# NAPA RIVER STEELHEAD AND SALMON MONITORING PROGRAM

## 2012-2013 SEASON

ADULT STEELHEAD, NAPA CREEK (MARCH 19, 2013)

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## INTRODUCTION

The Napa County Resource Conservation District (RCD) conducts fisheries monitoring in the Napa River watershed to collect data on native fish populations with emphasis on steelhead trout (*Oncorhynchus mykiss*) and Chinook salmon (*Oncorhynchus tshawytscha)*. The RCD's monitoring program includes adult spawner surveys, juvenile snorkel surveys, and outmigrant trapping with a rotary screw trap (RST) and fyke nets. The purpose of this program is to examine salmonid life history details, describe the composition of the Napa River fish community, and track ecological responses to ongoing habitat restoration. This report covers monitoring activities during the 2012-13 season. Previous reports are publically available for download from the RCD website (www.naparcd.org).

## FOCUS SPECIES

***Steelhead***

Steelhead in the Napa River watershed are part of the Central California Coast distinct population segment (DPS), which is listed as *Threatened* under the US Endangered Species Act. The listing was based on a long-term decline in steelhead abundance throughout the DPS, which stretches from just north of Ukiah south to Santa Cruz, and includes all streams tributary to the San Francisco Estuary.

**Figure 1.** Adult spawned-out female steelhead in the Napa River rotary screw trap (April 2, 2013)

Adult steelhead (Figure 1) return to the Napa River to spawn in the winter and spring, typically between January and March; although in years with abundant late-season rainfall, adult fish have been observed spawning as late as May. Steelhead spawning is difficult to document in natural river systems because adults migrate primarily at night and spawn during winter storm flows when visibility is low. Therefore, not much is known about the specific movement patterns of adult steelhead in the Napa River watershed. In order to maximize access to steep and often intermittent streams, adult fish are often observed migrating upstream on the receding limbs of winter storm flows. In years with below-average stream flows, access to small tributary streams, which this species prefers, can be limited or completely blocked. Steelhead spawning in the mainstem Napa River has been documented fairly regularly in recent years, although it appears to be most prevalent in dry years when access to prime tributary spawning habitat is limited by low streamflow (Koehler and Blank, 2010, 2011, 2012).

Juvenile steelhead (Figure 2) remain in freshwater for one or more years before migrating to the ocean as smolts (Figure 3). Juveniles (also called parr) typically remain in cool, shady streams with perennial flow for up to three years where they achieve lengths of around 125 to 200 mm (about five to eight inches) before smolting. During their freshwater growth phase, juvenile steelhead feed mostly on aquatic and terrestrial invertebrates and may move around within a stream and between streams at higher flows to seek out suitable habitat.

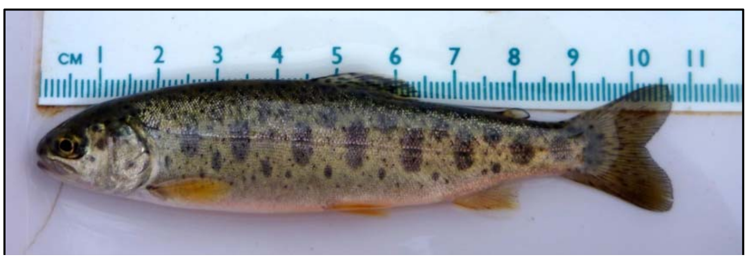

**Figure 2.** Typical Napa River steelhead parr with a fork length around 100mm


**Figure 3.** Typical Napa River steelhead smolt with a fork length around 185mm

***Chinook salmon***

Little is known about the historical abundance and distribution of Chinook salmon in the Napa River watershed (Leidy et al., 2005). Based on accounts of the Napa River's historical hydrology, ecology, and channel form it is likely that the watershed supported a relatively large, sustainable population of Chinook salmon (Stillwater Sciences, 2002). Napa River salmon populations were not well documented during the early twentieth century and may have been extinguished completely for some period of time. During the last decade, however, juvenile salmon have been consistently collected in the Napa River and adult spawning has been observed in most years, suggesting that a process of recolonization may be underway.

The Napa River Chinook salmon population is not included in either of the nearby Chinook salmon Evolutionarily Significant Units (ESU): the Central Valley Fall/Late Fall Run and the California Coastal Chinook Salmon ESUs. However, recent genetic analysis of Napa River Chinook samples found that ancestry of Chinook salmon found in the Napa River is primarily from the Central Valley Fall/Late Fall Run (Garza and Crandall, 2013).

**Figure 4.** Adult female Chinook salmon on spawning redd in the Napa River (2006)

Chinook salmon enter the Napa River to spawn in the fall, typically around late September and early October. Adult fish will hold in deep pools in the estuarine portion of the river near the city of Napa for a month or more waiting for the first rains of the season to generate runoff. Once a sufficient storm occurs, adult salmon swim immediately upstream to suitable spawning areas before flows recede. During this part of the year, winter baseflow is usually not well-established, and the Napa River is still very flashy (i.e. subject to rapid increases and decreases in flow). As a result, Chinook salmon migration can be limited both temporally and spatially by rapidly changing flow conditions. Salmon that make it to suitable spawning areas construct spawning redds (nests) in the streambed gravels and cobbles, typically within a day or two (Figure 4). After spawning, spent salmon will protect their redds and remain in the area for several weeks until they ultimately die. Peak spawning activity occurs from November through early January (Koehler, 2008).

Juvenile Chinook salmon spend several months rearing in the Napa River from January through June. Chinook salmon smolts are typically 80-100 mm (approximately three to four inches) long when they leave the river and enter the estuary (Figure 5). Outmigration occurs throughout the spring with a peak occurring in May as freshwater outflows diminish (Koehler and Blank, 2011).

**Figure 5.** Typical Napa River Chinook salmon smolt with a fork length around 90mm

## ADULT SPAWNER SURVEYS

The RCD conducted seven spawner surveys during the fall of 2012 and winter of 2013 to count and locate adult spawning steelhead and salmon. Results of these surveys are shown in Table 1. All spawner surveys were conducted following the protocols described in the California Salmonid Stream Habitat Restoration Manual (Flosi et al., 2010). The surveys were carried out in four reaches of the mainstem Napa River and three reaches within tributary streams: York, Heath, and Ritchey Creeks (Figure 6). Sampling reaches were selected based on historical presence of spawning activity and landowner access.

During the 2012-13 spawner surveys, just two adult Chinook salmon and two spawning redds (nests) were observed within the four mainstem sampling reaches. A series of storms occurred early in the rainy season with peak flows in November and December 2012. These storms produced favorable spawning flows for Chinook salmon during much of November and December; however, little evidence of widespread spawning was observed within our survey reaches during this time. A small number of juvenile Chinook (n=19) were collected during the

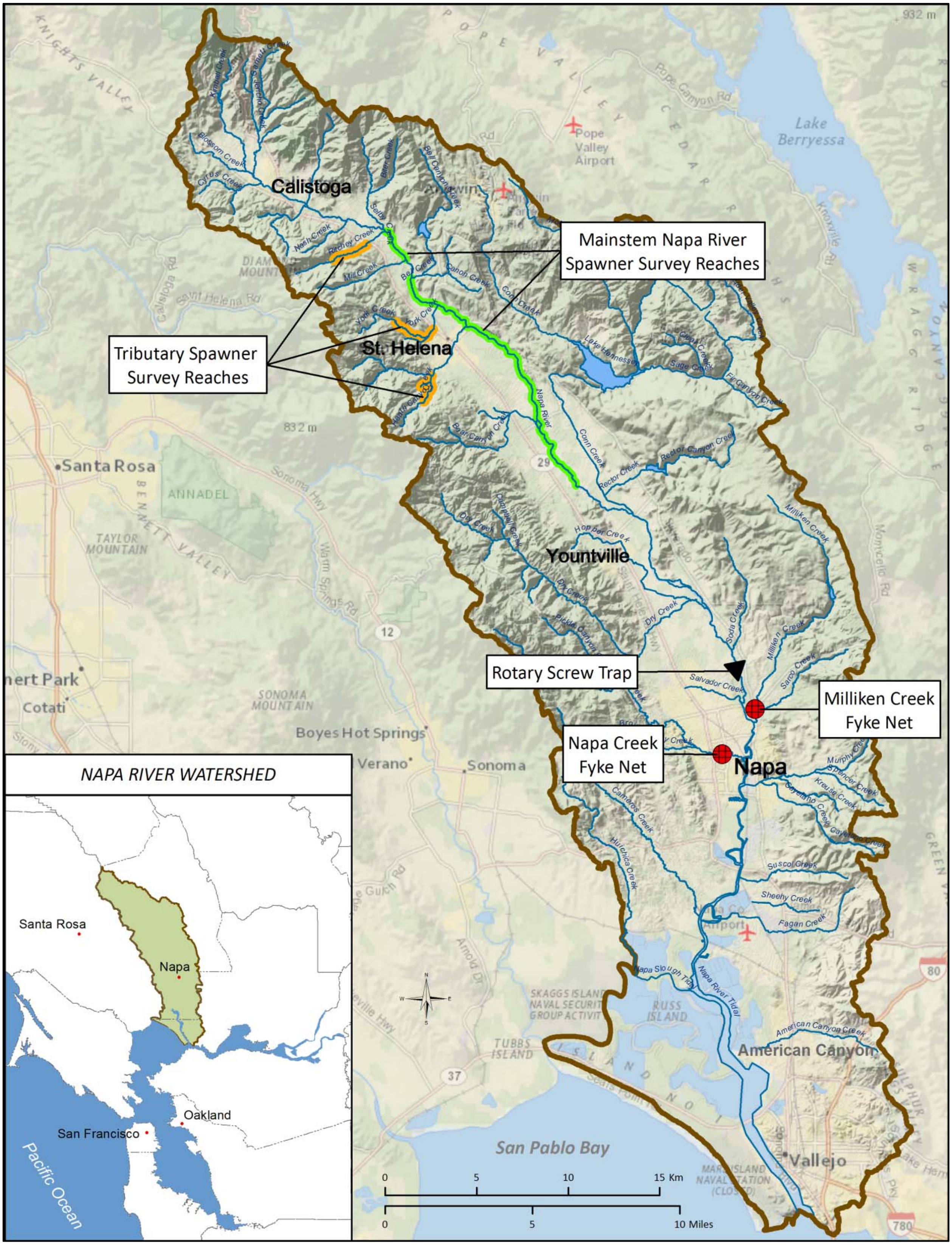


**Figure 6.** 2012-2013 steelhead and salmon monitoring sites in the Napa River watershed.

RCD's outmigrant trapping effort in spring 2013, which indicates that some Chinook spawning was successful this year; however, the exact location(s) of this spawning activity is unknown, and it does not appear to have been widespread.

RCD observed two adult steelhead near a spawning redd in the mainstem Napa River near St. Helena on January 11, 2013. In addition, adult steelhead were observed spawning in February and March near recently constructed habitat features in the Rutherford Restoration Reach of the Napa River [Observations made by Jorgen Blomberg (ESA-PWA), Jeremy Sarrow (Napa County Flood Control District), Josh Fuller (National Marine Fisheries Service), and Leslie Ferguson (SF Regional Water Quality Control Board)]. Despite follow-up visits to the reported spawning locations by RCD staff, photo documentation of these spawning events was not successful, as the fish had apparently left the area.

| Stream | Survey Reach[1] | Date | Target Species | Distance Surveyed (miles) | Number of Redds Counted | Number of Adult Fish Counted |
|---|---|---|---|---|---|---|
| Napa River | RDRT North | 12/12/2012 | Chinook | 2.41 | 0 | 0 |
| Napa River | Bale Lane | 12/14/2012 | Chinook | 0.8 | 0 | 0 |
| Napa River | Zinfandel | 12/19/2012 | Chinook | 2.24 | 0 | 0 |
| Napa River | Deer Park | 1/11/2013 | Chinook | 2.41 | 1 steelhead redd | 2 steelhead |
| York Creek | Spring Mt. Rd. crossing to dam | 2/20/2013 | Steelhead | 1.62 | 5 steelhead redds | 0 |
| Heath Creek (Tributary to Sulphur Creek) | Weir to natural limit of anadromy | 2/21/2013 | Steelhead | 1.15 | 1 steelhead redd | 0 |
| Ritchey Creek | Bothe State Park entrance rd. to upper road crossing | 2/22/2013 | Steelhead | 1.71 | 0 | 0 |

**Table 1.** Summary of adult spawner survey results during the 2012-13 season.

[1] Mainstem Napa River survey reaches included RDRT North (Rutherford Road Bridge to Zinfandel Lane Bridge), Bale Lane (Big Tree Road to Bale Lane), Zinfandel (Zinfandel Lane Bridge to Pope Street Bridge), and Deer Park (Pope Street Bridge to Deer Park Road Bridge) . Tributary survey extents are shown in Figure 6 and were determined by landowner access. Tributary surveys generally extended upstream to the limit of anadromy within each creek.

During tributary surveys, five steelhead redds were counted in York Creek on February 20, 2013, and one steelhead redd was counted in Heath Creek on February 21, 2013. No redds or adult salmonids were observed in Ritchey Creek during our spring 2013 tributary surveys. It was noteworthy that six adult steelhead were unexpectedly captured and released during the spring 2013 outmigrant trapping season: three in the RST (March 21, April 2, and April 5) and three in the Napa Creek fyke net (March 19, March 20, and March 28). Adult steelhead had never been captured in the RST in previous years. Based on the timing of these captures, steelhead spawning activity in the Napa River and its tributaries likely extended through at least early April.

As discussed earlier, observing adult steelhead is inherently difficult in natural stream systems due to poor visibility and the elusive nature of this species. In addition, adult steelhead do not necessarily die after spawning, so they may only remain in freshwater for a short period before returning to the ocean. Therefore our lack of direct observations does not necessarily indicate a lack of spawning activity, as it is likely that steelhead spawning may have occurred outside of our survey period. This is supported by the fact that we unexpectedly caught several adult steelhead in our outmigrant traps in March and April. Although rarely documented in the Napa River watershed, steelhead spawning appears to be sufficient in most years to maintain the current population, as evidenced by the relatively consistent smolt production we have observed during the past five years of monitoring.

## Outmigrant Trapping

The RCD has conducted annual outmigrant (smolt) monitoring with a rotary screw trap (RST) at the same location in the mainstem Napa River from 2009 to 2013 (Figure 6). In addition, outmigrant trapping with fyke nets was conducted in two tributary streams (Napa and Milliken Creeks) in 2012 and 2013.

### Rotary Screw Trap

An eight-foot diameter RST (Figure 7) was installed in the mainstem Napa River on January 30, 2013 at the same sampling location used in previous years. The site is located on private property approximately 3.2 km (2 miles) downstream of the Oak Knoll Avenue Bridge, very close to the upper extent of tidal influence. Approximately 67% (~118 miles) of the total anadromous salmonid habitat in the Napa River watershed is located upstream of this site. Details on how the trap was processed are discussed in Appendix A.

The RST was operated continuously for 82 days from January 30 through April 22, 2013, representing the second longest season in the program's five-year history (Figure 8). Stream flow during the 2013 sampling period was unusually low however, as no significant rainfall occurred after peak flows in November and December 2012. The low flow conditions throughout the spring likely reduced the RST's catch efficiency as well as shifted the season approximately one full month earlier than previous monitoring years. In an attempt to keep the trap spinning (operational), plywood deflector wings were installed upstream of the trap to direct flow into the cone (Figure 7, right photo). This configuration increased the rotation rate of the cone and allowed the trap to operate for several extra weeks. A hydrograph and continuous turbidity and water temperature data for the entire sampling period are shown in Appendix B.

**Figure 7.** Left: rotary screw trap in operation in February, Right: rotary screw trap tilted out of water due to low flow in late April (both photos taken facing downstream)

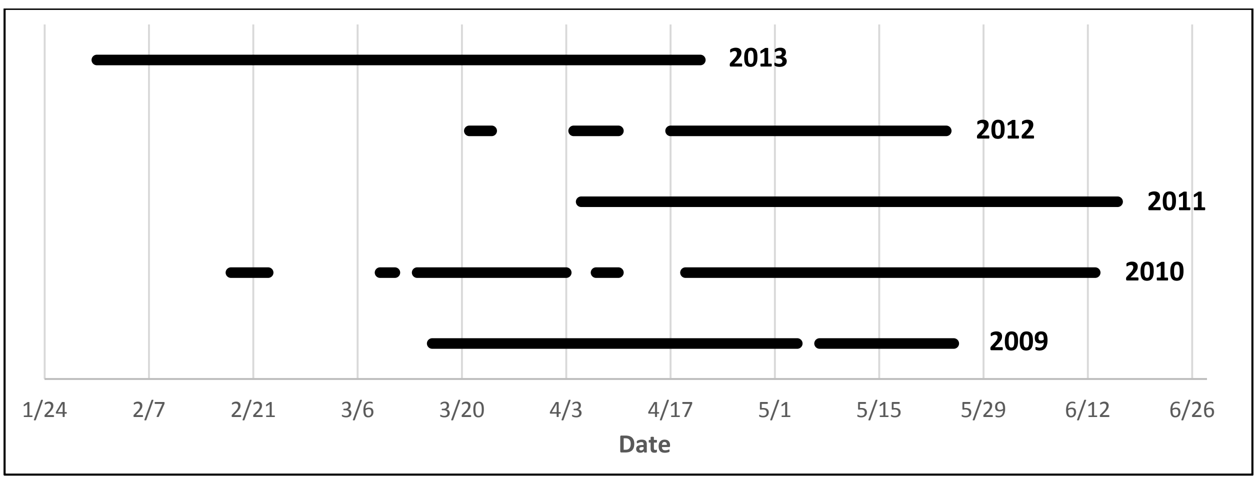


**Figure 8.** Napa River rotary screw trap periods of operation 2009-2013.
Note: gaps within each sampling season were due to high flows when the trap was not operated

During the 2013 season, a total of 4,708 fish were collected in the RST, comprised of twelve native species and five non-native species (Tables 2 and 3). This catch total was notably lower than all previous sampling years, and it is likely attributed to the lower flows and reduced trapping efficiency discussed in the following section.

From 2009 to 2013, native fish species comprised 98.5% of the total rotary screw trap catch (28,285 native fish, 434 non-native fish). This total does not include estimates of larval specimens (primarily native minnows and suckers), which were too abundant to accurately count. The three most common native species collected during this five-year monitoring period were Chinook salmon, California roach, and steelhead/rainbow trout. The most common non-native fish species encountered were bluegill, golden shiner, and fathead minnow.

A large number of steelhead fry (approximately 3,025) and three adult steelhead were unexpectedly captured in the RST during the 2013 season. Steelhead fry were captured throughout April; the adult steelhead were captured on March 21, April 2, and April 5. Steelhead fry have been captured in the RST in lower abundances in prior sampling years; however adult steelhead had never been captured in the RST before.

Based on steelhead smolt data from 2009 to 2013, it appears that the steelhead outmigration period peaks in early April and continues into early summer, depending upon flow conditions (Figure 9).

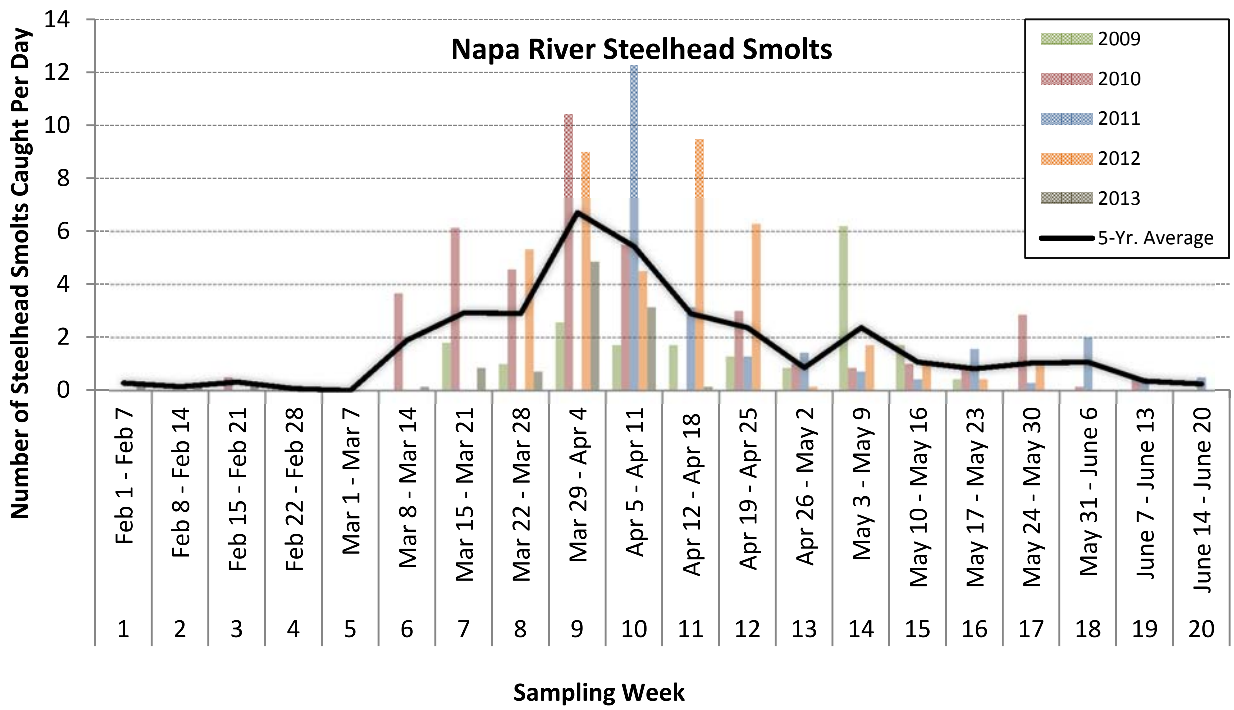


**Figure 9.** Weekly Napa River RST steelhead smolt catch rates for 2009 to 2013. The five year average of these data shows a peak in outmigrant activity occurring in early April.

| Common Name | Scientific Name | 2009 | 2010 | 2011 | 2012 | 2013 | Total |
|---|---|---|---|---|---|---|---|
| **Steelhead / Rainbow trout** | *Oncorhynchus mykiss* | | | | | | |
| Fry / Parr (<130 mm) | | 941 | 94 | 7 | 152 | 3,025 | **4,219** |
| Smolt (>130mm) | | 119 | 251 | 175 | 160 | 77 | **782** |
| Adult or Resident (>300 mm) | | 0 | 3 | 4 | 0 | 3 | **10** |
| **Chinook Salmon** | *Oncorhynchus tshawytscha* | | | | | | |
| Parr / Smolt | | 1 | 1,520 | 7,377 | 488 | 19 | **9,405** |
| **Kokanee/ Sockeye Salmon** | *Oncorhynchus nerka* | | | | | | |
| Parr / Smolt | | 0 | 342 | 0 | 0 | 0 | **342** |
| **Pacific Lamprey** | *Entosphenus tridentatus* | | | | | | |
| Adult | | 25 | 11 | 38 | 64 | 9 | **147** |
| Macrothalmia[1] | | - | - | - | - | 1 | **1** |
| Ammocete[1] | | - | - | - | 9 | 4 | **13** |
| **River Lamprey** | *Lampetra ayresi* | | | | | | |
| Adult[1] | | - | 2 | 21 | 9 | 3 | **35** |
| Macrothalmia[1] | | - | - | - | - | 15 | **15** |
| **Brook Lamprey** | *Lampetra cf. pacifica* | | | | | | |
| Adult[1] | | - | 0 | 64 | 7 | 174 | **245** |
| **Lampetra Sp. Ammocete[1]** | *Lampetra sp.* | - | - | - | 19 | 108 | **127** |
| **Unidentified Lamprey Sp.** | - | 216 | 248 | 111 | 25 | 6 | **606** |
| **Sacramento Splittail** | *Mylopharodon conocephalus* | 2 | 6 | 0 | 1 | 26 | **35** |
| **Hardhead** | *Pogonichthys macrolepidotus* | 0 | 0 | 1 | 0 | 0 | **1** |
| **Sacramento Pikeminnow** | *Ptychocheilus grandis* | 28 | 87 | 192 | 191 | 33 | **531** |
| **California Roach[2]** | *Hesperoleucus symmetricus* | 4,744 | 3,571 | 336 | 330 | 498 | **9479** |
| **Sacramento Sucker** | *Catostomus occidentalis* | | | | | | |
| Adult | | 82 | 419 | 207 | 33 | 78 | **819** |
| Juvenile / Larvae[2] | | 48,950 | 25,644 | 25,382 | 10,201 | 212 | **110,389** |
| **Tule Perch** | *Hysterocarpus traski* | 6 | 28 | 30 | 20 | 17 | **101** |
| **Prickly Sculpin** | *Cottus asper* | 242 | 124 | 62 | 66 | 329 | **823** |
| **Three-spine Stickleback** | *Gasterosteus aculeatus* | 116 | 76 | 273 | 50 | 34 | **549** |

**Table 2.** Native fish species collected annually in the Napa River rotary screw trap from 2009 through 2013.

[1] Juvenile and larval lamprey as well as adult river and brook lampreys were only differentiated consistently beginning with the 2012 season.

[2] Counts of larval sucker and small minnow specimens were visually estimated during periods of extreme abundance.

| Common Name | Scientific Name | 2009 | 2010 | 2011 | 2012 | 2013 | Total |
|---|---|---|---|---|---|---|---|
| **Bluegill** | *Lepomis macrochirus* | 29 | 100 | 86 | 41 | 11 | **267** |
| **Redear Sunfish** | *Lepomis microlophus* | 0 | 8 | 0 | 0 | 0 | **8** |
| **Pumpkinseed** | *Lepomis gibbosus* | 0 | 0 | 1 | 0 | 0 | **1** |
| **Green Sunfish** | *Lepomis cyanellus* | 0 | 2 | 5 | 0 | 0 | **7** |
| **Black Crappie** | *Pomoxis nigromaculatus* | 1 | 0 | 1 | 1 | 1 | **4** |
| **Largemouth Bass** | *Micropterus salmoides* | | | | | | |
| Larvae / Juvenile | | 0 | 969 | 0 | 0 | 0 | **969** |
| Adult | | 2 | 1 | 4 | 3 | 0 | **10** |
| **Western Mosquitofish** | *Gambusia affinis* | 1 | 0 | 2 | 3 | 1 | **7** |
| **Wakasagi** | *Hypomesus nipponensis* | 0 | 9 | 0 | 0 | 0 | **9** |
| **Threadfin Shad** | *Dorosoma petenense* | 0 | 2 | 3 | 1 | 0 | **6** |
| **Inland Silverside** | *Menidia beryllina* | 0 | 12 | 1 | 0 | 0 | **13** |
| **Fathead Minnow** | *Pimephales promelas* | 2 | 4 | 20 | 0 | 2 | **28** |
| **Common Carp** | *Cyprinus carpio* | 1 | 0 | 0 | 0 | 0 | **1** |
| **Golden Shiner** | *Notemigonus crysoleucas* | 1 | 11 | 18 | 1 | 22 | **53** |
| **White Catfish** | *Ameiurus catus* | 0 | 1 | 0 | 1 | 0 | **2** |
| **Brown Bullhead** | *Ameiurus nebulosus* | 2 | 3 | 3 | 3 | 0 | **11** |
| **Channel Catfish** | *Ictalurus punctatus* | 1 | 0 | 0 | 0 | 0 | **1** |
| **Striped Bass** | *Morone saxatilis* | 3 | 2 | 0 | 1 | 0 | **6** |

***Non-Fish Taxa***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Bullfrog** | *Rana catesbeiana* | | | | | | |
| Larvae (tadpole) | | 500 | 1,401 | 632 | 111 | 54 | **2,698** |
| Adult | | 1 | 2 | 5 | 2 | 0 | **10** |
| **Pacific Chorus Frog Tadpole** | *Pseudacris regilla* | 0 | 32 | 0 | 0 | 0 | **32** |
| **Signal Crayfish** | *Pacifastacus leniusculus* | 3 | 103 | 79 | 128 | 123 | **436** |
| **Red Swamp Crayfish** | *Procambarus clarkii* | 40 | 233 | 78 | 46 | 13 | **410** |
| **Red-eared Slider Turtle** | *Trachemys scripta elegans* | 0 | 3 | 1 | 1 | 1 | **6** |
| **Western Pond Turtle** | *Actinemys marmorata* | 2 | 1 | 1 | 1 | 1 | **6** |

**Table 3.** Non-native fish species and non-fish taxa collected annually in the Napa River rotary screw trap from 2009 through 2013

The median steelhead smolt length (fork length) during the past five years of sampling was 188mm (~ 7.4 inches). In 2013, the median steelhead smolt size was 197mm (~7.8 inches). The average size and range of steelhead smolts has been relatively consistent during the past five years (Figure 10), despite significant variability in environmental conditions including rainfall and seasonal flow patterns during that same period. Several studies have found a strong correlation between steelhead smolt size and ocean survival rates, with larger smolts having greater odds of returning as adults (Bond et al., 2008; Ward and Slaney, 1988; Ward et al., 1989). Given their large average size, we would expect Napa River steelhead smolts to have relatively high ocean survival rates, perhaps 15-25% based on literature estimates. The RCD will further test the hypothesis of high ocean survival in the coming years by tagging juvenile steelhead with passive induced transponder (PIT) tags and using a remote antenna in the river to detect returning adults. A total of 59 steelhead smolts were PIT tagged during the 2013 season.

The capture of 19 juvenile Chinook salmon in the RST in 2013 indicates that at least some adult salmon were able to successfully spawn during the 2012-13 season, despite very few adults being observed during spawner surveys. Chinook salmon abundance (both juveniles and adults) has fluctuated substantially during the past five years of monitoring, suggesting that the Napa River population is relatively small and unstable.

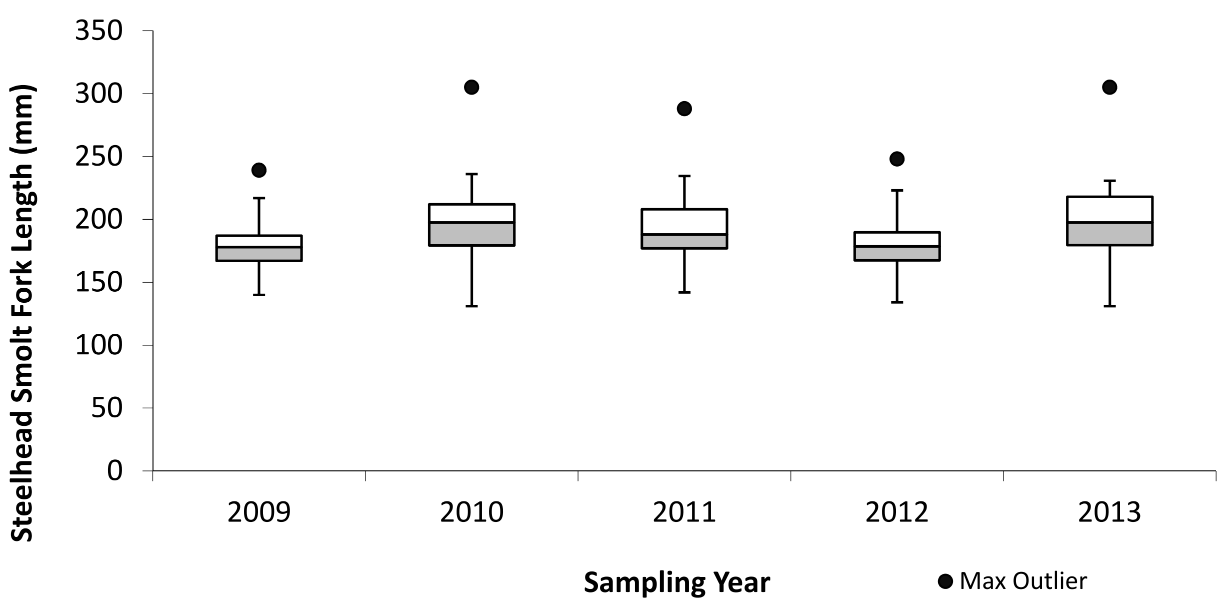


**Figure 10.** Box plot of steelhead smolt length from the Napa River rotary screw trap 2009-2013. Note: The bottom and top of each box are the 25th and 75th percentiles respectively. The line near the middle of each box is the median, and the vertical lines (whiskers) represent the lowest and highest values within 1.5 times the inter-quartile range. The maximum outlier values represent the largest individual measurement for each year.

**Rotary Screw Trap Efficiency**

In order to estimate what fraction of outmigrating steelhead and salmon are being captured by the RST (and therefore how many are being missed), trapping efficiency estimates must be calculated throughout the sampling period. For the past four years, the trapping efficiency of the RST has been calculated on a weekly basis from results of ongoing mark-recapture trials. Throughout each season, small groups of individual steelhead and salmon are marked and released approximately 1 km (~0.6 miles) upstream of the RST Monday through Friday of each week. The number of fish released is dependent upon catch rates, and therefore when few or no smolts are collected, efficiency releases cannot be conducted. In addition, no fish are marked and released upstream on Saturdays and Sundays to provide a distinct demarcation between weekly marking events. The total number of marked smolts that are recaptured is then divided by the total number of unmarked smolts collected that week to yield an efficiency estimate. Weekly trap efficiency data are also used in population estimate calculations.

A total of 56 steelhead smolts were fin clipped and PIT tagged and released upstream of the trap throughout the 2013 season (Table 4). Only one of these marked steelhead was subsequently recaptured. Additionally, ten Chinook smolts were marked and released, and only one was recaptured. It is not clear why we experienced such low recapture rates during the 2013 season, but it may be due to the unusually low flow conditions that persisted throughout the spring. Given these low recapture rates, trap efficiency estimates could not be confidently calculated for the 2013 sampling season. The average RST efficiency during the past several years has fluctuated from year to year and has averaged about 15% for steelhead and 24% for Chinook (Koehler and Blank, 2012). Trap efficiency appears to be strongly affected by streamflow, with higher trapping efficiencies at higher flows and vice versa.

| Year | Steelhead | | | | Chinook | | | |
|---|---|---|---|---|---|---|---|---|
| | Total number of smolts captured | Number of marked smolts released upstream | Number of smolts recaptured | Estimated annual trapping efficiency | Total number of smolts captured | Number of marked smolts released upstream | Number of smolts recaptured | Estimated annual trapping efficiency |
| 2010 | 242 | 201 | 23 | 11.4% | 1,371 | 702 | 139 | 19.8% |
| 2011 | 166 | 95 | 13 | 13.7% | 7,265 | 914 | 121 | 13.2% |
| 2012 | 142 | 84 | 17 | 20.2% | 406 | 272 | 102 | 37.5% |
| 2013 | 77 | 56 | 1 | not calculated | 19 | 10 | 1 | not calculated |

**Table 4.** Rotary screw trap efficiency estimates from 2010-2013

Note: Efficiency releases were not conducted during the 2009 season

**Smolt Passage Estimates**

Passage estimates are essentially population estimates for a specific lifestage (i.e. downstream migrants) that is presumed to be moving out of the system in a one-way downstream direction. These estimates are calculated using mark-recapture equations described in Carlson et al., 1998, as well as previous years' reports (Koehler and Blank, 2011). Smolt passage estimates represent the total number of fish estimated to have passed the trap site during each sampling season (Table 5). In order to have statistical confidence in such estimates, the efficiency of the collection method must be known to some degree. Due to the very low confidence we had in the 2013 trap efficiency estimates, smolt passage estimates could not be calculated for the 2013 season.

| Year | Days Sampled | Steelhead | | | Chinook | | |
|---|---|---|---|---|---|---|---|
| | | Captured | Passage Estimate | CPUE | Captured | Passage Estimate | CPUE |
| 2009 | 69 | 119 | not calculated* | 1.7 | 1 | not calculated* | 0 |
| 2010 | 89 | 242 | 1,946 (±738) | 2.7 | 1,371 | 6,888 (± 1,077) | 15.5 |
| 2011 | 72 | 166 | 970 (± 456) | 2.3 | 7,265 | 68,613 (± 19,611) | 101.5 |
| 2012 | 49 | 142 | 643 (±265) | 2.9 | 406 | 1,076 (± 183) | 8.3 |
| 2013 | 82 | 77 | not calculated* | 0.9 | 19 | not calculated* | 0.2 |

**Table 5.** Observed catch, total passage estimates, and catch-per-unit-effort (CPUE) of steelhead and Chinook smolts from 2009-2013

Note: One unit of effort is equal to one 24-hour period

*2009 and 2013 had very limited mark-recapture data preventing statistical confidence in passage estimates

Catch-per-unit-effort (CPUE) was calculated for steelhead and Chinook by dividing the total number of smolts captured by the number of days sampled per season. The CPUE may be a better metric for comparisons over multiple years with different sampling periods, yet it still does not take into account variability in flow patterns from year to year – a factor that is believed to have a significant effect on outmigrant movements. It is also important to note that the RST is located at a point that drains approximately 67% of the total salmonid habitat length within the Napa River watershed; therefore the passage estimates described above are partial estimates of total-basin populations. Additionally, the trap was only operated for a fraction of the total outmigration period each year, primarily due to budgetary and logistical constraints of sampling in a highly variable river system. Given these limitations, we feel that the most accurate and standardized metric for assessing population trends during the past five years of sampling is the CPUE.

Results for steelhead CPUE show a relatively stable or slightly increasing trend from 2009 to 2012 followed by a sharp decline in 2013 (Figure 11). This decline may be the result of poor trapping efficiency, differences in the sampling period from previous years, or a real reduction in the number of steelhead smolts migrating out of the system.

In contrast to steelhead, Chinook catch rates during the past five years show tremendous interannual variability (Figure 12). The variability in Chinook abundance suggests that the population is relatively small and may be more susceptible to environmental variability from one year to the next.

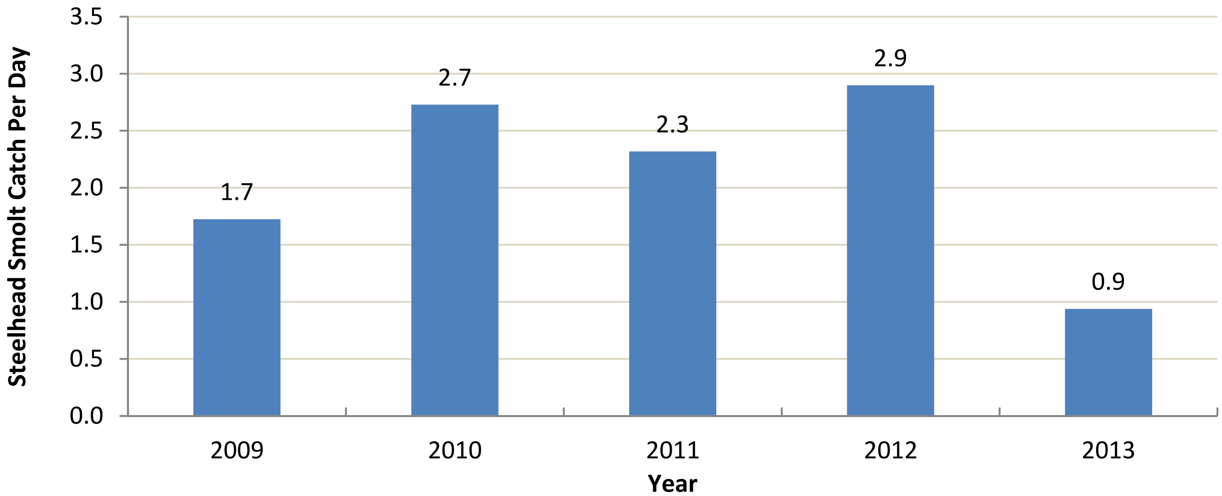


**Figure 11.** Steelhead smolt catch-per-unit-effort (CPUE) in the Napa River RST from 2009-2013.

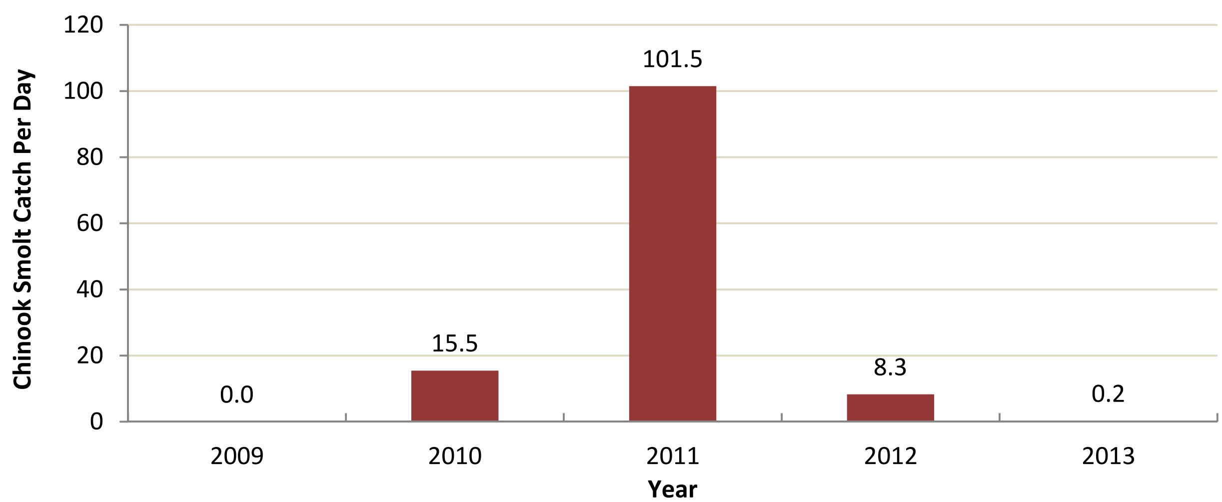


**Figure 12.** Chinook salmon smolt/parr catch-per-unit-effort (CPUE) in the Napa River RST from 2009-2013.

**Tributary Fyke Nets**

Fyke nets are portable fish traps that are commonly deployed in streams and other waterways to collect aquatic organisms. The nets used for this program are comprised of a series of hoops and funnels (fykes) that lead to the back of the trap where a livebox is connected via a short length of PVC pipe. Once inside the fyke net compartments or livebox, fish have a difficult time finding their way out, effectively becoming trapped. The traps are also equipped with extendable net wings to direct fish into the trap opening (Figure 13).

Fyke nets were installed and operated in Milliken Creek and Napa Creek during the spring 2012 and 2013 outmigrant seasons as part of a two-year study funded by the California Department of Fish and Wildlife and the California Department of Water Resources. The purpose of the study was to document the size (length and weight), relative abundance, and run timing of steelhead in major tributary streams where little current data existed. This trapping effort was also intended to help fill in data gaps for tributary streams that join the Napa River downstream of the RST.

**Figure 13.** Left: Milliken Creek fyke net, Right: Napa Creek fyke net (both photos taken facing downstream)

The fyke nets were installed in spring, when flows permitted access to the creek. Operating the fyke nets during periods of moderate to high stream flow proved especially difficult, and often impossible, due to high debris loading and gear damage. Therefore, we regularly were forced to remove both traps from the streams during storms, and often for several days afterwards, to allow the debris load to diminish. There was no fixed end date to the sampling period each year, and the traps were removed once flows and catch rates approached zero.

In 2012, both traps were operated for a total of 45 days (Koehler and Blank, 2012). In 2013, outmigrant trapping was conducted for a total of 43 days in Milliken Creek and 51 days in Napa Creek (Figure 14). Generally, traps were deployed for a minimum of four days per week throughout the season, but this was highly dependent on flow conditions. Both fyke nets were checked and processed daily following the protocols described in Appendix A.

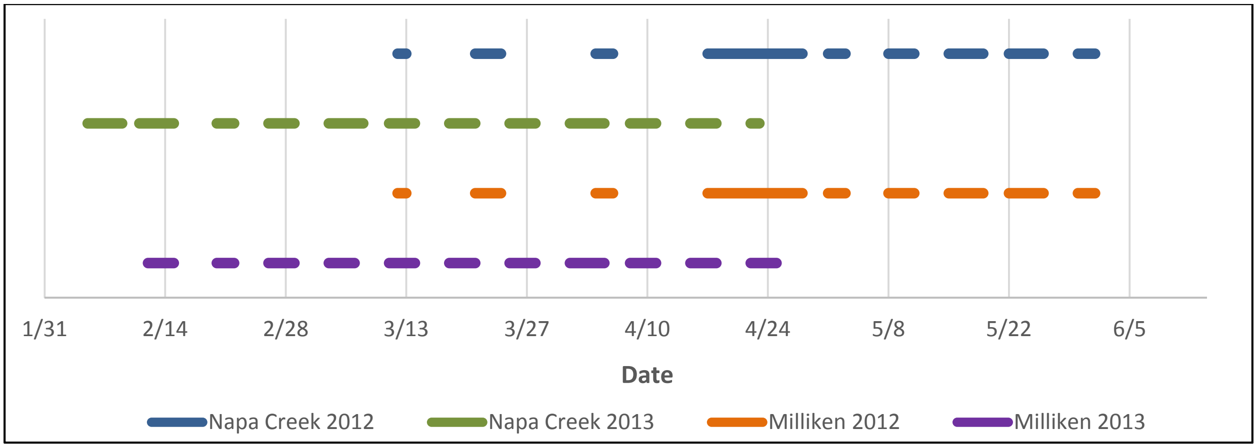


**Figure 14.** Fyke net periods of operation for Milliken and Napa Creek

Note: Traps were operated for a minimum of four days per week during each season. Larger gaps within the 2012 sampling season were due to high flow events when the traps were removed

In 2012 and 2013, we captured eleven native and seven non-native fish species in Milliken Creek (Table 6) and six native and one non-native fish species in Napa Creek (Table 7). In 2013, three adult steelhead (two females and one male) were caught in the Napa Creek fyke net and immediately released (Figure 15). These fish were captured on March 19, March 20, and March 28, 2013.

**Figure 15.** Adult spawned-out female steelhead captured and released from the Napa Creek fyke net (March 19, 2013)

| Common Name | Scientific Name | Milliken Cr. 2012 | Milliken Cr. 2013 |
|---|---|---|---|
| **Steelhead / Rainbow trout** | *Oncorhynchus mykiss* | | |
| Fry / Parr (<130 mm) | | 79 | 4 |
| Smolt (>130mm) | | 31 | 36 |
| Adult or Resident (>300 mm) | | 2 (steelhead) | 0 |
| **Chinook Salmon** (Parr) | *Oncorhynchus tshawytscha* | 1 | 0 |
| **Pacific Lamprey** (Adult) | *Entosphenus tridentata* | 9 | 8 |
| **River Lamprey** (Adult) | *Lampetra ayresi* | 1 | 0 |
| **Brook Lamprey** (Adult) | *Lampetra cf. pacifica* | 34 | 16 |
| **Lampetra Sp.** (Ammocete) | *Lampetra sp.* | 11 | 10 |
| **Unidentified Lamprey Sp.** (Ammocete) | - | 5 | 0 |
| **Sacramento Pikeminnow** | *Ptychocheilus grandis* | 7 | 9 |
| **California Roach** | *Hesperoleucus symmetricus* | 819 | 365 |
| **Sacramento Sucker** | *Catostomus occidentalis* | | |
| Adult | | 1 | 11 |
| Juvenile / Larvae | | 19 | 6 |
| **Tule Perch** | *Hysterocarpus traski* | 1 | 0 |
| **Prickly Sculpin** | *Cottus asper* | 141 | 130 |
| **Three-spine Stickleback** | *Gasterosteus aculeatus* | 109 | 57 |
| **Bluegill*** | *Lepomis macrochirus* | 27 | 3 |
| **Green Sunfish*** | *Lepomis cyanellus* | 1 | 2 |
| **Black Crappie*** | *Pomoxis nigromaculatus* | 2 | 0 |
| **Largemouth Bass*** | *Micropterus salmoides* | | |
| Adult | | 2 | 0 |
| Larvae (<25mm) | | 1 | 0 |
| **Inland Silverside*** | *Menidia beryllina* | 4 | 0 |
| **Fathead Minnow *** | *Pimephales promelas* | 5 | 6 |

***Non-Fish Taxa***

| | | | |
|---|---|---|---|
| **Bullfrog*** | *Rana catesbeiana* | | |
| Adult | | 7 | 7 |
| Tadpole | | 73 | 2 |
| **Western Toad (**Adult) | *Bufo boreas* | 12 | 3 |
| **Signal Crayfish*** | *Pacifastacus leniusculus* | 23 | 16 |
| **Red Swamp Crayfish*** | *Procambarus clarkii* | 10 | 9 |
| **Western Pond Turtle** | *Actinemys marmorata* | 3 | 1 |

**Table 6.** Catch data from the Milliken Creek fyke net during the 2012 and 2013 sampling seasons

*Non-native species

| Common Name | Scientific Name | Napa Cr. 2012 | Napa Cr. 2013 |
|---|---|---|---|
| **Steelhead / Rainbow trout** | *Oncorhynchus mykiss* | | |
| Fry / Parr (<130 mm) | | 49 | 16 |
| Smolt (>130mm) | | 23 | 12 |
| Adult or Resident (>300 mm) | | 1 (resident) | 3 (steelhead) |
| **Sacramento Pikeminnow** | *Ptychocheilus grandis* | 1 | 0 |
| **California Roach** | *Hesperoleucus symmetricus* | 456 | 222 |
| **Sacramento Sucker** | *Catostomus occidentalis* | | |
| Adult | | 3 | 11 |
| Juvenile / Larvae | | 33 | 0 |
| **Prickly Sculpin** | *Cottus asper* | 52 | 59 |
| **Three-spine Stickleback** | *Gasterosteus aculeatus* | 16 | 30 |
| **Green Sunfish*** | *Lepomis cyanellus* | 0 | 1 |
| ***Non-Fish Taxa*** | | | |
| **Bullfrog*** | *Rana catesbeiana* | | |
| Adult | | 1 | 0 |
| Tadpole | | 4 | 0 |
| **Signal Crayfish*** | *Pacifastacus leniusculus* | 45 | 15 |
| **Red Swamp Crayfish*** | *Procambarus clarkii* | 3 | 1 |
| **Red-eared Slider Turtle*** | *Trachemys scripta elegans* | 1 | 0 |
| **Western Pond Turtle** | *Actinemys marmorata* | 1 | 0 |

**Table 7.** Catch data from the Napa Creek fyke net during the 2012 and 2013 sampling seasons
*Non-native species

The median steelhead smolt length (measured as fork length) for Milliken Creek was 152mm in 2012 and 156mm in 2013. For Napa Creek, the median steelhead smolt length was 167mm in 2012 and 154mm in 2013 (Figure 16). These median steelhead smolt lengths were approximately 20-30mm less than those of steelhead collected in the Napa River RST over the past five years. Summarized steelhead smolt metrics for Napa and Milliken Creeks are provided in Table 8.

| Metric | Napa Creek | | Milliken Creek | |
|---|---|---|---|---|
| | 2012 | 2013 | 2012 | 2013 |
| Number of steelhead smolts captured | 23 | 12 | 31 | 36 |
| Median fork length (mm) | 167 | 154 | 152 | 156 |
| Median weight (g) | 48.6 | 36.5 | 38.6 | 37.1 |
| Standard Deviation in Length (mm) | 22.4 | 23.2 | 14.6 | 17.6 |
| Maximum Length (mm) | 215 | 194 | 184 | 205 |

**Table 8.** Steelhead smolt summary data from Napa Creek and Milliken Creek fyke nets

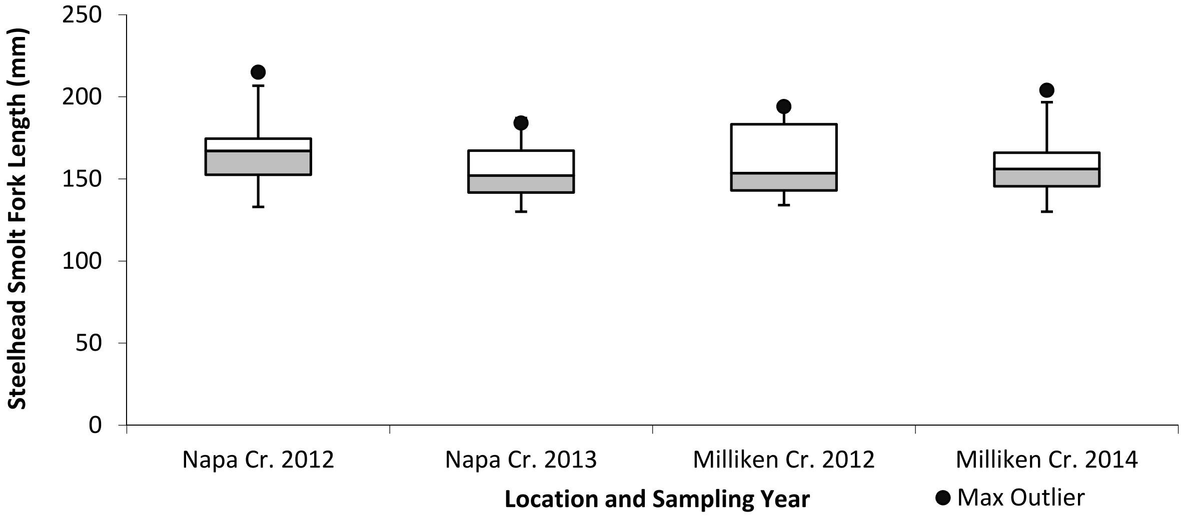


**Figure 16.** Box plot of steelhead smolt length from the Napa Creek and Milliken Creek fyke nets during the 2012 and 2013 sampling seasons.

Note: The bottom and top of each box are the 25th and 75th percentiles respectively. The line near the middle of each box is the median, and the vertical lines (whiskers) represent the lowest and highest values within 1.5 times the inter-quartile range. The maximum outlier values represent the largest individual measurement for each year.

In both Napa and Milliken Creeks, steelhead smolt catch rates peaked during the first two weeks in April and tapered off throughout the remainder of the spring. This outmigration timing was similar to that observed in the Napa River the past five years. We did not see any apparent relationship between the timing of downstream migration and smolt size for either stream (Figures 17 and 18).

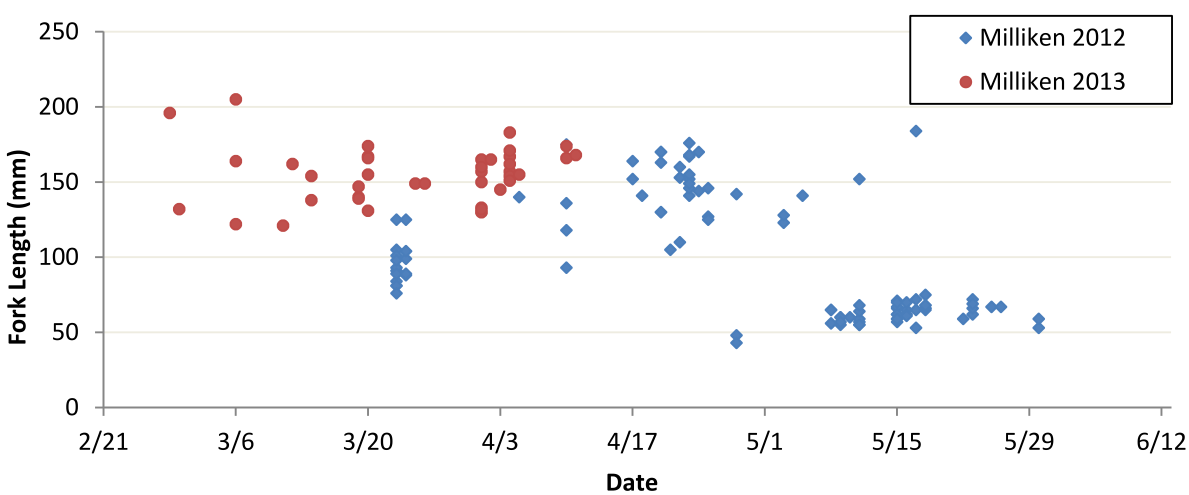


**Figure 17.** Measured steelhead lengths from Milliken Creek during the 2012 and 2013 seasons

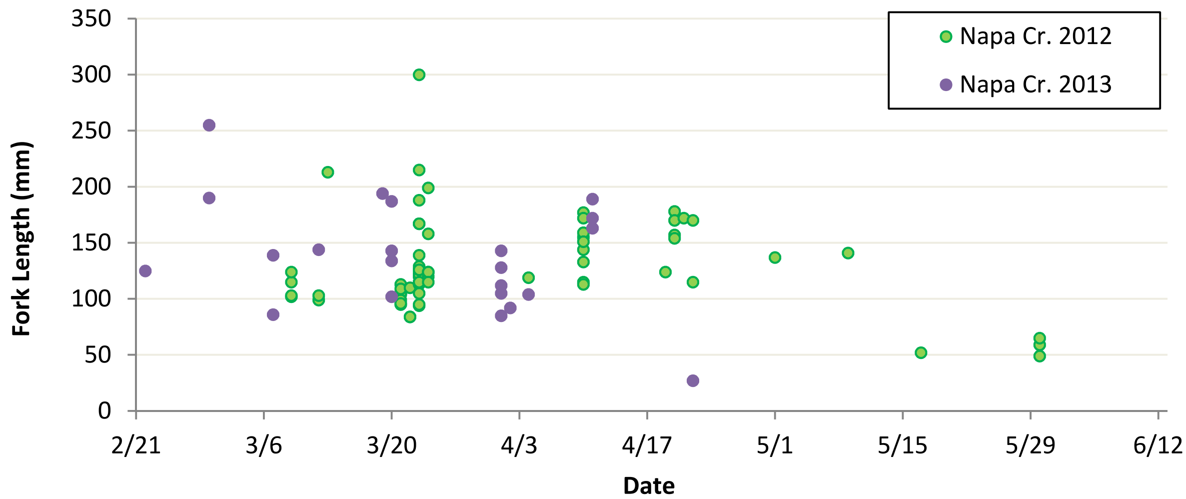


**Figure 18.** Measured steelhead lengths from Napa Creek during the 2012 and 2013 seasons

**Fyke Trap Efficiency**

As discussed above for the RST, the efficiency of fyke nets can be calculated from mark-recapture data. During the 2012 and 2013 seasons, individual steelhead were marked and released approximately 0.25 km (a minimum of two riffle-pool sequences) upstream of the trap. The number of fish released per week was highly dependent on catch rates, and therefore many weeks when few or no smolts were collected, efficiency releases were not able to be conducted. The total number of marked fish that were recaptured was then divided by the total number of unmarked steelhead collected that week to yield an estimate of trapping efficiency (Table 9).

| Year | Napa Creek | | | | Milliken Creek | | | |
|---|---|---|---|---|---|---|---|---|
| | Total number of smolts captured | Number of marked smolts released upstream | Number of smolts recaptured | Estimated annual trapping efficiency | Total number of smolts captured | Number of marked smolts released upstream | Number of smolts recaptured | Estimated annual trapping efficiency |
| 2012 | 23 | 5 | 0 | not calculated | 31 | 19 | 3 | 15.8% |
| 2013 | 12 | 7 | 0 | not calculated | 36 | 36 | 5 | 13.9% |

**Table 9.** Fyke trap efficiency estimates from the 2012 and 2013 seasons

Note: the absence of recapture data for the Napa Creek site in both years prevented calculations of trapping efficiency estimates

## CONCLUSIONS

- Catch rates of steelhead smolts in the RST declined sharply during the 2013 season. This decline may have been due to reduced trapping efficiencies caused by low-flow conditions that persisted during the entire sampling period.

- Adult steelhead were observed spawning in the mainstem Napa River and tributaries in winter and several adults were captured in our outmigrant traps in winter and spring. These observations are relatively rare in the Napa River watershed; however the unusually low flow conditions this year may have increased the likelihood of encountering spawning fish.

- An unexpectedly large number of steelhead fry (<40mm) were captured in the RST in April 2013, suggesting that at least one pair of steelhead spawned near the trap site.

- An unknown, but likely small, number of Chinook salmon successfully spawned in the Napa River in 2012-13, as indicated by the capture of 19 Chinook smolts in the RST. Our spawner surveys were relatively unsuccessful at documenting the locations of this spawning activity.

- Steelhead smolts collected in the RST during the past four years have had a median length of 188 mm (~7.4 inches); this large average size would be expected to produce high ocean survival rates. The size and range of steelhead smolts has varied little during the past five years.

- Steelhead smolts captured in Milliken and Napa Creeks in 2012 and 2013 were approximately 20-30 mm smaller on average than steelhead smolts captured in the RST during the past five years.

## FUTURE EFFORTS

The RCD and its partners plan to operate the RST in the same location in spring 2014. Fyke nets will be installed in two new tributary locations upstream of the RST in an effort to study steelhead movements, residence time, and potentially growth. The exact locations of these two traps have not been determined. Adult salmon spawner surveys will be conducted in the RDRT and Zinfandel sampling reaches in fall/winter 2013-14. RCD does not have funding to conduct additional adult steelhead surveys.

The RCD has constructed a remote PIT tag antenna in the Napa River near the RST, which will be operated continuously during the winter 2013 and spring 2014 seasons to detect tagged juveniles or returning adults from previous tagging efforts. Additionally, RCD plans to tag as many steelhead as possible from the RST and fyke nets to improve the odds of re-detecting these fish in the future.

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# APPENDICES

**APPENDIX A: OUTMIGRANT TRAP PROCESSING PROCEDURE AND DECISION TREE**

**APPENDIX B: NAPA RIVER FLOW, WATER TEMPERATURE, AND TURBIDITY**

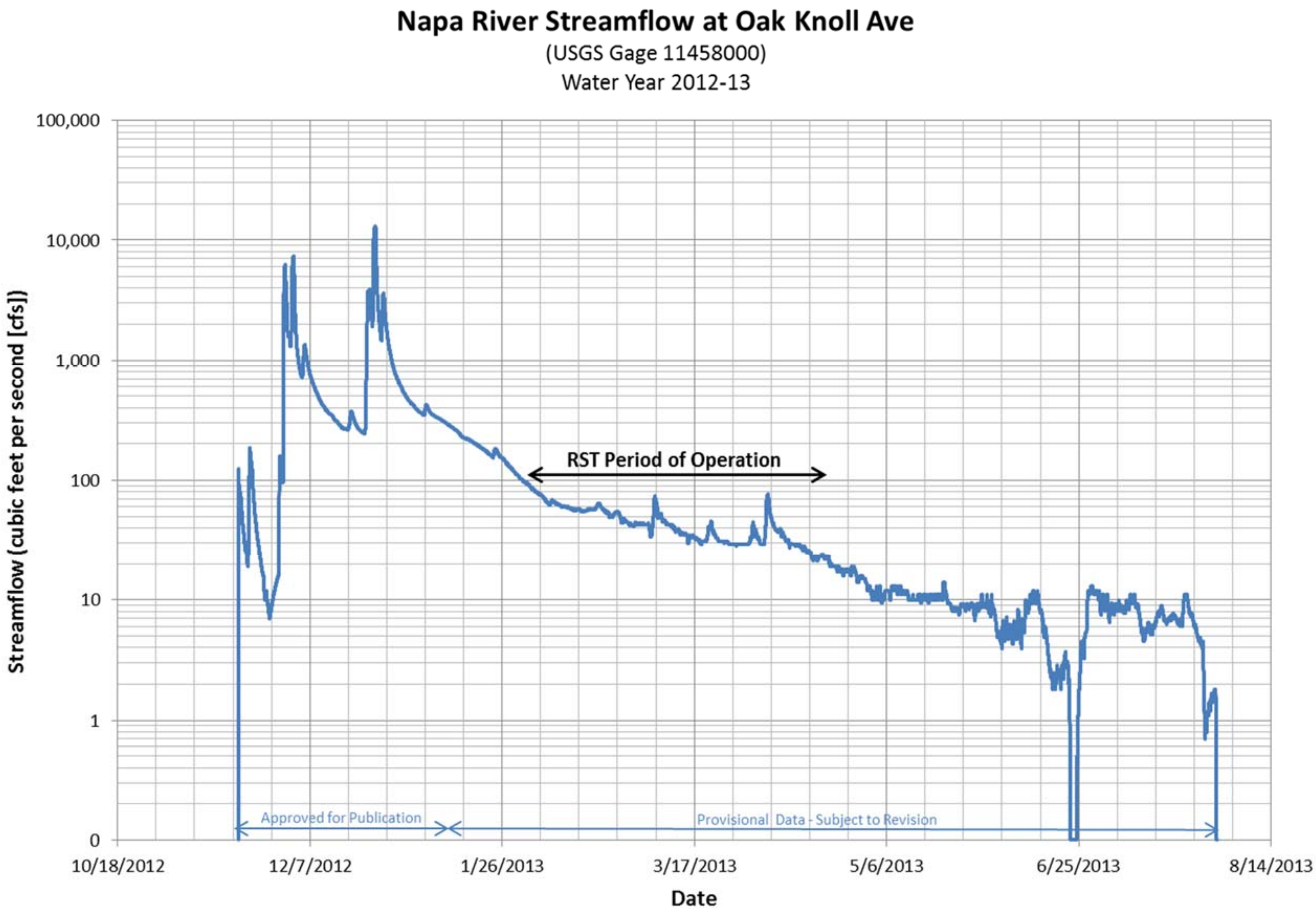
## Appendix A: Outmigrant Trap Processing Procedure and Decision Tree

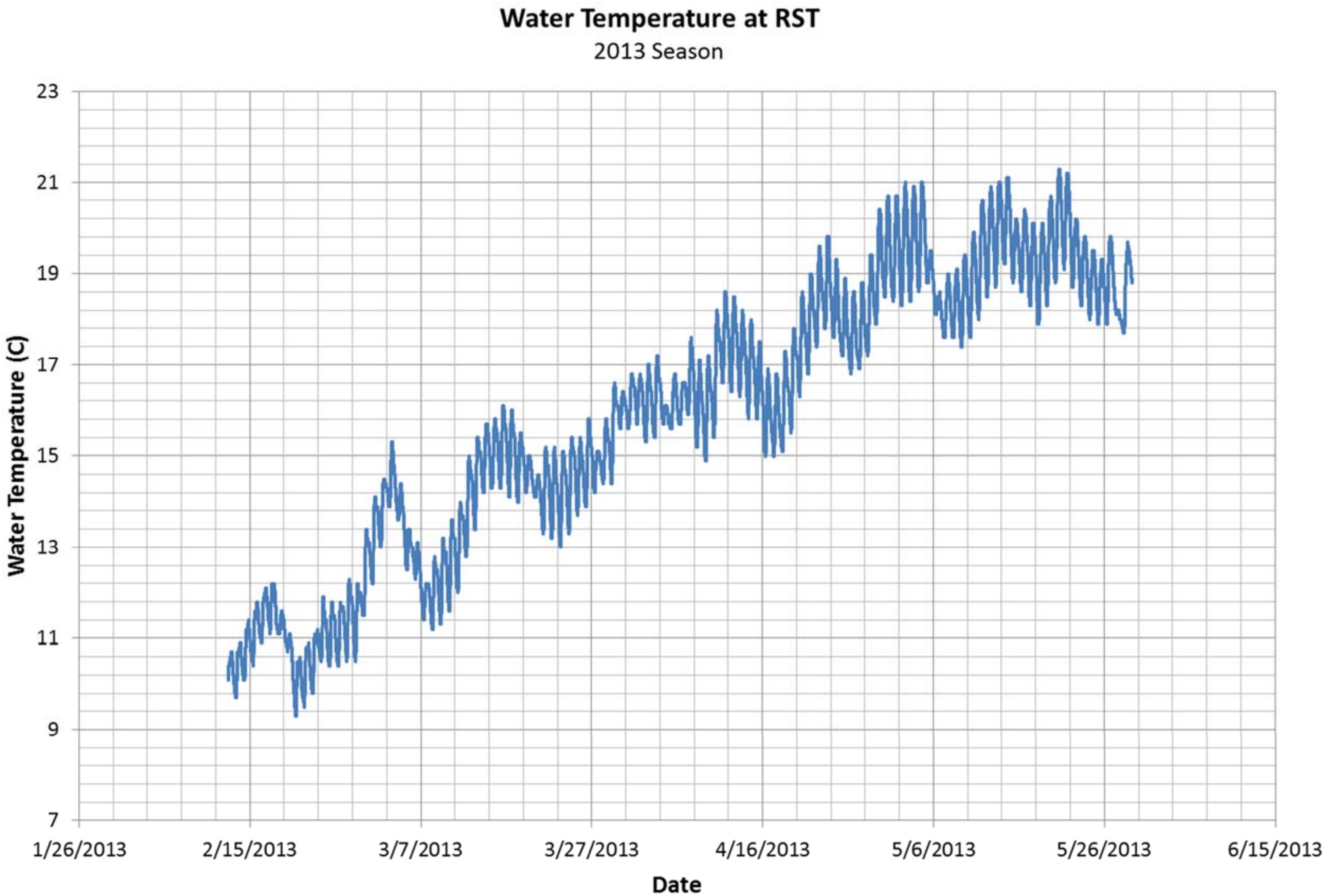
All traps are checked daily in the morning whenever possible by a permitted RCD biologist and an assistant (volunteer or other staff member). Dipnets are used to remove debris from the livebox first, non-target species second, and salmonids last. Salmonids are placed in five gallon buckets with battery operated pumps providing aeration. Non-target species are identified to the species level if possible, counted, and released immediately downstream.

Following the decision tree below, a randomly-selected subset of salmonids each day are placed into a "drug bucket" containing fresh stream water dosed with an anesthetic solution of MS-222 (Tricaine-S) at a concentration of 40-60 mg/L. These fish are allowed to become mildly sedated for several minutes before being processed. Once the fish is sedated, it is weighed to the nearest 0.1g and measured to the nearest millimeter. Depending on the objective of a given year's study, some salmonids receive a small partial fin clip for genetic analysis and for mark-recapture purposes. Some steelhead smolts are also tagged with PIT tags and/or alphanumeric tags for mark recapture and long-term tracking purposes. Scales can be collected from a range of smolt sizes to determine age class structure. Processed fish are allowed to completely recover in aerated fresh water buckets before either being released immediately downstream or transported to an upstream release site for trap-efficiency trials. Salmonids that are simply counted are released immediately downstream.

| Species | Fork Length | Is the fish a recapture? | Number to process | Processing Procedure | Release site |
|---|---|---|---|---|---|
| **Steelhead** | <40mm (fry) | n/a | all | Count | down |
| | < 130 mm (yoy/parr) | n/a | first 20 | Record length, weight. Collect genetics tissue sample (pooled) | down |
| | | | 21+ | Count | down |
| | ≥ 130 mm (smolts) | no | first 30 | Record length, weight, marks, tag ID's. Collect genetics (individual ID) | up |
| | | | 31+ | Count | down |
| | | yes | all | Record any marks/tag ID's, **Do not anesthetize** | down |
| | adult | n/a | all | Record any marks (look for a clip) and sex, estimate length. **Do not anesthetize. Take pictures if possible** | down (immediate release) |
| **Chinook or other salmon** | ≥ 40 mm (smolts) | no | first 20 | Record length, weight. Collect genetics tissue sample (pooled) | up |
| | | | 21+ | Count | down |
| | | yes | all | Record observed marks. **Do not anesthetize** | down |
| | < 40 mm (yoy/parr) | n/a | all | Count | down |
| **All other species** | all | n/a | all | Count | down |

**APPENDIX B: NAPA RIVER FLOW, WATER TEMPERATURE, AND TURBIDITY**




Water Temperature at RST
2013 Season
Water Temperature (C)
23
21
19
17
15
13
11
9
7
1/26/2013
2/15/2013
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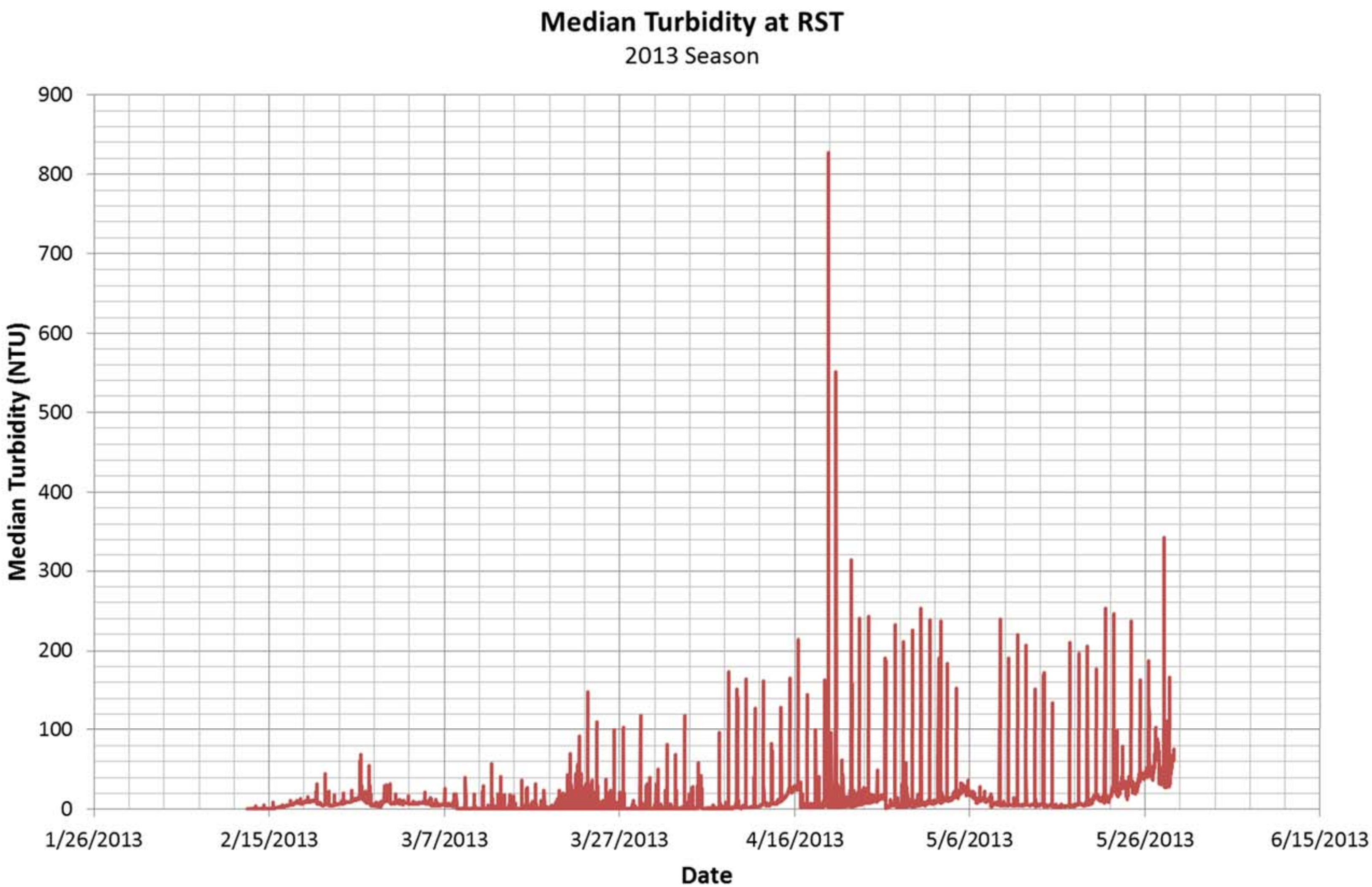
5/26/2013
6/15/2013
Date


Median Turbidity at RST
2013 Season
Median Turbidity (NTU)
900
800
700
600
500
400
300
200
100
0
1/26/2013
2/15/2013
3/7/2013
3/27/2013
4/16/2013
5/6/2013
5/26/2013
6/15/2013
Date