Fishery Foundation of California

STANISLAUS RIVER SALMONID DENSITY AND DISTRUBUTION SURVEY REPORT (2005-2007)

(DRAFT)

By

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Table of Contents

Stanislaus River Anadromous Fish Surveys 2005-2007

Abstract

Snorkel surveys were conducted on the lower Stanislaus River during 2005-2007 to determine the distribution, abundance, and habitat use patterns of juvenile Chinook salmon and rainbow trout. Young Chinook salmon were abundant in late winter and early summer throughout most of the river from Goodwin Dam downstream to Oakdale. Their distribution shifted downstream through the spring and their numbers declined sharply from mid April to mid June coincident with the Vernalis Adaptive Management Program experimental storage releases from New Melones Reservoir. We speculate that that VAMP flows encouraged the young salmon to leave the river and migrate to the estuary. Young trout were abundant at all times of the year throughout the river with the highest concentrations in the upper portion of the river at Goodwin Dam and Two Mile Bar. Yearling trout were concentrated in the upper portion of the river below Goodwin Dam where summer water temperatures were consistently below 13^{o}C, whereas downstream temperatures reached 14-16^{o}C. Young salmon and young and yearling trout were found in significantly higher densities in fast sites and in experimental sites where gravel had been placed in the river to create riffle habitat. Striped bass were observed in the lower reaches during the summer, and were potential predators on young salmon and trout.

Introduction

In January 2000, the Fishery Foundation of California (Foundation) entered into a cooperative agreement with the US Fish and Wildlife Service to monitor Chinook salmon and rainbow/steelhead trout via snorkel surveys within the lower Stanislaus River in years 2000 and 2001. The Central Valley Project Improvement Act (CVPIA) provided funding. New Melones Dam on the Stanislaus River is part of the Central Valley Project. The CVPIA provides for the mitigation, protection, and restoration of fish and wildlife resources and associated habitats within California's Central Valley. This report documents the results of the surveys in 2005 through 2007. Observations and data are summarized below. Detailed data are presented in the appendix.

Purpose

The purpose of the investigation was to survey spatial and temporal distribution and abundance and habitat use by juvenile salmonids within the lower Stanislaus River. The information will assist in implementing the CVPIA activities related to determining water needs for the Stanislaus River. Specifically, the snorkel surveys help in determining habitat use patterns of juvenile salmonids under different flow regimes that occur over the year. Understanding what habitats juvenile salmonids seek out will help determine habitat restoration needs. Understanding how juvenile salmonids respond to specific flow changes will help in evaluating the importance of flow in triggering emigration patterns. CVP actions to improve salmon and steelhead populations in the Stanislaus River include habitat improvements and "fish friendly" flow releases from New Melones Dam. The snorkel survey was intended to observe responses to these fish actions to evaluate the benefits of such actions

Objectives/Questions Addressed by Study

- Collect information on the life history of anadromous salmonids in the lower Stanislaus River.
- Determine the seasonal distribution and relative abundance of juvenile salmonids.
  - How are Chinook salmon and trout distributed within the Stanislaus River?
  - Are certain reaches or habitat types utilized disproportionately?
  - Do juvenile Chinook salmon and trout shift their distribution within the river in response to changes in habitat conditions (temperature, flow, predators, competitors, physical habitat, etc)?
- Collect information that can be used to evaluate the need for and benefits of habitat restoration.
- Collect information that can be used to evaluate restoration projects.
- Relate distributions and relative abundance of different life stages of juvenile salmonids and other fishes to habitat conditions (water temperature, turbidity, velocity, cover, vegetation, substrate, geomorphology, predators, aquatic invertebrates, etc).
  - What habitat factors relate to fish distribution and habitat use?
  - How do juvenile Chinook salmon respond to changes in flow and water temperature?
- Document changes in juvenile salmonid distribution and abundance patterns as a consequence of supplemental spring flows of the Vernalis Adaptive Management Program (VAMP).
- Develop conceptual models of the life history, distribution and relative abundance, and habitat use patterns of juvenile salmonids to define fishery needs on the Stanislaus River and help plan, select, and evaluate restoration actions.
- Evaluate the general Habitat Suitability Index models available for juvenile salmonids as to how well they represent the site-specific habitat conditions and populations of the lower Stanislaus River.
- Evaluate what factors may limit growth and survival, and downstream movements of juvenile anadromous salmonids, particularly what factors affect young salmon from reaching smolt size sufficiently early to allow successful migration through the Bay-Delta estuary before it warms and becomes intolerable for successful migration to the ocean.
  - Do juvenile Chinook emigrate on specific cues such as water temperature or river flow?
- Evaluate the extent of over-summering juvenile Chinook salmon and the potential contribution of this life history type based on on-going distribution and abundance surveys.
  - Is there a significant reduction in salmonid densities over the summer and if so what factors are related to that reduction?
  - Are there any differences in abundance between years and if so what factors might contribute to these differences?
- Determine life history types that contribute to anadromous salmon and steelhead escapement to the river based on distribution and abundance survey data.
- Evaluate the adequacy of lower river habitat for growth and survival of juvenile anadromous salmonids, especially fry and fingerling Chinook salmon.

- Relate the findings of the study to those of other studies documented in the scientific literature.

Sampling Sites

The river from one mile below Goodwin Dam downstream to the vicinity of Oakdale was divided into eight reaches (Figure 1). Two to four sites were surveyed per reach for a total of twenty-two sites covering a range of habitat types within each reach. Access to the river was a consideration in site selection. The eight sample reaches were Goodwin Dam (RM 57.5), Two-Mile Bar (RM 56.6), Knight's Ferry (RM 54.5), Lovers Leap (RM 52.2), Honolulu Bar (RM 49.6), Orange Blossom (RM 46.9), Oakdale Recreation Area (RM 40), and McHenry Park (RM 28.5). Habitat types surveyed included low velocity (little or no current) and moving water, and in some cases experimental areas where gravel had been introduced to enhance spawning habitat. Whenever possible, slackwater pool margins were selected for the low velocity sites. In instances when no pool habitat was available, glide habitat margins were selected to represent slow-water habitat in a reach. Riffle or higher velocity glide habitats were selected to represent fast-water habitat. Areas near the downstream end of high gradient riffles or narrow reaches of glide habitat where velocities are higher relative to other glide habitat area were selected as fast-water habitat. Experimental sites were generally riffle habitat, but often had a combination of fast and slow water habitat. Experimental sites were not added to the survey design until week sixteen when it became obvious that these areas had unique habitat and unusually high use by juvenile salmonids. A more detailed description of the sampling sites is provided in Table 1. GPS coordinates are shown in Table 2.

Table 1. Survey reaches and sampling sites for snorkel surveys of the Stanislaus River in 2005 through 2007.

Site	Slow	Fast	Experimental	Side Channel
Goodwin Dam (RM 57.5)				
Length (m)	63	42		
Average width (m)	41.2	18.6		
Average depth (m)	5.2	0.85		
Habitat type	Pool[1]	Riffle		
Two-Mile Bar (RM 56.6)	**Slow**	**Fast**		
Length (m)	66	65		
Average width (m)	36	24.3		
Average Depth (m)	1.6	1.2		
Habitat type	Pool	Fast glide/riffle		
Knights Ferry (RM 54.5)	**Slow**	**Fast**	**Experimental**	
Length (m)	62	55	70	
Average width (m)	30.1	24.5	40.1	
Average Depth (m)	1.8	1.5	0.6	
Habitat type	Slow glide/pool	Fast glide	Tailout/riffle	

[1] Classification per DFG 1998.

Lovers Leap (RM 52.2)	**Slow**	**Fast**	**Experimental**		
Length (m)	70	84	98		
Average width (m)	24.6	19.6	39.1		
Average Depth (m)	1.4	1.6	0.7		
Habitat type	Slow glide/lat. Scour	Fast glide/lat. scour	Mid-glide gravel bar		
Honolulu Bar (RM 49.6)	**Slow**	**Fast**		**Mid**	**Right**
Length (m)	72	68		45	45
Average width (m)	28.2	21.7		20	7
Average Depth (m)	0.9	0.6		0.55	0.5
Habitat type	Slow glide	Fast glide/riffle tailout		slow glide	fast glide
Orange Blossom (RM 46.9)	**Slow**	**Fast**	**Experimental**		
Length (m)	46	49	43		
Average width (m)	31.2	26.8	26.4		
Average Depth (m)	1.1	0.8	0.5		
Habitat type	Slow glide	Fast glide	Tailout/riffle/lat. scour		
Oakdale (RM 40.0)	**Slow**	**Fast**		**Side channel**	
Length (m)	57	74		50	
Average width (m)	23.9	24.5		6	
Average Depth (m)	1.4	0.95		0.43	
Habitat type	Slow glide/lat. Scour	Fast glide		fast glide/riffle	
McHenry Park (RM 28.5)	**Slow**	**Fast**			
Length (m)	80	55			
Average width (m)	26	29			
Average Depth (m)	>2	1.88			
Habitat type	Slow glide/pool	Fast glide			

Table 2. Midpoint coordinates for 2005-2007 Stanislaus River snorkel survey sites.

Site Name	Latitude	Longitude
Goodwin Slow	N37.85755	W120.63558
Goodwin Fast	N37.85880	W120.63547
2-Mile Bar Fast	N37.84334	W120.64355
2-Mile Bar Slow	N37.84504	W120.64341
Knights Ferry Exp	N37.81885	W120.66731
Knights Ferry Slow	N37.81851	W120.66632
Knights Ferry Fast	N37.81817	W120.66537
Lovers leap Exp.	N37.80912	W120.68100
Lovers Leap Slow	N37.80880	W120.69317
Lovers Leap Fast	N37.80840	W120.69219
Honolulu Bar	N37.80027	W120.72658
Orange Blossom Exp.	N37.78807	W120.76250
Orange Blossom Slow	N37.78947	W120.76343
Orange Blossom Fast	N37.78873	W120.76296
0akdale Slow	N37.77080	W120.87089
Oakdale Fast	N37.77091	W120.87019

Methods

Sites within each reach were marked with red survey flags set at the upper and lowermost boundaries of each sample site. Additionally, orange colored rocks were placed in the divers path 1.5 meters (m) from shore to help them identify site boundaries.

During the first two surveys, sampling at each survey site consisted of two divers swimming upstream along the stream margin on opposite banks. Divers were positioned so that the maximum lateral area could be observed (~1.5 m from the river margin depending on visibility – Figure 2). In addition to the two upstream margin transects, a mid-stream transect was also surveyed. Initially the mid-stream area was surveyed laterally by stretching a rope across the river that allowed the diver to cross the river and record mid-stream fish use. This method was replaced after the second survey period because of the difficulty of observing fish. It was replaced by a mid-stream transect parallel to the two margin transects. Painted rocks were placed at 10-meter intervals along the approximate midpoint of the stream to guide the divers. After the upstream ascent in a margin transect, one diver descended the middle of the river using the painted rocks for orientation on the midline. This method proved much more effective in documenting midstream habitat use.

Figure 1. Diver moving upstream along more of sampling site.

Observations were recorded on dive slates. Variables recorded include fish species, age group (salmonid young, yearling, and adult), depth of observation, water column location, distance from bank, and any unique habitat conditions. Species were determined by divers trained in recognizing species with specialized training in distinguishing between young salmon and trout. Size was determined by training the divers to visually estimate the size of standard-length, painted, lead weights prior to each week's survey. Size of fish was recorded by groups, not individual fish. Depths were measured with a 3-ft PVC rod attached to the divers wrist.

For each sampling date and sampling site, indices of abundance were calculated for juvenile salmon and trout. The number of each species and life stage per 100 square meters surveyed for the entire site was calculated to provide an index of abundance for salmon and for trout. Because the area surveyed differed among the 24 sites, total observations were standardized to a 100 square-meter index.

Water temperature was recorded at each site at the start of each survey. Recordings were made at approximately the same time of day at each site within a reach for temporal consistency among sites.

Statistical analyses were conducted on the survey data to compare within and among reach water temperatures and fish observations. MS Excel statistical package was used for T-test comparison between means and Analysis of Variance among three or more treatments (sites or reaches). The log of the number of fish observed per 100 square-meter was used as the variable in tests of differences in mean number of fish observed.

Generally, the patterns in fish density observed as described in this report were statistically significant.

Results

Stream Flows

The lower Stanislaus River discharge (flow) in the year 2005 study period from Feburary 13 through December ranged from a high of 1450 cfs to a low of 200 cfs (Figure 2). Flows were maintained by reservoir releases at approximately 1400 from April 30 through June 2. These spring releases are generally referred to as the Vernalis Adaptive Management Program releases, which vary depending on the water year type. Flows were near 300 cfs for the remainder of the summer through the winter except for a short period from October 19-25 when flows reached approximately 950 cfs.

In 2006 flows on the river increased to over 6,000 cfs with a peak of 6,524 cfs on April 4th. This period of high flows prevented regular snorkel surveys from being performed on the river until early June when flows receded to approximately 1,500 cfs. Two surveys were performed at this high flow period in February when the river was at 1,600 cfs and in May at 4,000 cfs. The low flow for 2006 was 473 cfs from December through early January. Flows exceeded 100 cfs for the remainder of the year.

River flows in the year 2007 study period (January 3 - July 13) ranged from a low of 424 cfs to a high of 1,291 cfs. Throughout this survey period flows on the river fluctuated more frequently than in past years. The river rose in early January to approximately 950 cfs and fell to 600 cfs in February, in early March it rose again to 1200 cfs and fell to approximately 400 cfs in late March through mid April. In late April it rose again to approximately 1200 cfs and fell to 600 cfs in early June where it remained through the rest of the surveys.

Stream Habitat

Variation in flow between years 2005 through 2007 resulted in significant changes in the amount of low-velocity, high-cover margin habitat, particularly in the fast-water sites of the upper four reaches of the river. During the higher flow periods, flooded vegetation was abundant at all sites. As flows receded in late spring of both years, the margin habitat receded as well. Flooded margin habitat under the 300-400 cfs base flows is only about 10% of that at 1500 cfs or higher based on visual observations. Side channels at the Honolulu Bar and Oakdale sites became disconnected from the main channel at flows less than 500 cfs. Stranding of young salmonids may have occurred in isolated pools of side channels when side channels became disconnected, however no surveys were made in the side channels after they became disconnected. The side channels remained watered after they were disconnected from the main channel via inter-gravel flow.

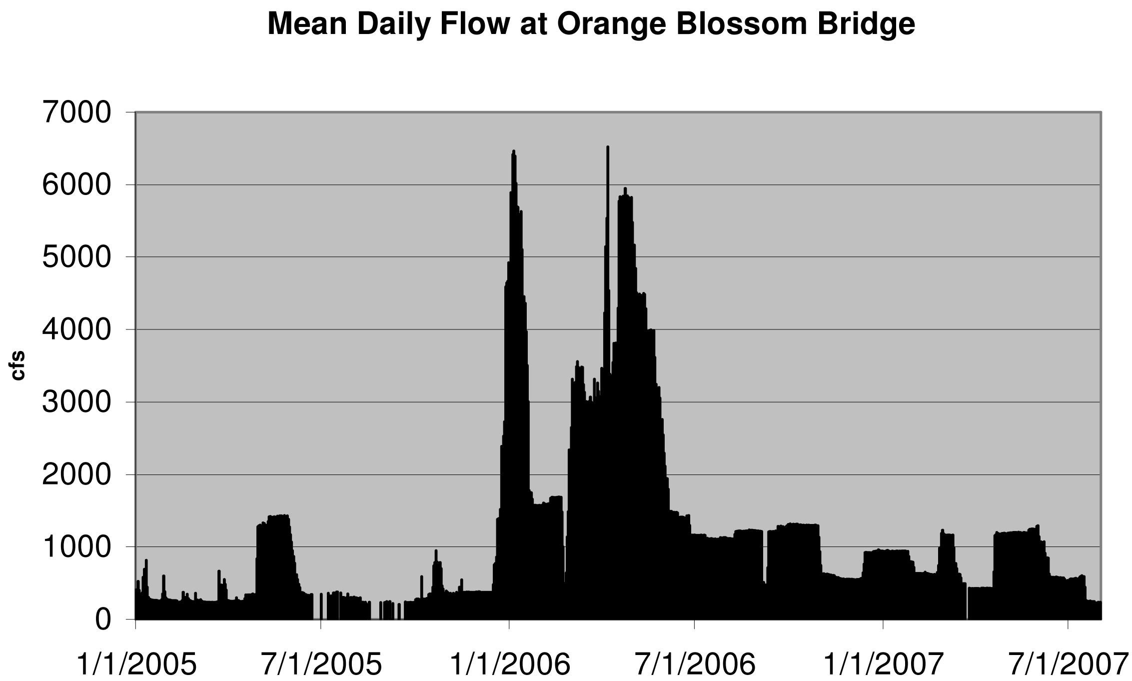

Figure 2. Daily Stanislaus River flow as measured at Orange Blossom Bridge from 1/1/05 to 8/1/07. Zero flow days were cause by gauge malfunction. (Source: CDEC)

Water Temperature

Water temperature varied considerably within years and between locations during the study period (Figure 3). Water temperatures varied from 8 to 12 °C during winter and spring surveys, and warmed up to 16ºC below Honolulu Bar in the summer and fall surveys.

Water temperatures increased sharply as VAMP flow releases ended and air temperatures peaked into early summer reaching 16°C at the lower sites and 11-12°C at Goodwin in both years. Water temperatures remained below 16°C through the study period at the upper reaches including Goodwin, Two-Mile bar, Knights Ferry, and Lovers Leap.

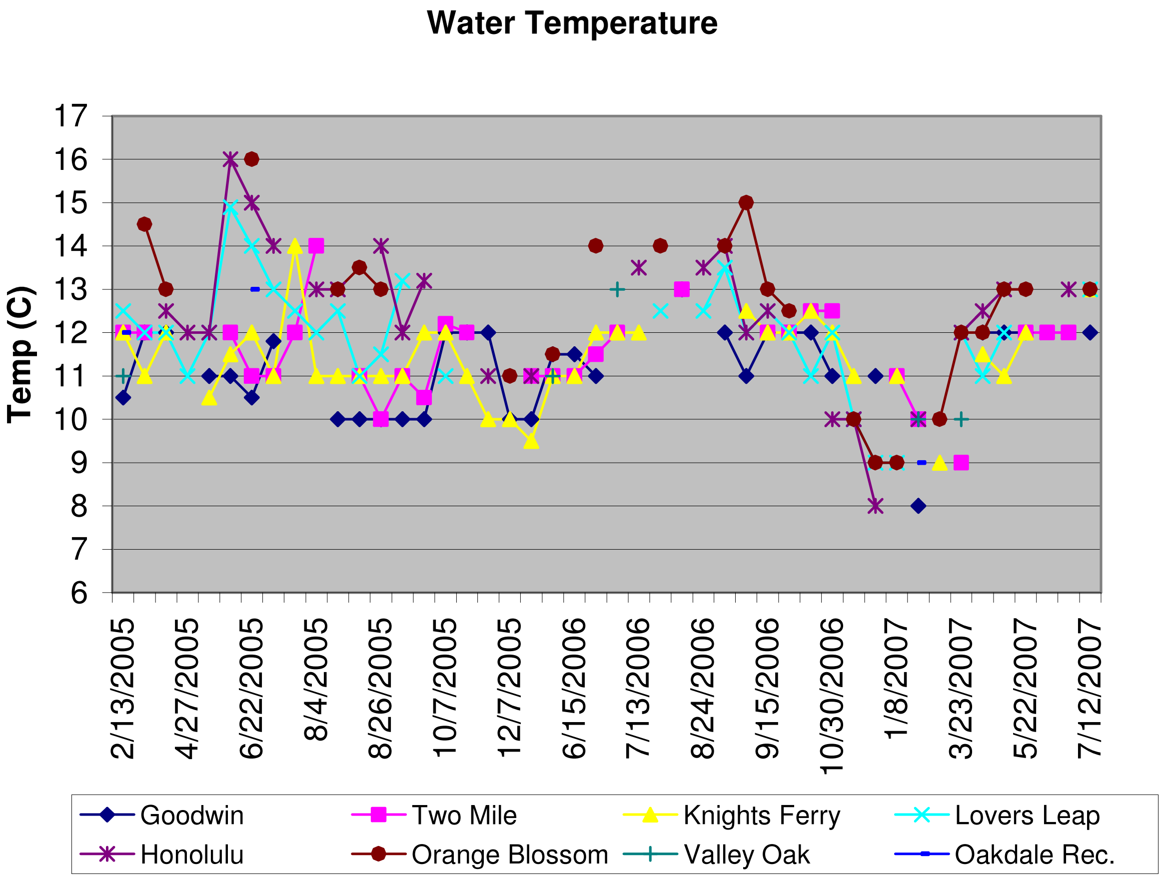

Figure 3. Water temperature measured during snorkel surveys from Feburary 2005 to August 2007.

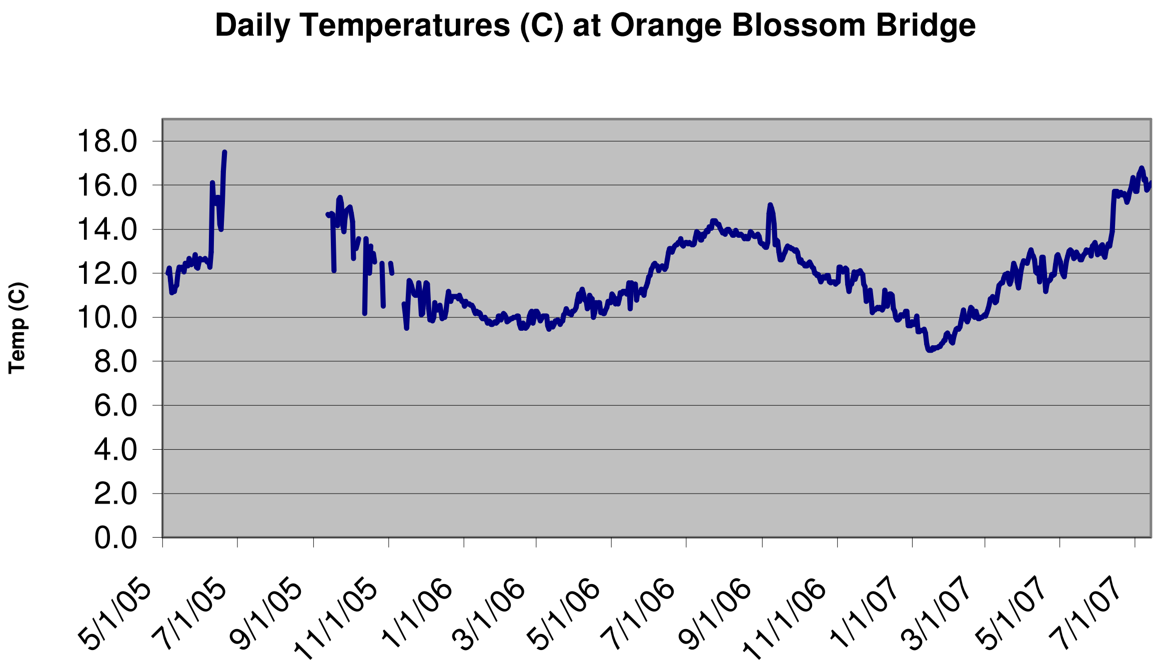

Figure 4. Water temperature measured at Orange Blossom Bridge from Feburary 2005 to August 2007 data obtained from USGS CDEC.

Chinook Salmon Distribution

Year 2005 (Figure 5)

Young Chinook salmon were observed from the beginning of the surveys (Feburary 13) through late October in the 2005 survey (Figure 5). Peak abundance occurred during March and April when densities reached over 90 per 100m^2 in the middle and lower reaches. Most of the young salmon were fingerling pre-smolts in the 50-80 mm size range. Young salmon were relatively abundant at all sites through early summer.

Chinook densities declined in early May with few observed throughout the summer. From July through October Chinook were most abundant at Goodwin where the temperatures remained around 12ºC. Most were 80-120 mm in size. From July to October Chinook density was very low throughout the study area (<1/100m^2) with the exception of Goodwin. Remaining Chinook observed were singles or doubles and were over 120mm in length. All were found in relatively high velocity habitat adjacent to deep water. None were observed after late October in all sites except for Honolulu Bar where a small number (<2/100m^2) were observed in early December.

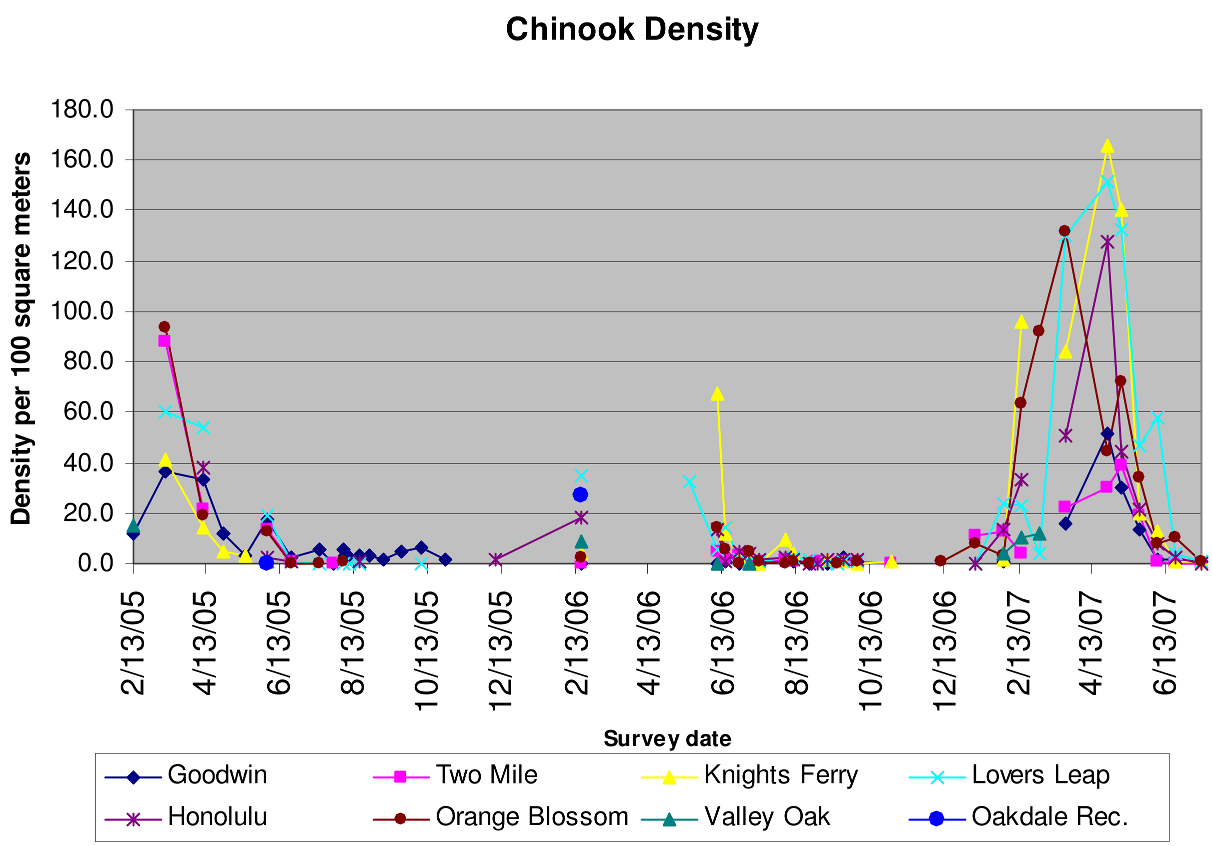

Figure 5. Average density of young Chinook salmon at eight sampling sites from February 2005 to July 2007.

Newly hatched fry (30-40 mm) were first observed March 13, 2005. Fry densities were highest in Two-Mile Bar, Lovers Leap and at Orange Blossom Bridge, and lowest at Oakdale Recreation at the lower reach of the river.

Year 2006 (Figure 5)

With the discharge reaching over 6,000 cfs in early January 2006, the first survey began in late Febuary when the flows dropped to approximately 1600 cfs. Chinook fry were observed at all sites during this survey. Flows went up again in early March peaking at 6,524 cfs in April curtailing snorkel surveys again until June. Surveys began again on June 9th and continued on through the year. Fry were least abundant in the upper reaches especially at Goodwin and Two-Mile Bar where densities were the lowest (Figure 5). Density declined sharply in late June and gradually dropped more through the summer to low numbers ($<2/100m^2$) throughout the rest of the year. Generally density was substantially higher in most reaches in 2005 than 2006.

Year 2007 (Figure 5)
The highest densities of Chinook observed for all three years was in the spring and summer of 2007. Surveys started in early January and continued through July. Newly hatched fry (30-40mm) were first observed January 8, 2007. Fry densities were highest in Knights Ferry, Honolulu Bar and Lovers Leap, and lowest at Goodwin Dam and Two-Mile Bar at the upper most reach of the river. Peak abundance occurred April and May when densities reached over 150 per $100m^2$ in the middle and lower reaches. Most of the young salmon were fingerling pre-smolts in the 50-80 mm size range. Chinook densities declined in late May but were observed at every site through the rest of the survey ending in mid July.

Trout Young (Age 0)

Year 2005 (Figure 6)
Young trout began to appear in early March from Goodwin Dam downstream to Orange Blossom Bridge (Figure 6). They did not appear in higher numbers in all reaches until early June. They were most abundant through the year at Goodwin, Two-Mile Bar and Knights Ferry at the upper end of the survey area. Densities were highest from September to October with peak denities reaching over 30 per $100m^2$ at Goodwin Dam. Densities declined in November through the rest of the survey year.

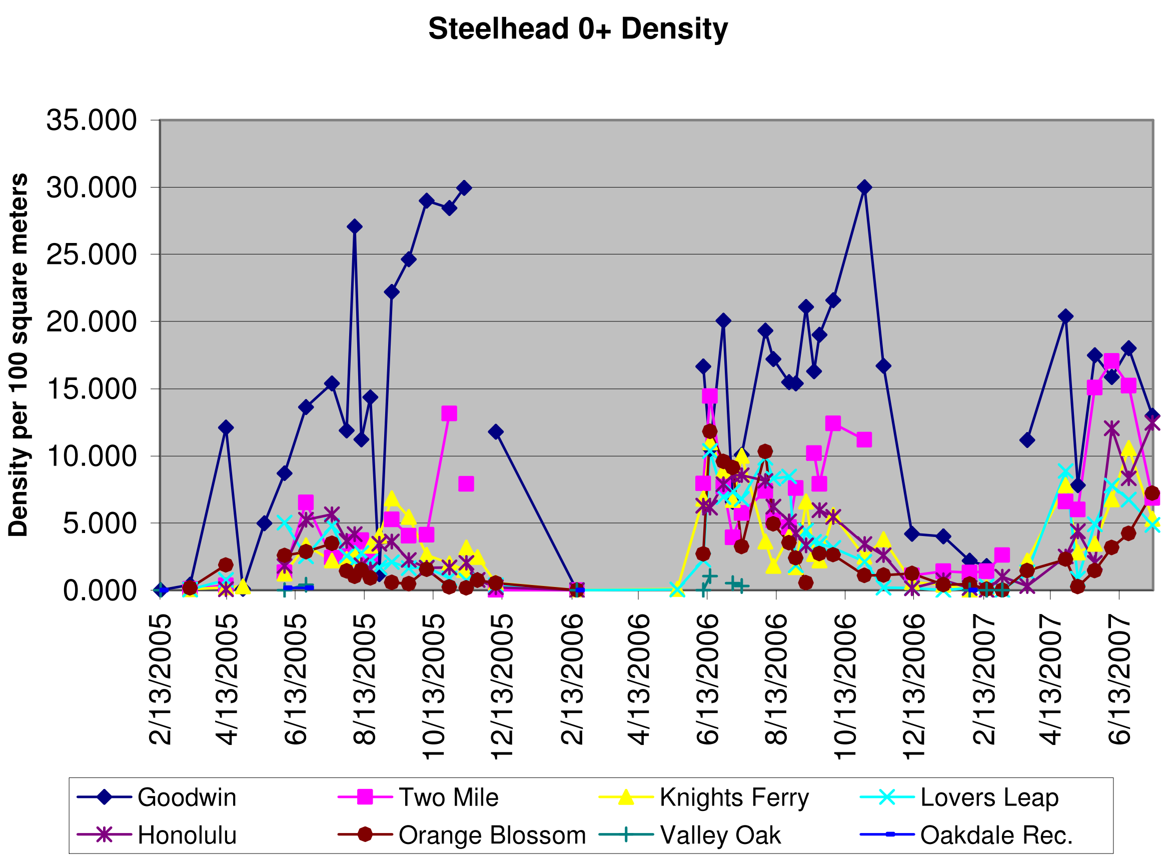

Figure 6. Average density of young trout at eight sampling sites from February 2005 to July 2007.

Year 2006 (Figure 6)

In year 2006 high flows on the river prevented snorkel surveys until the discharge reached 1500 cfs in early June. Young trout were observed at all sites in these June surveys. High densities were observed from June through October with peak densities in June and July for all reaches with the exception of Goodwin Dam. Goodwin had its highest densities in late October with 30 per 100m². With the exception of Goodwin densities began to decline in the late summer at all other sites. By late October densities at all sites were less than 5 per 100m².

Year 2007 (Figure 6)

Young trout were present in low numbers from the beginning of the surveys starting in January. Newly hatched fry were first observed in March and April at all sites. In this same time period densities grew at all reaches. Densities of young trout were highest in the upper reaches of the river at Goodwin Dam and Two-Mile bar, which had peak densities of over 20 per 100m² in late April. Lovers Leap, Knights Ferry and Honolulu Bar showed peak densities in June with 12 per 100m². Densities were at their highest in 2007 for all sites in April through July. Surveys ended July 13, 2007.

Trout Yearlings (Age 1+)

Years 2005-2007 (Figure 7)

Yearling trout were observed through most of the survey periods, and were most abundant in the upper reach between Goodwin Dam and Two-Mile Bar (Figure 7). They became more common in the lower reach in late spring, particularly at experimental sites in the lower river reaches (Knights Ferry, Lovers Leap, and Orange Blossom).

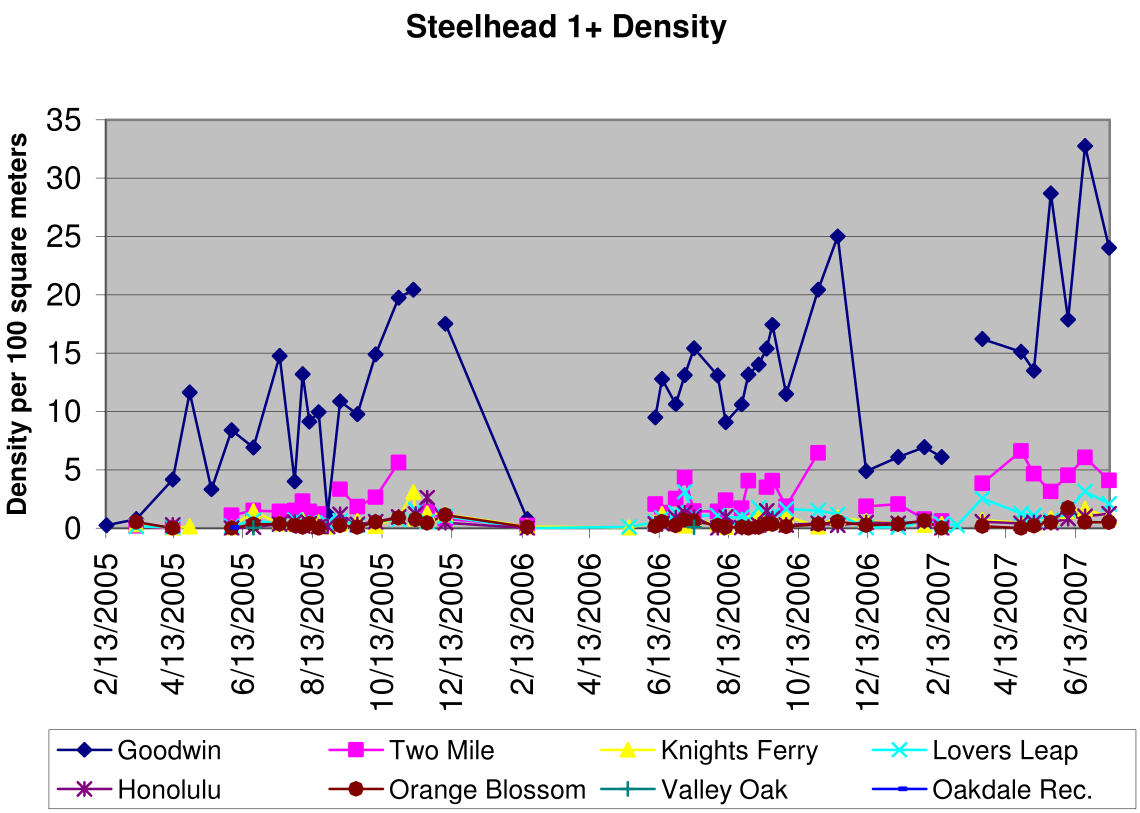

Figure 7. Average density of yearling trout at eight sampling sites from February 2005 to July 2007.