NAPA RIVER STEELHEAD AND SALMON SMOLT MONITORING PROGRAM

ANNUAL REPORT – YEAR 3

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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 (RST). The purpose of this program is to describe salmonid life history details, generate salmonid population estimates, document the composition of the Napa River fish community, and track ecological responses to ongoing habitat restoration. The RST has been installed annually at the same location in the mainstem Napa River north of Trancas Avenue approximately 400 meters (0.25 miles) upstream of the extent of tidal influence. Approximately 67% (118 miles) of the total salmonid habitat in the Napa River watershed is located upstream of this point.

This report covers the third consecutive sampling season, which began on April 6, 2011 and extended through June 17, 2011. Installation of the trap was delayed by over one month due to high flows. Once installed, the trap was able to be operated continuously without significant interruption for 72 consecutive days.

A total of 24 fish species were captured (13 native, 11 exotic). The total non-larval catch was 9,042 fish, which was comprised of 8,898 natives and 144 exotics. Larval and juvenile (< 25mm in length) Sacramento sucker (*Catostomus occidentalis*) were also extremely abundant, and an estimated 25,000 were collected. As with previous years, native species dominated the total catch, accounting for 98.4% of all specimens. Three fish species were collected in 2011, which had not been previously captured in the RST: hardhead (*Mylopharodon conocephalus*) threadfin shad (*Dorosoma petenense*), and pumpkinseed (*Lepomis gibbosus*). All three species were already known to occur in the Napa River watershed.

A total of 177 steelhead (*Oncorhynchus mykiss*) were captured in 2011, including 166 smolts, 7 parr, and 4 large individuals (>300mm in length), which were likely resident trout. The median length of steelhead smolts was 188 mm compared to 198mm in 2010 and 178 mm in 2009.

A total of 7,265 Chinook salmon (*O. tshawytscha*) parr and smolts were captured, compared to 1,371 captured in 2010 and only a single Chinook caught in 2009.

Throughout the sampling period, a total of 95 steelhead smolts and 914 Chinook smolts were marked and released upstream of our trap to determine trap efficiency. A total of 13 steelhead smolts and 121 Chinook smolts were recaptured, yielding trap efficiencies of 13.7% for steelhead and 13.2% for Chinook. In total, fin clips were collected from 154 steelhead and 1,276 Chinook for genetic analysis.

BACKGROUND

The Napa River is known to have 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).

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). The RCD initiated the smolt monitoring program in 2009; prior to this, smolt trapping had never been conducted for the Napa River watershed (Koehler 2009, Koehler and Blank 2010).

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

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

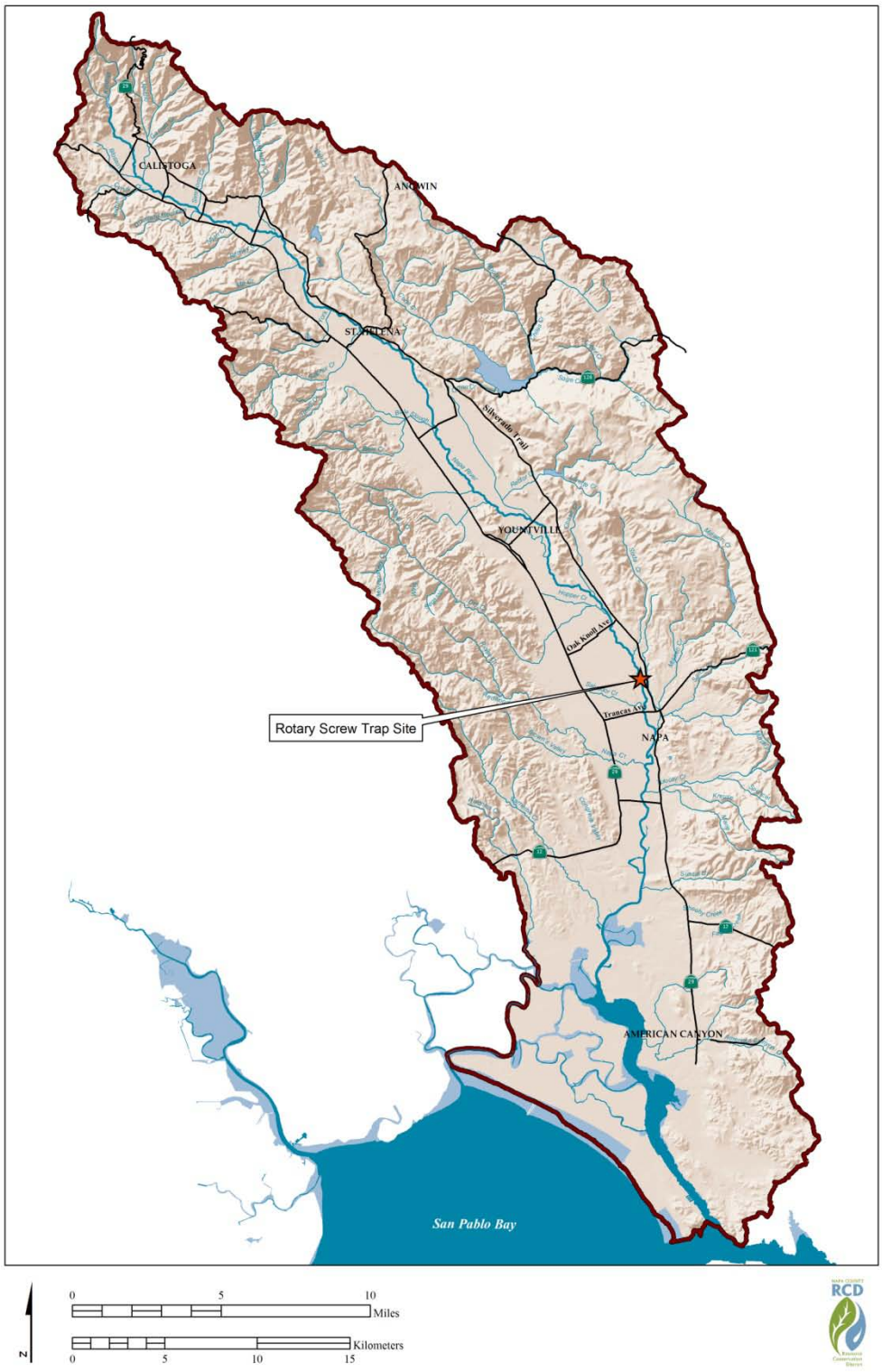

Figure 1. Rotary screw trap monitoring site located on the mainstem Napa River approximately two miles downstream of the Oak Knoll Avenue Bridge.

METHODS

Rotary Screw Trap

A rotary screw trap (RST) with an 8-foot diameter cone was installed in the mainstem Napa River approximately 3.2 km (2 miles) downstream of the Oak Knoll Avenue Bridge on private property (Figure 1). The site is located approximately 400 meters (0.25 miles) 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. Approximately 67% (118 miles) of the total anadromous salmonid habitat in the Napa River watershed is located upstream of this point.

The trap was assembled onsite with the assistance of a group of volunteers and positioned at the head of a deep pool approximately 300 feet in length. The trap was in operation continuously (24 hours per day, 7 days per week) from April 6, 2011 to June 17, 2011, for a total of 72 sampling days. RCD planned to install the trap in mid February; however high stream flows throughout February and March prevented safe installation of the trap until early April. A hydrograph of the entire sampling period is shown in Appendix A.

The trap was visually inspected daily for proper operation, and debris was removed as needed. The number of revolutions per minute (RPM) was recorded daily. 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.

Trap Processing

Fish were removed from the RST's live box with dip nets daily starting around 9:00 AM. All fish were identified to species, counted, visually inspected for marks or tags and either released off the back of the trap or placed into five gallon buckets with battery operated air pumps. All fish that were simply counted were released immediately downstream without anesthetization. A random selection of up to twenty individual Chinook and up to thirty steelhead were fully processed each day. Full processing included anesthetizing, weighing, measuring, and fin-clipping each individual. Fork length to the nearest millimeter and weight to nearest tenth of one gram was recorded for each individual. Fin clips were used as marks for trap efficiency trials as well as providing tissue samples for genetic analysis. The trap processing decision tree is shown in Appendix B.

An anesthetic solution of MS-222 (Tricaine-S) at a concentration of 40-50 mg/L was used to sedate the fish prior to processing. Maximum exposure time to the anesthetic at this dosage was thirty minutes, which was based on guidance by the manufacturer (Western Chemical 2009). Sedated fish were allowed to recover in fresh, aerated water before being released. The degree of smoltification was determined by visual examination and fork length. Juvenile salmon were classified as parr if parr marks were distinct and smolts if parr marks were not

visible and the fish exhibited a silvery appearance. All steelhead greater than 130 mm FL were classified as smolts. Steelhead larger than 300 mm were classified as adults or resident rainbow trout.

Trap Efficiency

Trapping efficiency trials were run continuously throughout the sampling period on a five-day release schedule. On weekdays (Monday-Friday), a subset of the total steelhead and salmon collected in the trap were marked with fin clips, placed in aerated five-gallon buckets, and transported approximately 1 km (0.62 miles) upstream of the RST for release. The release site was located two riffle-pool sequences above the trap to help ensure the release group was properly re-acclimated to the stream environment prior to encountering the trap again. No marked fish were released upstream of the trap on weekends (Saturday and Sunday). This strategy was employed in an effort to generate weekly trap efficiency estimates and clearly define the mark-recapture events. A total of 95 marked steelhead smolts and 914 marked Chinook smolts were released upstream of the RST for efficiency trials over the course of the entire sampling period.

Population Estimates

The number of fish captured by the trap represented only a portion of the total fish moving downstream in that time period. Total salmonid out-migration estimates (by species) were determined on a weekly basis for 0+ Chinook salmon and 1+ and 2+ steelhead trout using stratified mark-recapture methods described by Carlson et al. (1998). The approximately unbiased estimate equation for a 1-site study was used to determine total population size (U_h) in a given capture and trapping efficiency period (h). Variance was computed, and the value was used to calculate 95% confidence intervals (CI) for each weekly population estimate. Trap efficiency data was combined (pooled by week) and run through the equation to determine the weekly estimate.

Weekly trapping efficiency estimates were not generated in 2009 due to budgetary constraints; therefore population estimates for 2009 were derived using Petersen mark-recapture equations described by Koehler (2009).

RESULTS AND DISCUSSION

During 72 days of operation in 2011, a total of 24 fish species were captured including 13 natives and 11 exotics (Tables 1 and 2). The total non-larval catch was 9,042 fish, which was comprised of 8,898 natives and 144 exotics. Larval and juvenile Sacramento sucker (< 25mm in length) were highly abundant with an estimated 25,000 individuals collected. Exact counts of these individuals were not feasible given budgetary and staffing constraints. Non-fish taxa observed are shown in Table 3.

Common Name	Scientific Name	2011 Total
Steelhead Smolt (silvery)	*Oncorhynchus mykiss*	166
Steelhead Parr (<130 mm)	*Oncorhynchus mykiss*	7
Steelhead/Rainbow adult (>300 mm)	*Oncorhynchus mykiss*	4
Chinook Parr/Smolt	*Oncorhynchus tshawytscha*	7,265
River Lamprey adult	*Lampetra ayresi*	21
Western Brook Lamprey	*Lampetra richardsoni*	64
Pacific Lamprey adult	*Lampetra tridentata*	38
Lamprey Sp. (Ammocete)	*Lampetra sp.*	111
Sacramento Splittail	*Pogonichthys macrolepidotus*	0
Sacramento Pikeminnow	*Ptychocheilus grandis*	192
California Roach	*Hesperoleucus symmetricus*	336
Sacramento Sucker	*Catostomus occidentalis*	207
Sacramento Sucker Larvae/Juveniles	*Catostomus occidentalis*	25,382*
Tule Perch	*Hysterocarpus traski*	30
Prickly Sculpin	*Cottus asper*	62
Three-spine Stickleback	*Gasterosteus aculeatus*	273

*Counts of larval specimens were estimated

Table 1. Native fishes captured during the 2011 sampling season

Common Name	Scientific Name	2011 Total
Bluegill	*Lepomis macrochirus*	86
Pumpkinseed	*Lepomis gibbosus*	1
Green Sunfish	*Lepomis cyanellus*	5
Black Crappie	*Pomoxis nigromaculatus*	1
Largemouth Bass	*Micropterus salmoides*	4
Western Mosquitofish	*Gambusia affinis*	2
Threadfin Shad	*Dorosoma petenense*	3
Inland Silverside	*Menidia beryllina*	1
Fathead Minnow	*Pimephales promelas*	20
Golden Shiner	*Notemigonus crysoleucas*	18
Brown Bullhead	*Ameiurus nebulosus*	3

Table 2. Exotic fishes captured during the 2011 sampling season

Common Name	Scientific Name	2011 Total
Bullfrog Tadpole	*Rana catesbeiana*	632
Bullfrog Adult	*Rana catesbeiana*	5
Signal Crayfish	*Pacifastacus leniusculus*	79
Red Swamp Crayfish	*Procambarus clarkii*	78
Red-eared Slider Turtle	*Trachemys scripta elegans*	1
Western Pond Turtle	*Actinemys marmorata*	1

Table 3. Non-fish taxa captured during the 2011 sampling season

Native fish species dominated the total catch, accounting for 98.4% of all non-larval specimens collected. Chinook salmon was the most abundant species with 7,265 parr/smolts captured; this species accounted for 80.3% of the total catch for the 2011 sampling season.

The 2011 sampling year produced far higher catches of juvenile Chinook salmon than either of the two previous sampling years. Based on these results and ongoing monitoring of adult salmon spawning, it appears that there is a high degree of variability associated with the Napa River Chinook salmon population from year to year. However, long-term monitoring that spans at least two lifecycles (i.e. a minimum of ten years) is needed to more accurately assess their population trends within the watershed.

Three fish species were collected in 2011, which had not been previously captured in the RST: hardhead (*Mylopharodon conocephalus*), threadfin shad (*Dorosoma petenense*), and pumpkinseed (*Lepomis gibbosus*). The hardhead is a large native minnow, which was already known to occur in the Napa River watershed. The hardhead specimen collected in the trap was dead at time of processing and kept as a voucher specimen. Threadfin shad are an introduced species, which is abundant in the estuarine portion of the Napa River. Pumpkinseed is an introduced sunfish species, which has been stocked extensively in ponds and reservoirs throughout California, including those in the Napa River watershed.

A total of 177 steelhead were captured during the 2011 sampling season, including 166 smolts, 7 parr, and 4 adults (likely resident rainbow trout). Steelhead smolts ranged from 142-288 mm with a median length of 188 mm (Figure 2). Length-to-weight ratios for all steelhead collected are shown in Figure 3.

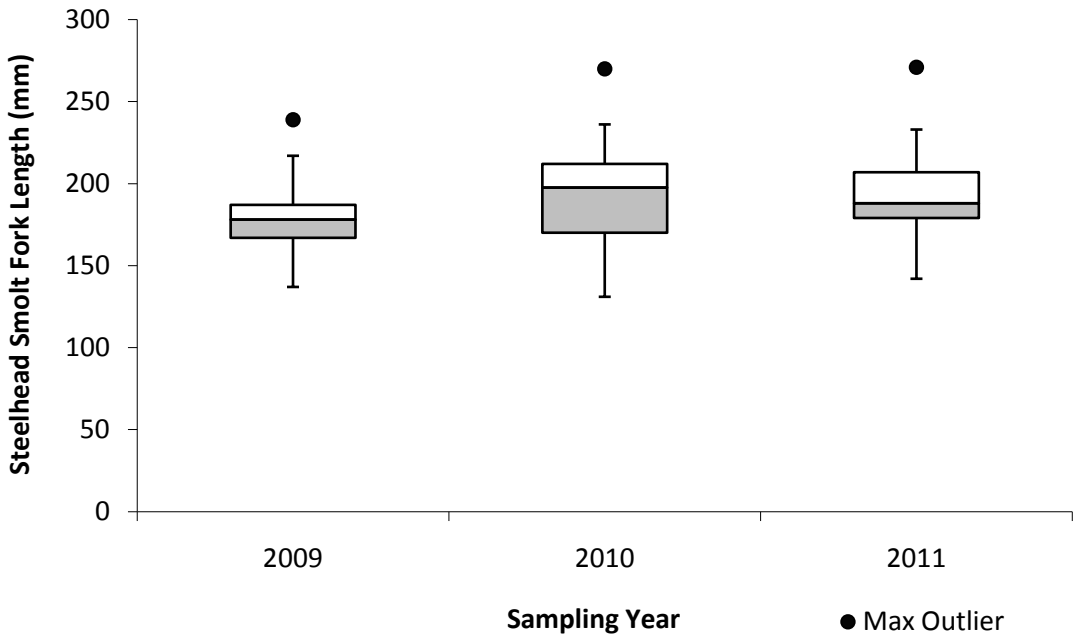

Figure 2. Box plot of steelhead smolt length data from 2009-2011.
Note: the bottom and top of the box are the 25th and 75th percentiles respectively, the band near the middle of the box is the median, and the vertical lines (whiskers) represent the lowest and highest values within 1.5 times the inter-quartile range of the lower and upper quartile respectively. The maximum outlier values represent the largest individual measurement for each year.

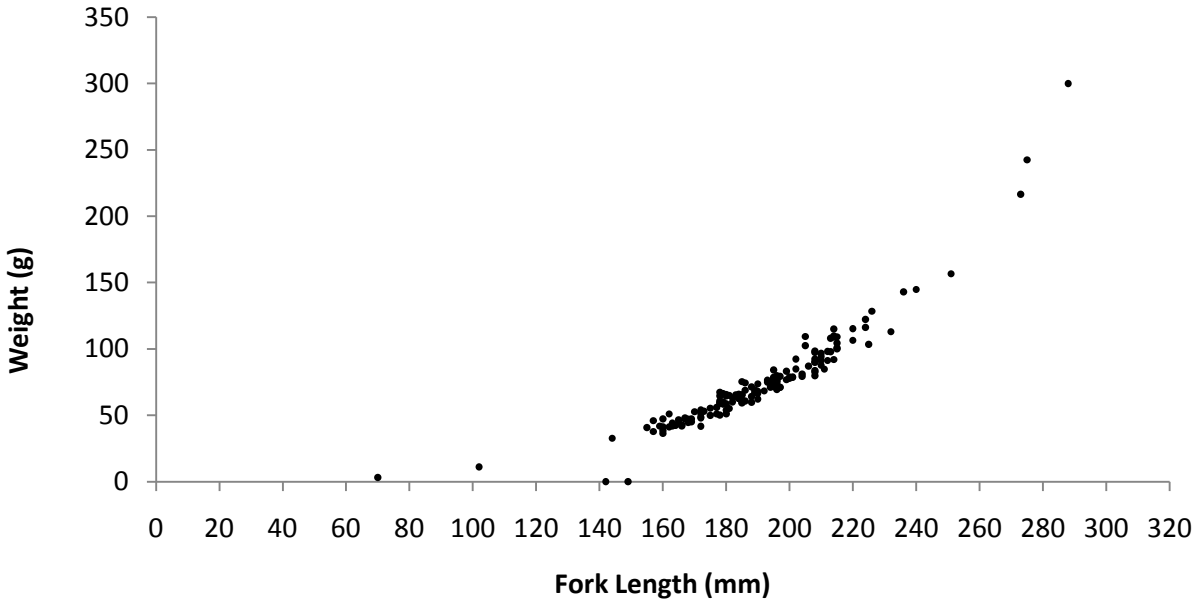

Figure 3. Length-to-weight ratios for all steelhead/rainbow trout caught in 2011.
Note: Several individuals were measured for length but not weighed and are therefore plotted directly on the X-axis.

The most common steelhead smolt size class was 180-185mm (Figure 4), which was similar to previous sampling years. Steelhead smolt weights ranged from 32.7– 216.6 g with a median weight of 67.3 g (Table 4).

Fin clips were collected from 154 steelhead and 1,276 Chinook for genetic analysis. Results of this analysis are expected to be available in early 2012.

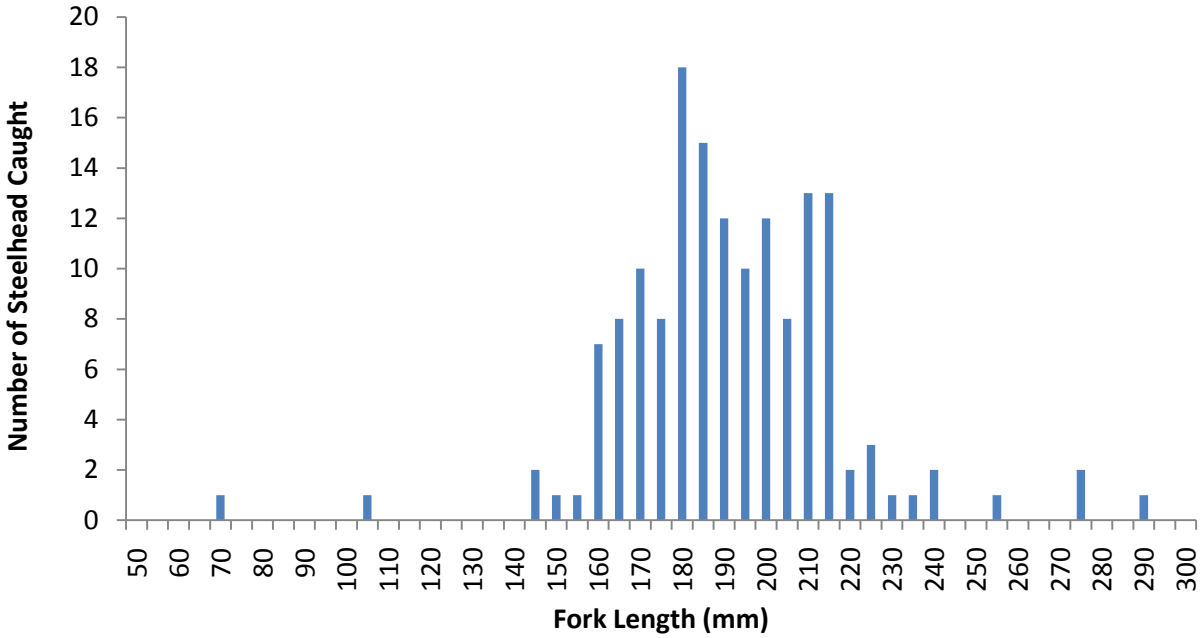

Figure 4. Length-frequency distribution for all steelhead/rainbow trout caught in 2011

Sampling Year	2009	2010	2011
Total Number Caught	119	224	166
Median Length (mm)	178	198	188
Maximum Length (mm)	239	270	273
Minimum Length (mm)	126	131	142
Median Weight (g)	58.1	81.3	67.3
Maximum Weight (g)	142.0	249.5	216.6
Minimum Weight (g)	21.5	25.3	32.7

Table 4. Steelhead smolt biometric data from 2009 - 2011.

Steelhead were collected fairly consistently throughout the entire trapping period with the highest numbers captured during the first week of sampling. The highest catches corresponded with elevated flows following storms (Figure 5), which was consistent with catch rate patterns observed in both of the previous sampling years. Chinook catch rates peaked from late May to early June and also appeared to correlate with increases in streamflow later in the spring (Figure 6).

Due to high flows throughout February and March, we were unable to safely launch the trap until April. This represented a significant loss of potential sampling and undoubtedly reduced the overall catch for the season. The fact that our highest catch rates for steelhead smolts occurred within the first week of sampling suggests that steelhead outmigration was already well underway once the trap was operational. There is no way of knowing how many fish may have left the system prior to the trap being installed. However, data from the 2010 season suggests that late February and March is within the period of peak outmigration for steelhead; therefore the total passage estimates for this year are likely biased low and represent a fraction of the actual number of steelhead outmigrants.

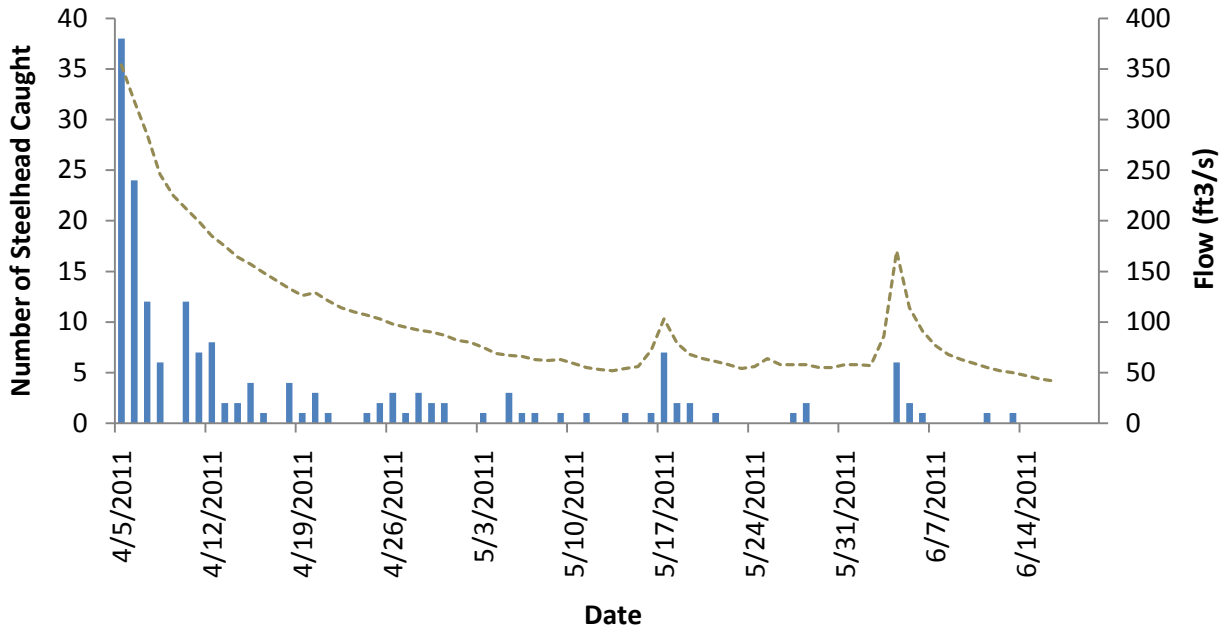

Figure 5. Daily steelhead catch (blue bars) relative to daily mean streamflow (gray line) during the entire sampling period. Flow data source: USGS 11458000 - Napa River at Oak Knoll Ave.

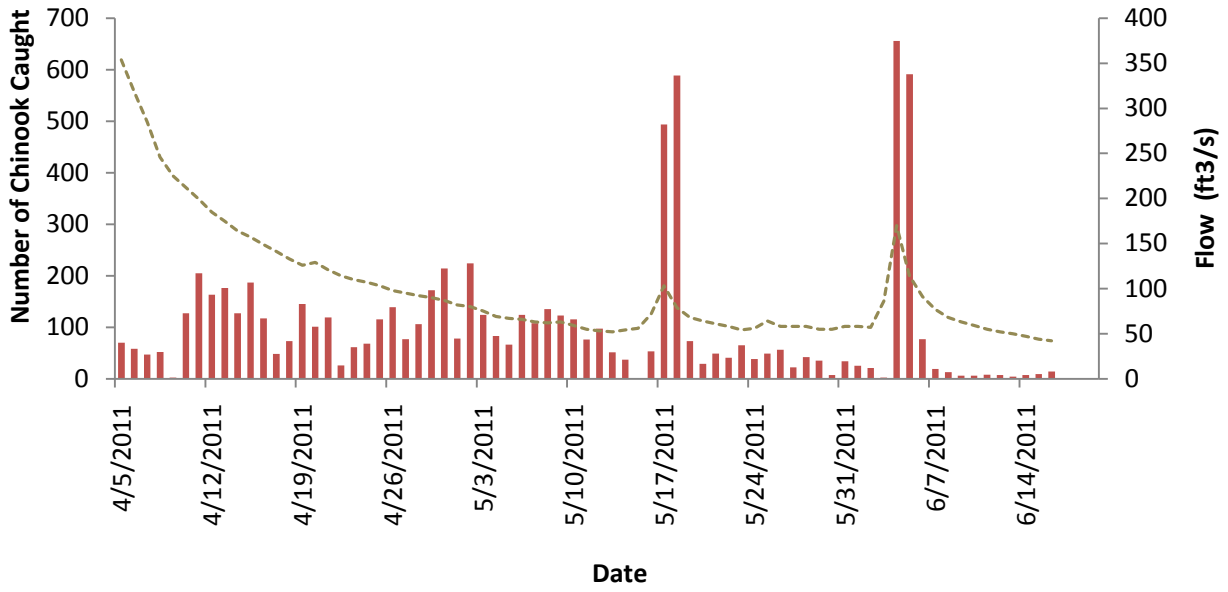

Figure 6. Daily Chinook catch (red bars) relative to daily mean streamflow (gray line) during the entire sampling period. Flow data source: USGS 11458000 - Napa River at Oak Knoll Ave.

Trap Efficiency

A total of 95 steelhead were released upstream of the trap throughout the sampling season, and 13 of these fish were recaptured. This yielded an overall trapping efficiency rate of 13.7% for steelhead, which was slightly higher than the 2010 efficiency rate of 11.1%. The difference in efficiency may be attributed to differences in streamflow, fish movement patterns, or other unknown factors.

For Chinook salmon, 914 fish were released upstream of the trap throughout the sampling season, and 121 of these fish were recaptured, yielding an overall trapping efficiency rate of 13.2%. This represented a significant decline from the 2010 efficiency rate of 19.8%. As with steelhead, the difference from one year to another may be due to many factors. Estimated trapping efficiencies over the entire sampling period for each species are given in Table 5.

Species	Total number of smolts captured	Number of marked smolts released upstream	Number of marked smolts recaptured	Estimated 2011 trapping efficiency
Steelhead	166	95	13	13.7%
Chinook	7,265	914	121	13.2%

Table 5. Trapping efficiency estimates over the entire sampling period.

Population Estimates

A comparison of population (or total passage) estimates is shown in Table 6. These values represent the total number of each species estimated to have passed the trap site during each sampling season. It is important to note that the trap catches approximately 67% of the total salmonid habitat length within the Napa River watershed; therefore these are partial estimates of total-basin populations. Additionally, the trap was only in place for a fraction of the entire outmigration period due to logistical limitations of sampling during periods of high flow.

It is too early to draw conclusions about population trends based on three years of data. Additionally, population estimates derived from our 2009 data exhibited high potential error due to extremely low mark-recapture rates. Several additional years of monitoring will be required to more accurately describe population status and trends for both steelhead and Chinook within the watershed.

Year	Days Sampled	Steelhead			Chinook		
		Observed	Estimated	CPUE	Observed	Estimated	CPUE
2009	69	71	2,519* (± 2,810)	1.0	1	N/A	N/A
2010	90	224	1,946 (±738)	2.5	1,371	6,888 (± 1,077)	15.2
2011	72	166	970 (± 456)	2.3	7,265	68,613 (± 19,611)	100.9

Table 6. Observed catch, total passage estimates, and catch-per-unit-effort (CPUE) of steelhead and Chinook smolts from 2009-2011.

Note: Catch-per-unit-effort (CPUE) for steelhead and Chinook smolts was calculated by dividing the observed catch by the total number of days sampled.

*2009 estimates were calculated using the Peterson mark-recapture equation

CONCLUSIONS

- We captured significantly more Chinook salmon in 2011 than in either of the previous two years. The increased catch rate was evident even when the data were converted to catch-per-unit-effort to correct for differences in sampling duration from one year to the next.

- Catch rates of steelhead smolts were comparable to what was observed in 2010, although the total catch was likely reduced due to missed sampling opportunities during February and March.

- Trapping efficiency declined significantly for Chinook salmon, and increased slightly for steelhead in 2011. Additional sampling years are needed to determine the typical annual variability in trapping efficiencies for both species.

- Steelhead and Chinook outmigrate mostly during spring storm flow events.

- Steelhead smolts collected during the past three years have been consistently large (median ~180-200mm), suggesting they have favorable chances for ocean survival.

- The freshwater Napa River fish community is comprised primarily of native species.

- The RCD and its partners plan to operate the RST in the same location for at least the next three years and have secured funding to do so.

ACKNOWLEDGEMENTS

We would like to thank Napa River Steelhead for their ongoing support of this project. We are particularly grateful to all the volunteers that donated much of their own time to checking and maintaining the trap, specifically Wayne Ryan, Kevin Bradley, Frank Bradley, Steve Orndorf, Alan Shepp, Ric Bollen, Mike Filippini, Guy Carl, John Nogue, Ron Sheffer, Bill Potter, and Eamon Griffin.

We would especially like to thank Will Drayton and Jack Todeschini from Treasury Wine Estates for their assistance. We would also like to thank Chad Edwards and Dave Steiner for their help with checking and maintaining the trap.

The County of Napa and the Gasser Foundation have been important partners helping to fund this program for the past three years. We are very thankful for their ongoing support.

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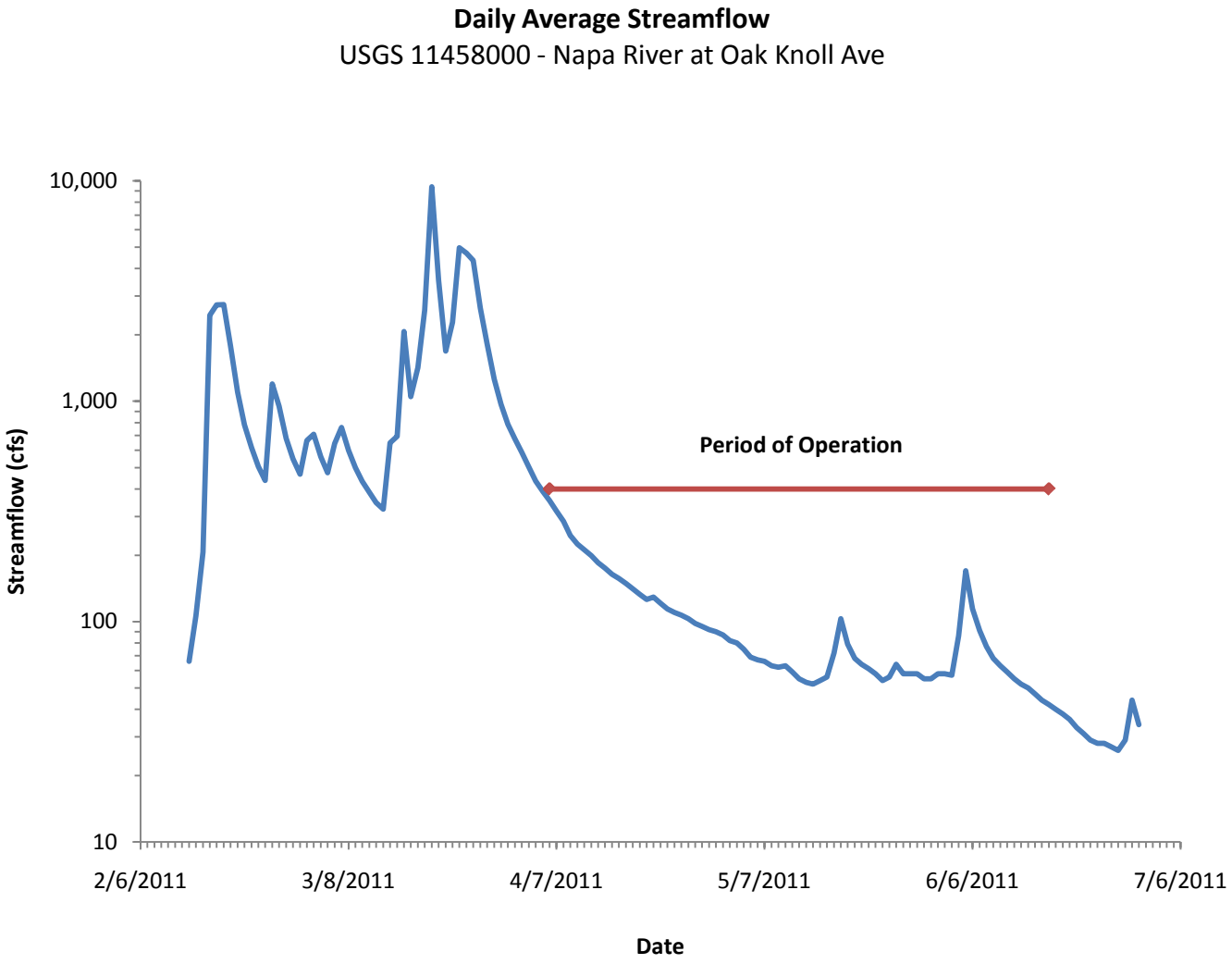
APPENDICES

APPENDIX A: NAPA RIVER HYDROGRAPH

APPENDIX B: TRAP PROCESSING DECISION TREE

APPENDIX C: PHOTOS

APPENDIX A: **NAPA RIVER HYDROGRAPH**



APPENDIX B: TRAP PROCESSING DECISION TREE

Napa County RCD

2011 Rotary Screw Trap Decision Tree

Species	Size	Recap?	# of fish	Work up	Release site
Steelhead	≥ 130 mm (smolts)	no	first 30	record observed & applied marks, length, weight, genetics (individual ID)	up
			31+	count	down
		yes	all	record observed marks, **Do not anesthetize**	down
	< 130 mm (yoy/parr)	n/a	first 20	length, weight, genetics (pooled)	down
			21+	count	down
	adult	n/a	all	record observed 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	length, weight, genetics (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

NOTE:

Steelhead and salmon should only be in the Tricaine solution for **30 minutes or less.**

All steelhead and salmon should be visually inspected for marks before being processed. **Recaptured fish should not be anesthetized.**

APPENDIX C: PHOTOS

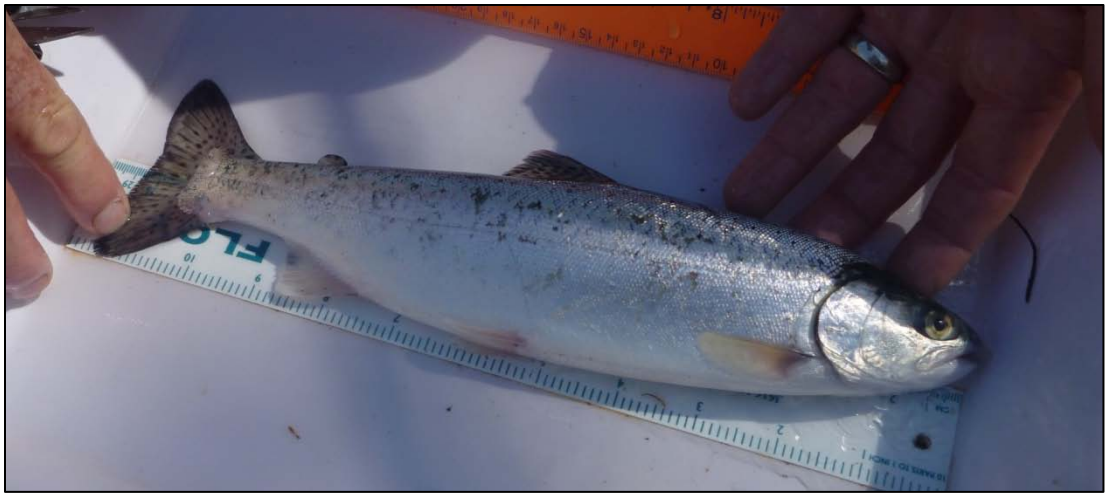
RST site on the Napa River under high flow conditions prior to installation (~11,500cfs, March 20, 2011)

Chinook salmon parr/smolts

Hardhead


Hardhead (showing frenum on upper lip)


Steelhead Parr



Steelhead smolt

Sacramento pikeminnow

Pacific lamprey

Threadfin Shad

Largemouth bass


Black Crappie

Pumpkinseed

Green sunfish


Brown bullhead