Instream Restoration of Lower West Fork McGarvey Creek

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Acknowledgments

This report is dedicated to John Schwabe, Habitat Restoration Specialist, who retired from the California Department of Fish and Game in December 2007. John spent two decades in the Klamath area working on stream restoration throughout the Lower Klamath Sub-Basin. He has been a source of inspiration and motivation to the Yurok Tribal Fisheries Program over the years and his enthusiasm and dedication will be sorely missed. This report details the last project in which YTFP and John worked collaboratively to restore fish habitat in the sub-basin and is just a small piece of the long legacy he leaves behind to aid in restoration of Lower Klamath fish populations.

The author also wishes to thank the following individuals, whose assistance was instrumental in the success of this project: Carl Anderson, Sarah Beesley, Dwayne Davis, Rocco Fiori, Nick Fulkins, Josh Jimenez, Delmer Jordan Jr., Walt Lara III, Aldaron McCovey, Daniel McQuillen, Todd Moon, Richard Nelson III, Steven Nova Jr., Chay-Gee Sylvia, A.J. Webster, and David Weskamp.

Background

The Yurok People have inhabited the lands of and sustained themselves upon the resources of the Klamath River for centuries. The Yurok Tribe's entire culture is largely based upon the Klamath River and its associated fish populations. Today, only a fraction of historic anadromous fish runs return to spawn in the Klamath River and its tributaries. Although many factors have contributed to these declines in native fish runs, degradation of freshwater habitat has been pervasive in the Klamath River Basin. Kier and Associates (1991) note that "the fish habitats of the basin have been greatly diminished in extent and value in the past century by the construction of impassable dams and by stream diversions and sand and silt from mining, logging, grazing, road development, and floods." The declining health and productivity of the Klamath River's anadromous fisheries is of great cultural and economic concern to the Yurok Tribe.

To proactively address these declines, the Tribe initiated the Lower Klamath Restoration Partnership (LKRP), a large-scale, coordinated watershed restoration effort throughout the Lower Klamath sub-basin in conjunction with Green Diamond Resource Company (GDRC – formerly Simpson Resource Company) and the California Coastal Conservancy. This cooperative framework is intended to meet the mandates and objectives of tribal, state, and federal planning efforts, the Northwest Economic Adjustment Initiative and the state and federal ESA through innovative solutions to resource management issues between private landowners, Tribal interests, and public agencies.

In order to provide for meaningful restoration plans that truly address the limiting factors facing each salmonid species in a given drainage, the Yurok Tribe initiated the Lower Klamath River Watershed Assessment. This interdisciplinary effort, consisting of historical and current condition assessments throughout each of the Lower Klamath tributaries, resulted in the prioritization of restoration activities throughout the basin. The Lower Klamath Sub-Basin Watershed Restoration Plan (Gale and Randolph 2000) identifies chronic streambed sedimentation, heavily degraded instream and riparian habitat, and loss of habitat connectivity as the primary factors for salmonid decline. In order to address these problems, the Sub-Basin Plan prioritizes treatment of upslope sediment sources, in conjunction with instream and riparian restoration and fish barrier treatment.

McGarvey Creek is ranked third out of all 24 Lower Klamath tributaries for watershed restoration activities (Gale and Randolph 2000). As a result, the Yurok Tribal Watershed Restoration Department (YTWRD) conducted an upslope road assessment and restoration need inventory throughout the McGarvey Creek watershed during winter 1996-1997. This inventory resulted in a prioritized list of road segments in need of treatment and/or decommissioning, and YTWRD crews undertook these upslope restoration activities from 1997-2007. YTWRD has completed decommissioning of all medium and high priority roads in the McGarvey Creek watershed and GDRC has been actively upgrading all road segments that were not scheduled for decommission. As a result, the LKRP is nearing the completion of all upslope restoration throughout this top-ranked tributary. In addition, YTFP has undertaken fish barrier modification within the drainage, reestablishing access to large portions of the watershed's historic anadromous salmonid range.

Now that upslope erosion sources have been addressed in the watershed, it is imperative to accelerate instream and riparian restoration measures to achieve the restoration goals set forth in the Lower Klamath Watershed Restoration Plan (Gale and Randolph 2000).

Historic logging extracted virtually all conifers from riparian corridors and large wood recruitment zones in this watershed and these areas were not re-planted following logging activities (Gale and Randolph 2000). As a result, red alder currently dominate riparian forests that were historically dominated by mature coastal redwood, Douglas fir and Port Orford cedar (Table 1). These deciduous trees rarely attain diameters large enough to affect pool habitat formation or sediment storage and do not provide long-term habitat complexity and channel stability. Large wood inventories conducted in West Fork McGarvey Creek (Table 1) reveal that instream wood is limited in the anadromous reach and that much of this wood is in a moderate to advanced state of decay.

To address these conditions, YTFP constructed large wood habitat structures in lower West Fork McGarvey Creek and planted adjacent riparian habitats with native conifers. Native conifers attain large diameters (>30 in.) and provide complex riparian canopies, maintain long-term bank stability, reduce sediment delivery rates, and allow for formation of critical instream habitats (e.g. pools). Adding large wood to the channel is facilitating short-term goals such as improving spawning and rearing potential by increasing habitat complexity and altering sediment storage dynamics. Long-term benefits of these restoration treatments include reduction of sediment delivery, increased channel and bank stability, increased instream and riparian habitat complexity, and improved large wood recruitment potential in the McGarvey Creek drainage.

The McGarvey Creek watershed is located in the Klamath Glen HSA, which was given the highest priority rating throughout California in the California Department of Fish and Game's *Recovery Strategy for California Coho Salmon*. Placement of instream LWD and conifer revegetation were identified as top priority restoration measures required in this HSA to meet the goals identified in this coho salmon recovery plan (CDFG 2004).

Project Area

The Lower Klamath sub-basin encompasses the lower 40 miles of the Klamath River and its tributaries, between the confluence with the Trinity River and the Pacific Ocean. There are 25 anadromous fish bearing tributaries within the sub-basin (Figure 1). The Yurok Indian Reservation extends one mile on either side of the mainstem throughout the lower 44 miles of the Klamath River. An aquatic and riparian habitat summary for the sub-basin is presented in Table 1. A summary of aquatic species presence by tributary is presented in Table 2. All project work occurred within Lower Terwer Creek.

McGarvey Creek is a third order stream draining 8.6 miles in the lower portion of the sub-basin (Figure 1). McGarvey Creek's mainstem begins at an elevation of 5 feet at its confluence with the Klamath and extends 4.9 miles to its headwaters, located at an elevation of 600 feet. McGarvey Creek is moderately to highly confined throughout most of its course, with "B" and "C" channel types dominant throughout (see Rosgen 1994 for channel type descriptions). The lower portion of the creek flows through a broad low-gradient floodplain which is routinely inundated when the Klamath River is under high flow conditions.

The McGarvey Creek watershed supports anadromous populations of late fall-run chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), steelhead (*O. mykiss*), and coastal cutthroat trout (*O. clarki clarki)*. West Fork McGarvey Creek, the principle tributary in the drainage, totals 2.2 miles in length and supports populations of coho salmon, steelhead coastal cutthroat trout, and both lamprey species. 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.

Other fish species likely to benefit from improved habitat conditions in these 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*) (Table 2).

Other sensitive species located within these drainages, that might benefit from these activities 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*) (Table 2).

This project area is located in the lower reach of West Fork McGarvey Creek on private property owned by Green Diamond Resource Company (GDRC – formerly Simpson Resource Company) (Figure 3).

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 and upriver approximately one mile. Turn right onto the GDRC road # M10. A GDRC key is required to pass through the gate located at the road turnoff. Follow the M10 road approximately 1.5 miles to the bridge crossing McGarvey Creek. The mouth of the West Fork enters on the left bank (looking downstream) 1,200 feet upstream of this bridge. The top of the project reach is located 2,100 feet upstream of the mouth.

Project Objectives

The objectives of this project were as follows:

- Improve anadromous salmonid spawning and rearing potential by increasing habitat diversity, creating/improving pool habitat and providing fish cover in the lower 1,350 feet of West Fork McGarvey Creek.
- Reduce sediment delivery rates by stabilizing streambanks throughout the lower 1,350 feet of West Fork McGarvey Creek.
- Reestablish redwood and Douglas fir within the riparian corridor of West Fork McGarvey Creek where past riparian logging and have left a riparian canopy composed almost exclusively of red alder. This will significantly increase future LWD supplies, streambank stability and stream shading.
- Monitor and evaluate project effectiveness by establishing a permanent geo-referenced, detailed 3D topographic channel survey and photographic monitoring sites throughout the project reach.
- Improve skills and knowledge of YTFP employees/Yurok Tribal members through hands-on experience implementing instream habitat improvement and riparian restoration projects, topographic survey monitoring, and operating heavy equipment.

Project Methods

A Level IV habitat inventory (Flosi et al. 1998) of West Fork McGarvey Creek was conducted in 1996 as part of the Lower Klamath River sub-basin restoration planning effort. Although primary pool habitats comprised 69% of the total length surveyed only 11% were greater than three feet deep (Table 1). The average shelter rating for pool habitats in 1996 was extremely low (30.2 out of 300 possible). Subsequent annual habitat surveys conducted through the project reach indicate pool habitats have further simplified, resulting in less available habitat for rearing salmonids (YTFP, Unpublished Data). Based on these findings, YTFP constructed habitat cover structures based on methods outlined in Rosgen (1996) and Flosi et al. (1998).

All logs and rootwads used in this project were salvaged from “Humboldt stream crossings” during nearby road decommissioning projects. In addition, several fir trees 18”-24” diameter had to be removed from roadbeds prior to decommissioning. YTWRD was able to push these trees over with an excavator to keep the rootwads intact. YTFP worked in conjunction with YTWRD to transport and stockpile this LWD during the 2005-2007 road decommissioning work seasons in McGarvey Creek. All the wood was stockpiled adjacent to the mouth of the West Fork, at the lower end of the project reach. This resulted in a substantial savings to this project for costs that would have been associated with locating and transporting LWD to the project site.

Based on pre-implementation discussions with Rocco Fiori (Fiori GeoSciences – consulting Geologist) and John Schwabe (CDFG Project Manager), it was determined that all structures would be built without the use of boulders, cable or other means of artificial anchoring. Instead we chose to make use of the stream's soft streambanks and adjacent alder canopy to naturally position and anchor the placed LWD. Not only does this approach result in more natural and aesthetically appealing fish habitat but it alleviates concerns about the long-term fate of cable, rebar and other unnatural materials typically used for anchoring. In addition, it alleviates concerns about the introduction of large diameter boulders in a stream reach where the largest streambed particle size (D_{100}) is 3"-4" and the potential long-term impacts such large boulders could have on the geomorphic function of an alluvial stream reach.

All wood was transported to each structure site and subsequently placed in the channel with the use of a Kubota PC200 Excavator fitted with a bucket & thumb and a set of log-lifting tongs. In addition, A dresser 540 frontend loader was used to transport wood from the stockpile site to the excavator (located across the creek) to minimize the number of required stream crossings.

All fir logs that had rootwads intact were positioned by shoving the end opposite the rootwad into the soft streambanks until just the rootwad and a short section of the tree stem remained exposed. In most cases this resulted in 20-30 feet of the log being inserted into the streambank, providing excellent holding power far superior to that which would normally occur with traditional boulder placement and anchoring techniques. Redwood logs and other larger diameter material were primarily placed in the channel as "digger logs", with one end intertwined between streambank alders and/or other pieces of placed LWD to minimize shifting or movement potential.

Conifer saplings were planted using standard tree planting techniques. Care was taken to select planting sites with appropriate soil and light conditions for each species to maximize survivability. Crewmembers took care when burying root systems to prevent "J-rooting" and ensured each tree was stabilized.

Project Tasks

All work commenced August, 2007 and was completed in March, 2008. Below is a summary of completed tasks:

- We secured 70-80 redwood and Douglas fir logs that were excavated or otherwise removed during the course of road decommissioning being conducted by the Yurok Tribe Watershed Restoration Department in upper McGarvey Creek. These logs were transported to a staging area near the mouth of West Fork McGarvey Creek with a 20-yard end-dump truck.
- Crews installed block nets upstream and downstream of the heavy equipment crossing site on the mainstem of McGarvey Creek at the gaging station, as well as installing a mesh fence and situating emergency clean-up supplies in the project area as specified in the 1600 permit.

- An excavator was used to re-establish access on the decommissioned M800 road that crosses at the gage station and parallels West Fork McGarvey Creek. In addition, two defunct stream crossings along this road were used to provide access to the West Fork floodplain.
- Stockpiled logs were sorted and transported up this re-established road access to the appropriate structure construction sites throughout the project reach.
- We constructed approximately 20 instream structures throughout the project reach, comprised of a total of 61 logs and/or rootwads (Figures 3-4, Table 3). No anchoring was used in constructing these structures as detailed above in the project methods.
- Once structure placement was complete, the M800 roadbed and stream crossings were decommissioned, as well as being thoroughly ripped and loosened to facilitate tree planting. Residual logs and wood were buried and placed on the disturbed portions of the floodplain, as well as wood and vegetative debris being spread on the ripped roadbed surface.
- All remaining LWD that was not placed in structures was stockpiled along the M-10 road for use during summer 2008 structure construction in mainstem McGarvey Creek.
- Crews planted a total of 2,100 bareroot coastal redwood and 1,900 bareoot Sitka spruce throughout lower West Fork McGarvey Creek (Figure 5). This included 700 redwood and 900 spruce planted within the project area and an additional 1,400 redwood and 1,000 spruce planted upstream of the project area to a large redwood LWD jam believed to be the coho anadromous barrier. All bareroot trees were stock purchased from Hastings Tree Nursery in Smith River California.
- 249 five-gallon potted coastal redwood trees, 133 five-gallon potted western red cedar trees, and 23 five-gallon big-leaf maple trees were planted throughout the project area (Figure 5). The potted trees, donated by YTFP from our native tree nursery in Klamath, were planted along the areas adjacent to the stream channel that were disturbed by the excavator. The conifer trees averaged 24”-36” tall and the maple trees averaged 48”-72” tall. They were utilized to accelerate revegetation in the disturbed areas due to their larger size and more developed root systems.
- YTFP planted a total of 630 willow sprigs throughout the abandoned beaver pond just upstream of the project reach (Figure 5). The beaver dam that held back this pond was washed away in high flows approximately 4-5 years ago and no beaver have been observed in the area since prior to this event. The old pond site is one of the few large areas in McGarvey Creek with a wide open tree canopy and adequate direct solar input to support willows. As a result we planted the willow sprigs in addition to the conifer bareroot trees planted in the area to facilitate reestablishment of a diverse native riparian canopy. It is YTFP’s hope that a reestablished willow canopy will eventually attract beaver back to the area.

- YTFP removed a large Himalayan blackberry patch from the old landing and quarry site adjacent to the confluence of Mainstem and West Fork McGarvey Creeks (Figure 5). Upon removing this berry patch, a large earthen berm was discovered that had been constructed perpendicular and adjacent to the stream channel out of tailings from the quarry site. Our consulting geologist/Geomorphologist (Rocco Fiori) determined that this berm was creating an undesirable floodplain restriction and would impair flood flows. As a result, the berm was removed with the excavator and the material used to recontour the floodplain prior to being revegetated with native conifers.
- YTFP conducted pre-project stream channel topographic surveying using a total station during July 2007. This surveying, conducted with a Nikon total station, included a full longitudinal profile of West Fork McGarvey Creek from the old beaver pond (upstream of this project area) down through the confluence with mainstem McGarvey Creek. In addition, five monumented stream channel cross-sections were installed and surveyed in this same reach (Figure 3). These geomorphic surveys provided baseline for long-term geomorphic monitoring of the site. The topographic surveys will be repeated during summer 2008 to document channel changes following the first winter after structure installation, and will also be repeated in future years on a regular interval.
- Each piece of placed LWD was marked with a sequentially numbered aluminum tag and two survey pins were inserted at each exposed end of every piece of wood (Figure 97, Table 3). These pins were then all surveyed using a Nikon total station during late fall 2007 (Figures 3-4). These pins will be resurveyed during summer 2008 and on regular intervals thereafter to document any shifting or movement of each of the LWD pieces. This will provide valuable long-term data on the effectiveness of our anchor-free LWD placement approach.
- Long-term photographic monitoring stations were established and photographs were taken of pre- and post-restoration conditions throughout the project area.

Monitoring Results

A detailed three dimension topographic survey of the project area was surveyed during July 2007. All surveying was conducted using a Nikon Total Station and the resultant topographic data was brought into ArcView and rectified to the Klamath Glen USGS 1993 DOQ. This survey included a longitudinal profile of West Fork McGarvey Creek from the old beaver pond (upstream of this project area) down through the confluence with mainstem McGarvey Creek. In addition, five monumented stream channel cross-sections were installed and surveyed in this same reach (Figures 6-11). Permanent benchmarks and cross section pins were established to allow repeat surveying over time. The topographic surveys will be repeated during summer 2008 to document channel changes following the first winter after structure installation, and will also be repeated in future years on a regular interval.

Restoration goals included the placement of large woody debris throughout the project reach to increase habitat diversity, pool depth, and cover complexity. The topographic surveys will be repeated during summer 2008 to document channel changes following the first winter after structure installation, and will also be repeated in future years on a regular interval. Analysis of successive longitudinal profiles throughout the reach will provide YTFP with the ability to assess geomorphic channel changes over time.

In addition, it was a project goal to effectively place large woody debris without the use of boulders, cable or other means of artificial anchoring. A potential concern with this approach would be how much this wood will move over time during high flow events and what the fate and effectiveness of the wood is if and when such movement occurs. Each piece of placed LWD was marked with a sequentially numbered aluminum tag and two survey pins were inserted at each exposed end of every piece of wood (Figure 97, Table 3). These pins were then all surveyed using a Nikon total station during late fall 2007 (Figure 3-4). These pins will be resurveyed during summer 2008 and on regular intervals thereafter to document any shifting or movement of each of the LWD pieces. This will provide valuable long-term data on the effectiveness of our anchor-free LWD placement approach and allow us to adapt our placement techniques to best achieve our restoration goals.

Project Reporting Metrics

Habitat Projects (all):

Watershed plan identifying project as a priority:

- Lower Klamath Sub-Basin Watershed Restoration Plan (Gale and Randolph 2000)
- Recovery Strategy for California Coho Salmon (CDFG 2004)

Priority habitat limiting factors identified in plans that are addressed by project:

- Increase/improve instream fish cover
- Protection/stabilization of streambanks
- Revegetation/rehabilitation of riparian canopies

This project addressed the following tasks in the California state coho recovery plan:

- Task # KR-KG-13 Supplement ongoing efforts to provide short-term and log-term benefits to coho salmon by restoring LWD and shade through a) LWD placement and c) improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors.
- Task # KR-KG-08a Implement the plan to restore in-channel and riparian habitat in tributaries.
- Task # KR-KG-07 Treat sediment sources and improve riparian and instream habitat conditions to provide adequate and stable spawning and rearing areas for coho salmon.
- Task # KR-KG-09 Develop a plan to provide suitable accumulations of woody cover in slow-velocity habitats for coho salmon winter rearing on a short-term basis by placing wood in needed areas until natural supplies become available.

Type of monitoring included in project:

- Geomorphic surveying (channel cross sections and a longitudinal profile).
- LWD movement monitoring (total station survey of each LWD piece).
- Photographic documentation of pre- and post-restoration conditions.

Number of stream miles treated/affected by project:

- Stream miles treated: 0.53 miles (2,800 feet)
- Stream miles affected: 0.53 miles (2,800 feet)

Instream Habitat Projects (HI):

Description of instream treatments used, including site locations referenced to an established landmark, number of treatment sites, and any modifications to site/treatment design:

- See Project Methods and Project Tasks sections above.

Riparian Habitat Projects (HR):

Number of miles treated: 0.53 miles (2,800 feet)

Number of acres treated: 4.8 acres

Number of acres and type of invasive species controlled: 0.02 acres – Himalayan blackberry.

Species and size of trees planted: Willow (sprigs ~1-2" diameter x 24" long), Douglas fir (18"-24"), coastal redwood (18"-36"), western red cedar (24"-36"), Sitka spruce (18"-24"), big-leaf maple (48"-72").

Number of trees/density of plantings: 2,100 bareroot coastal redwood, 249 5-gallon coastal redwood, 133 5-gallon western red cedar, 1,900 bareroot Sitka spruce, 23 5-gallon big-leaf maple, and 630 willow sprigs. Trees were spaced every eight feet throughout the planting areas.

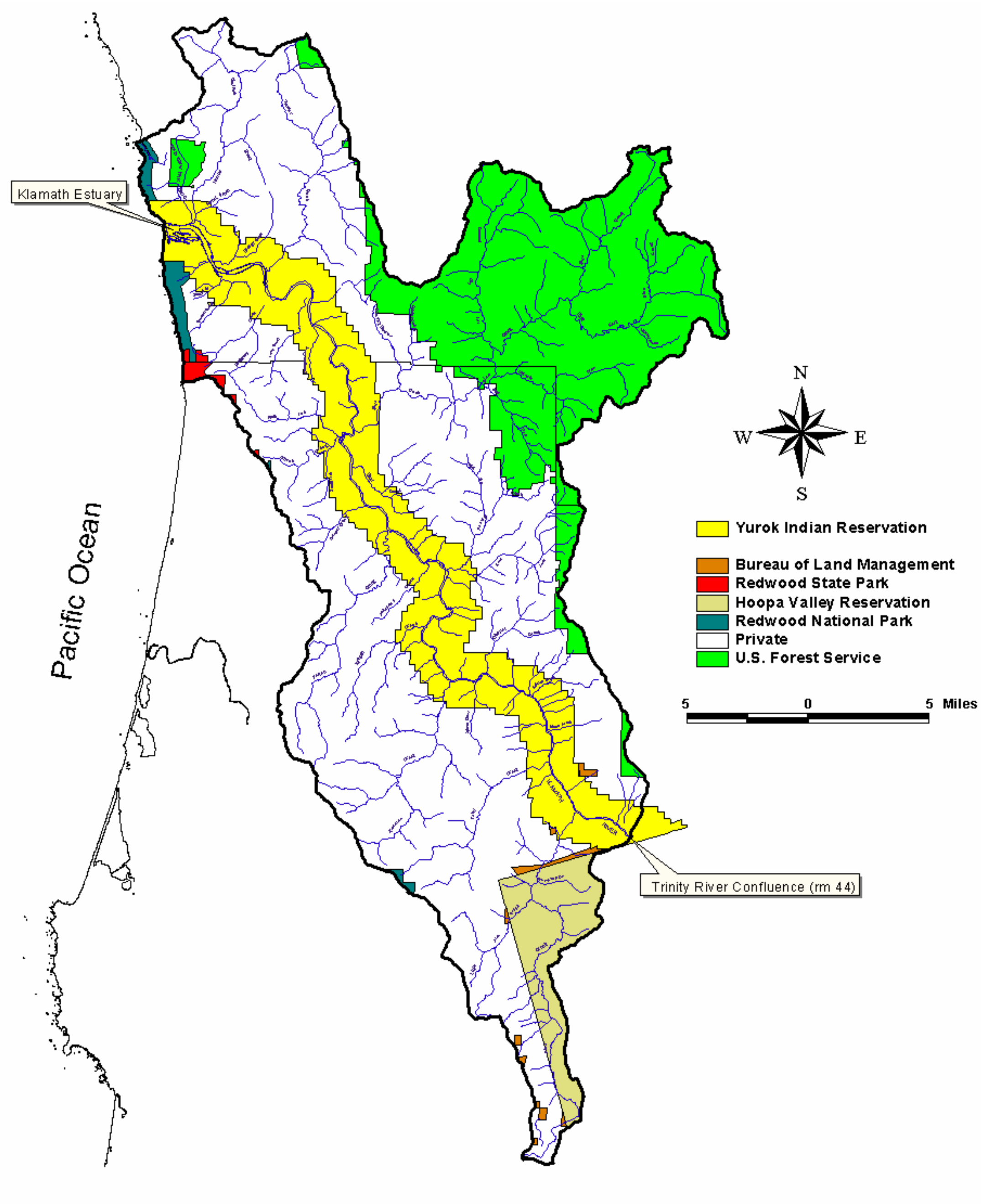

Figure 1. Lower Klamath River Sub-basin, California.

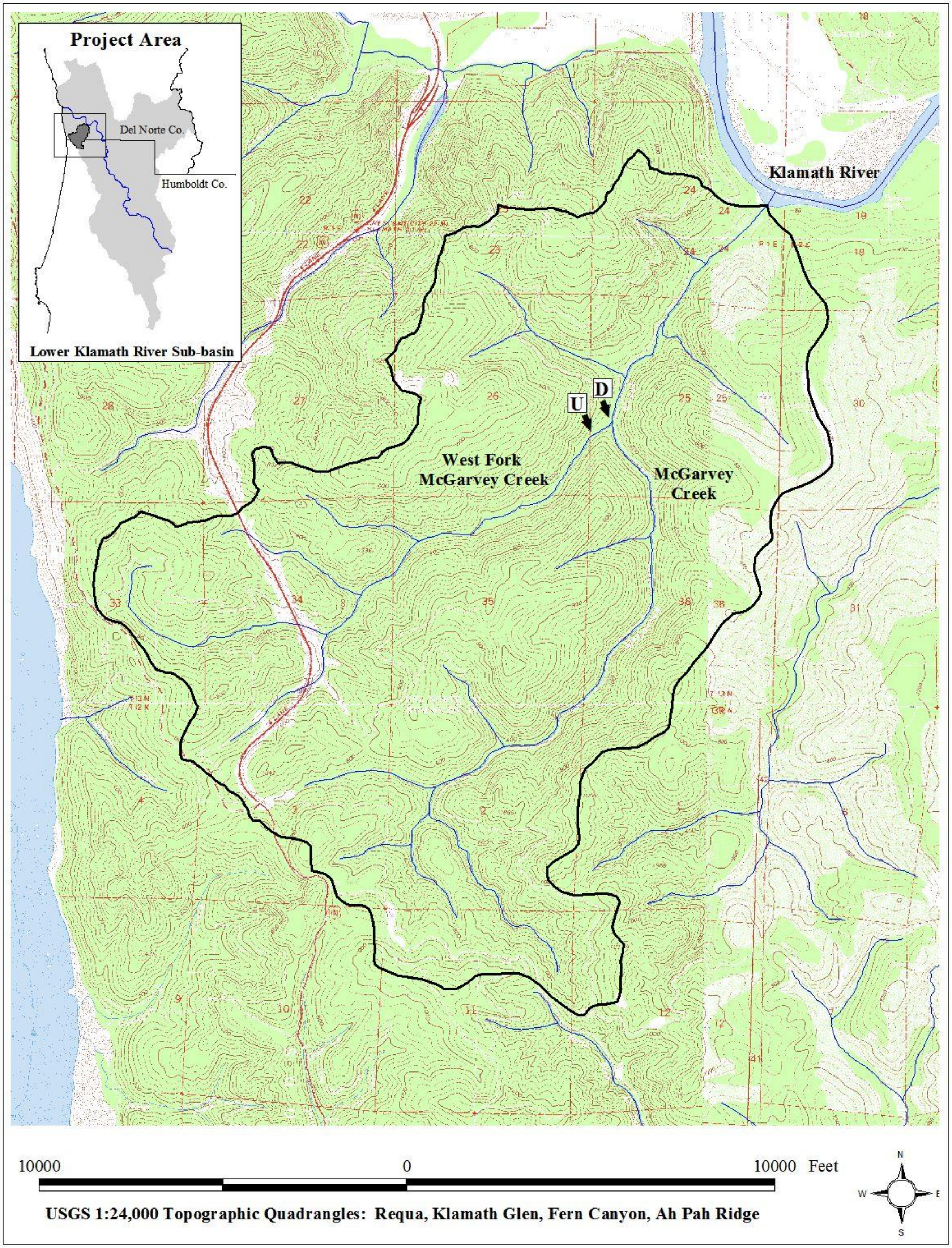

Figure 2. Instream restoration project location map, West Fork McGarvey Creek, Lower Klamath River, California, 2008.

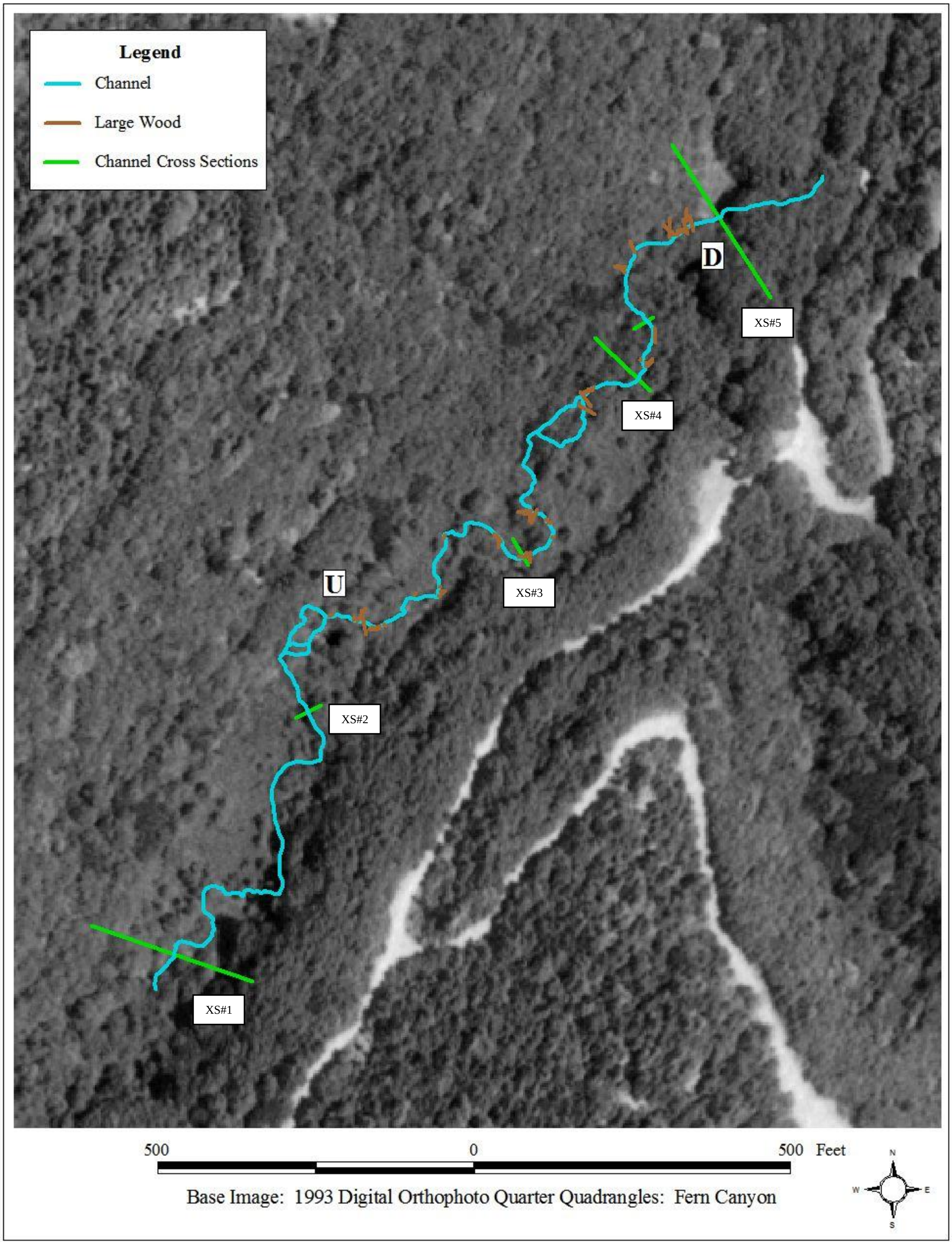

Figure 3. Digital orthophoto detailing surveyed stream thalweg, channel cross sections, and locations of placed large woody debris, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

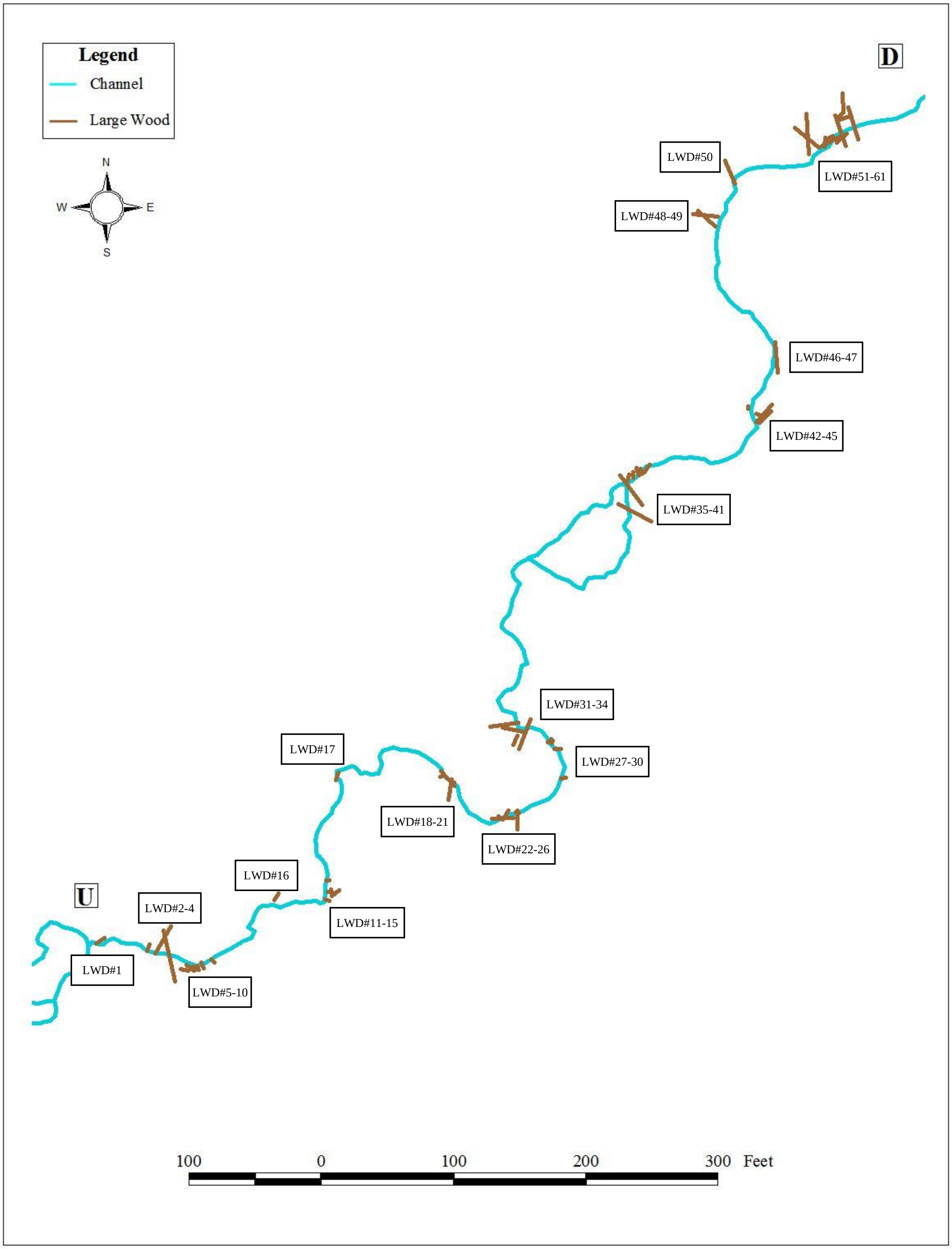

Figure 4. Stream channel thalweg within project reach and locations of placed large woody debris, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

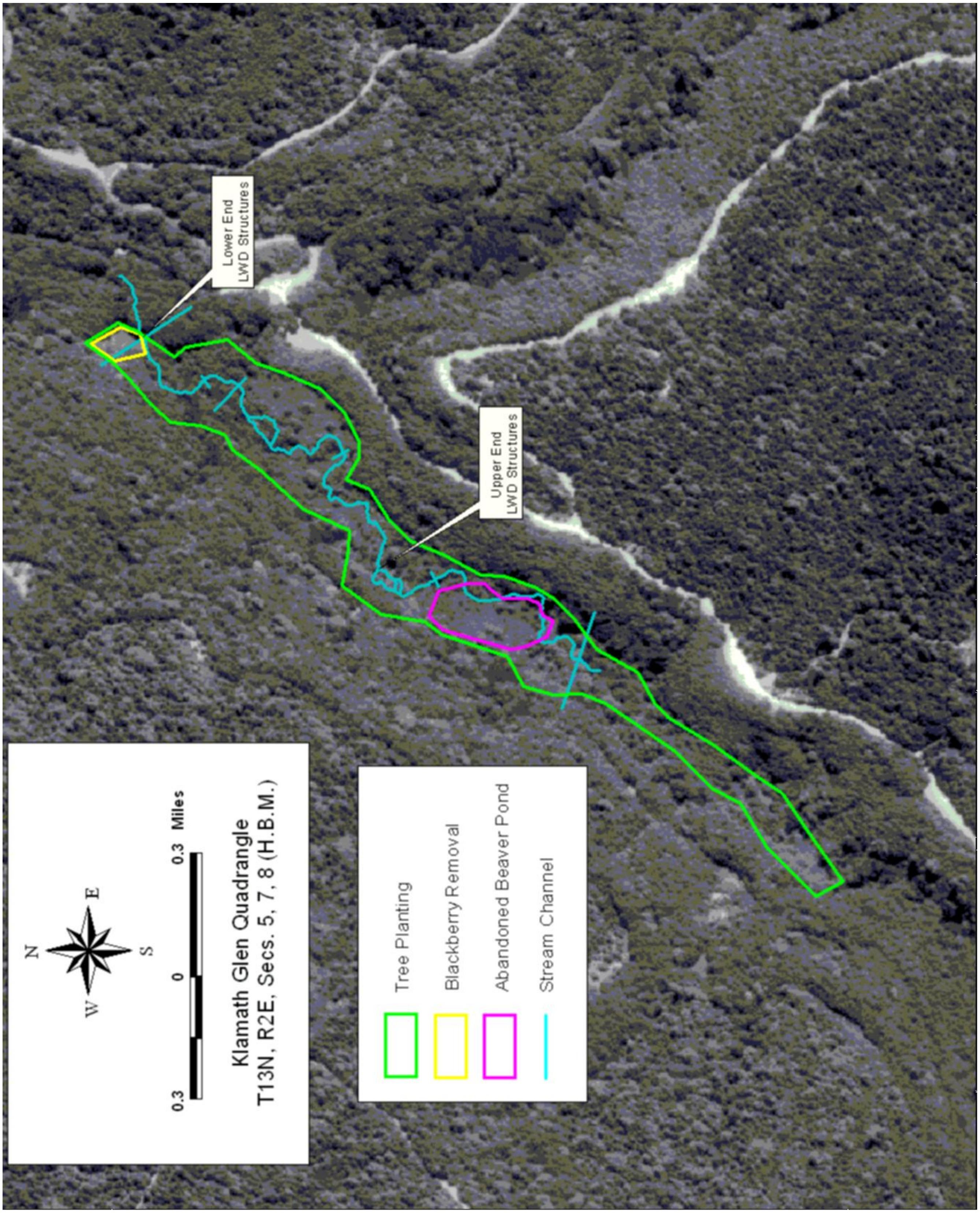

Figure 5. Riparian tree planting and exotic vegetation removal sites,
West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Table 1. Summary of physical habitat and riparian parameters by tributary, Lower Klamath River, California, 1996-1998.

Tributary	Drainage Size (sq. mi.)	Stream Order	Dominant Channel Type	Pool:Flatwater:Riffle Ratio	% Pools >=3ft Max. Depth	Ave. Shelter Rating	Prim./Sec. Cover Type	Prim./Sec. Substrate Type	Ave. Embeddedness (%)	Ave. Canopy Closure (%)	% Conifers in Canopy	Existing LWD Density (# pieces/mile)	Total Future LWD Density (# pieces/mile)	% Future LWD Composed of Live Conifers	% Future LWD Composed of Deciduous Trees <2' Dia.	Sub-surface Flow Severity
High Prairie Creek	4.2	2	A-4	46:44:10	7.1	31.5	LWD/BL	GR/SC	25-50	80%	23%	N/S	N/S	N/S	N/S	M
Hunter Creek																
- Mainstem	23.8	4	C-4	43:50:07	48.4	20.0	BL/LWD	GR/SC	50-75	79%	10%	186	328	14.9%	55.5%	H
- East Fork		3	B-4	26:73:01	10.5	18.8	LWD/BL	GR/SL	50-75	88%	7%	351	456	13.0%	55.4%	M
- Mynot Creek	4.9	2	F-4	49:48:03	5.3	23.7	TV/BL	GR/SA	50-75	76%	15%	209	381	33.8%	32.7%	H
Hoppaw Creek																
- Mainstem	4.9	3	F-4	37:39:24	1.7	15.7	LWD/SWD	GR/SC	50-75	91%	11%	275	413	24.4%	28.4%	H
- North Fork		2	A-4	62:11:27	2.0	17.1	LWD/BL	GR/SC	50-75	95%	27%	537	556	41.8%	23.5%	L
Saugep Creek	1.7	2	F-4	38:56:06	2.5	11.4	TV/SWD	GR/SL	50-75	84%	0%	N/S	N/S	N/S	N/S	L
Terwer Creek																
- Mainstem	32.8	4	B-3	36:52:12	32.9	67.1	BL/WW	BL/GR	0-25	61%	18%	169	512	21.9%	12.3%	M
- East Fork		3	A-2	35:59:07	13.7	84.7	BL/WW	BL/GR	25-50	71%	5%	264	519	20.7%	11.8%	N/A
McGarvey Creek																
- Mainstem	8.6	3	C-4	70:26:04	18.5	27.8	LWD/SWD	GR/SC	50-75	89%	8%	359	907	7.4%	61.4%	M
- West Fork		2	C-4	74:20:06	11.4	30.2	LWD/SWD	SL/GR	50-75	94%	11%	445	1,129	6.4%	68.9%	N/A
Tarup Creek	4.9	3	C-4	71:19:10	25.8	20.5	LWD/SWD	GR/SC	50-75	97%	7%	228	515	12.1%	59.2%	H
Omagaar Creek	2.5	2	B-4	35:52:13	5.0	19.4	LWD/BL	GR/SC	25-50	95%	10%	233	641	14.7%	56.4%	H
Blue Creek																
- Mainstem (below barrier)	128.3	5	C-2	23:61:16	88.4	14.2	BL/WW	BL/LC	25-50	41%	34%	N/S	N/S	N/S	N/S	N/A
- Crescent City Fork	13.4	4	B-2	27:61:12	51.3	17.2	BL/WW	LC/BL	25-50	87%	42%	169	569	56.1%	16.6%	N/A
- Nickowitz Creek	12.4	3	B-2	25:66:09	22.0	14.8	BL/WW	GR/SC	25-50	90%	27%	135	567	39.8%	31.4%	N/A
- Slide Creek	5.7	2	A-2	19:65:16	42.4	18.5	BL/WW	LC/BL	25-50	38%	77%	94	538	69.3%	2.3%	N/A
- West Fork	9.7	3	B-2	30:62:08	44.3	17.5	BL/WW	LC/GR	50-75	86%	12%	216	590	12.7%	41.3%	N/A
Ah Pah Creek																
- Mainstem	16.3	4	B-3	33:61:06	3.8	16.2	LWD/SWD	GR/SA	25-50	84%	8%	394	778	19.9%	54.0%	M
- North Fork		3	B-4	40:54:06	11.1	15.9	LWD/SWD	GR/SC	25-50	82%	9%	262	777	27.7%	53.4%	M
- South Fork		2	A-2	34:63:03	5.4	12.7	SWD/LWD	GR/SA	25-50	89%	9%	400	890	21.0%	48.4%	M
Bear Creek																
- Mainstem	19.3	3	A-2	38:47:15	9.8	74.1	BL/WW	BL/LC	25-50	73%	8%	188	323	26.2%	16.6%	H
- North Fork		3	B-3	32:52:16	6.3	78.4	BL/WW	BL/GR	25-50	77%	7%	312	533	23.4%	10.8%	N/A
Surpur Creek	5.7	3	B-3	73:23:04	19.9	16.5	BL/SWD	GR/SC	50-75	89%	6%	321	677	21.5%	46.2%	L
Little Surpur Creek	2.7	2	A-2	64:35:01	19.7	13.2	SWD/BL	SC/GR	50-75	93%	10%	255	486	21.1%	59.9%	L
Tectah Creek	19.9	3	B-3	48:45:07	27.8	18.6	BL/LWD	LC/SC	25-50	86%	11%	131	559	23.0%	49.5%	M
Johnsons Creek	3.4	2	B-3	69:27:04	15.6	15.6	BL/UC	SC/GR	50-75	94%	3%	116	474	3.5%	73.9%	H
Pecwan Creek (Lower Mainstem)	27.7	4	B-2	24:62:14	45.0	22.2	WW/BL	GR/BL	50-75	74%	31%	N/S	N/S	N/S	N/S	L
Mettah Creek																
- Mainstem	10.7	3	B-2	40:51:09	11.2	30.0	BL/WW	GR/SC	50-75	86%	17%	112	150	14.5%	12.5%	L
- South Fork		2	B-2	24:64:12	7.1	29.1	WW/BL	GR/SC	50-75	89%	22%	181	143	4.6%	20.4%	N/A
Roaches Creek	29.5	4	B-2	46:49:05	37.7	31.0	BL/WW	GR/BL	50-75	78%	30%	34	112	35.5%	8.2%	L
Morek Creek	4.0	2	A-2	24:51:25	4.6	18.9	BL/WW	GR/BL	50-75	85%	34%	78	309	4.5%	80.6%	L
Cappell Creek	8.6	2	A-2	43:30:27	18.6	21.8	WW/BL	BL/GR	50-75	79%	41%	N/S	N/S	N/S	N/S	L
Tully Creek																
- Mainstem	17.3	3	B-3	24:71:05	34.7	14.8	BL/WW	BL/GR	25-50	79%	8%	106	254	12.9%	9.9%	L
- Robbers Gulch		2	B-3	39:52:09	12.5	13.5	BL/SWD	SC/BL	50-75	84%	8%	166	363	10.3%	3.1%	N/A

Cover Type Codes: LWD= Large Woody Debris SWD=Small Woody Debris BL=Boulder WW=Whitewater TV=Terrestrial Vegetation UC=Undercut Bank

Substrate Codes: SL=Silt/Clay SA=Sand GR=Gravel SC=Small Cobble LC=Large Cobble BL=Boulder

Table 2. Summary of aquatic species presence by tributary,
Lower Klamath River, California, 1996-2002.

Tributary	Chinook Salmon	Coho Salmon	Steelhead	Coastal Cutthroat Trout	Resident Rainbow Trout	Pacific/Brook Lamprey	Prickly/Coastrange Sculpin	Speckled Dace	Threespine Stickleback	Klamath Small Scale Sucke	Pacific Giant Salamander	Yellow Legged Frog	Tailed Frog
High Prairie Creek	n	y	y	y	n	y	y	y	y	y	y	y	y
Hunter Creek													
- Mainstem	y	y	y	y	n	y	y	y	y	y	y	y	y
- East Fork	y	y	y	y	n	n	y	n	n	n	y	n	y
- Mynot Creek	y	y	y	y	n	y	y	y	y	y	y	n	n
- Kurwitz Creek	n	n	y	y	n	n	y	n	n	y	y	n	y
Hoppaw Creek													
- Mainstem	y	y	y	y	n	y	y	y	y	y	y	n	y
- North Fork	n	y	y	y	n	n	y	y	y	y	y	n	y
Saugep Creek	y	y	y	y	n	y	y	y	y	y	y	n	n
Waukell Creek	n	y	n	y	n	y	y	y	n	n	n	n	n
Terwer Creek													
- Mainstem	y	y	y	y	n	y	y	y	y	n	y	y	y
- East Fork	n	y	y	y	n	n	y	n	n	n	y	n	y
McGarvey Creek													
- Mainstem	y	y	y	y	n	y	y	y	y	y	y	y	y
- West Fork	n	y	y	y	n	y	y	y	y	y	y	y	n
Tarup Creek	y	y	y	y	n	y	y	y	y	y	y	y	n
Omagaar Creek	n	y	y	y	n	n	y	y	n	n	y	y	y
Blue Creek													
- Mainstem (below barrier)	y	y	y	y	y	y	y	y	y	y	y	y	n
- Mainstem (above barrier)	n	n	n	n	y	n	n	n	n	n	y	n	n
- East Fork	n	n	n	n	y	n	n	n	n	n	y	n	n
- Crescent City Fork	y	y	y	y	y	n	y	n	n	n	y	n	n
- Nickowitz Creek	y	n	y	n	y	n	y	n	n	n	y	n	n
- Slide Creek	n	n	y	n	y	n	y	n	n	n	y	n	n
- West Fork	y	y	y	n	n	n	y	y	n	n	y	n	n
Ah Pah Creek													
- Mainstem	n	y	y	y	n	n	y	y	n	n	y	y	y
- North Fork	n	n	y	y	n	n	y	y	n	n	y	n	y
- South Fork	n	y	y	y	n	n	y	y	n	n	y	n	y
Bear Creek													
- Mainstem	y	y	y	y	n	n	y	y	y	y	y	y	y
- North Fork	n	n	y	y	n	n	y	n	n	n	y	y	y
Surpur Creek	n	n	y	y	n	n	y	y	n	n	y	y	n
Little Surpur Creek	n	y	y	y	n	n	y	y	n	n	y	y	n
Tectah Creek	y	y	y	y	n	y	y	y	y	n	y	y	y
Johnsons Creek	y	y	y	y	n	n	y	y	n	y	y	y	y
Pecwan Creek													
- Mainstem	y	y	y	y	n	n	y	y	n	y	y	y	n
- East Fork	n	n	n	n	y	n	n	n	n	n	y	n	n
- West Fork	n	n	n	n	y	n	n	n	n	n	y	n	y
Mettah Creek													
- Mainstem	y	n	y	y	n	n	y	y	n	n	y	y	n
- South Fork	n	n	y	y	n	n	n	n	n	n	y	y	y
Roaches Creek	y	y	y	n	y	y	y	y	y	n	y	y	n
Morek Creek	n	n	y	n	n	n	y	n	n	n	y	y	y
Cappell Creek	n	n	y	n	y	n	y	n	n	n	y	n	n
Tully Creek													
- Mainstem	n	n	y	n	n	n	y	n	n	n	y	y	n
- Robbers Gulch	n	n	y	n	n	n	n	n	n	n	y	n	n

Table 3. Summary of large woody debris placed in lower West Fork McGarvey Creek, Lower Klamath River, California, 2007.

LWD Piece #	Tag #	Species	Length (ft)	Width (in)	Rootwad Present (Y/N)	Notes
1	37	Redwood	12	48	Y	Large rootwad on bank
2	38	Redwood	10	36	Y	Plunged in bank
3	39	Fir	28.5	26	Y	Digger log
4	40	Redwood	42	22	N	Full-channel spanner
5	41	Redwood	12	28	N	Redwood slab slanted on bank to deflect flow
6	42	Redwood	12	12	N	Plunged in bank
7	43	Fir	30	12	Y	Plunged in bank
8	44	Fir	30	14	Y	Plunged in bank
9	45	Fir	30	16	Y	Plunged in bank
10	46	Fir	30	13	4	Plunged in bank
11	47	Fir	30	19	Y	Plunged in bank
12	48	Fir	30	16	Y	Plunged in bank
13	49	Fir	30	17	Y	Plunged in bank
14	50	Fir	10	12	N	Vertical Anchor Pole
15	51	Fir	30	14	Y	Plunged in bank
16	52	Redwood	12	32	Y	Rootwad plunged in bank in natural alcove
17	53	Fir	6	40	Y	Rootwad placed in backwater above large natural spanner log
18	54	Redwood	15	28	N	Positioned parallel to left bank
19	55	Fir	30	17	Y	Plunged in bank under tag#54
20	56	Redwood	18	24	N	Spanner log over tag #54 Right bank end shifted downstream during winter 2007-2008
21	57	Fir	10	12	N	Vertical Anchor Pole
22	58	Redwood	19	24	N	Old-growth root placed over tag#59-62
23	59	Fir	30	22	Y	Plunged in bank
24	60	Fir	30	24	Y	Plunged in bank
25	61	Redwood	15	28	Y	Placed in natural alcove over tag#62
26	62	Fir	30	12	Y	Plunged in bank
27	63	Fir	30	17	Y	Plunged in bank
28	64	Fir	30	16	Y	Plunged in bank
29	65	Fir	30	17	Y	Plunged in bank
30	66	Fir	30	15	Y	Plunged in bank
31	67	Redwood	27	28	N	Angled spanner log with 2' plunge into right bank
32	68	Redwood	9	32	Y	Perched over pool below #67 - wad angled into pool
33	69	Redwood	18	36	N	Digger log
34	70	Redwood	27	32	N	Digger log
35	71	Maple	31	24	N	Digger log
36	72	Maple	36	36	N	Full-channel spanner
37	73	Fir	30	14	Y	Plunged in bank
38	74	Maple	10	18	N	Digger log
39	75	Redwood	8	28	Y	Angled against bank between tags#74+76
40	76	Fir	30	12	Y	Plunged in bank
41	77	Fir	30	16	Y	Plunged in bank
42	78	Redwood	18	20	N	Placed parallel to right bank with tags#79-80 Upper end pivoted D/S during winter 2007-2008 and now a spanner
43	79	Fir	30	15	Y	Plunged in bank
44	80	Redwood	14	30	N	Keyed in over tag#79 and underneath overhanging alder just upstream
45	-	Redwood	12	32	N	Plunged in left bank Forgot to place log tag but has survey pin and flagging. Need to add log tag.
46	81	Fir	30	17	Y	Plunged in bank under tag#82
47	82	Redwood	25	36	Y	Positioned parallel to right bank
48	83	Fir	25	24	Y	Digger log - stem crossed under tag#84 and keyed between alders
49	84	Fir	25	24	Y	Digger log - stem crossed over tag#83 and keyed between alders
50	85	Redwood	27	34	N	Digger Log
51	86	Redwood	33	28	Y	Forked Digger log placed in WF McGarvey conflucence pool
52	87	Fir	29	16	Y	Digger log angled 45 degrees under tag#86
53	88	Fir	20	16	N	Placed in backwater below tags#86-87
54	89	Fir	10	18	N	Placed in backwater below tags#86-87
55	90	Redwood	7	12	N	Placed in backwater below tags#86-87
56	91	Fir	30	12	Y	Plunged in bank
57	92	Redwood	27	36	N	Digger log
58	93	Redwood	29	36	N	Digger log
59	94	Redwood	8	24	N	Placed on floodplain to prevent tags#92-93 from shifting
60	95	Redwood	8	36	N	Placed on floodplain to prevent tags#92-93 from shifting
61	96	Redwood	16	72	Y	Hugh burl/rootwad placed on floodplain beind tags#92-95 Too large to move to creek

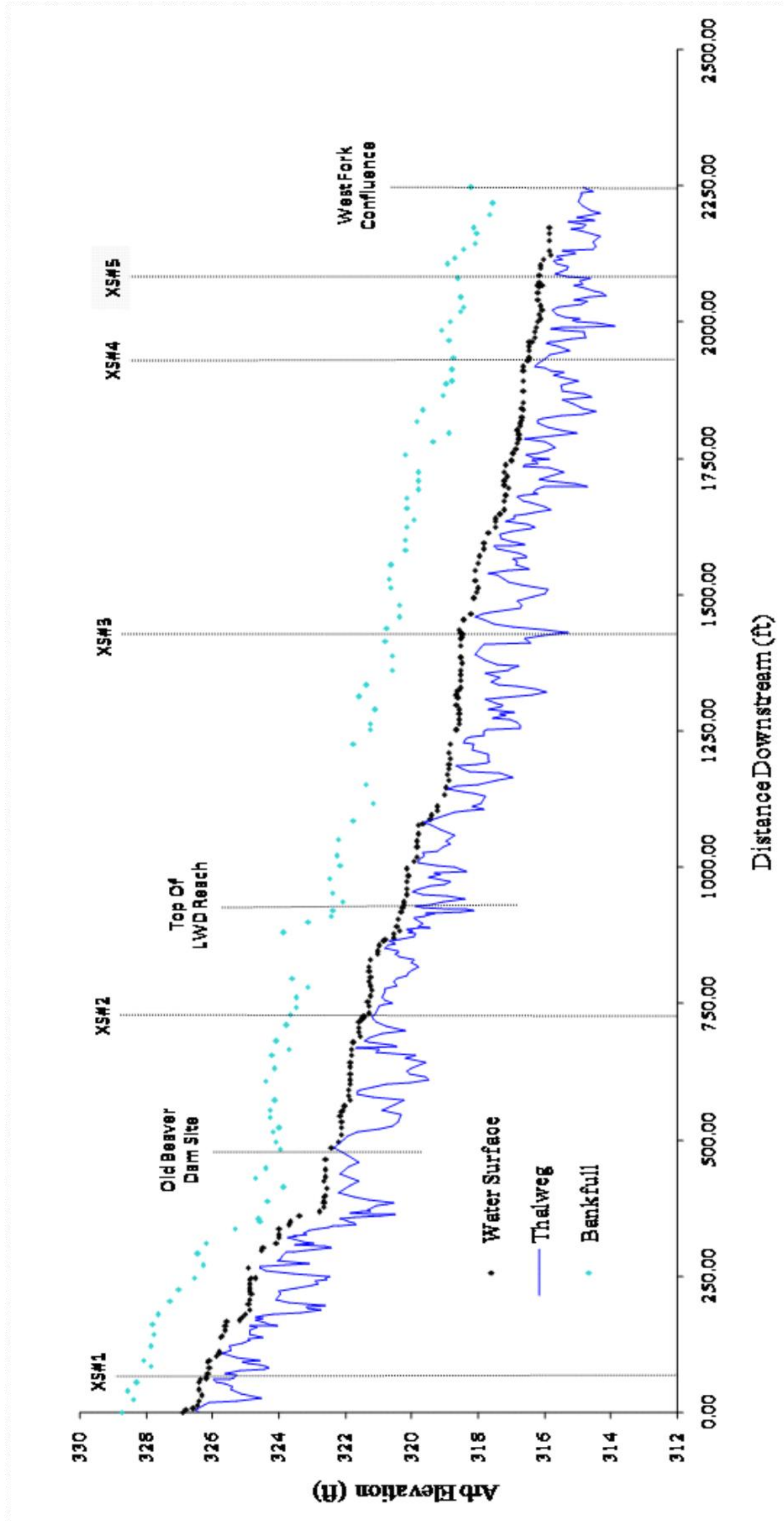

Figure 6. Longitudinal profile of lower 2,250 feet of West Fork McGarvey Creek stream channel, Lower Klamath River, California, 2007.

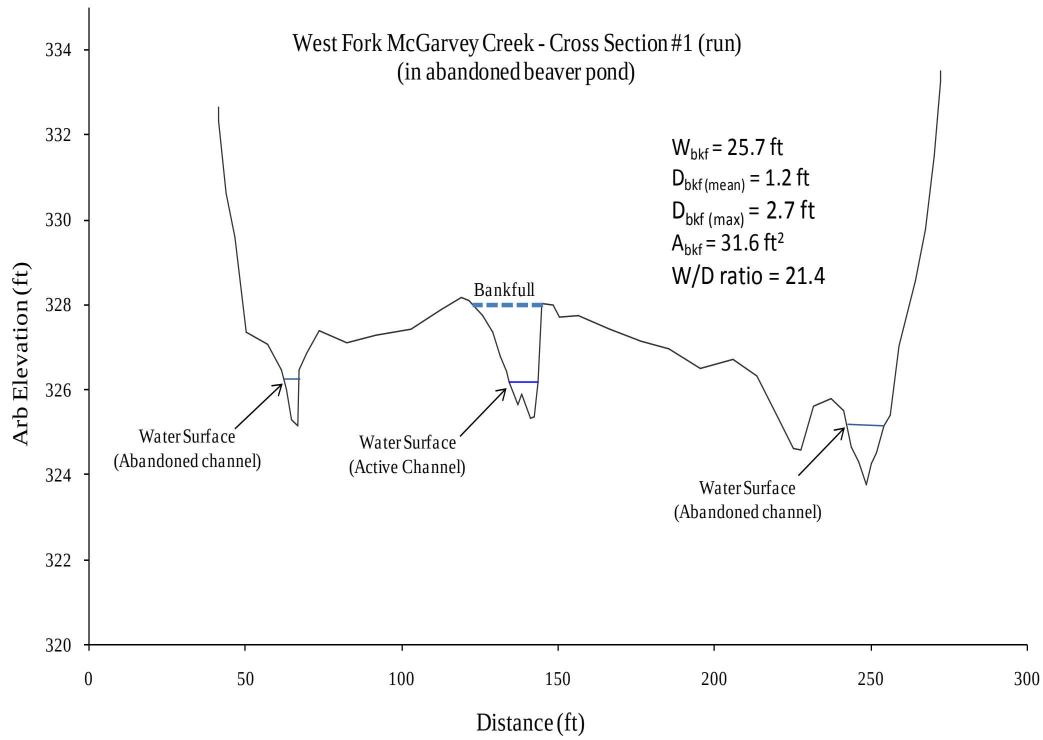

Figure 7. Channel cross-sectional profile (XS#1) upstream of project reach in abandoned beaver pond, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

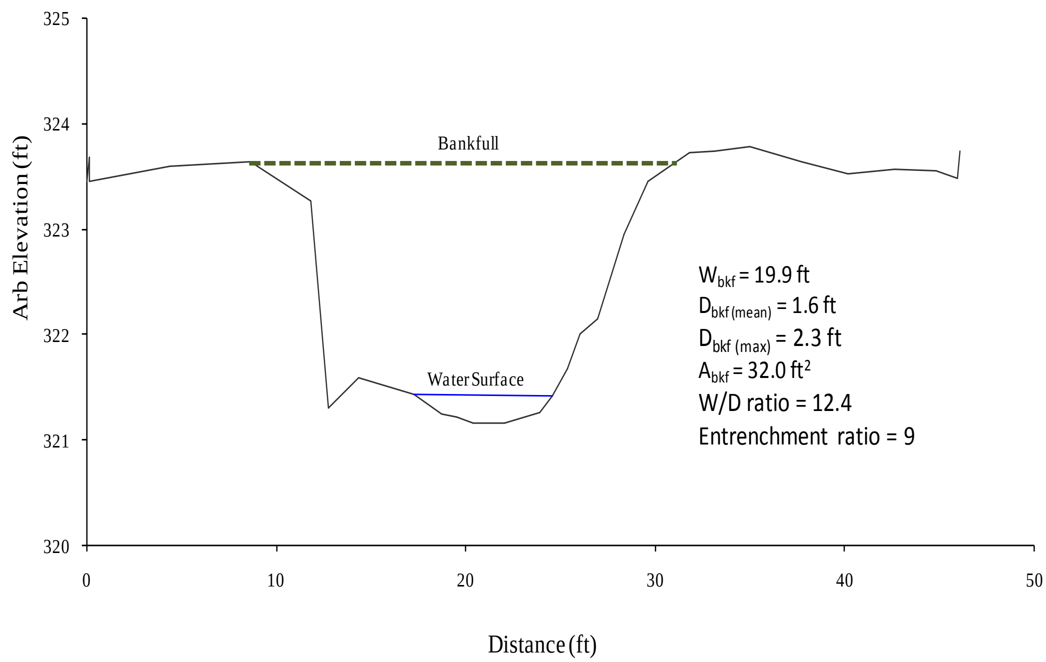

Figure 8. Channel cross-sectional profile (XS#2) in riffle upstream of project reach, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

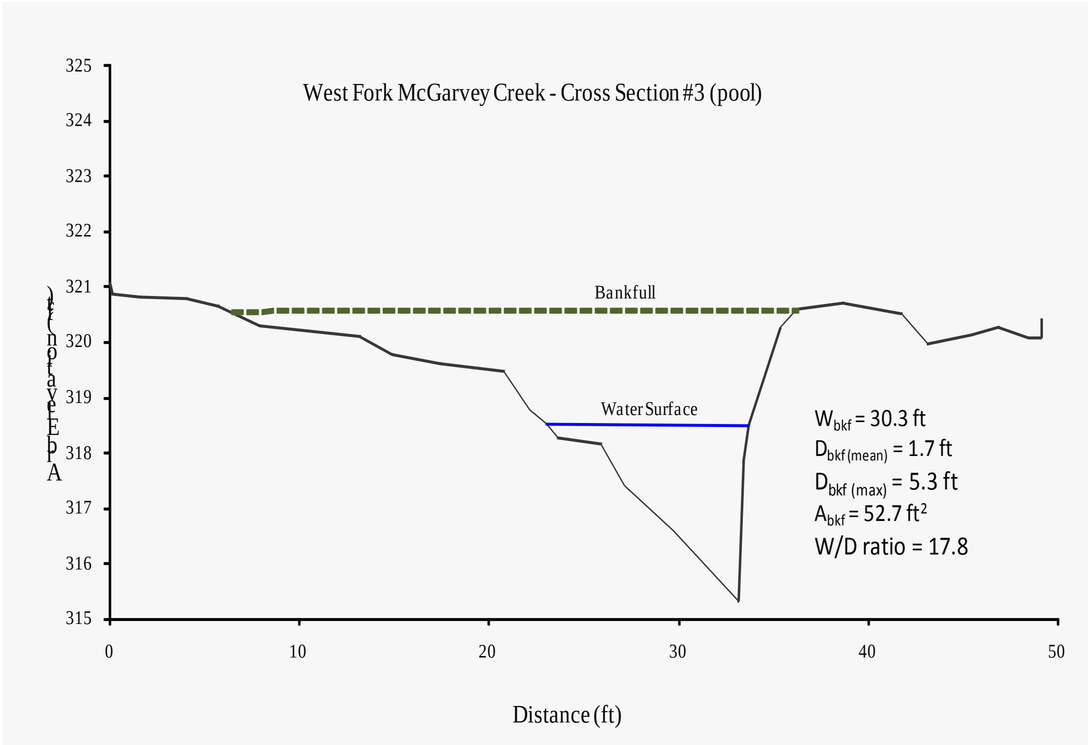

Figure 9. Channel cross-sectional profile (XS#3) in lateral scour pool in project reach, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

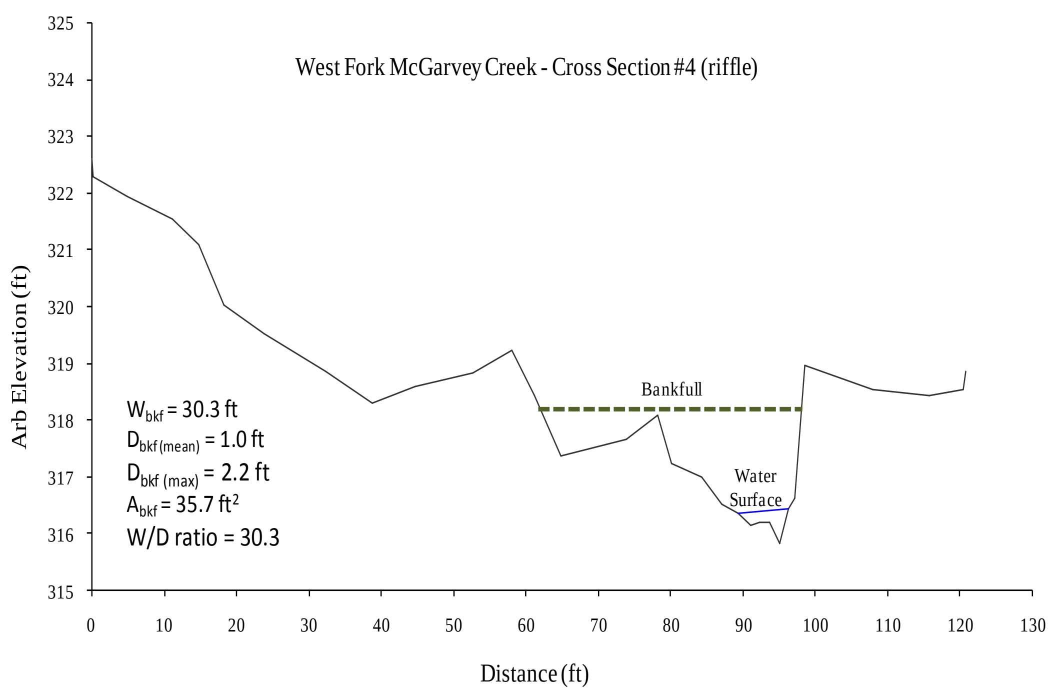

Figure 10. Channel cross-sectional profile (XS#4) in riffle in project reach, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

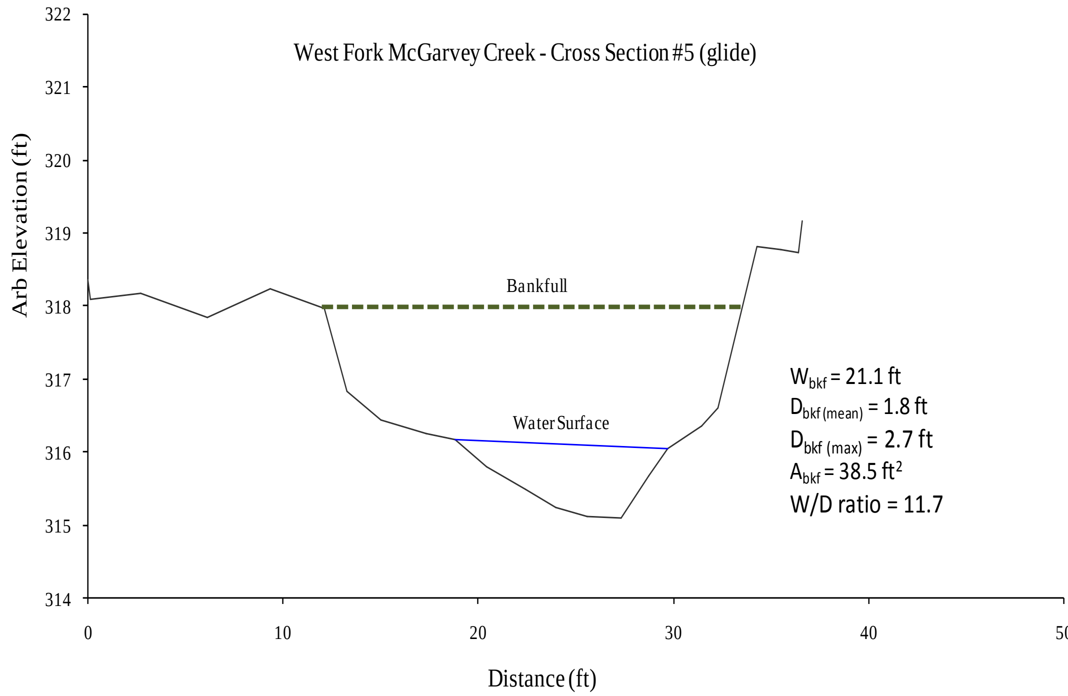

Figure 11. Channel cross-sectional profile (XS#5) in glide in project reach, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 12. McGarvey Creek watershed, Lower Klamath River, California, 2005.

Figure 13. Large woody debris retrieved from “Humboldt” stream crossing during road decommissioning, McGarvey Creek, Lower Klamath River, California 2006.

Figure 14. LWD being transported from road decommissioning site to West Fork stockpile area, McGarvey Creek, Lower Klamath River, 2006.

Figure 15. Road decommissioning-salvaged LWD being unloaded at West Fork stockpile area, McGarvey Creek, Lower Klamath River, California, 2007.

Figure 16. Rootwad being transported to West Fork stockpile area, McGarvey Creek, Lower Klamath River, California, 2007.

Figure 17. Transporting LWD to stream channel, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 18. Transporting LWD to stream channel, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 19. Positioning LWD between anchor trees along stream channel, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 20. Watershed Restoration Specialist providing excavator training to YTFP crew member, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 21. Fir log being plunged into streambank with excavator, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 22. Fir log being plunged into streambank with excavator, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 23. Fir log being plunged into streambank with excavator, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 24. Fir log being plunged into streambank with excavator, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 25. Fir log being plunged into streambank with excavator, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 26. Shallow pool at top end of project reach prior to installation of LWD piece #1, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 27. Shallow pool at top end of project reach following installation of LWD piece #1, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 28. LWD piece #1 following first winter, West Fork McGarvey Creek, Lower Klamath River, California, 2008.

Figure 29. Shallow pool near top end of project reach during installation of LWD pieces #2-4, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 30. Shallow pool near top end of project reach during installation of LWD pieces #2-4, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 31. LWD pieces #2-4 following first winter, West Fork McGarvey Creek, Lower Klamath River, California, 2008.

Figure 32. LWD pieces #2-4 following first winter, West Fork McGarvey Creek, Lower Klamath River, California, 2008

Figure 33. Shallow pool near top of project reach prior to installation of LWD pieces #5-10, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 34. Shallow pool near top of project reach during installation of LWD pieces #5-10, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 35. Shallow pool near top of project reach following installation of LWD pieces #5-10, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 36. LWD pieces #5-10 following first winter, West Fork McGarvey Creek, Lower Klamath River, California, 2008.

Figure 37. Shallow pool near top of project reach following installation of LWD pieces #11-15, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 38. LWD pieces #11-15 following first winter, West Fork McGarvey Creek, Lower Klamath River, California, 2008.

Figure 39. LWD piece #16 following first winter, West Fork McGarvey Creek, Lower Klamath River, California, 2008.

Figure 40. LWD piece #16 following first winter, West Fork McGarvey Creek, Lower Klamath River, California, 2008.

Figure 41. Backwater pool above natural full-spanning log prior to placing rootwad (LWD piece #17), West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 42. Rootwad (LWD piece #17) being placed in backwater pool, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 43. Rootwad (LWD piece #17) following placement in backwater pool, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 44. LWD piece #17 following first winter, West Fork McGarvey Creek, Lower Klamath River, California, 2008.

Figure 45. LWD piece #17 following first winter, West Fork McGarvey Creek, Lower Klamath River, California, 2008.

Figure 46. Shallow pool prior to installation of LWD pieces #18-21, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 47. Shallow pool during installation of LWD pieces #18-21, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 48. Shallow pool following installation of LWD pieces #18-21, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 49. Shallow pool following installation of LWD pieces #18-21, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 50. LWD pieces #18-21 following first winter, West Fork McGarvey Creek, Lower Klamath River, California, 2008.

Figure 51. LWD pieces #18-21 following first winter, West Fork McGarvey Creek, Lower Klamath River, California, 2008.

Figure 52. Shallow pool prior to installation of LWD pieces #22-26, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 53. Shallow pool prior to installation of LWD pieces #22-26, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 54. Shallow pool following installation of LWD pieces #22-26, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 55. Shallow pool following installation of LWD pieces #22-26, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 56. LWD pieces #22-26 following first winter, West Fork McGarvey Creek, Lower Klamath River, California, 2008.

Figure 57. LWD pieces #22-26 following first winter, West Fork McGarvey Creek, Lower Klamath River, California, 2008.

Figure 58. Shallow pool following installation of LWD pieces #27-30, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 59. Shallow pool following installation of LWD pieces #27-30, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 60. LWD pieces #27-30 following first winter, West Fork McGarvey Creek, Lower Klamath River, California, 2008.

Figure 61. LWD pieces #27-30 following first winter, West Fork McGarvey Creek, Lower Klamath River, California, 2008.

Figure 62. Shallow pool during installation of LWD pieces #31-34, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 63. Shallow pool following installation of LWD pieces #31-34, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 64. Shallow pool following installation of LWD pieces #31-34, West Fork McGarvey Creek, Lower Klamath River, California, 2007.

Figure 65. LWD pieces #31-34 following first winter, West Fork McGarvey Creek, Lower Klamath River, California, 2008.

Figure 66. LWD pieces #31-34 following first winter, West Fork McGarvey Creek, Lower Klamath River, California, 2008.