning water temperatures were over 68°F. The trap was not operated and remained non-operational until safe temperature limits recurred.

The trap was not operated when high flows may have caused water velocities within the live box to exceed the swimming capabilities of the smallest fish, which may result in mortalities greater than 5%. Live boxes were checked and cleared of debris more than once a day during periods of high flow and/or in very windy conditions. Traps and live boxes were inspected daily during operation to check for any damage. All dip nets were inspected daily to check for rips in the mesh. Fish holding buckets were inspected weekly for leaks, cracks and sharp protrusions. Fish safety was paramount, and information gathering was considered secondary.

Fish handling occurred in the early morning when water temperatures were typically low. All fish measured for the biosample were anesthetized with tricaine methanesulfonate (MS-222) prior to processing. Up to 30 individuals of each species and developmental stage were randomly sub sampled from the daily catch. Biosampled salmonids were measured to the nearest mm fork length (FL) and examined for developmental stage, recapture marks, health and physical irregularities. All captured salmonids that were not biosampled were tallied according to species, developmental stage, and/or age and examined for recapture marks. Fish other than Chinook salmon, coho salmon, and steelhead were considered non-target species. Non-target fishes captured were only identified to species and tallied.

Juvenile Chinook salmon were classified as young of the year (YOY). Coho salmon were classified as either YOY or smolt, the latter of which were much larger in size, silvery, and lacked distinct parr marks. Steelhead were classified as YOY (<75 mm), parr, or smolts. Again, delineation of parr and smolts was subjective and based primarily on the degree of silvery coloration and distinctness of the parr marks.

Mark/Recapture Sampling

When capture numbers were high enough to provide an adequate sample, an intensive mark-recapture sampling technique was employed to generate population estimates for Chinook salmon. The Mattole has too few Coho to undertake efficiency estimation and the MSG has found that juvenile steelhead don't emigrate promptly after marking and release (McEwan, 1996). Population estimates were generated using the modified 1-site version of the Rawson model as described by Carlson *et al*. (1998), stratified on a weekly basis.

Population estimates were conducted for Chinook salmon juveniles using standard mark-recapture techniques. The mark-recapture protocol is as follows: one day out of each 7-day trapping week, up to 200 juvenile Chinook salmon were marked by snipping a thin vertical slice from the tip of the caudal fin, alternating between the upper and lower caudal lobes on successive days. Chinook salmon marked for trap efficiency trials were held in a live box to assess mortality from handling and marking, and then were released about 75 meters upstream from the trap. Fish were released at dusk in order to reduce predation. Recaptures of marked Chinook salmon occurred over the ensuing 3 days.

Quality Assurance/Quality Control Procedures

Prior to the initiation of trapping, a training session is required for all trap personnel. Training was given by experienced MSG staff and covers fish identification, trap operation, fish measurement (fork lengths of juvenile salmonids), data recording, trap efficiency estimation, safety, and QA/QC procedures. Trained trap operators counted the total number of fish trapped, and were able to accurately identify the species of each individual fish. On at least one trapping day every two weeks, the Principal Investigator (or designee) verified identification and re-measured a 20% sample of captured salmonids. If greater than 1% error in identification or 10% error in measurement was found, the trap operator received additional review in identification and/or measurement techniques.

All trapping operations were conducted in close coordination and communication with DFG personnel stationed in Eureka and Fortuna. When in operation, traps are monitored and cleaned at least once a day, and more often when debris loading or increased fish numbers caused increased mortality. If mortalities were to exceed 5 percent on any single day, trapping would be suspended immediately and DFG personnel notified within 24 hours. Resumption of trapping would occur only after DFG concurrence that corrective action had been implemented to eliminate mortalities. Fortunately, this was not required this year due to low mortality rates throughout the season.

Results

The rotary screw trap was deployed on April 24, 2009. Start dates coincide with river flows reaching levels safe enough for trap installation. The MSG strives to seek the earliest start date possible for each given season. End dates are in part due to the water-year type, timing and duration of sustained high water temperatures, catch levels and the accumulation of algal drift. The end date for 2009 was July 7, after numerous days of sustained high water temperatures and low Chinook salmon catch totals. Juvenile salmonid monitoring on the Mattole River occurred for 57 days in 2009, compared with 72 days in 2008, 63 days in 2007, 58 days in 2006 and 37 days in 2005.

Physical Environment

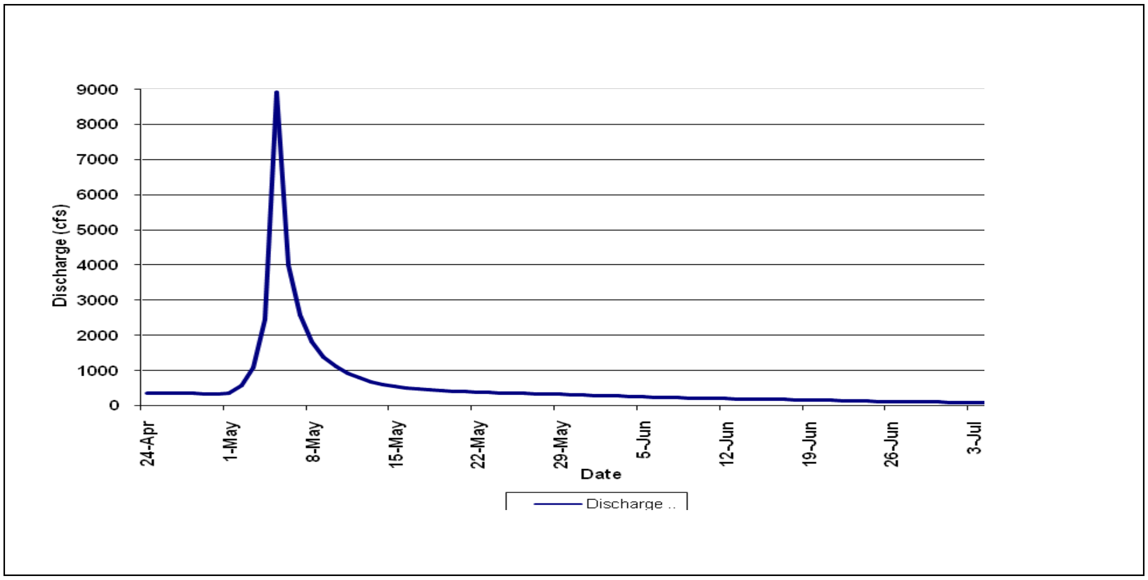
Discharge

The 2009 season began when river flows reached levels safe enough for MSG personnel to install the 1.5m rotary screw trap. Typically, this is around 300 cubic feet per second (cfs). On the first day of trapping, April 24, 2009, the flow of the Mattole River was 358 cfs.

Flow data for the 2009 season is presented in Figure 3. This data was collected by the USGS gauging station #11469000 (Petrolia, CA). It is worth noting that this particular gauging station is just upstream of the largest of Mattole tributaries, the Lower North Fork. After collecting data on flow levels in the Lower North Fork in 2005, the MSG believes that this tributary contributes another 10-15% to the flows collected at the USGS gauging station.

A series of storms occurred around May 1, 2009. These storms produced a large amount of rainfall that raised the river flows to a high of over 8900 cfs. This event delayed trapping for several weeks. Trapping was resumed on May 19, 2009. This event caused major damage to the anchoring system that was not able to be repaired until May 18.

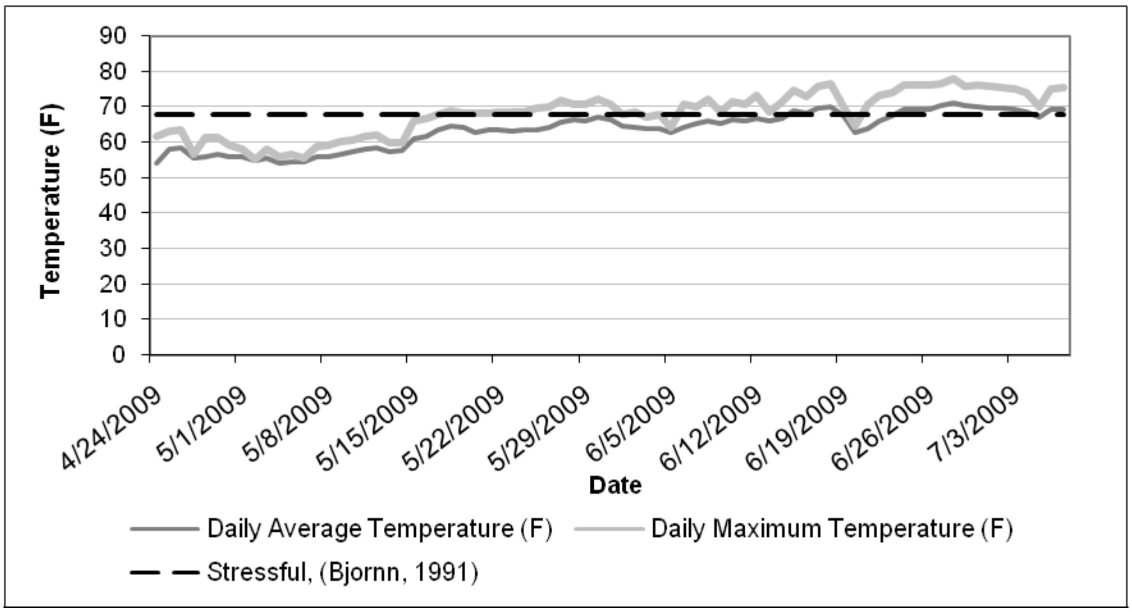
Figure 3 Discharge at USGS gauging station #11469000 (Petrolia, CA) 2009.



Water Temperature

Water temperature data for the 2009 season (Figure 4) was obtained using a *Hobo Water Temp Pro v2* temperature logger. The temperature logger was connected to a chain and weighted down to a depth of 1 meter below the water surface. This logger monitored river temperatures from April 24, 2009 through July 7, 2009. Average water temperatures at the DSMT trap site for the 2009 season were above 68º F, the stressful level salmonids (Bjornn, 1991), for 17 out of the 74 days that trapping occurred. The maximum weekly average temperature (MWAT) was 71.21°F on June 28, 2009, which is considered unsuitable for coho (>63°F MWAT) as well as steelhead (66°F MWAT) (Coates et al. 2002).

Figure 4 Maximum and Daily Average Water Temperatures (F) 2009.

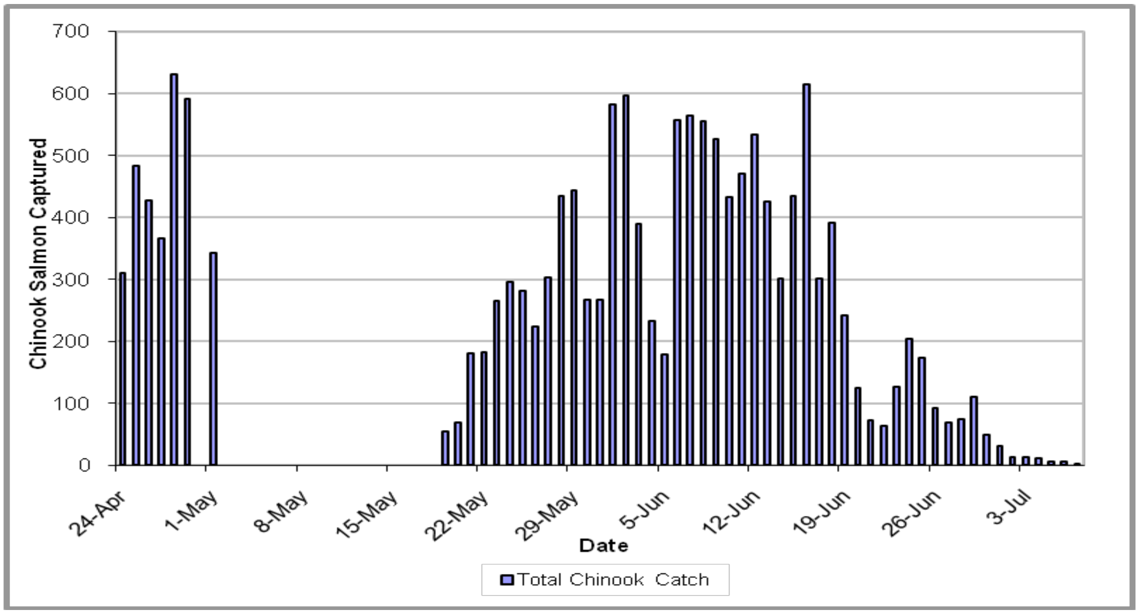


Chinook Salmon Monitoring

Chinook salmon catch totals and population estimate

For the 2009 season, a total of 15,988 Chinook salmon were captured, as compared with 18,457 for 2008, 10,953 for 2007, and 8,008 for the 2006 season. The majority of these fish migrated during the month of June (Figure 5), however it is unknown how many Chinook salmon emigrated during the sustained high river flows in which the trap was not operated. Based on the modified 1-site version of the Rawson model as described by Carlson *et al*. (1998), the population estimate for Chinook salmon in 2008 was 129,712 with 95% confidence that the true number lies between 95,361 and 164,062. The MSG has been using the modified 1-site version of the Rawson model as described by Carlson *et al*. for four consecutive years. Using this model, the MSG's population estimates based on downstream migrant trapping in recent years were 78,298 (2006), 151,404 (2007), 121,794 (2008) and 129,712 (2009).

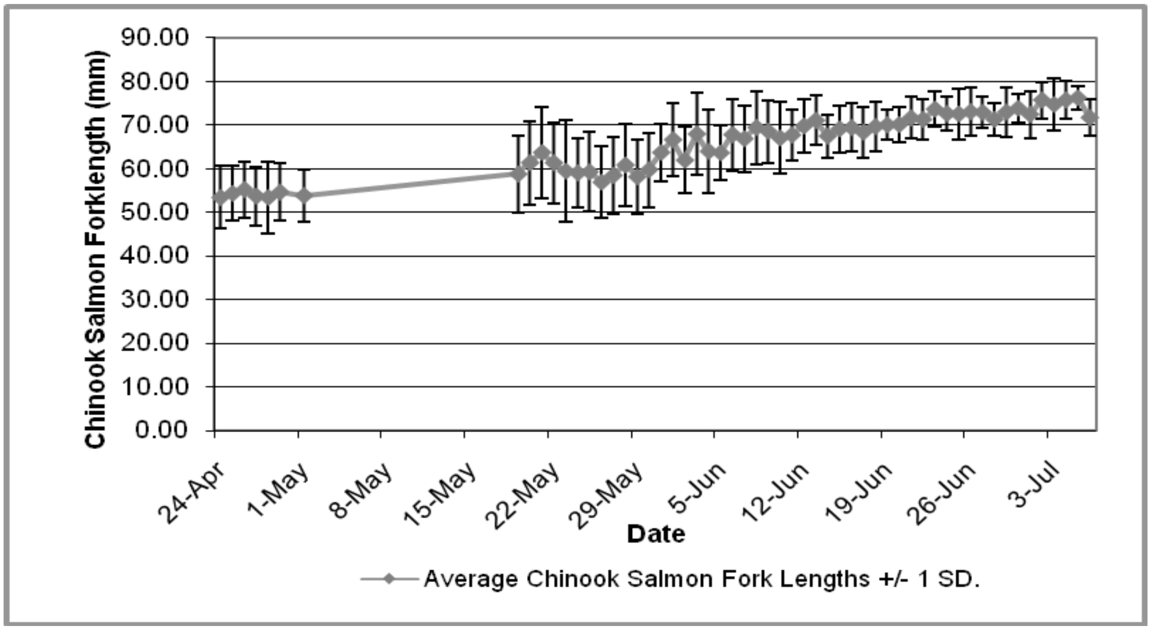
Figure 5 Chinook salmon daily catch totals, 2009.



Chinook Salmon Fork Lengths

Fork lengths from 1,572 (1.2% of the total catch) Chinook salmon were measured in 2009 (Figure 6). Initial catches of Chinook salmon resulted in an average fork length of 53.37 mm (sd = 7.20, n =30). Final catches revealed an average fork length of 71.67 mm (sd =4.13, n =6). This is an increase of over 18 mm throughout the season. The highest average forklength of the season was 76.20 on July 5.

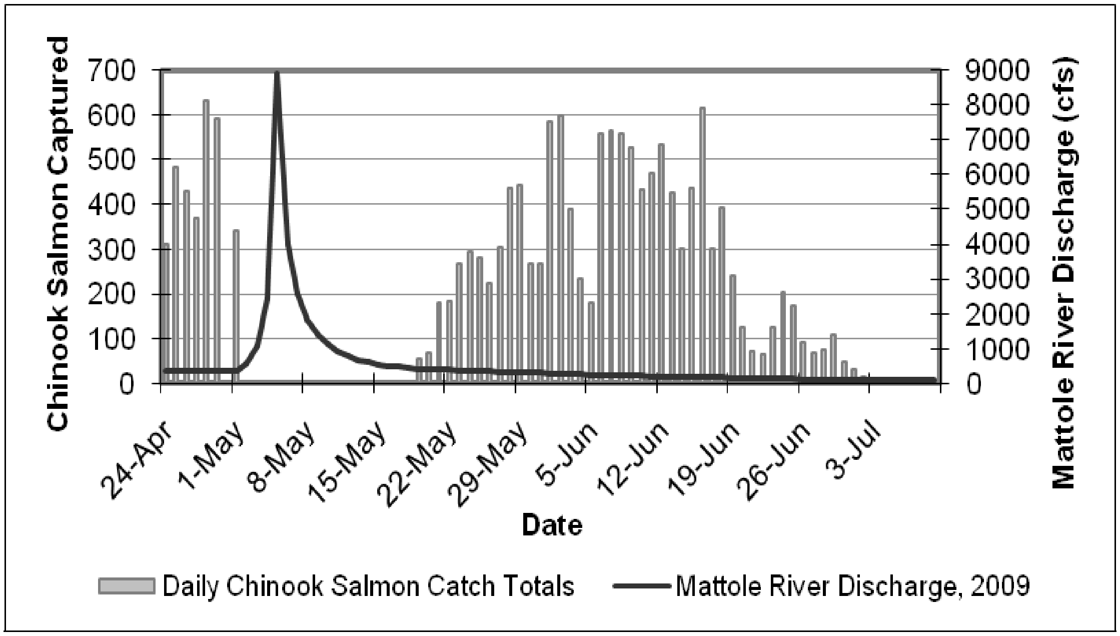
Figure 6 Average Chinook salmon forklengths.



Chinook Salmon Catches and Discharge

During the 2009 season, the Chinook salmon run showed a common tendency in which juveniles emigrated during the descending limb of the hydrograph. There was significant emigration prior to the 2009 season high flow event (Figure 7) with lower daily catches when trapping was resumed.

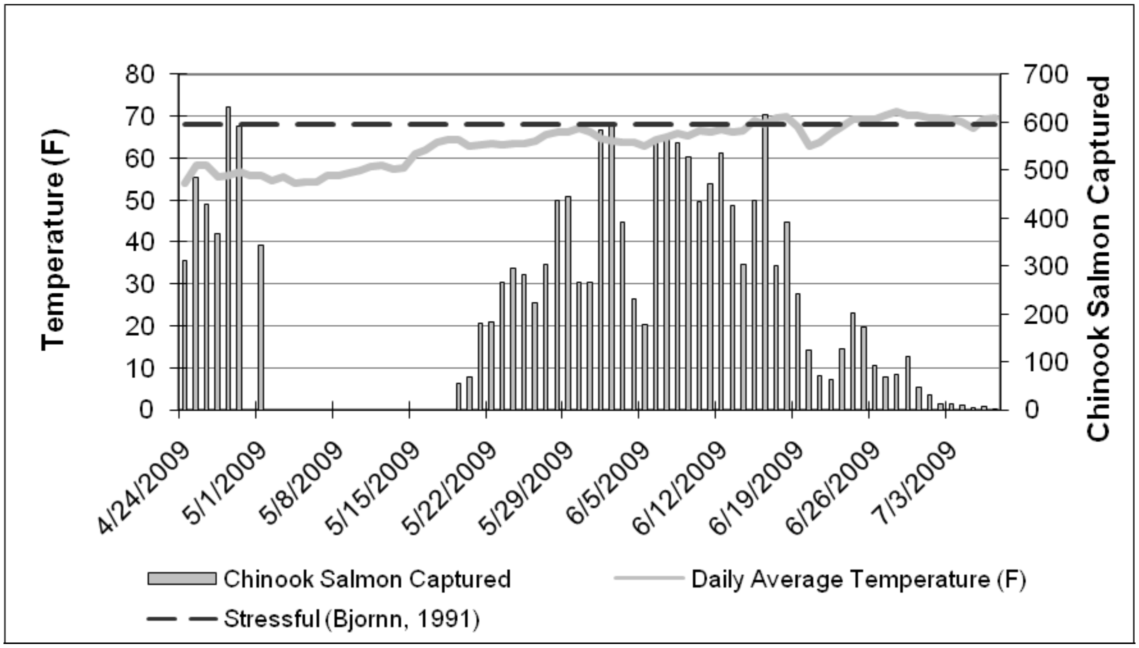
Figure 7 Chinook daily catch and discharge, 2009.



Chinook salmon catches and water temperatures

Initial catches of Chinook salmon occurred at temperatures around 54° F (Figure 9). The first peaks of the Chinook salmon run occurred well before temperatures approached the stressful level of 68º F, lending support to the hypothesis that other physical factors had a greater influence on the Chinook emigration pattern this year. Temperatures over the stressful level 68º F occurred around mid to late June and again around early July. Due to the late mouth closure this year coupled with declining Chinook observations in the trap, we are fairly confident the bulk of the Chinook emigrants were able to reach the ocean prior to thermal stress compromising their survival. Stressful levels of temperature and low numbers of Chinook salmon were the main factor in ending the trapping season.

Figure 8 Daily Chinook salmon catch and average water temperature.

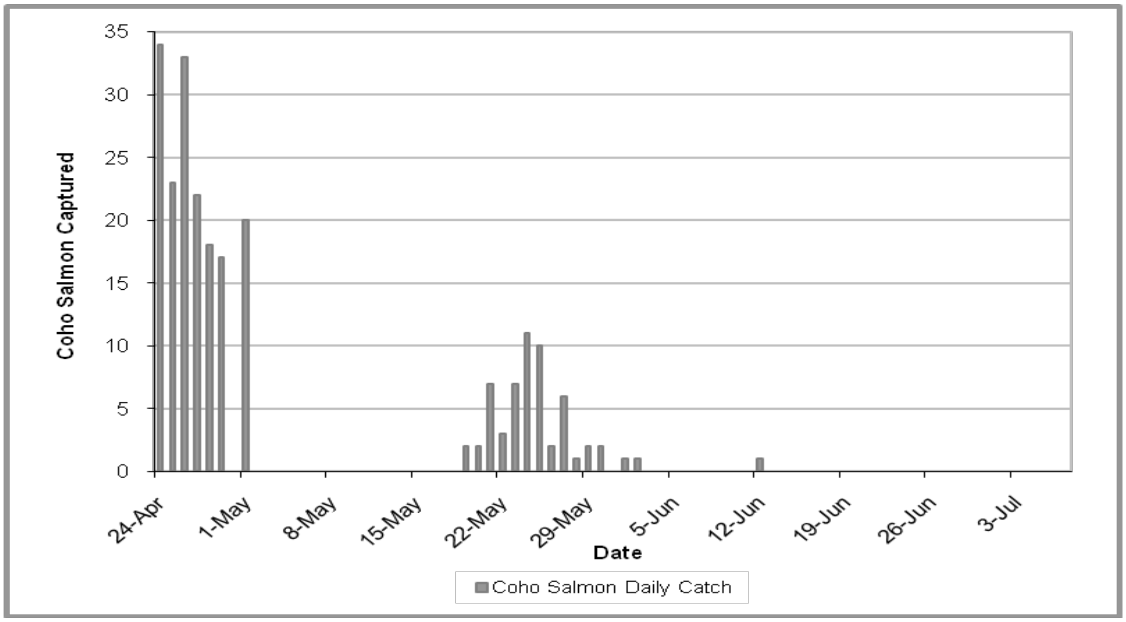


Coho salmon monitoring

Coho Catch Totals and Population Estimates

During the 2009 season, a total of 225 coho salmon smolts were captured (Figure 9), as compared with 313 in 2008, 222 in 2007 and 450 coho salmon smolts for the 2006 season. A single Coho young of the year (YOY) was captured in 2009, with zero YOY captures in 2008 and 2007, and 2 YOY captures in 2006. The majority of the Coho in 2009 emigrated during the first week of trapping and last week of April. Approximately 99.6% of the 2009 total catch was comprised of smolts. Due to the extremely low numbers of coho salmon in the Mattole, the modified 1-site version of the Rawson model as described by Carlson *et al*. (1998) was not used and no population estimate was calculated for coho salmon in 2009.

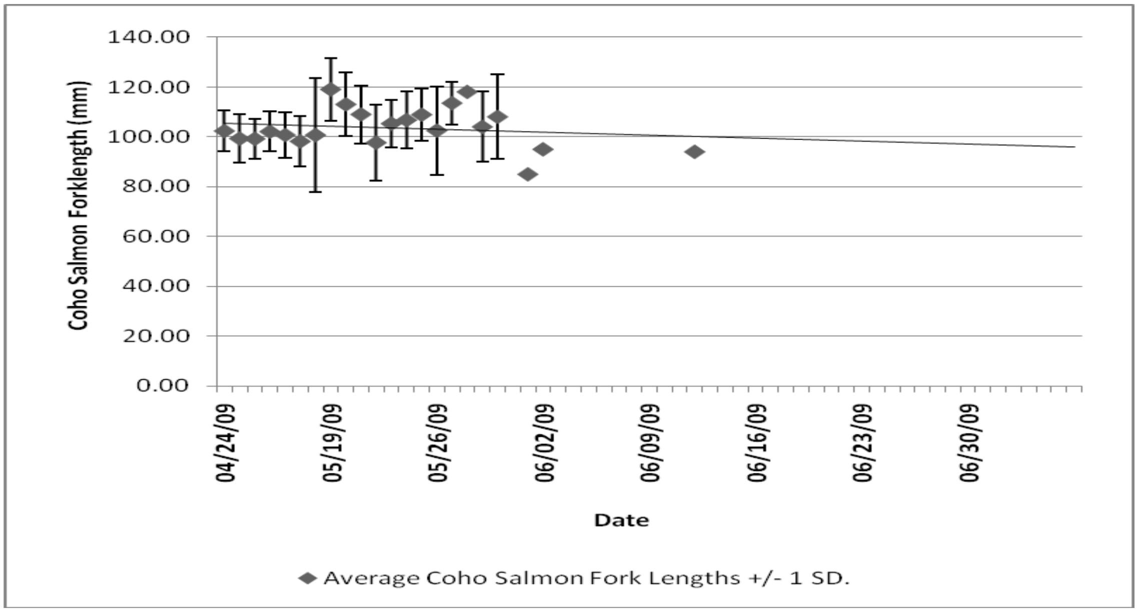
Figure 9 Coho salmon daily catch totals, 2009.



Coho salmon fork lengths

Fork lengths from 225 coho salmon were measured (Figure 10), or 100% of the total catch. Initial coho salmon smolt catches resulted in a daily average fork length of 102.3 mm (sd=8.18, n=30).

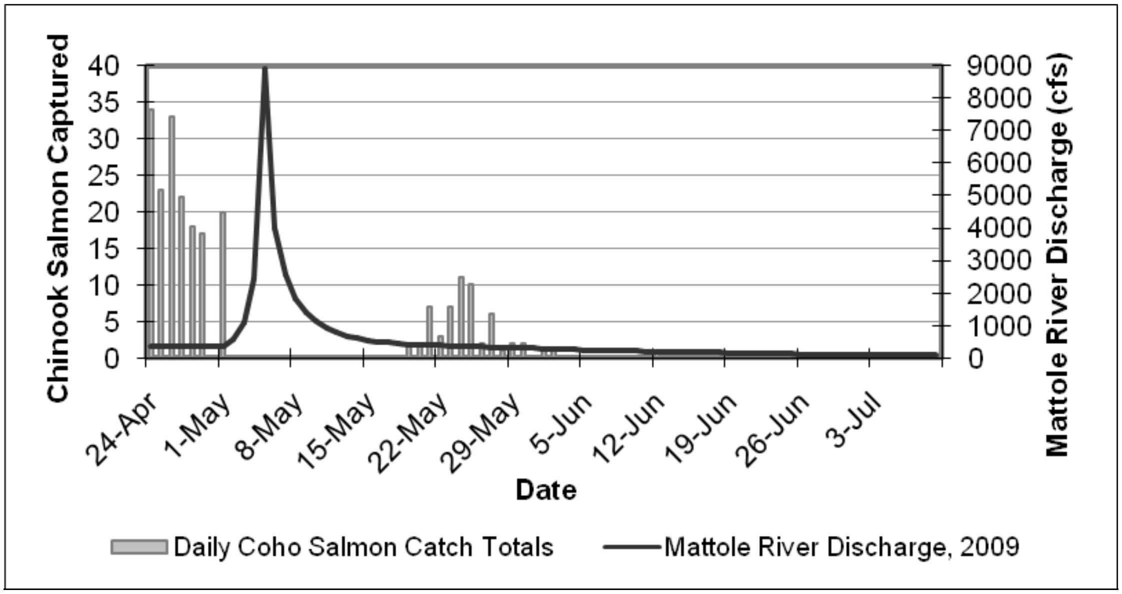
Figure 10 Average coho salmon forklengths.



Coho Salmon Catch and Discharge

The largest pulse of coho salmon occurred during the last week of April, with the majority of coho salmon smolts emigrating throughout the descending limb of the hydrograph, prior to this season’s large rain event (Figure 11).

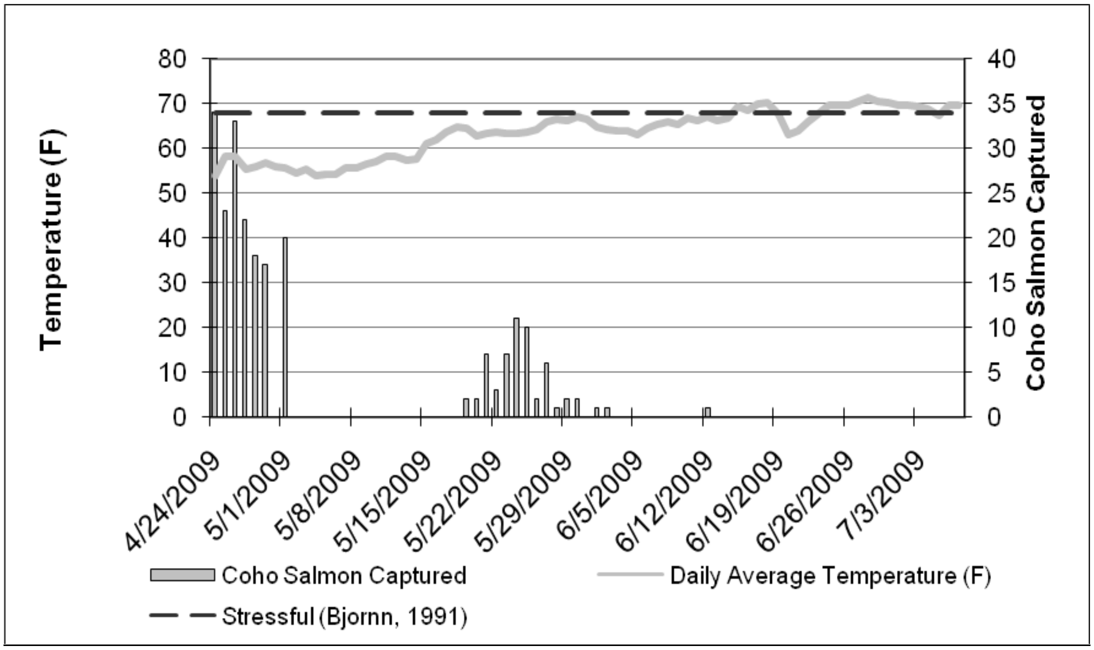
Figure 11 Coho salmon daily catch and discharge.



Coho salmon catches and water temperatures

Initial catches of coho salmon occurred at temperatures around 53° F (Figure 13). The entire coho salmon run occurred before temperatures reached and remained at the stressful level of 68° F, indicating it is likely water temperature did not negatively impact coho survival during emigration.

Figure 12 Daily coho salmon catch and average water temperatures.



Steelhead Monitoring

Steelhead catch totals

During the 2009 season, 12,340 young of year (YOY), 2441 parr, and 160 smolts were captured (Figures 13-15), as compared with 23,515 YOY, 3,129 parr, and 377 smolts in 2008. Catch totals in 2007 were the highest of recent years. In the 2007 season, 35,847 YOY, 1,834 parr, and 309 smolts were captured and 15,461 YOY, 712 parr, and 189 smolts were captured in 2006.

Figure 13 Steelhead YOY catch totals. 2009.

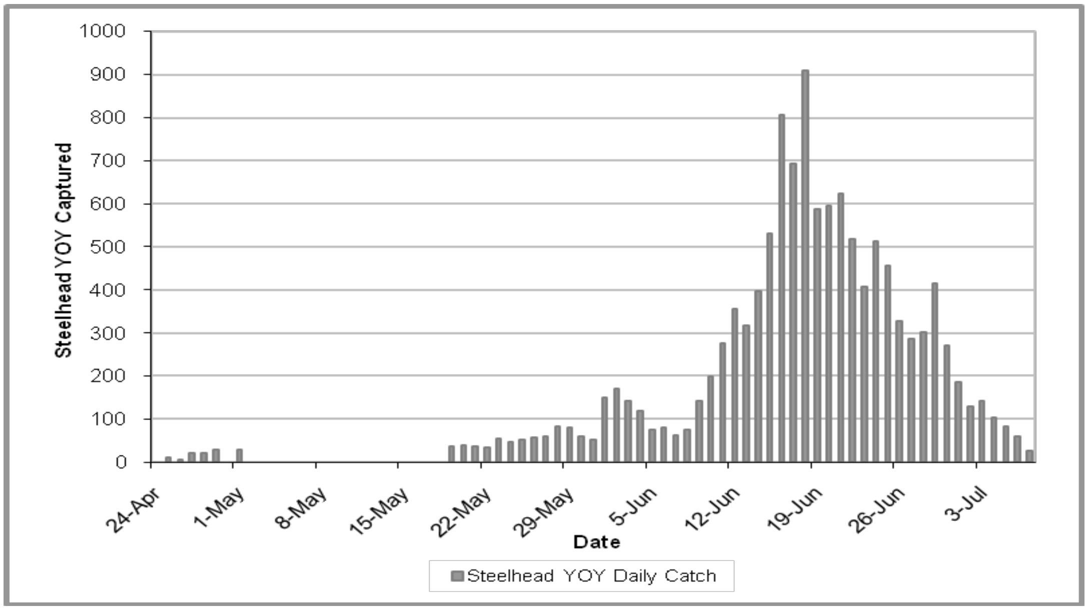


Figure 14 Steelhead parr catch totals. 2009.

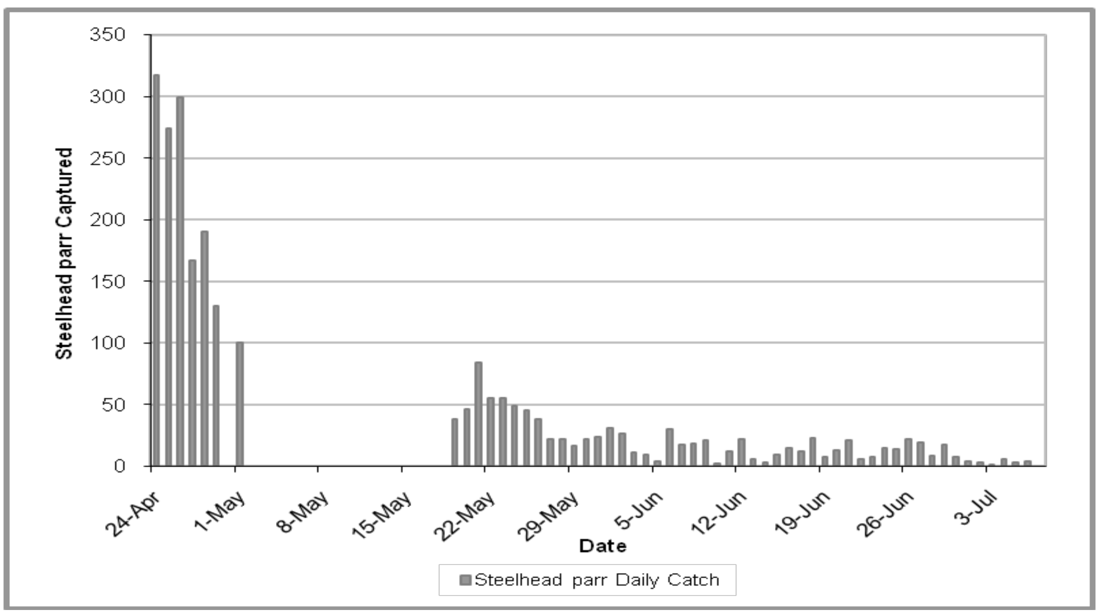
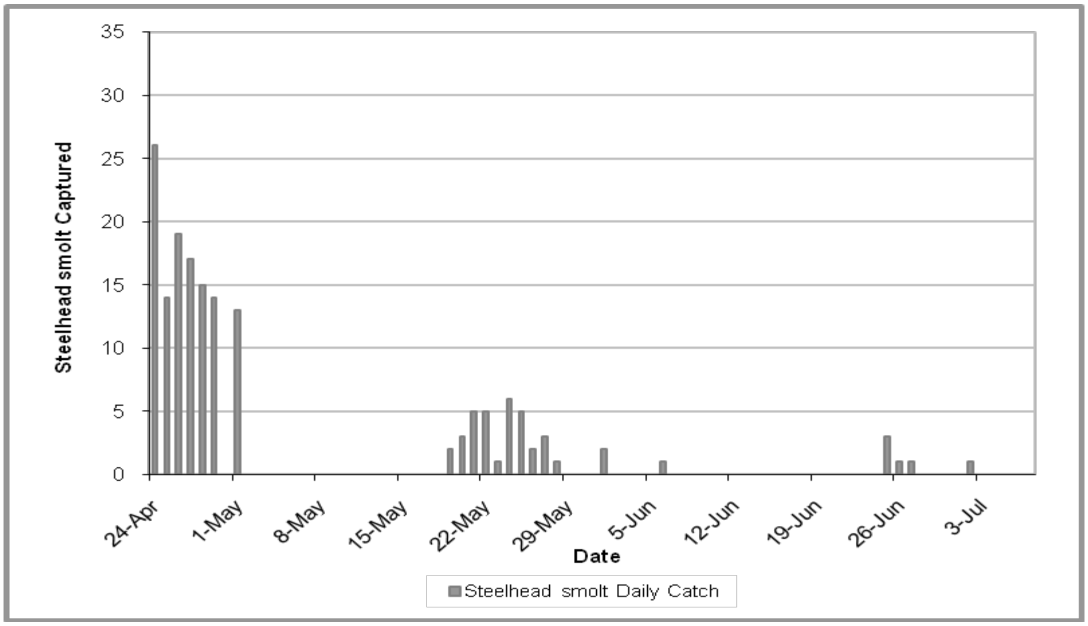


Figure 15 Steelhead smolt catch totals.



Steelhead Fork Lengths

Steelhead fork length data for 2009 is presented in Figures 16-18. A total of 1,526 steelhead YOY were measured, or 12.8% of the total catch, with 1,026 parr, or 32.8% of the total catch, and 128 smolts, or 34.0% of the total catch. Average fork lengths for YOY and parr both increased over the course of the season, as average smolt fork lengths decreased.

Figure 16 Average forklengths for Steelhead YOY.

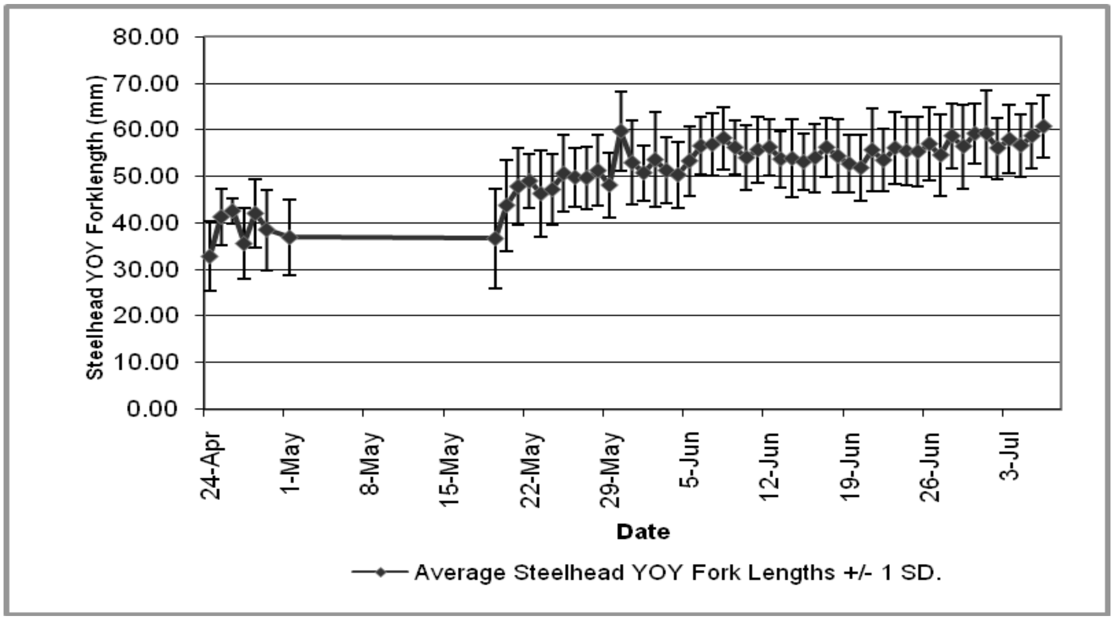


Figure 17 Average forklength for Steelhead parr.

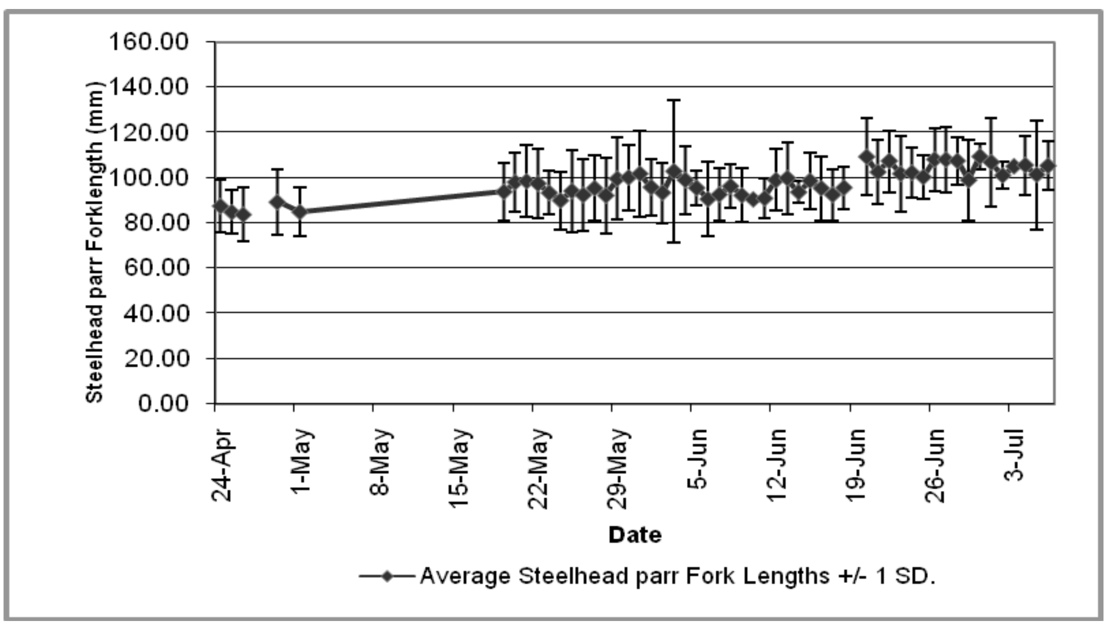
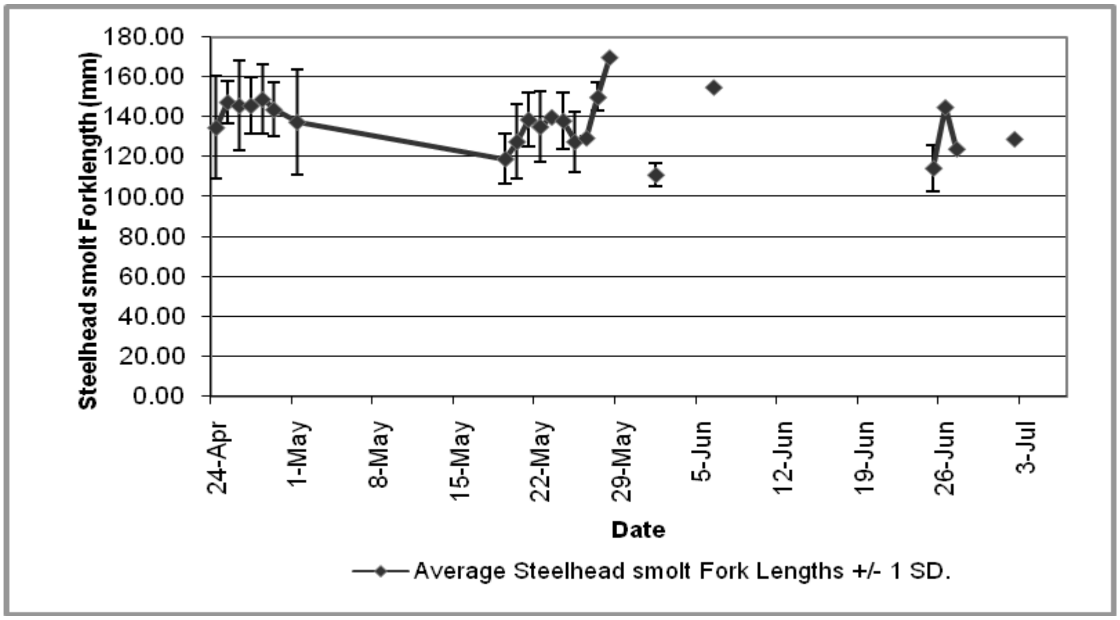


Figure 18 Average forklength for Steelhead smolts.



Steelhead catches and discharge

During the 2009 season, the Steelhead runs showed a common trend in which juveniles emigrated during the descending limb of the hydrograph (Figures 19-21).

Figure 19 Steelhead YOY daily catch and discharge.

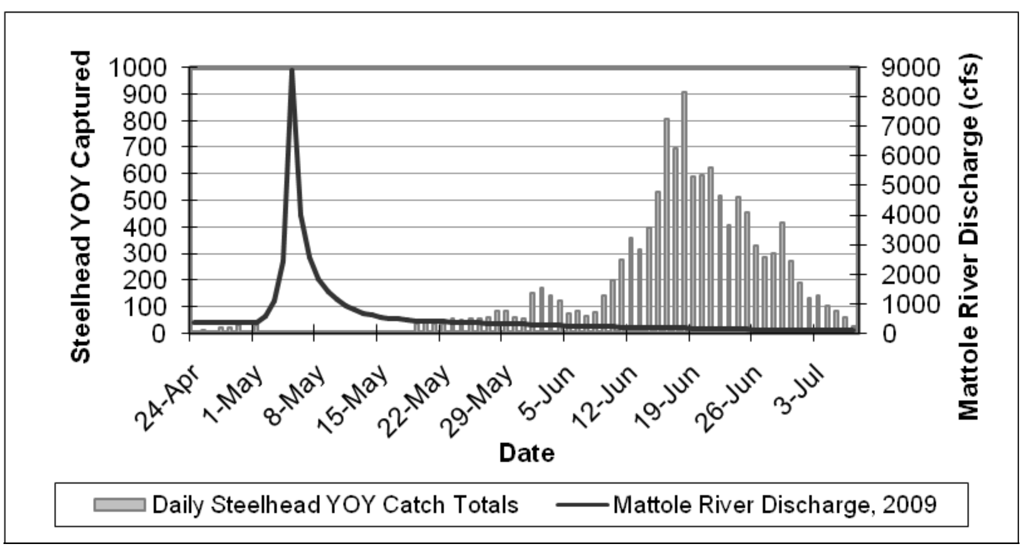


Figure 20 Steelhead parr daily catch and discharge.

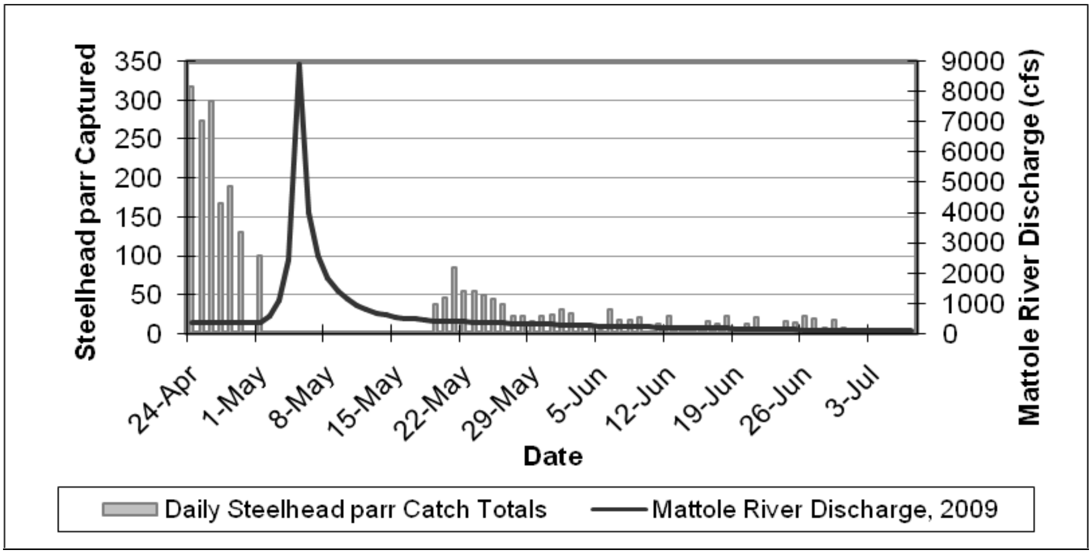
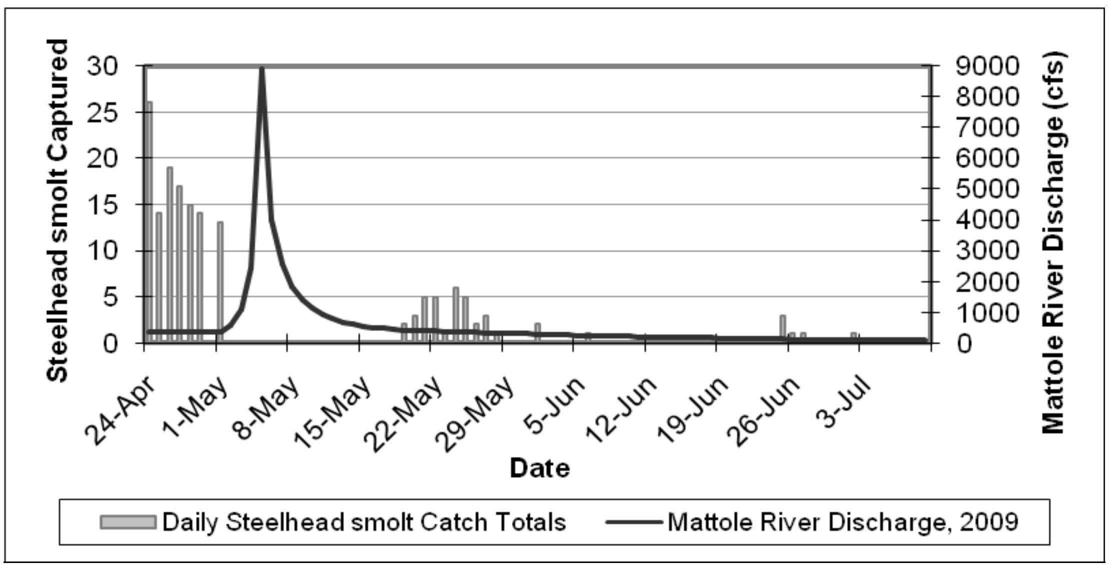


Figure 21 Steelhead smolt daily catch and discharge.



Steelhead catches and water temperature

Initial catches of steelhead juveniles occurred at temperatures around 53° F. Steelhead YOY catch totals increased as temperatures reached the stressful level of 68° F. The majority of the parr and smolt run occurred before temperatures reached 68° F. (Figures 22-24). Unlike Chinook and coho salmon juveniles, fewer steelhead YOY were captured when the temperatures were cooler and more favorable. Higher numbers of steelhead YOY were captured as the temperatures increased and significant numbers of steelhead YOY were captured at temperatures above the threshold.

Figure 22 Daily steelhead YOY catch and average water temperature.

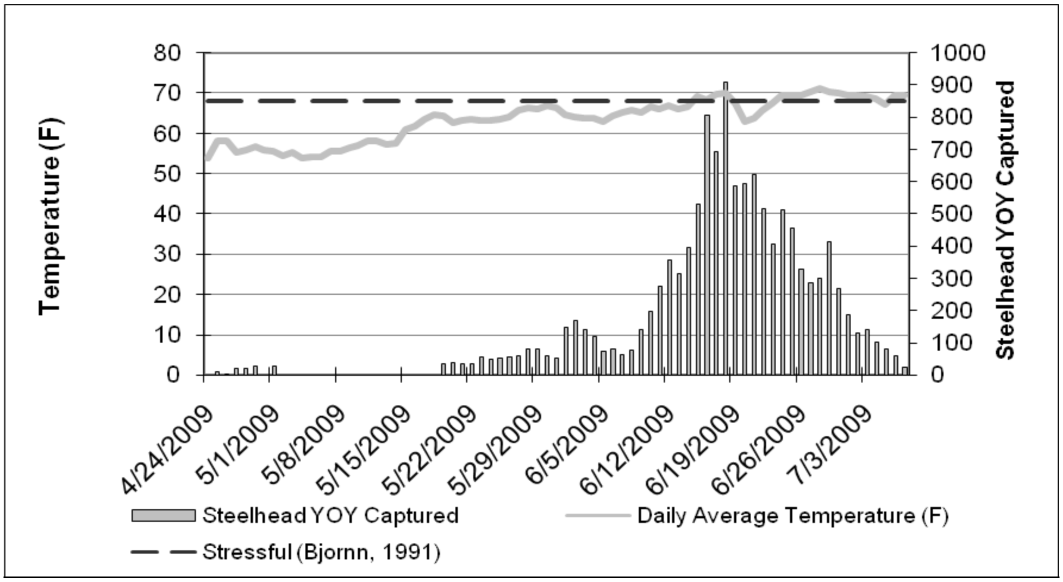


Figure 23 Daily steelhead parr catch and average water temperature.

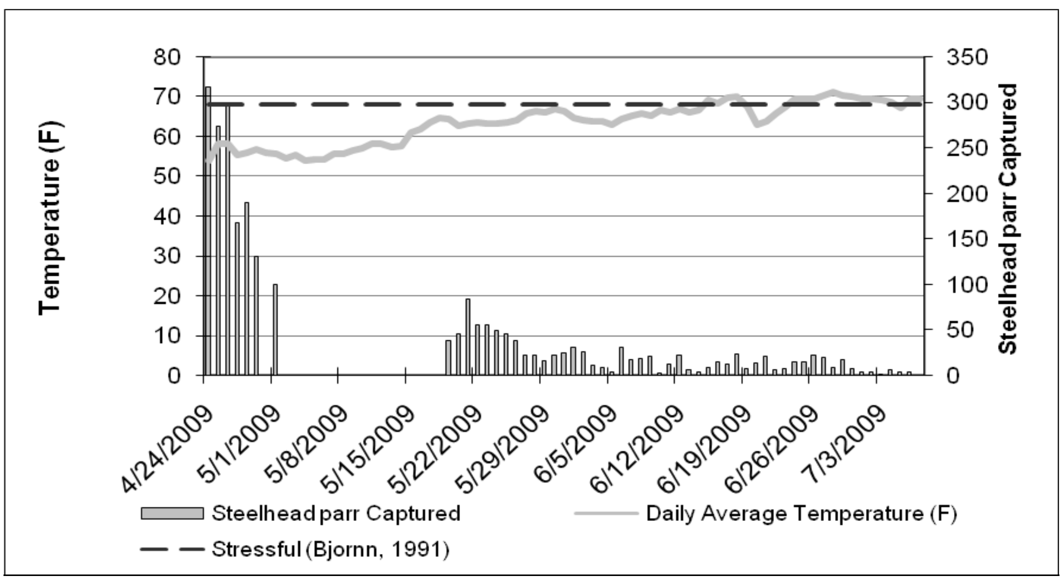
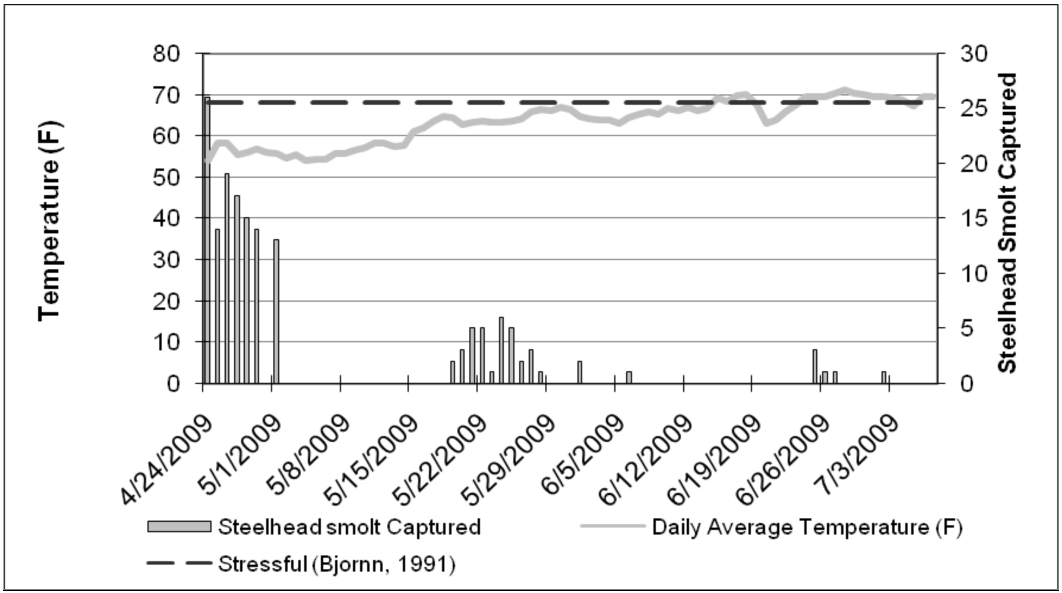


Figure 24 Daily steelhead smolt catch and average water temperature.



Discussion

Many factors influence the emigration of juvenile salmonids on the Mattole River. The two most important influences of emigration are water flow and water temperature. In 2009 there was a large storm event that raised the flow of the river considerably. Flow data taken from the USGS gauging station in Petrolia showed an increase in river flows of over 8000 cfs from a series of storms in early May. This event damaged the anchoring system for the trap, which was not able to be repaired until the river flows dropped, and subsequently data was not able to be collected for a period of two weeks. Therefore a large gap is present in all catch data collected. Water temperatures remained relatively cool throughout most of the trapping season, with stressful temperatures not recorded until mid to late June. The majority of the outmigration had already taken place by this time. Only the steelhead YOY run was affected by the rise in water temperature, this being the driving force behind the peak of their emigration.

The start date of April 24, 2009 was two weeks later than the start date in 2008. This two week difference in start dates combined with the two weeks in which the trap was out of commission resulted in a month of difference in days trapping was possible compared with 2008. However the Chinook salmon catch totals from 2008 (18,457 Chinook captures) and 2009 (15,988 Chinook captures) are still relatively close in comparison, as are the population estimates (121,794, and 129,712, respectively). These data seem to indicate that it is possible that more Chinook might have emigrated in 2009 than in 2008. Also worth noting is that the mouth of the Mattole River in 2009 closed over a month later than in 2008, allowing the majority of these fish access to the Pacific ocean and preventing the large stranding events that have occurred in previous years.

A total of 225 coho salmon smolts were captured in 2009, compared with 313 in 2008, 222 in 2007, and 450 in 2006. Although this is not one of the higher catch totals in recent years, this number of captures shows that a decent number of coho salmon were able to survive the record low flows of 2008. Over five miles of river that is considered pristine coho habitat went dry in 2008. It is encouraging to know that these fish somehow found a way to survive. A total of 1 coho salmon young of the year was captured in 2009, with 0 in 2008 and 2007, and 2 in 2006.

The steelhead YOY catch totals in 2009 were the lowest in the last four years. As in previous years, the largest pulses of YOY were captured towards the end of the season when flows receded and temperatures climbed. This appears to be a common trend for steelhead in the Mattole River. Steelhead parr and smolt catch totals were similar to previous years.

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