# NAPA RIVER STEELHEAD AND SALMON SMOLT MONITORING PROGRAM

## ANNUAL REPORT – YEAR 1

## JULY, 2009


*NAPA COUNTY RESOURCE CONSERVATION DISTRICT*

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## ACKNOWLEDGEMENTS

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## ABSTRACT

The Napa County Resource Conservation District (RCD) initiated a salmonid outmigrant monitoring program in 2009 using a rotary screw trap. This program represented the first outmigrant trapping effort ever undertaken for the Napa River basin. A group of over 30 volunteers assisted with installation, daily processing, and maintenance of the trap, which was located in the mainstem Napa River north of Trancas Avenue (~400 meters upstream of the extent of tidal influence). Sampling extended from March 17 to May 26, 2009 (69 days). A total of 22 fish species were captured (12 native, 10 exotic). The total catch was 6,566 fish with an additional 48,950 larval specimens (Cyprinid and Catostomid species).

Native species dominated the total catch (n=6,523), comprising 99% of all non-larval specimens. A total of 1,059 steelhead (*Oncorhynchus mykiss*) were captured, including 119 smolts and 940 fry. Capture of steelhead fry (20-50 mm FL) indicates local spawning in the lowest reaches of the non-tidal Napa River, which had not been documented prior to this study. Genetics samples were collected from 123 steelhead for analysis by the National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries) Southwest Science Center. A total of 69 steelhead were marked and released upstream to determine trap efficiency. Only one fish was recaptured, yielding an estimated efficiency of 1.45%; however there is low confidence in this estimate given the relatively small release group size. One Chinook salmon (*Oncorhynchus tshawytscha*) smolt (FL= 90mm) was captured and released. A genetics sample was collected from this specimen for comparison with cohorts from previous years. The average steelhead smolt length was 178mm, which suggests Napa River steelhead smolts tend to be large and therefore likely experience relatively high marine survival.

The Napa RCD and its partners plan to operate the trap annually to develop salmonid population estimates and track ecological responses to ongoing habitat restoration.

# BACKGROUND

The Napa River historically supported three salmonid species: steelhead (*Oncorhynchus mykiss*), Chinook salmon (*Oncorhynchus tshawytscha*), and coho salmon (*Oncorhynchus kisutch*). There has been a significant decline in the distribution and abundance of steelhead and coho salmon in the Napa River and its tributaries since the late 1940s (USFWS 1968; Anderson 1969; Leidy et al. 2005). The U.S. Fish and Wildlife Service (1968) estimates that the Napa River watershed once supported runs of 6,000–8,000 steelhead, and 2,000–4,000 coho salmon, and that by the late 1960s, coho salmon were extinct in the watershed, and the steelhead run had reduced to about 1,000 adults. Napa River steelhead belong to the Central California Coast Steelhead Distinct Population Segment (DPS), which was listed as a threatened species under the Federal Endangered Species Act in August 1997.

Little is known about the historical abundance or distribution of Chinook salmon in tributaries to the San Francisco Estuary (Leidy et al. 2005). However, based on analysis of natural channel form, hydrology, and ecology, it is believed that the Napa River likely supported a large, sustainable population of Chinook salmon under historical conditions (Stillwater Sciences, 2002). Chinook salmon have been regularly reported in the Napa River since the 1980's, and since 2001, an estimated 400-600 fall-run Chinook have spawned each year in the mainstem Napa River and several tributary streams (Koehler 2005a, 2006, 2007, 2008). The Napa County Resource Conservation District (RCD) began a salmon monitoring program in 2003 to track adult Chinook abundance and distribution within a five-mile reach of the Napa River near Rutherford. Capture of juvenile salmon in spring of 2004-2009 indicates that successful spawning occurs in most years. The genetics of these fish has been sampled for multiple years and is being analyzed by the National Oceanic and Atmospheric Administration Fisheries Service (NOAA) Southwest Science Center located in Santa Cruz, California.

Despite long-term habitat degradation and loss, the Napa River watershed still contains extensive areas of relatively high-quality steelhead and salmon habitat. In fact, it has been identified as one of the most important anchor watersheds within the San Francisco Estuary for the protection and recovery of regional steelhead populations (Becker et al. 2007). In priority watersheds such as this, frequent monitoring is needed to assess fish population status and track trends through time. To address this need, the RCD initiated a smolt monitoring program in 2009. Prior to 2009, smolt surveys had never been conducted for the Napa River watershed.

The objective of this monitoring program is to answer the following questions:

- What is the annual index of steelhead and Chinook smolt outmigration from the Napa River?
- What is the average length and weight of smolts from the Napa River?
- What is the genetic relationship between Napa River steelhead and salmon and other known stocks?
- When does smolt outmigration occur in the Napa River watershed?

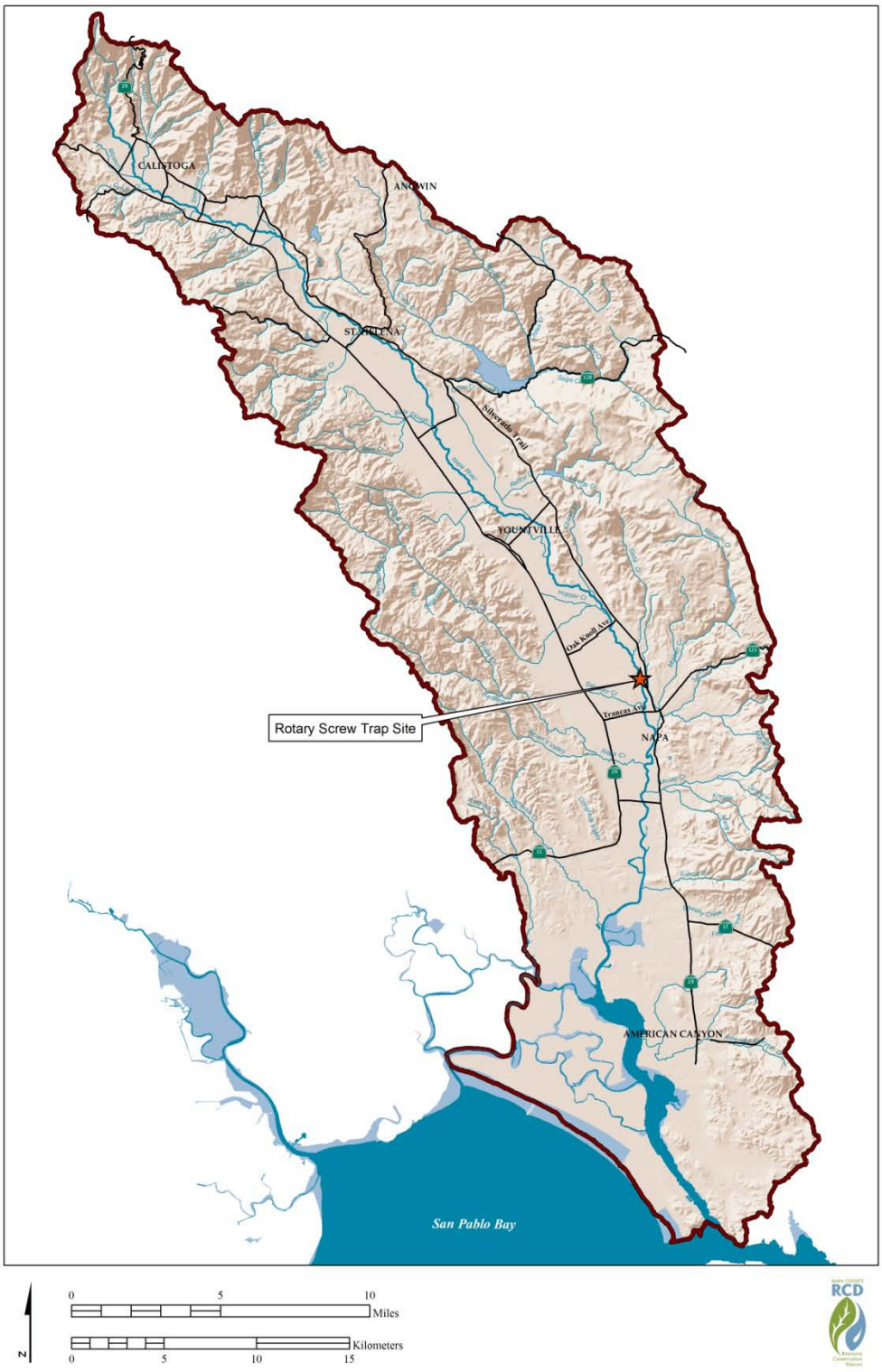


**Figure 1.** Rotary screw trap monitoring site located on the mainstem Napa River approximately two miles downstream of the Oak Knoll Avenue Bridge.

# METHODS

A rotary screw trap (RST) with an 8-foot diameter cone was installed in the mainstem Napa River approximately 2 miles downstream of the Oak Knoll Avenue Bridge on private property (Figure 1). The site is located approximately 1,500 feet upstream of the upper extent of tidal influence at the lowest point in the mainstem where a rotary screw trap can be deployed and still maintain continuous downstream flow.

The trap was assembled onsite with assistance of a large group of volunteers and positioned in a deep pool approximately 300 feet in length. The trap was moved upstream three times during the sampling period in order to keep the cone spinning, and it was ultimately positioned at the head of the pool where water velocities were greatest. The trap was in operation continuously (24 hours per day, 7 days per week) from March 17, 2009 to May 26, 2009 with the exception of two days (May 6-7, 2009) when flows were too high and debris clogged the cone.

The trap was visually inspected daily and debris was removed as needed. The number of revolutions per minute (RPM) was counted periodically to document proper trap function. Streamflow was recorded daily from the USGS streamgage (# 11458000) at Oak Knoll Ave Bridge two miles upstream of our sampling site. Field data were recorded on waterproof data sheets and transferred to a Microsoft Excel database at the RCD office.

Fish were removed from the livebox with dipnets every morning and placed in five gallon buckets with battery operated pumps providing aeration. Fish were identified to species, counted, scanned for marks or tags and released off the back of the trap. Salmonids above 100 mm FL were placed into a bath containing an anesthetic solution of MS-222 (Tricaine-S) at a concentration of 50-60 mg/L. These fish were allowed to become mildly sedated before being measured and weighed. They were allowed to completely recover in freshwater before being transported in 5 gallon buckets to a release site. Steelhead that were simply counted remained in an aerated bucket of water and were not anesthetized. Fork length (mm) and weight to 0.1g was recorded for a subsample of randomly selected fish of each species on each trapping day. If catch rates were low, all fish were fully measured.

The degree of smoltification (parr, transitional, or smolt) was determined by visual examination. Juvenile Chinook and steelhead were classified as parr if parr marks were distinct, transitional if parr marks were not distinct, and smolts if parr marks were not visible and the fish exhibited a silvery appearance.

A fin clip (usually pelvic) was collected from all salmonids for genetic analysis and for mark-recapture purposes. Scales were also collected from a range of smolt sizes to determine age class structure. Although scale analysis was beyond the scope of this year's monitoring effort, all scale samples have been archived at the RCD office and can be analyzed at a later date to determine size-at-age for migrating juvenile salmonids.

Beginning on 4/13/2009 and extending through the end of the sampling period (42 sampling days), all steelhead and salmon smolts were given fin clips and transported approximately 1 km

upstream (two riffle-pool sequences) and released. A total of 69 steelhead and one Chinook salmon smolts were released upstream (total=70 upstream releases).

Due to budgetary constraints, this year's trapping program did not include weekly or flow-variable capture efficiency calculations. Trapping efficiency during the entire 2009 sampling period was estimated from the recapture of a known number of previously marked fish. Note: mark-recapture releases were conducted for 42 of the total 69 sampling days.

Migration over the discreet period, $N_i$, was estimated using the Peterson mark-recapture equation;

$$\hat{N}_i = \left[ \frac{(M_i + 1)(C_i + 1)}{(R_i + 1)} \right] - 1$$

Where

$M_i$ = Number of fish marked and released during discreet period *i*,
$C_i$ = Number of unmarked fish captured during discreet period *i*, and
$R_i$ = Number of marked fish recaptured during discreet period *i*.

The variance, $V(N_i)$, of the Peterson estimate was calculated using;

$$V(\hat{N}_i) = \hat{N}_i^2 \frac{(C_i - R_i)}{[(C_i + 1)(R_i + 2)]}$$

Since only one Chinook was captured, no juvenile production or capture efficiency estimates were calculated. Total steelhead smolt production was calculated by determining migration estimates and variance over the entire mark-recapture period (42 days), and assigning 95% confidence intervals (CI) of ± 1.96 (sd).

It should be noted that due to extremely low recapture rates and variable release rates, migration estimates calculated with these equations are prone to large error and must be interpreted with that limitation in mind.

# RESULTS

During 69 days of operation in 2009, a total of 22 fish species were captured including 12 natives and10 exotics (Table 1). The total catch was 6,566 fish with an estimated 48,950 larval specimens comprised of a mix of Cyprinid and Catostomid species. Most larvae appeared to be Sacramento sucker and California roach.

| Species | Scientific Name | Origin | Total Count |
|---|---|---|---|
| Steelhead Smolt/1+ parr | *Oncorhynchus mykiss* | Native | 120 |
| Steelhead Fry/Parr (YOY) | *Oncorhynchus mykiss* | Native | 940 |
| Chinook Salmon smolt | *Oncorhynchus tshawytscha* | Native | 1 |
| River Lamprey adult | *Lampetra ayresi* | Native | 79 |
| Pacific Lamprey adult | *Lampetra tridentata* | Native | 25 |
| Lamprey Sp. (Ammocete) | *Lampetra sp.* | Native | 137 |
| Sacramento Splittail | *Pogonichthys macrolepidotus* | Native | 2 |
| Sacramento Pikeminnow | *Ptychocheilus grandis* | Native | 28 |
| California Roach | *Hesperoleucus symmetricus* | Native | 4,744 |
| Sacramento Sucker | *Catostomus occidentalis* | Native | 82 |
| Tule Perch | *Hysterocarpus traski* | Native | 6 |
| Prickly Sculpin | *Cottus asper* | Native | 242 |
| Pacific Staghorn Sculpin | *Leptocottus armatus* | Native | 1 |
| Three-spine Stickleback | *Gasterosteus aculeatus* | Native | 116 |
| Mixed Fish Larvae Spp. | Families *Catostomidae, Cyprinidae* | Native | 48,950 |
| Bluegill | *Lepomis macrochirus* | Exotic | 29 |
| Black Crappie | *Pomoxis nigromaculatus* | Exotic | 1 |
| Largemouth Bass | *Micropterus salmoides* | Exotic | 2 |
| Western Mosquitofish | *Gambusia affinis* | Exotic | 1 |
| Fathead Minnow | *Pimephales promelas* | Exotic | 2 |
| Common Carp | *Cyprinus carpio* | Exotic | 1 |
| Golden Shiner | *Notemigonus crysoleucas* | Exotic | 1 |
| Brown Bullhead | *Ameiurus nebulosus* | Exotic | 2 |
| Channel Catfish | *Ictalurus punctatus* | Exotic | 1 |
| Striped Bass | *Morone saxatilis* | Exotic | 3 |
| **Other Taxa Captured** | | | |
| Bullfrog Tadpole | *Rana catesbeiana* | Exotic | 500 |
| Bullfrog Adult | " " | Exotic | 1 |
| Signal Crayfish | *Pacifastacus leniusculus* | Exotic | 3 |
| Crayfish Sp. (unidentified) | unknown | - | 40 |
| Western Pond Turtle | *Actinemys marmorata* | Native | 2 |

**Table 1.** Total catch from the RST during the sampling period. Note: an estimated 48,950 larval *Catostomid* and *Cyprinid* species were captured.

Native species dominated the total catch (n=6,523), comprising 99% of all non-larval specimens. A total of 1,059 steelhead (*Oncorhynchus mykiss*) were captured, including 119 smolts and 940 fry.

One Chinook salmon (*Oncorhynchus tshawytscha*) smolt (FL= 90mm) was captured and released. A genetics sample was collected from this specimen for comparison with cohorts from previous years. Genetics samples were collected from 123 steelhead for analysis by NOAA Fisheries.

Beginning on April 13 and ending on May 26, a total of 69 steelhead were marked with a pelvic fin clip and released upstream to determine trap efficiency. During this 42 day period, a total of 71 steelhead smolts were captured, including one recapture (Table 2). This yields an estimated trapping efficiency of 1.45%; however there is very low statistical confidence in this estimate given the small release group size, and low recapture rate.

The estimated total passage of steelhead smolts during this time (42 days or 61% of the total trapping period) was 2,519 smolts (± 2,810). The large error associated with this estimate is attributed to both the small release group size and the low number of recaptures. The only Chinook smolt captured this year was also marked and released upstream but was not recaptured. Generating an estimate of Chinook outmigrants from this single piece of data is not possible.

| Year | Release Begin Date | Release End Date | Steelhead | | Chinook | |
|---|---|---|---|---|---|---|
| | | | observed | estimated | observed | estimated |
| 2009 | April 13 | May 26 | 71 | 2,519 (± 2,810) | 1 | N/A |

**Table 2.** Smolt trapping efficiency release dates, observed catch during this period, and estimated total passage of steelhead and Chinook smolts.

Steelhead length ranged from 20 - 239 mm with a median length of 174. Steelhead smolts ranged from 126 - 239 with a median length of 178 mm (Figure 2).

Steelhead smolt weights ranged from 21.5 – 142 g with a median weight of 58.1 g. The one Chinook smolt captured was 90 mm long and weighed 10.4 g (Figure 3).

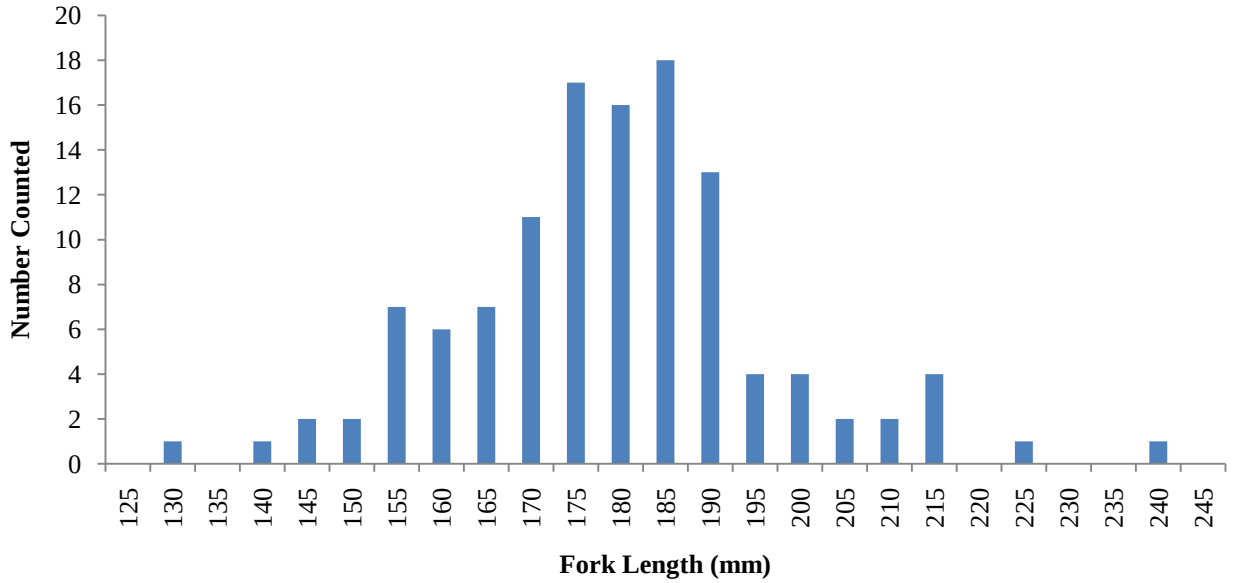


**Figure 2.** Length-frequency distribution for all steelhead smolts.

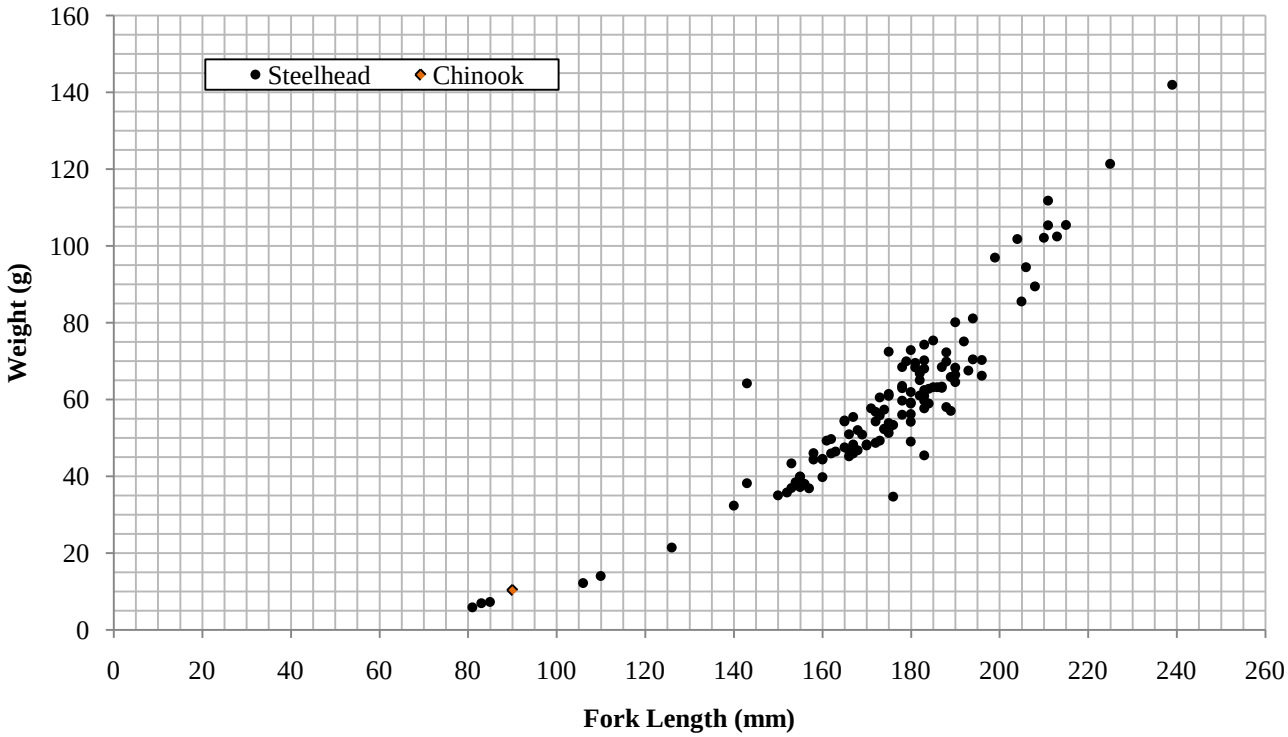


**Figure 3.** Length-to-weight ratios for all measured salmonids (includes parr and smolts).

Steelhead were captured fairly consistently over the entire trapping period with the highest numbers captured on May 3-5 (Figure 4). This spike in captures corresponds to a high flow event, which peaked on May 5.

On March 29, we began capturing freshly emerged salmonid fry that were too small for positive identification (20-25 mm FL). Throughout the trapping period, we continued catching these young-of-year, which were determined to be steelhead as they grew large enough to allow for positive identification. A total of 940 young-of-year steelhead were captured during the trapping period. A photo of these fry is shown in the appendix.

The trap stopped spinning on May 26 and was removed several days later.

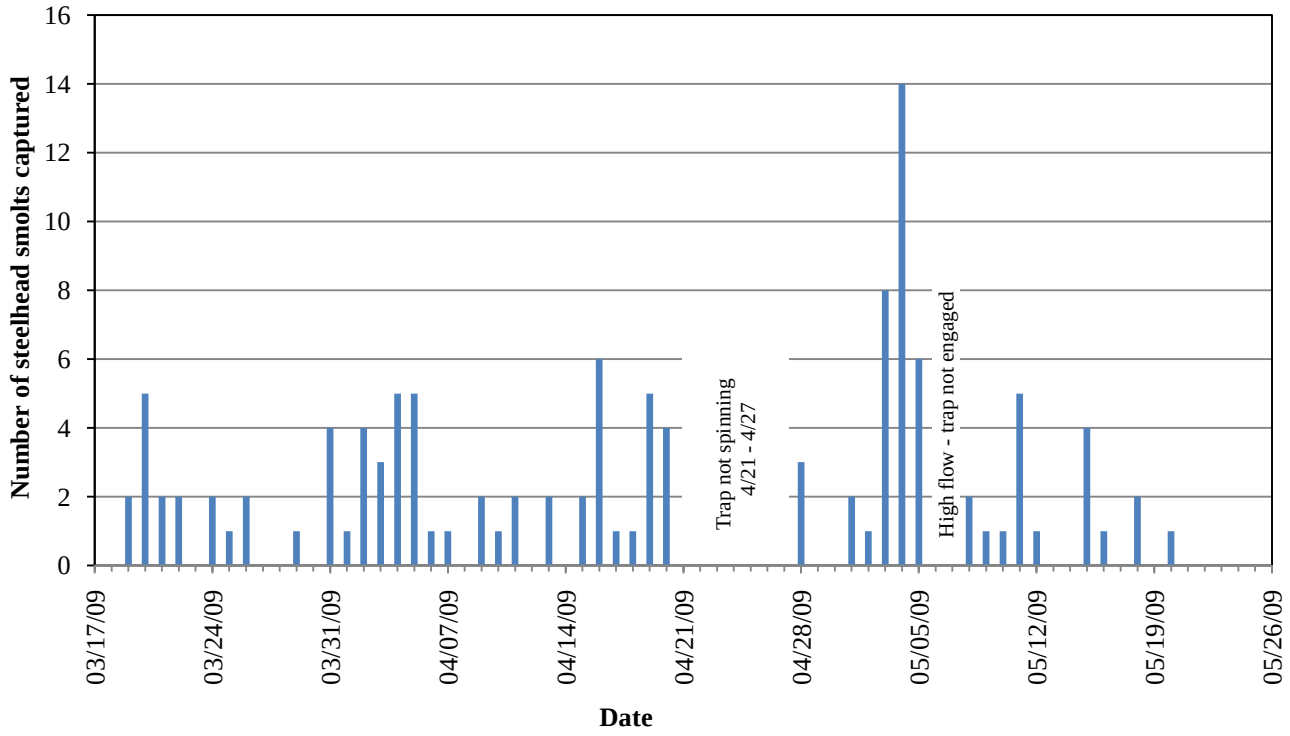


**Figure 4.** Steelhead smolt catch during the entire sampling period.

## DISCUSSION

Capture of steelhead fry ranging from 20 to 50 mm indicates local spawning occurred in 2009 in the lowest reaches of the non-tidal Napa River, which had not been documented prior to this study. It is not known whether these young-of year steelhead emigrate downstream to the estuary during their first year or are able to successfully rear in the lower non-tidal reaches of the Napa River in the vicinity of the trapping site. We are collecting water temperature data with continuous data-loggers in summer 2009 to evaluate conditions in the deep pool just below the trapping site. In general, water temperatures in the mainstem have been found to be unsuitably warm in summer to support steelhead rearing (Koehler 2005b).

Analysis of the scale morphology of returning adult steelhead indicates that there is strong size-dependent mortality at sea, with the largest smolts (> 150 mm FL) showing the greatest survival advantage (Bond et al 2008). Given the relatively large median size of Napa River smolts (178mm), we would expect relatively high marine survival.

Smolt outmigration in 2009 is likely underestimated because some fish emigrated prior to trap installation and after trap removal. We consistently captured steelhead smolts immediately following trap installation on March 17, suggesting that the beginning of the steelhead outmigration was probably missed. It is uncertain how many fish may have emigrated prior to trap installation. We hope to install the trap earlier in the season in future years in order to better define the beginning of the steelhead outmigration period.

## FUTURE MONITORING PLANS

1. Conduct outmigrant monitoring at the same location beginning March 1, 2010 and extending through June as flows permit.

2. Conduct trap efficiency releases throughout the monitoring period as funding permits.

3. Conduct continuous water temperature monitoring in summer 2009 to document salmonid rearing conditions in the lower mainstem Napa River.

4. Determine age class structure of steelhead smolts using scale analysis as funding permits.

5. Continue to collect genetic data to build a parentage database for Napa River salmonids.

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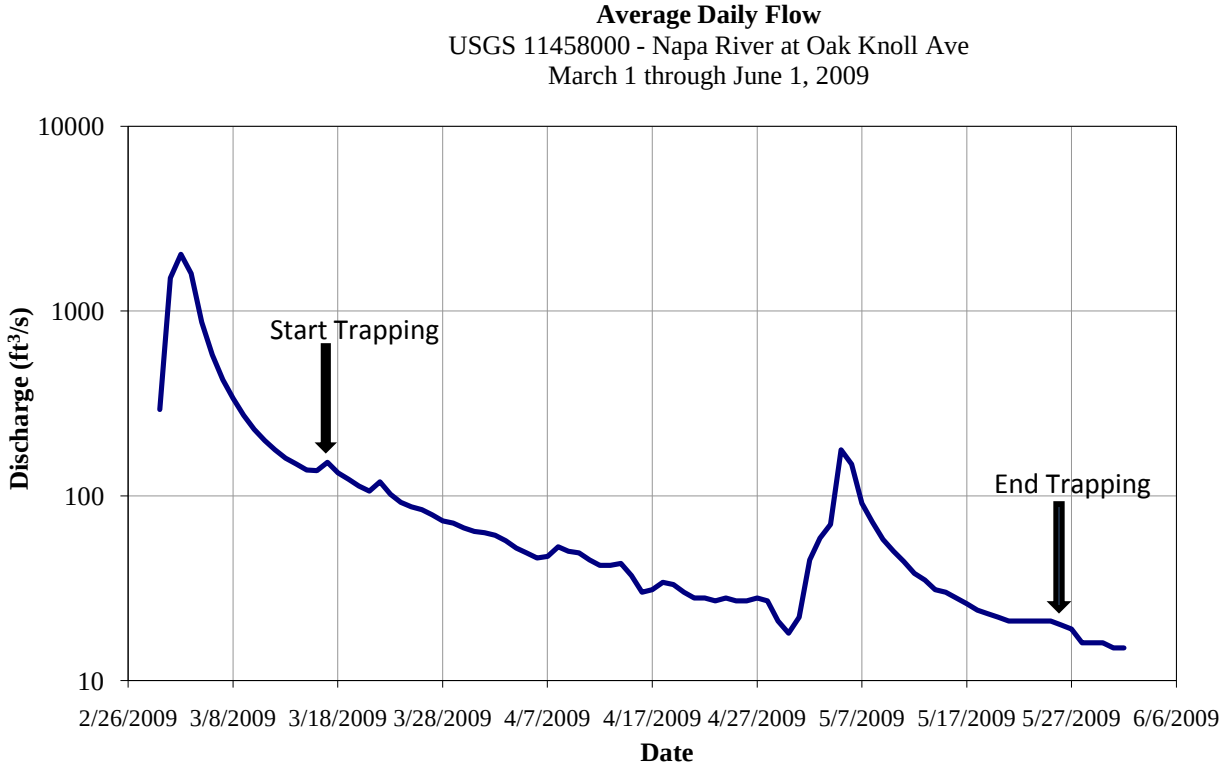
# APPENDICES


Average Daily Flow
USGS 11458000 - Napa River at Oak Knoll Ave
March 1 through June 1, 2009
10000
1000
100
10
Discharge (ft3/s)
Start Trapping
End Trapping
2/26/2009
3/8/2009
3/18/2009
3/28/2009
4/7/2009
4/17/2009
4/27/2009
5/7/2009
5/17/2009
5/27/2009
6/6/2009
Date

## PHOTOS

**Rotary Screw Trap**

**Steelhead smolt**

**Steelhead fry**


**Sacramento Sucker**

**River Lamprey**

**Pacific Lamprey**

**Striped Bass**


**Bluegill**