# Stanislaus River Anadromous Fish Surveys 2000-2001

## Abstract

## Introduction

The Fisheries Foundation of California (Foundation) surveyed fish in the lower Stanislaus River in year 2000 and 2001 for the US Fish and Wildlife Service (FWS) with funding from the Central Valley Project Improvement Act (CVPIA). The surveys were conducted with funding from the Central Valley Project Improvement Act under contract to the FWS. The CVP New Melones Project on the Stanislaus River provides water supply for municipal and agricultural users in the Sacramento and San Joaquin Valleys and the Bay area. The study was conducted under the CVPIA mandate that includes fish and wildlife protection, restoration, and mitigation as project purposes. In January 2000, the Foundation entered into a cooperative agreement with the US Fish and Wildlife Service to monitor chinook salmon and steelhead trout within the Stanislaus River. The monitoring program was funded under cooperative agreement # 114200J033 in February of 2000. Additional finding was provided in (2001) to expand the project to include juvenile trout summer rearing. The survey is funded for years 2000 through 2001.

### Purpose

The purpose of the investigation is to survey spatial and temporal macro habitat (water temperature, stream gradient and habitat type, etc.) use and determine factors related to that use by juvenile and adult chinook salmon and steelhead trout within the lower Stanislaus River.

### Objectives

- Determine the seasonal distribution of juvenile and adult salmonids in the Stanislaus River.
- Determine macro-habitat use by salmonids.
- Relate fish distributions to macro habitat conditions.
- Compare macro habitat conditions under different spring flows including supplemental spring flows of the Vernalis Adaptive Management Program (VAMP).
- Assess effect of VAMP on salmonid fish distribution and abundance.

<u>Questions to be addressed:</u>

- How are chinook salmon and steelhead trout distributed within the Stanislaus River?
- Are certain reaches or habitat types utilized disproportionately?
- What macro habitat factors relate to fish distribution?
- Do juvenile chinook salmon and steelhead trout shift their distribution within the river in response to changes in habitat conditions (temperature, flow, predators, competitors, physical habitat, etc)?
- Do juvenile chinook salmon rear within the Stanislaus River throughout the summer?
- Is there a significant reduction in salmonid densities over the summer and if so what factors are related to that reduction?
- Do juvenile chinook emigrate on specific queues such as water temperature or river flow?
- How do juvenile chinook salmon respond to changes in flow and water temperature?

- Are there any differences in abundance between years and if so what factors might contribute to these differences?

## 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 that cover a range of habitat types. Access to the river was a consideration in site selection. The eight sample reaches were Goodwin Dam (RM 57.5), 2-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 slow, fast, and in some cases experimental areas where gravel had been introduced to enhance spawning habitat. Whenever possible, slackwater pools margins were selected as slow sites. In instances when no pool habitat was available, glide habitat margins were selected to represent slow habitat in a reach. Riffle or higher velocity glide habitat were selected to represent fast 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 habitat. Experimental sites are generally riffle habitat, but often had a combination of fast water and slow margin habitat. Experimental sites were not added to the survey design until week 16 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.

Table 1. Survey reaches and sampling sites for fish surveys of the Stanislaus River in 2000 and 2001.

| 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 | riffle | | |
| **2-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 | |
| **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 | | | |

## Methods

Because protocols for snorkel surveys in streams similar to the Stanislaus River are not well established, there was substantial latitude during the first year of the study to develop appropriate techniques to meet the objectives of the study. 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 the margin for quick boundary determination.

During the early 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). 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.

Observations were recorded on dive slates. Variables recorded include fish species, size, depth of observation, water column location, distance from bank, and habitat orientation. Size was determined by training the divers to visually estimate the size of standard-length, painted, lead weights prior to each week's survey. 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.

## Results

### Stream Flows

The lower Stanislaus River discharge (flow) in the year 2000 study period from March 15 through December ranged from a high of 1580 cfs to a low of 350 cfs (Figure 2). Flows were maintained by reservoir releases at approximately 1500 from April 21 through June 11. 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 on through the winter except for a short period of spill from October 17-25 that reached approximately 1100 cfs.

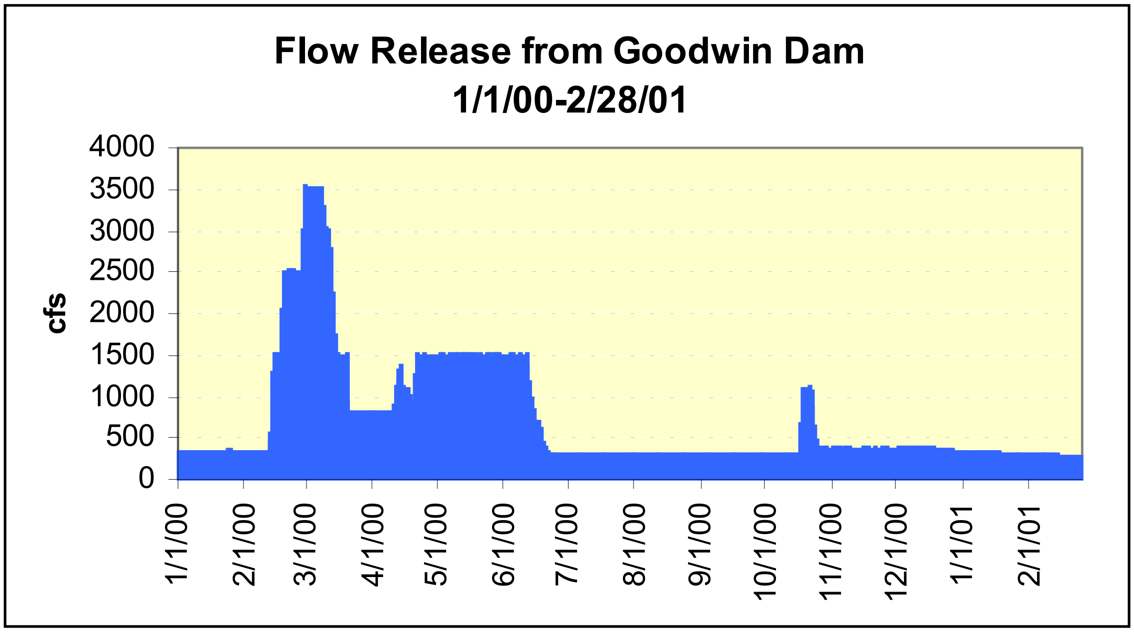



Figure 2. Daily Stanislaus River discharge from Goodwin Dam from 1/1/00 to 2/28/01. CDEC does not have data for the remainder of 2001 at this station. (Source: CDEC)

Flows were lower in 2001, which was a drier year (Figure 3). VAMP releases of 1200 cfs extended from April 20 to May 19. Summer storage releases varied from 400-800 cfs and reached the minimum release of 300 cfs in mid September.

### Stream Habitat

Differences in flow between year 2000 and 2001 resulted in significant changes in the amount of low-velocity, high-cover, margin habitat particularly in the fast-water sites of the upper 4 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.

Similarly, connectivity between the low-velocity, high cover side channels at Honolulu Bar and Oakdale Recreation Area was maintained at flows greater than 760 cfs. At lower flows, these habitats were disconnected from the mainstem and became inaccessible and unsuitable for rearing purposes. Stranding of young salmonids may occur in these disconnected side channels, although no attempt was made to determine if stranding occurred.

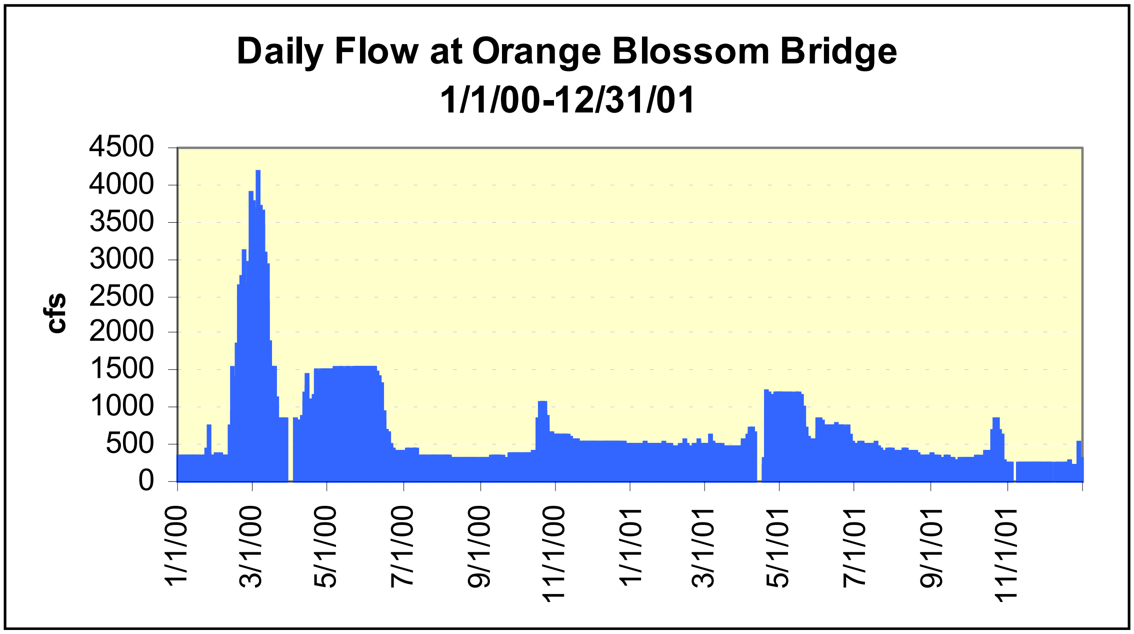



Figure 3. Daily Stanislaus River flow as measured at Orange Blossom Bridge from 1/1/00 to 12/31/01. (Source: CDEC)

## Water Temperature

Recorded water temperature varied significantly both temporally and spatially during the study period from March 15th 2000 and December 2001 (Figure 4). Water temperatures reached a minimum of 8 to 10 $^{o}$C during January, but warmed to near 15 $^{o}$C by early April at the lower stations. Water temperatures dropped about 2$^{o}$C at the onset of VAMP in mid April 2000 and 2001 at the lower river stations as flow rose.

Water temperatures increased sharply as flows declined and air temperatures peaked into early summer reaching 19$^{o}$C at Oakdale and 13-14$^{o}$C at Goodwin in both years. Water temperatures remained below 16$^{o}$C through the study period at Goodwin, Two-Mile bar, Knights Ferry, and Lovers Leap. Temperatures in excess of 16$^{o}$C were recorded during the summer at Honolulu-Bar, Orange Blossom Bridge and Oakdale.

Water temperatures began to decline in September. Water temperatures fell to 10-12 $^{o}$C by November.

## Chinook Salmon Distribution

<u>Year 2000 (Figure 5)</u>

Young chinook salmon were observed from the beginning of the surveys (March 26) through the end (Dec 18) in the Year 2000 survey (Figure 5). Peak abundance occurred

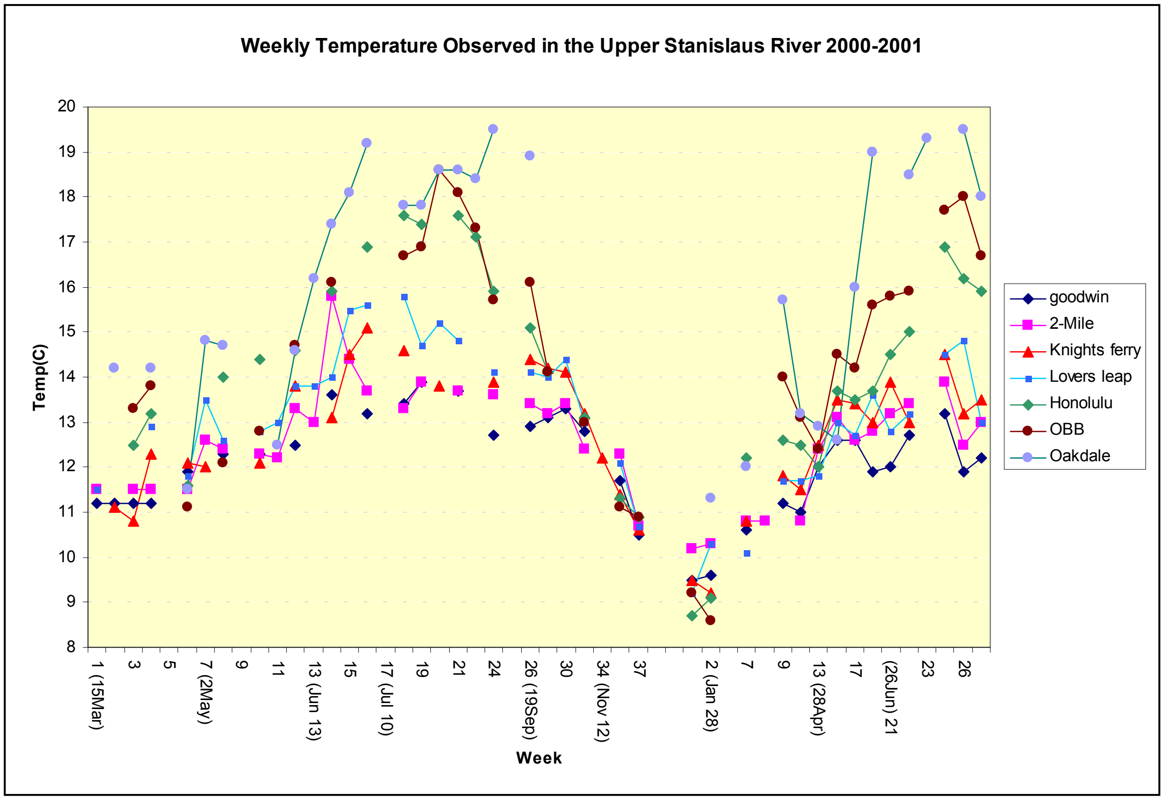



Figure 4. Water temperature measured during snorkel surveys from March 2000 to August 2001.

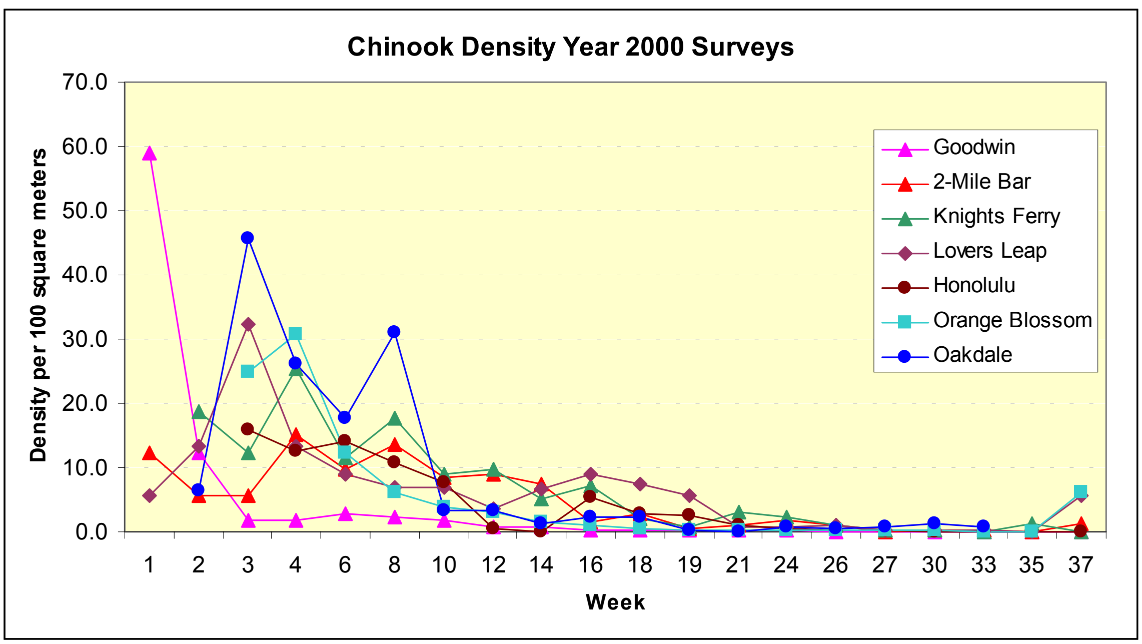



Figure 5. Average density of young chinook salmon at seven sampling sites in year 2000 survey. (Week 1 began on March 15.)

during weeks 3-8 (late March-Early May) when densities reached 46/100m$^{2}$. Young salmon were relatively abundant at all sites with the exception of Goodwin where densities never exceeded 3/100m$^2$ after week 1.

Chinook densities declined after week 8 (May 7) with few observed after week 19 (July 24). From week 16 to 24 (July 3-Sept 5) chinook were most abundant between Two Mile Bar and Lovers Leap. Temperatures below Lovers Leap were unfavorable (>16$^o$C). From week 27 to week 35 (Sept 27-Nov 19) chinook density was very low throughout the study area (<1/100m$^2$). 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 mid November.

Fry began to emerge on December 18 (Week 37). Fry densities were highest in Lovers Leap and at Orange Blossom Bridge, and lowest at Goodwin and Two-Mile Bar at the upper reaches of the river.

Year 2001 (Figure 6)

Surveys began in late January in year 2001. Fry were least abundant in the upper reaches especially at Goodwin where densities were the lowest (Figure 6). Density declined after week 5 (February 25) and was very low by week 17 (May 25). Generally density was higher in the spring of 2001 than 2000.

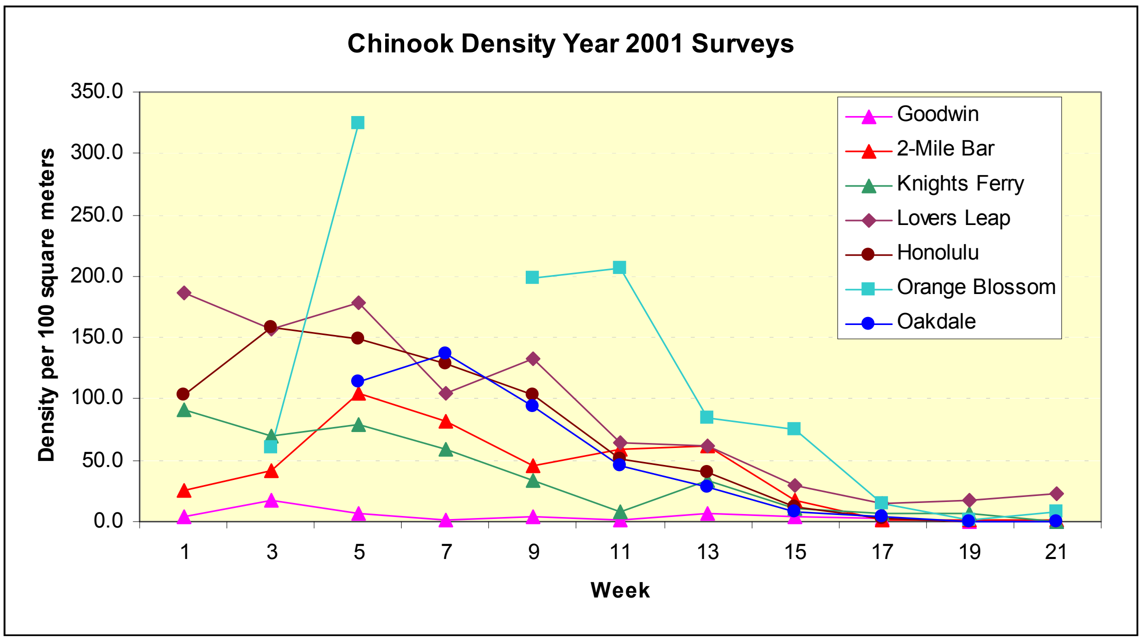



Figure 6. Average density of young chinook salmon at seven sampling sites in year 2001 survey. (Week 1 began on January 22.)

## Steelhead Trout Young (Age 0)

Year 2000 (Figure 7)

Young steelhead began to appear in mid April (week 4) from Goodwin Dam downstream to Lovers Leap (Figure 7). They did not appear in higher numbers in downstream reaches below Lovers Leap until late June (week 14). They were most abundant through the year at Goodwin and 2-Mile Bar at the upper end of the survey area. They were also relatively abundant at Knights Ferry, Lovers Leap, and Orange Blossom late in the year at experimental sites within these reaches (experimental sites are discussed later).

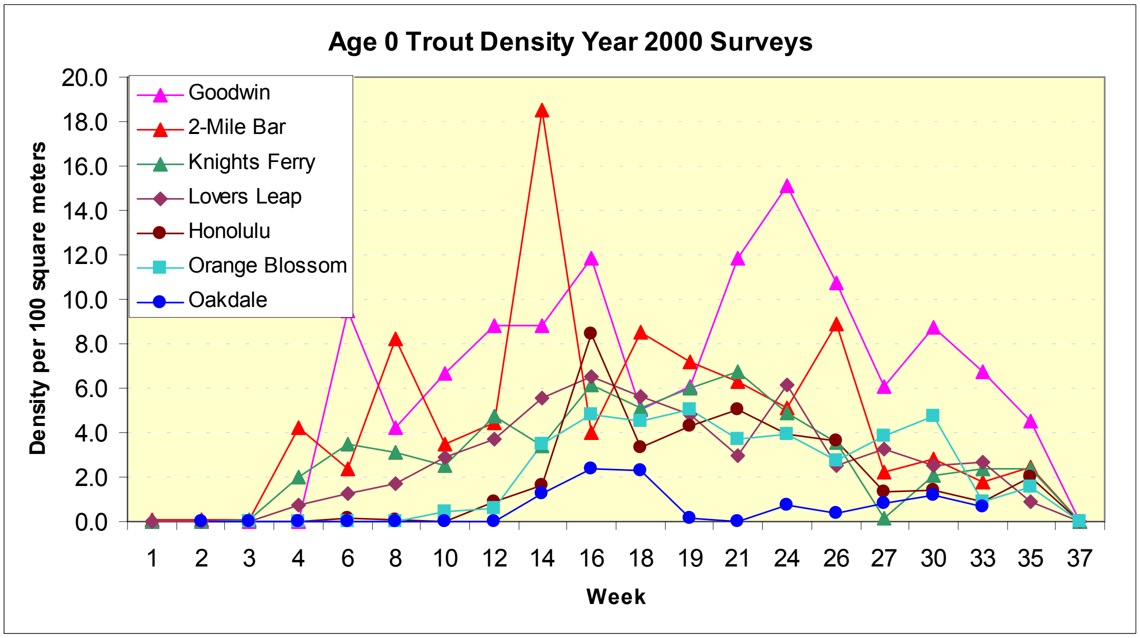



Figure 7. Average density of young steelhead trout at seven sampling sites in year 2000 survey. (Week 1 began on March 15.)

Year 2001 (Figure 8)

Young steelhead trout began to appear in large numbers in April in the upper river reaches as in year 2000. They began appearing in higher densities in the lower reaches in May. Highest densities occurred at upper river reaches and at experimental sites in the lower river reaches (Knights Ferry, Lovers Leap, and Orange Blossom).

## Steelhead Trout Yearlings (Age 1+)

Years 2000-2001 (Figures 9 and 10)

Yearling steelhead trout occurred year round in the lower Stanislaus River, but were most abundant in the upper reach between Goodwin Dam and 2-Mile Bar (Figures 9 and 10). They became more common in the lower reach from May through the end of the year, particularly at experimental sites in the lower river reaches (Knights Ferry, Lovers Leap, and Orange Blossom).

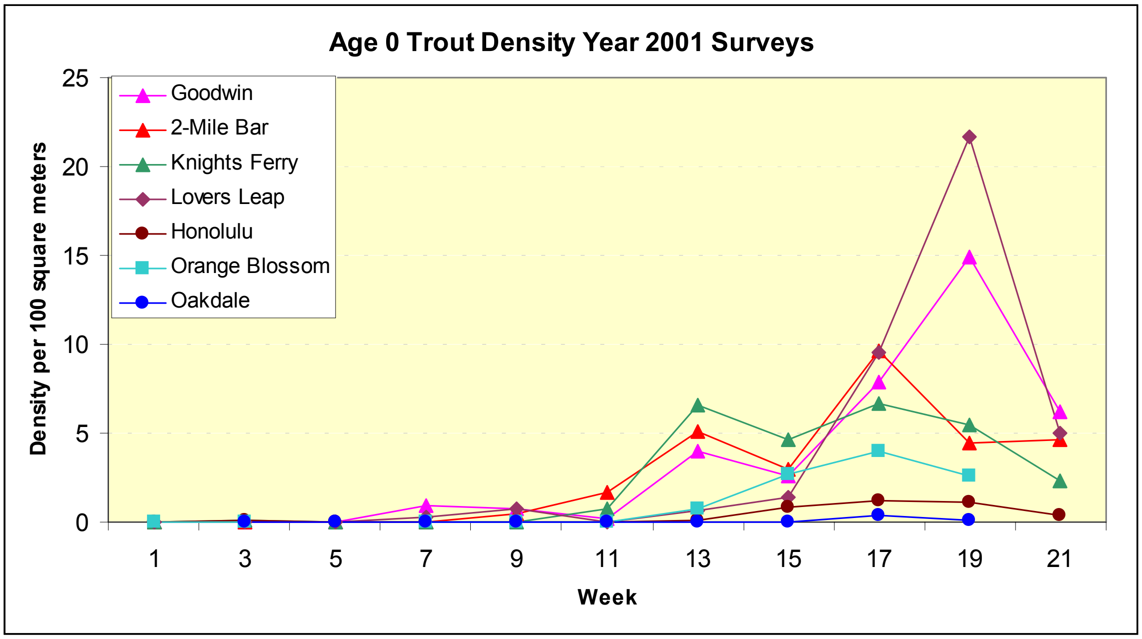



Figure 8. Average density of 1+ steelhead trout at seven sampling sites in year 2001 survey. (Week 1 began on January 22.)

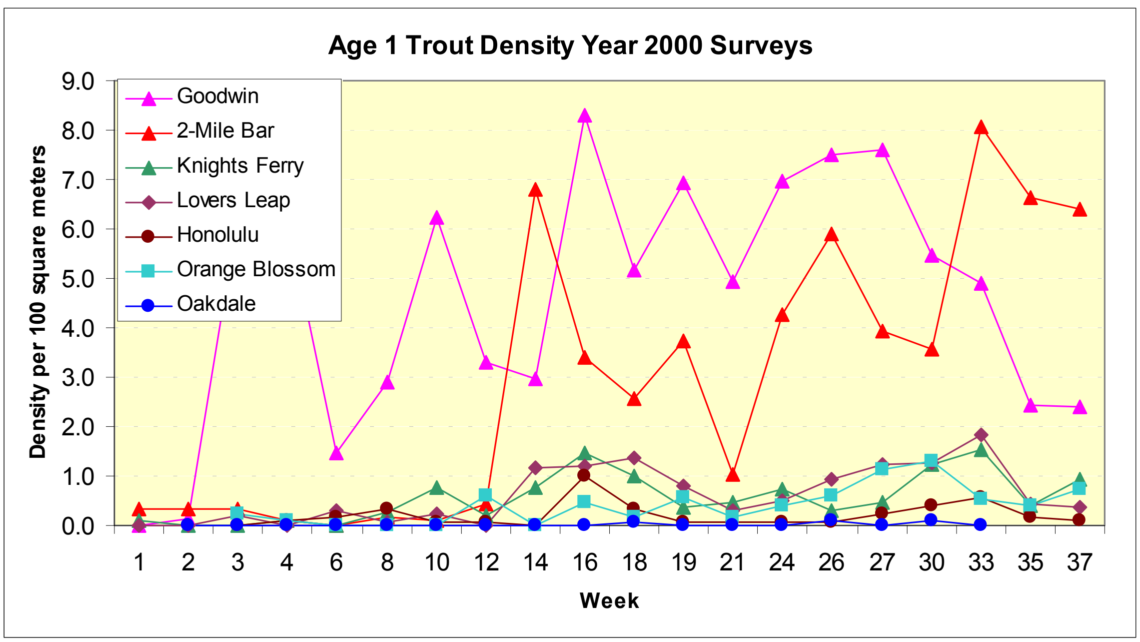



Figure 9. Average density of 1+ steelhead trout at seven sampling sites in year 2000 survey. (Week 1 began on March 15.)

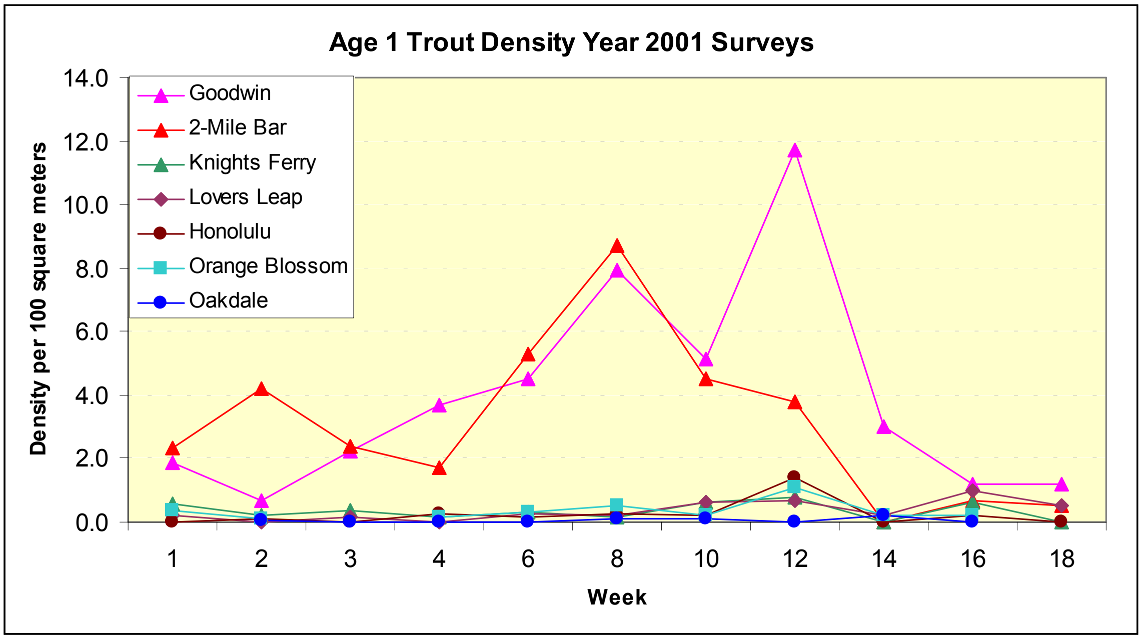



Figure 10. Average density of yearling steelhead trout at seven sampling sites in year 2001 survey. (Week 1 began on January 22.)

## Observations of Adult Chinook

On 6 June 2000, three adult chinook were observed in a deep pool during snorkel surveys at the Knights Ferry Bridge. These fish were in poor condition and appeared to have already spawned. An adult female was captured by hand and photographed. A brief examination confirmed that she had spawned (badly abraded lower caudal fin and absence of eggs). The condition of the fish at that time of year strongly suggests that it was a winter-run salmon, but it could not be confirmed without genetic testing.

To better document the presence of adult chinook in the river at that time, bi-monthly exploratory dives were conducted from Goodwin Dam to Knights Ferry.

Adult Chinook were observed on six dates from Goodwin Dam down to Orange Blossom Bridge:

- **20 June 2000 -** Seven adult chinook salmon were observed approximately 10 pounds from 2-Mile Bar to one mile above Knights Ferry. Fish were brightly colored (pre-spawn) and all were observed in deep turbulent pools.

- **12 July 2000 -** Two adult chinook salmon were observed between Goodwin Dam and Lovers Leap: one female approximately 10 lbs and one male approximately 25 lbs. They were found in a deep turbulent pool below an approximately 7-ft fall.

- **13 July 2000 -** Seven adult chinook salmon approximately 8-10 lbs were observed in a slow deep pool one mile above the Orange Blossom Bridge. All were very bright (silvery) suggesting that they had recently migrated into the river.

- **21 July 2000 -** Seven adult chinook salmon were observed between Goodwin Dam and 2-Mile Bar. Fish were again bright and weighed approximately 12-15 lbs. All were observed in the turbulent head of a deep pool.

- **3 August 2000 -** Two adult chinook salmon were observed on shallow gravel bar at Lovers Leap. No evidence of recent spawning activity was observed in the area.

- **11 August 2000 -** Nine adult chinook salmon were observed from Goodwin Dam to Knights Ferry. Fish ranged in size from 10-30 lbs and were in turbulent pool and slow water pool habitats. To verify these observations, DFG deployed gill nets overnight in the Button Brush recreation area. Twenty-two adult chinook salmon were captured and of those, 3 were adipose clipped fish. The ad-clipped fish were later determined to be strays from the Feather River Hatchery.

## Discussion and Conclusions

### Distribution of Juvenile Salmon and Steelhead in Lower Stanislaus River

Young salmon were abundant throughout the survey area by January. Density of fry salmon was lowest in the upper sites below Goodwin Dam. Exploratory dives in the reach between Goodwin Dam and Two-Mile Bar found the reach was made up of deep, slow pools and high gradient riffles with little spawning habitat. Pool tailouts within this reach were highly scoured and possessed mainly angular cobble substrate with diameters in excess of 3 inches (median axis). Although several redds were observed in these tailouts, the reach generally lacked spawning gravels. The favorable rearing conditions observed in this reach throughout the year make it a prime candidate for restoration. Maximizing the spawning potential within this reach for salmon and trout would allow for greater utilization of the low summer temps.

Abundance of juvenile salmon declined rapidly throughout the river during the periods of VAMP storage releases (April 16 to June 15 in 2000; and April 16 to May 15 in 2001). This decline is likely indicative of active emigration of fingerling and smolt salmon downstream into the lower river, the San Joaquin River, and the Bay-Delta. Small numbers of juvenile salmon were observed through the summer in the upper reaches where water temperatures did not exceed 16 $^{o}$C especially at experimental sites in the Lovers Leap and Knight's Ferry reaches.

Young steelhead trout began to emerge from the gravel at the upper river sites by April and were abundant from May through September. They were most abundant at Goodwin and 2-Mile Bar in the upper most section and least abundant at Oakdale, the lowermost site. Young trout reached the lower river sites by June where they remained common through the summer and fall except at lower most site at Oakdale where water temperature was the highest in the study reach at 18-20$^{o}$C.

Yearling and post-yearling trout were concentrated in the upper river for most of the 2000 and 2001 survey period at Goodwin and 2-Mile Bar. Small numbers were observed in lower reaches particularly within experimental sites (Knight's Ferry, Lovers Leap, and Orange Blossom). Water temperatures rarely exceeded 15 $^{o}$C in the upper river, whereas downstream temperatures were near or reached stressful levels of 18-20 $^{o}$C during most of the summer. Yearling trout were slightly more abundant in 2001 than in 2000 in downstream reaches as water temperatures was slightly lower with higher flows in 2001. Abundance at Goodwin and 2-Mile Bar appeared to increase over the summer, which may indicate a positive upstream movement of yearling trout into the cooler waters of the upper river below Goodwin Dam.

### Movement and Factors Related to Movement

Juvenile salmon likely emigrate from the Stanislaus River as fry during the winter of wet years. The low densities of young salmon observed in 2000 as compared to 2001 is possibly due to high winter emigration during high flows in 2000; whereas, flows were low through the winter of 2001. Another explanation for the higher densities of salmon in 2001 is that greater escapement of adult salmon into the river occurred in the fall of 2000 than in 1999, which resulted in greater production of young in 2001.

In both 2000 and 2001 it appeared that large numbers of juvenile salmon migrated from the river during VAMP storage releases. As designed VAMP pulse flows in spring may trigger emigration of pre-smolt and smolt salmon from the river.

VAMP storage releases from mid April through mid May (2001) or mid June (2000) may also trigger downstream dispersal of age 0 trout into the lower reaches especially in years such as 2001 when the only pulse of flow for the year is the VAMP flow.

## Habitat Use by Juvenile Salmon and Steelhead in the Lower Stanislaus River

Soon after emergence in winter fry salmon were observed concentrated in slow-water, margin habitats of the entire study reach. As they grew through the spring they were more abundant in faster water and were often observed sharing feeding lanes on current seams with yearling and adult trout. Throughout the spring and summer, velocity appeared to play a more important role in where salmonids were in a given habitat unit as they were often observed in higher velocity areas without vegetation but never observed in zero velocity, vegetated areas. Likewise, during reductions in flow, juvenile salmonids tended to follow the higher velocity water as it moved towards the head or tail of a site.

In contrast, age 0 and age 1 trout were generally equally abundant in slow and faster water in some reaches, but showed a preference for faster water in upstream reaches and slower water in downstream reaches. Both showed a strong preference for habitat of the experimental reaches.

Based on snorkel observations, young salmon and trout often selected flooded vegetation as it provided velocity refuge, overhead cover, and protection from predators.

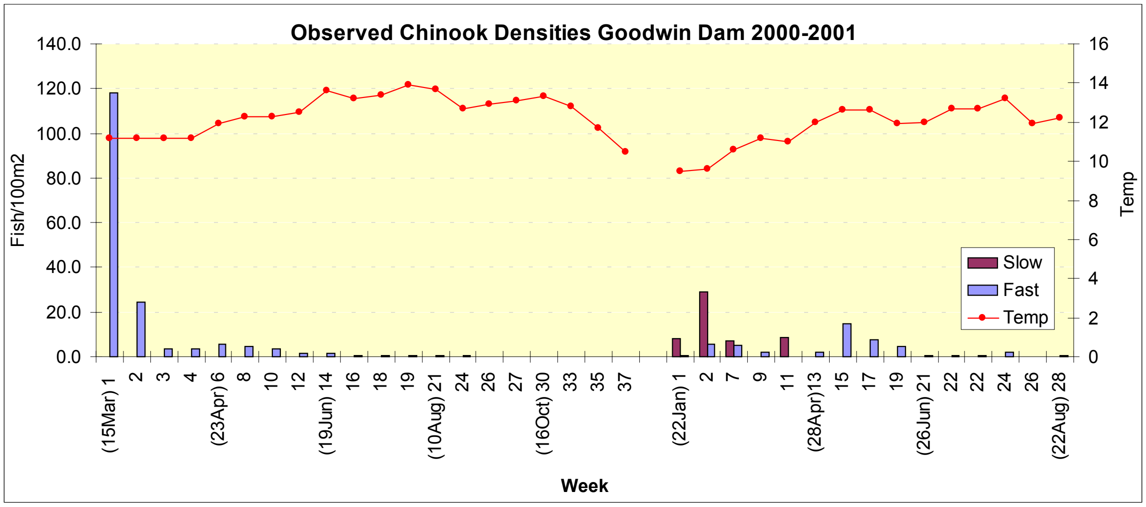
## Predatory Fish

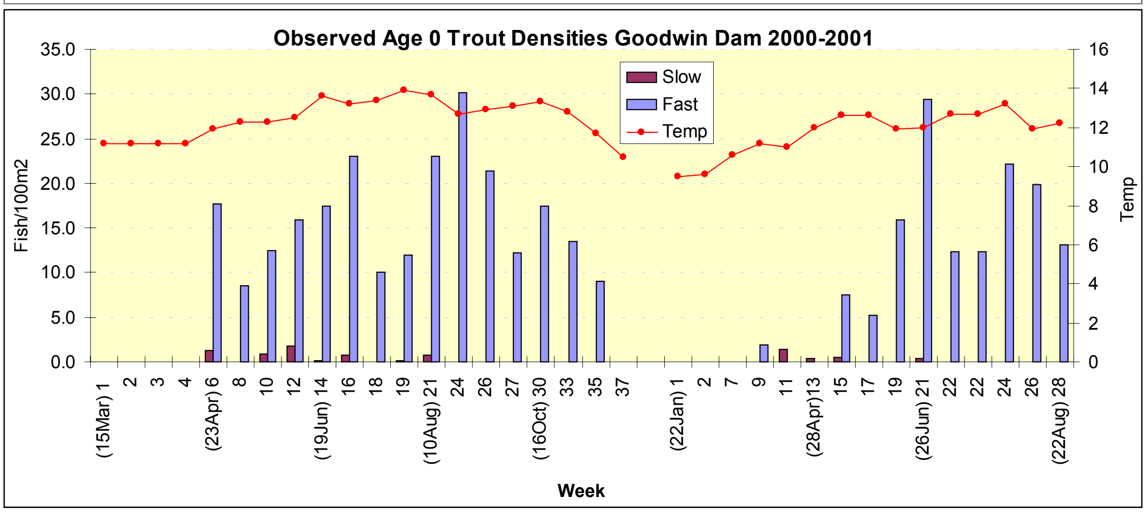
Striped Bass were observed at Lovers Leap and at Knights Ferry from May through the end of June. Fish ranged from 5 –30 pounds and were observed in all habitats. Bass were observed chasing juvenile trout on two occasions but were never successful. Bass distribution is though to be limited to the river downstream of the historic Knights Ferry Bridge due to a set of falls about 3 feet tall exists in the area. This barrier may be important to juvenile salmonids that over summer in the river as it most likely gives refuge from predatory fish.

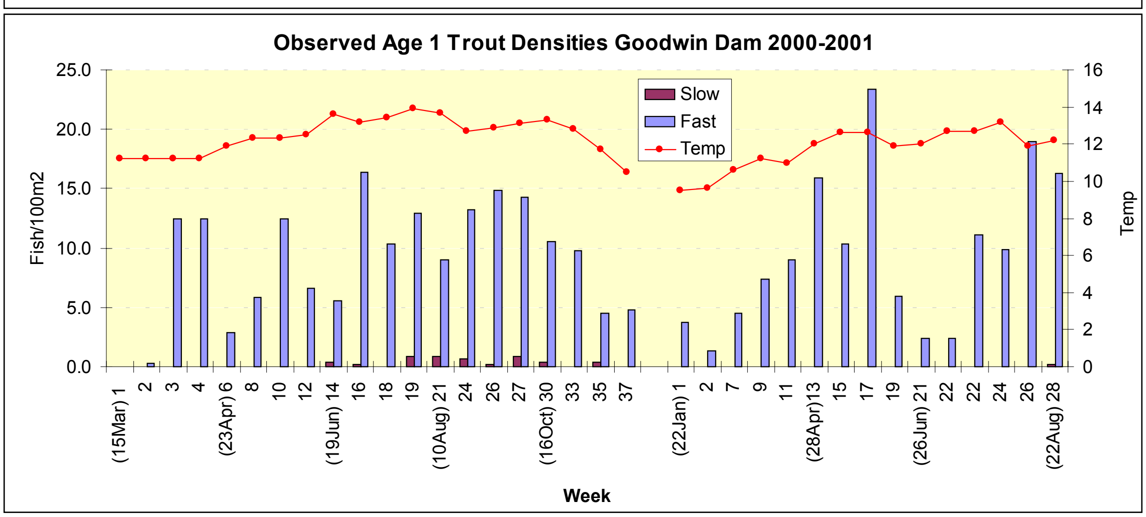
American Shad were observed on three occasions in June through July at Lovers Leap. Shad were observed in schools of 20 or more and were found primarily in the faster habitats. Although no predation was observed, it has been documented that shad prey upon juvenile salmonids.

Predatory fish may pose a significant threat to salmonids residing in and migrating from the Stanislaus River. Juveniles in the upper river where the water is less turbid may stand a higher chance of being preyed upon. The recently approved Portable Alaskan Weir Project (SPCA?) may provide a unique opportunity to remove or at least exclude both Striped bass and Shad from the upper river where they would presumably do the most damage.

# Appendix A – Goodwin



### Juvenile Salmon

In the Goodwin reach, with the exception of weeks 1 and 2 of year 2000 and week 2 of year 2001, chinook densities were low (<20/100m$^2$) throughout the survey period in both the fast and slow sites. Density was highest at the fast-water site after February, whereas it was higher at slow water sights in January and February 2001. Only fry were observed at the slow site and most often on the extreme margin in less than 3 inches of water. No young salmon were observed at either habitat site after week 24 in year 2000.

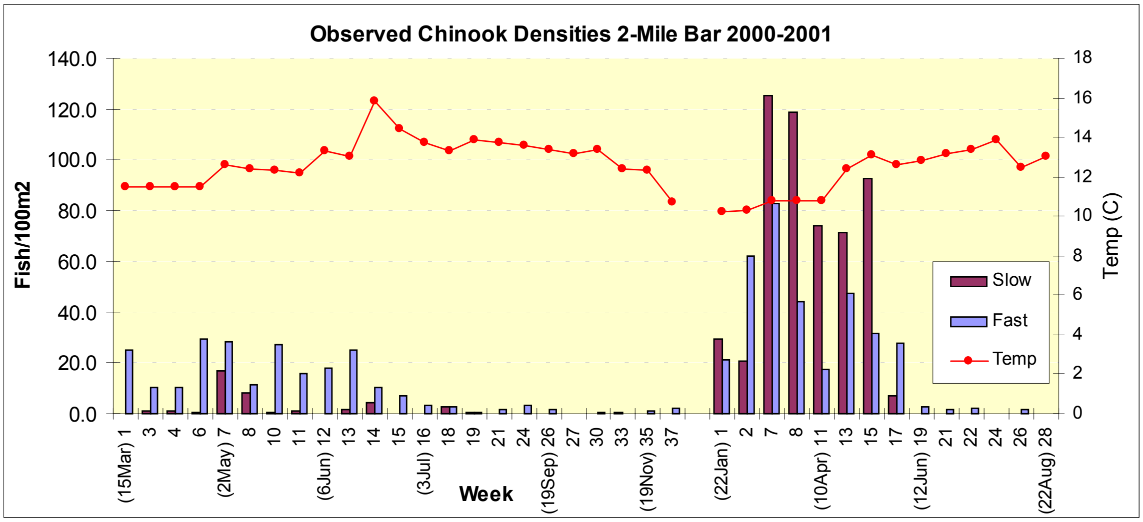
### Age 0 Trout

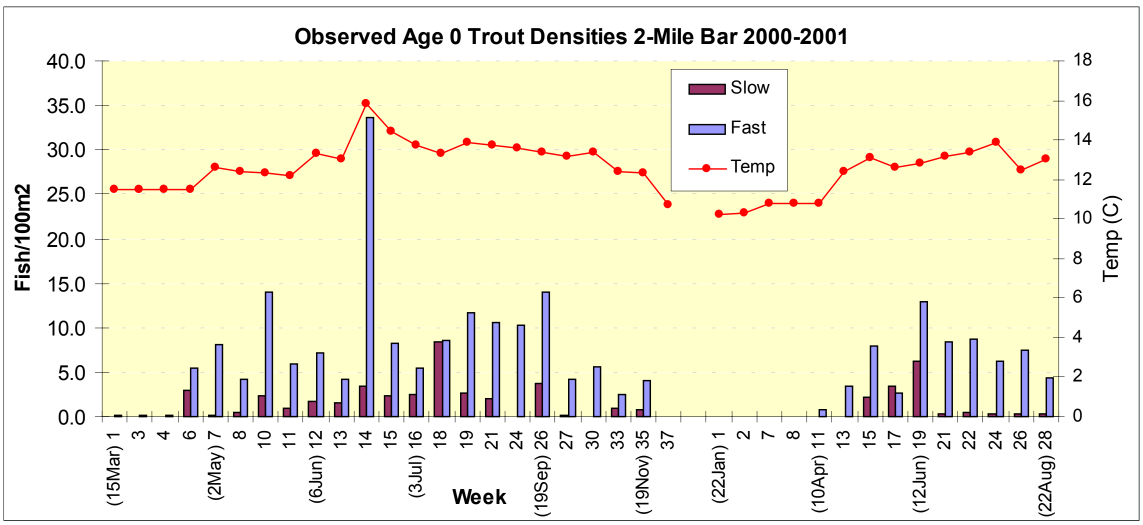
Age 0 trout first were observed at Goodwin in late April 2000 and late March 2001. They remained abundant through the spring and summer of both years, and through the fall of 2001. Nearly all observations were from the fast water section.

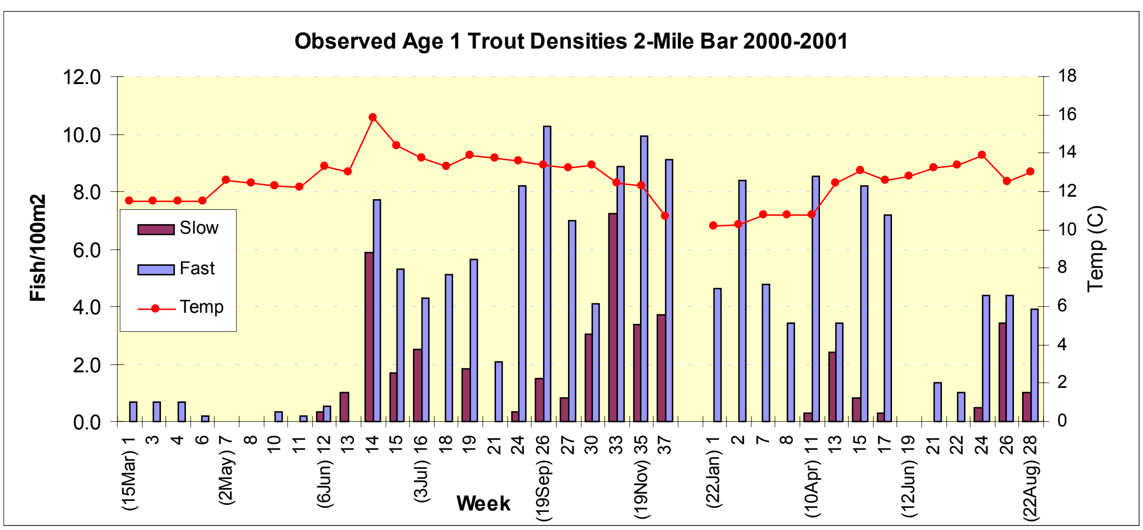
### Age 1 Trout

Age 1 trout were relatively abundant year-round at Goodwin. Nearly all were observed in fast water habitat.

# Appendix B - Two-Mile



### Juvenile Chinook Salmon

Chinook salmon were observed throughout the survey period. Peak densities in year 2000 occurred from week 6 through week 13 (10-30/100m$^2$) after which they steadily declined through week 35. Most were observed in the fast water section. Juvenile salmon were far more abundant in 2001. One explanation is the high winter flows in 2000 may have moved many newly emerged fry downstream of the study reach; whereas the low flows of 2001 retained more fry. Fry from fall 2000 spawners began to appear in week 37 of 2000. In 2001 from January through mid May higher densities occurred in slow water as fry predominated. Most of the young salmon left the reach after a month of VAMP flows from mid April to mid May.

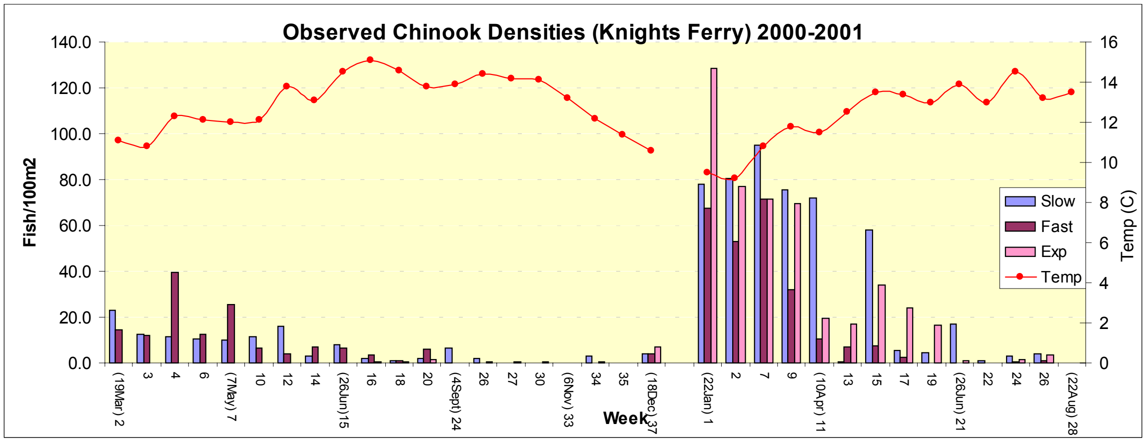
### Age 0 Trout

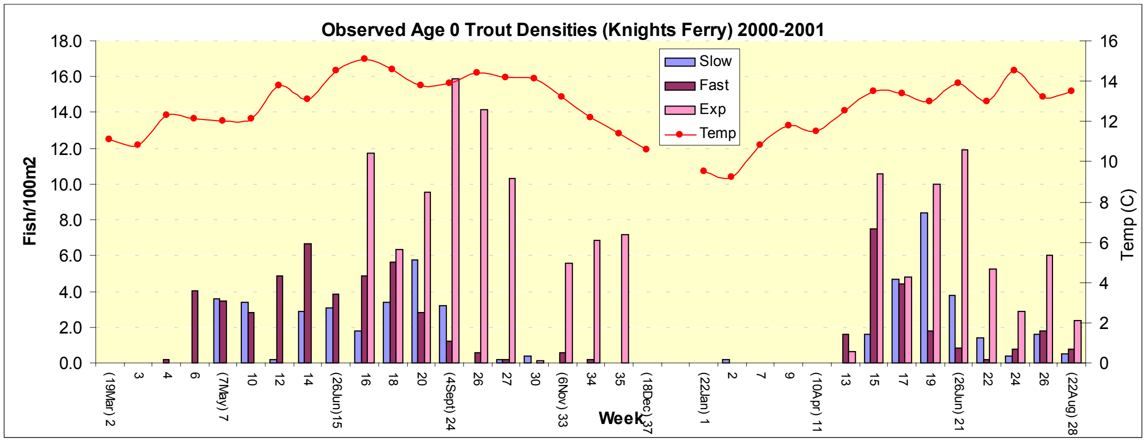
Age 0 trout first appeared in abundance in April 2000 and 2001. They were observed through the remainder of each year with the majority observed in the fast water section.

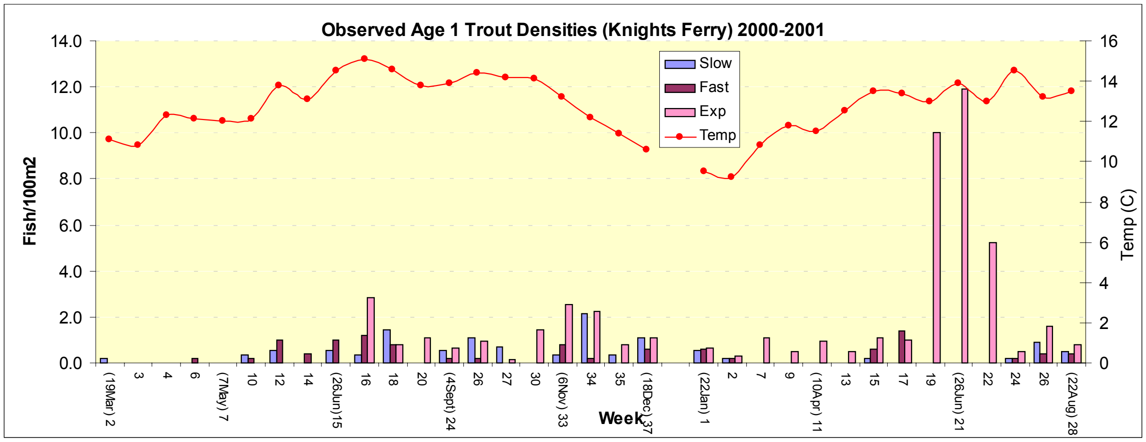
### Age 1 Trout

Age 1 trout were relatively abundant year-round at 2-Mile Bar. The majority were observed in fast water habitat.

# Appendix C – Knight's Ferry



## Juvenile Chinook Salmon

Three sites were surveyed in the Knights Ferry reach: slow-water, fast-water, and experimental. The slow-water site was a slow glide where velocities were slightly higher than the true slackwater sites found upstream in Goodwin and Two-Mile Bar. The experimental site was added in week 16 after observations made during exploratory surveys at a similar site in the Lovers Leap reach indicated concentrations of juvenile salmonids at gravel introduction sites.

As at the upper two sites previously discussed, the density of young salmon observed was much higher in 2001 than 2000. Young salmon were abundant in all three habitat types until mid April after which most were captured in the experimental and fast water sections.

The salmon observed in week 37 of 2000 included newly hatched fry as well as yearlings of the 1999-2000 cohort that remained as a small group of 12-15 fish that were observed periodically at the head of a mid channel pool that was approximately 11 feet deep. The yearling salmon were all in excess of 120 mm and were fully smolted when last observed.

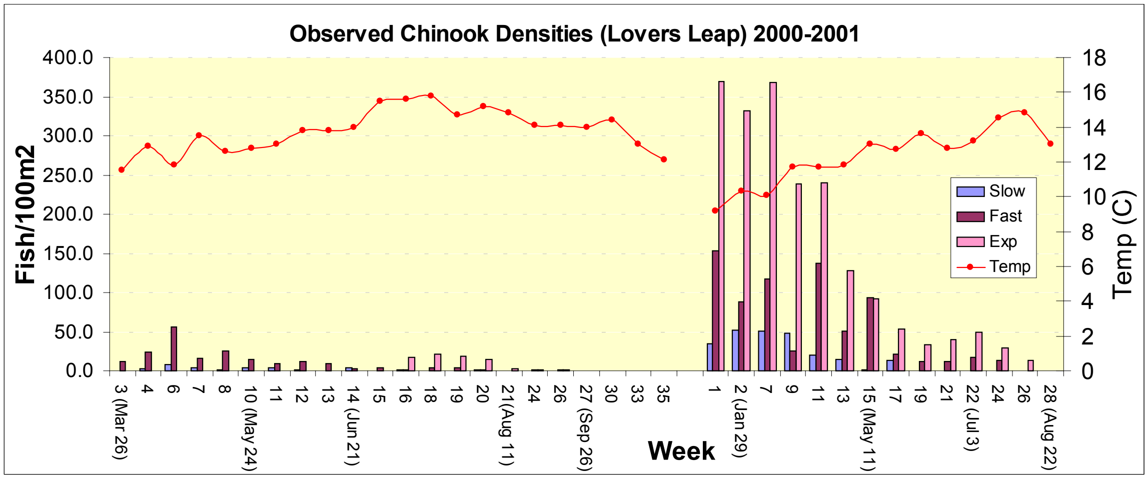
## Age 0 Trout

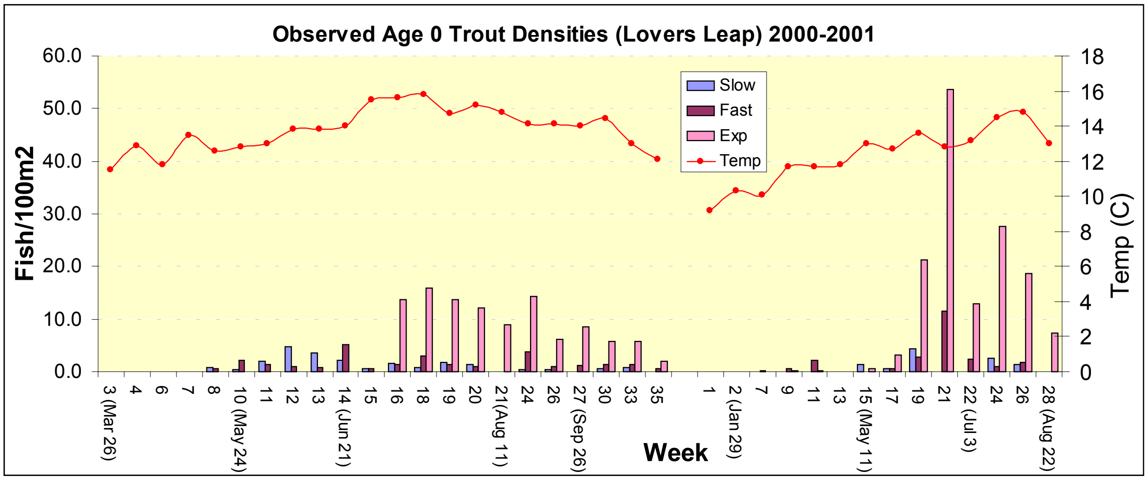
As at the upstream stations, age 0 trout first appear in April of 2000 and 2001. They were most abundant at the experimental station especially during the summer and fall. Note that surveys did not commence at the experimental station until week 16 of 2000.

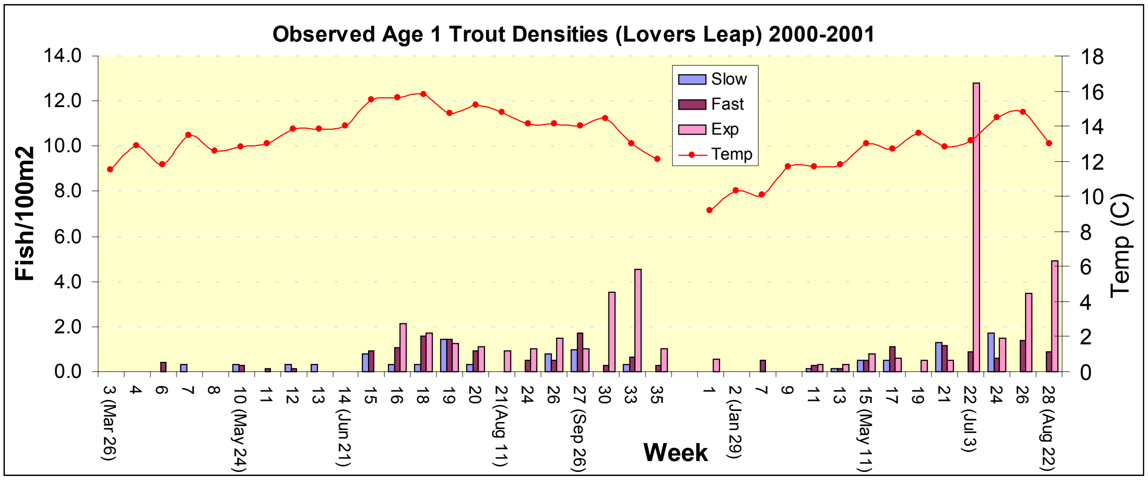
## Age 1 Trout

Age 1 trout were captured in low numbers through most of the study period at Knight's Ferry. As for young, yearling densities were higher at the experimental station.

# Appendix D – Lovers Leap



### Juvenile Chinook Salmon

Three sites were surveyed in the Lovers Leap reach: slow-water, fast-water, and experimental. The experimental site was added in week 16 after observations made during exploratory surveys in the reach indicated concentrations of juvenile salmonids at gravel introduction sites. The number of young salmon observed in 2000 declined gradually through week 14. Salmon numbers rapidly declined in both the slow and fast habitats, but particularly in the slow water habitat. At this time snorkel surveys were extended over much of the reach to determine if there was an unseen shift in distribution to habitats that were being overlooked. Nothing unusual was observed except at a site approximately 0.5 miles upstream where at a gravel introduction site where salmon densities similar to peak densities observed earlier in the year at the fast and slow sites were noted. Thereafter this new site was also included in the survey, as were similar experimental sites at Knight's Landing and Orange Blossom Bridge. Salmon densities in excess of 15 per 100m2 were observed at this new site through week 20, after which density rapidly declined through week 30.

As at the upper three sites previously discussed, the density of young salmon observed was again much higher in 2001 than 2000. Young salmon were most abundant in the experimental habitat. Densities in the experimental site were also about double those in the slow water site and more than 4 times the observed density from the fast water site.

No fry salmon were observed in week 37 as at the upper three stations.

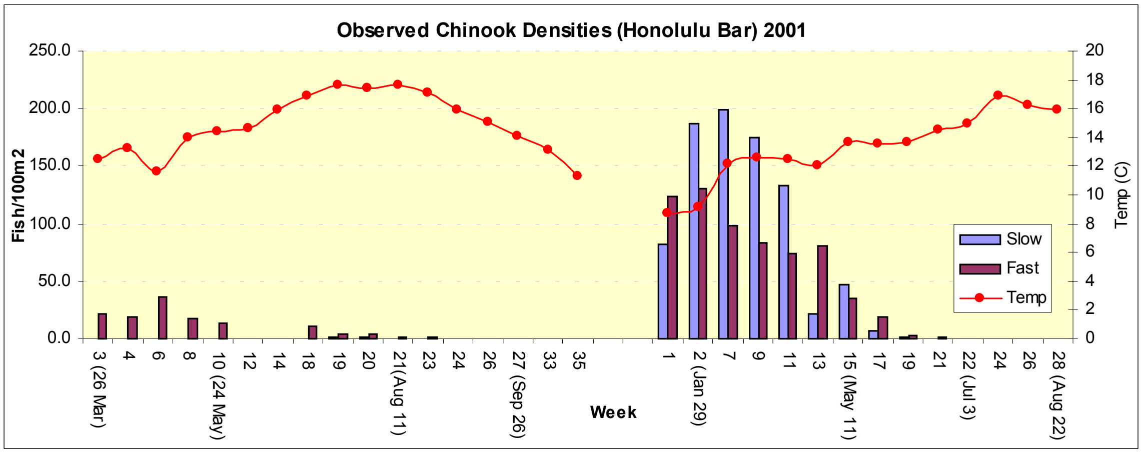
### Age 0 Trout

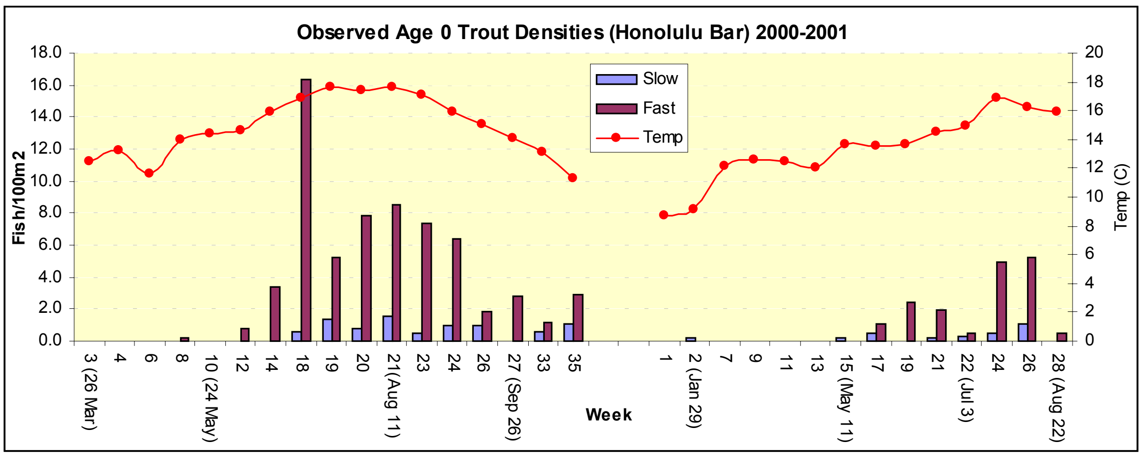
As at the upstream stations, age 0 trout first appear in April of 2000 and 2001. Again, they were most abundant at the experimental station especially during the summer and fall. Note that surveys did not commence at the experimental station until week 16 of 2000. Densities observed were slightly higher in 2001. Water temperatures were slightly lower and flow higher in July of 2001 than 2000.

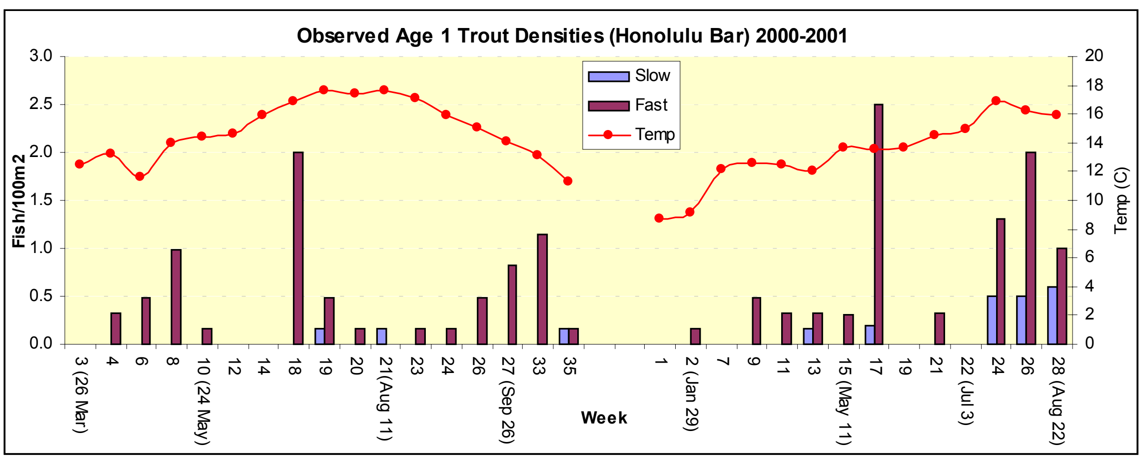
### Age 1 Trout

Age 1 trout were captured in low numbers through most of the study period. As for young, yearling densities were higher at the experimental station. Again, densities were higher in the summer of 2001 than 2000.

# Appendix E – Honolulu Bar



### Juvenile Chinook Salmon

Only two sites were surveyed in the Honolulu Bar reach: slow-water and fast-water. Again, they were far more abundant in 2001 than in 2000. The number of young salmon observed in 2000 declined gradually through week 10. Salmon were most abundant in the slow-water habitat. Small numbers were observed through the summer of 2000 predominantly in the slow-water habitat. Young salmon were abundant through mid May in 2001 after which few were observed through the summer.

No fry salmon were observed in week 37 as at the upper three stations.

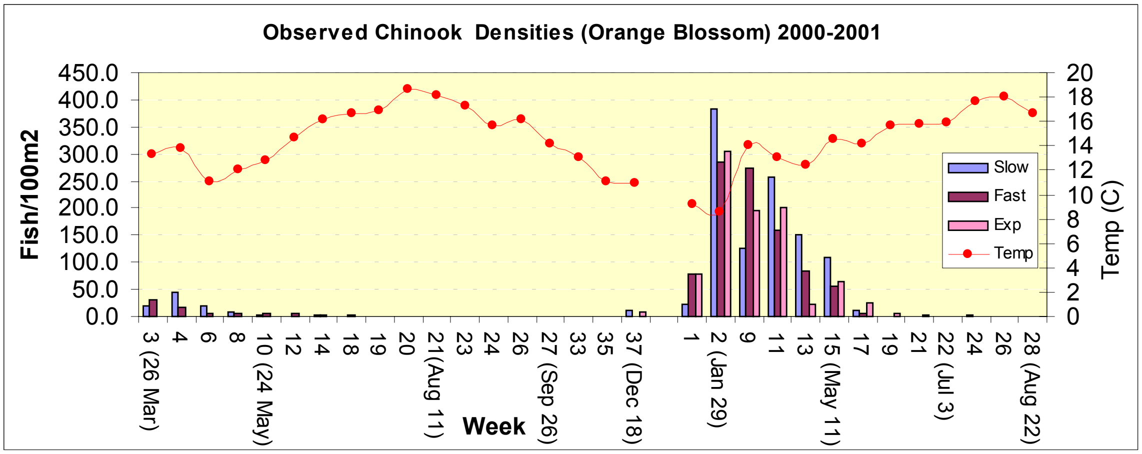
### Age 0 Trout

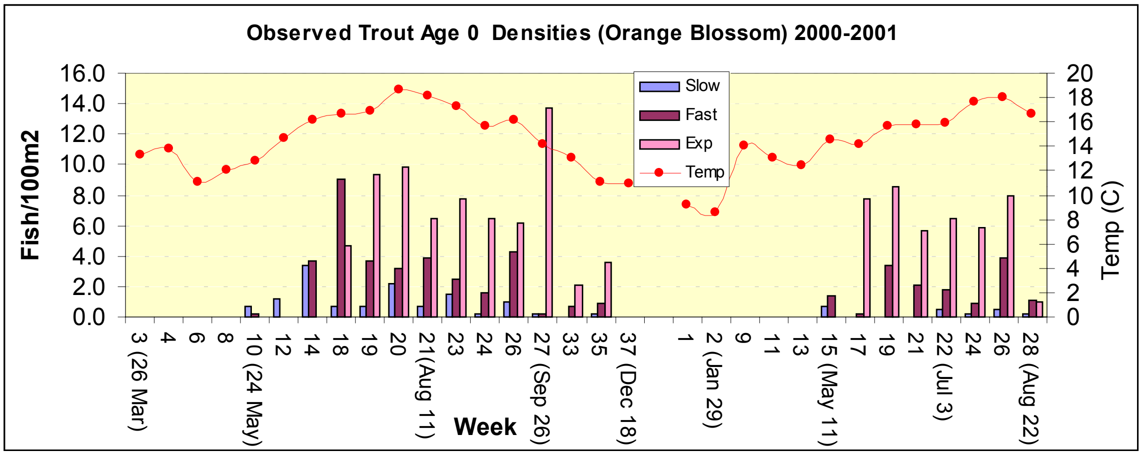
Unlike the upstream stations, age 0 trout did not appear until May in 2000 and 2001. Densities observed were higher in June 2000 despite higher water temperatures. June flows were higher in 2000.

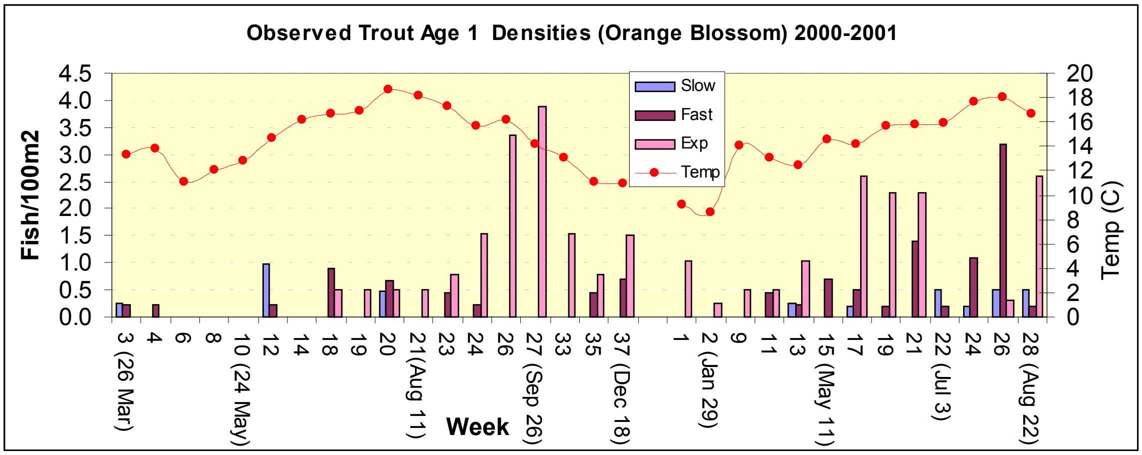
### Age 1 Trout

Age 1 trout were captured sporadically in low numbers through most of the study period. Most were observed at the slow water site.

# Appendix F - Orange Blossom



## Juvenile Chinook Salmon

Three sites were surveyed in the Orange Blossom reach: slow-water, fast-water, and experimental. The experimental site was added in week 16 of 2000 after observations made during exploratory surveys in the reach indicated concentrations of juvenile salmonids at gravel introduction sites. The number of young salmon observed in 2000 declined gradually through week 18. Salmon numbers rapidly declined in both the slow and fast habitats, but particularly in the slow water habitat. Unlike the upstream experimental sites, few salmon were observed at the experimental site in 2000. A major difference with the upper sites was the higher water temperature at Orange Blossom (> 16EC).

As at the sites previously discussed, the density of young salmon observed was again much higher in 2001 than 2000. Young salmon were not more abundant in the experimental habitat as at the upstream sites.

Some fry salmon were observed in week 37 as at the upper three stations.

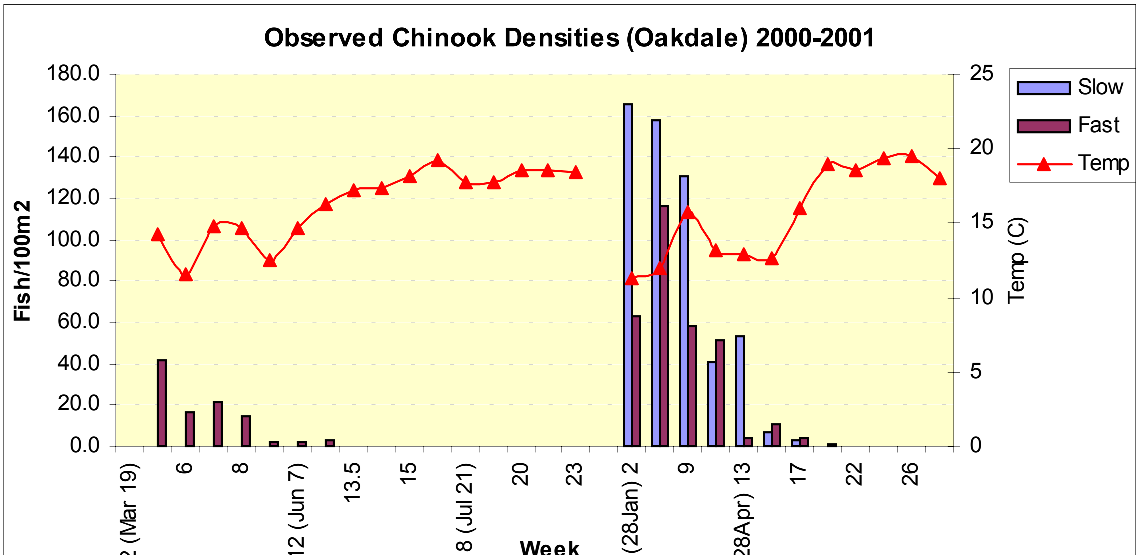
## Age 0 Trout

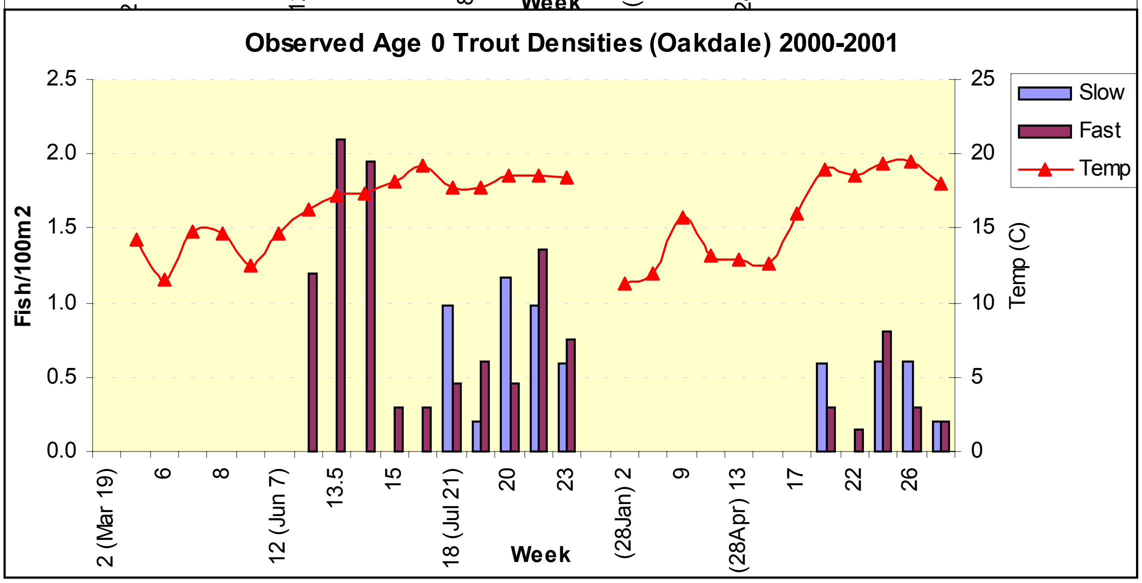
Unlike upstream stations, age 0 trout did not first appear in April of 2000 and 2001 but rather in May. Again, they were most abundant at the experimental station especially during the summer and fall. Densities observed were similar in 2000 and 2001. Water temperatures were also similar in July of the two years.

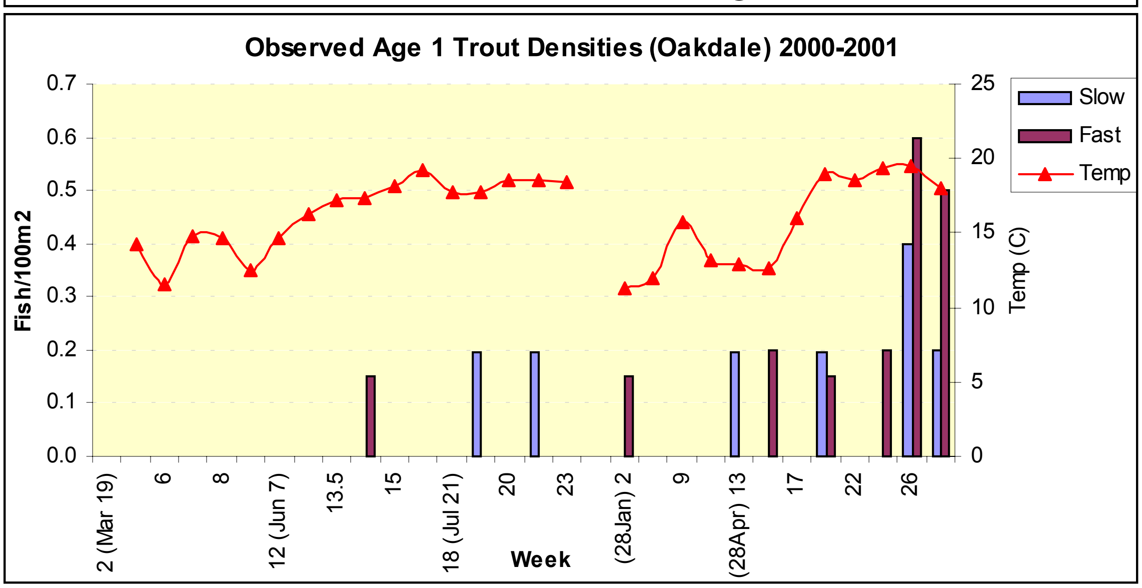
## Age 1 Trout

Age 1 trout were captured in low numbers through most of the study period. As for young, yearling densities were higher at the experimental station.

## Appendix G – Oakdale



## Juvenile Chinook Salmon

Only two sites were surveyed in the Oakdale reach: slow-water and fast-water. Again, they were far more abundant in 2001 than in 2000. The number of young salmon observed in 2000 declined gradually through week 10. Salmon were most abundant in the slow-water habitat. No young salmon were observed after mid June. Young salmon were abundant through April in 2001 after which few were observed through the summer.

No fry salmon were observed in week 37 as at upstream stations.

## Age 0 Trout

Unlike the upstream stations where age 0 trout appeared in April or May, they did not appear until June at Oakdale in 2000 and 2001. Densities observed were higher in June 2000 than 2001. Water temperatures were lower in 2000 in June because June flows were higher in 2000 than 2001. Age 0 trout were initially more abundant in the slower water site, but their densities were similar late in the summer.

## Age 1 Trout

Age 1 trout were observed sporadically in very low numbers during the study period. Most were observed at the slow water site. They were more abundant in the summer of 2001 than 2000 despite water temperatures of 18-20EC.