# Lower Terwer Creek Off-Channel Wetland Enhancement

**Prepared by:**

**Sarah Beesley**
**Yurok Tribal Fisheries Program**
PO Box 1027 – Klamath, California 95548

and

**Rocco Fiori, Fiori GeoSciences**
PO Box 387 – Klamath, California 95548

**In Partnership with:**

**U.S. Fish & Wildlife Service**
FY 2009 Partners for Fish & Wildlife Program Funding
Agreement # 813319J192

**April 2012**

## Acknowledgements

The Yurok Tribal Fisheries Program (YTFP) would like to acknowledge the U.S. Fish and Wildlife Service for partnering with us to complete this project. The author also extends a big thanks to the Yurok Tribal employees that assisted with this project: Delmer "Seagull" Jordan, Aldaron McCovey, Steven Nova Jr., Ryan Ray, Andrew Antonetti, Scott Silloway, Gil Calleja , Monica Hiner, Dwayne Davis, AJ Webster, Justin Coldwell, Cautipeshaun Donahue, Nick Folkins, Dave Hillemeier, and Lea Hewett. YTFP would also like to thank the landowners for their support of watershed restoration in the Lower Klamath and our other project partners: National Oceanic and Atmospheric Administration, U.S. Bureau of Reclamation, the Karuk Tribe, Larry Lestelle, California Department of Fish and Game, and the U.S. Geological Society.

## **Introduction**

The Yurok People have relied upon Klamath River and coastal resources for their subsistence, cultural, and economic livelihood since time immemorial. Central to Yurok culture is the harvest of anadromous fish. Runs of anadromous fish currently returning to spawn in Lower Klamath tributaries are depressed when compared with historical numbers. Extensive timber removal and road building activities has resulted in chronic sedimentation of streams and floodplains, a significant loss of channel-stored wood and riparian conifers, and a concomitant loss of habitat diversity and production potential in the sub-basin (Payne & Associates 1989; Gale and Randolph 2000; Beesley and Fiori 2007 & 2008; Gale and Beesley 2006; Voight and Gale 1998).

In the Klamath River, all runs of chinook salmon (*Oncorhynchus tshawytscha*), green sturgeon (*Acipenser medirostris*), and Pacific lamprey (*Lampetra tridentata*) are on the decline and coho salmon (*O. kisutch*) are listed as "threatened" under the Endangered Species Act. The Yurok Tribe is dedicated to rehabilitating degraded habitats to levels that support robust, self-sustaining populations of native anadromous fish. To help address this need, the Yurok Tribe's Fisheries (YTFP) and Watershed (YTWRP) programs have been conducting fisheries and watershed assessments, and implementing instream and upslope restoration activities in the Lower Klamath River Sub-basin since the late 1990s.

Initial restoration planning efforts included developing the Lower Klamath Sub-Basin Watershed Restoration Plan that prioritized upslope restoration and identified tributary specific restoration objectives for each Lower Klamath tributary (Gale and Randolph 2000). Sub-basin restoration objectives included: 1) reducing sediment inputs from upslope sources by treating high priority watershed road segments and stream crossings; 2) restoring native, conifer-dominated riparian forests; and 3) enhancing freshwater aquatic habitats. Since 2007, YTFP has been working with Rocco Fiori of Fiori GeoSciences (FGS) to design and implement innovative stream and floodplain enhancement projects in priority Lower Klamath tributaries. Treatments have included installation of constructed and engineered wood jams (CWJs and ELJs) to facilitate formation and maintenance of productive fish habitats (e.g. spawning beds, deep pools, slow velocity rearing habitats), and enhancing off-channel habitats to increase salmonid rearing capacity (Beesley and Fiori 2009; YTFP 2010; Fiori 2010; Fiori et al. 2009, 2010, 2011a & 2011b; Hiner et al. 2012; Beesley and Fiori 2012; YTFP 2012).

Slow velocity habitats such as beaver ponds, pools associated with complex wood jams, and off-channel habitats (e.g. backwater pools, side channels) are important to both adult and juvenile salmonids. These types of habitats provide salmonids refuge from high water velocities or poor water quality occurring in the river, and offer diverse habitats for fish to rest, forage, and/or stage prior to initiating ocean entry or upriver migration. These areas are especially important to juvenile salmonids during winter - spring and directly influence fish growth just prior to ocean entry (Lestelle 2007; Hillemeier et al. 2009; Silloway 2010; Silloway and Beesley 2011; Hiner et al. 2011). Overwinter growth and survival of juvenile salmonids is very important since it is well documented that ocean survival of juvenile salmonids is positively correlated to their size at ocean entry (Scrivener and Brown 1993; Quinn and Peterson 1994). Studies conducted in Oregon indicate that ocean survival of juvenile chinook was greatly increased when fish entered the ocean at sizes greater than 120 mm fork length (Nicholas and Hankin 1989).

In 2009, YTFP and FGS partnered with the U.S. Fish and Wildlife Service (USFWS) (Partners for Fish and Wildlife, Arcata, CA) and the National Oceanic and Atmospheric Administration (NOAA) (Coastal and Marine Habitat Restoration Program - American Recovery and Reinvestment Act Funds). One of the primary objectives of this partnership was to implement priority off-channel wetland restoration in lower Terwer Creek, a coastal Lower Klamath tributary (Figure 1). Other project partners included private landowners including Green Diamond Resource Company and a small-scale rancher, the Karuk Tribe and Larry Lestelle, the U.S. Bureau of Reclamation (BOR), and the U.S. Geological Society (USGS).

## Project Objectives

Primary objectives of the off-channel wetland enhancement project included:

- Restoring habitat complexity and stream channel stability in lower Terwer Creek by installing willow siltation baffles, constructing tree planting islands, and enhancing off-channel wetlands. These actions were implemented to provide immediate and long-term benefits for adult and juvenile salmonids and other aquatic dependent wildlife. These tasks were accomplished through coordinated use of NOAA and USFWS funding.
- Evaluating project effectiveness by conducting physical and biological monitoring including topographic surveys, water quality monitoring, and assessing fish use of the recently enhanced off-channel wetlands in Terwer Creek. These tasks were accomplished through coordinated use of USFWS, NOAA, and BOR funding and with assistance from the USGS.
- Creating high quality, resource-based employment opportunities for Yurok tribal members.

## Off-Channel Habitat Enhancement

In late summer 2010, YTFP and Rocco Fiori (Fiori GeoSciences – FGS) used heavy equipment to enhance two existing off-channel habitat features in the Lower Arrow Mills project area (Figures 2-5). The off-channel habitat feature located on the west side of Terwer Creek was named Pond A, while the off-channel habitat feature constructed on the east side of the creek was named Pond B (Figures 2-5). The ponds were excavated to increase the size and depth of the features using an excavator and dozer (Figure 6). Excavated materials were loaded into 20-yard dump trucks and transported off-site to an approved disposal area (Figure 6).

Off-channel enhancement efforts of Pond A included enhancing the existing outlet channel, construction of a 700 ft side channel feature at the existing inlet, and adding large wood and vegetation (e.g. live willow) to increase habitat complexity (Figures 7-9). The volume excavated to form Pond A was approximately 1,200 cubic yards providing an inundated area of ~ 0.39 acres. The as-built design for Terwer Creek Pond A is presented as Appendix A.

A total of six planting islands (a.k.a. fish habitat structures) were constructed in Terwer Creek Pond A and five were installed in the constructed side channel using an excavator and hand crews (Figures 9-10). Planting islands consisted of a combination of large wood materials (e.g.

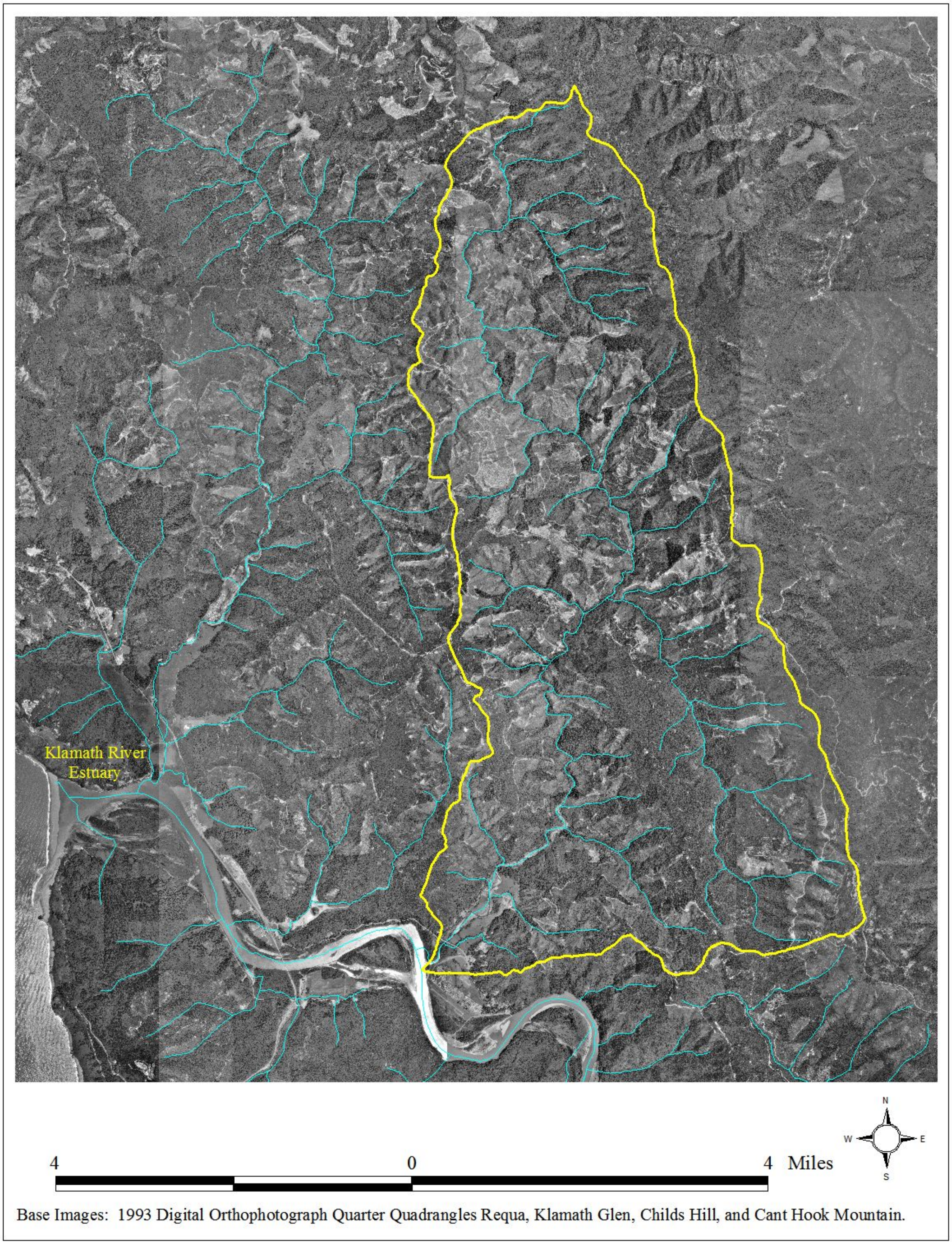



Figure 1. The Terwer Creek watershed, Lower Klamath River Sub-basin, California.


Figure 2. The Lower Arrow Mills Project Area in Terwer Creek, Lower Klamath River Sub-basin, California (Base image: 2005 NAIP Aerial Imagery).

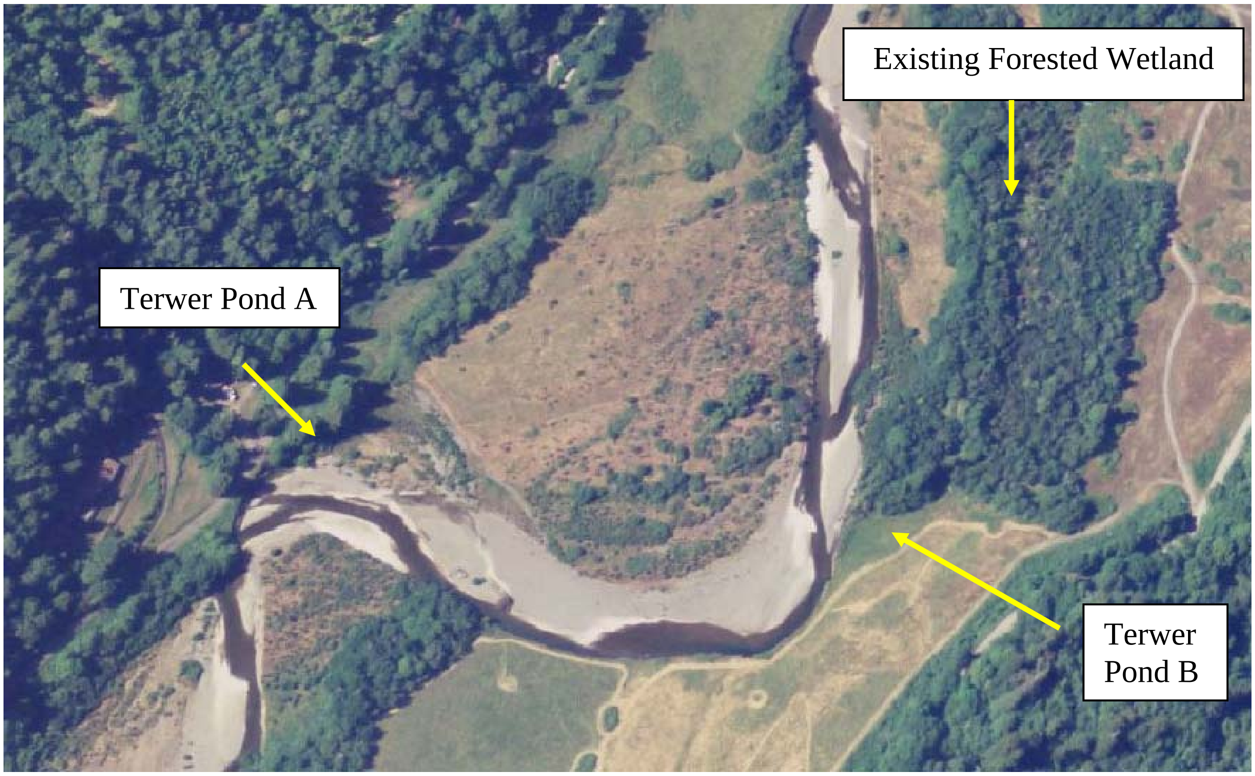



Figure 3. Aerial imagery of lower Terwer Creek depicting existing off-channel habitats prior to enhancement efforts, Lower Klamath River (Base image: 2005 NAIP Aerial Imagery).

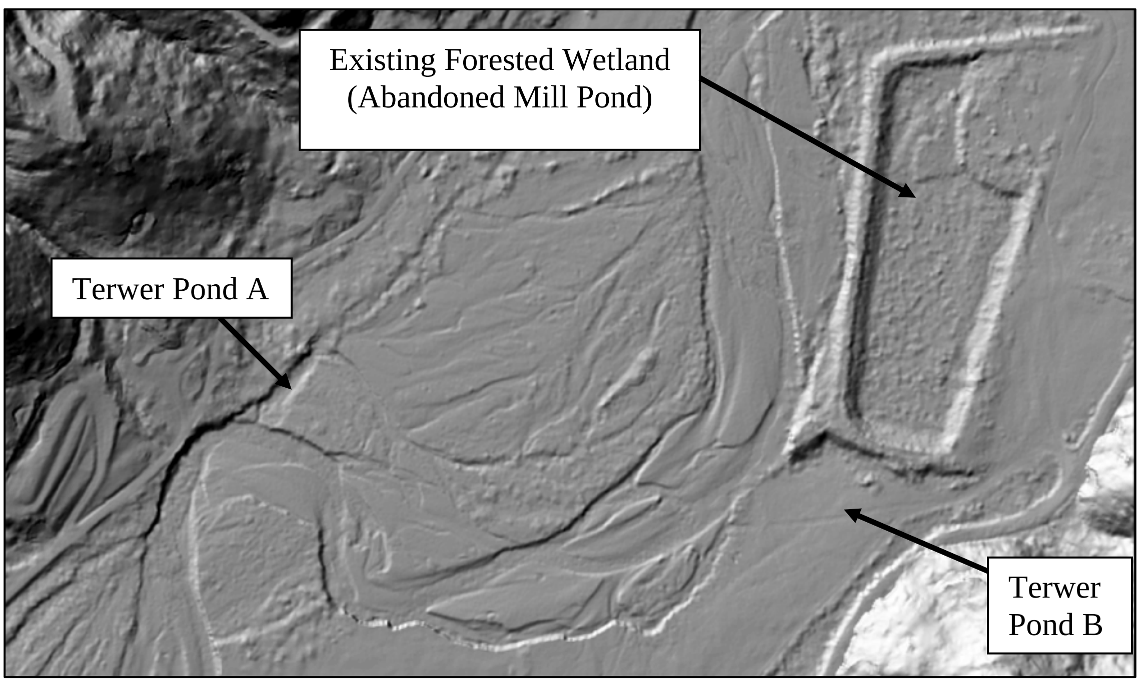



Figure 4. LiDAR imagery of lower Terwer Creek depicting existing off-channel habitats prior to enhancement efforts, Lower Klamath River (Base image: 2009 LiDAR Imagery).


Figure 5. Aerial photograph of lower Terwer Creek depicting recently enhanced off-channel wetland habitats, Lower Klamath River (Summer 2011).

Figure 6. Yurok Tribal Fisheries Program staff using heavy equipment to enhance off-channel habitats in lower Terwer Creek, Lower Klamath River (Summer 2010).


Figure 7. Photographs of Pond A constructed during 2010 in Terwer Creek, Lower Klamath River (Photo Site: TC Pond A-1; Dates: a) July 15, 2010, b) July 27, 2010, and c) 10/30/10).

Figure 8.  Photograph of the outlet channel and PIT tag antenna arrays of Terwer Creek Pond A.

Figure 9.  Photographs of the PIT tag antenna arrays and the fish habitat structures constructed in Terwer Creek Pond A (Winter 2011 – Top; Fall 2011 – Bottom).

Figure 10. Photographs of large wood and willow planting islands installed in a constructed side channel feature of lower Terwer Creek.

nurse logs and/or viable redwood rootwads), live willow, and native trees (Figures 9-10). Planting islands were configured to provide increased habitat complexity in the newly constructed habitats. In addition to planting island construction, YTFP also installed willow mattresses along the edges of the newly enhanced portion of Pond A (Figure 7).

Off-channel enhancement efforts of Pond B included construction of a ~300 ft outlet channel, enhancing the existing inlet channel, removing a relic levee to connect Pond B to an existing ~3.5 acre wetland, and adding large wood and vegetation (e.g. live willow and wetland plants) to increase habitat complexity (Figures 11-13). The volume excavated to form Pond B was approximately 5,200 cubic yards providing an inundated area of ~ 1.1 acres. The as-built design for Terwer Creek Pond B is presented as Appendix B.

## Physical Monitoring

YTFP conducted detailed topographic surveys in the Lower Arrow Mills project area to document both baseline and post-project conditions. For these surveys, YTFP and FGS established a network of permanent bench marks and numerous cross sections in the project area using a real time kinematic GPS total station, an optical total station, and various survey related computer software. All of the topographic surveys were conducted using the GPS total station or the optical total station and a Recon data recorder. Baseline topographic surveys were conducted in the Lower Arrow Mills project area during fall 2009. Surveys were repeated to document conditions following enhancement efforts (summer 2010) and following winter flows (summer 2011). Survey data was then imported into YTFP GIS and Microsoft Excel for analysis and to create the as-built designs (Appendices A-B).

In fall 2010, crews established two permanent water quality monitoring sites in Terwer Creek Pond A: Pond A_Outlet, and Pond A_Middle (Figure 14). YTFP deployed HydroLab Datasondes (datasonde) at these monitoring sites to document diurnal fluctuations in water

Figure 11. Photographs of Terwer Creek Pond B prior to enhancement efforts during summer (Top) and during winter flows (Middle and Bottom), Lower Klamath River (2009).


Figure 12. Photographs of Pond B constructed during 2010 in Terwer Creek, Lower Klamath River (Photo Site: TC Pond B-1; Dates: a) 7/15/10, b) 7/28/10, and c) 10/31/10).

Figure 13. Photographs looking upstream at the breached levee and existing wetland habitats (Top) and looking downstream through the breached levee during off-channel habitat enhancement of Terwer Creek Pond B, Lower Klamath River (summer 2010).

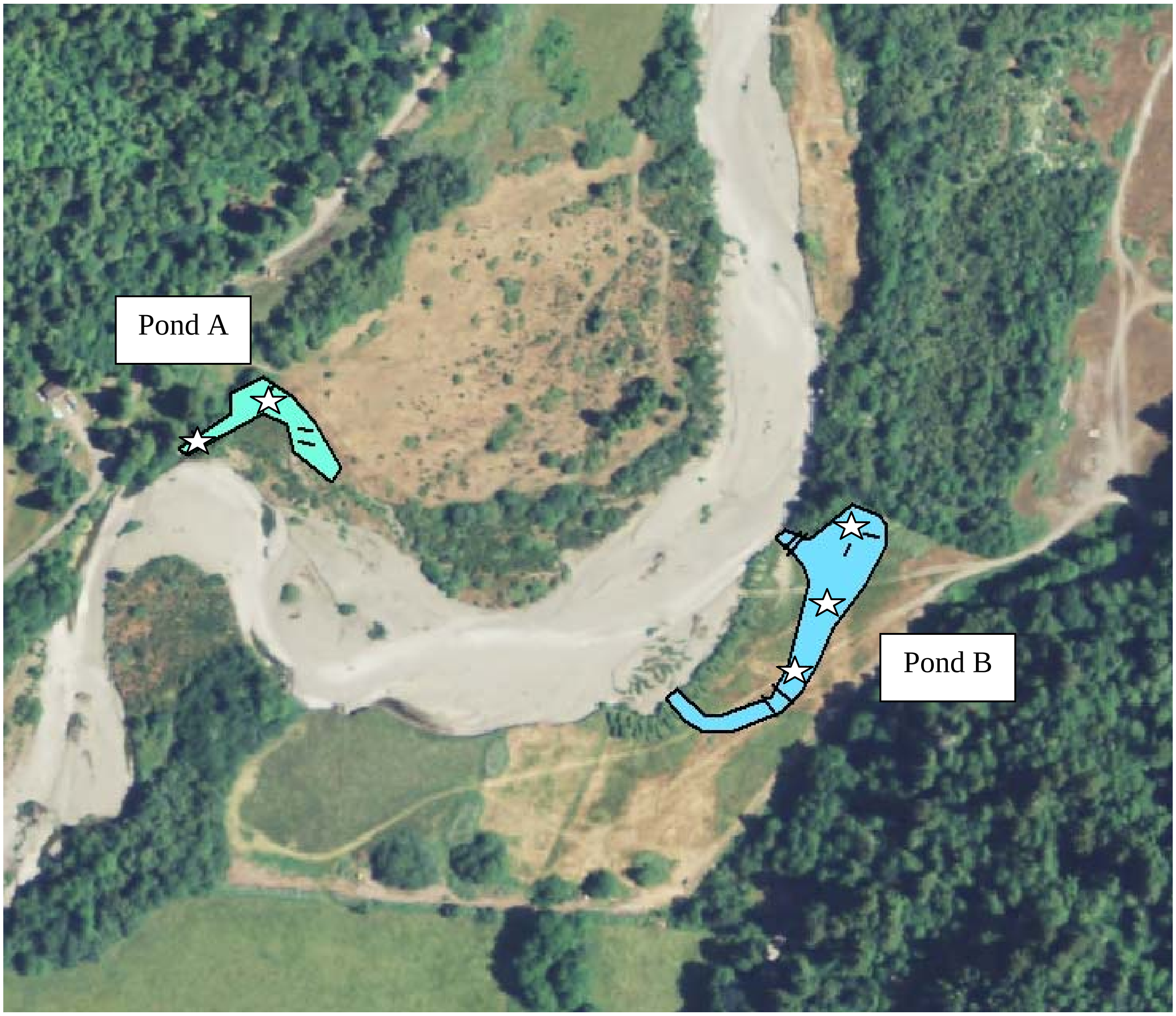
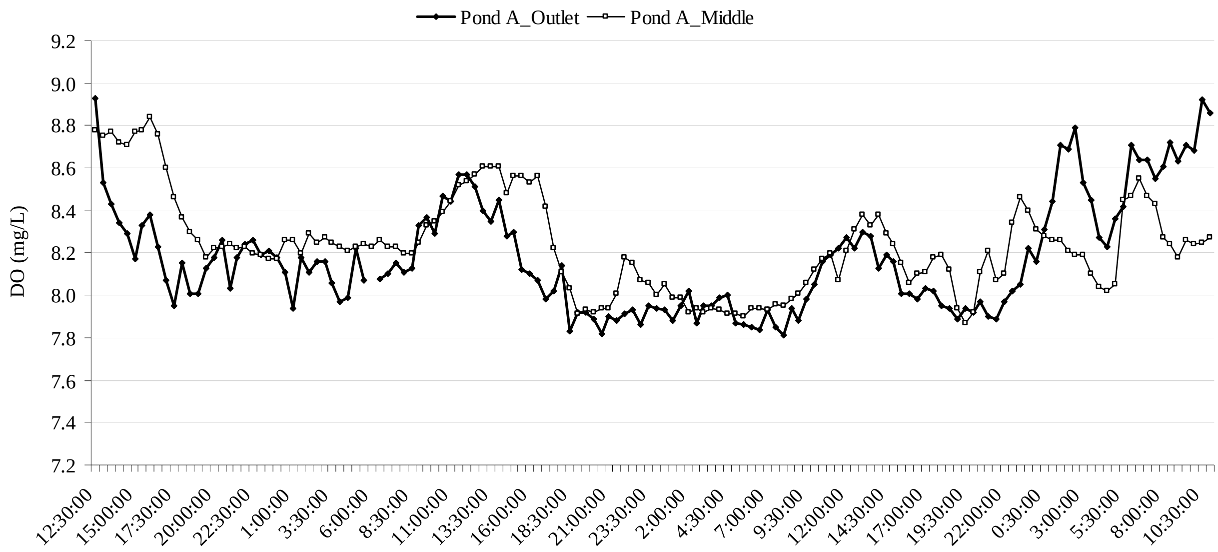



Figure 14. Map depicting water quality monitoring sites (stars) within two constructed off-channel wetlands of Terwer Creek, Lower Klamath River (Base Image: 2009 NAIP imagery).

quality parameters in the newly enhanced Pond A. 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.

Water quality was monitored at the Terwer Pond A sites during November 2010 (Figures 15-16) and during late February – early March 2011 (Figures 17-18). In fall 2010, water quality was more variable at the Terwer Pond A_Outlet site compared to conditions recorded at Pond A_Middle (Figures 15-16). Dissolved oxygen values ranged from 7.81 to 8.93 mg/L at



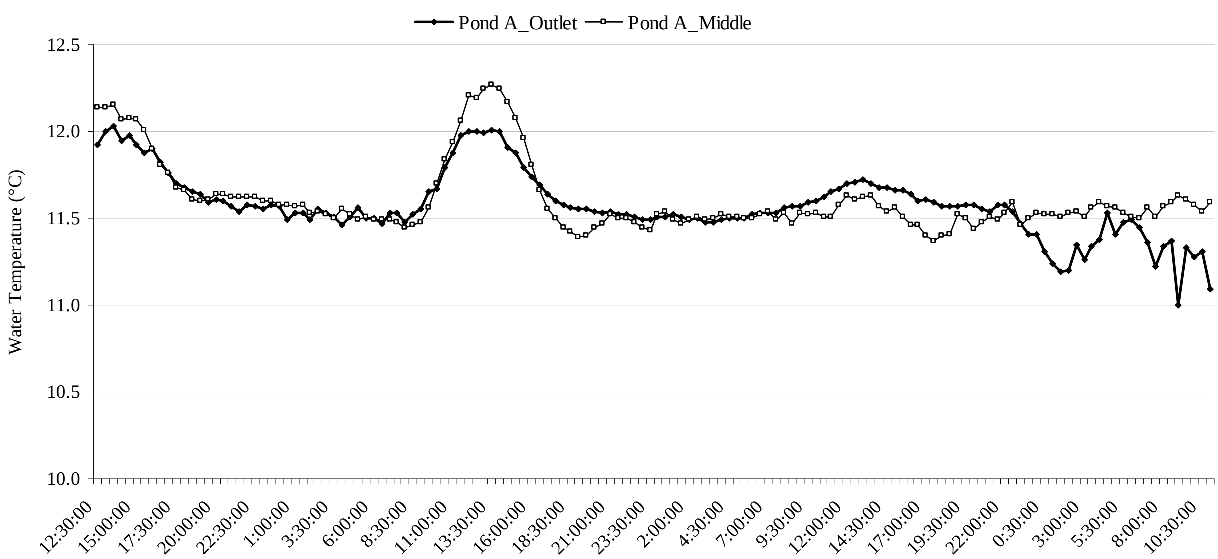
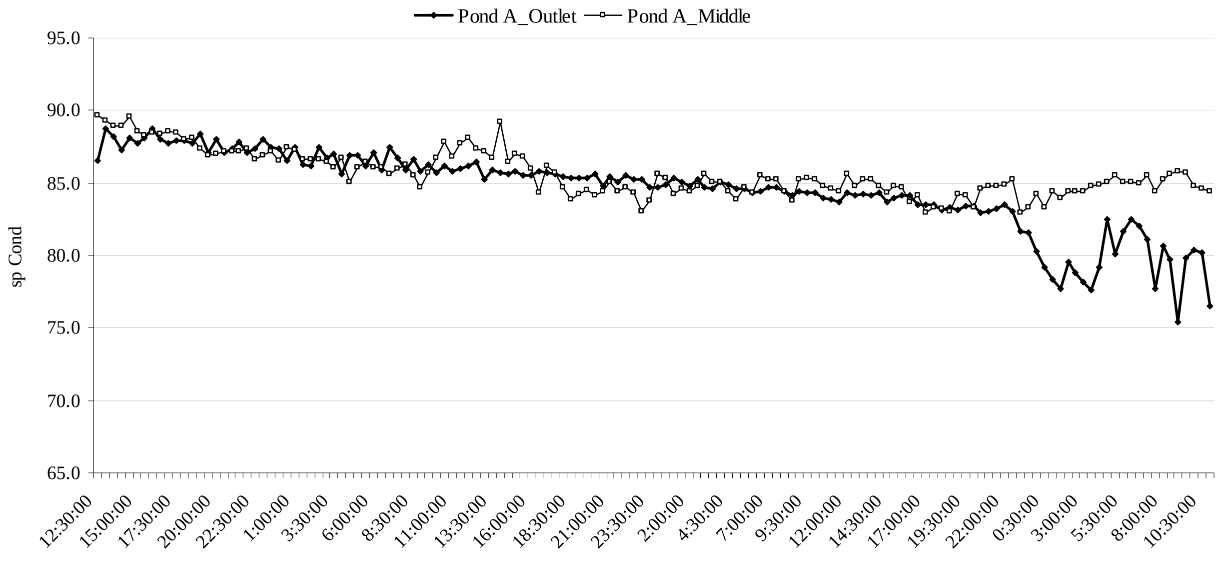




Figure 15. Water quality data (Dissolved Oxygen (DO), Water Temperature) collected from 11/24/10 (12:30 hours) to 11/27/10 (11:00 hours) at two monitoring sites located within Terwer Creek Pond A, Lower Klamath River.



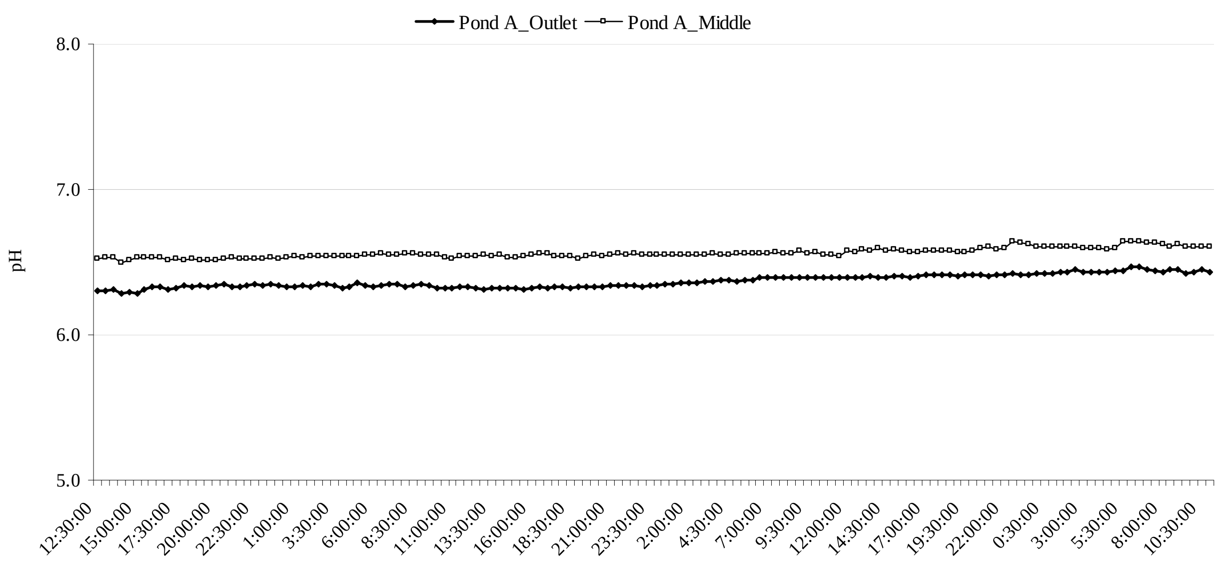
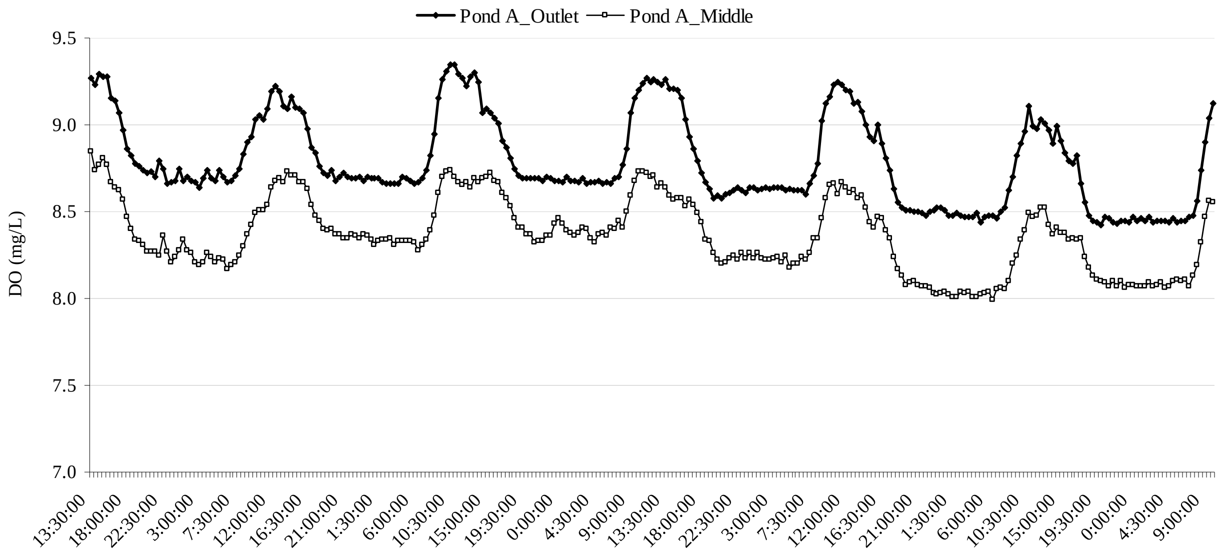




Figure 16. Water quality data (Specific Conductance (sp Cond), pH) collected from 11/24/10 (12:30 hours) to 11/27/10 (11:00 hours) at two monitoring sites located within Terwer Creek Pond A, Lower Klamath River.



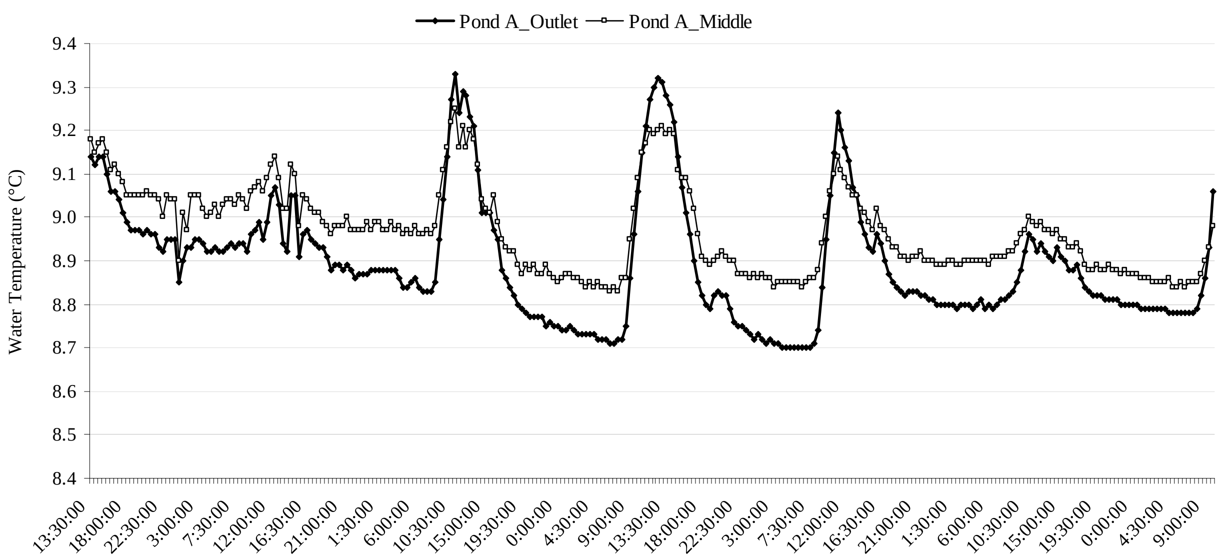
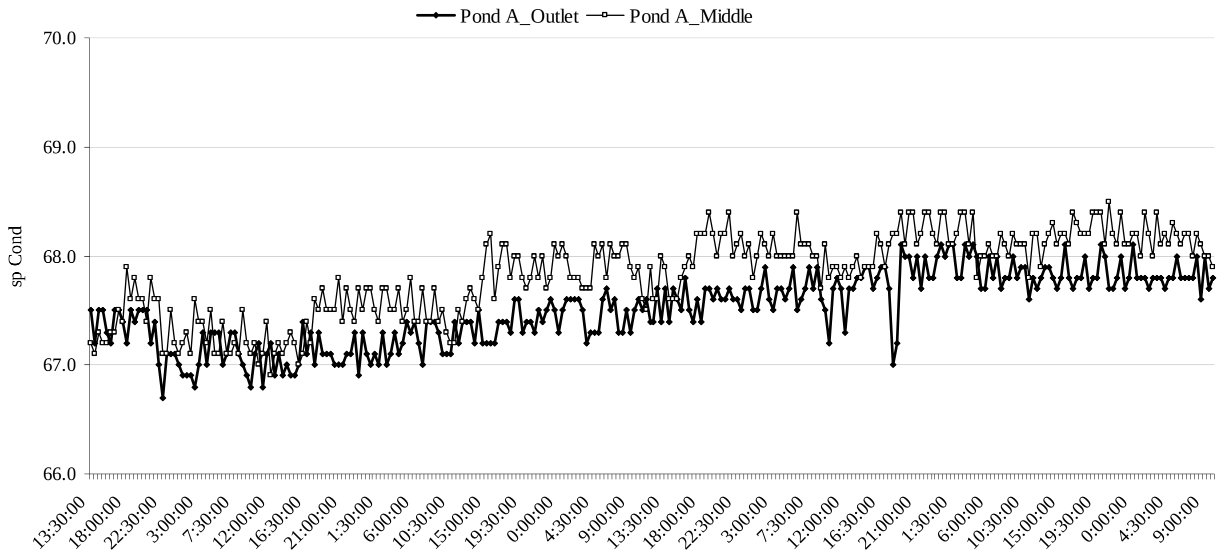




Figure 17. Water quality data (Dissolved Oxygen (DO), Water Temperature) collected from 02/23/11 (13:30 hours) to 03/01/11 (10:00 hours) at two monitoring sites located within Terwer Creek Pond A, Lower Klamath River.



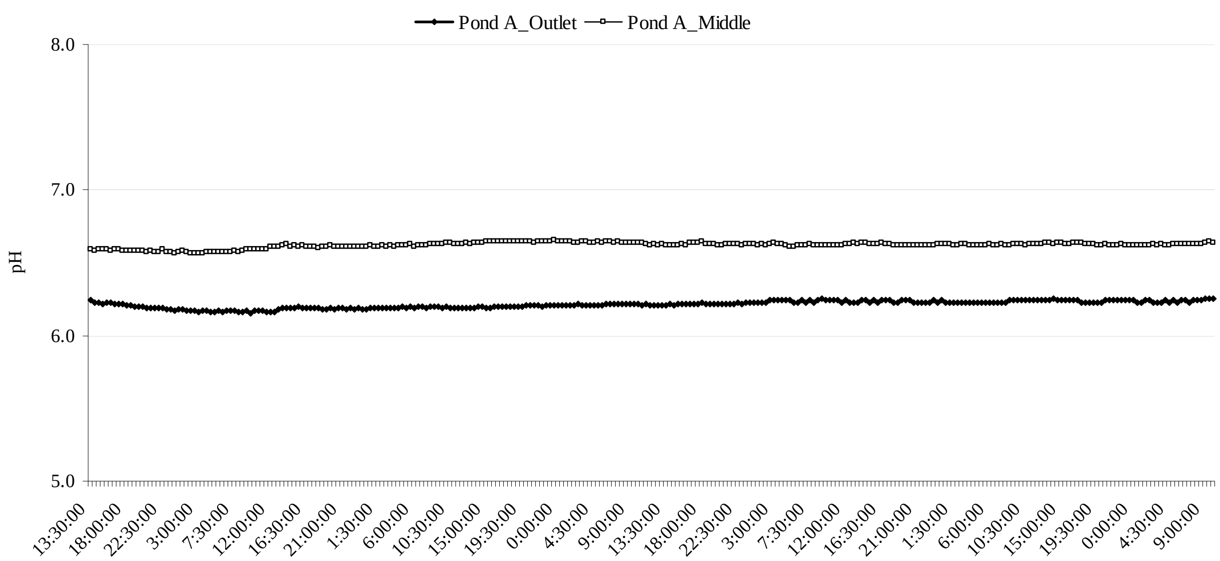




Figure 18. Water quality data (Specific Conductance (sp Cond), pH) collected from 02/23/11 (13:30 hours) to 03/01/11 (10:00 hours) at two monitoring sites located within Terwer Creek Pond A, Lower Klamath River.

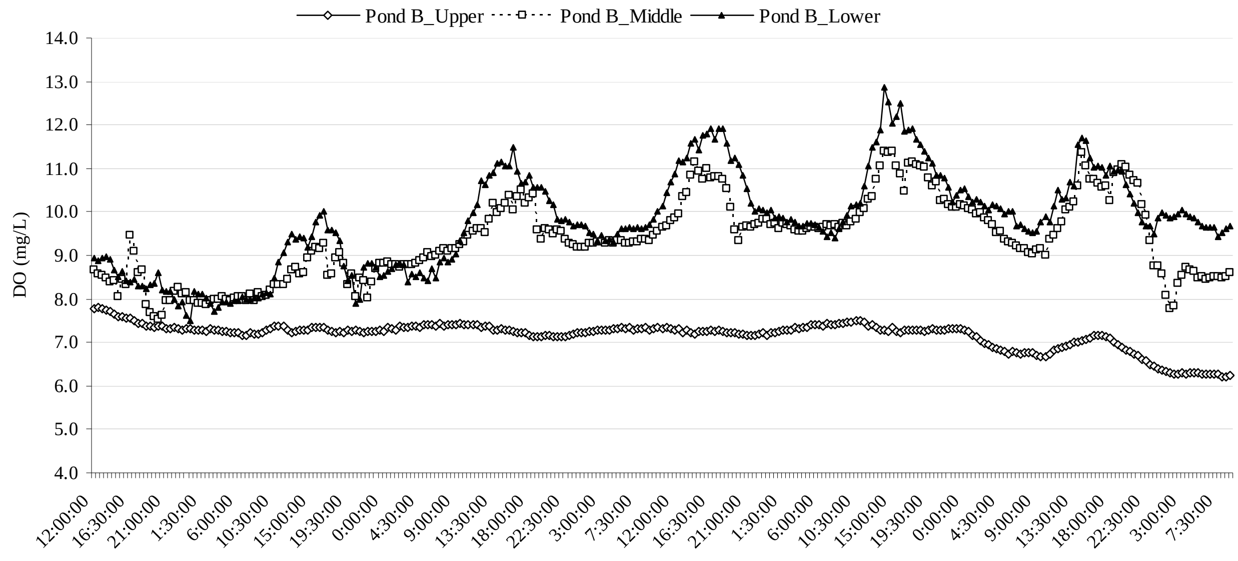
Pond A_Outlet and ranged from 7.87 to 8.84 mg/L at the Pond A_Middle site (Figure 15). Water temperature during the fall monitoring period ranged from 11.0 to 12.3 °C at the two monitoring sites (Figure 15). Specific conductance values recorded during November were similar for the two sites for most of the sampling period (Figure 16). Specific conductance values ranged from 75.4 to 88.7 µS/cm at Pond A_Outlet and ranged from 82.9 to 89.7 µS/cm at the Pond A_Middle site (Figure 16). Recorded values for pH ranged from 6.28 to 6.64 during November for the two sites (Figure 16).

Water quality patterns were similar for the two sites during the winter 2011 monitoring period; however, dissolved oxygen values recorded at Pond A_Outlet were on average 0.43 mg/L higher than values recorded at Pond A_Middle (Figure 17). Dissolved oxygen values ranged from 8.42 to 9.35 mg/L at Pond A_Outlet and from 7.99 to 8.85 mg/L at Pond A_Middle (Figure 17). Water temperature during the winter monitoring period ranged from 8.7 to 9.3 °C at Pond A_Outlet and from 8.8 to 9.3 °C (Figure 17). Water temperatures were slightly higher (Average of 0.07 °C higher) at Pond A_Middle relative to temperatures recorded at Pond A_Outlet (Figure 17). During this monitoring period, specific conductance values ranged from 66.7 to 68.1 µS/cm at Pond A_Outlet and from 66.9 to 68.5 µS/cm at the Pond A_Middle site (Figure 18). Recorded values for pH ranged from 6.17 to 6.66 during winter for the two sites (Figure 18).

Crews established three permanent water quality monitoring sites in Terwer Creek Pond B: Pond B_Upper, Pond B_Middle, and Pond B_Lower (Figure 14). These three sites were monitored during January 2011 to document diurnal fluctuations in water quality parameters (Figures 19-20). Dissolved oxygen values were the least variable at Pond B_Upper with a range from 6.21 to 7.79 mg/L (Figure 19). Dissolved oxygen values recorded at the Pond B_Middle and Pond B_Lower sites were higher and more variable relative to values recorded at Pond B_Upper (Figure 19). Dissolved oxygen values ranged from 7.62 to 11.39 mg/L at Pond B_Middle and ranged from 7.49 to 12.86 mg/L at Pond B_Lower (Figure 19). Water temperature during the January monitoring period ranged from 7.5 to 12.1 °C at the three monitoring sites (Figure 19).

Specific conductance values recorded during this monitoring period were the lowest at the Pond B_Upper site with values ranging from 73.6 to 75.7 µS/cm (Figure 20). Specific conductance values recorded at Pond B_Middle and Pond B_Lower were more variable compared to values recorded at Pond B_Upper (Figure 20). At these sites, specific conductance values ranged from 76.3 to 82.6 µS/cm (Figure 20). Recorded values for pH ranged from 6.39 to 7.30 at the three sites during the January monitoring period (Figure 20). During this monitoring period, pH was lowest at Pond B_Upper and highest at the Pond B_Lower site (Figure 20).

Water quality was also monitored in Terwer Creek Pond B during early March 2011. Unfortunately only two datasondes were available so only Pond B_Middle and Pond B_Lower were monitored during this period. Water quality conditions were very similar for these two sites during the March monitoring period (Figures 21-22). Dissolved oxygen values ranged from 7.74 to 11.90 mg/L and water temperatures were from 7.4 to 13.0 °C at these two sites during this monitoring period (Figure 21). Specific conductance ranged from 52.9 to 73.4 µS/cm and pH values ranged from 6.42 to 7.68 at these two sites (Figure 22).



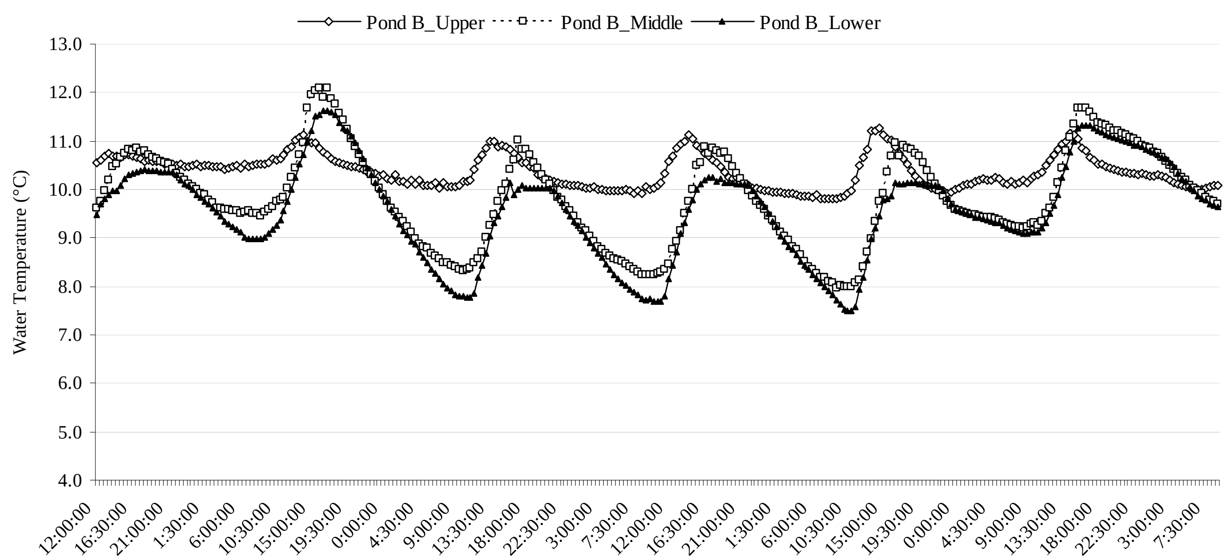
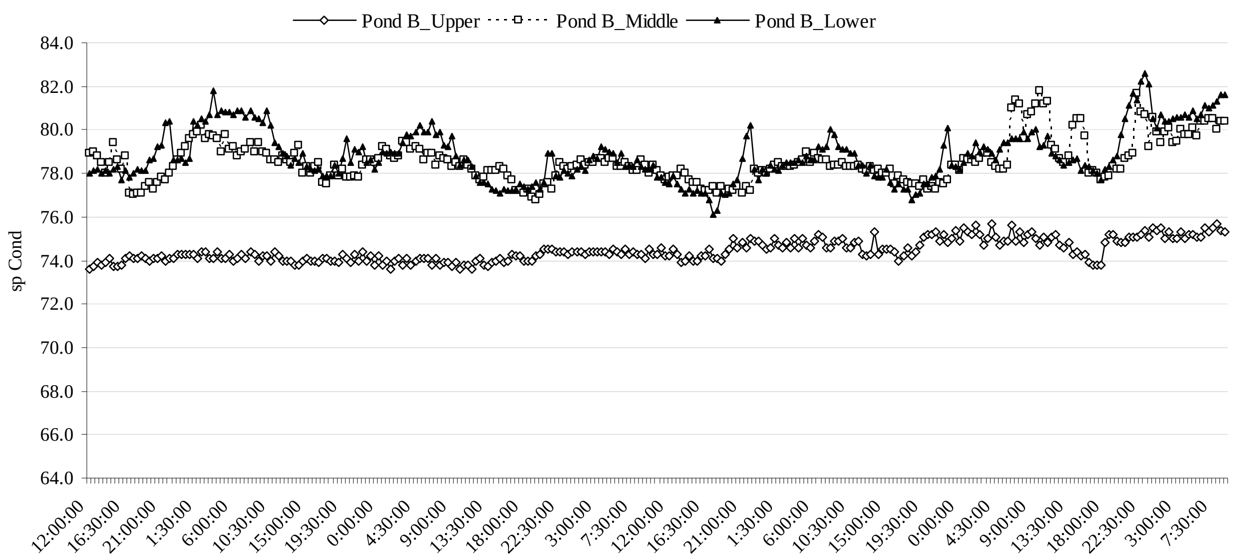




Figure 19. Water quality data (Dissolved Oxygen (DO), Water Temperature) collected from 01/23/11 (12:00 hours) to 01/29/11 (09:00 hours) at three monitoring sites located within Terwer Creek Pond B, Lower Klamath River.



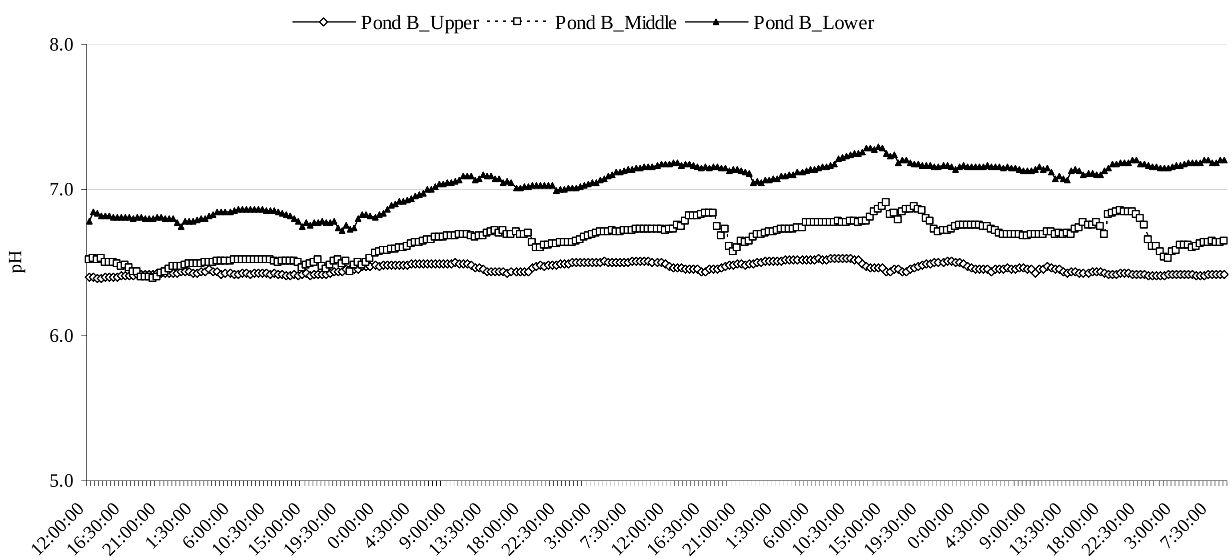
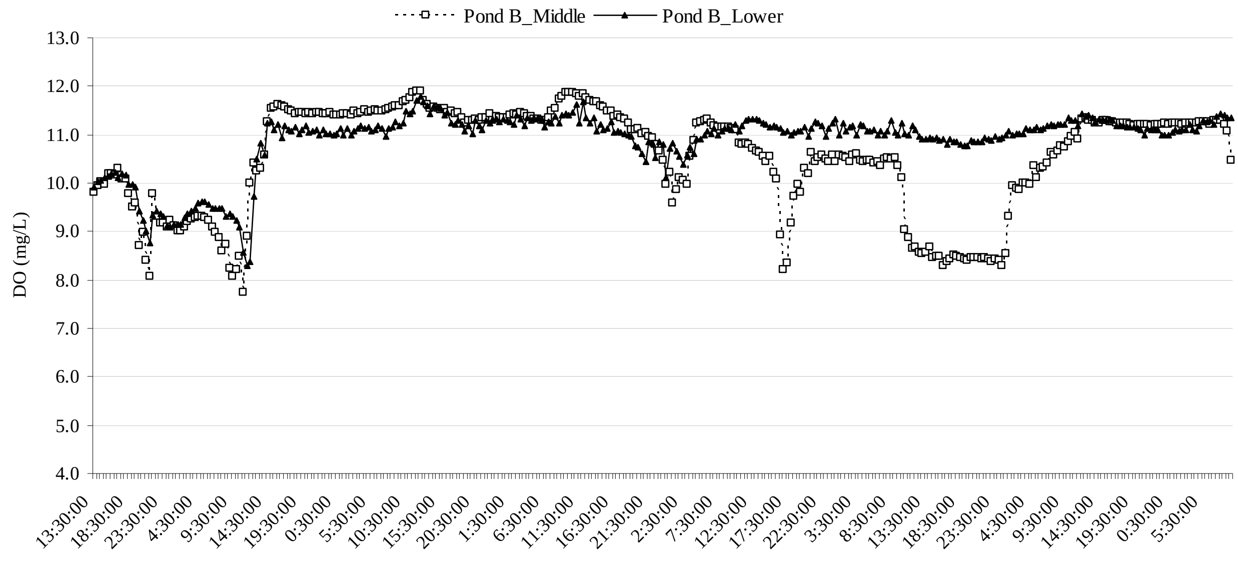




Figure 20. Water quality data (Specific Conductance (sp Cond), pH) collected from 01/23/11 (12:00 hours) to 01/29/11 (09:00 hours) at three monitoring sites located within Terwer Creek Pond B, Lower Klamath River.



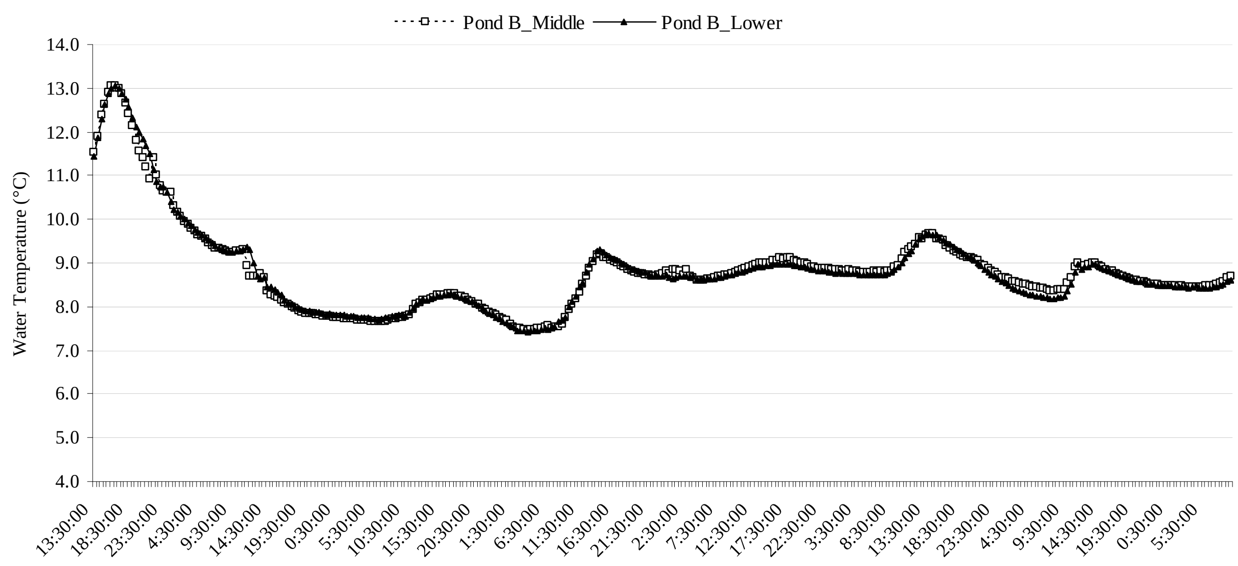
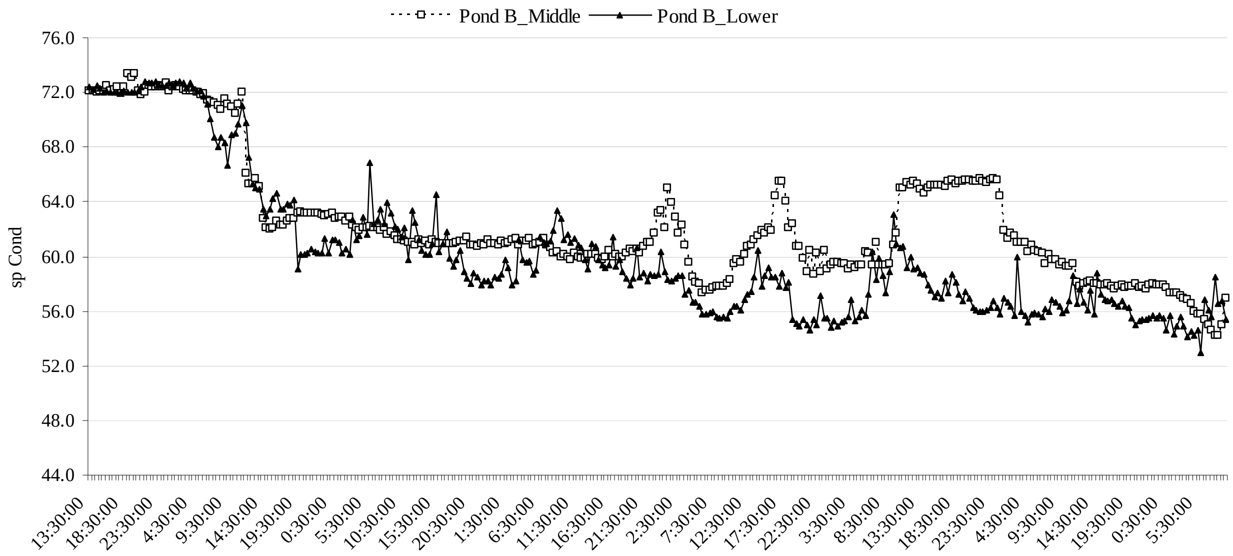




Figure 21. Water quality data (Dissolved Oxygen (DO), Water Temperature) collected from 03/01/11 (13:30 hours) to 03/08/11 (09:30 hours) at two monitoring sites located within Terwer Creek Pond B, Lower Klamath River.



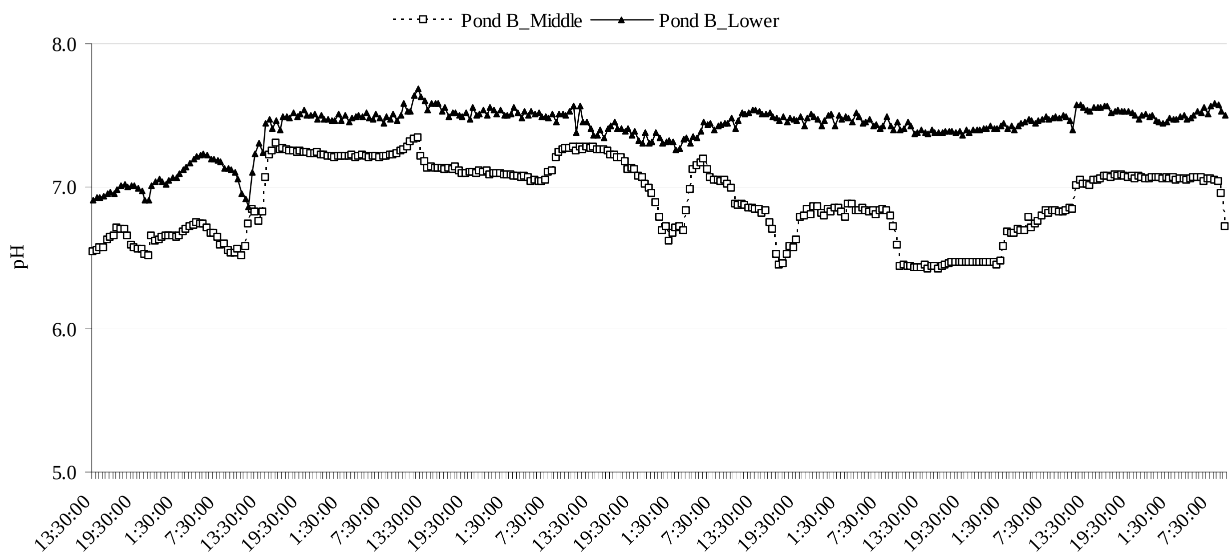




Figure 22. Water quality data (Specific Conductance (sp Cond), pH) collected from 03/01/11 (13:30 hours) to 03/08/11 (09:30 hours) at two monitoring sites located within Terwer Creek Pond B, Lower Klamath River.

YTFP also established six permanent photographic monitoring sites in the project area using a hand-held GPS receiver (sub-meter accuracy) (Table 1; Figures 7, 12, 23-25). These sites will allow YTFP to document short- and long-term habitat changes in the project area and are part of a larger network of permanent photo-points that exists in the Terwer Creek valley.

## Quantified Treatments

1. Overall stream length affected: 2,200 feet
2. Stream length planted or protected: 2,200 feet
3. Riparian zone to be planted or protected (length x width): 2,200 feet x 50-150 feet
4. Total fencing: N/A
5. Trees planted (number, by species): 34 Coastal Redwood, 64 Douglas Fir, 92 Sitka Spruce, 22 Western Red Cedar, 21 Port Orford Cedar, 148 Cottonwood, 6 Big Leaf Maple, and 61 Red Alder
6. Non-native vegetation removed (length x width): N/A
7. Stream bank restoration sites (number, length of stream, and technique): N/A
8. Instream habitat structures installed (number, type): ~15 willow and large wood structures
9. Road stream crossings removed/upgraded (number, type of treatment): N/A
10. Number fish barriers removed: N/A
    a. Length of upstream habitat made accessible: N/A
11. Quantity of off-channel pond/wetland habitat enhanced or created: 1.5 acres

Table 1. Photographic monitoring site information for the Lower Terwer Creek Off-Channel Wetland Enhancement Project, Lower Klamath River (2010-2012).

| File Name | Date | Site Name | Description | Lattitude | Longitude | Orientation |
|---|---|---|---|---|---|---|
| TC Pond A-1_071510 | 7/15/2010 | TC Pond A-1 | Pre-Project | 41.5265 | -123.9900 | West-Towards Road |
| TC Pond A-1_072710 | 7/27/2010 | TC Pond A-1 | During Project | 41.5265 | -123.9900 | West-Towards Road |
| TC Pond A-1_103010 | 10/30/2010 | TC Pond A-1 | As-Built | 41.5265 | -123.9900 | West-Towards Road |
| TC Pond A-Outlet_061710 | 6/17/2010 | TC Pond A-Outlet | Pre-Project | 41.5261 | -123.99122 | North East - Up Valley |
| TC Pond A-Outlet_030812 | 3/8/2012 | TC Pond A-Outlet | Post-Project | 41.5261 | -123.99122 | North East - Up Valley |
| TC Pond A-Outlet_042412 | 4/24/2012 | TC Pond A-Outlet | Post-Project | 41.5261 | -123.99122 | North East - Up Valley |
| TC Pond A-2_052511 | 5/25/2011 | TC Pond A-2 | Post-Project | 41.5266 | -123.9906 | North East - Upstream |
| TC Pond A-2_042412 | 4/24/2012 | TC Pond A-2 | Post-Project | 41.5266 | -123.9906 | North East - Upstream |
| TC Pond A-3_052511 | 5/25/2011 | TC Pond A-3 | Post-Project | 41.5267 | -123.9905 | North East - Upstream |
| TC Pond A-3_042412 | 4/24/2012 | TC Pond A-3 | Post-Project | 41.5267 | -123.9905 | North East - Upstream |
| TC Pond A-4_052511 | 5/25/2011 | TC Pond A-4 | Post-Project | 41.526472 | -123.99011 | North West - Towards Pond |
| TC Pond A-4_101411 | 10/14/2011 | TC Pond A-4 | Post-Project | 41.526472 | -123.99011 | North West - Towards Pond |
| TC Pond A-4_042412 | 4/24/2012 | TC Pond A-4 | Post-Project | 41.526472 | -123.99011 | North West - Towards Pond |
| TC Pond B-1_071510 | 7/15/2010 | TC Pond B-1 | Pre-Project | 41.5262 | -123.9859 | South, Towards Pond B |
| TC Pond B-1_072810 | 7/28/2010 | TC Pond B-1 | During Project | 41.5262 | -123.9859 | South, Towards Pond B |
| TC Pond B-1_103110 | 10/31/2010 | TC Pond B-1 | As-Built | 41.5262 | -123.9859 | South, Towards Pond B |
| TC Pond B-1_032912 | 3/29/2012 | TC Pond B-1 | Post-Project | 41.5262 | -123.9859 | South, Towards Pond B |
| TC Pond B-1_033012 | 3/30/2012 | TC Pond B-1 | Post-Project | 41.5262 | -123.9859 | South, Towards Pond B |

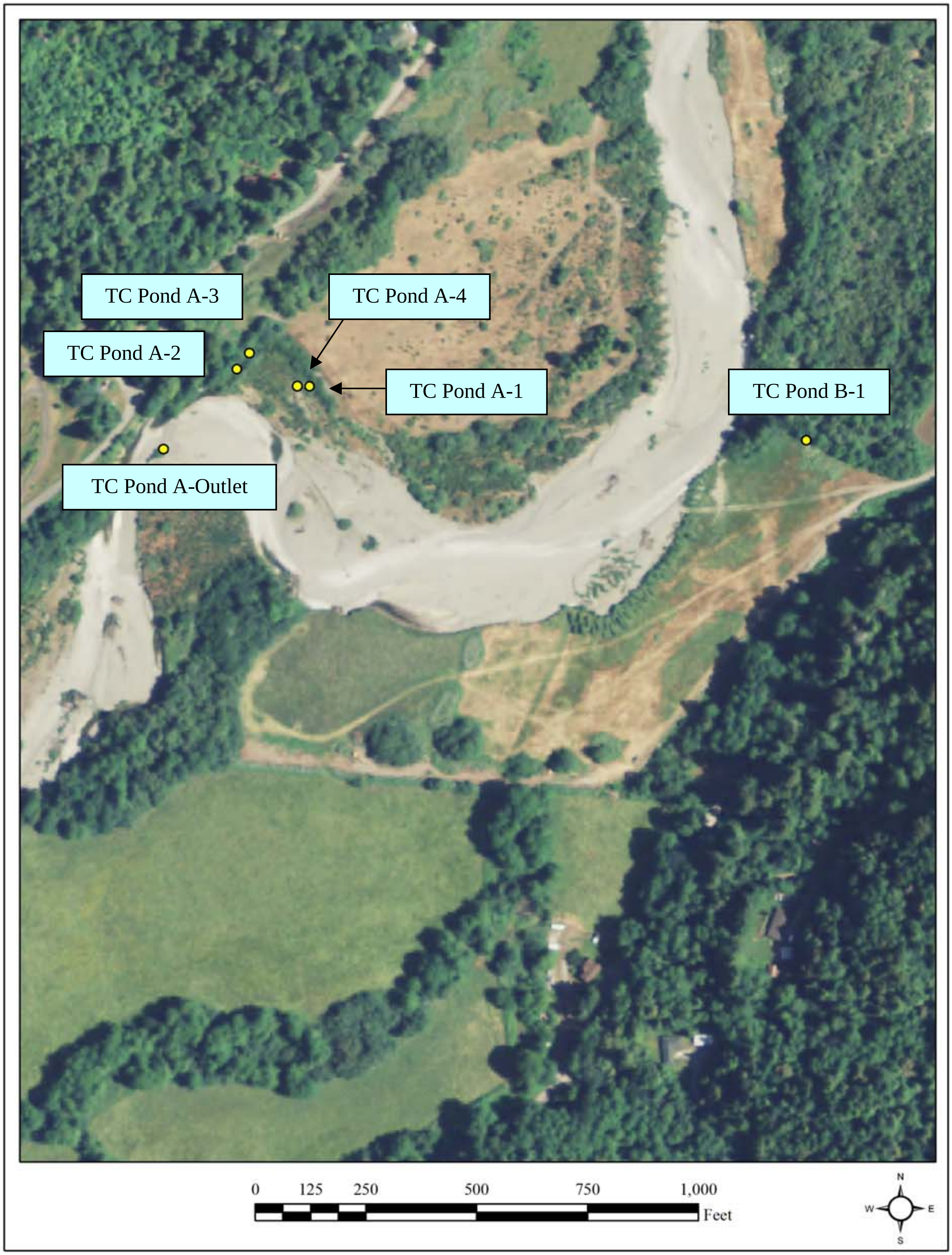



Figure 23. Map depicting permanent photo-monitoring sites established in the 2010 - 2012 Terwer Creek bioengineering project reach, Lower Klamath River.

Figure 24.  Photographs taken from a permanent photo-monitoring site in Terwer Creek, Lower Klamath River (Site: TC Pond A-3:  Top-May 2011, Bottom-April 2012).

Figure 24.  Photographs taken from a permanent photo-monitoring site in Terwer Creek, Lower Klamath River (Site: TC Pond A-2:  Top-May 2011, Bottom-April 2012).

Figure 25. Photographs taken from a permanent photo-monitoring site in Terwer Creek, Lower Klamath River (Site: TC Pond A-Outlet: Top 6/17/10, Middle 5/25/11, Bottom 4/24/12).

**References Cited**

Beesley, S. and R.A. Fiori. 2007. Lower Klamath River Tributary Delta and Subsurface Flow Study, Lower Klamath River Sub-basin, California. Yurok Tribal Fisheries Program, Klamath, California.

Beesley, S. and R.A. Fiori. 2008. Cooperative Restoration of Tribal Trust Fish and Wildlife Habitat in Lower Klamath River Tributaries. Yurok Tribal Fisheries Program, Klamath, California.

Beesley, S. and R.A. Fiori. 2012. Lower Terwer Creek Riparian Revegetation Project. Yurok Tribal Fisheries Program, Klamath, California.

Fiori, R.A., J. Benegar, S. Beesley, T.B. Dunklin, C. Moore, D. Gale and S. Nova. 2009. Preliminary Evaluation of Experimental Wood Loading Performance Following a Five Year Flood Event. American Fisheries Society Cal/Neva Conference. April 2nd, 2009. Santa Rosa, California.

Fiori, R.A., S. Beesley, D. Weskamp, D. Hillemeier, J. Beneger, S. Nova, and T.B. Dunklin. 2010. Valley and Stream Habitat Restoration in the Lower Klamath Sub-Basin. Klamath Basin Science Conference. February 4th, 2010. Medford, Oregon.

Fiori, R.A. 2010. Mega Wood Loading Projects for Coho Recovery: How Do We Get There? Examples from North Coastal California. Salmonid Restoration Federation and American Fisheries Society Cal/Neva Joint Conference. March 13th, 2010. Redding, California.

Fiori, R.A., M. Hiner, S. Beesley, S. Silloway, S. Nova, and R. Grubbs. 2011a. Preliminary Evaluation of Off-Channel Habitats Constructed in Tributaries of the Lower Klamath River. Salmonid Restoration Federation Conference. March 23-26, 2011. San Luis Obispo, California.

Fiori, R.A., M. Hiner, S. Beesley, S. Silloway, A. Antonetti, R. Grubbs, W. Harling, C. Wickman. 2011b. Why Up and Down Matters in the Design of Off-Channel Habitats. Salmonid Restoration Federation Conference. March 23-26, 2011. San Luis Obispo, California.

Gale, D.B. and S. Beesley. 2006. Lower Terwer Creek Riparian Restoration Project (Phase I). Yurok Tribal Fisheries Program, Klamath, California.

Gale, D.B. and D.B. Randolph. 2000. Lower Klamath River Sub-basin Watershed Restoration Plan. Yurok Tribal Fisheries Program, Klamath, California.

Hillemeier, D., T. Soto, S. Silloway, A. Corum, M. Kleeman, and L. Lestelle. 2009. The Role of the Klamath River Mainstem Corridor in the Life History and Performance of Juvenile Coho Salmon (*Oncorhynchus kisutch*) - Year 2 Report May 2007 – May 2008. Report to the U.S. Bureau of Reclamation, Klamath Area Office, Klamath Falls, Oregon.

Lestelle, L. 2007. Coho Salmon (*Oncorhynchus Kisutch*) Life History Patterns in the Pacific Northwest and California. Prepared for the U.S. Bureau of Reclamation, Klamath Area Office, Klamath Falls, Oregon.

Nicholas, J.W. and D.G. Hankin. 1989. Chinook Salmon Populations in Oregon Coastal River Basins: Descriptions of Life Histories and Assessment of Recent Trends in Run Strengths. Oregon Department of Fish and Wildlife. No. EM 8402, March 1989. Oregon State University Extension Service, Corvallis, Oregon.

Payne and Associates. 1989. Lower Klamath River Tributary Delta Study. Thomas R. Payne and Associates. Arcata, California. Report to the Bureau of Indian Affairs, Redding, California.

Quinn, T.P., and N.P. Peterson. 1994. The Effects of Forest Practice on Fish Populations. Timber-Fish-Wildlife Report F4-94-001 to Washington Department of Natural Resources. 157 p.

Scrivener, J.C., and T.G. Brown. 1993. Impact and Complexity from Forest Practices on Streams and their Salmonid Fishes in British Columbia. Pages 41-49 *in* G. Shooner et S. Asselin [ed.] Le developpement du Saumon atlantique au Quebec: connaitre les regles due jeu pour reussir. Colloque international de la Federation quebecoise pour le saumon atlantique. Quebec, decembre 1992. Collection *Salmo salar* no 1:201p.

Silloway, S. 2010. Fish Surveys Related to the Proposed Del Norte Highway 101 Klamath Grade Raise Project. Yurok Tribal Fisheries Program, Klamath, California.

Silloway, S. and S. Beesley. 2011. Fish Surveys Related to the Proposed Del Norte Highway 101 Klamath Grade Raise Project: Addendum Report 2010-2011. Yurok Tribal Fisheries Program, Klamath, California.

Voight, H.N. and D.B. Gale. 1998. Distribution of fish species in tributaries of the Lower Klamath River: an interim report, FY 1996. Yurok Tribal Fisheries Program, Klamath, California.

Yurok Tribal Fisheries Program. 2010. Lower Terwer Creek Streambank and Riparian Restoration - U.S. Fish and Wildlife Service – Tribal Landowner Incentive Program Project. Yurok Tribal Fisheries Program, Klamath, California.

Yurok Tribal Fisheries Program. 2012. Juvenile Coho Salmon use of Constructed Off-channel Habitats in Two Lower Klamath River Tributaries: McGarvey Creek & Terwer Creek. Yurok Tribal Fisheries Program, Klamath, California.