Fish Surveys Related to the Proposed Del Norte Highway 101 Klamath Grade Raise Project: Addendum Report 2010-2011

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Abstract

The Yurok Tribal Fisheries Program conducted fish surveys, water quality monitoring, and habitat mapping activities in select tributary and wetland habitats of the Klamath River estuary during summer 2010 and winter 2011. Off-estuary tributary and wetland habitats provide critically valuable rearing areas for juvenile salmonids from throughout the Klamath Basin and continue to be vulnerable to past and ongoing land use activities. The 2010-2011 study was a continuation of baseline fisheries investigations initiated in 2009 to increase understanding of fish use and abundance patterns in areas that may be impacted by the proposed Del Norte 101 Klamath Grade Raise, Road Rehabilitation and Bridge Replacement Project or other related highway improvement projects. Study areas in 2009 included Spruce Creek, Panther Creek, Hunter Creek, and Salt Creek (Hunter Road and Arbor Glen wetlands); while the 2010-2011 study focused on Spruce Creek, Panther Creek, and lower Hunter Creek.

Target species of this study included coho salmon, chinook salmon, steelhead trout, and coastal cutthroat trout. Mark-recapture studies were conducted in the Spruce Creek wetland and Panther Creek Pond to generate population estimates for juvenile coho salmon and trout species during summer 2010 and winter 2011. Fish population estimates indicated that Spruce Creek had the highest abundance of juvenile coho during the sampling period, with 85 coho estimated during July 2010, 23 in September 2010, and 1,073 juvenile coho estimated during winter surveys. Coho population estimates from Panther Creek Pond during July 2010 (16 fish), September 2010 (5 fish), and winter 2011 (651 fish) were lower than in Spruce Creek. The largest trout population numbers were estimated for Panther Creek Pond during July 2010 (49 fish), September 2010 (94 fish), and winter 2011 (240 fish). Trout populations estimated in Spruce Creek were much lower with 24 fish estimated during July 2010, 13 fish in September 2010, and 144 fish during winter 2011. Monthly snorkel surveys were performed in lower Hunter Creek during late summer 2010 to document fish use and temporal trends of target species. Species observed during these inventories included a juvenile coho salmon and multiple age classes of coastal cutthroat trout, and steelhead. Water quality monitoring and bathymetric surveys were also conducted in Panther Creek Pond to further characterize fish habitat conditions.

Introduction

Yurok People have relied on the resources of the Lower Klamath River for their subsistence, cultural, and economic livelihood since time immemorial. Central to Yurok culture and livelihood is subsistence harvest of Klamath River fish populations. Anthropogenic activities occurring over the past century have drastically altered or degraded river, tributary, and estuary habitats and resulted in substantial declines to Klamath River fish runs and greatly impacted the productivity of the basin. The long-term goal and priority water resource need of the Yurok Tribe is to restore Klamath Basin habitats to levels that support robust populations of native fish. To address this long-term objective, the Yurok Tribal Fisheries Program – Lower Klamath Division (YTFP) works with restoration partners, including other Tribal Departments, state and federal resource agencies, small-scale agricultural producers, and private landowners, to assess, identify, and treat factors limiting anadromous fish in the Lower Klamath River.

Given the moderating climatic effects of the ocean and ongoing restoration efforts, tributaries of the Lower Klamath River Sub-basin are considered an important salmon stronghold; especially if conditions unfavorable to salmon survival continue to progress in basins to the south and further inland. The Klamath River estuary serves as a vital staging area and nursery for spring and fall-run chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), steelhead trout (*O. mykiss*), coastal cutthroat trout (*O. clarki clarki*), green and white sturgeon (*Acipenser spp.*), eulachon (*Thaleichthys pacificus*), longfin smelt (*Spirinchus thaleichthys*), and multiple species of lamprey (*Lampetra spp.*). Off-estuary and coastal tributaries of the Lower Klamath also provide critically important rearing and staging habitat for salmonids from throughout the basin (Soto et al. 2008; Hillemeier et al. 2009; YTFP 2009; Silloway 2010; Fiori et al. 2011a and 2011b; Pagliuco et al. 2011). These habitats provide salmonids refuge from high water velocities or poor water quality conditions occurring elsewhere and offer diverse habitats for fish to forage or stage prior to initiating ocean entry or upriver migration.

In 2009, the California Department of Transportation (Caltrans) funded YTFP to conduct fish surveys in tributary habitats that may be impacted by the proposed Del Norte (DN) Highway 101 Klamath Grade Raise, Road Rehabilitation and Bridge Replacement (KGR) Project (Silloway 2010). These habitats included wetland complexes located in Spruce Creek, Panther Creek, Hunter Creek, and Salt Creek (Hunter Road and Arbor Glen wetlands) (Figure 1). The primary target species of these fisheries surveys were coho salmon, currently listed as Threatened pursuant to both federal and state Endangered Species acts (ESAs) and the longfin smelt which was recently listed as Threatened pursuant to the California ESA. Secondary target species of these efforts included steelhead trout, coastal cutthroat trout, and chinook salmon.

YTFP has documented significant use of these wetland complexes by both natal and non-natal juvenile salmonids; however, patterns of fish use and seasonal abundance vary from year to year (Soto et al. 2008; Hillemeier et al. 2009; Silloway 2010). The purpose of the 2009 study was to provide data relating to target fish species within the proposed KGR project area. Specific objectives of the initial study included quantifying numbers of target species in Spruce Creek, Panther Creek Pond, and Salt Creek marsh; assessing the Hunter Road and Arbor Glen wetlands; documenting fish habitat conditions and use within a selected reach of lower Hunter Creek; and documenting water quality conditions at each study site. The initial study period was

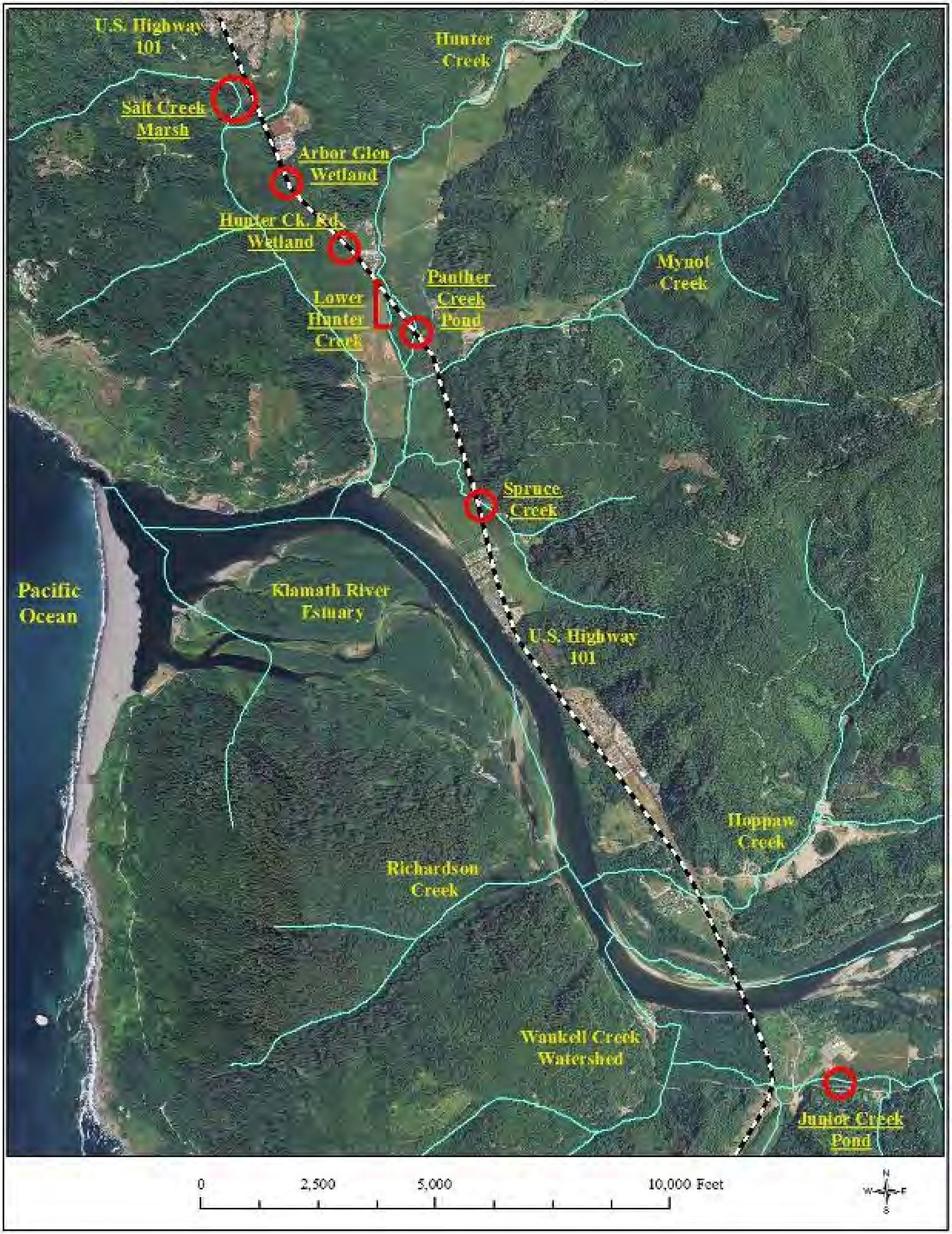


Figure 1. Map depicting several off-estuary fish monitoring sites located in the Lower Klamath River Sub-basin, California (Base Image: 2009 NAIP Imagery).

May – October 2009 to coincide with the typical construction season. The 2010 report also includes a review of past fish monitoring efforts in the study area and other tributaries of the Lower Klamath River (Silloway 2010). Given the annual variability in fish use of off-estuary habitats of the Klamath River, Caltrans decided to fund another year of surveys in a few priority areas to increase understanding of potential KGR impacts and further develop measures to avoid or limit impacts to valuable resources.

Study Area

The proposed KGR project area is located on the north side of the Klamath River estuary; an area of significant spiritual, cultural, and economic importance to the Yurok People. The major watersheds draining the north side of the estuary include Hoppaw Creek, Salt Creek, and Hunter Creek (Figure 1). The Salt-Hunter valley was once a complex backwater feature of the Klamath River estuary comprised of a vast network of low gradient, anastamosed channels and conifer-dominated wetlands. Agricultural development and other land management activities conducted in the early 1900s resulted in substantial wetland conversion and loss of channel and riparian complexity (Beesley and Fiori 2004, 2007 & 2008). By the mid-1960s, most of the off-channel habitats and slough features in the valley had been altered, impaired, or filled; and Salt Creek was diverted into a very simplified channel along the western valley side wall (Figure 1).

Salt Creek now enters the estuary less than one mile upstream of the Pacific Ocean (Figure 1). Lower Salt Creek contains several current and remnant beaver dams and vast open and emergent wetland habitats including the Arbor Glen and Hunter Road wetlands. Salt Creek supports spawning populations of coho salmon, steelhead, and coastal cutthroat trout and valuable rearing and staging habitat for non-natal fish migrating through the estuary (Beesley and Fiori 2004; Silloway 2010). Hunter Creek is a fourth order watershed draining to the Klamath River estuary just upstream from the Salt Creek confluence (Figure 1). The 28.7 mi^2 watershed supports spawning populations of chinook and coho salmon, steelhead, and coastal cutthroat trout (Gale and Randolph 2000). Lower Hunter Creek and its tributaries also provide valuable rearing and staging habitat for non-natal salmonids (Beesley and Fiori 2008; Silloway 2010).

Spruce Creek and Panther Creek enter the eastern side of lower Hunter Creek (Figure 1). The dominant fish habitats in both tributaries are beaver influenced ponds and emergent wetlands. Spruce Creek enters Hunter Creek just upstream of the confluence with the Klamath River and therefore is greatly influenced by mainstem flow events and the Pacific Ocean (Beesley and Fiori 2008). The channel between DN Highway 101 and Hunter Creek is comprised mostly of beaver influenced ponds and sinuous channel reaches formed primarily by backwater processes. Spruce does not likely support spawning populations of salmon. The system does support spawning populations of coastal cutthroat and possibly steelhead. Lower Spruce Creek provides critically important juvenile rearing habitat for non-natal coho and other salmonids (Silloway 2010).

Panther Creek is primarily a spring fed system that enters Hunter Creek directly upstream of the Requa Road Bridge (Figure 1). Panther Creek Pond is located just upstream of the confluence with Hunter Creek and is comprised mostly of deep, open water habitat with complex edge habitats and interconnected emergent wetlands. This unique tributary provides critically valuable, high quality rearing habitat to non-natal salmonids and native wildlife (Soto et al. 2008; Hillemeier et al. 2009; Silloway 2010). Lower Panther Creek does not likely support spawning populations of anadromous salmonids given the lack of spawning gravels. However, the upper reaches may support native populations of resident steelhead and coastal cutthroat trout.

Study Objectives

Study objectives for 2010-2011 were to: 1) conduct quantitative fish sampling in Spruce Creek and Panther Creek adjacent to DN Highway 101 during summer 2010 and winter 2011 (Task 3.1); 2) conduct snorkel inventories of Hunter Creek in the vicinity of DN Highway 101 during late summer 2010 (Task 3.2); and 3) conduct 3-dimensional bathymetric surveys and water quality monitoring in Panther Creek Pond during summer 2010 (Task 3.3) (Figures 1-2).

Caltrans and participating resource agencies agreed that an additional year of pre-construction surveys of fish population and habitat conditions in Panther, Spruce, and Hunter creeks would further improve Caltrans' ability to 1) develop project alternatives, construction scenarios and other measures necessary to avoid and/or minimize impacts to species of concern; 2) further characterize baseline conditions and set a baseline for monitoring compliance to assess the effectiveness of the implemented minimization measures; and 3) assure that any project impacts to aquatic organisms are fully mitigated once construction is complete.

Task 3.1 – Fish Surveys at Spruce Creek and Panther Pond

Fish Survey Methods

Mark-recapture fish surveys were performed in Spruce Creek and Panther Pond in July 2010, September 2010, and late January - February 2011 to assess population abundance of juvenile salmonids. For each population estimate, YTFP conducted 2-3 trapping events. Each trapping event consisted of a 24 hour set with one week between each trapping event.

The initial trapping event was the marking phase, where all target fish (coho salmon and native trout species) captured were anesthetized with Tricane Methanesulfonate (MS-222), enumerated and identified by species, measured (FL), weighed (g), scanned with an Allflex handheld scanner to detect PIT tags. If no PIT tag was detected, all fish greater than 64 mm and 2.9 g were marked with a 12 mm, 134.2 kHz, Super Tag 2 PIT tag. PIT tags were inserted into a small surgical incision made in the underside of the fish near the pelvic fin. All PIT tags were sterilized in povidone/10% iodine hospital antiseptic solution before insertion into the body cavity. PIT tagged fish were scanned with the Allflex scanner and the individual tag numbers were recorded, and the fish were identified as PIT tag marks (M). All fish less than or equal to 64 mm and 2.9 g were given a specific fin clip (e.g. upper or lower lobe of caudal fin) and noted as a mark (M). This procedure was slightly modified during the winter 2011 population estimate due to the large number of fish captured. All trout and just a portion of the coho captured in the first trapping event were marked with an upper or lower caudal fin clip and noted as a mark (M). Marked fish

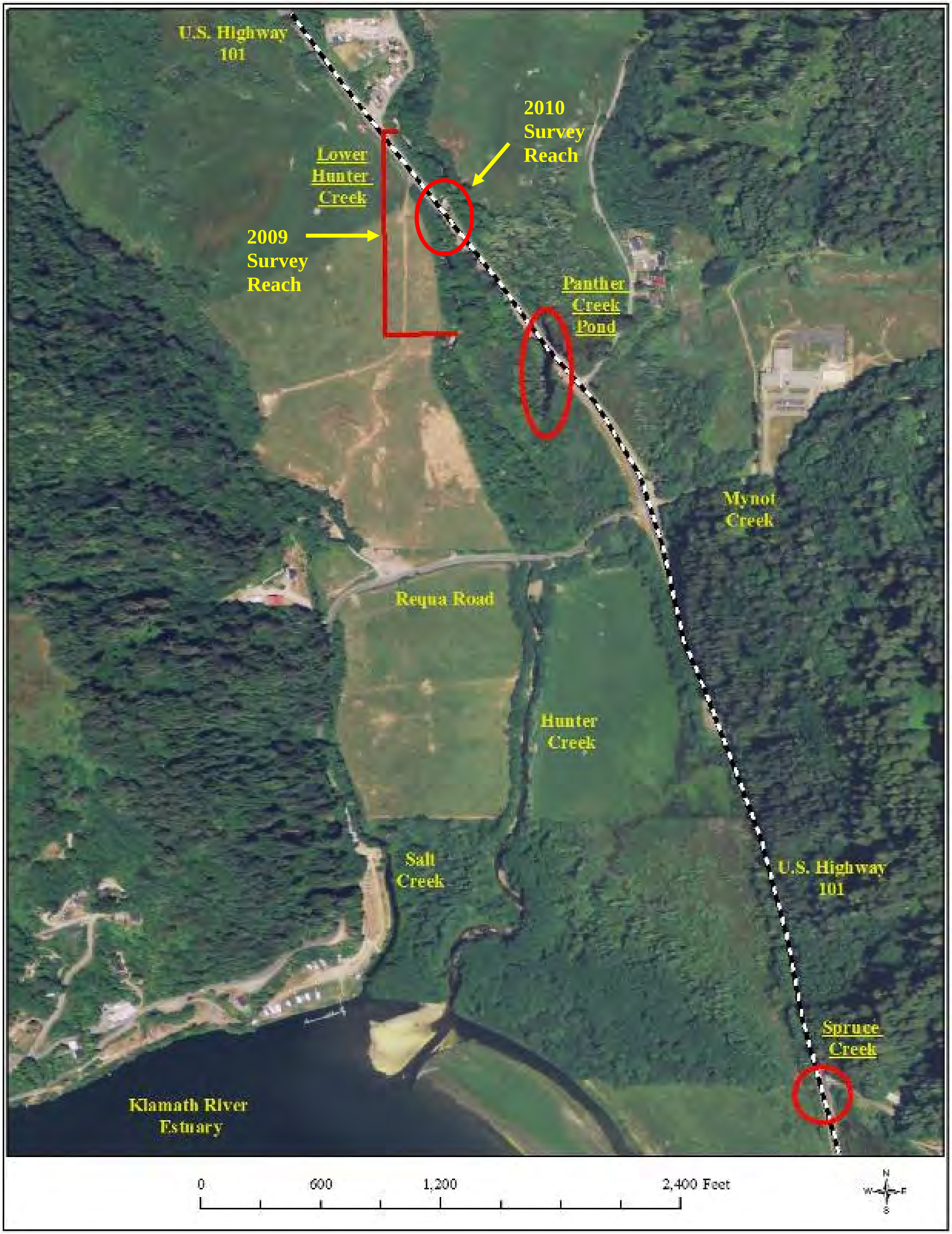


Figure 2. Map depicting fish monitoring sites located in Spruce Creek, Panther Creek, and lower Hunter Creek, Lower Klamath River Sub-basin, California (Base Image: 2009 NAIP Imagery).

were placed in holding pens to recover and then returned to the sampling area after they resumed a normal swimming pattern. All non-target fish species and amphibians captured during sampling events were identified and enumerated.

The second trapping event was considered the first recapture event and traps were deployed in the same areas as during the marking event. All target fish captured were anesthetized with MS-222, enumerated and identified by species, measured, weighed, scanned for a PIT tag, and examined for the presence of the appropriate fin clip mark. All fish with PIT tag detections or fish displaying the appropriate fin clip from the marking event were recorded as recaptures (R). All coho captured that were not previously marked with a PIT tag were implanted with a 12 mm, 134.2 kHz, Super Tag 2 PIT tag. All sampled fish were allowed to recover in holding pens and were later returned to the sampling area after they resumed a normal swimming pattern.

Population estimates for juvenile coho salmon and trout species were calculated using the mark-recapture data and the Bailey (1951) equation of the Lincoln-Peterson estimator. Coho salmon population estimates were based on both parr and presmolt data; whereas trout population estimates were based on parr, presmolt, and adult data. Cutthroat and steelhead data were lumped together to better facilitate population estimation (larger sample sizes).

This mark-recapture method assumes:

1. Animals marked in the initial trapping event have time to mix into the population prior to the recapture event so that marked and unmarked animals have an equal probability of being caught;

2. The population is closed, so the size is constant.

3. Animals do not lose marks between the sampling periods.

4. All marks are reported on discovery in the second sample

The Bailey Equation:

$$\hat{N} = \frac{(C+1)M_1}{M_2 + 1}$$

Where M_1 is the number of individuals marked in the first and second capture events, M_2 is the number of marked individuals caught in the second and third capture event, C is the total catch from the second and third capture events, and N-hat is the estimated population size (N).

The 95% confidence interval was estimated by first calculating the standard error of N:

$$s_N = \sqrt{\frac{N^2(C - M_2)}{(C+1)(M_2 + 2)}}$$

Then the following equation was used to calculate the 95% confidence interval:

$$CI_{95\%} = N \pm 1.96(s_N)$$

To improve the summer and fall population estimates in Spruce Creek, a third trapping event was conducted. For this method, population estimates were calculated using the mark-recapture data and the Schnabel (1938) estimator, an extension to the Lincoln-Peterson estimator. For this estimator, individuals caught at each sample are first examined for marks, then marked and released. Only a single type of mark was used because we just needed to distinguish two types of individuals: *marked* (caught in one or more prior samples); and *unmarked* (never caught before). For each sample *t*, the following is determined and all assumptions used in the Peterson estimate still apply to the Schnabel estimator (Krebs 1998):

C_t = Total number of individuals caught in sample t

R_t = Number of individuals already marked (Recaptures) when caught in sample t

M_t = Number of marked animals in the population just before the t^{th} sample is taken.

$$N\hat{} = SUM\ (M_t\ C_t)\ /\ ((SUM\ R_t) + 1)$$

For this study, sampling efforts in Spruce Creek were confined to areas located on either side of the DN Highway 101 culvert within the Caltrans right-of-way (Figures 3-6). The area located upstream of the culvert (Spruce_East) consisted of a confined stream channel with a mean width of 12 ft and a mean depth of 2.5 ft. Spruce_East was heavily colonized by aquatic vegetation and dense stands of willow and a prominent beaver dam existed ~30 yards upstream of the culvert (Figures 3-5). The area downstream of the highway culvert (Spruce_West) (Figure 5) consisted of a deep pool with a mean width of 10 ft and a maximum depth of 10 ft and was influenced by beaver dams located downstream of the study area (Figure 3).

YTFP set hooped fyke nets during all mark-recapture events in Spruce Creek. A 2.5 ft x 3 ft hooped fyke net with two trap compartments and 2.5 ft x 25 ft wing block nets attached to either side of the opening was set in an upstream orientation, capturing fish moving in an upstream direction, during trapping events in Spruce_East (Figure 3). Spruce_West was sampled using a 3 ft x 4 ft hooped fyke net with three trap compartments and 3 ft x 25 ft wing block nets attached to either side of the opening. This trap was set near the pool tail in a downstream orientation, capturing fish moving in a downstream direction (Figure 3). A block net (3 ft x 25 ft) was placed ~ 130 ft downstream of the Spruce_West trapping site (Figure 3). A second block net was placed ~ 90 ft upstream of the Spruce_East trapping site (Figure 3). These nets were set to impede immigration and emigration of fish between trapping events (i.e. ensure a closed system).

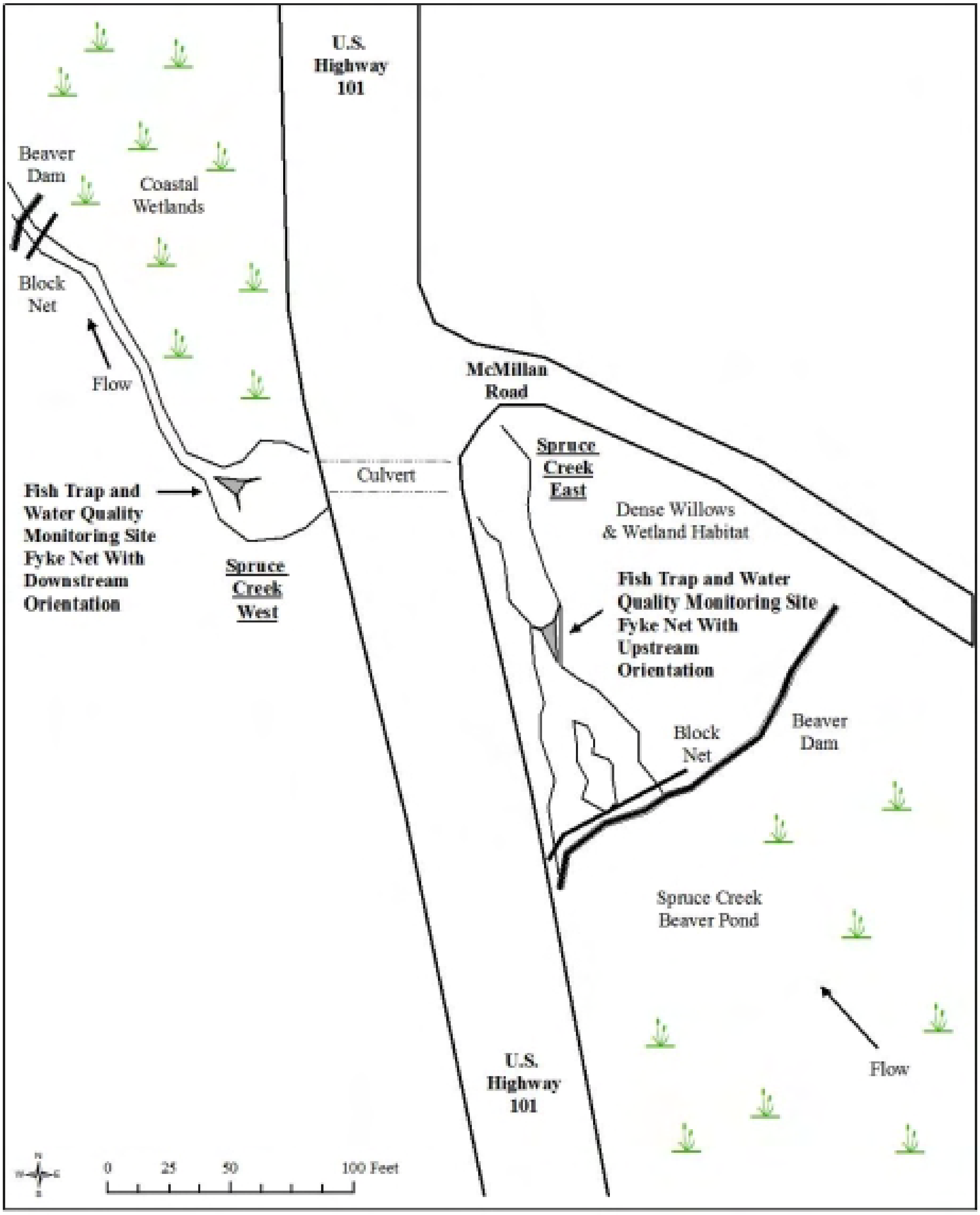


Figure 3. Map depicting fish monitoring sites located in Spruce Creek, Lower Klamath River Sub-basin, California.

Figure 4. Photographs looking upstream (Left) and downstream (Right) at a study area (Spruce_East) located in lower Spruce Creek, Lower Klamath River, California (June 2011).

Figure 5. Photographs of a prominent beaver pond located in lower Spruce Creek, Lower Klamath River, California (Top – February 2009; Bottom - June 2011).

Figure 6. Photographs looking downstream at a study area (Spruce_West) located in lower Spruce Creek, Lower Klamath River, California (June 2011).

Fish sampling was performed throughout the available habitat in Panther Pond using two 3 ft x 4 ft hooped fyke nets. All of the traps set near Panther Pond's primary outlet were set with an upstream orientation, and all other traps were set with a downstream orientation or perpendicular to the primary flow line depending on the areas sampled (Figure 7). Each fyke net had three trap compartments and had 3 ft x 25 ft wing block nets attached to either side of the opening.

To help ensure that the population was closed (one of the mark-recapture estimator assumptions), downstream and upstream oriented hooped fyke nets (2.5 ft x 3 ft) were placed in Panther Creek ~ 30 yards downstream of Panther Pond in the first available reach with a confined channel. Two Biomark PIT tag antenna arrays were also deployed just upstream of the lower trapping location (Figure 7). The antenna arrays encompass the entire channel and detect and document directional movement of full duplex PIT tagged fish. The traps allowed YTFP to document any loss of marked fish from the study area, while the PIT tag antennas continuously monitored lower Panther Creek for PIT tags. Traps were checked daily for any marked or PIT tagged fish, and PIT tag monitoring data was downloaded and assessed regularly during the study.

Figure 7. Map depicting fish monitoring sites located in Panther Creek pond Creek, Lower Klamath River Sub-basin, California.

Prior to conducting the fish surveys during July and September 2010, YTFP monitored water quality at the sites using HydroLab Datasondes to assess conditions and ensure that fish sampling efforts would not result in overt stress or harm to fish. Prior to each deployment, a trained technician properly calibrated each datasonde for temperature, specific conductivity, pH, and dissolved oxygen, and programmed the datasondes to collect water quality parameters at 30 minute intervals for 72 hours. Water quality readings were obtained in the same location and depth as each datasonde at deployment and retrieval with a hand held YSI 85 multi-parameter meter to ensure proper calibration and allow for a side-by-side comparison of parameters. After retrieval, datasondes were returned to the laboratory for data retrieval and cleaning. In Spruce Creek, water quality readings were recorded at the two trapping locations (Spruce_East and Spruce_West) (Figure 3). At Spruce_East the datasonde was set 1.8 ft below the water surface (~ 0.7 ft above the stream bed). At Spruce_West, the datasonde was set at 2.5 ft below the water surface (1.5 ft above the stream bed). In Panther Pond, water quality readings were recorded at the trap site located nearest to the outlet of the pond (Figure 7). At this site, the datasonde was set 3.5 ft below the water surface (1.5 ft above the pond's bottom).

Salmonid Age-Length Criteria

Based on Coho Ecology Study data collected in the Lower Klamath, the following criteria was used to separate YOY (age 0+) fish from age 1+ fish in this report. In June, juvenile coho less than 90 mm were considered YOY and coho greater than 90 mm were considered age 1+ fish. In July, juvenile coho less than 105 mm were considered YOY and coho greater than 105 mm were considered age 1+ fish. In August, juvenile coho less than 110 mm were considered YOY and coho greater than 110 mm were considered age 1+ fish. The size ranges for juvenile steelhead tend to be 15 mm less than the ranges set for juvenile coho during the sampling period. In June, juvenile steelhead less than 90 mm were considered YOY and steelhead from 90 to 149 mm were considered age 1+ fish, and steelhead 150 mm or larger were considered age 2+ fish. Coastal cutthroat tend to be even smaller at age relative to coho and steelhead. In June, juvenile cutthroat less than 85 mm were considered YOY, cutthroat from 85 to 139 mm were considered age 1+ fish, and cutthroat 140 mm or larger were considered age 2+ fish. However, actual age determination is difficult without conducting intensive scale analysis given that fish growth rates likely vary among habitats sampled and prior to entry into non-natal rearing areas.

Spruce Creek Results

July 2010 trapping events in Spruce Creek yielded population estimates of 85 juvenile coho and 24 cutthroat (Table 1; Figures 8-9). No steelhead were captured in Spruce Creek during July. Fork lengths for coho captured in Spruce Creek during July ranged from 60 to 95 mm (Figure 10). Fork lengths for cutthroat captured in Spruce Creek during July ranged from 138 to 265 mm (Figure 11). Prior to the July fish surveys, dissolved oxygen levels in the project area ranged from zero to 6.68 mg/L at Spruce_West and from 3.83 to 6.63 mg/L at Spruce_East (Figure 12). Water temperatures recorded in Spruce Creek during July ranged from 14.29 to 20.09 °C at Spruce_West and from 15.28 to 23.23 °C at Spruce_East (Figure 12). Specific conductance values recorded in Spruce Creek during July ranged from 73.7 to 151.9 µS/cm at Spruce_West and from 74.5 to 81.5 µS/cm at Spruce_East. Values of pH recorded in Spruce Creek during July ranged from 6.41 to 6.82 at Spruce_West and from 6.40 to 6.72 at Spruce_East.

Table 1. Mark-recapture population estimates for juvenile coho salmon and trout species in Spruce Creek, Lower Klamath River, California.

Species	Mark Date	Total Marked	Recapture Date	Total Capture[1]	Total Recap[1]	Recapture Date	Total Capture[2]	Total Recap[2]	Abundance Estimate	95% CI (+/-)
Coho	07/14/11	15	7/21/2011	12	1	7/28/2011	14	6	85	47
Trout	07/14/11	12	7/21/2011	11	5	7/28/2011	12	11	24	6
Coho	09/22/10	18	09/28/10	4	2	10/01/10	4	4	23	8
Trout	09/22/10	4	09/28/10	7	2	10/01/10	7	7	13	4
Coho	02/11/11	257	02/23/11	70	16	N/A	N/A	N/A	1,073	432
Trout	02/11/11	52	02/23/11	24	8	N/A	N/A	N/A	144	37

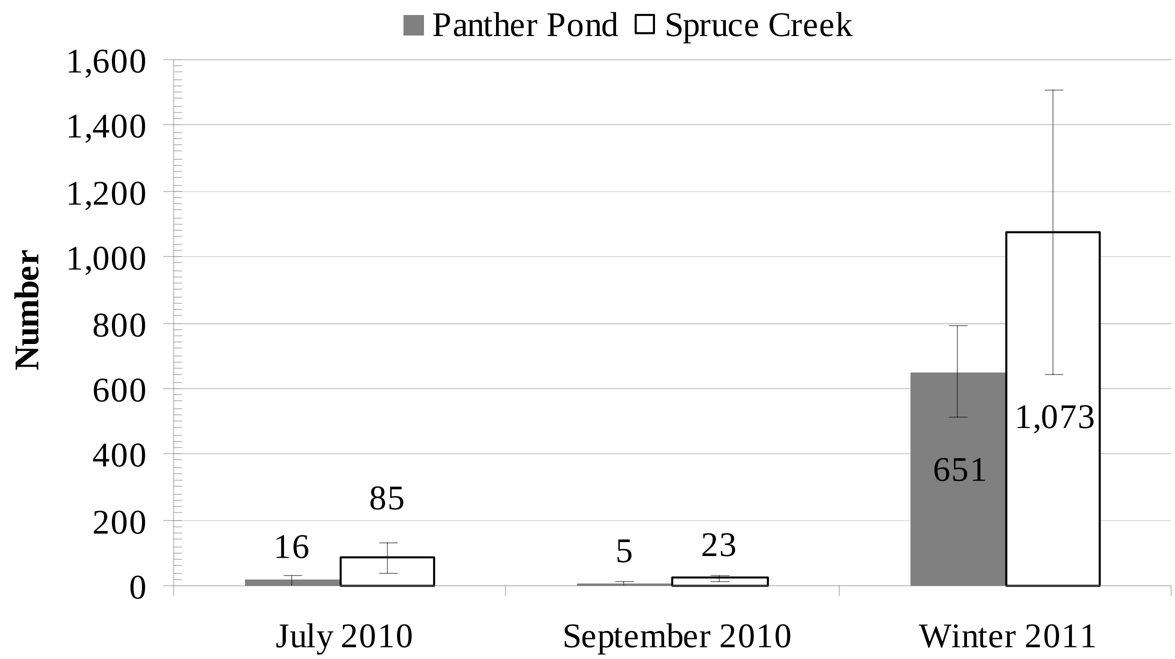


Figure 8. Mark-recapture population estimates for juvenile coho salmon in Spruce Creek and Panther Creek Pond, Lower Klamath River, California.

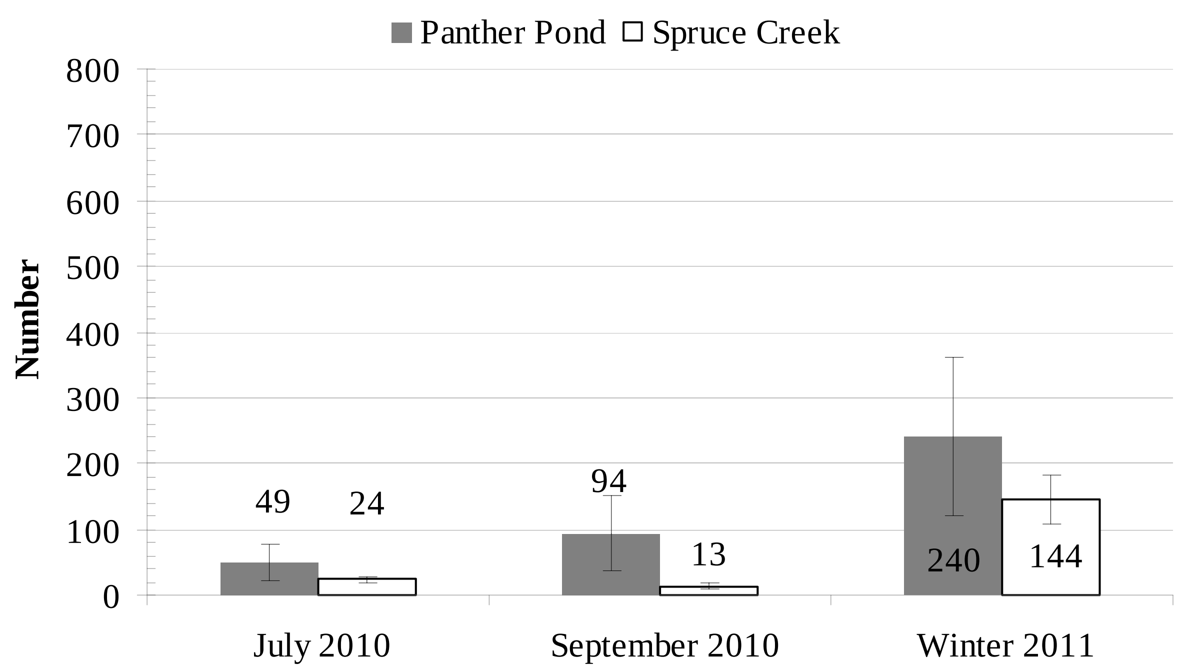


Figure 9. Mark-recapture population estimates for trout species in Spruce Creek and Panther Creek Pond, Lower Klamath River, California.

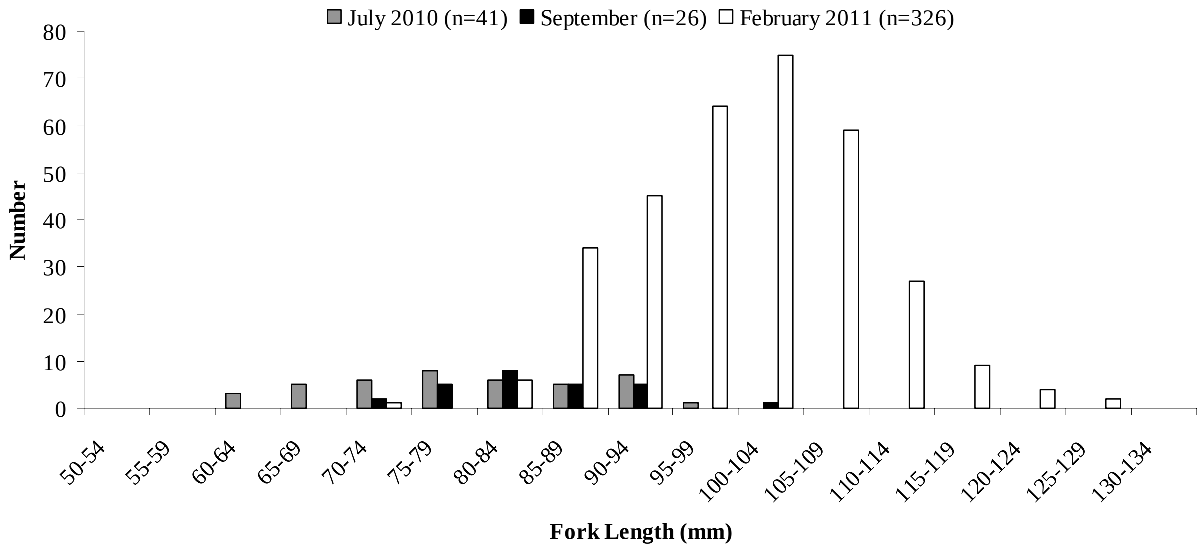


Figure 10. Length frequency for juvenile coho salmon captured during mark-recapture sampling efforts conducted in Spruce Creek during 2010 – 2011, Lower Klamath River, California.

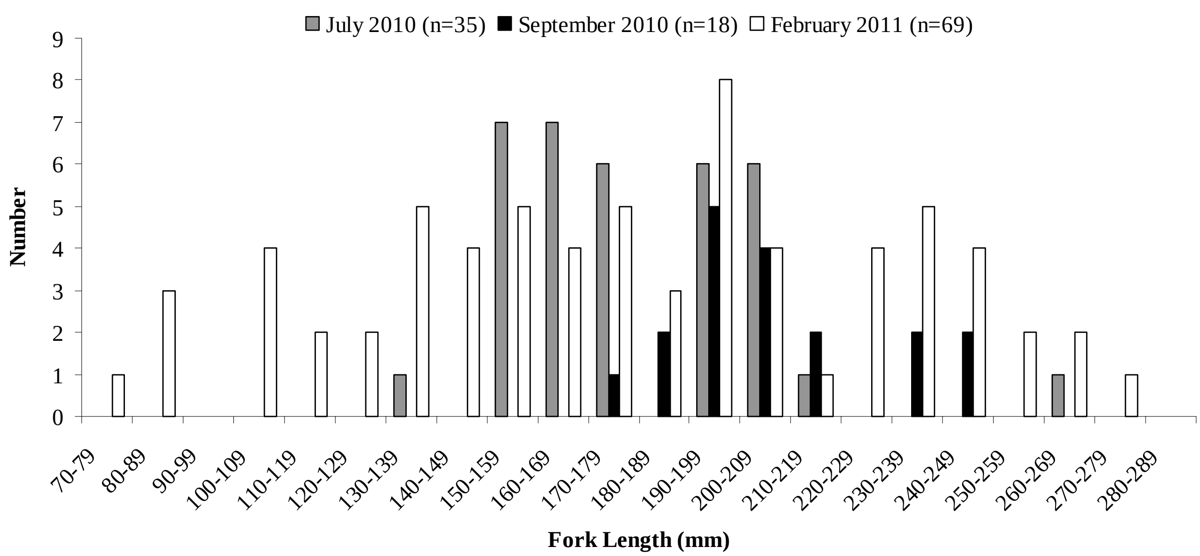
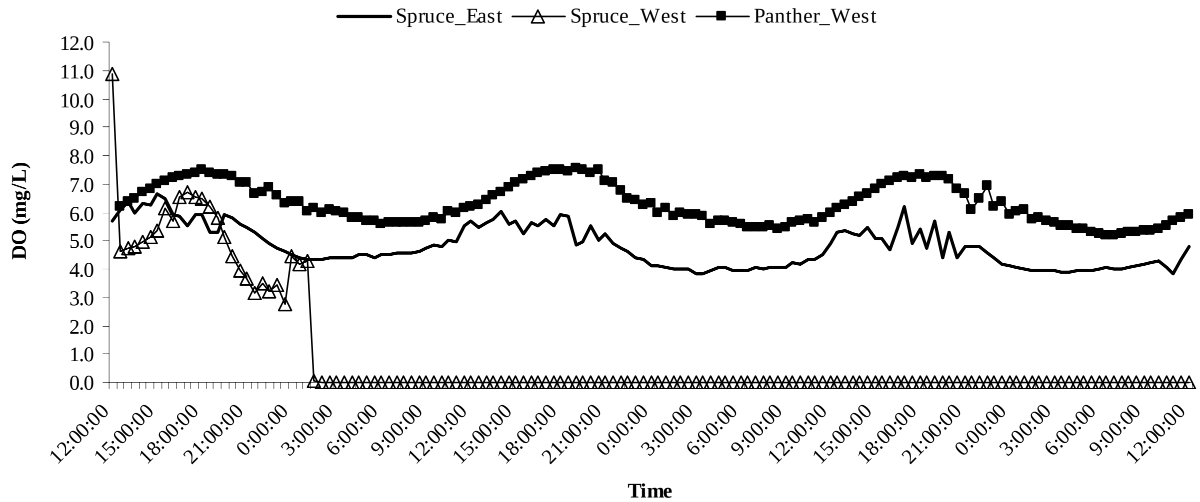


Figure 11. Length frequency for coastal cutthroat trout captured during mark-recapture sampling efforts conducted in Spruce Creek during 2010 – 2011, Lower Klamath River, California.



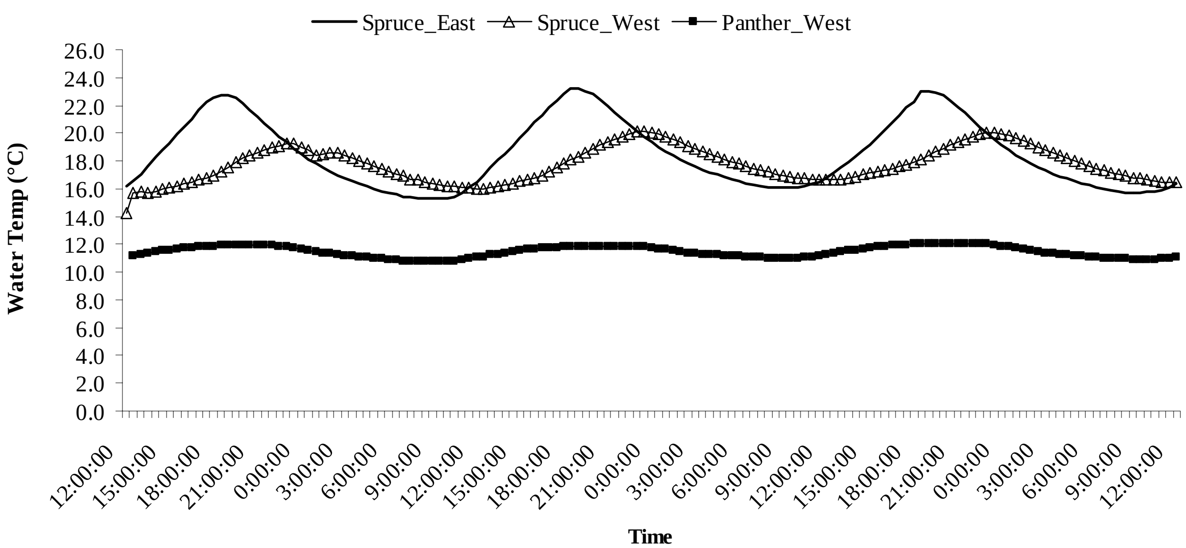
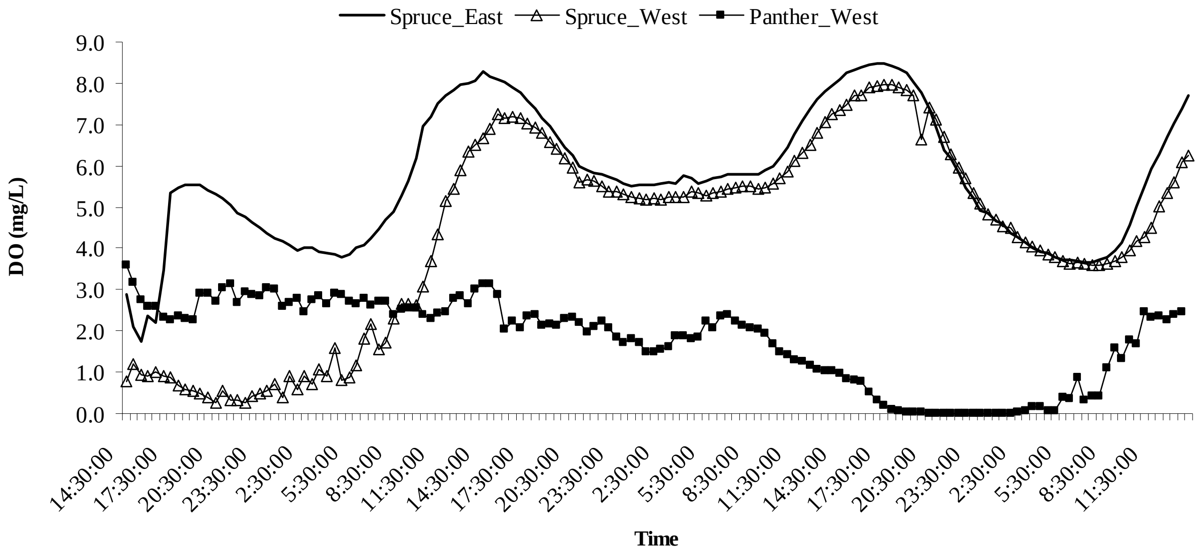


Figure 12. Water quality data collected from 7/09/10 (12:00 hours) to 7/12/10 (12:00 hours) at two monitoring sites located in Spruce Creek and at Panther Pond, Lower Klamath River.

In September 2010, juvenile salmonid captures decreased compared to July with a total of 23 coho and 13 cutthroat trout estimated in Spruce Creek (Table 1; Figures 8-9). No steelhead trout were captured in Spruce Creek during September. Fork lengths for coho captured in Spruce Creek during September ranged from 72 to 103 mm (Figure 10), and fork lengths for cutthroat ranged from 174 to 245 mm (Figure 11). Dissolved oxygen levels recorded in Spruce Creek prior to the September fish surveys ranged from 0.25 to 7.98 mg/L at Spruce_West and from 1.76 to 8.48 mg/L at Spruce_East (Figure 13). Water temperatures recorded in Spruce Creek during September ranged from 13.90 to 16.70 °C at Spruce_West and from 13.87 to 17.19 °C at Spruce_East (Figure 13). Specific conductance values recorded in September ranged from 92.5 to 116.6 µS/cm at Spruce_West and from 92.7 to 124.0 µS/cm at Spruce_East. Values of pH recorded in both sampling areas of Spruce Creek during September ranged from 6.25 to 6.72.

Trapping events conducted during winter 2011 in the Spruce Creek wetland complex yielded population estimates of 1,073 coho salmon and 144 juvenile trout (Table 1; Figures 8-9). Fork lengths for coho captured in Spruce Creek during winter 2011 ranged from 74 to 125 mm (Figure 10), while fork lengths for trout species ranged from 71 to 275 mm (Figures 11 & 14).

Non-target species captured in Spruce Creek during this study included several native fish species, a few native amphibian species, and a few invasive aquatic species (Table 2). The most common non-salmonid fish species observed during 2010-2011 included three spine stickleback, speckled dace, and sculpin species (Table 2). The assemblages of aquatic organisms observed during 2010-2011 in Spruce Creek were very similar to the assemblages observed in this study area during the initial 2009 KGR study (Table 3). There were a few more invasive fish species observed during 2010-2011 relative to 2009; however numbers captured were very low (Tables 2-3). YTFP staff exterminated all invasive species captured during this study.



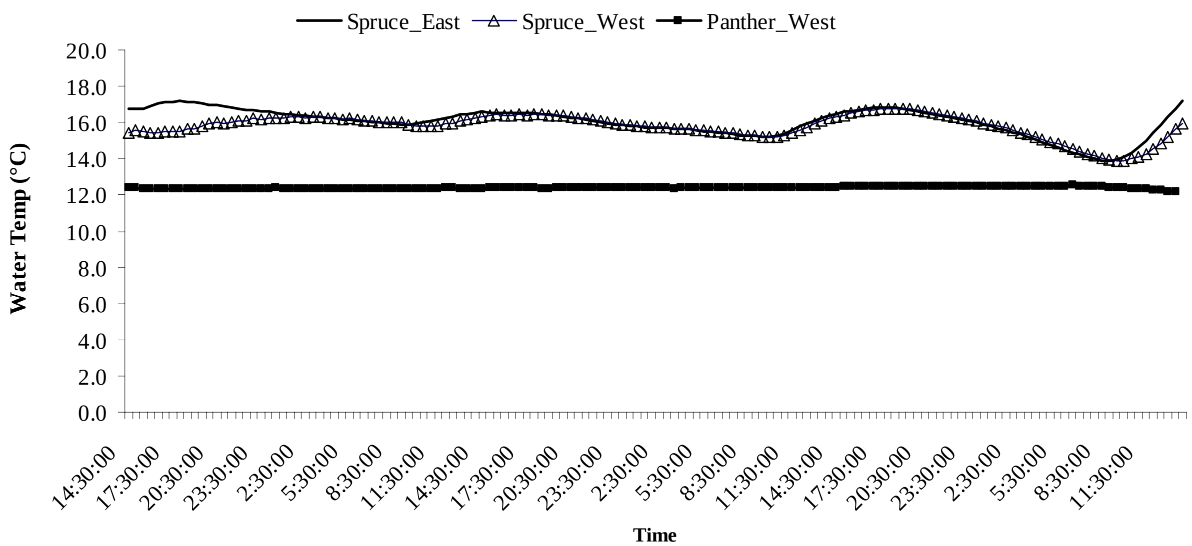


Figure 13. Water quality data collected from 09/17/10 (14:30 hours) to 09/20/10 (14:00 hours) at two monitoring sites located in Spruce Creek and at Panther Pond, Lower Klamath River.

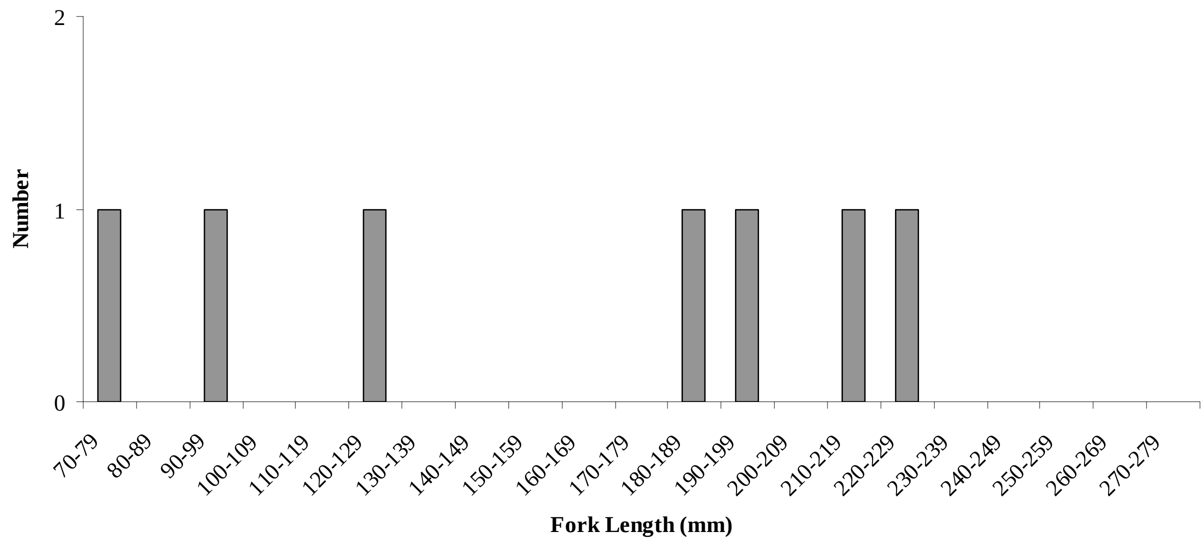


Figure 14. Length frequency for steelhead trout captured during mark-recapture sampling efforts conducted in Spruce Creek during February 2011, Lower Klamath River, California.

Table 2. Non-salmonid species captured during fish monitoring activities conducted in Spruce Creek, Lower Klamath River, California (July 2010, September 2010, February 2011).

Species	**07/14/10**	**07/21/10**	**07/28/10**	**09/22/10**	**09/28/11**	**10/01/10**	**02/11/11**	**02/23/11**
Three Spine Stickleback	234	209	108	283	170	100	Present	15
Sculpin Spp.	0	2	0	12	6	2	Present	
Speckled Dace	70	12	79	28	24	26	Present	12
Klamath Small-Scale Sucker	0	0	0	1	0	0	Present	8
Golden Shiner	0	0	0	0	0	0	0	0
Ammocete (Lampertra)	5	1	0	0	2	1	0	0
Western Brook Lamprey	0	0	0	0	1	1	0	0
Rough Skin Newt	9	4	0	1	3	1	0	0
Northwest Salamander	0	0	0	0	0	1	0	0
Pacific Giant Salamander	0	0	0	0	0	0	0	0
Red Legged Frog	0	0	0	1	0	1	0	0
Green Sunfish	2	0	0	2	1	0	0	0
Fathead Minnow	1	1	0	0	0	0	0	0
Brown Bullhead	3	0	1	0	0	0	0	0
Bull Frog - Tadpole	0	0	0	0	0	0	0	0

Table 3. Non-salmonid species captured during fish monitoring activities in two wetlands of the Lower Klamath River, California ("x" indicates presence) (July 2010 – February 2011).

Species	Spruce 2009	Spruce 2010-11	Panther 2009	Panther 2010-11
Three Spine Stickleback	x	x	x	x
Sculpin Spp.	x	x	x	x
Speckled Dace	x	x	x	x
Klamath Small-Scale Sucker	x	x	x	x
Golden Shiner	x			
Ammocete (Lampertra)	x	x	x	x
Western Brook Lamprey		x		
Rough Skin Newt	x	x	x	x
Northwest Salamander	x	x	x	x
Pacific Giant Salamander			x	
Reg Legged Frog		x		x
Green Sunfish	x	x	x	
Fathead Minnow		x		
Brown Bullhead		x	x	
Bull Frog - Tadpole	x			

Panther Pond Results

July trapping events in the pond yielded population estimates of 16 juvenile coho salmon and 49 juvenile trout (Table 4; Figures 8-9). Fork lengths for coho captured in Panther Pond during July ranged from 85 to 154 mm (Figure 15), while cutthroat trout fork lengths ranged from 62 to 354 mm (Figure 16). Only one juvenile steelhead was captured in Panther Pond during July (176 mm FL) (Figure 17). Dissolved oxygen levels recorded in Panther Pond during July ranged from 5.17 to 7.53 mg/L and water temperatures ranged from 10.76 to 12.03 °C (Figure 12). Specific conductance values recorded in Panther Pond during July ranged from 57.2 to 62.2 µS/cm while pH values recorded during this time ranged from 6.35 to 6.52.

In September 2010, the number of juvenile coho salmon captured in Panther Pond decreased dramatically and a population estimate could not be generated (Table 4; Figure 8). In contrast, the number of juvenile trout captured in Panther Pond during September increased relative to July with an estimate of 94 trout (Table 4; Figure 9). Fork lengths for coho captured in Panther Pond during September ranged from 83 to 120 mm (Figure 15), while fork lengths for cutthroat ranged from 98 to 372 mm (Figure 16). Two juvenile steelhead were captured in Panther Pond during September (166 - 204 mm FL) (Figure 17). Dissolved oxygen levels recorded in Panther Pond during September ranged from 0.01 to 3.58 mg/L, and water temperatures recorded ranged from 12.18 to 12.52 °C (Figure 13). Specific conductance values recorded in Panther Pond during September ranged from 68.0 to 74.3 µS/cm while pH values recorded during this time ranged from 6.12 to 6.19.

Table 4. Mark-recapture population estimates for juvenile coho salmon and trout species in Panther Pond, Lower Klamath River, California.

Species	Mark Date	Total Marked	Recapture Date	Total Capture[1]	Total Recap[1]	Recapture Date	Total Capture[2]	Total Recap[2]	Abundance Estimate	95% CI (+/-)
Coho	07/14/10	8	07/21/10	1	0	N/A	N/A	N/A	16	15
Trout	07/14/10	18	07/21/10	18	6	N/A	N/A	N/A	49	27
Coho	09/22/10	5	09/28/10	2	0	N/A	N/A	N/A	5	N/A
Trout	09/22/10	33	09/28/10	16	5	N/A	N/A	N/A	94	56
Coho	01/25/11	217	02/02/11	167	55	N/A	N/A	N/A	651	138
Trout	01/21/11	22	01/25/11	28	2	02/02/11	26	10	240	121

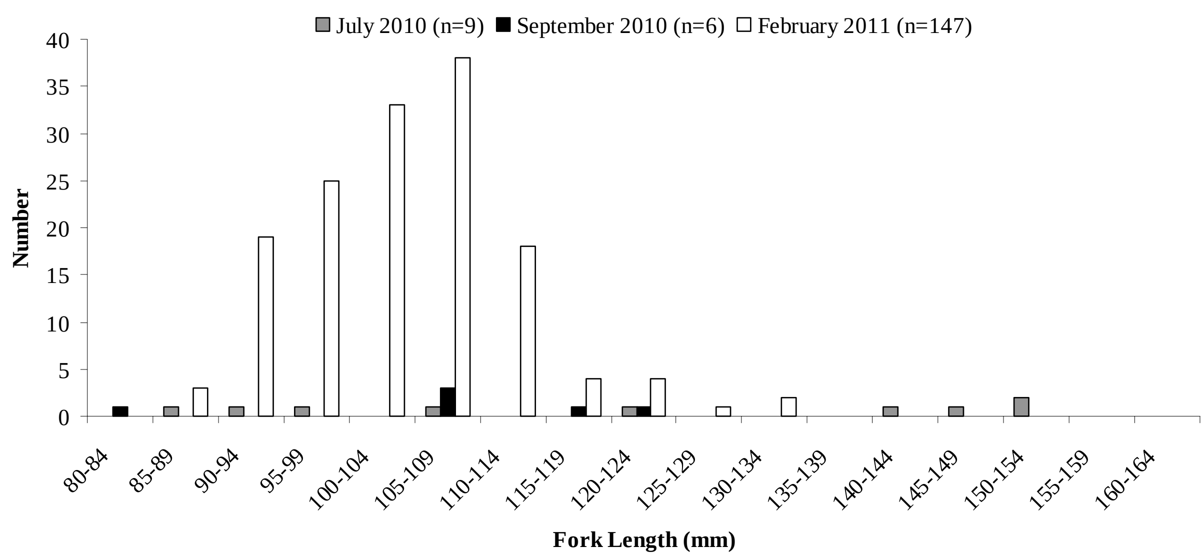


Figure 15. Length frequency for juvenile coho salmon captured during mark-recapture sampling efforts conducted in Panther Creek Pond during 2010 – 2011, Lower Klamath River, California.

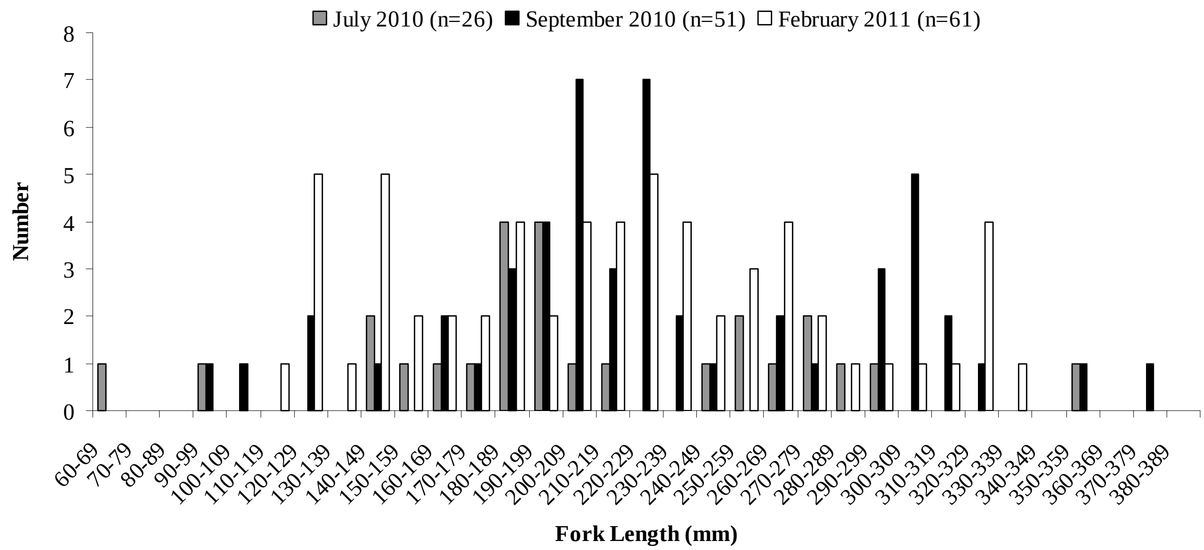


Figure 16. Length frequency for coastal cutthroat trout captured during mark-recapture sampling efforts conducted in Panther Creek Pond during 2010 – 2011, Lower Klamath River, California.

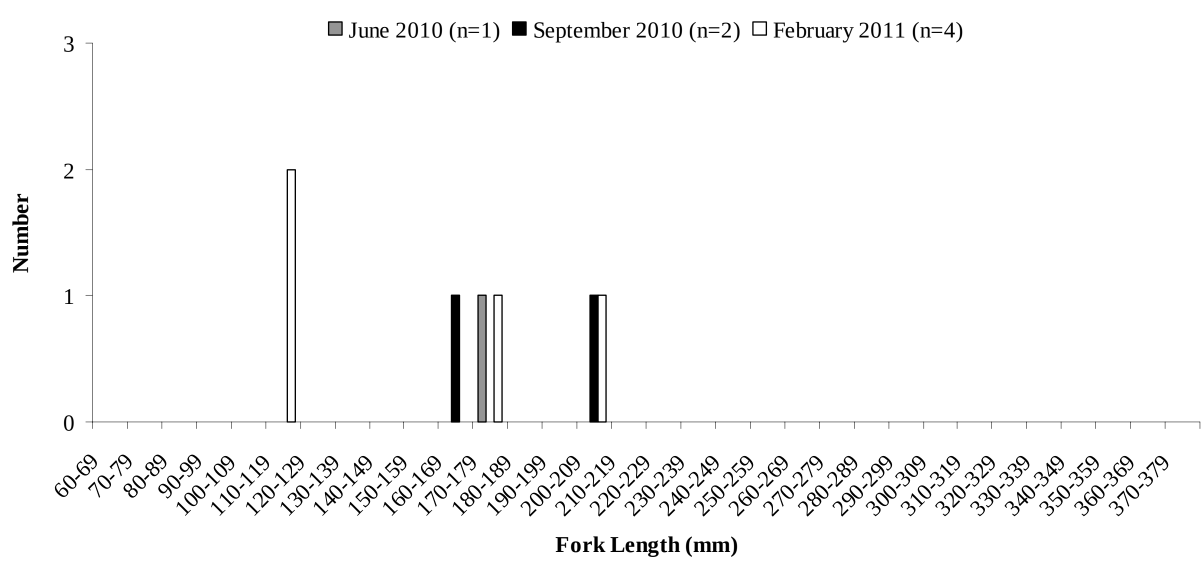


Figure 17. Length frequency for steelhead trout captured during mark-recapture sampling efforts conducted in Panther Creek Pond during 2010 – 2011, Lower Klamath River, California.

Winter trapping events in Panther Pond yielded population estimates of 651 coho salmon and 240 juvenile trout (Table 4; Figures 8-9). Fork lengths for coho captured in Panther Pond during winter 2011 ranged from 85 to 132 mm (Figure 15), while fork lengths for cutthroat ranged from 114 to 338 mm (Figure 16). A total of four juvenile steelhead were captured in Panther Pond during winter with fork lengths ranging from 117 to 200 mm (Figure 17).

Non-target species captured in Panther Pond during this study included several native fish species and several native amphibian species (Table 5). The most common non-salmonid fish species observed during 2010-2011 included three spine stickleback, speckled dace, sculpin species, and Klamath small-scale sucker (Table 5). Assemblages of aquatic organisms observed during 2010-2011 in Panther Pond were very similar to the assemblages observed in this study area during the initial 2009 KGR study (Table 3). The primary difference was the lack of invasive species observed in Panther Pond during the 2010-2011 surveys (Table 3).

Table 5. Number of non-salmonid species captured during fish monitoring activities conducted in Panther Pond, Lower Klamath River, California (July 2010, September 2010, January - February 2011).

Species	**07/14/10**	**07/21/10**	**09/22/10**	**09/28/10**	**01/25/11**	**02/02/11**
Three Spine Stickleback	49	26	61	36	Present	58
Sculpin Spp.	55	24	22	30	Present	60
Speckled Dace	0	1	4	1	0	0
Klamath Small-Scale Sucker	7	12	1	1	5	27
Golden Shiner	0	0	0	0	0	0
Ammocete (Lampertra)	0	0	1	0	0	0
Western Brook Lamprey	0	0	0	0	0	0
Rough Skin Newt	2	8	31	10	Present	54
Northwest Salamander	0	0	0	2	Present	42
Pacific Giant Salamander	0	0	0	0	0	0
Reg Legged Frog	0	0	0	0	0	5
Green Sunfish	0	0	0	0	0	0
Fathead Minnow	0	0	0	0	0	0
Brown Bullhead	0	0	0	0	0	0
Bull Frog - Tadpole	0	0	0	0	0	0

Task 3.2 – Snorkel Inventories of Lower Hunter Creek

A reach of lower Hunter Creek was monitored for the presence and temporal trends of target species in the vicinity of the DN Highway 101 Bridge. Based on the 2009 KGR data and discussions with Caltrans and the resource agencies, the 2010 Hunter Creek inventory reach was confined to habitats located from just downstream and upstream of the bridge (2009 - 387 m; 2010 - 49 m) (Figure 2). Stream habitat units were measured for length and maximum depth; while stream width was measured at the bottom third, middle, and upper third of each unit. A shallow pool (less than 1.0 meter depth), a run/riffle complex with a small rootwad influenced side pool, and riffle were classified in the project reach during summer 2010 (Table 6).

A trained fisheries biologist performed snorkel surveys in the project reach on 08/05/10, 09/21/10, and 10/22/10 (Table 7). For each survey, the diver employed a three-pass snorkel survey methodology and swam from the bottom of the reach or unit upstream to the top. During each snorkel survey, the diver measured water and air temperature and took notes regarding weather, discharge, and visibility conditions, which could affect the ability of the diver to observe fish. Population estimates by species and age class were made for each habitat unit using general bounded count methods (Hankin and Mohr 2001; Stillwater Sciences 2008).

For this method, the dive counts were sorted in increasing order as $m_1 \leq m_2 \leq m_3$ and the population was estimated as:

$$Y_B = m_3 + (m_3 - m_2)$$

and the mean squared error was estimated as:

$$MSE\ (Y_B) = (m_3 - m_2)^2$$

All three events recorded similar numbers of YOY and age 1+ steelhead trout and cutthroat trout (Table 5). Very few age 2+ trout were observed during the 2010 surveys. Trout tended to be well distributed throughout the project reach with fish occupying a majority of the available habitat. On 08/05/10, one YOY coho salmon was observed in the shallow, root wad influenced pool located under the highway bridge (Table 7).

Table 6. Habitat information for a 2010 summer snorkel survey reach located in Hunter Creek, Lower Klamath River, California.

Habitat Unit No.	Habitat Type	Habitat Length (ft)	Max Depth (ft)	Width (ft) Top	Middle	Bottom	Notes
1	Shallow Pool	86	2.5	23	24	42	Downstream of DN Highway 101 Bridge
2	Run-Riffle	130	1.0	6	24	35	Under DN 101 Highway Bridge; Small Rootwad Influenced Side Pocket
3	Riffle	15	0.2	6	6	6	Upstream of DN Highway 101 Bridge

Table 7. Snorkel survey data collected in a fish inventory reach located in Hunter Creek, Lower Klamath River, California (Summer 2010).

Date	Diver	Weather	Visibility	Discharge (cfs)	Water Temp (°F)	Air Temp (°F)	
8/5/2010	SS	Overast	Excellent	5	53	60	
Species	**Code**	**Age**	**Pass 1**	**Pass 2**	**Pass 3**	**Pop Est.**	**MSE Est.**
Unknown Trout	TR	0+	10	11	12	13	1
Steelhead Trout	SH	1+	10	13	12	14	1
Coastal Cutthroat Trout	CT	1+	5	9	6	12	9
Coastal Cutthroat Trout	CT	2+	7	5	5	9	4
Coho Salmon	CO	0+	1	1	1	1	N/A

Date	Diver	Weather	Visibility	Discharge (cfs)	Water Temp (°F)	Air Temp (°F)	
9/21/2010	SS	Clear	Excellent	5	53	65	
Species	**Code**	**Age**	**Pass 1**	**Pass 2**	**Pass 3**	**Pop Est.**	**MSE Est.**
Unknown Trout	TR	0+	8	10	10	10	0
Steelhead Trout	SH	1+	9	9	9	9	0
Coastal Cutthroat Trout	CT	1+	3	5	4	6	1
Coastal Cutthroat Trout	CT	2+	4	2	2	6	4
Coho Salmon	CO	0+	0	0	0	0	N/A

Date	Diver	Weather	Visibility	Discharge (cfs)	Water Temp (°F)	Air Temp (°F)	
10/22/2010	SS	Overcast	Excellent	5	53	58	
Species	**Code**	**Age**	**Pass 1**	**Pass 2**	**Pass 3**	**Pop Est.**	**MSE Est.**
Unknown Trout	TR	0+	6	8	8	8	0
Steelhead Trout	SH	1+	8	8	7	8	1
Coastal Cutthroat Trout	CT	1+	3	3	2	3	0
Coastal Cutthroat Trout	CT	2+	2	2	2	2	0
Coho Salmon	CO	0+	0	0	0	0	N/A

SS = Scott Silloway

Task 3.3 – Habitat Mapping at Panther Pond

Water Quality Assessment

In July 2010, crews established several permanent water quality monitoring sites in Panther Pond: West_1, Panther_West, West_3, West_4, Panther_Bridge, East_1, and Panther_East (Figure 18). YTFP used a combination of sampling methods to further characterize water quality conditions in the pond during the typical construction season. HydroLab Datasondes (datasonde) were deployed at specific monitoring sites to document diurnal fluctuations in water quality parameters. Crews also used a datasonde to conduct water quality transect surveys at the various monitoring sites in the pond. Prior to each use, datasondes were properly calibrated by a trained technician for temperature, specific conductivity, pH, and dissolved oxygen. Datasondes were programmed to record water quality parameters every 30 minutes for each deployment, which encompassed approximately 48 hours. Water quality readings were obtained using a hand held dissolved oxygen/conductivity instrument at each site just prior to datasonde deployment and retrieval to ensure proper calibration of the datasondes. After each deployment, datasondes were brought back to the laboratory to be downloaded and cleaned.

YTFP conducted water quality monitoring in Panther Pond during August, September and October 2010 and February 2011 (Table 8). The first datasonde deployments occurred on 8/13/10 at Panther_Bridge and at Panther_West (Table 8, Figure 19). Water temperatures at Panther_Bridge ranged from 11.30 to 13.43 °C during the 48 hour deployment period (Figure 19). Water temperatures recorded at Panther_West for this 48 hour period ranged from 11.98 to 12.40 °C (Figure 19). Dissolved oxygen (DO) levels were the lowest at the datasonde that was placed near the pond bottom at the Panther_Bridge site (Figure 19). DO levels recorded by this sonde during the 48 hour period ranged from 0.91 to 4.92 mg/L, while DO levels in the upper water column at Panther_Bridge were from 4.60 to 9.31 mg/L (Figure 19). The DO levels recorded at Panther_West for this period were very similar to the upper water column at the bridge with minimum and maximum values at 5.83 and 9.20 mg/L, respectively. Specific Conductance appeared to be very similar at the three monitoring stations with values ranging from 62.0 to 69.6 µS/cm (Figure 19).

The second deployment was initiated on 8/20/10 at Panther_West and Panther_East (Table 8, Figure 20). Water temperature at Panther_West fluctuated from 11.74 to 13.21°C during the 48 hour deployment period (Figure 20). Water temperatures recorded at Panther_East were similar to temperatures recorded on the west side of the highway with values ranging from 11.44 to 13.09°C (Figure 20). The datasonde deployed near the pond's bottom at Panther_West was set too low and the probe appeared to have been recording conditions in the sediment. DO levels measured in the upper water column at Panther_West ranged from 4.45 to 6.42 mg/L during the monitoring period (Figure 20). For this sampling period, specific conductance appeared to be similar at all three monitoring sites with values ranging from 64.6 to 67.8 µS/cm (Figure 20).

The final datasonde deployment of August was initiated on 8/27/10 at West_4, East_1, and Panther_East (Table 8, Figure 21). Water temperatures recorded at West_4 and East_1 showed very little diurnal fluctuation, with values ranging from 11.38 to 11.95°C (Figure 21). Conditions at Panther_East showed greater variability relative to the other sites monitored during

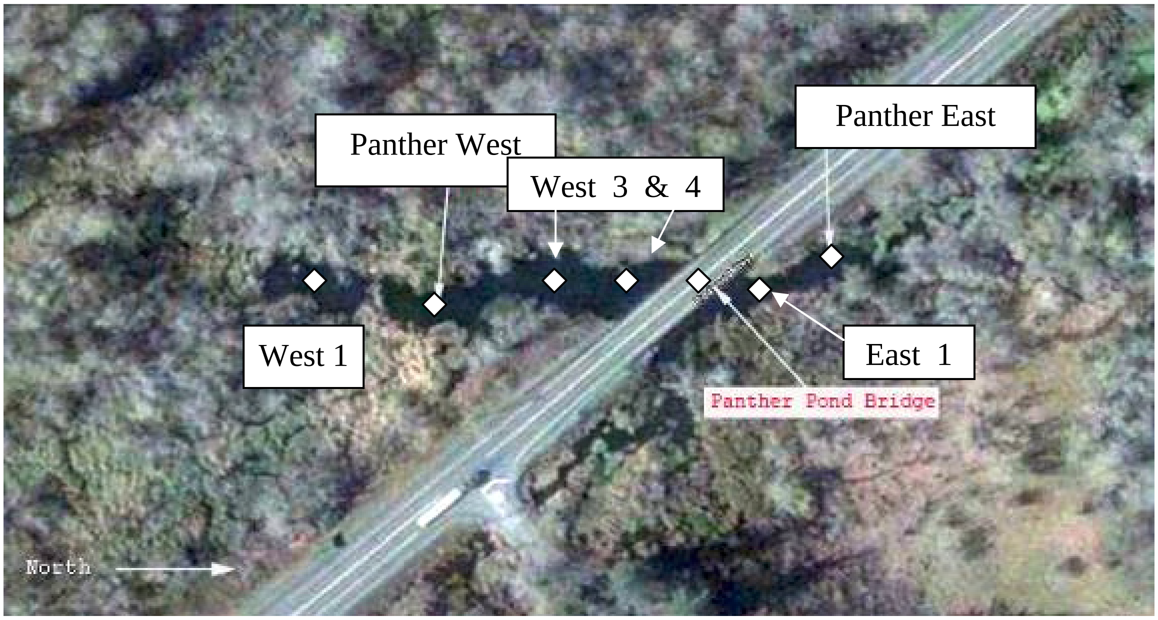


Figure 18. Water quality monitoring sites located in Panther Creek Pond, Lower Klamath River.

Table 8. Schedule of water quality monitoring events conducted at sites located in Panther Creek Pond, Lower Klamath River.

Site	**Depth**	**Date Deploy**	**Date Retrieve**
Panther_Bridge	BTM	08/13/10	08/15/10
Panther_Bridge	TOP	08/13/10	08/15/10
Panther_West	MID	08/13/10	08/15/10
Panther_West	BTM	08/20/10	08/22/10
Panther_West	TOP	08/20/10	08/22/10
Panther_East	MID	08/20/10	08/22/10
West_4	MID	08/27/10	08/29/10
Panther_East	MID	08/27/10	08/29/10
East_1	MID	08/27/10	08/29/10
West_4	BTM	09/03/10	09/05/10
West_4	TOP	09/03/10	09/05/10
East_1	MID	10/09/10	10/11/10
West_4	MID	10/09/10	10/11/10
Panther_Bridge	MID	02/05/11	02/10/11
Panther_East	MID	02/05/11	02/10/11
East_1	MID	02/05/11	02/10/11

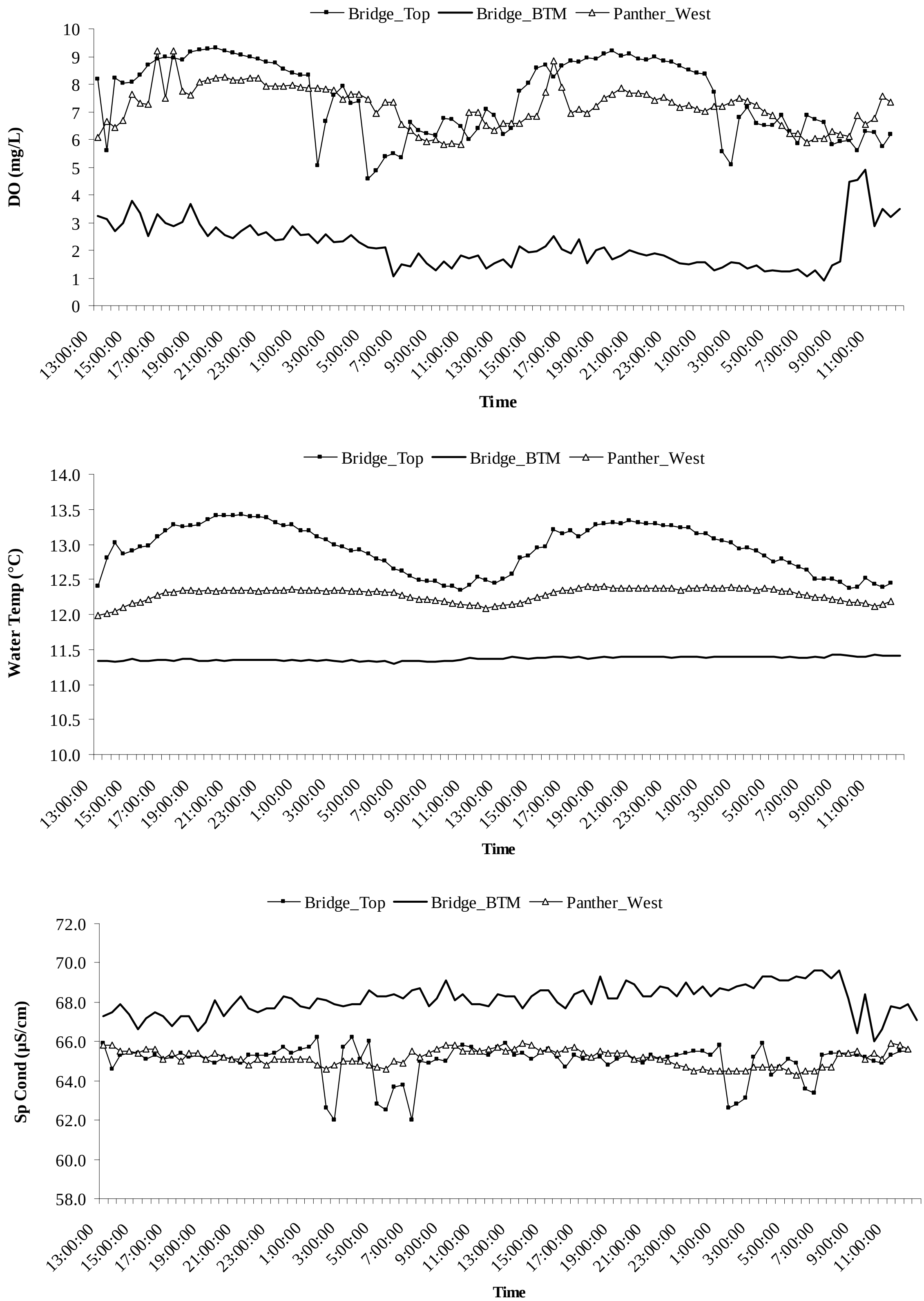


Figure 19. Water quality data collected from 8/13/10 (13:00 hours) to 8/15/10 (12:00 hours) at three monitoring sites located within Panther Creek Pond, Lower Klamath River.

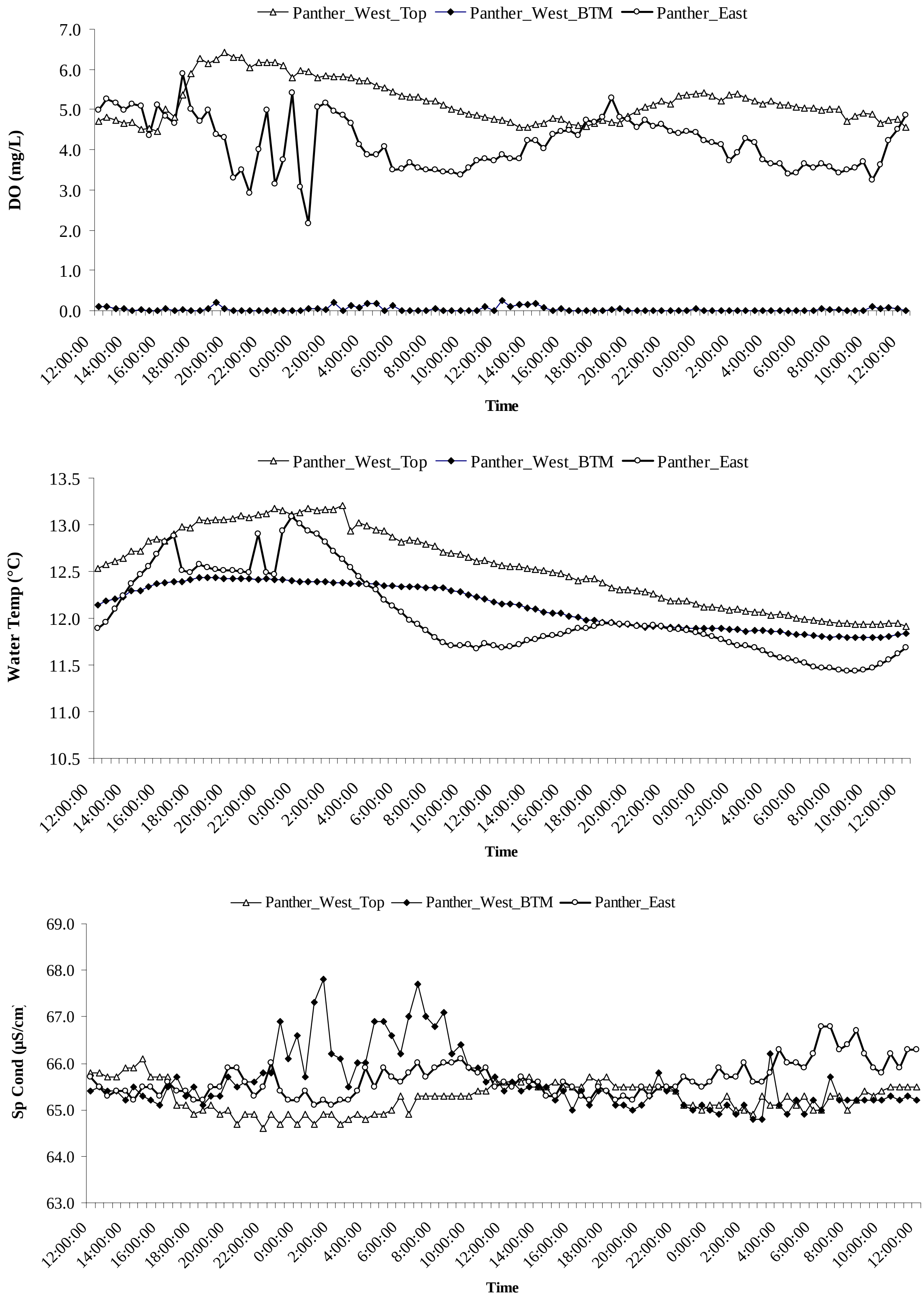


Figure 20. Water quality data collected from 8/20/10 (12:00 hours) to 8/22/10 (12:00 hours) at three monitoring sites located within Panther Creek Pond, Lower Klamath River.

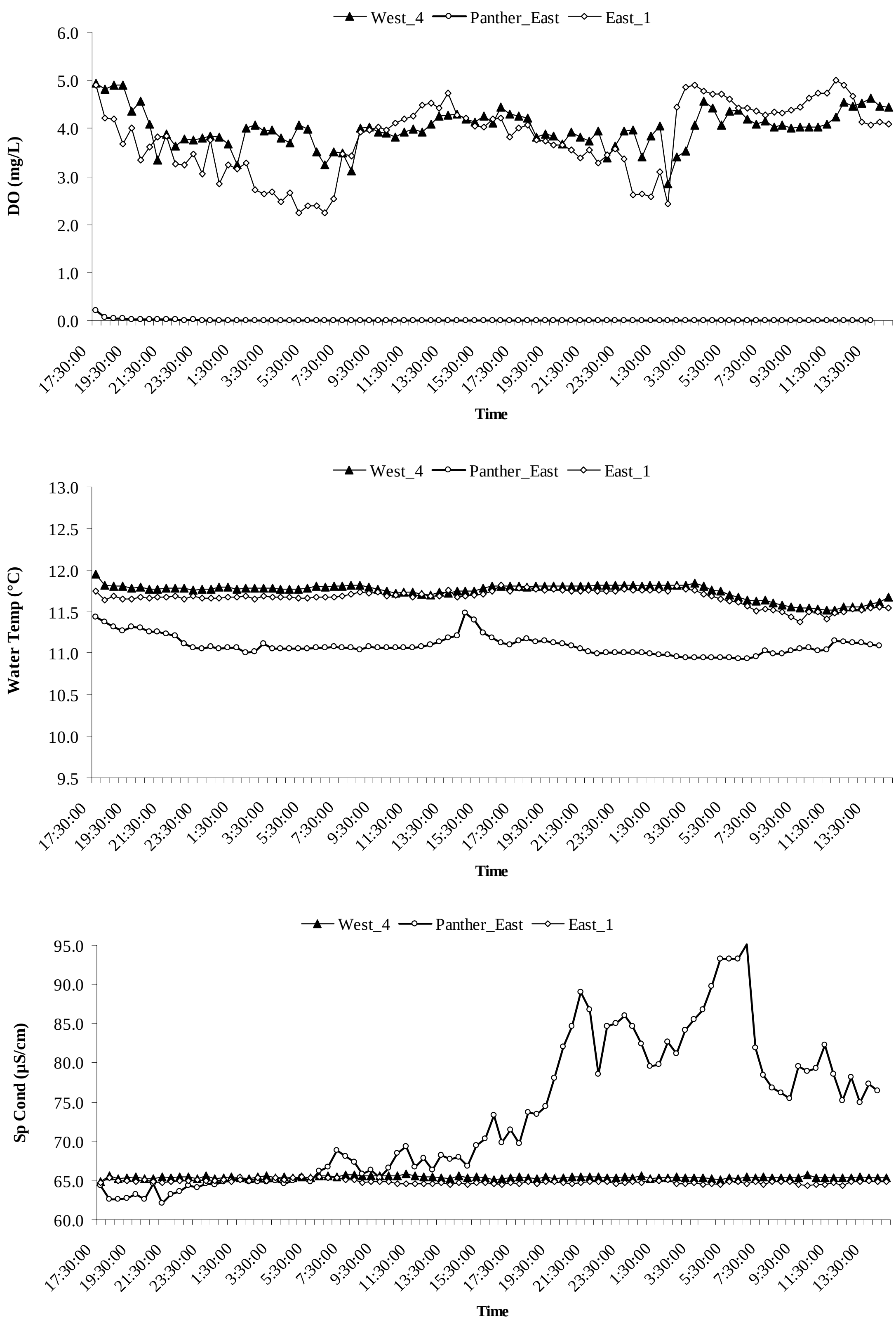


Figure 21. Water quality data collected from 8/27/10 (17:30 hours) to 8/29/10 (14:30 hours) at three monitoring sites located within Panther Creek Pond, Lower Klamath River.

the same period with temperatures ranging from 10.93 to 12.29 °C (Figure 21). However, DO and specific conductance levels recorded at this site indicated that the probe must have been set too close to the pond's bed (Figure 21). DO levels recorded at West_4 and East_1 during this period were relatively low with values ranging from 2.24 to 5.0 mg/L (Figure 21). Specific conductance values recorded at West_4 and East_1 ranged from 64.4 to 65.8 µS/cm (Figure 21). Specific conductance values recorded at these two site in late August were very similar to values recorded at the various sites monitored during the first two sampling periods (Figures 19-21).

On 9/3/10, YTFP deployed two datasondes at West_4 (Table 8). One datasonde was placed near the bottom and the other was placed in the upper water column (Figure 22). Once again, the data collected at the lower-most site indicated the probe slipped into the substrate at some point during the monitoring period (Figure 22). Water temperatures recorded by the datasonde in the upper water column ranged from 11.55 to 12.31°C during this 48 hour sampling period (Figure 22). DO values recorded in the upper water column of West_4 ranged from 3.44 to 5.47 mg/L during the sampling period. DO values recorded by the lower-most datasonde started out at values of 3.0 – 4.95 mg/L then dropped to nearly zero by the end of the sampling period (Figure 22). Specific conductance values recorded in the upper water column of West_4 in early September were very similar to values recorded at the various sites in August (Figures 19-22).

YTFP conducted two intensive water quality transect surveys of Panther Pond on 9/4/10 (Tables 9-10, Figures 23-24). The first survey was conducted during the morning hours (09:30 to 10:15 Hours) and the second survey was conducted in the afternoon (16:00 to 17:00 Hours). For these surveys, YTFP used a datasonde to collect depth integrated water quality data at all of the Panther Pond sites. At each site, water quality data was collected near the bottom of the pond, in the middle of the water column, and near the surface of the pond. In addition to water quality data, crews recorded the maximum depth at each site, the time each measurement was recorded, and the water depth of each measurement (Tables 9-10, Figures 23-24).

Water temperatures recorded during the morning transect survey were similar among the sites with values ranging from 11.70 to 14.21 °C (Table 9, Figure 23). In general, the warmest temperatures were recorded near the surface while the cooler temperatures occurred close to the pond's bottom (Figure 23). This pattern was also observed for DO measurements taken during the morning survey (Figure 23). DO levels were highest near the surface at all of the sites with values ranging from 5.71 mg/L at Panther_Bridge to 6.96 mg/L at West_3 (Figure 23). DO levels recorded near the bottom ranged from 4.2 mg/L at West_1 to 5.18 mg/L at Panther_West (Figure 23). Specific conductance recorded during the morning survey ranged from 64.1 to 67.3 µS/cm with the highest values occurring near the bottom of the pond (Table 9).

Water temperatures recorded during the afternoon transect were slightly higher than during the morning transect (Table 10, Figure 24). The warmest temperatures were again recorded near the pond's surface with values ranging from 14.08 to 16.08 °C (Figure 24). Water temperature values recorded near the pond's bottom ranged from 11.89 to 13.03 °C (Figure 24). DO levels recorded near the surface of the pond were more variable relative to the morning samples with values ranging from 5.14 to 8.40 mg/L (Figures 23-24). DO levels recorded near the bottom ranged from 4.07 mg/L at Panther_Bridge to 8.01 mg/L at Panther_East (Figure 24). Specific conductance recorded during the afternoon survey ranged from 57.4 to 66.9 µS/cm (Table 10).

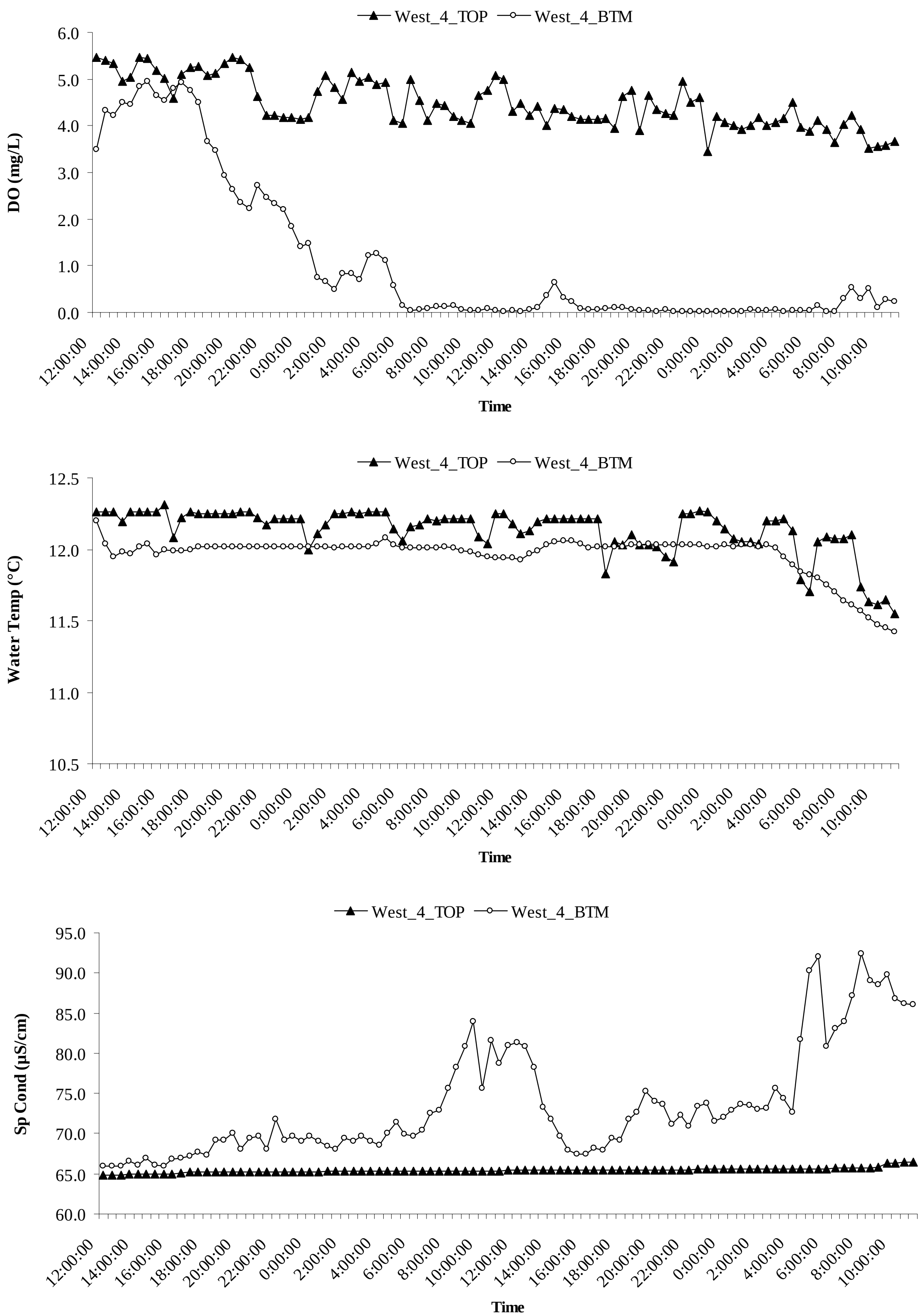


Figure 22. Water quality data collected from 9/3/10 (12:00 hours) to 9/5/10 (11:00 hours) at two monitoring sites located within Panther Creek Pond, Lower Klamath River.

Table 9. Water quality data collected in the morning hours of 9/4/11 at several monitoring sites located within Panther Creek Pond, Lower Klamath River.

Site	Temp °F	DO%	DO(mg/L)	Sp. Co	PH	Sal	Depth	Depth (max)	Time
West_1									
BTM	12.83	39.4	4.2	67.3	6.23	0.02	3.6	3.8	9:32:00 AM
MID	13	48.3	5.12	66	6.13	0.02	1.6		9:34:00 AM
TOP	13.78	52.6	5.81	65.4	6.2	0.02	0.5		9:35:00 AM
Panther West									
BTM	12.6	48.7	5.18	65.9	6.23	0.02	6.8	6.9	9:39:00 AM
MID	12.68	49.5	5.23	65.8	6.12	0.02	3.4		9:41:00 AM
TOP	14.21	68.5	6.93	64.4	6.24	0.02	0.5		9:42:00 AM
West_3									
BTM	12.4	44.4	4.7	66.6	6.12	0.02	7.6	7.8	9:45:00 AM
MID	12.73	47.8	5.24	65.6	6.14	0.02	3.7		9:47:00 AM
TOP	14.14	67.3	6.96	64.6	6.23	0.02	0.5		9:48:00 AM
West_4									
BTM	11.95	40.5	4.45	66.5	6.21	0.02	7.6	7.7	9:54:00 AM
MID	12.29	42	4.51	66.2	6.16	0.02	4		9:55:00 AM
TOP	13.44	57.2	5.93	65.2	6.18	0.02	0.5		9:57:00 AM
Panther Bridge									
BTM	11.91	40.3	4.33	66.4	6.15	0.02	9	14	10:00:00 AM
MID	12.15	40.7	5.71	64.4	6.15	0.02	4.6		10:01:00 AM
TOP	13.33	56.7	5.71	64.4	6.15	0.02	0.5		10:03:00 AM
East_1									
BTM	11.9	45.5	4.95	66.1	6.19	0.02	9	9.8	10:06:00 AM
MID	12.23	43.1	4.66	66.1	6.16	0.02	4.6		10:07:00 AM
TOP	13.83	56.3	5.77	64.8	6.24	0.02	0.5		10:08:00 AM
Panther East									
BTM	11.77	45.6	4.97	66.7	6.33	0.02	6.3	6.3	10:13:00 AM
MID	12.64	53.4	5.67	65.1		0.02	3		10:14:00 AM
TOP	13.65	57.9	6.04	64.1	6.24	0.02	0.5		10:15:00 AM

Table 10. Water quality data collected in the afternoon of 9/4/11 at several monitoring sites located within Panther Creek Pond, Lower Klamath River.

Site	Temp °F	DO%	DO(mg/L)	Sp. Co	PH	Sal	Depth	Depth (max)	Time
West_1									
BTM	13.03	56.8	6.01	66.9	6.32	0.02	3.6	3.8	16:09
MID	13.24	59.8	6.28	66.8	6.19	0.02	1.6		16:10
TOP	14.95	50.9	5.14	66.3	6.22	0.02	0.5		16:12
Panther West									
BTM	12.55	61.3	6.58	66.4	6.28	0.02	6.8	6.9	16:18
MID	12.8	48.7	5.18	66.5	6.37	0.02	3.4		16:19
TOP	14.24	61.2	6.25	59.7	6.26	0.02	0.5		16:20
West_3									
BTM	12.37	67.4	7.22	66.8	6.3	0.02	7.6	7.8	16:24
MID	12.69	52	5.58	57.4	6.23	0.02	3.7		16:25
TOP	16.61	72.3	7.09	65	6.34	0.02	0.5		16:26
West_4									
BTM	12.04	45.2	4.9	66.4	6.2	0.02	7.6	7.7	16:29
MID	12.39	42.2	4.53	66.1	6.17	0.02	4		16:31
TOP	14.08	53.5	5.48	65.5	6.22	0.02	0.5		16:32
Panther Bridge									
BTM	11.89	37.2	4.07	66.4	6.15	0.02	9	14	16:37
MID	12.3	52.1	5.59	66.9	6.18	0.02	4.6		16:38
TOP	16.08	75.5	7.53	64.9	6.38	0.02	0.5		16:39
East_1									
BTM	12.16	49.9	5.38	65.8	6.25	0.02	9	9.8	16:42
MID	12.41	59.7	6.39	65.4	6.15	0.02	4.6		16:43
TOP	16.38	82.1	8.11	64.4	6.4	0.02	0.5		16:44
Panther East									
BTM	12.3	74.3	8.01	65.3	6.31	0.02	6.3	6.3	16:47
MID	12.74	70.3	7.48	65.9	6.2	0.02	3		16:48
TOP	15.38	85.2	8.4	64.3	6.29	0.02	0.5		16:50

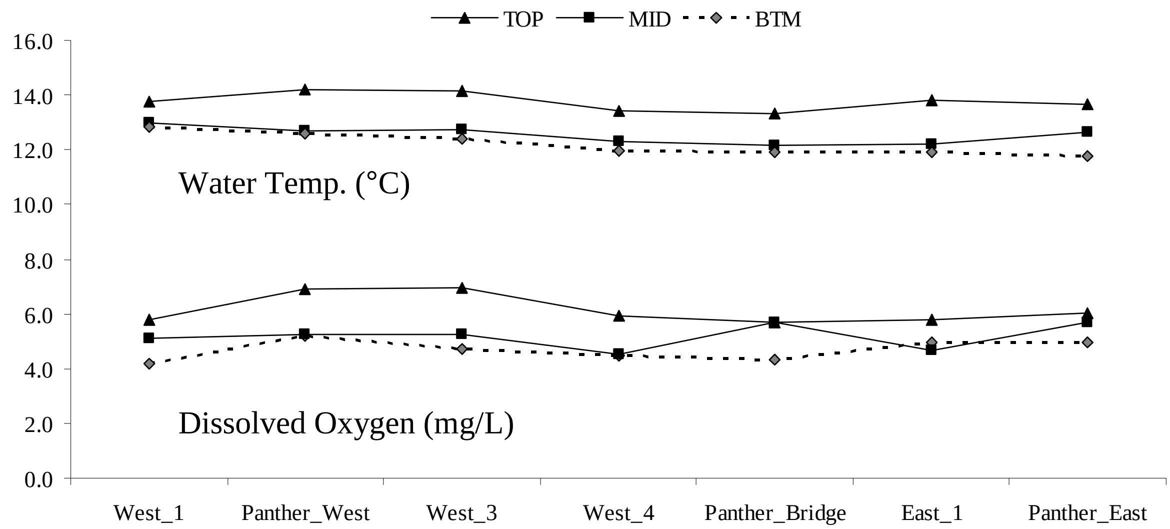


Figure 23. Water temperature and dissolved oxygen data collected in the morning hours of 9/4/11 at several monitoring sites located within Panther Creek Pond, Lower Klamath River.

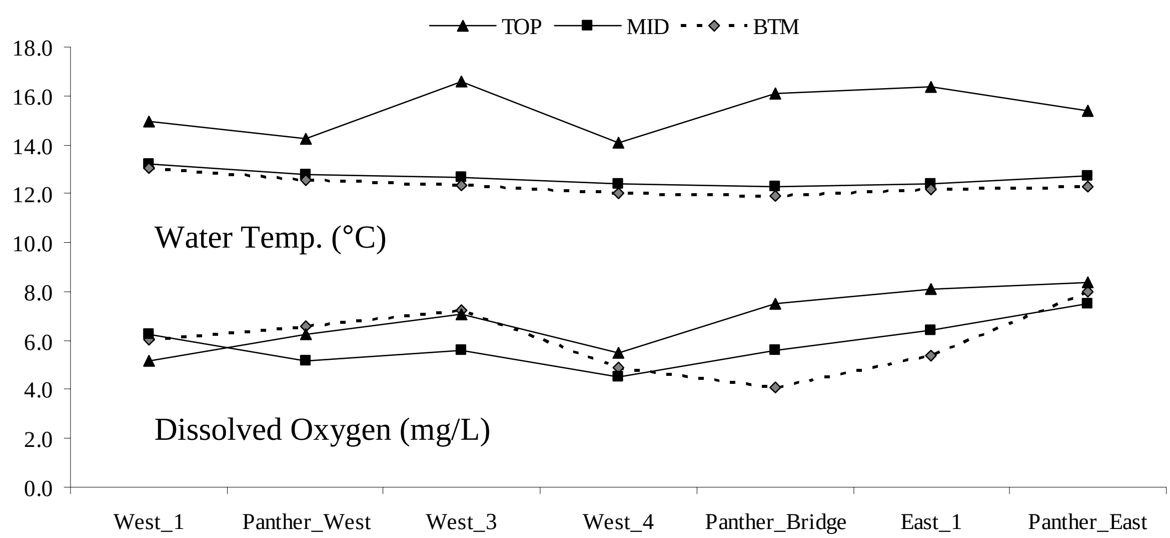


Figure 24. Water temperature and dissolved oxygen data collected in the afternoon of 9/4/11 at several monitoring sites located within Panther Creek Pond, Lower Klamath River.

The final 2010 datasonde deployment was initiated on 10/9/10 at East_1 and West_4 (Table 8, Figure 25). Water quality conditions were similar among the two sites monitored during the 48 hour sampling period (Figure 25). Water temperatures recorded at East_1 were just slightly lower than at West_4 with values ranging from 11.18 to 11.47 °C (Figure 25). Water temperatures recorded at West_4 during the same period ranged from 11.43 to 11.68 °C (Figure 25). DO values recorded during the monitoring period ranged from 5.01 to 8.22 mg/L at East_1 and from 5.54 to 6.95 mg/L at West_4 (Figure 25). Specific conductance values recorded in October at West_4 and East_1 ranged from 62.8 to 64.9 µS/cm (Figure 25).

On 2/5/11, YTFP crews deployed datasondes at Panther_Bridge, Panther_East, and East_1 to document winter conditions (Table 8, Figure 26). As expected, water temperatures recorded during this period were noticeably lower relative to water temperatures recorded during summer 2010. Alternately, DO values recorded in February 2011 were relatively higher than values recorded during summer 2010. DO values recorded at the three sites in February ranged from 5.45 to 8.59 mg/L (Figure 26). Specific conductance values recorded in February at Panther_Bridge and East_1 were similar to values documented during summer 2010 with values ranging from 61.3 to 66.6 µS/cm (Figure 26). Specific conductance values recorded during February at Panther_East were more variable relative to the data collected at the other two sites with recorded values ranging from 69.9 to 84.2 µS/cm (Figure 26).

Panther Pond Bathymetry

YTFP survey crews used a Nikon DTM Total Station to conduct 3-dimensional topographic surveys of the bed and banks of Panther Creek Pond. Crews established several permanent benchmarks and a total of 30 cross sections in Panther Pond during summer 2010 (Figures 27). Nine cross sections were surveyed in habitats located west of the Panther Creek bridge, while 21 cross sections were surveyed in habitats located east of the bridge (Figures 27-28). Habitats located south of the Peine Road culvert were not included in the 2010 survey (Figure 27).

A GIS-based digital elevation model (DEM) of Panther Pond bathymetry was created through visual interpolation of three different data types: 1) YTFP total station survey points; 2) 1ft LiDAR (Light Detection And Ranging) DEM, contours and hillshade (2009); and 3) USGS and NAIP aerial imagery (1988, 1993, 1998 and 2009) (Figure 29). Elevation control for the YTFP total station data was adjusted to equal the elevation of a nearby National Geodetic Survey (NGS) benchmark (DH6370). The total station data was then rotated to fit the topography depicted on the LiDAR hillshade and aerial imagery. Two foot contour lines were heads-up digitized by bounding elevation groups represented in the survey point data where available. In areas where point data was sparse, contour lines were formed based on interpretation of other supporting spatial data. The goodness of fit of the bathymetric DEM was evaluated in the field by comparing relative water depths and vegetation patterns to the mapped contours.

Figure 25. Water quality data collected from 10/9/10 (14:00 hours) to 10/11/10 (13:30 hours) at two monitoring sites located within Panther Creek Pond, Lower Klamath River.

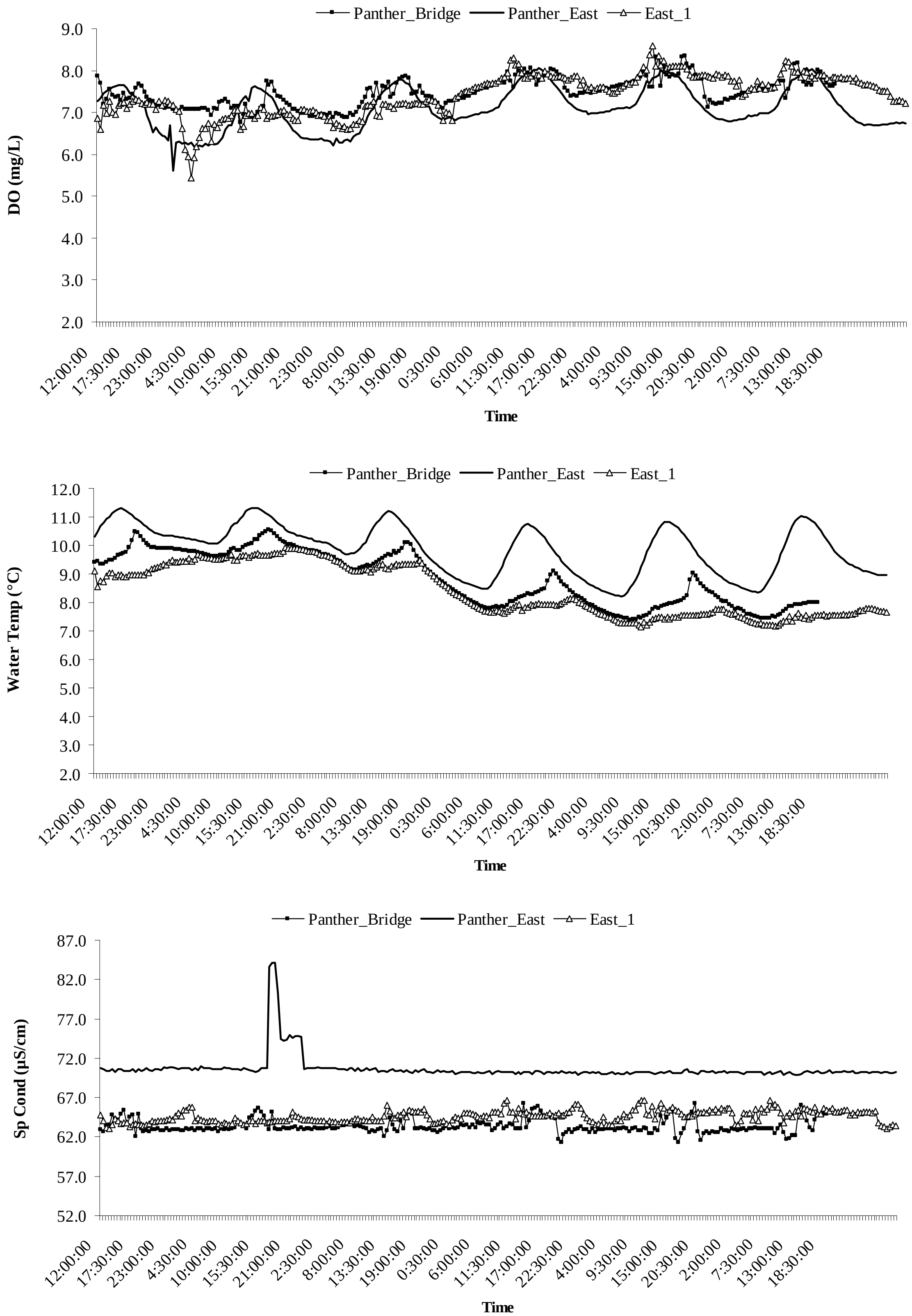


Figure 26. Water quality data collected from 2/5/11 (12:00 hours) to 2/11/11 (07:00 hours) at three monitoring sites located within Panther Creek Pond, Lower Klamath River.

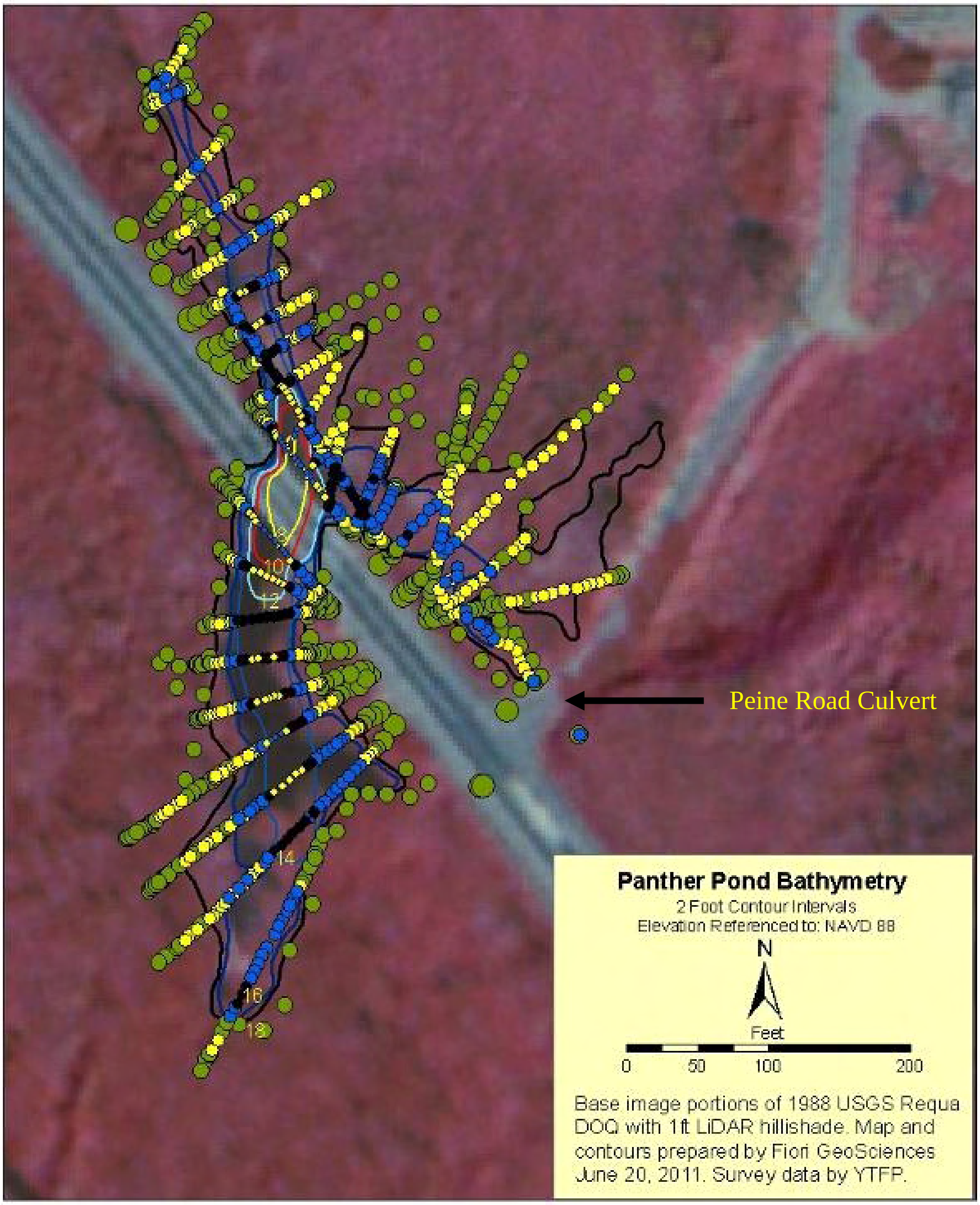


Figure 27. Map depicting topographic survey points collected in Panther Creek Pond during summer 2010 and derived contour lines, Lower Klamath River, California.

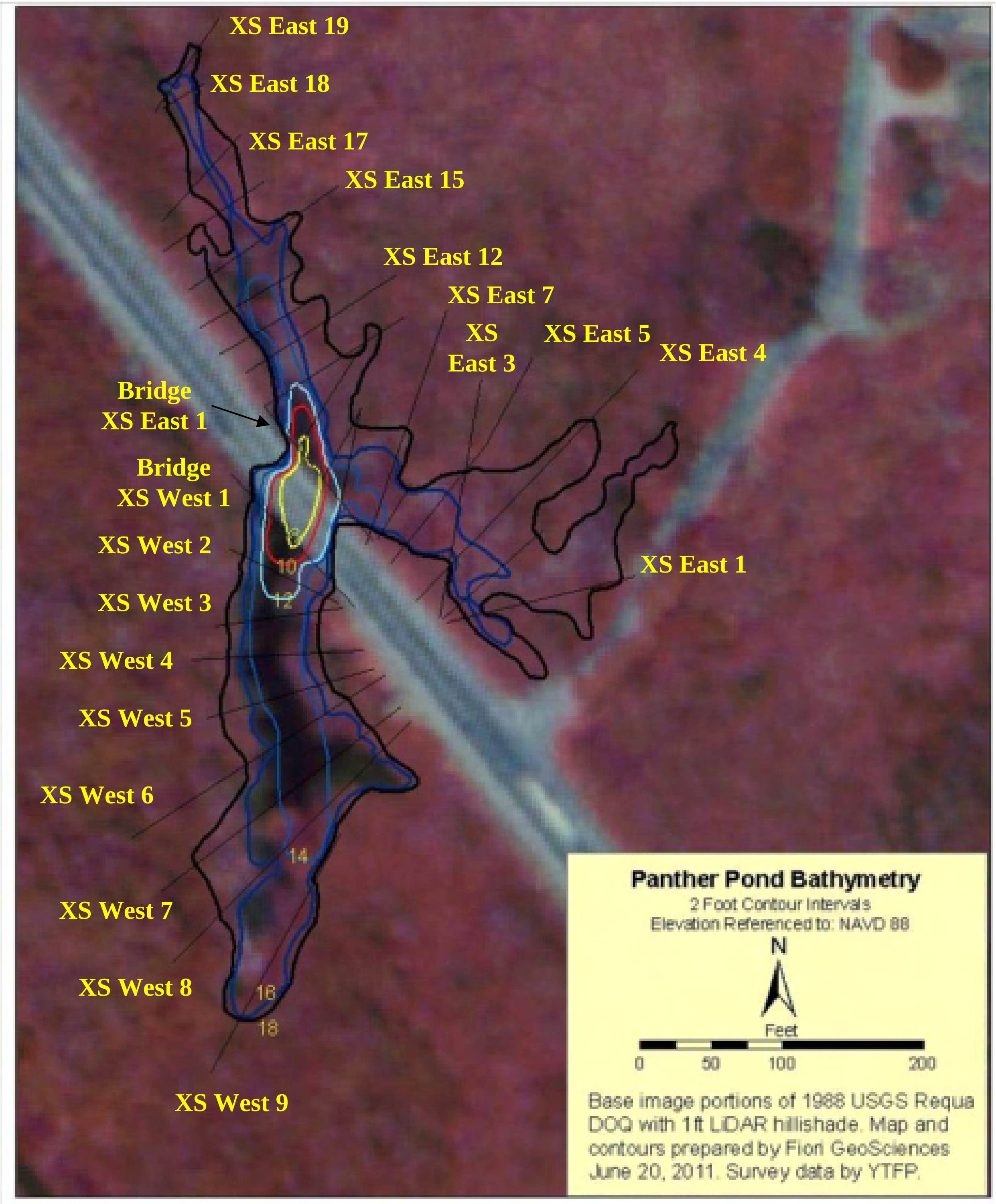


Figure 28. Map depicting cross section locations surveyed in Panther Creek Pond during summer 2010, Lower Klamath River, California.

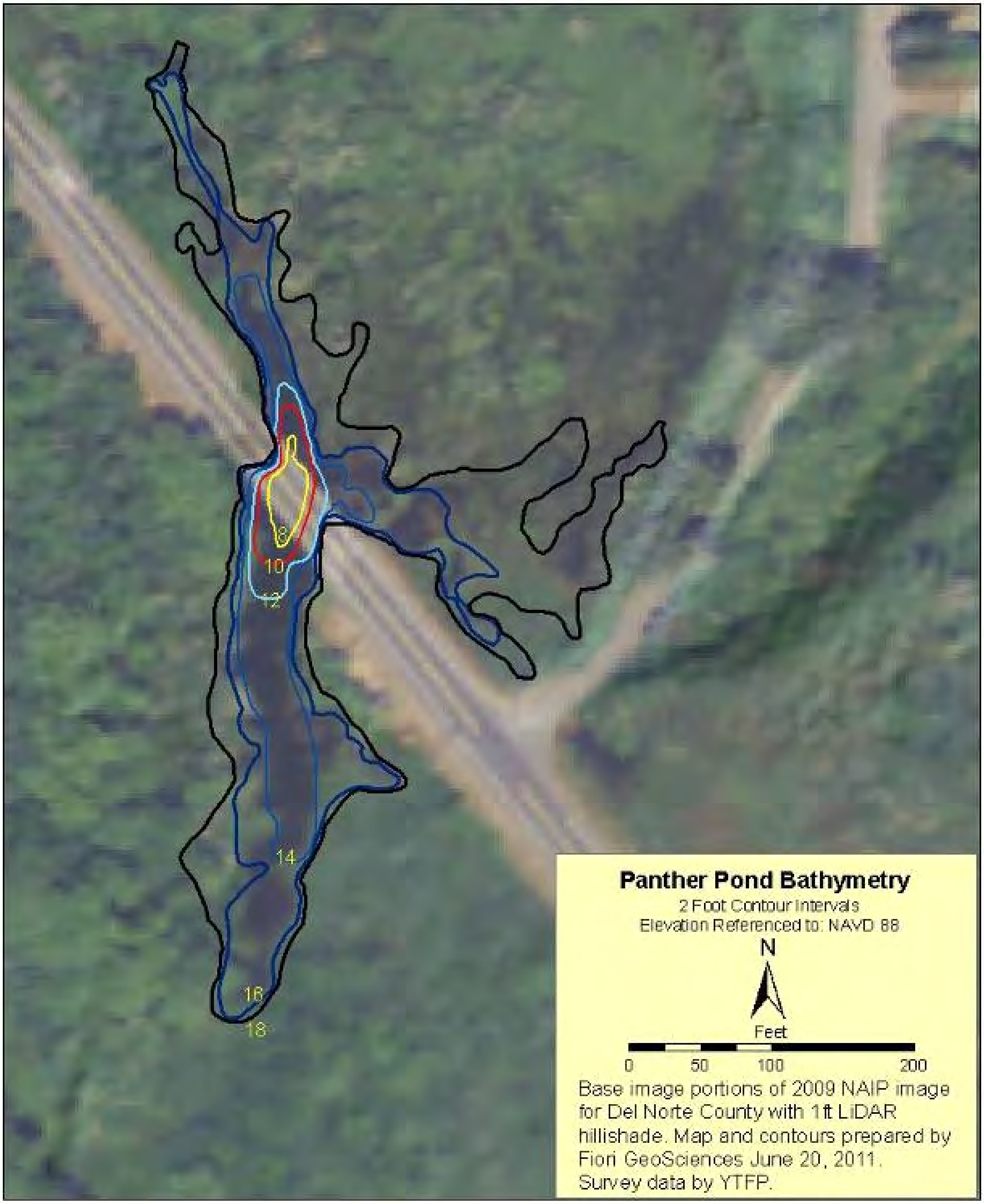


Figure 29. Bathymetric map of Panther Creek Pond, Lower Klamath River, California.

The pond is relatively deep (8-11 ft) and U-shaped in the vicinity of the bridge (Figures 28, 30-31). Habitats located to the west of the bridge were generally free of submerged aquatic vegetation relative to habitats surveyed to the east of the bridge (Figure 32). Maximum water depths measured in the west side of the pond ranged from 11.22 ft at the bridge to 5.23 ft at the west end of the pond (Figure 30). Topography of habitats surveyed to the east of the bridge was more variable relative to habitats surveyed to the west of the bridge. The east side of the pond has more submerged and emergent aquatic vegetation and vegetated islands (e.g. old beaver hut) (Figures 32-33). Habitats surveyed on the east side of the pond consisted of fairly shallow edge water habitat (2-4 ft) and deep water habitats located near the bridge (6-11 ft) (Figure 31).

Discussion

Fish Assessments

Summer population estimates for juvenile coho salmon in Spruce Creek were 85 fish during July 2010 and 23 fish for September 2010 (Figure 8). Length frequency analysis for coho captured during these surveys indicated that most of the fish captured were YOYs (Figure 34). The initial KGR study survey conducted in June 2009 resulted in a population estimate of 43 juvenile coho in the Spruce Creek sampling area with the population consisting of both YOY and age 1+ coho (Figures 34-35). Juvenile coho were not captured in this area during subsequent sampling events conducted in July through October 2009 (Figure 35). Recent surveys conducted in June 2011 resulted in population estimates of 42 yearling coho and 35 YOY coho in the Spruce Creek wetland complex (Figure 35). Data collected since 2009 suggests Spruce Creek supports variable numbers and age classes of juvenile coho during summer through early fall.

Summer population estimates for juvenile trout in Spruce Creek were 24 fish during July 2010 and 13 fish for September 2010 (Figure 9). In June 2009, a population of 50 trout was estimated in Spruce Creek; however, subsequent sampling efforts in July through October did not result in any other trout captures (Figure 36). Length frequency distributions generated from these studies indicate that a majority of the cutthroat and steelhead using this area during summer are age 1+ and older (Figure 37). In June 2011, YTFP estimated a population of 62 yearling cutthroat trout in Spruce Creek; however, steelhead were too scarce during this survey to generate a population estimate (Figure 36). It is unclear why so few native trout were captured in Spruce Creek during summer 2010 relative to trout capture data collected during both June 2009 and June 2011.

Juvenile coho population numbers estimated during summer 2010 in Panther Pond were very low relative to estimates generated during summer 2009 and June 2011 (Figure 38). In June 2011, YTFP estimated a population of 329 yearling coho salmon residing in Panther Pond (Figure 38). Too few YOY coho salmon were captured during the June 2011 survey to generate a population estimate. Data collected since 2009 indicates that a majority of the juvenile coho captured in Panther Pond during summer – early fall are age 1+ fish (Figures 10 & 39).

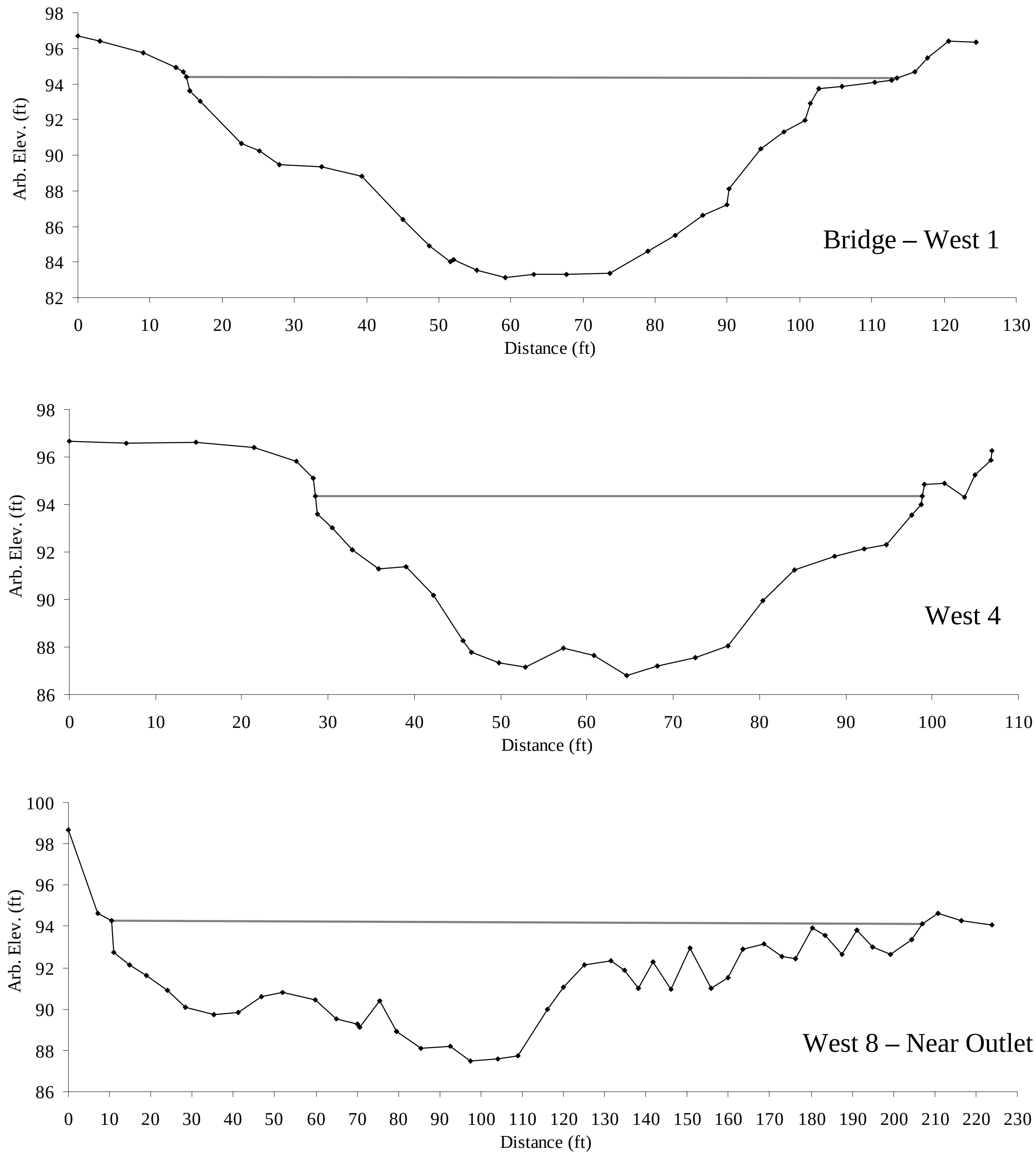


Figure 30. Cross sections surveyed to the west of the U.S. Highway 101 Bridge in Panther Creek Pond, Lower Klamath River, California (Surveys conducted in summer 2010).

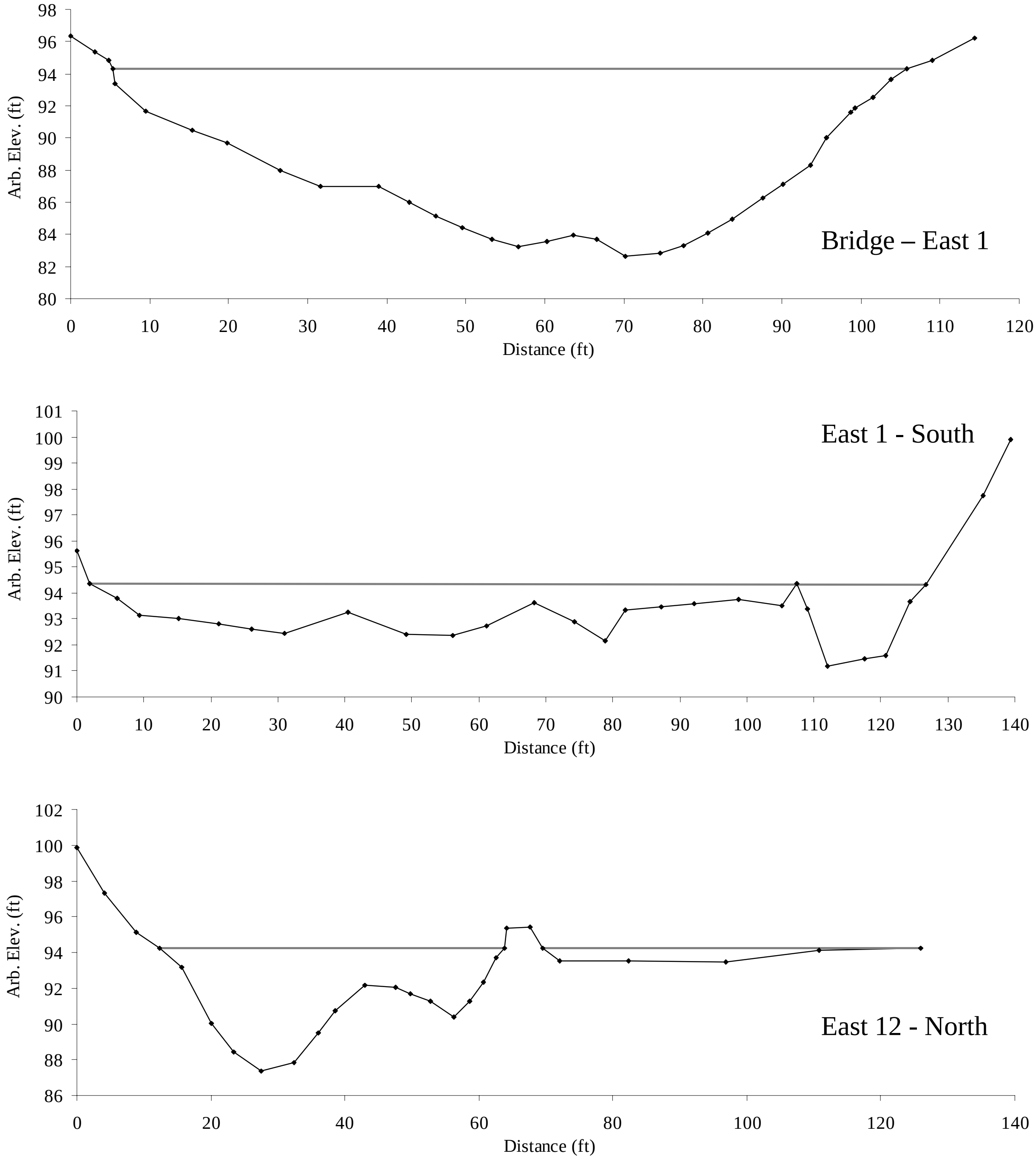


Figure 31. Cross sections surveyed to the east of the U.S. Highway 101 Bridge in Panther Creek Pond, Lower Klamath River, California (Surveys conducted in summer 2010).

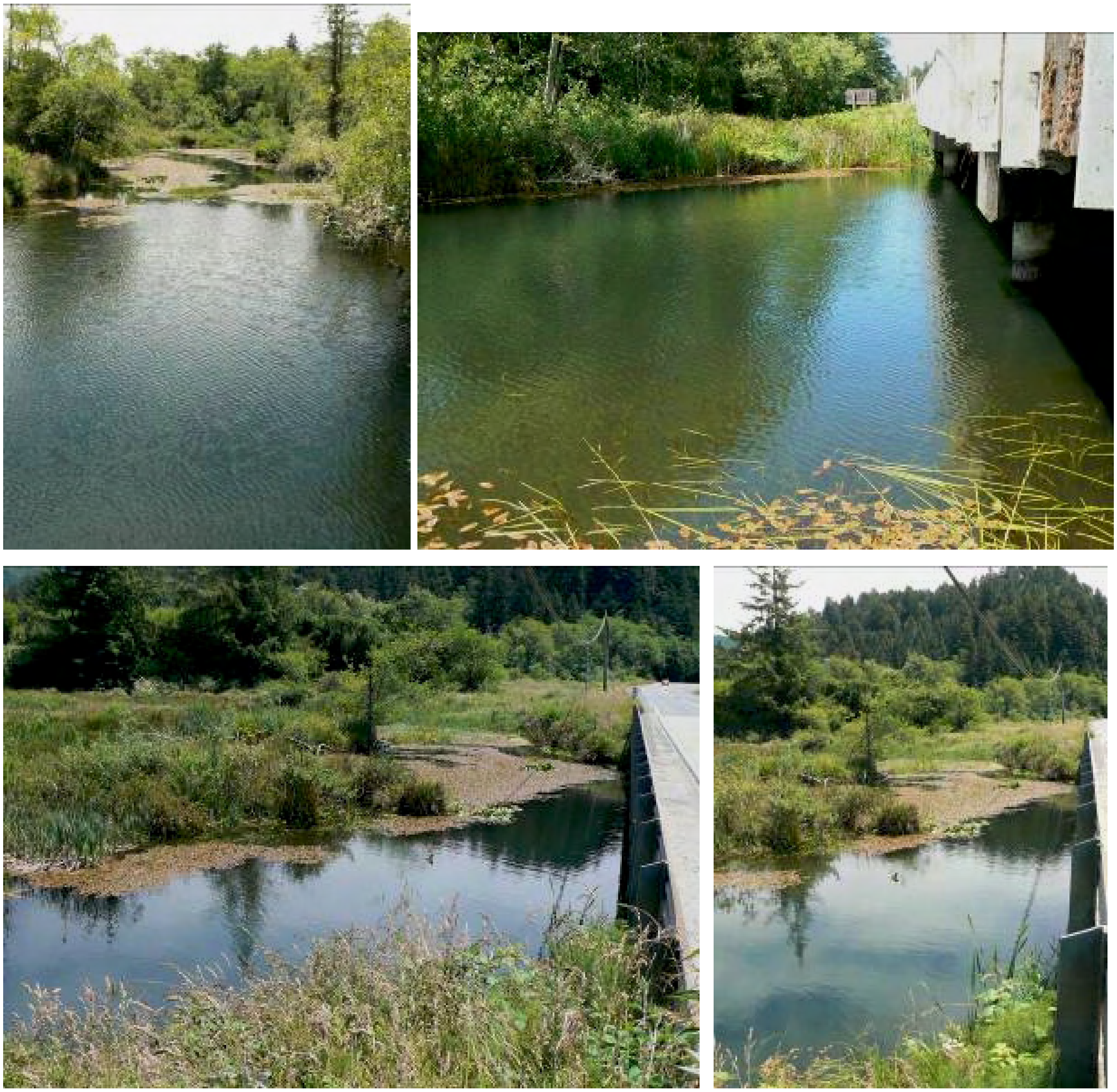


Figure 32. Photographs of habitats located downstream (Top) and upstream (Bottom) of U.S. Highway 101, Panther Creek, Lower Klamath River, California (June 2011).

Figure 33. Photograph of a vegetated island and old beaver hut located in Panther Creek pond, Lower Klamath River, California (June 2011).

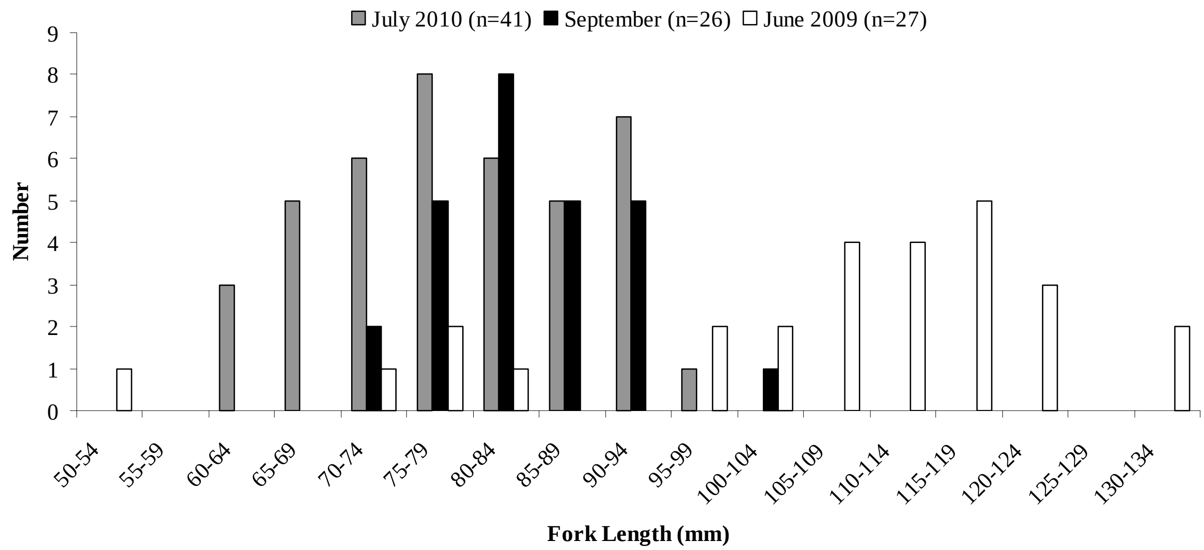


Figure 34. Length frequency for coho salmon captured during mark-recapture sampling efforts conducted in Spruce Creek during 2009 - 2010, Lower Klamath River, California.

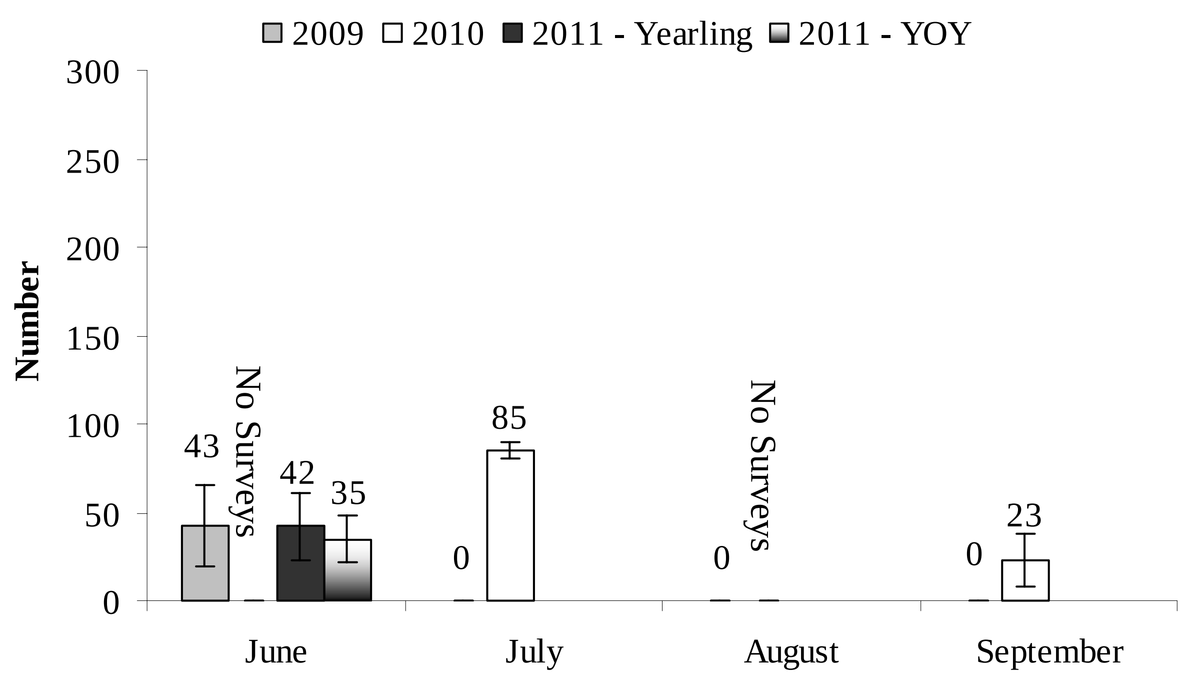


Figure 35. Mark-recapture population estimates for juvenile coho salmon in Spruce Creek during summer 2009 - 2011, Lower Klamath River, California.

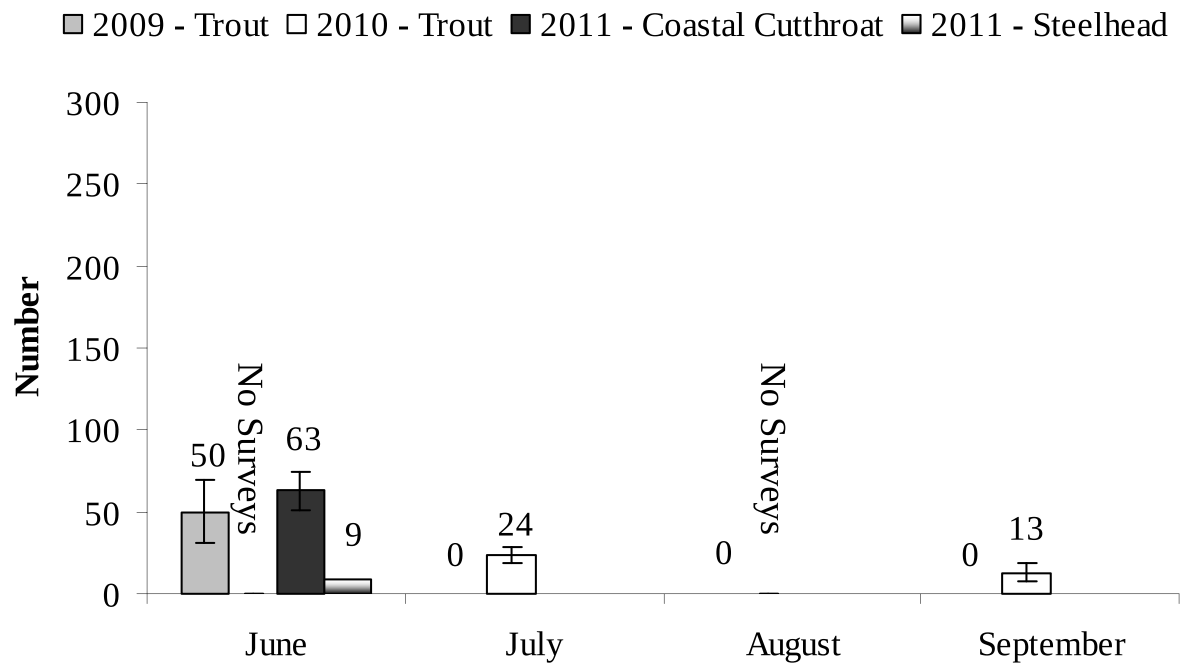


Figure 36. Mark-recapture population estimates for trout species in Spruce Creek during summer 2009 - 2011, Lower Klamath River, California.

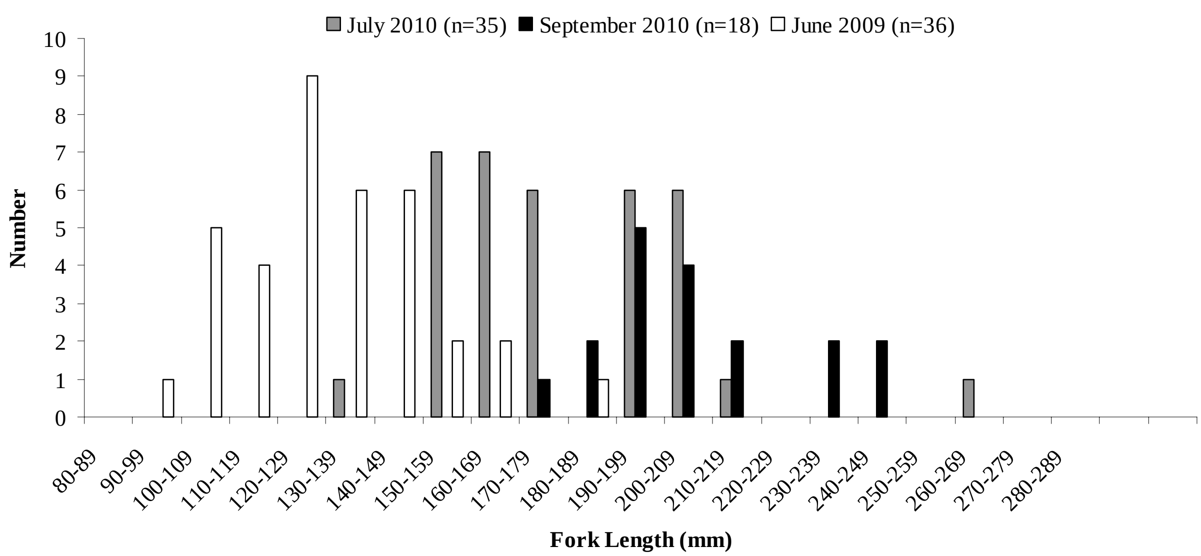


Figure 37. Length frequency for trout species captured during mark-recapture sampling efforts conducted in Spruce Creek during 2009 - 2010, Lower Klamath River, California.

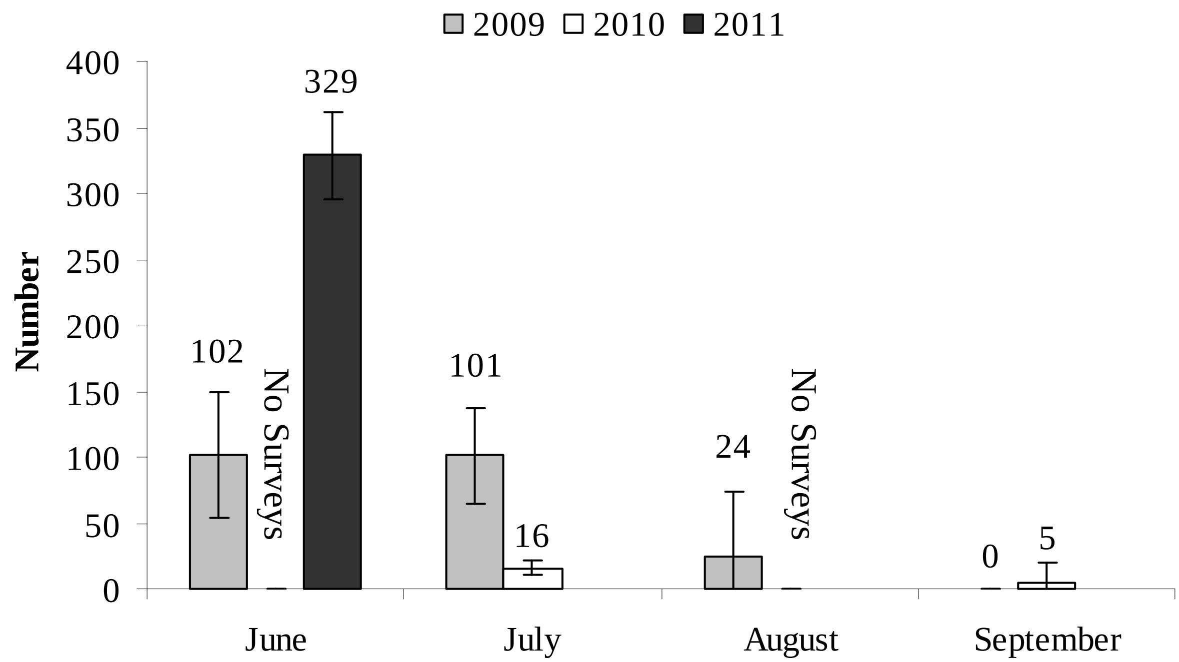


Figure 38. Mark-recapture population estimates for juvenile coho salmon in Panther Creek Pond during summer 2009 - 2011, Lower Klamath River, California.

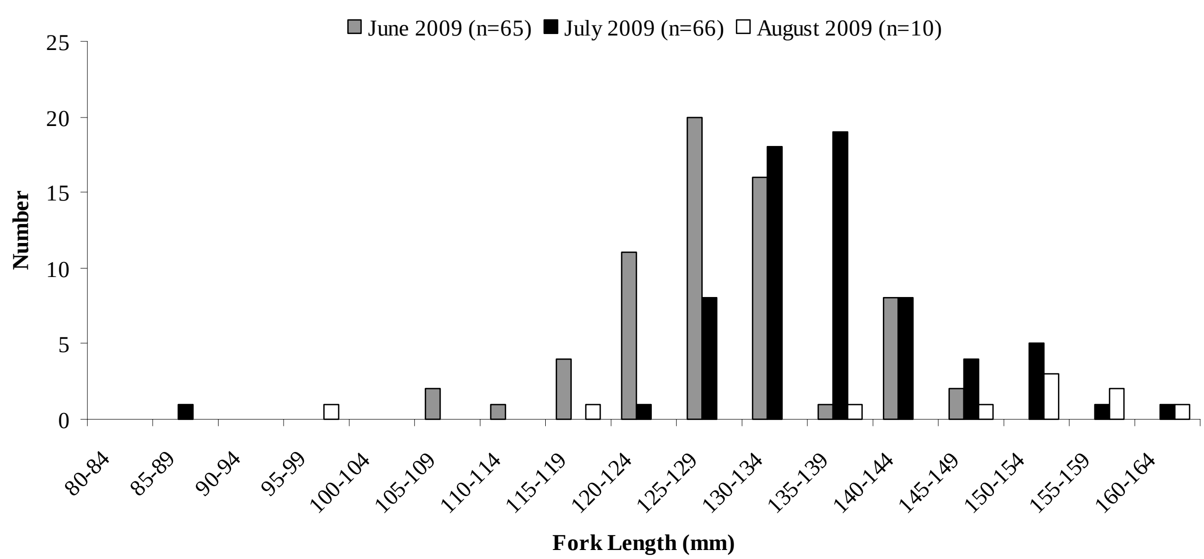


Figure 39. Length frequency for juvenile coho salmon captured during mark-recapture sampling efforts conducted in Panther Creek Pond during 2009, Lower Klamath River, California.

Summer population estimates for juvenile trout in Panther Pond were 49 fish during July 2010 and 94 fish for September 2010 (Figure 40). In June 2009, over 100 trout were estimated in Panther Pond; however, numbers dropped to 34 trout in August and zero in September (Figure 40). Population estimates generated in summer 2009 and 2010 were relatively low compared with population estimates generated from surveys conducted in June 2011 (Figure 40). Again, most of the coastal cutthroat and steelhead captured in Panther Pond during summer – early fall have consisted of yearlings and older age fish, including adult cutthroat trout (> 270 mm FL) (Figures 16 & 41). Very few adult cutthroat trout were observed in Spruce Creek during the 2010-2011 surveys relative to Panther Pond (Figures 11-16).

Fisheries data collected in off-estuary and coastal wetland complexes of the Lower Klamath River suggest that juvenile salmonids and adult cutthroat trout use these types of habitats year-round; however, overwinter use tends to be much greater than during summer months (Figures 8-9) (Soto et al. 2008; Hillemeier et al. 2009; YTFP 2009; Silloway 2010; YTFP In Progress). In both sampling areas, significantly more juvenile coho salmon and trout were captured during winter 2011 than during July or September 2010 (Figures 8-9). In Spruce Creek, juvenile coho captured during winter 2011 were substantially larger than juvenile coho captured during summer and early fall 2010 (Figure 10). Comparing size frequency data for coho captured during summer to the winter size frequency data was difficult for Panther Pond given the low sample sizes during 2010 (Figure 15). The largest coho were captured during July 2010 in Panther Pond (> 144 mm FL) (Figure 15), however this was based on a small sample size (n=9). The largest coho in Spruce Creek was captured during winter 2011 (125 mm FL) (Figure 10).

Our investigation in Panther Pond over the last few years, indicates juvenile coho appear to be using a majority of the available habitats during both summer and winter. However, our surveys have not included wetland habitats located south of Peine Road. YTFP plans to initiate fish surveys in those habitats during 2011-2012 as part of another study we are conducting. Although more information is needed, data collected during summer months at the Panther Creek PIT tag station and lower trap site show that juvenile salmonids migrate into lower Panther Creek from Hunter Creek for short periods before heading back downstream (YTFP In Progress). Fish access into Panther Pond during summer is questionable due to low flow levels and extensive colonization of the outlet channels by aquatic and invasive vegetation. Fish use and distribution patterns observed in the pond during summer combined with the apparent lack of fish passage into and out of the pond make developing a bridge replacement construction scenario capable of avoiding impacts to ESA listed fish and other aquatic species impossible.

Similar conditions exist in the Spruce Creek wetland during summer. A beaver dam and extremely low flows likely prohibit access into and out of the wetland complex during the typical construction period. The potential to relocate fish out of the potential construction area (Spruce_West and Spruce_East) may be feasible given the presence of the beaver pond located upstream of the surveyed habitat (Figure 3). However, the beaver pond is located on private property and the landowner has tried to drain this feature multiple times over the past few years. If safe relocation of fish is not feasible at this site, then developing a culvert replacement scenario capable of avoiding potential impacts to ESA listed fish will be impossible.

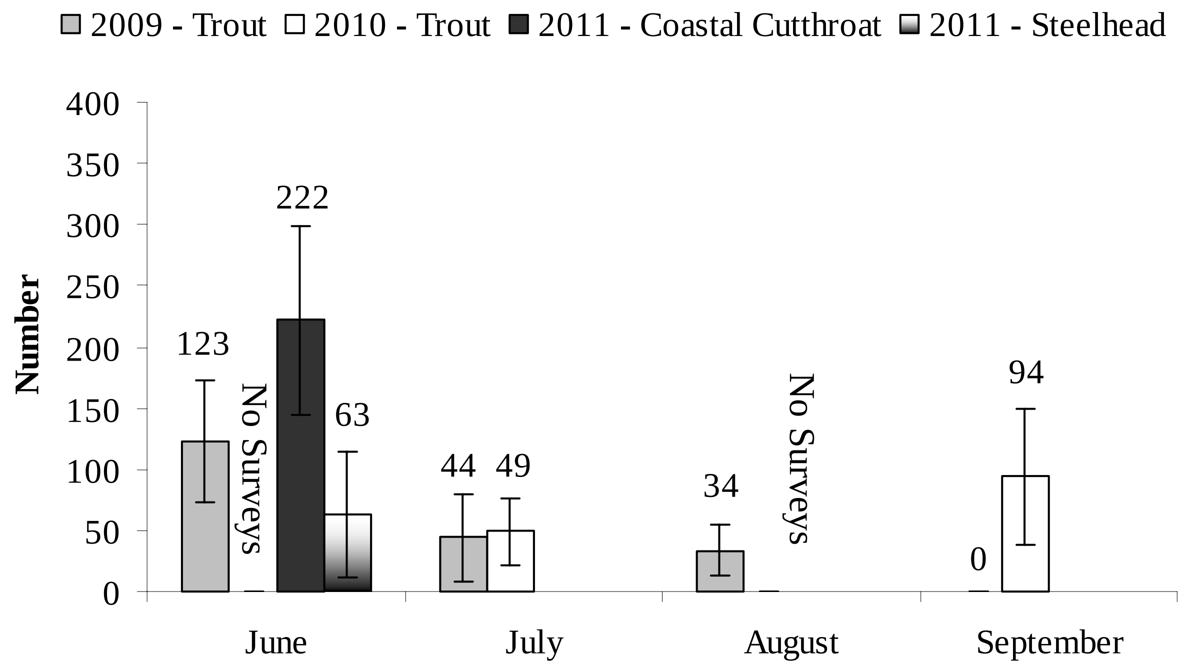


Figure 40. Mark-recapture population estimates for trout species in Panther Creek Pond during summer 2009 - 2011, Lower Klamath River, California.

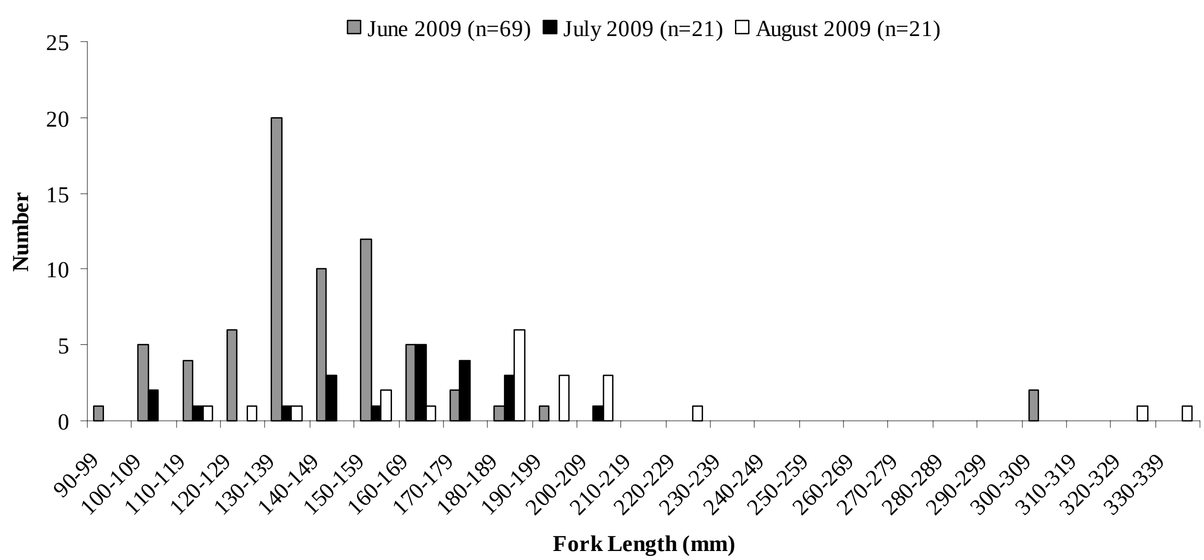


Figure 41. Length frequency for juvenile trout species captured during mark-recapture sampling efforts conducted in Panther Creek Pond during 2009, Lower Klamath River, California.

Over the course of the KGR study (~spring 2009 - mid-June 2011), a total of 617 PIT tagged coho have been documented in Panther Pond. These PIT tagged fish included juvenile coho that were tagged during the KGR trapping events as well as coho that entered the system with PIT tags already implanted. From these tagged fish and operation of the PIT tag antenna arrays located in lower Panther Creek, we have gained important insight regarding juvenile coho migration timing, survival, growth, and non-natal use of within this coastal wetland.

Several environmental factors influence migration timing of juvenile coho salmon, including temperature and stream flow (Lestelle 2007). Since initiating this study in 2009, the Lower Klamath region has experienced three different spring water year types: dry, relatively normal, and wet (Figure 42). Hydrologic differences between these water years likely influenced the ability of coho smolts to emigrate from the Spruce Creek and Panther Pond study areas and the ability of YOY coho to move into these habitats for summer rearing opportunities. In 2009, a dry spring year (Figure 42), 108 PIT tags were applied to juvenile coho or detected in Panther Pond. The PIT tag antenna arrays detected 64.8% of these tags leaving Panther Creek during 2009 (March through December) and 2010 (calendar year). The peak of coho smolt emigration for 2009 occurred during Julian week 18, April 30 – May 6 (Figure 43). None of the remaining 2009 PIT tagged coho were detected moving downstream past the antennas until spring 2010.

In 2010, the Lower Klamath region experienced a wet spring with steady precipitation occurring throughout March and April and a fairly significant storm event in early June (Figure 42). In 2010, a total of 181 PIT tags were established in Panther Pond. The PIT tag antenna arrays detected 80.1% of these marks leaving Panther Creek in 2010 (Figure 43). Higher than normal stream flows occurring during spring and June 2010 seem to have caused the coho smolts occupying Panther Pond to depart at a higher rate than during 2009. In 2010, peak emigration of coho smolts (n=58) occurred during Julian week 15, April 9-15 (Figure 43). A second peak in coho smolt emigration (n=32) occurred during Julian week 17, April 23-29. A third smaller peak (n=8) occurred during Julian week 22, May 28-June 3 (Figure 43). The last coho smolt was detected moving out of Panther Pond on June 6, 2010. This high departure rate helps explain the low numbers of age 1+ coho rearing in Panther Pond during the summer months of 2010 (Figure 38). The high flow event in June 2010 may also explain why more YOY coho were captured in Panther Pond during summer 2010 relative to summer 2009. The June 2010 high flow event occurred during a period of redistribution for YOY coho salmon (Lestelle 2007) and the elevated stream flows likely increased their ability to access Panther Pond.

During 2011, a relatively normal spring water year (Figure 42), 328 PIT tags were established in coho juveniles in Panther Pond. From these marks only 42.1% were detected passing downstream of the PIT tag antenna arrays in 2011 (Figure 43). The peak coho smolt migration (n=35) for 2011 occurred during Julian week 16, April 16-22 (Figure 43). A second small peak (n=5), occurred during Julian week 22, May 28-June 3 (Figure 43). A total of 18% of the 2011 marks were recaptured during the 06/14/11 trapping event. Based on migration patterns documented in 2009 and 2010, YTFP considers these coho to be summer holdovers. These June recaptures likely represent only a small portion of the currently unaccounted for 2011 PIT tagged coho. It is also possible some of these PIT tagged coho left the system without being detected by the antennas. During some high flow events fish have the ability to bypass the antenna arrays via alternate flow paths that become available when the river and/or Hunter Creek backwaters

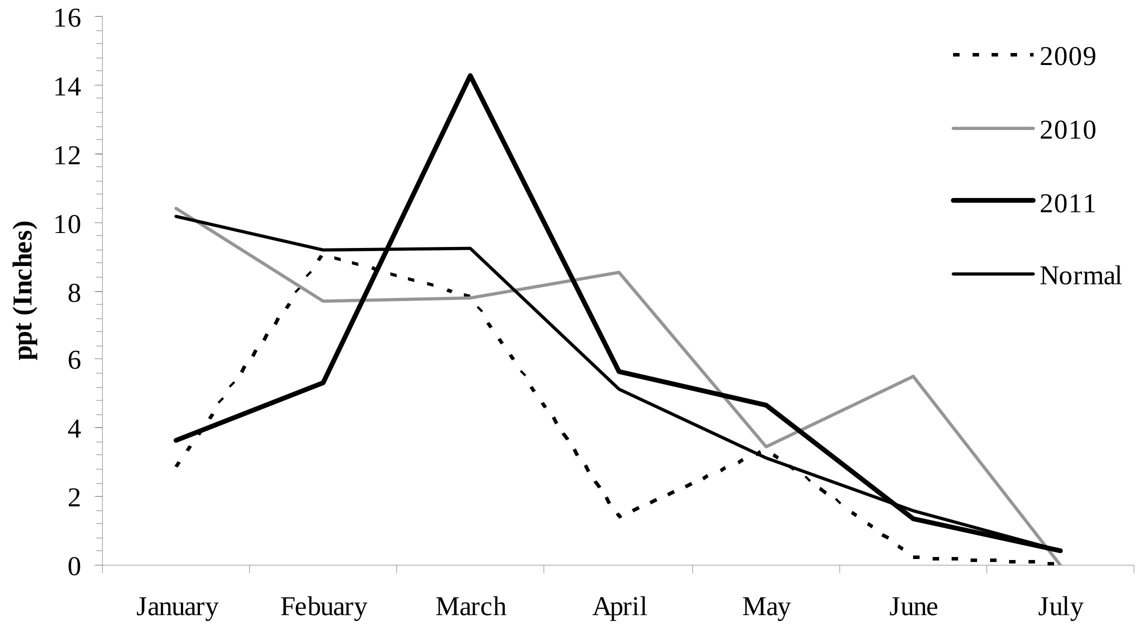


Figure 42. Monthly recorded precipitation compared to normal precipitation for Crescent City, California (Data obtained from the Crescent City, CA Weather Station (KCEC) via Weather Underground: wunderground.com).

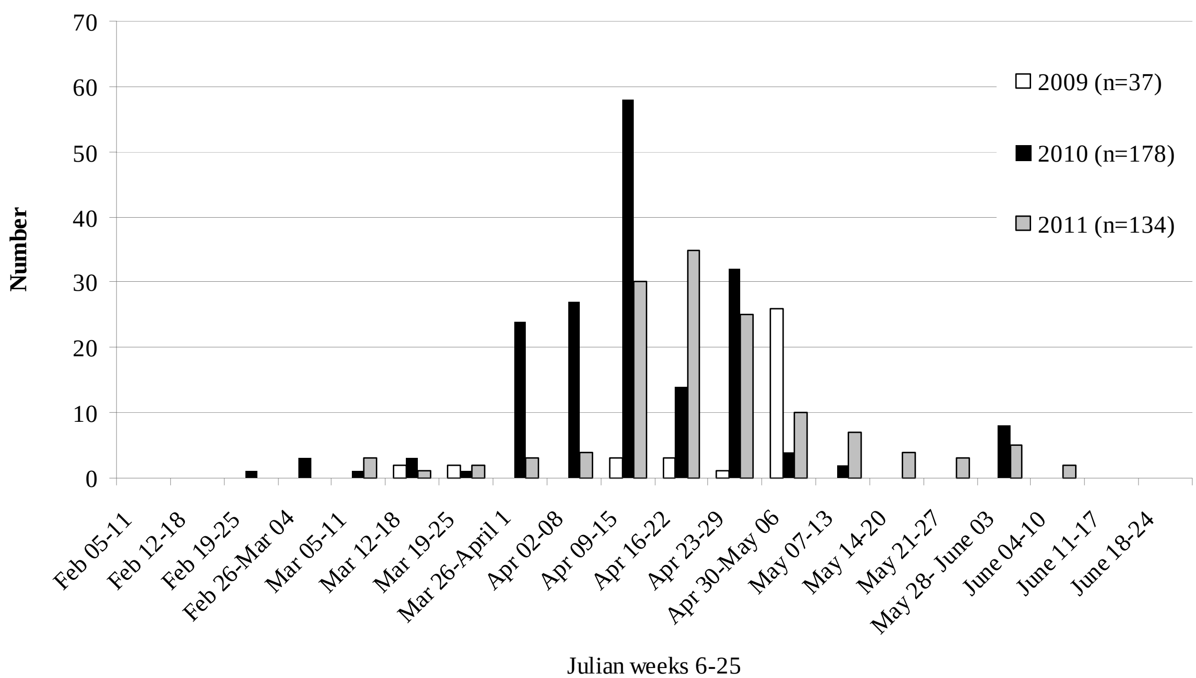


Figure 43. Smolt migration timing of coho salmon for three years of fish emigrating from Panther Pond into Panther Creek, tributary to Hunter Creek, Lower Klamath River, California.

the lower reaches of Panther Creek and Panther Pond. The other consideration is mortality of PIT tagged fish either from "natural" causes or by anglers. Fish residing in Panther Pond are susceptible to legal harvest by Yurok Tribe members and illegal harvest by non-tribal anglers.

The maximum residency documented for a juvenile coho in Panther Pond is 503 days. This coho was tagged by YTFP as it entered Panther Creek on 11/21/08 as a YOY (85 mm; 7.4 g). This coho was recaptured in the pond by YTFP on 05/26/09 (130 mm; 21.9 g) and then again on 04/09/10 (158 mm; 38.4 g). On 04/14/10 this fish was detected at the antennas moving out of the system. During its residency in Panther Pond, this coho grew 73 mm (0.147 mm/day) and gained 31 grams of weight (0.062 g/day). YTFP has documented at least four coho juveniles who have resided in Panther Pond for more than 360 days, three residing for more than 300 days, 12 residing for more than 250 days, and seven coho residing for more than 200 days.

Growth rates in Panther Pond were calculated for both juvenile coho and cutthroat trout between 2009 and 2011. Thirty-eight coho individuals with recapture rates greater than 20 days, (maximum of 313 days, mean of 127 days) were used for the growth rate analysis. The mean growth rate for juvenile coho residing in Panther Pond was 0.195 mm/day (Figure 44), with a minimum of 0.078 mm/day and a maximum of 0.453 mm/day. The mean change in weight for juvenile coho was 0.106 g/day (Figure 45), with a minimum of -0.075 g/day and a maximum of 0.226 g/day. Twenty-three cutthroat individuals (age 1+ or older) with recapture rates greater than 34 days (maximum of 584 days, and a mean of 175 days) were used for the growth rate analysis. The mean growth rate for cutthroat was 0.342 mm/day (Figure 46), with a minimum of 0.149 mm/day and maximum of 1.075 mm/day. The mean change in weight for cutthroat was 0.345 g/day (Figure 47), with a minimum of 0.09 g/day and maximum of 0.782 g/day.

Growth rates in Spruce Creek were calculated for both juvenile coho and cutthroat trout between 2009 and 2011. Thirteen coho individuals were used with recapture rates greater than 60 days (maximum of 207 days, mean of 136 days). The mean growth rate for juvenile coho was 0.138 mm/day (Figure 44), with a minimum of 0.067 mm/day and maximum of 0.187 mm/day. The mean change in weight for juvenile coho was 0.034 g/day (Figure 45), with a minimum of 0.008 g/day and maximum of 0.05 g/day. Ten cutthroat trout individuals (age 1+ or older) were used with recapture rates greater than 70 days (maximum of 207 days, and a mean of 152 days). The mean growth rate for cutthroat trout was 0.414 mm/day (Figure 46), with a minimum of 0.135 mm/day and maximum of 1.221 mm/day. The mean change in weight for cutthroat was 0.526 g/day (Figure 47), with a minimum of 0.107 g/day and maximum of 1.671 g/day.

Beginning in 2008, YTFP has implanted ~100 to 200 YOY coho in the Hunter Creek watershed with PIT tags each year. YTFP has also been PIT tagging juvenile coho in several other Lower Klamath tributaries since 2006 in cooperation with the Karuk Tribe who is applying PIT tags to juvenile coho within the Mid Klamath region (Soto et al. 2008; Hillemeier et al. 2009). Recently, basin stakeholder groups have begun PIT tagging juvenile coho from the Scott and Shasta Rivers. Several of these coho have entered the Panther Creek system and have been subsequently recaptured in Panther Pond during our abundance surveys. All of the fish tagged outside of the Hunter Creek watershed are referred to as non-natal fish. Since the initiation of the KGR study in 2009, YTFP has identified 13 non-natal fish and 11 natal fish from the Hunter Creek watershed (excluding Panther Creek) residing in Panther Pond, which equates to a 54%

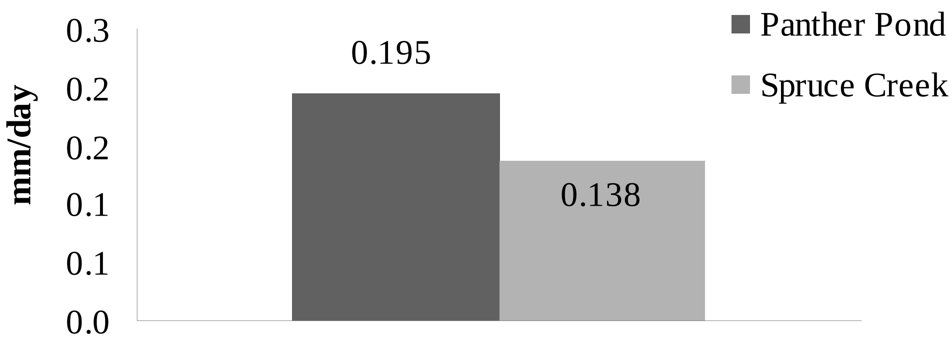


Figure 44. Mean growth rate estimates for juvenile coho salmon residing in two coastal wetlands (Panther Pond and Spruce Creek) of the Lower Klamath River, California (2009-2011).

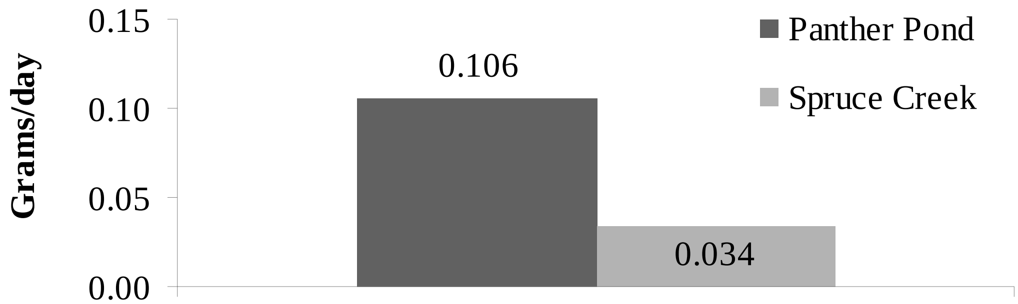


Figure 45. Mean weight change for juvenile coho salmon residing in two coastal wetlands (Panther Pond and Spruce Creek) of the Lower Klamath River, California (2009-2011).

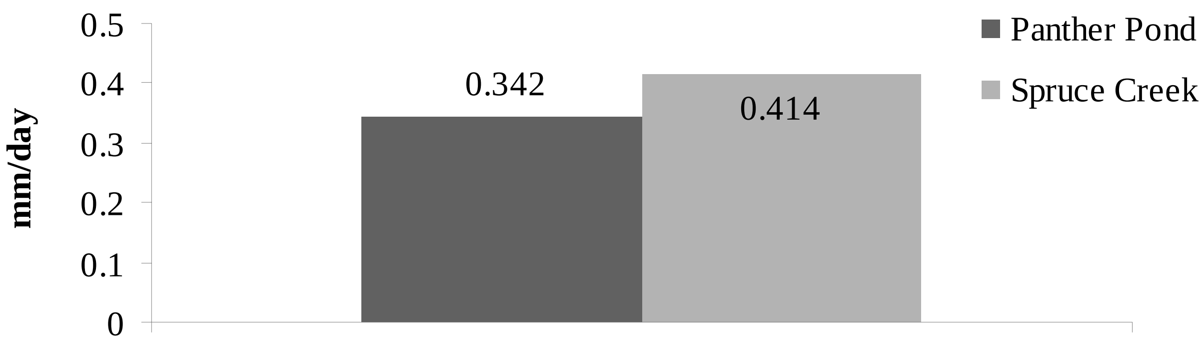


Figure 46. Mean growth rates for coastal cutthroat trout (≥ age 1+) residing in two coastal wetlands (Panther Pond and Spruce Creek) of the Lower Klamath River, California (2009-2011).

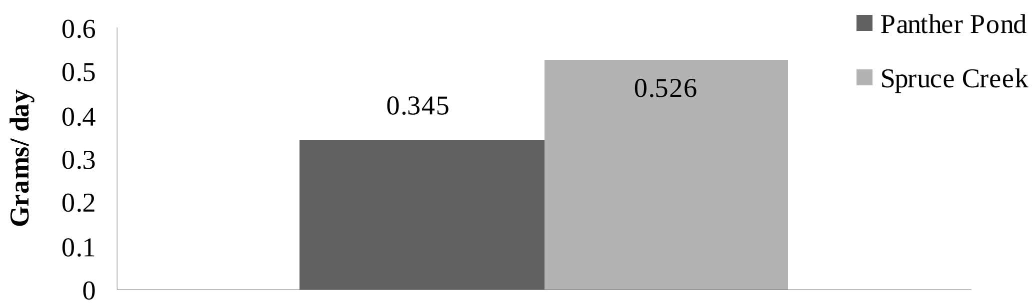


Figure 47. Mean weight change for coastal cutthroat trout (≥ age 1+) residing in two coastal wetlands (Panther Pond and Spruce Creek) of the Lower Klamath River, California (2009-2011).

non-natal to natal fish ratio. Most of the non-natal fish observed in Panther Pond were from other Lower Klamath tributaries such as the Crescent City Fork of Blue Creek, Ah Pah Creek, McGarvey Creek (2), West Fork McGarvey Creek, and Terwer Creek (2). One of non-natal coho recaptured in Panther Pond was from Aikens Creek, a Mid Klamath tributary. Numerous non-natal fish have been detected by the Panther Creek PIT tag antenna system since their installation in early 2008 but were not part of the KGR study (Hiner 2009; YTFP In Progress).

In Spruce Creek, YTFP identified 11 non-natal fish during the duration of the KGR fish surveys and only one natal fish from the Hunter Creek watershed, which resulted in a 91.7% non-natal to natal ratio. Most of the non-natal fish observed in the Spruce Creek study area were from other Lower Klamath tributaries such as Ah Pah Creek, McGarvey Creek (3), and Terwer Creek (3). The rest of the non-natal juvenile coho captured in Spruce Creek were PIT tagged in the Mid Klamath region. Some of the Mid Klamath coho were tagged at Klamath River monitoring sites (e.g. Big Bar and Sandy Bar) and from Independence Creek and Grider Creek. The higher ratio of non-natal to natal fish documented in Spruce Creek is likely due to the proximity of the two study areas to the Klamath River. Spruce Creek enters Hunter Creek just upstream of the confluence with the Klamath River, while Panther Creek enters Hunter Creek ~ 0.5 miles upstream of the confluence with the river (Figure 1). Spruce Creek is the first tributary that non-natal fish encounter when entering Hunter Creek, while Panther Creek is the first high quality slow velocity tributary that natal fish from Hunter Creek would encounter. However, more data is needed to really assess the ratio of natal juvenile coho to non-natal coho in these habitats.

Lower Hunter Creek

Reducing the length of the Hunter Creek inventory reach in 2010 made comparing the two years difficult. The major differences between the two years included reduced observations of both salmon and trout in the vicinity of the bridge and a general loss of habitat complexity in 2010. A sediment wave or "slug" appeared to have migrated into the study reach during winter 2009 – 2010 and resulted in the filling of pools and loss of undercut banks. However, both surveys indicate that this area of lower Hunter Creek provides valuable juvenile rearing habitat to variable numbers of native salmon and trout during summer – early fall. Many of the Lower Klamath tributaries experience prolonged periods of subsurface flows during summer – early fall; therefore, summer rearing habitat in the sub-basin is critically valuable to both natal and non-natal salmonids (Gale and Randolph 2000; Beesley and Fiori 2007).

Panther Creek Habitat Assessments

Results of the 2010 water quality investigations of Panther Pond supported findings of previous studies (Silloway 2010). In general, dissolved oxygen levels were consistently low throughout habitats of Panther Pond during summer – early fall 2010 (Figures 12-13, 19-25; Tables 9-10). However, YTFP continues to document extensive use of Panther Pond and other Lower Klamath off-channel habitats that experience relatively low dissolved oxygen levels by juvenile coho salmon, coastal cutthroat, and steelhead (Figures 35-36 & 38-39) (Beesley and Fiori 2004; Soto et al. 2008; Hillemeier et al. 2009; Silloway 2010; Fiori et al. 2011a and 2011b).

In summer 2010, YTFP and Fiori GeoSciences constructed the first off-channel habitat feature in lower McGarvey Creek with support from the U.S. Fish and Wildlife Service and U.S. Bureau of Reclamation (Figure 48). YTFP worked with Yurok Tribe Environmental Program staff to monitor post-construction water quality in the McGarvey Creek alcove from fall 2010 through spring 2011 (Fiori et al. 2011a and 2011b). Dissolved oxygen levels recorded in this constructed habitat during winter – spring 2011 were consistently low (Figure 49). However, YTFP has consistently captured juvenile coho salmon and other native salmonids in the constructed alcove during periods of low dissolved oxygen (Figure 49). Trapping events conducted in the McGarvey Creek alcove during June 2011 resulted in the capture of 51 YOY coho salmon, one YOY chinook salmon, cutthroat trout, and multiple native fish and amphibian species (YTFP In Progress). Dissolved oxygen measured in the McGarvey alcove during this period was 3.44 mg/L (15.6 °C) (YTFP In Progress).

Fisheries investigations conducted in off-estuary and coastal tributary habitats of the Lower Klamath River continue to document the importance of both winter and summer rearing habitat for natal and non-natal juvenile salmonids (Beesley and Fiori 2004; Soto et al. 2008; Hillemeier et al. 2009; Silloway 2010; Fiori et al. 2011a and 2011b; Pagliuco et al. 2011; YTFP In Progress). Both the Spruce Creek wetland complex and Panther Pond provide year-round rearing habitat for juvenile coho salmon, coastal cutthroat trout, and steelhead and therefore are extremely important to the survival and recovery of Klamath Basin salmonid populations.

Figure 48. Photographs of a constructed off-channel habitat feature in lower McGarvey Creek, Lower Klamath River, California (Summer – Fall 2010).

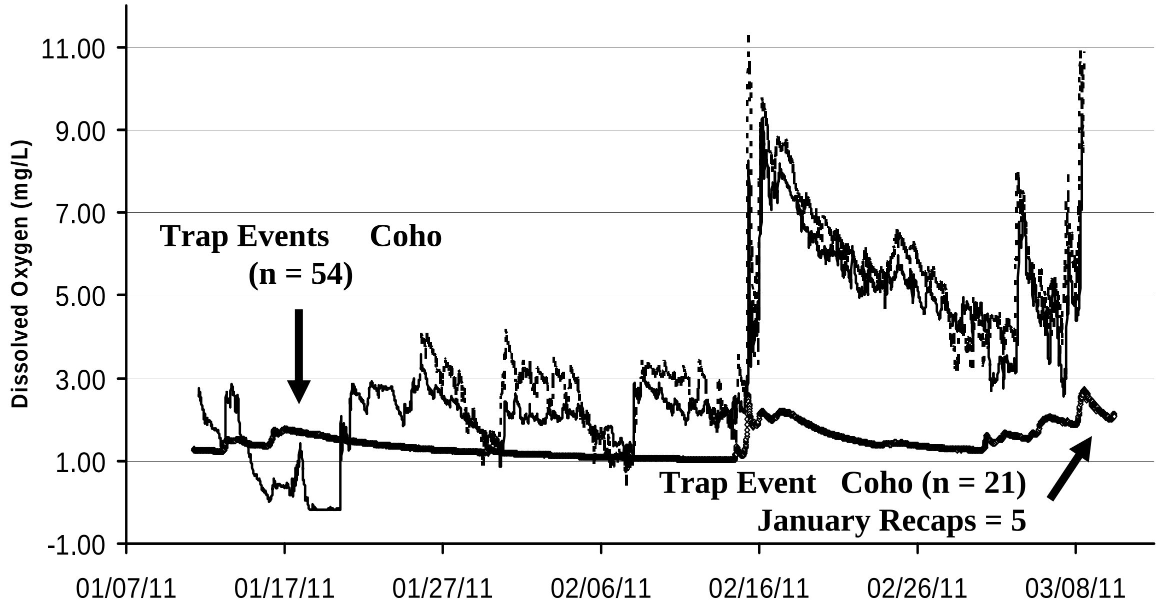


Figure 49. Dissolved oxygen measured at three sites within a newly constructed off-channel habitat feature in McGarvey Creek (Alcove I), Lower Klamath River, California.

Observations of Panther Creek Pond conducted over the last several years by YTFP staff indicate that reed canary grass (*Phalaris arundinacea*) (RCG) is actively establishing vegetative mats in critically valuable deep, open water rearing habitats within the pond (Figures 50-51). This coincides with further RCG colonization of productive edge water and shallow water habitats in Panther Pond. YTFP considers reducing RCG and promoting native vegetation in Spruce Creek, Panther Creek, and lower Hunter Creek priority wetland and fisheries enhancement measures.

Figure 50. Photographs looking at the west side of Panther Creek Pond during spring 2008 (Left) and during June 2011 (Right), Lower Klamath River, California (note the reed canary grass mats colonizing the deep water habitats in the June 2011 photograph).

Figure 51. Photograph depicting aquatic vegetation colonizing deep water habitats of Panther Creek pond during June 201, Lower Klamath River, California (note the reed canary grass mats).

Recommendations

Based on the importance of Spruce, Panther, and lower Hunter creeks to native anadromous salmonids of the Klamath Basin, YTFP recommends the following actions:

- Continue monitoring summer – fall populations of target species in Panther Pond and the Spruce Creek wetland to improve understanding of annual variability in these systems.

- Conduct a detailed assessment of the Panther Creek Pond outlet during the typical construction period to determine if fish passage into and out of the pond is feasible. If passage is determined to be hindered or prohibited then additional studies should be conducted to determine the feasibility of modifying the outlet conditions to ensure fish passage to and from the pond during the construction season. Providing native fish the ability to leave the area during pile driving and re-enter the pond when pile driving is complete would increase Caltrans' ability to minimize fisheries impacts.

- Continue monitoring Panther Pond bathymetry and expand the topographic surveys to include wetland habitats located to the south of Peine Road. Additionally, vegetation transects should be established and surveyed in the pond to monitor RGC colonization and increase the ability to document and track habitat conditions over time.

- Continue working to develop and implement protection and enhancement measures for existing habitats and find opportunities to create additional wetlands in the Lower Klamath.

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