Stream and Riparian Habitat Enhancement of Waukell Creek: Phase I

Prepared by:

Sarah Beesley
Yurok Tribal Fisheries Program
P.O. Box 1027
Klamath, CA 95548

Rocco Fiori
Fiori GeoSciences
PO Box 387
Klamath, CA 95548

Funded by:

U.S. Fish & Wildlife Service
FY 2007 Partners for Fish & Wildlife Program Funding
Grant Agreement # 813317J221

U.S. Environmental Protection Agency
FY 2008 West Coast Estuaries Initiative
Grant Agreement # WS – 96947701 - 0

U.S. Bureau of Indian Affairs
FY 2006 Watershed Restoration Program Funding

September 2010

Introduction

The Klamath River estuary and its associated habitats are of great cultural and economic value to the Yurok People. The Klamath River estuary is comprised of mainstem, slough, and wetland habitats as well as off-estuary tributary stream and wetland habitats (Figure 1). These areas provide vital nursery and staging habitat for spring and fall-run chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), steelhead trout (*O. mykiss*), coastal cutthroat trout (*O. clarki clarki*), sturgeon (*Acipenser spp.*), eulachon (*Thaleichthys pacificus*), flounder (*Platichthys spp.*), and lamprey (*Lampetra spp.*). It is likely that tens of millions of juvenile salmonids migrate through the Klamath River estuary every year on their way to the ocean.

Anthropogenic changes over the past century have drastically degraded aquatic and riparian habitats in the Lower Klamath Sub-basin and estuary (Gale and Randolph 2000; Beesley and Fiori 2004, 2007, and 2008; Hiner and Brown 2004); and resulted in substantial declines to anadromous fish runs. Man-made dams and water diversions in the upper basin and in several major tributaries have reduced Klamath River flows, severely altered its natural hydrograph, and greatly impacted the productivity of the Klamath River estuary.

Lower Klamath tributaries, especially those draining to the estuary, provide critically important rearing and staging habitat for both natal and non-natal salmonids (Beesley and Fiori 2004 and 2007b; Hiner and Brown 2004; Wallace 2007; Soto et al. 2008; YTFP 2009; Hillemeier et al. 2009; Silloway 2010). Off-estuary and coastal tributaries provide salmonids refuge from high water velocities or poor water quality occurring in the mainstem; and offer diverse habitats for fish to forage or stage prior to initiating ocean entry or upriver migration. These areas are especially important to non-natal juvenile coho during winter - spring and directly influence fish growth just prior to ocean entry (Lestelle 2007; Soto et al. 2008; YTFP 2009; Hillemeier et al. 2009; Silloway 2010). Studies conducted in the Pacific Northwest suggest ocean survival of juvenile salmon is greatly increased when fish enter the ocean at larger sizes (120-160 mm).

Since 2000, Yurok Tribal Fisheries Program (YTFP) has been conducting fisheries, water quality, and hydrologic and geomorphic assessments in the Klamath River estuary and several off-estuary tributaries to characterize historic and existing conditions; identify factors currently limiting salmonid production; and develop strategies to improve conditions for Tribal Trust fish and wildlife (Beesley and Fiori 2004 and 2008; Hiner and Brown 2004; Hiner 2006 and 2008). Objectives include using real time monitoring of fish use patterns, assessment of geomorphic and hydrologic conditions, peer-reviewed research, and previous experience to develop long-term geomorphic and water management related solutions to identified limiting factors; increasing salmonid rearing and staging capacity by enhancing existing habitats and creating new, complex habitats; and improving hydrologic function in the Klamath River. To help accomplish these goals, YTFP has been working with our consultant, Rocco Fiori (Fiori GeoSciences (FGS)), a California Licensed Geologist experienced in coastal watershed assessment and rehabilitation.

Waukell Creek enters the Klamath River estuary approximately 3.5 river miles (RM) upstream of the Pacific Ocean (Figure 2). Past management activities (i.e. modifications such as channel straightening, floodplain simplification, and wood removal), including relocation of U.S. Highway 101 through the watershed in the 1960s, have greatly altered hydrogeologic and

Figure 1. Map of the Klamath River estuary and several priority off-estuary tributaries.

Figure 2. The Waukell Creek watershed, Lower Klamath River Sub-basin, California.

geomorphic conditions in this system. The highway was built on ~1.6 miles of lower Waukell (Figures 2-4). The stream was routed to the east side of the valley and a steep concrete grade control ramp was installed to accommodate the significant increase in gradient resulting from channel realignment and loss of floodplain (Figures 2, 4-5). The highway grade control structure and culvert located upstream have prohibited fish access to the upper watershed since the 1960s.

Although the Waukell Creek watershed is greatly impaired, lower Waukell and its tributaries (Saugep Creek, Junior Creek) (Figures 1-2) provide critically valuable overwinter rearing habitat to a significant number of juvenile coho (Soto et al. 2008; Hillemeier et al. 2009). Salmonid spawning habitat is limited in the lower watershed and mark-recapture studies indicate that a majority of the juvenile coho using this area are not natal to the system (Soto et al. 2008; Hillemeier et al. 2009). YTFP has documented similar non-natal rearing patterns for juvenile coho in off-estuary habitats located on the north side of the river (Spruce Creek, Panther Creek) (Figure 1) (Beesley and Fiori 2004; Silloway 2010; Soto et al. 2008; Hillemeier et al. 2009).

Given the importance of the estuary and its associated off-estuary habitats to Yurok culture and livelihood and the concurrent need to greatly increase survival and productivity of anadromous fish runs of the Klamath Basin, YTFP initiated a comprehensive watershed assessment and restoration planning effort in Waukell Creek in 2007. YTFP received funding to help accomplish watershed assessment and restoration goals from the U.S. Environmental Protection Agency (USEPA) (West Coast Estuary Initiative), U.S. Bureau of Reclamation (BOR) (Native American Affairs Program), and the U.S. Fish and Wildlife Service (Partners for Fish and Wildlife Program). This report summarizes Phase I restoration monitoring and implementation activities conducted in Waukell Creek from 2008 through July 2010. Activities performed during this period included 1) monitoring restoration effectiveness; 2) constructing fish habitat improvement structures; and 3) planting native conifers in riparian habitats of Waukell Creek.

Project Location

The Lower Klamath River Sub-basin encompasses the lower 40 miles of the Klamath River and its tributaries, from the confluence with the Trinity River to the Pacific Ocean (Figure 1). There are 25 anadromous fish bearing tributaries in the sub-basin (Gale and Randolph 2000). The Yurok Indian Reservation extends one mile on either side of the mainstem throughout the lower 44 miles of the Klamath River (Figure 1). Waukell Creek is a third order Lower Klamath tributary draining 4.3 mi^2 of forested hillslopes and low gradient coastal valley habitats (Figures 1-2). All restoration activities occurred in Waukell Creek between 05/06/09 and 09/30/10. Restoration effectiveness monitoring occurred from spring 2008 through July 2010.

Waukell Creek begins at an elevation of five feet at its confluence with the Klamath River estuary and extends 3.6 miles to its headwaters, located at an elevation of 400 feet. The project reach consisted of stream and riparian habitats located in Waukell Creek from RM 1.6 to 2.1 (Figure 6). Prior to initiating this project, habitat complexity and instream cover was relatively low throughout the project reach (Voight and Gale 1998). Existing fish cover was comprised of small woody debris and overhanging terrestrial vegetation. Since the highway construction, the riparian canopy of the watershed has been dominated by red alder (*Alnus rubrus*). Riparian

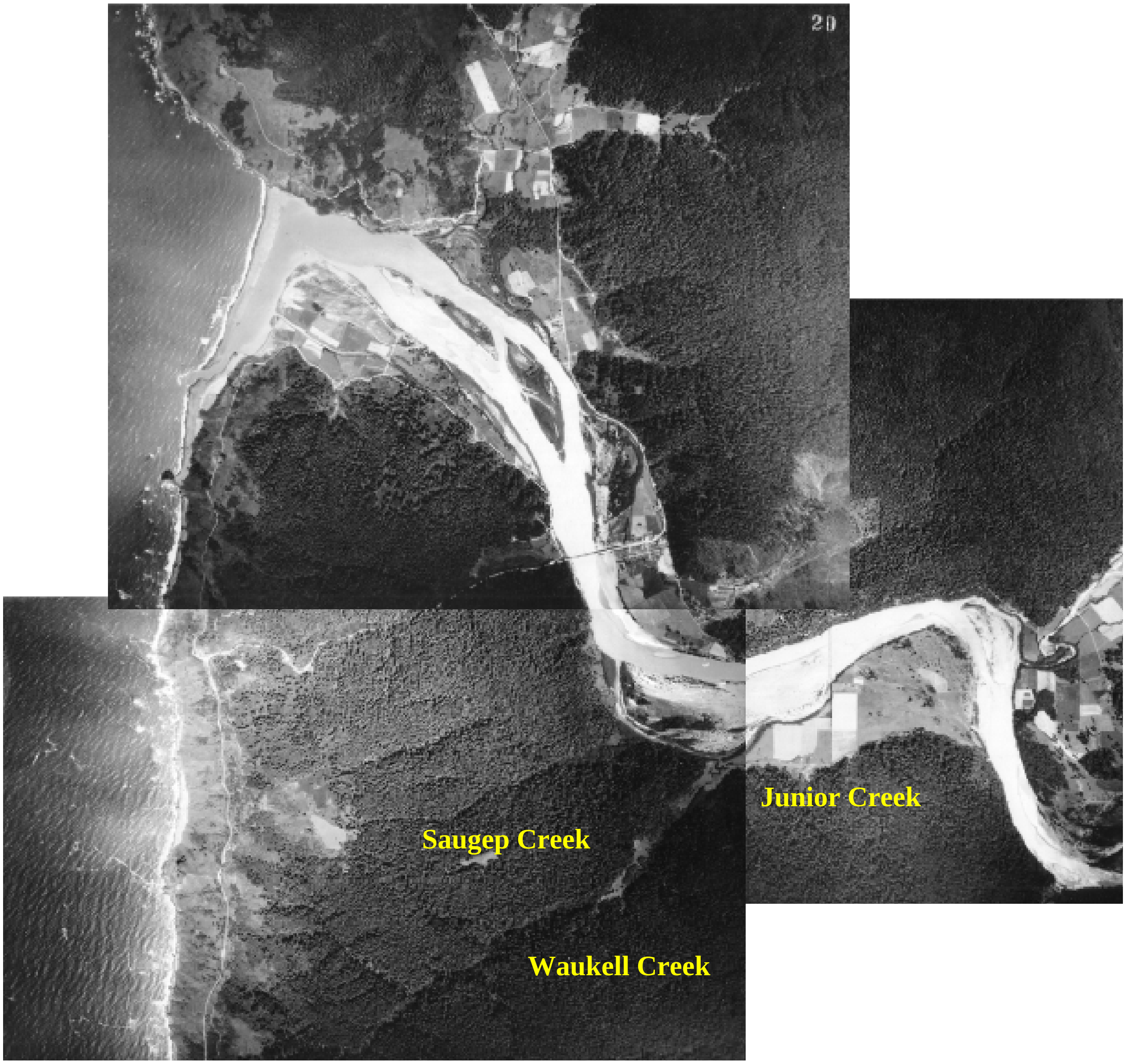


Figure 3. Mosaic of 1936 aerial photographs of the Klamath River estuary and Waukell Creek.

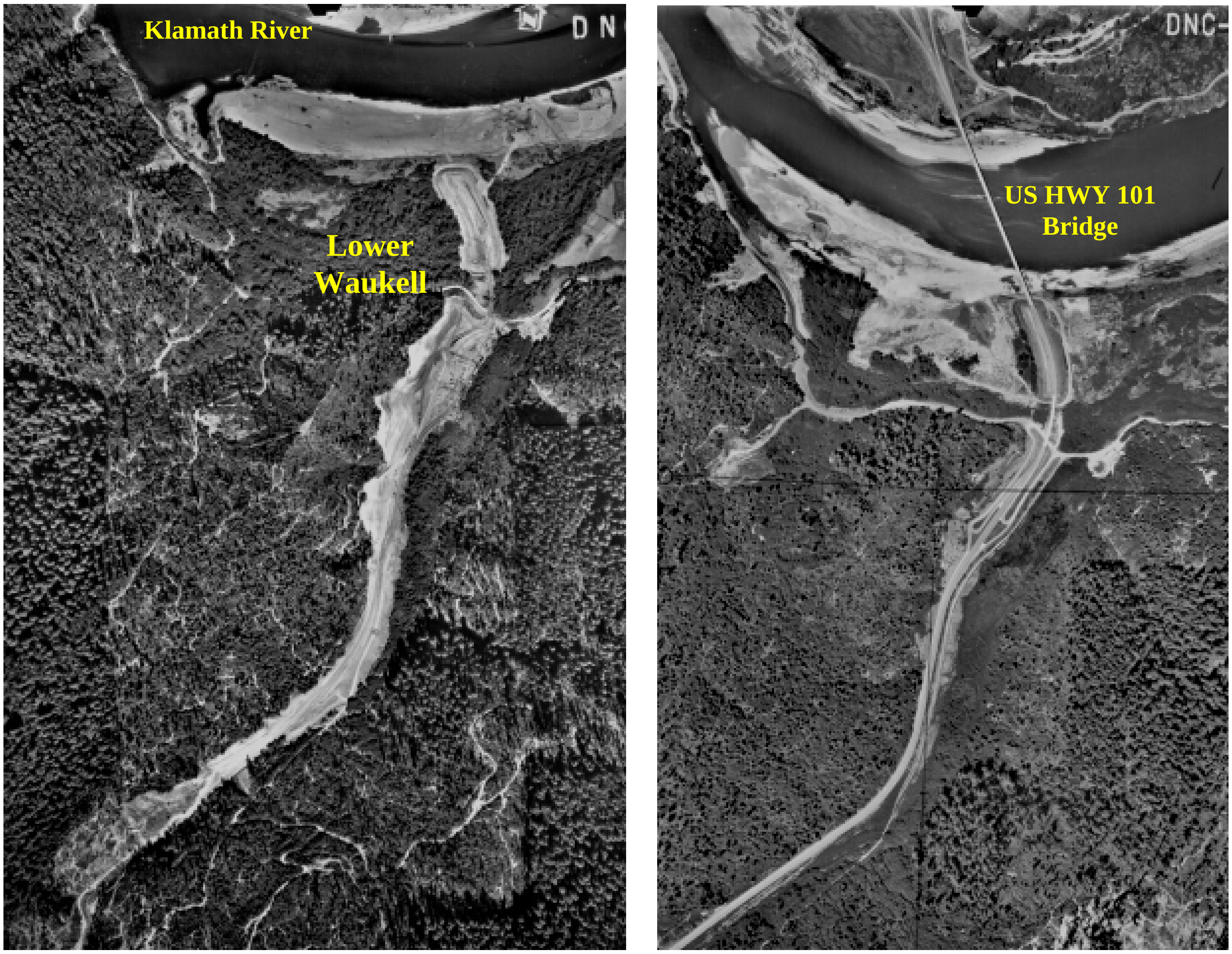


Figure 4. Waukell Creek during construction of U.S. Highway 101 (Left-1963 and Right-1969).

Figure 5. Highway grade control ramp in Waukell Creek (Left-Winter 1996 and Right-2007).

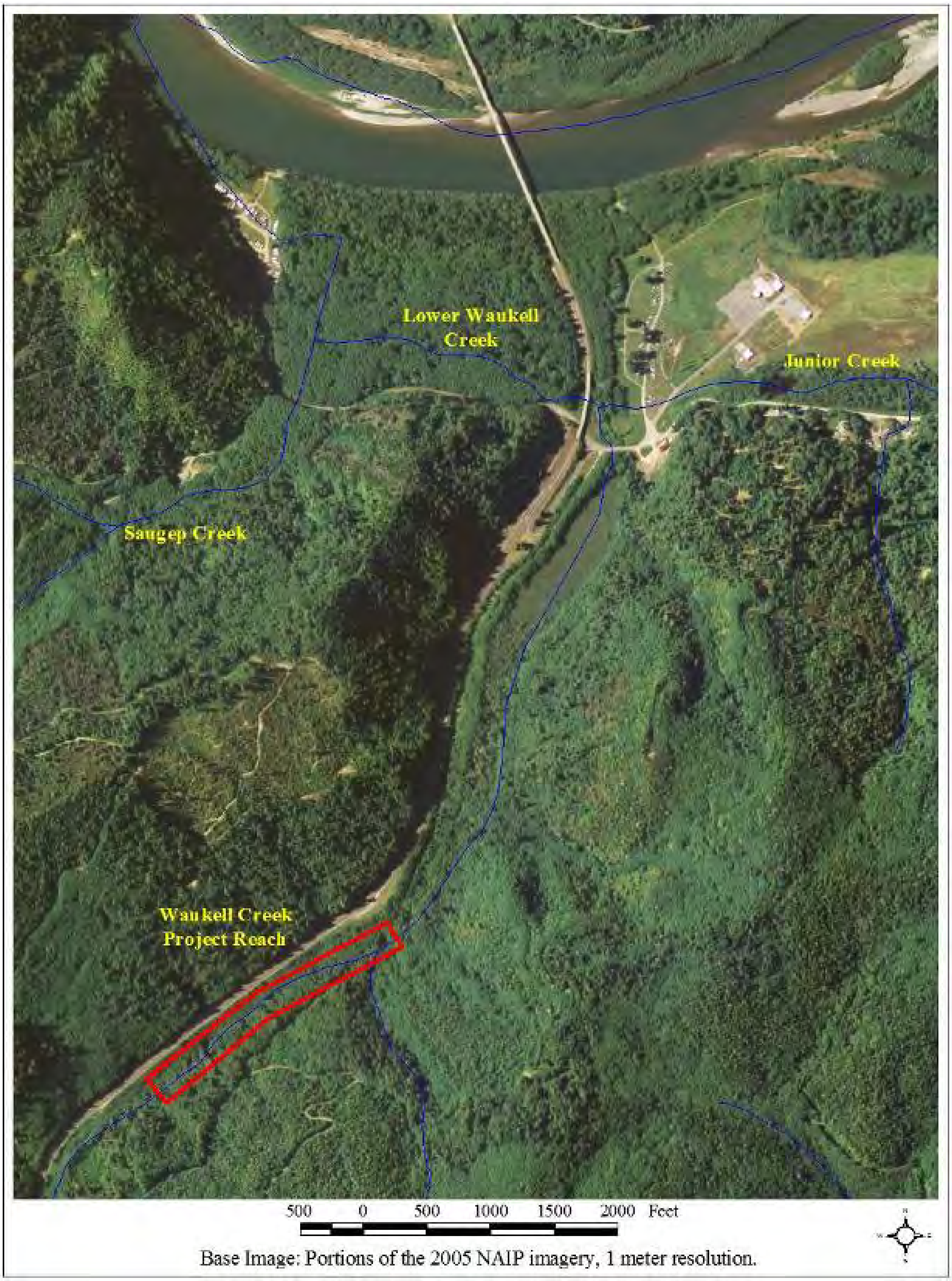


Figure 6. Map depicting the 2009-2010 project reach in Waukell Creek.

habitats in the project reach also contain several other native deciduous trees and conifers. Wetland habitats located downstream of the project reach are heavily impacted by the presence of reed canary grass (*Phalaris arundinacea*) (RCG) (Figure 7). RCG is also present in the project reach but in sparse patches located along the stream margins. Vegetation conditions for the Waukell Creek watershed are described in more detail by Loya (2008 & 2009).

Figure 7. Photographs of reed canary grass stands in coastal wetland habitats of Waukell Creek.

Driving Directions

The following are driving directions to the Waukell Creek project reach:
Heading south from the town of Klamath on U.S. Highway 101, take the first exit immediately after crossing the Klamath River. Turn right at the stop sign and travel under the highway. Turn right onto the dirt frontage road immediately past the northbound Hwy 101 onramp. A GDRC key is required to pass through the gate located 100 yards up this road. Follow this road approximately 0.5 miles to a log bridge crossing over Waukell Creek (Figure 6). Restoration activities summarized in this report were conducted in habitats located upstream of this bridge (RM 1.2 to 2.1) (Figure 6).

Landowner Contact:
Green Diamond Resource Company (GDRC)
Contact: Dan Berman, Aquatic Monitoring Supervisor
PO Box 68 - Korbel, CA 95550-0068
Office: (707) 668-4432

Species of Concern

Coho salmon within the Klamath Basin have been listed as threatened under the Federal and California State Endangered Species Acts, while chinook salmon, steelhead and sea-run cutthroat trout have all previously been petitioned for Federal listing and their status within the Klamath Basin continues to be of great concern. The Waukell Creek watershed supports spawning populations of coho salmon, steelhead, and coastal cutthroat trout. Waukell Creek and its major tributaries, Saugep Creek and Junior Creek, also provide rearing and staging habitat for a significant number of non-natal salmonids, especially juvenile coho salmon (Soto et al. 2008; Hillemeier et al. 2009). Other important fish species inhabiting the watersheds include: Pacific lamprey (*Lampetra tridentata*), Western brook lamprey (*L. richardsoni*), Klamath smallscale sucker (*Catostomus rimiculus*), speckled dace (*Rhinichthys osculus*), threespine stickleback (*Gasterosteus aculeatus*), coastrange sculpin (*Cotus aleuticus*), and prickly sculpin (*C. asper*). Sensitive amphibian species in the area include: Pacific giant salamander (*Dicamptodon ensatus*), southern torrent salamander (*Rhyacotriton variegatus*), red-legged frog (*Rana aurora*), foothill yellow-legged frog (*Rana boylei*), and tailed frog (*Ascaphus truei*).

Methods and Results

Wood Loading

In late summer 2009, YTFP and FGS used heavy equipment and hand tools to construct 13 constructed wood jams (CWJs) in fluvial habitats of Waukell Creek using wood provided and purchased from GDRC (Figure 8; Appendix A). Salvage wood was collected from approved landings located in close proximity to the wood loading reach during early summer 2009 (Figure 9). End dump trucks and our front-end loader were then used to deliver the salvaged wood to pre-determined staging areas located in the project reach. YTFP also purchased logs from GDRC to use as pilings to provide increased jam stability (Appendix A). A total of 80 pieces of wood were used to construct the CWJs in Waukell Creek.

CWJs constructed for this project were a variation of engineered log jams (ELJs) described by Abbe et al. (2003a, 2003b, 2005); and mimicked naturally occurring features such as bar apex jams, sluice gate jams, staggered abutment jams, and toppled riparian trees (Fiori et al. 2009-2010; Fiori 2010). CWJs were constructed using the same geomorphic and engineering principles as ELJs; where mechanically driven logs, riparian trees, stumps, and other landforms were used to create a geometry of interlocking logs and/or whole trees to provide the resisting elements necessary for maintaining stability and function under a variety of flows. CWJs constructed for this project did not require use of imported rock/cable or rebar anchor systems.

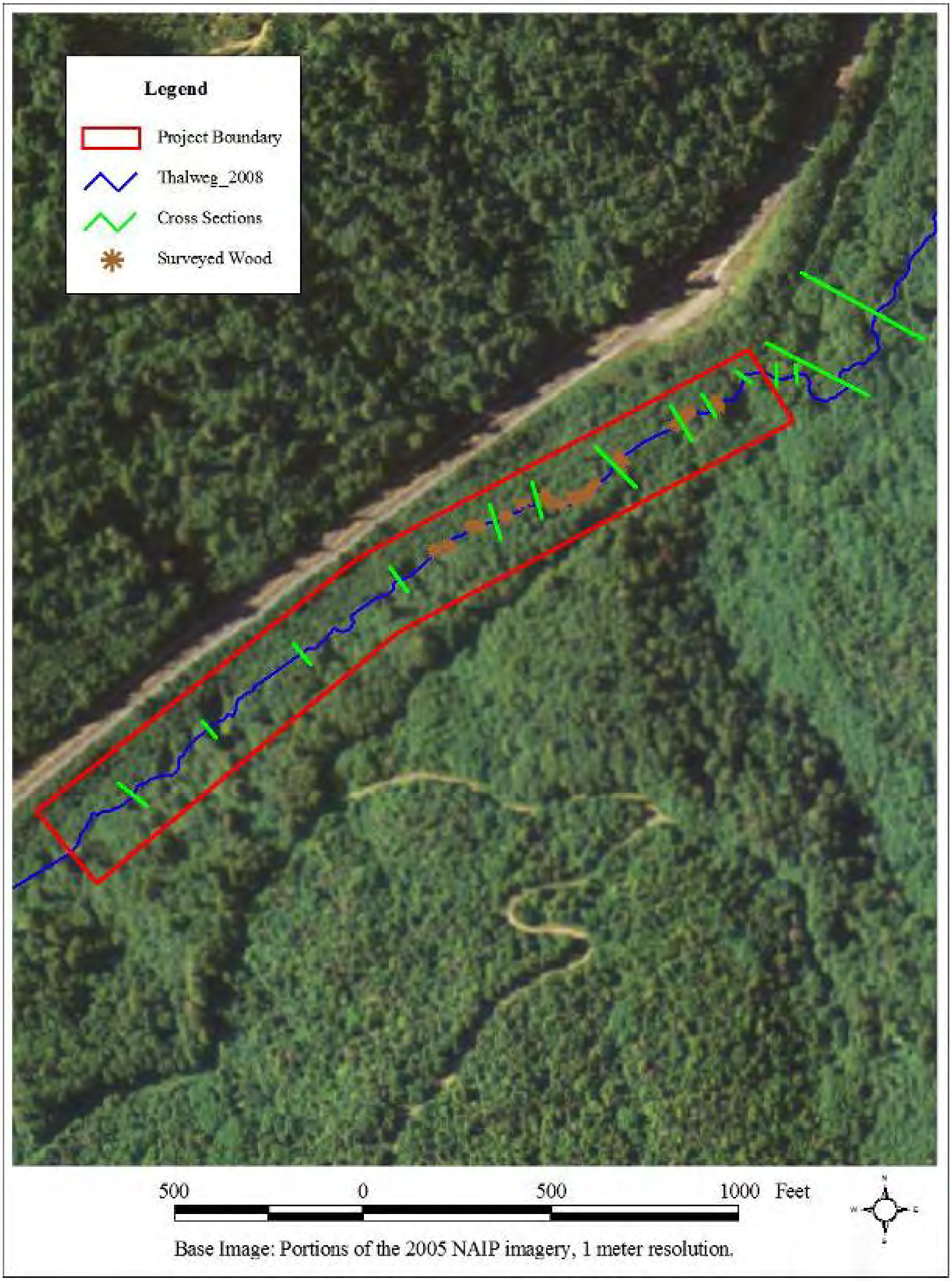


Figure 8. Map depicting the complex wood jams constructed in Waukell Creek during 2009.

Figure 9. YTFP and Fiori GeoSciences salvaging wood from Green Diamond Resource Company lands (Top); and crews staging wood in the Waukell Creek project reach (Bottom).

The objectives of the wood loading component of this project included: 1) increasing instream cover for juvenile and adult salmonids and other aquatic dependent species; 2) sorting and retaining spawning gravel for natal salmonids; 3) forming and maintaining complex fluvial habitats; and 4) reducing sediment delivery rates in the upper watershed; and 5) increasing the amount of complex, slow velocity habitat available to juvenile salmonids during winter-spring.

Tree Planting

In spring 2010, YTFP crews planted 2,550 bareroot coastal redwoods (*Sequoia sempervirens*) in riparian habitats of Waukell Creek (Figures 10-11). Planting efforts were focused on habitats located upstream of the 2009 wood loading reach to facilitate future wood recruitment to the structure reach, and to allow heavy equipment access to the constructed sites during the next few years to modify or add to the reach if necessary. Crews took care when selecting planting sites and when burying root systems to facilitate improved survival. Surveys will be conducted in the tree planting reach for a minimum of three years to assess survival. YTFP will be continuing riparian enhancement efforts throughout Waukell Creek over the next several years to promote increased plant diversity and wood recruitment in the watershed. A priority long-term goal of these efforts is to reduce the impacts of RCG on aquatic habitats by promoting native conifers and a diverse assemblage of wetland plants to outcompete RCG.

Project Monitoring

In 2008-2009, YTFP worked with the Yurok Land Management survey crew to establish a network of permanent bench marks in the Waukell Creek watershed using a real time kinematic GPS total station, an optical total station, and Survey Pro Software. Survey crews also used the optical total station to conduct baseline topographic surveys of stream and floodplain habitats within the project reach in spring-summer 2008. During these surveys crews established several permanent cross sections in Waukell Creek to help document changes in channel geometry over time (Figure 12). Repeat topographic surveys were conducted through the wood loading reach before and following structure construction. Following CWJ construction, crews placed identification tags on each piece of placed wood and surveyed every piece (tip and base) to document its position (Figures 13-14). In summer 2010, repeat surveys were conducted in the wood loading reach to document post-project conditions following the first winter (Appendix B).

Topographic data collected since 2008 revealed slight changes in channel profile and geometry following CWJ construction and winter 2009-2010 flows (Appendix B). CWJ construction appeared to influence pool scour at sites 5-9 (Appendix B – Thalweg Profile). Cross section data collected in 2010 revealed minimal improvements in channel geometry at a few of the monitored sites (i.e. development of a low flow channel and flood benches) following winter 2009-2010 (Appendix B). Data collected downstream of the CWJs revealed some deposition occurring in the channel following winter 2009-2010 (Appendix B). Wood surveys conducted in 2010 indicated negligible movement of placed wood during winter 2009-2010.

YTFP also established several permanent photographic monitoring sites in the project area to document baseline conditions, and to document short- and long-term habitat changes in the project area (Appendix A). Post-project photograph and topographic monitoring will be repeated annually or semi-annually in the future to allow us to continue assessing restoration effectiveness. Information gained from these monitoring efforts will continue to be applied to past and future restoration efforts in the Lower Klamath River.

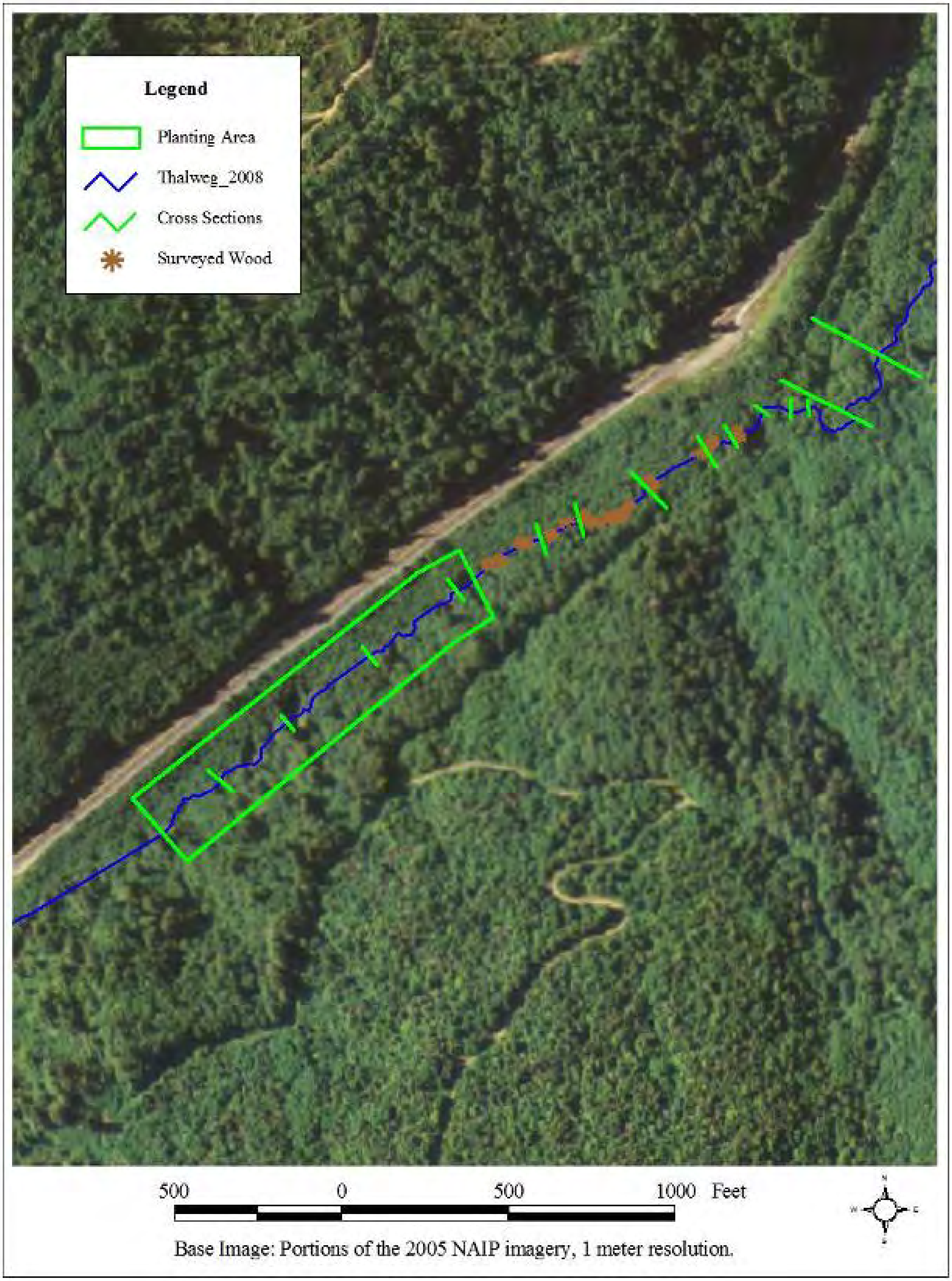


Figure 10. Map depicting the area planted in Waukell Creek during 2010.

Figure 11. Redwood saplings planted in riparian habitats of Waukell Creek during spring 2010.

Figure 12. Photographs of complex wood jams constructed in Waukell Creek in summer 2009 and the numbered ID tags applied to the placed wood for monitoring purposes.

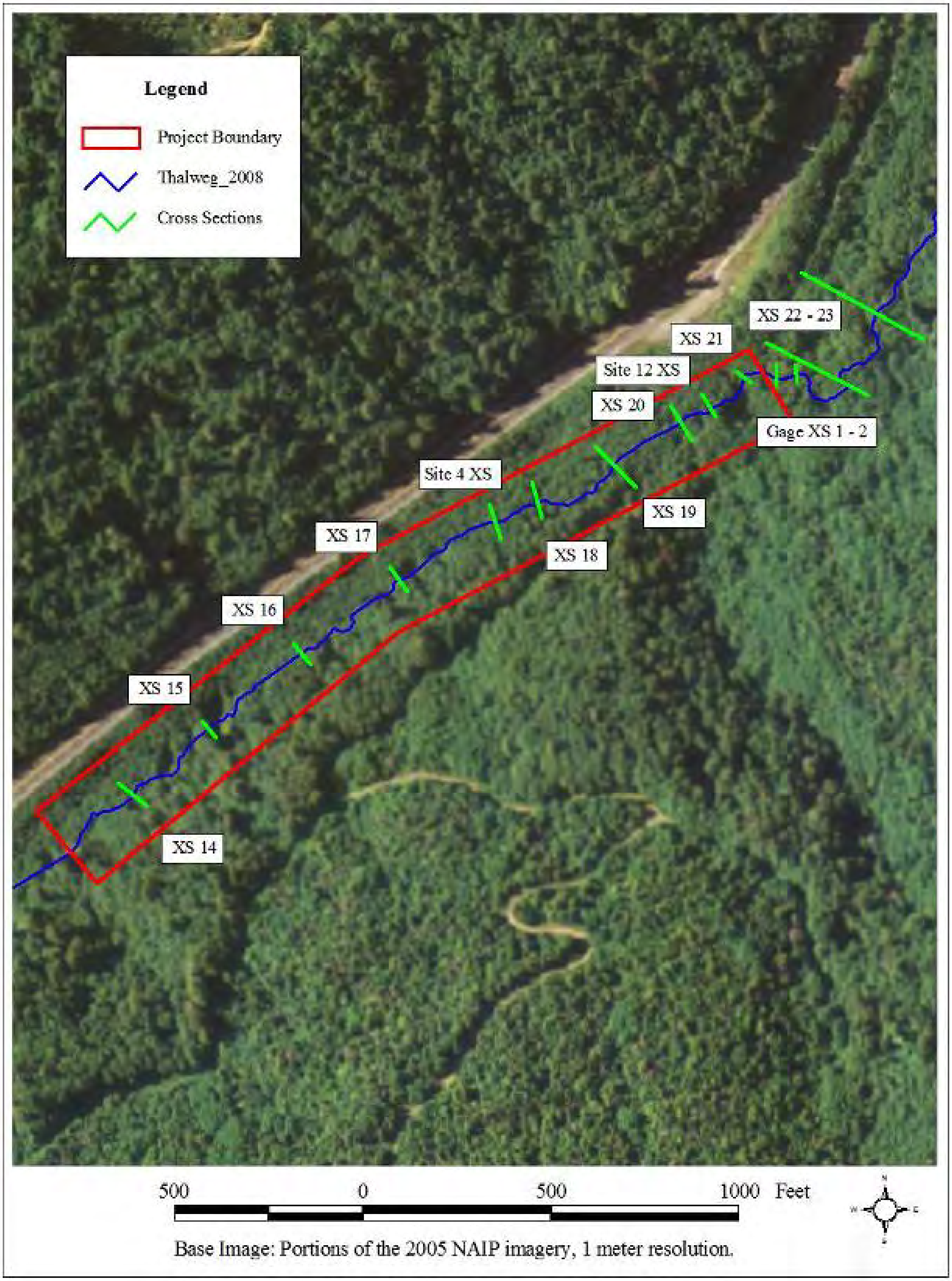


Figure 13. Map depicting topographic survey data collected in Waukell Creek during 2008-10.

Figure 14. Map depicting 2009 wood placement sites and surveyed logs in Waukell Creek.

Project Summary

Overall stream length affected: 0.5 miles
Stream length planted or protected (with fence): 0.25 miles
Riparian zone planted or protected (length x width): 0.25 miles x 75 feet
Total fencing: N/A
Trees planted (number, by species): 2,550 Coastal Redwood (*Sequoia sempervirens*)
Non-native vegetation removed (length x width): N/A
Stream bank restoration sites (number, length of stream, and technique): N/A
In-stream habitat structures installed (number, type): 13 Complex Wood Jams
Road stream crossings removed/upgraded (number, type of treatment): N/A
Number fish barriers removed: N/A
Length of upstream habitat made accessible: N/A

Literature Cited

Abbe, T.B., A. Brooks, and D.R. Montgomery. 2003a. Wood in River Restoration and Management. pp. 367-389 in: S. Gregory et al. (ed.), Wood in World Rivers. American Fisheries Society, Bethesda, Maryland.

Abbe, T.B., G. Pess, D.R. Montgomery, and K.L. Fetherston. 2003b. Integrating Engineered Log Jam Technology in River Rehabilitation. Pages 443–490 *in* D.R. Mongtomery, S. Bolton, D. B. Booth, and L. Wall, editors. Restoration of Puget Sound Rivers. University of Washington Press, Seattle.

Abbe, T.B., D.R. Montgomery, C.A. Adams, R.C. Riley, K.M. Robinsen, and E.L. Owens. 2005. Bank Protection and Habitat Enhancement using Engineered Log Jams: An Experimental Approach Developed in the Pacific Northwest. Natural Resources Concervation Service, U.S. Department of Agriculture. 169 p.

Beesley, S. and R.A. Fiori. 2004. Habitat Assessment and Restoration Planning in the Salt Creek Watershed, Lower Klamath River Sub-Basin, California. Yurok Tribal Fisheries Program, Klamath, California.

Beesley, S. and R.A. Fiori. 2007. Geomorphic and Hydrologic Assessment and Restoration Planning in the Salt Creek watershed, Lower Klamath River sub-basin. Yurok Tribal Fisheries Program, Klamath, California.

Beesley, S. and R.A. Fiori. 2007b. Geomorphic and Hydrologic Assessment and Restoration Planning in the Salt Creek watershed, Lower Klamath River sub-basin. 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.

Fiori, R.A., J. Beneger, 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.

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.

Hiner, M. 2006. Seasonal Water Quality in the Klamath River Estuary and Surrounding Sloughs, 2001 - 2003. Yurok Tribal Fisheries Program, Klamath, California.

Hiner, M. 2008. Klamath River Estuary Juvenile Salmonid Monitoring Project. Yurok Tribal Fisheries Program, Klamath, California.

Hiner, M. and A. Brown. 2004. Monitoring and Evaluation of Current and Historical Physical Habitat Conditions, Water Quality, and Juvenile Salmonid use of the Klamath River Estuary. Yurok Tribal Fisheries Program, Klamath, California.

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

Loya, S. 2008. Waukell Creek Vegetation Survey and Mapping. Report prepared for the Yurok Tribal Fisheries Program. McBain and Trush, Inc., Arcata, California.

Loya, S. 2009. Results of Howell's Montina Surveys, Addendum to: Waukell Creek Vegetation Survey and Mapping. Report prepared for the Yurok Tribal Fisheries Program. McBain and Trush, Inc., Arcata, California.

Silloway, S. 2010. Fish Surveys Related to the Proposed Del Norte Highway 101 Klamath Grade Raise Project. 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.

Wallace, M. 2007. Personal Communication. California Department of Fish and Game, Arcata, California.

Yurok Tribal Fisheries Program. 2009. A Complete Life History Monitoring of Salmonids in McGarvey Creek, Lower Klamath River Sub-Basin, 2006-2009. Yurok Tribal Fisheries Program, Klamath, California.

Appendix A. Waukell Creek 2009 Wood Loading Project Photo-Monitoring

Photo-monitoring of wood loading sites constructed in 2009 occurred immediately before construction in September 2009, and post-construction in December 2010. Additional photographs of these sites were taken during reconnaissance field evaluations during the year since construction. The photographs included herein were selected to provide the best before and after views of the 13 sites and show site conditions with moderate winter flows. The 2010 water year tested these sites with two peak flow events that had a 4.2 year and a 1.1 year recurrence interval ratings according to record analysis for the nearby USGS Smith River gage at Jed Smith. Waukell Creek was flowing at approximately 15 cfs at the time of the December, 2010 photographs. The 12/10/13 photographs indicate the constructed wood jams (CWJs) performed well in terms of stability and habitat formation.

Figure 1. Typical view representative of depleted wood and channelized conditions within the project reach. Upstream view from Site 1. Image dates: top 9-24-2009, bottom 12-05-2010.

Figure 2. Paired before and after downstream view of Sites 1 and 2. Image dates: top 9-24-2009, bottom 12-05-2010.

Figure 3. View of Site 1 from right bank. Image date 12-05-2010.

Figure 4. Down stream view of Sites 2, 3 and 4 from left bank at Site 1. Image date 12-05-2010.

Figure 5. Upstream view of Site 2 from right bank. Image date 12-05-2010.

Figure 6. Downstream view of Site 3 from right bank. Image date 12-05-2010.

Figure 7. Uptream view of Site 3. Image date 12-05-2010.

Figure 8. Paired before and after downstream views of Site 4. Image dates: top 9-29-2009, bottom 12-05-2010.

Figure 9. Upstream view of Site 4 from the left bank. Image date 12-05-2010.

Figure 10. Paired before and after downstream views of Site 5. Image dates: top 9-29-2009, bottom 12-05-2010.

Figure 11. View of Site 5 from the right bank. Image date 12-05-2010.

Figure 12. Paired before and after downstream views of Site 6. Image dates: top 9-29-2009, bottom 12-05-2010.


Figure 13. Downstream view of Site 6 from right bank. Image date 12-05-2010.

Figure 14. Paired before and after upstream views of Site 7. Image dates: top 9-29-2009, bottom 12-05-2010.

Figure 15. Downstream view of Site 8 from Site 7. Image date 12-05-2010.

Figure 16. Paired before and after downstream views of Site 9 from Site 8. Image dates: top 9-29-2009, bottom 12-05-2010. Top image shows site prep of stream bed needed to fit multiple pieces of large wood.

Figure 17. Paired before and after upstream views of Site 9. Image dates: top 9-29-2009, bottom 12-05-2010. Top image shows site prep of stream bed to fit multiple pieces of large wood. Man in red jacket is standing on buried wood exposed during construction.

Figure 18. Paired before and after upstream views of Site 10. Image dates: top 9-29-2009, bottom 12-05-2010.

Figure 19. Downstream view of Site 10. Image date 12-05-2010.

Figure 20. View of Site 10 from the right bank. Image date 12-05-2010.

Figure 21. Paired before and after downstream views of Site 11. Image dates: top 9-30-2009, bottom 12-05-2010.

Figure 22. Downstream view of Site 11 from left bank. Image date 12-05-2010

Figure 23. Paired before and after upstream views of Site 12. Image dates: top 9-29-2009, bottom 12-05-2010.

Figure 24. Downstream view of Site 12 from Site 11. Image date 12-05-2010

Figure 25. Upstream view of Site 12 from right bank. Image date 12-05-2010

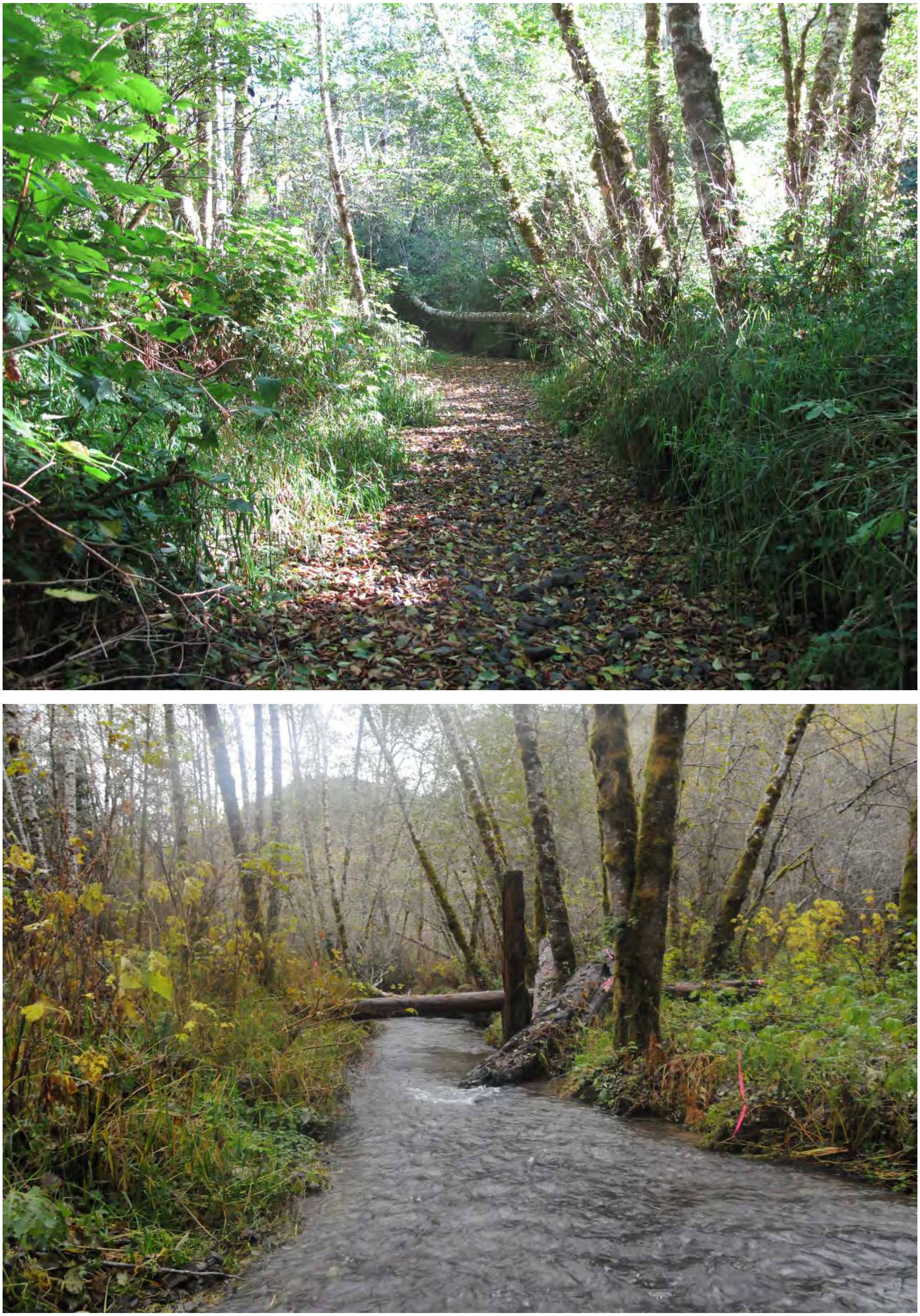
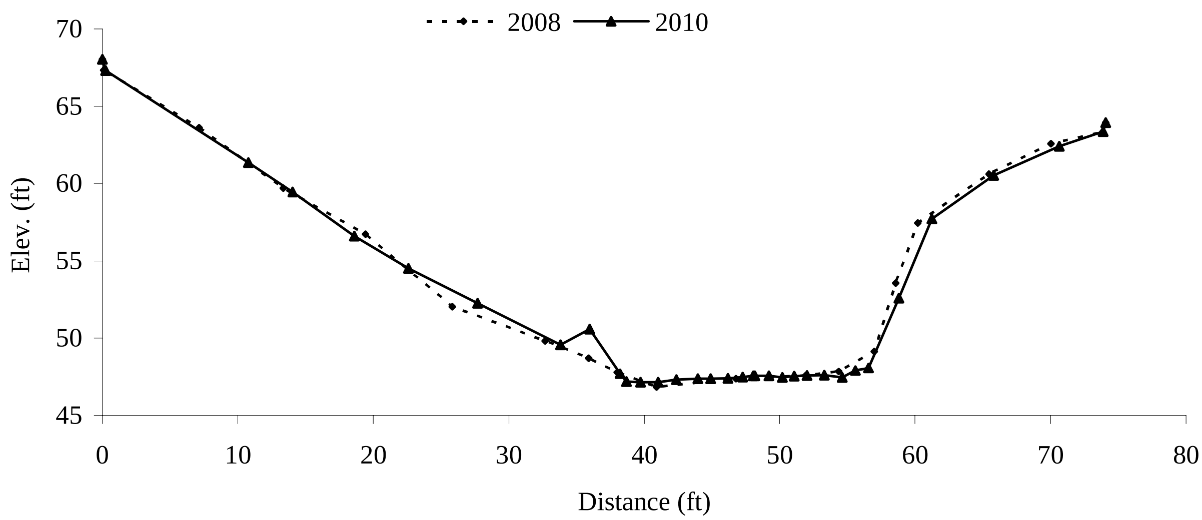


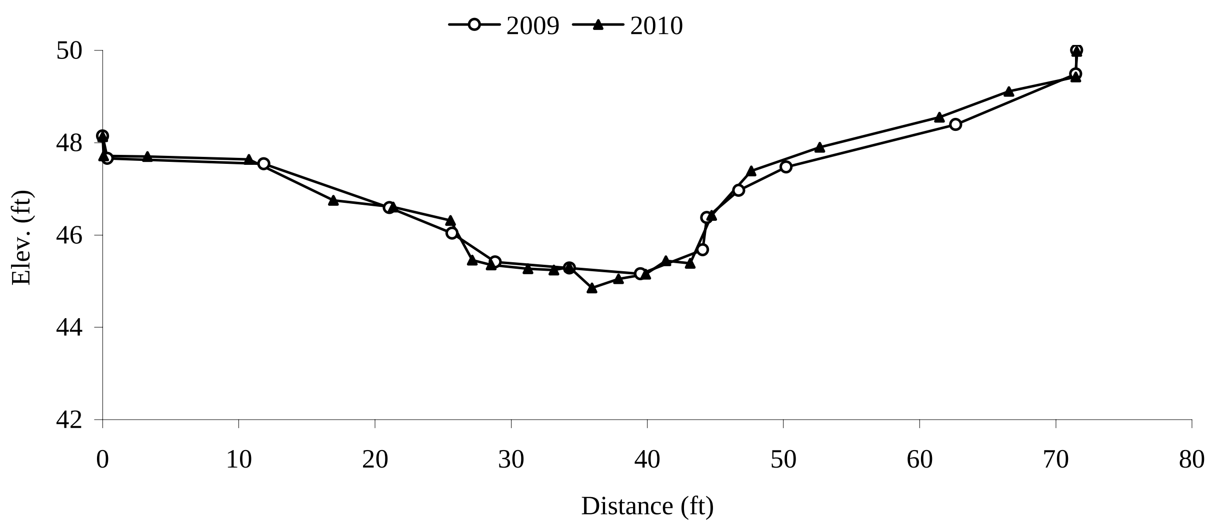
Figure 26. Paired before and after downstream views of Site 13. Image dates: top 9-30-2009, bottom 12-05-2010.

Figure 27. Uptream view of Site 13 from left bank. Image date 12-05-2010

Appendix B. Topographic data collected in Waukell Creek 2008 – 2010.

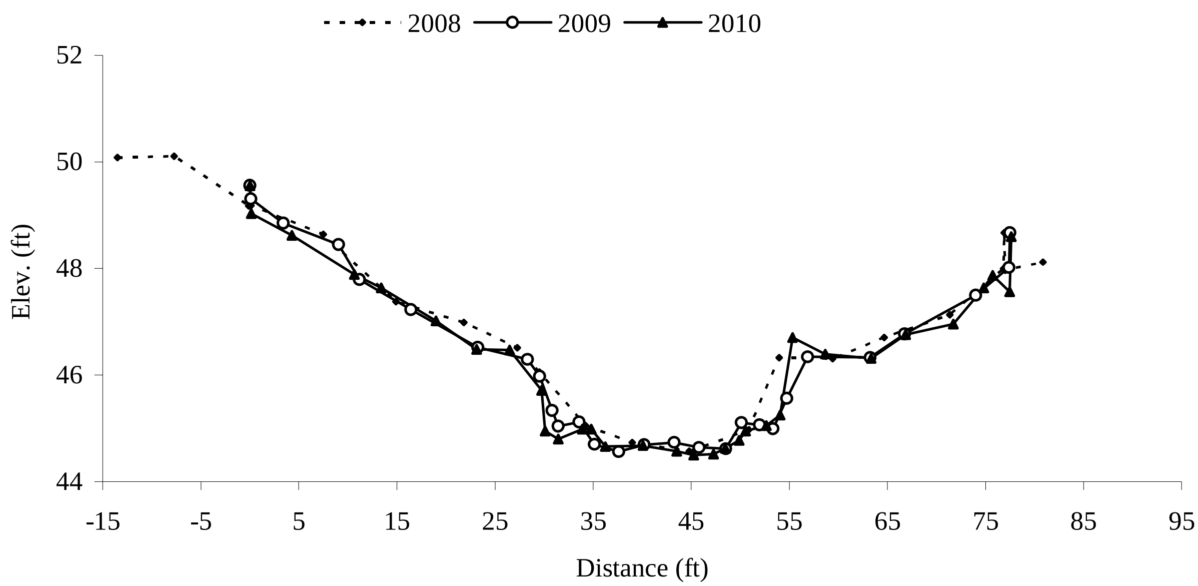


Cross Section 17

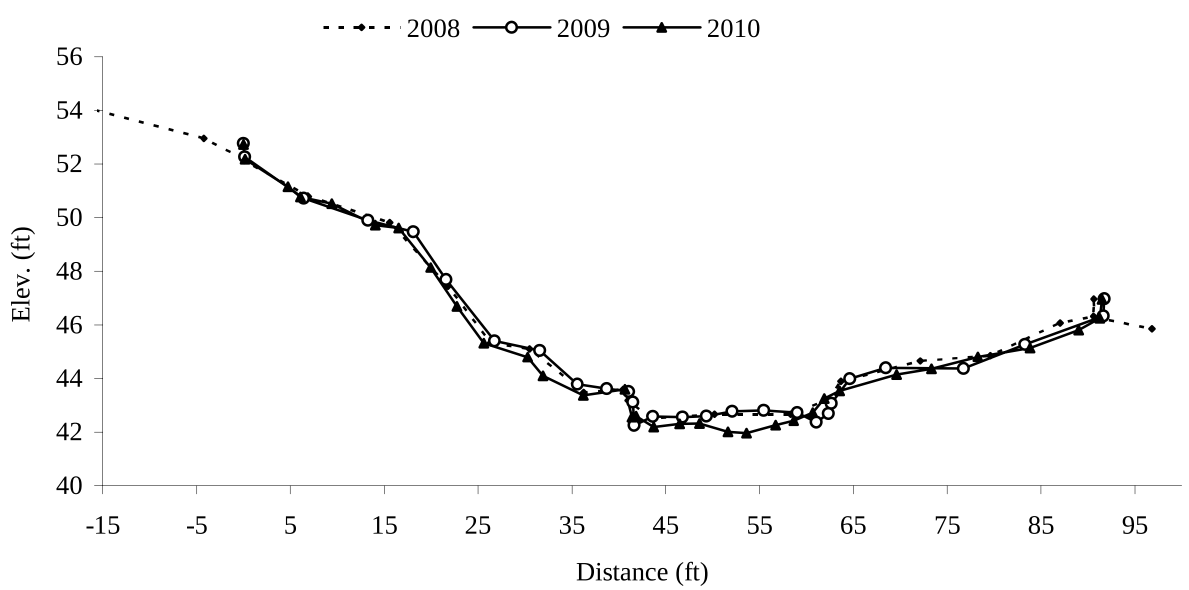


Site 4 Cross Section

Appendix B. Continued.

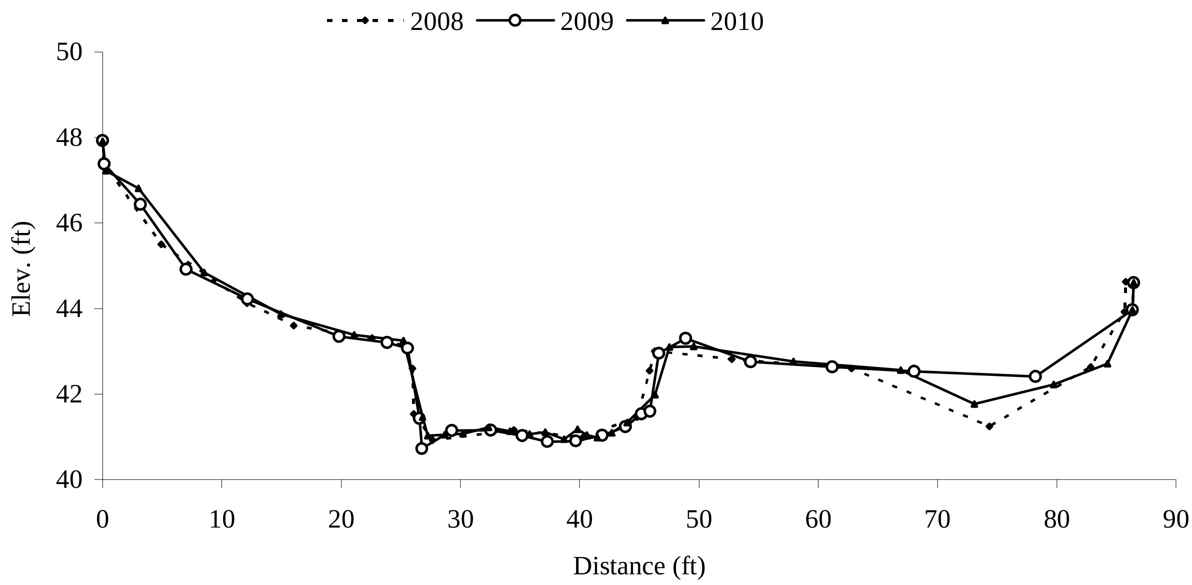


Cross Section 18

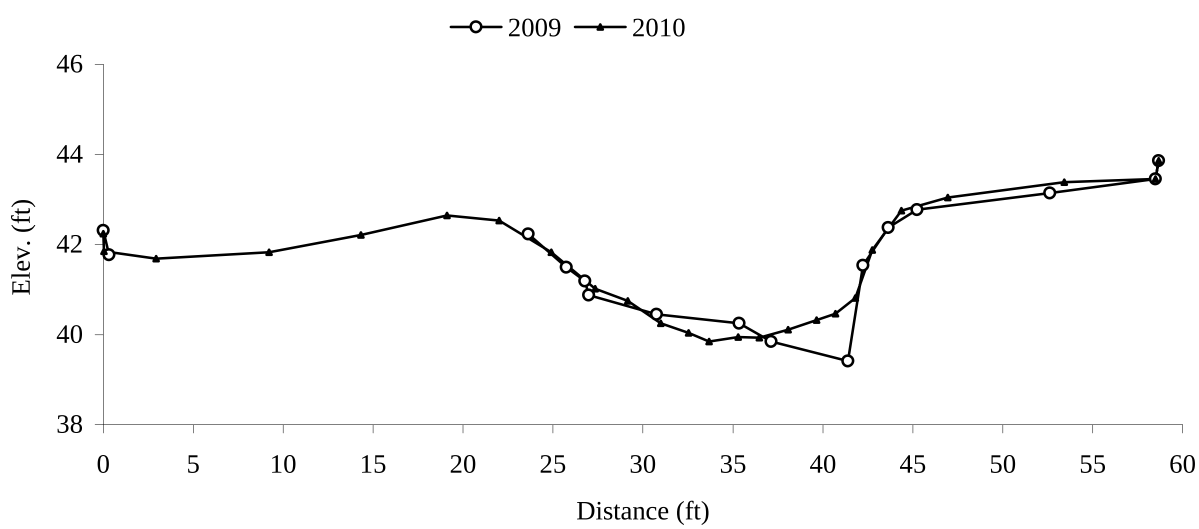


Cross Section 19

Appendix B. Continued.



Cross Section 20



Site 12 Cross Section

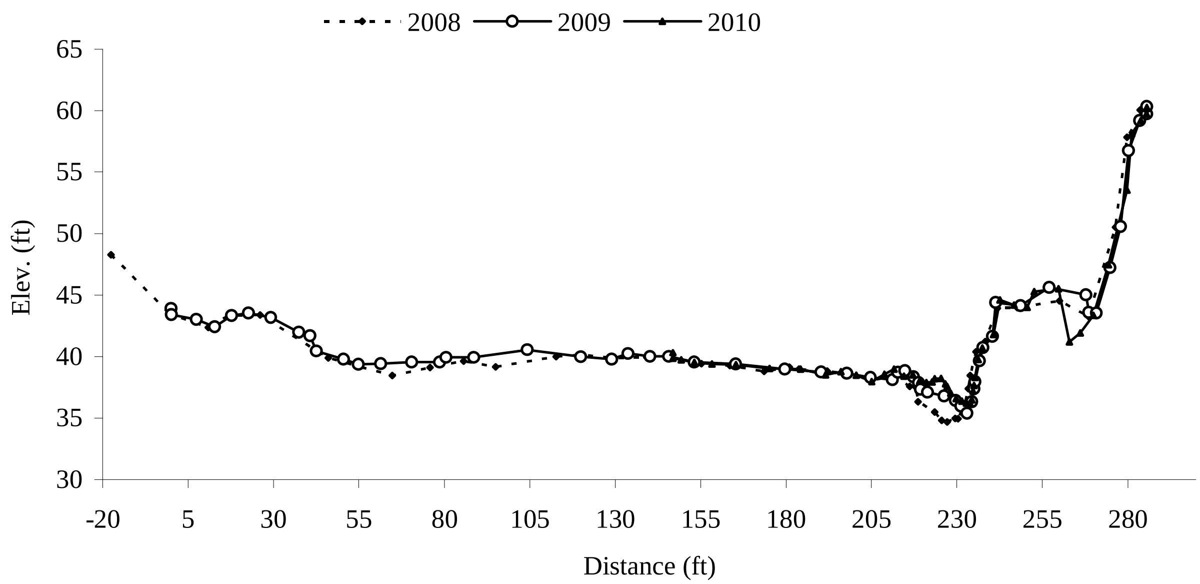
Appendix B. Continued.

Cross Section 21

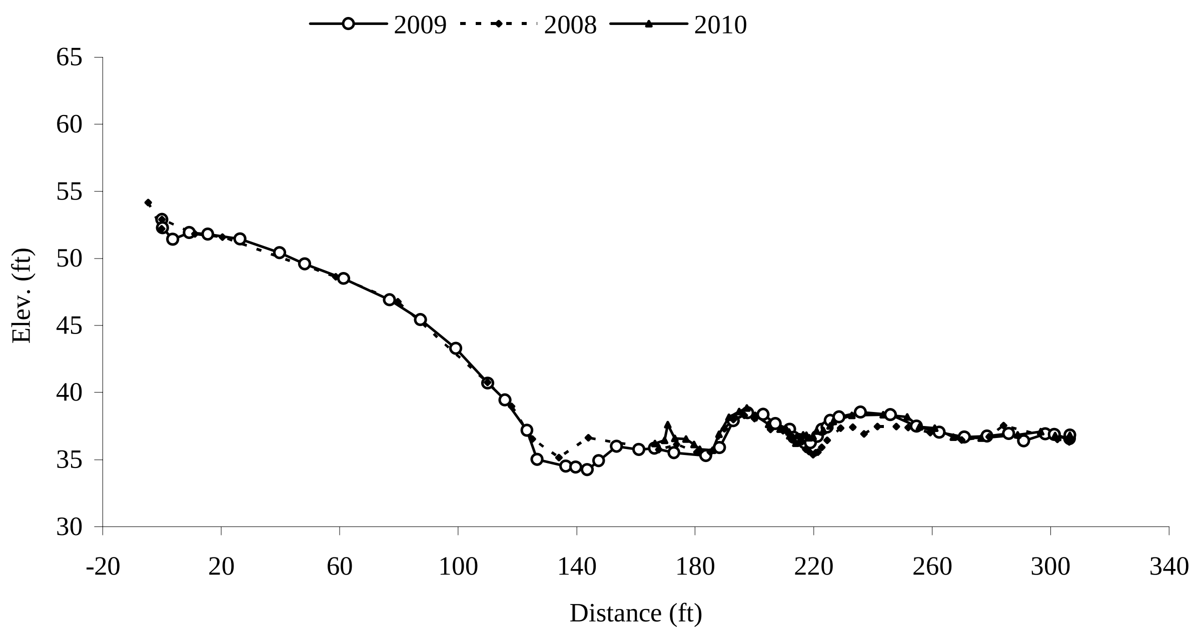
Gage Cross Section 1

Gage Cross Section 2

Appendix B. Continued.



Cross Section 22



Cross Section 23