High Priority Tasks for Salt Creek

- Continue coordinating with pertinent landowners to try and develop mutually desirable conservation easement strategies or other innovative approaches that would result in long-term protection and enhancement of critically important wetlands in Salt Creek.

- Continue working to obtain full landowner support and a final design for the High Prairie Creek confluence reach. This task would also include preparing any necessary documents and permit applications required to implement the preferred design.

- Continue coordinating with the CalTrans and the Counties of Humboldt and Del Norte on future road-related projects (i.e. grade raises, bridge or culvert replacements) to ensure resource and cultural concerns are addressed and to help direct any mitigation activities. This effort is performed by multiple Tribal Departments and requires, at times, a high level of internal and external coordination and thus funding.

- Continue collecting physical and biological baseline data in the watershed. Priority programs to maintain include topographic surveying, water quality and quantity monitoring, and juvenile coho investigations. Information gained from these programs has been invaluable and will allow us to quantify the effectiveness future restoration.

Hunter Creek

Hunter Creek is a fourth order watershed draining to the north side of the Klamath River estuary less than one mile upstream of the Pacific Ocean (Figure 16). The 28.7 mi^2 watershed supports anadromous populations of chinook and coho salmon, steelhead and coastal cutthroat trout, and multiple lamprey species. Lower Hunter Creek also provides critical rearing and staging habitat for non-natal fish migrating through the estuary. The Klamath River estuary serves as a vital nursery and staging area for spring and fall-run chinook, coho, winter and summer-run steelhead, coastal cutthroat, sturgeon, eulachon, and lamprey. It is likely that tens of millions of juvenile salmonids migrate through the estuary every year on their way to the ocean (Wallace 1995). Estuary rearing allows juvenile fish to grow and physiologically adapt for ocean survival prior to ocean entry. Studies conducted in Oregon indicate that ocean survival of juvenile chinook was greatly increased when fish entered the ocean at larger sizes (120-160 mm) (Nicholas and Hankin 1989).

Studies conducted in the Klamath River estuary indicate that estuary rearing of juvenile chinook tends to be brief, with mean residency time ranging between 8.7 - 16.2 days (Wallace 2000). Results from water quality and food availability studies suggest that water management activities, seasonal high water temperatures, and a lack of preferred prey items for juvenile salmonids play a role in the limited estuary residency of juvenile chinook (Wallace 1995; Wallace 1998; Hiner and Brown 2004). These limiting conditions present a juvenile salmonid with the option to enter the ocean at a sub-optimal size or find better quality rearing habitat in off-estuary areas. Off-estuary habitats of the Klamath River include the lower reaches of Salt Creek; Hunter Creek and its tributaries: Spruce Creek,

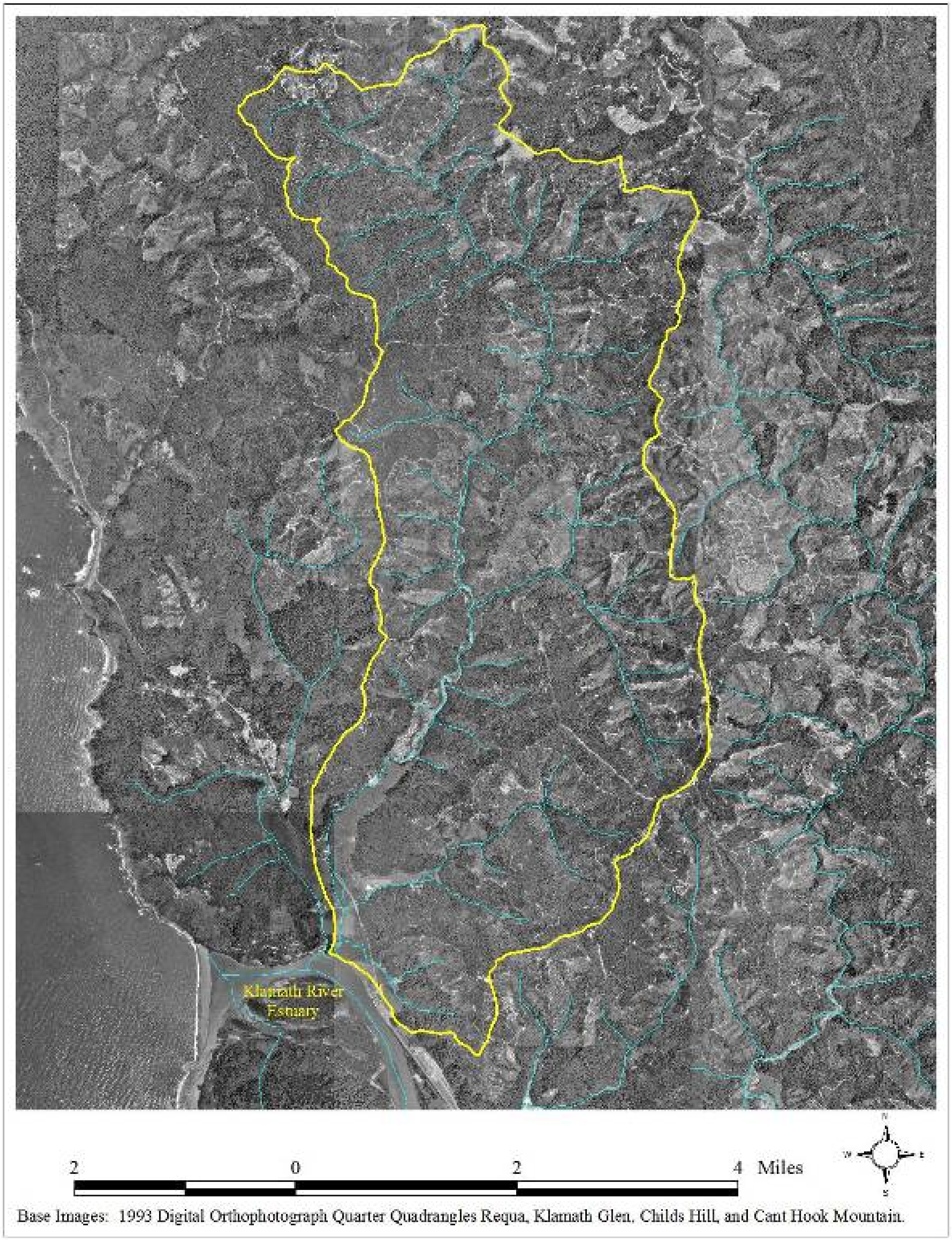


Figure 16. The Hunter Creek watershed, Lower Klamath River Sub-basin, California.

Mynot Creek, and Panther Creek; Hoppaw Creek; Richardson Creek; and Waukell Creek (Figure 17). Recent fisheries investigations conducted in these tributaries suggest that significant numbers of natal and non-natal salmonids use off-estuary habitats during the year, especially during winter – spring (Figure 18) (Beesley and Fiori 2004; YTFP In Progress).

YTFP has been conducting physical and biological monitoring in Hunter Creek since the late 1990s. YTFP conducted baseline stream and riparian habitat mapping and large wood inventories in the anadromous portion of the watershed and monitored salmonid outmigration in lower Hunter Creek from 1996 to 2001 (Tables 1 – 2). Over the past several years, YTFP has also been collecting historic information for the area to better characterize the changes in fisheries and riparian habitat through time. The watershed has been impacted by historic and current water and land management activities that have resulted in draining and conversion of off-estuary wetlands, removal of old growth conifers from riparian habitats, simplification of stream and riparian habitats, increased channel sedimentation, and loss of large wood in the fluvial corridor of Hunter Creek (Beesley and Fiori 2004; Hiner and Brown 2004; Gale and Randolph 2000; Graham Matthews & Associates 2006). Large flood events occurring over the last 150 years have exacerbated degraded watershed conditions by increasing rates of riparian loss, channel widening, and valley aggradation. To address these conditions, the CCC and CDFG implemented extensive riparian planting and large wood placement projects in Hunter Creek and East Fork Hunter Creek beginning in the late 1990s.

Channel aggradation in lower Hunter Creek has also resulted in damage to private property in a residential housing community located in the watershed (Figures 19 – 20). In 2004, channel instability occurring in the vicinity of the residential community prompted a concerned landowner to obtain an emergency gravel extraction permit to excavate a new channel away from the housing development (Figures 20 – 21). The excavation was conducted by a local dairy business in October 2004 and with minimal guidance and no regulatory oversight. Although there were several storms and high flow events during winter 2004 – 2005; the residential community sustained minimal damage (Figure 22). However, poor channel design resulted in substantial bank erosion and loss of riparian vegetation (primarily willow, alder, and shrubs) throughout the treatment reach.

In fall 2005, the operators from the previous year took over the emergency permit and worked with NOAA to design and excavate a new channel through the reach (Figure 23). However, the operation was once again carried out with minimal technical guidance and no regulatory oversight. The result was construction of an oversized channel with nearly vertical banks (Figure 24). The residential community did not suffer flood damage that winter but the implemented design resulted in significant bank erosion and further loss of riparian plants. Throughout the two year extraction process, YTFP and FGS worked hard to coordinate with the initial permit holder, the operators, the U.S. Army Corps of Engineers, and NOAA to ensure resource protection for Tribal Trust fish and wildlife. Unfortunately, gravel was extracted in a manner that resulted in a substantial loss of fisheries and wildlife habitat due to a lack of regulatory oversight prior and during the two year project. YTFP and FGS continue to work with the landowners to develop a mitigation strategy for the site and to design a properly functioning channel through the reach to reduce flooding impacts to local residents and improve conditions for Tribal Trust fish and wildlife.

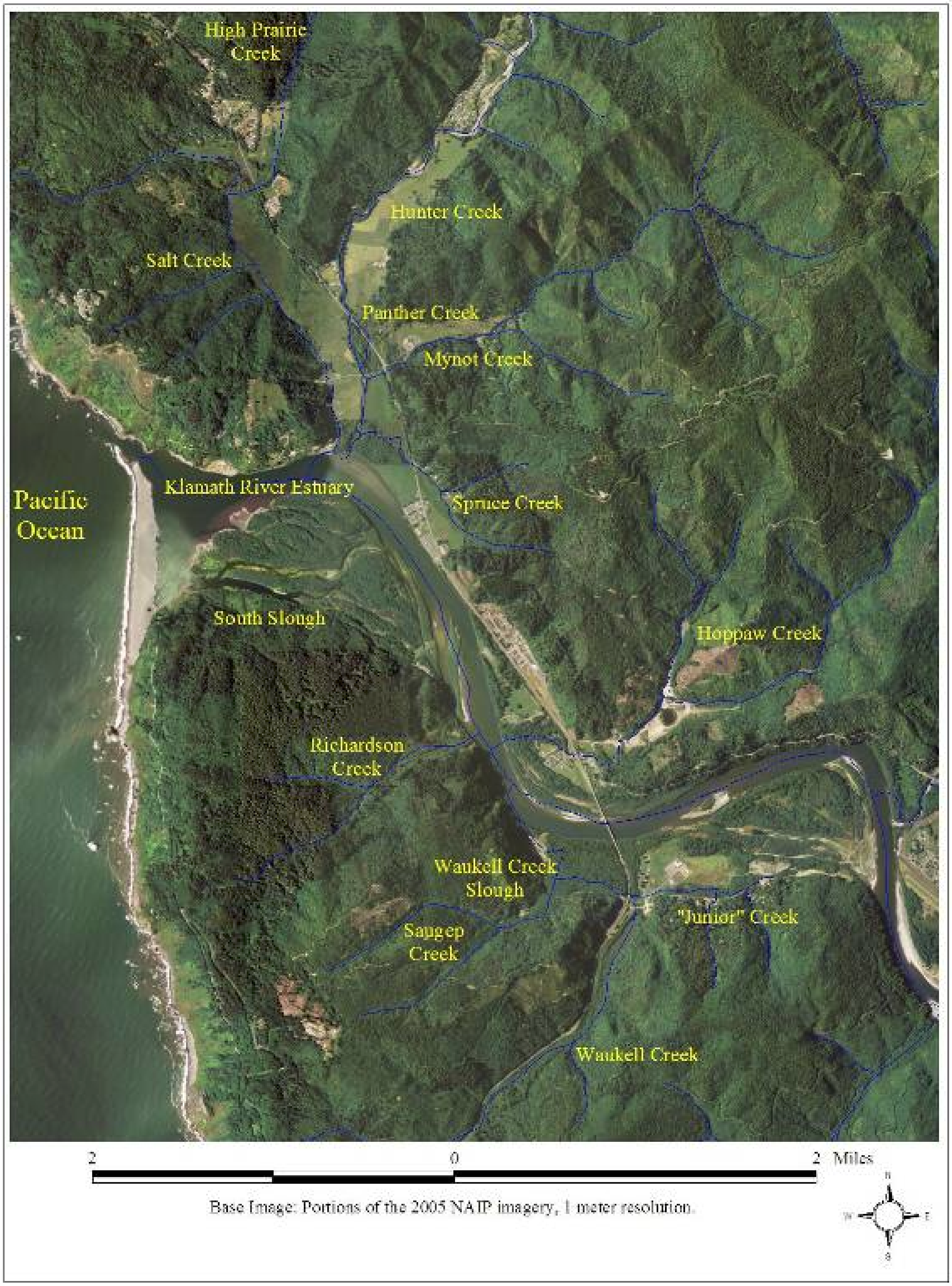


Figure 17. Map of the Klamath River Estuary and associated off-estuary tributaries, Lower Klamath River Sub-basin, California (Base image: portions of the 2005 NAIP imagery, 1 meter resolution).

Figure 18. A juvenile coho salmon (120 mm fork length) captured in a migrant trap located in lower Salt Creek, Lower Klamath River Sub-basin, California (April 2003).

Table 1. Summary of physical habitat and riparian parameters by tributary, Lower Klamath River Sub-basin, 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 Sub-basin, California, 1996-2002.

Tributary	**Chinook Salmon**	**Coho Salmon**	**Steelhead**	**Coastal Cutthroat Trout**	**Resident Rainbow Trout**	**Pacific/Brook Lamprey**	**Prickly/Coastrange Sculpi**	**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

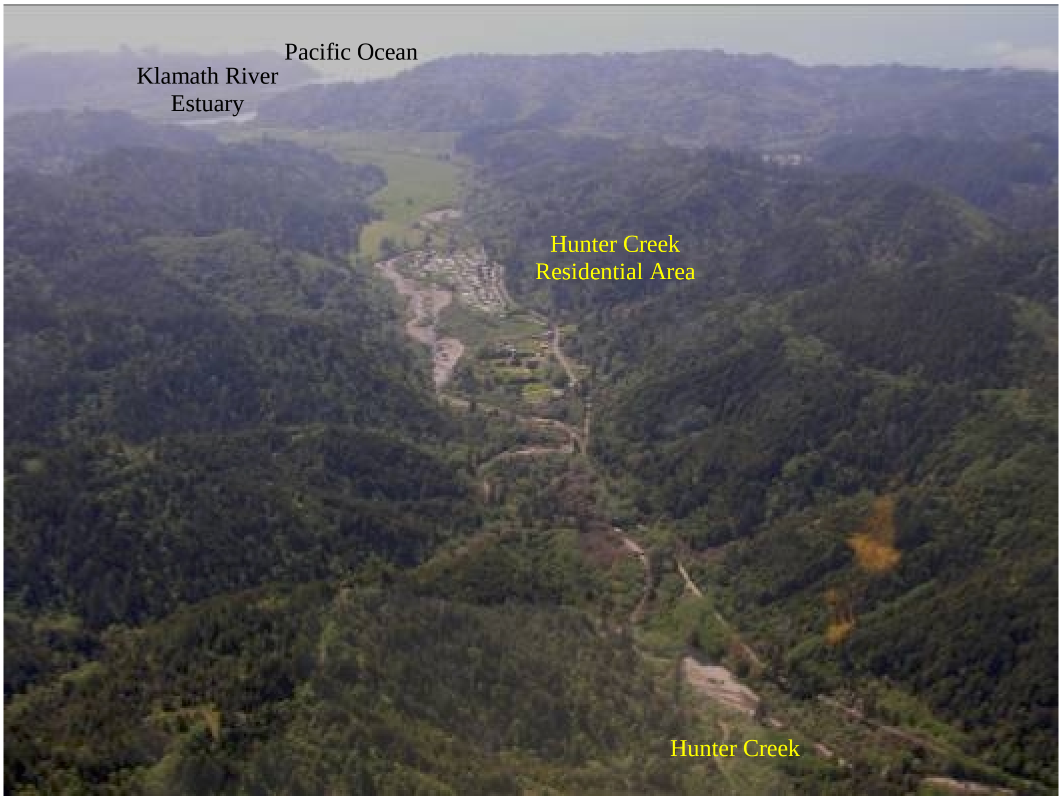
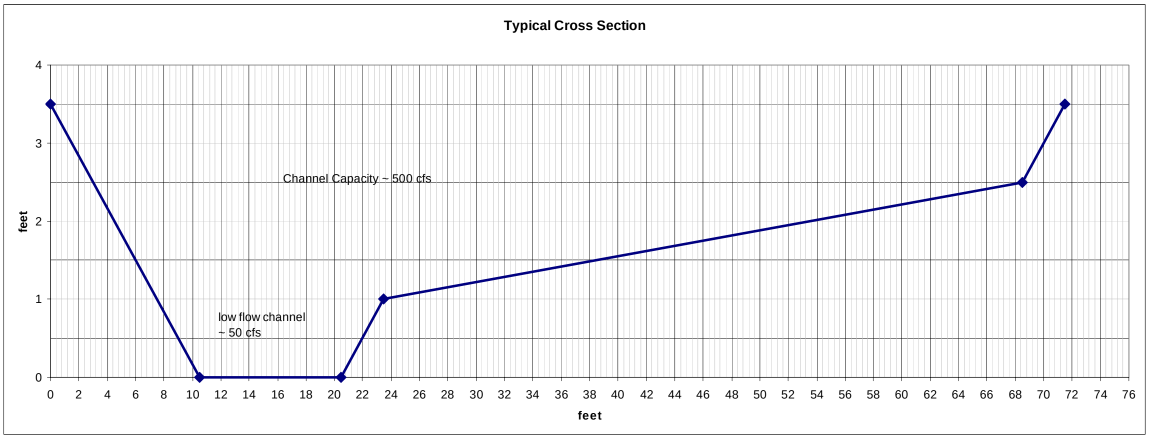


Figure 19. Oblique aerial photograph of lower Hunter Creek obtained from a small airplane, Lower Klamath River Sub-basin, California (April 2005).

Figure 20. Photographs of the fluvial corridor of Hunter Creek and the housing development, Lower Klamath River Sub-basin, California (October 2004).

Figure 21. Photographs of the fluvial corridor of Hunter Creek during channel excavation operations, Lower Klamath River Sub-basin, California (Late October 2004) (Note the white house located in the top three photographs).

Figure 22. Hunter Creek in the vicinity of the housing development during a high flow event in December 2004, Lower Klamath River Sub-basin, California.



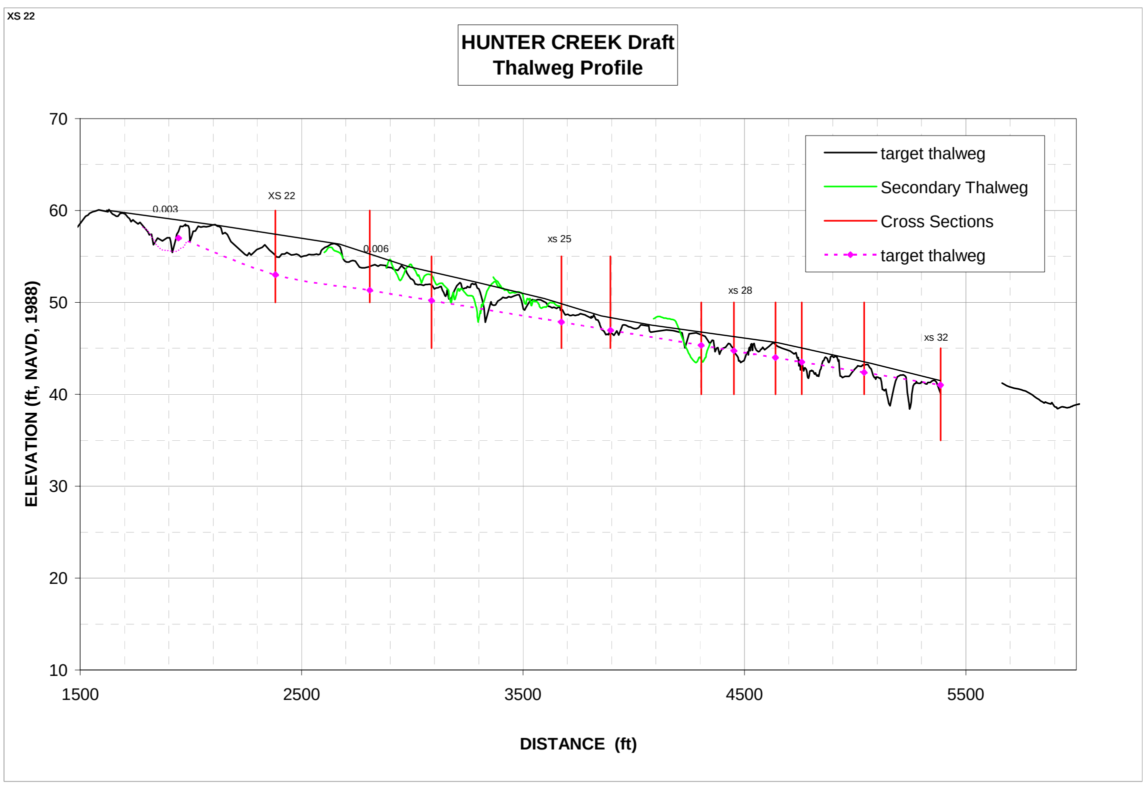


Figure 23. Example of a typical cross section design (top image) and thalweg profile (bottom image) provided by the National Oceanic and Atmospheric Administration for Hunter Creek, Lower Klamath River Sub-basin, California.

Figure 24. Photographs of the fluvial corridor of Hunter Creek during the second year of channel excavation operations, Lower Klamath River Sub-basin, California (October 2005).

Hydrologic and Topographic Assessments

Stream gages were installed at key locations in Salt Creek and High Prairie Creek (Salt Creek's major tributary) during fall 2005 and in Hunter Creek during April 2006 to examine stream flow, wetland storage and outflow relations, and Klamath River backwater interactions in these tidally influenced watersheds (Figure 25). Water stage was recorded at these sites every ten minutes using Global Water Level Loggers and permanent cross sections were established at all four gage locations. Discharge was measured at various flow levels over the study period to develop stage rating curves for High Prairie Creek, lower Salt Creek, and Hunter Creek. Crest stage gages were installed in winter 2006 and 2007 to document peak flow elevations and estimate water surface profiles for critical reaches in these watersheds (Figure 25).

A network of survey control points was established using GPS Total Stations in spring 2006. Control points were tied to National Geodetic Survey (NGS) benchmarks with a 1988 North American Vertical Datum (NAVD88) and 1983 North American Datum (NAD83) for horizontal coordinates. YTFP has since been conducting optical total station surveys of stream channels and floodplains in the Hunter-Salt valley to develop an accurate topographic model of the estuary and priority off-estuary habitats (Figure 26). A combination of topographic and bathymetric surveys, aerial photograph mapping, and U.S. Geological Survey (USGS) 10 meter Digital Elevation Model (DEM) contours are being used to develop the digital terrain model (DTM). The DTM of the project area is continually evolving as more topographic and bathymetric data is collected and incorporated into YTFP GIS. YTFP will also obtain Light Detection and Radar (LiDAR) imagery and DEMs for the YIR in 2009.

Location and elevation data of stream gages, staff plates, crest stage gages were collected during 2006 – 2007 to allow the conversion of water surface elevations measured at the various locations to a common vertical datum. The topographic-hydrologic data has allowed YTFP to examine how flow and tide conditions in the Klamath River estuary influence the tributaries draining the north side of the Klamath River estuary. YTFP will continue documenting backwater conditions and other hydrologic parameters over the next few years to assist restoration planning efforts. Collecting this data over multiple water year types (i.e. dry versus wet years) will provide critical data necessary for developing geomorphic based restoration alternatives for these and other priority off-estuary tributaries.

YTFP and FGS also established topographic survey control in the vicinity of the residential community in 2004 prior to the initial channel excavation. YTFP and FGS collected pre- and post-extraction data for this reach in both 2004 and in 2005. In 2006, YTFP coordinated with Graham Mathews & Associates to conduct a more extensive survey of lower Hunter Creek (Figure 27) (Graham Matthews & Associates 2006). The survey data collected in lower Hunter Creek since 2004 has been incorporated into YTFP GIS and the DTM of the Klamath River estuary. Given the legal complexities associated with the 2004 and 2005 extractions, we have proceeded with caution with regards to developing potential restoration designs in the vicinity of the residential community. However, we continue to coordinate with the landowners and regulatory authorities and collect geomorphic data in lower Hunter Creek to help determine the best approach to channel instability and riparian dysfunction in this reach.

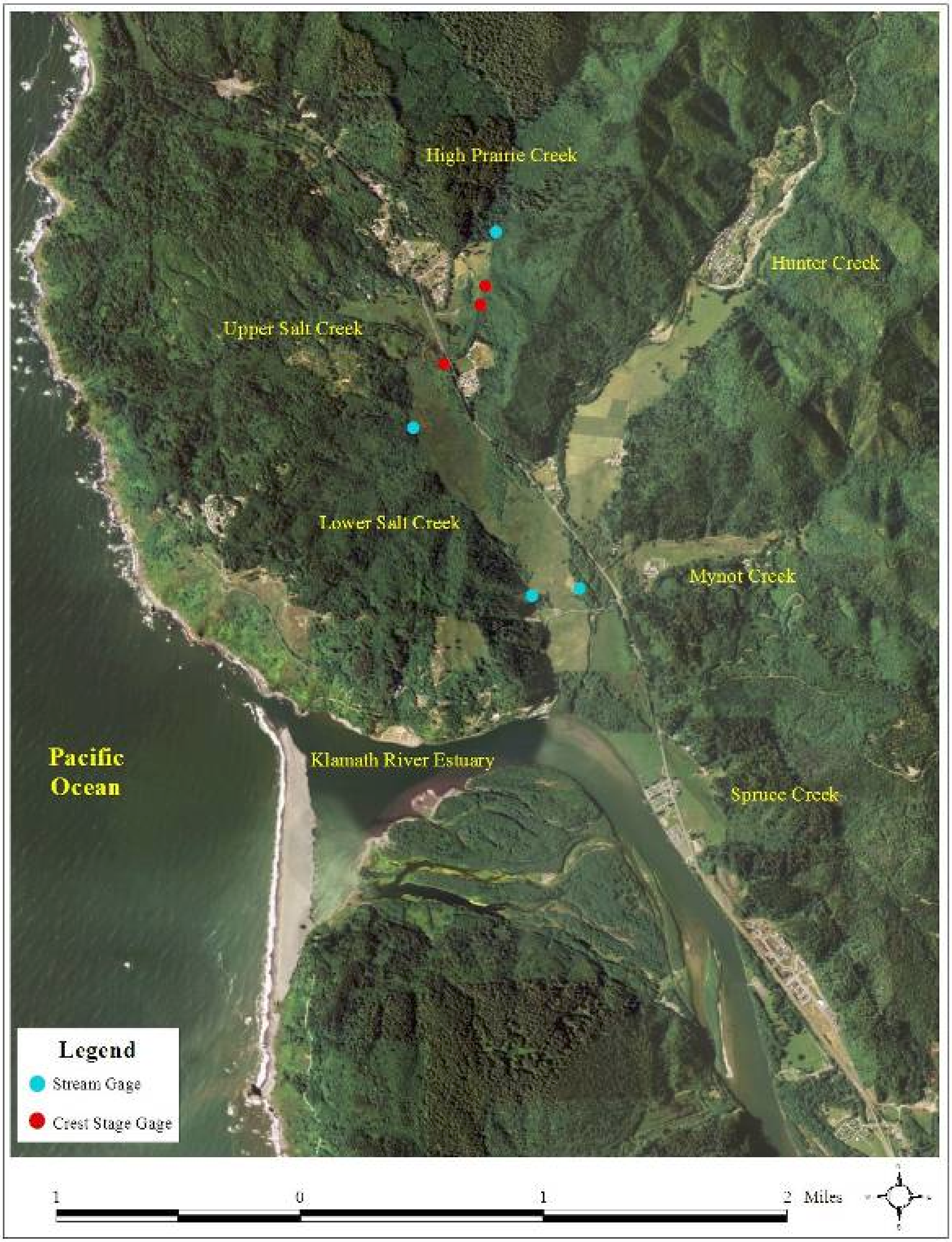


Figure 25. Stream monitoring and crest stage gage locations in Salt Creek and lower Hunter Creek, Lower Klamath River Sub-basin, California. Base image: portions of the 2005 NAIP imagery (1 meter resolution).

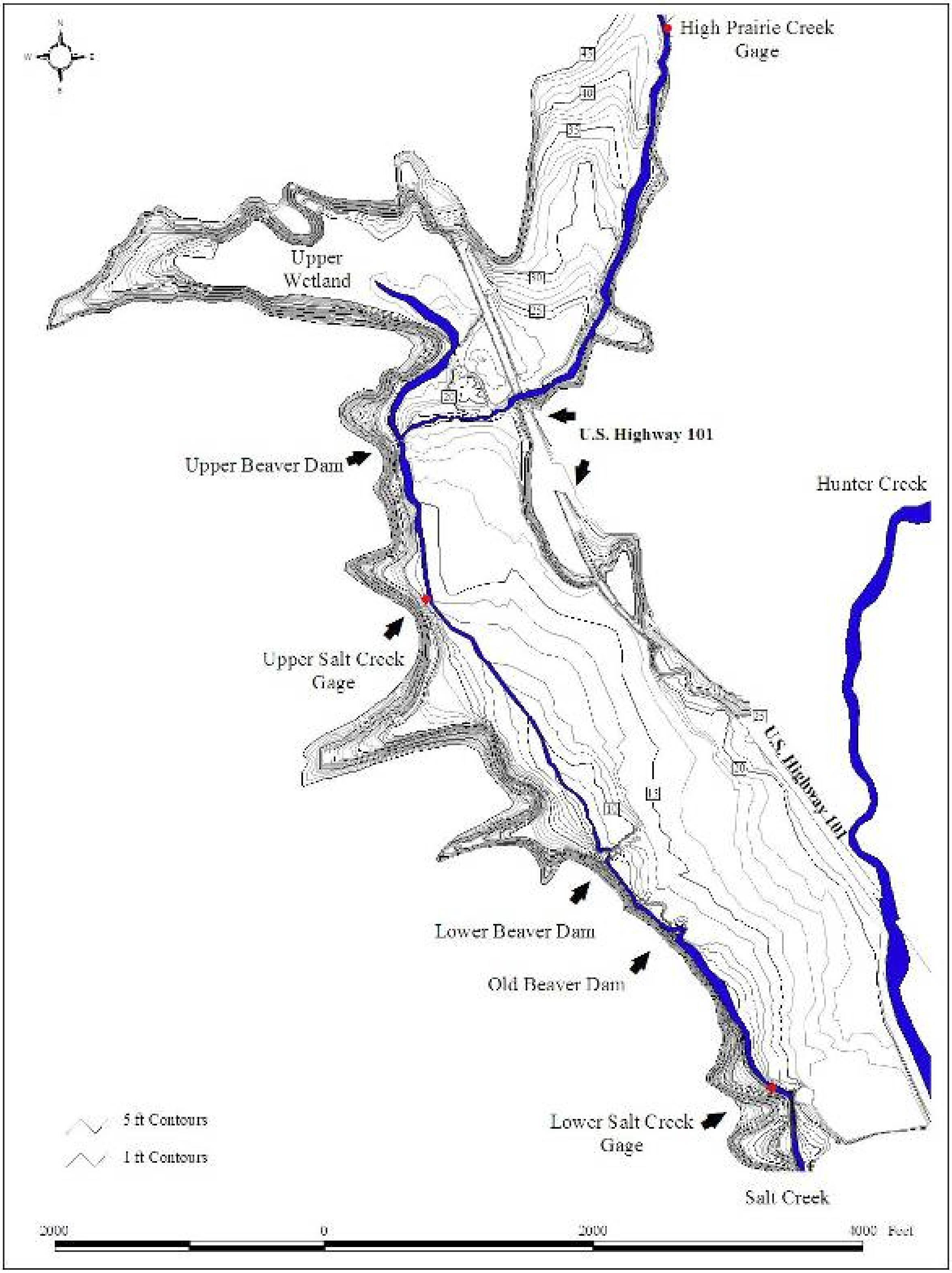


Figure 26. A GIS-based topographic model developed for the Hunter-Salt valley, Lower Klamath River Sub-basin, California.

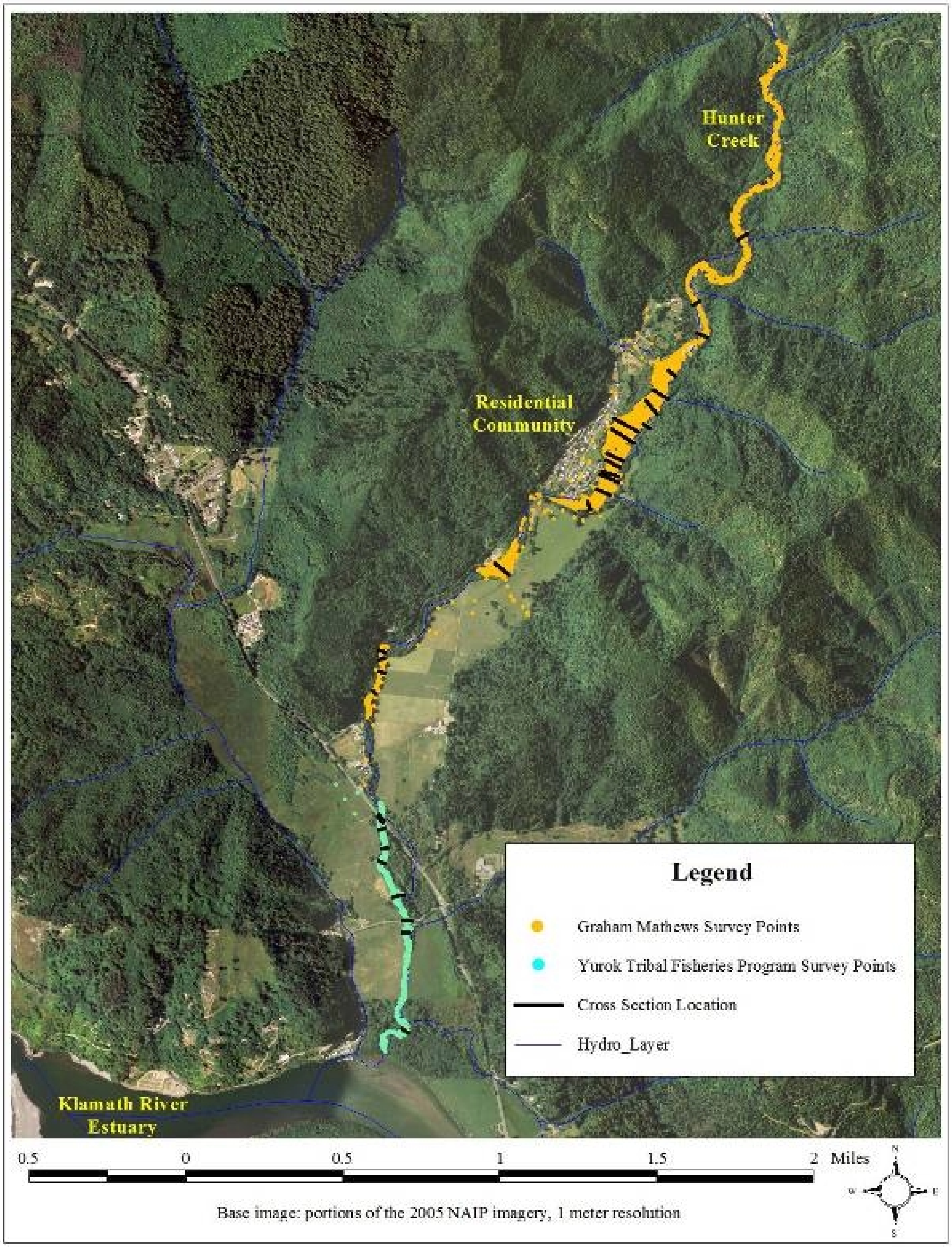


Figure 27. Map depicting the 2006 – 2007 topographic surveys of lower Hunter Creek, Lower Klamath River Sub-basin, California.

Water Quality Monitoring

Water quality monitoring stations were established in lower Salt Creek, Hunter Creek, Spruce Creek, Mynot Creek, Panther Creek, and in an unnamed tributary to Hunter Creek to help characterize the range of water quality conditions present during the juvenile salmonid emigration period (Figure 28). These stations were monitored for water temperature, dissolved oxygen, conductivity, and salinity at various tide cycles from 31 March – 22 August 2006 using a hand-held YSI 85 Meter. Water temperatures were also monitored continuously using Optic Tid Bit thermisters in Salt Creek, Hunter Creek, Spruce Creek, Mynot Creek, and Panther Creek. Water temperature was recorded every 30 minutes at these sites from June – October 2006. Daily maximum, minimum, and mean water temperatures were calculated from the continuous data using BoxCar Pro software. DataSondes were deployed at sites in Salt Creek, Hunter Creek, Spruce Creek; and in Panther Creek during spring – fall 2007 to document water quality conditions over 24 hour intervals. Parameters measured included: water temperature, dissolved oxygen, conductivity, pH, and salinity.

Data collected in the Hunter-Salt valley since 2000 has revealed that water quality in the lower reaches of Salt Creek, Hunter Creek, and Spruce Creek were greatly influenced by Klamath River flows and tide cycles during most of the year (Figure 29). Water quality at the unnamed tributary, Mynot Creek, and Panther Creek appeared less influenced by tide cycles or mainstem river conditions, especially from spring – fall (Figure 29). Off-estuary water quality conditions on the north side of the Klamath River appeared favorable to adult and juvenile salmonids from winter through early summer. However, dissolved oxygen appeared to be limiting to salmonids in all of the creeks except Hunter Creek and Mynot Creek. Both Hunter Creek and Mynot Creek provide cold and highly oxygenated water over the entire year (Beesley and Fiori 2004; Hiner and Brown 2004; Beesley and Fiori 2007a). However, flow levels in lower Mynot Creek limit fish access and use during summer – fall. YTFP will continue monitoring water quality and quantity in the Klamath River estuary to improve our understanding of the conditions available to adult and juvenile salmonids and determine how best to enhance these areas to improve salmonid growth and survival.

Historic Condition Assessment

YTFP has been coordinating with several local specialists and resources to obtain copies of historic maps, photographs, and written material to better document changes in habitat conditions of the Klamath River estuary and its tidally influenced tributaries through time (Beesley and Fiori 2004; Hiner and Brown 2004; Beesley and Fiori 2007a). Aldaron Laird, a local environmental planner, prepared a historical study of the Klamath River estuary that included several historic maps of the area from the 1850s to the 1950s (Laird 2008). These maps provided critical insight into the historic configuration of the estuary and the complexity and range of habitats formerly available (Figures 12 – 13) (Laird 2008). YTFP is incorporating these maps into our GIS to begin delineation and classification of historic channel habitats, valley morphology, and riparian vegetation types. Spatial statistics will be generated for these features for each map to further document habitat changes through time. Understanding how the estuary and its associated habitats respond to natural and anthropogenic disturbances is critical when developing restoration strategies.

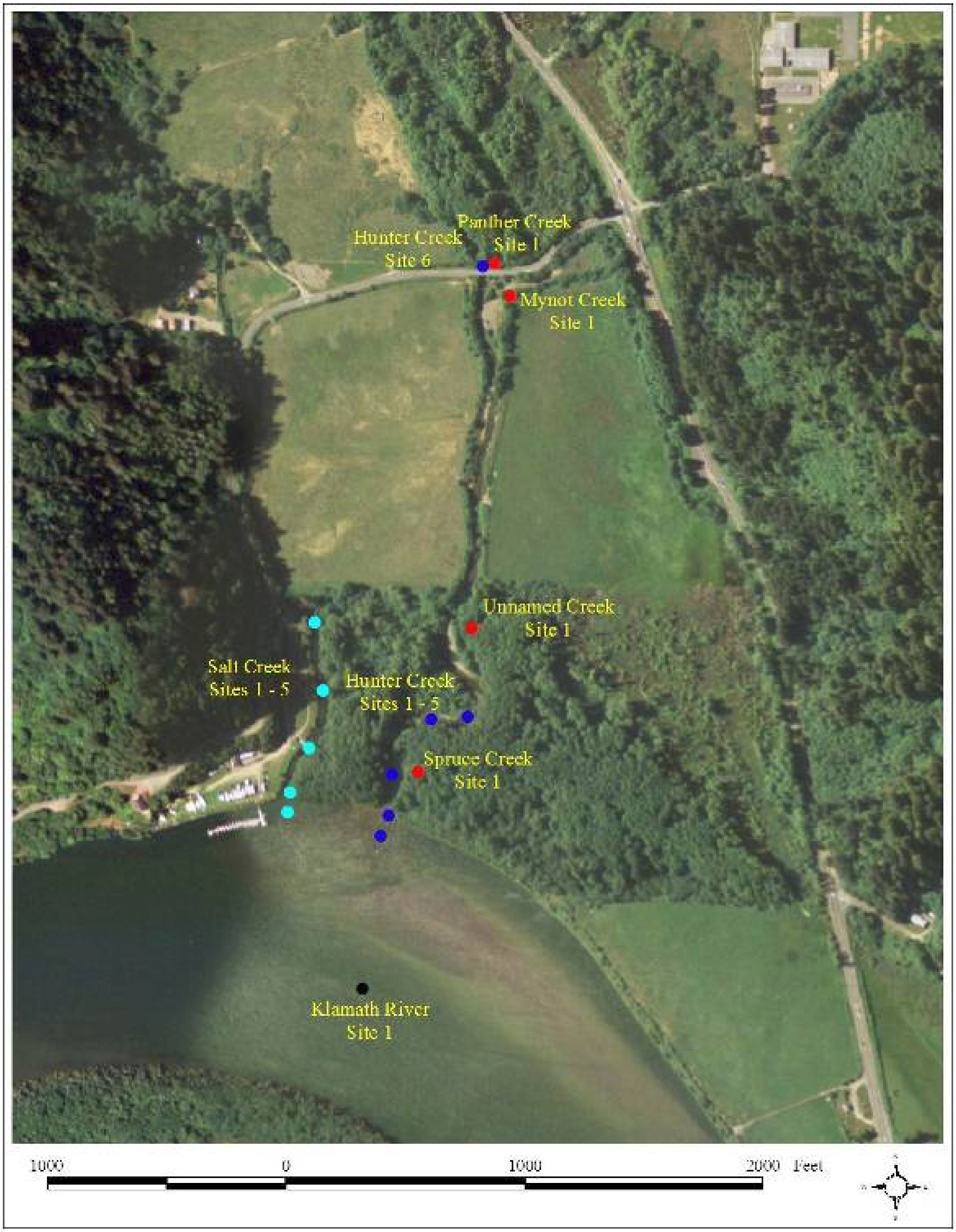
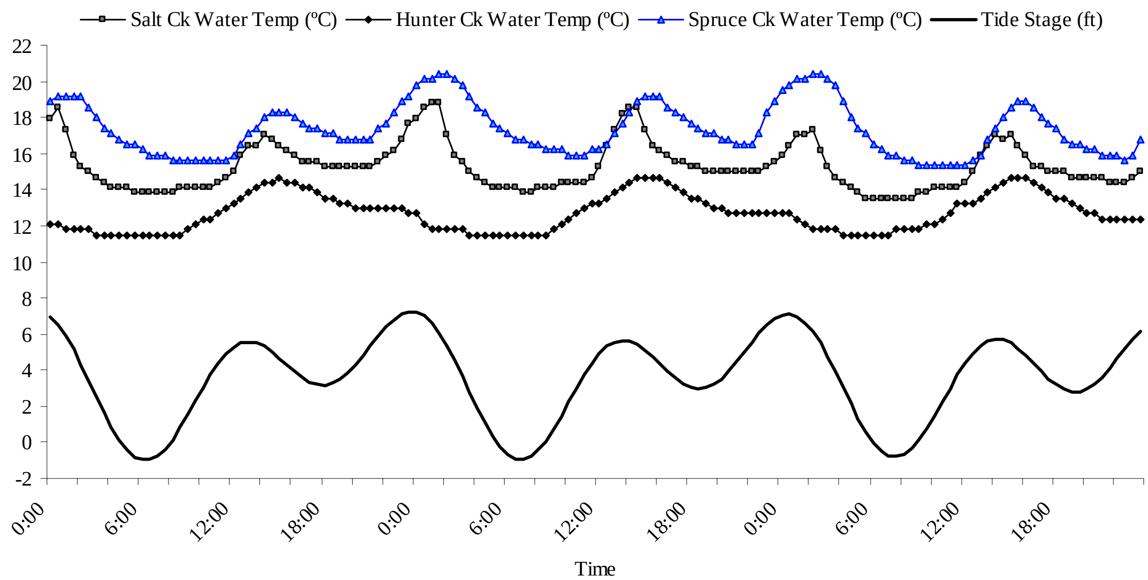


Figure 28. Water quality monitoring stations located in the Klamath River and tributaries of the Lower Klamath River Sub-basin, California. Base image: portions of the 2005 NAIP imagery (1 meter resolution).



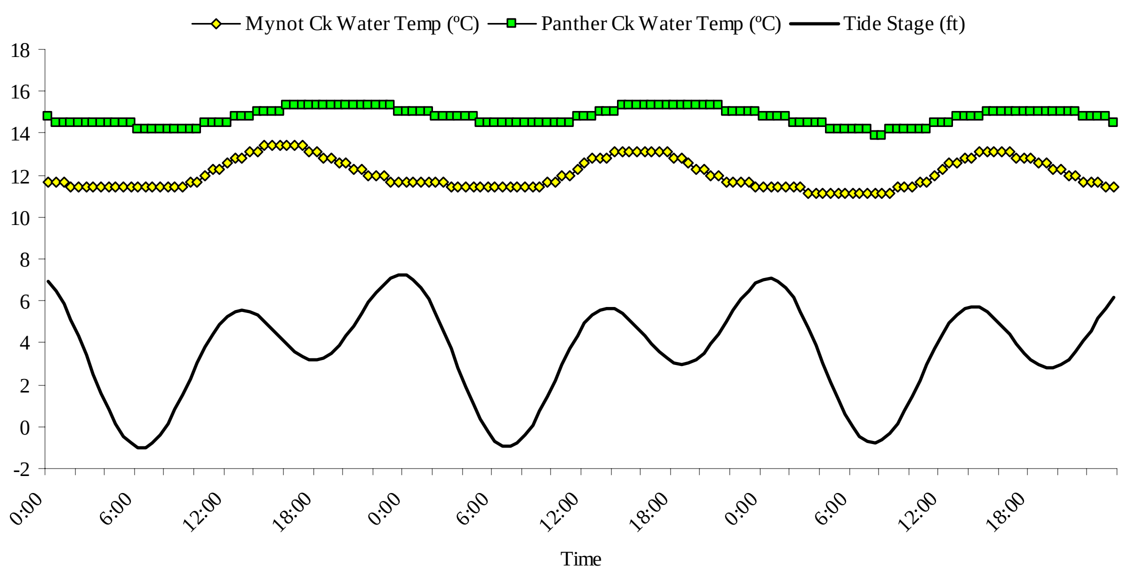


Figure 29. Water temperature recorded at several stations located in tributaries of the Klamath River estuary and predicted tide stage from the National Oceanic and Atmospheric Administration for Crescent City, California, for the period 24 – 26 July 2006.

Hunter Creek Recommendations

The restoration assessment and planning efforts conducted in the Hunter-Salt valley during this project were vital to a larger-scale, coordinated effort led by YTFP to develop and initiate a prioritized restoration plan for the Klamath River estuary and its associated tributaries, sloughs, and wetlands. Restoration objectives include developing geomorphic based approaches for mainstem and tributary habitats that address identified limiting factors (i.e. simplification of estuary habitats, poor hydrologic function, and limited estuary salmonid rearing and staging capacity). Anticipated outcomes of implementing large-scale off-estuary restoration measures include: 1) increasing hydrologic connectivity and geomorphic function in off-estuary tributaries; 2) creating complex stream and wetland habitats to increase adult salmonid spawning and staging potential and juvenile salmonid rearing capacity; 3) altering sediment storage and delivery dynamics; 4) promoting future wood recruitment; 5) increasing flood and sediment retention capacity to account for global climate changes and rising sea levels; and 6) facilitating wetland functions such as nutrient cycling and sediment retention to improve water quality of tributaries draining to the estuary.

Although YTFP has collected a fairly significant amount of physical and biological data in the Hunter-Salt valley, more information regarding the influences of the sediment (emanating from tributaries and the Klamath River), Klamath River flows, and the Pacific Ocean on off-estuary habitats is required to truly develop meaningful fisheries enhancement designs. Also, YTFP continues to work with landowners and stakeholders to increase support for fisheries restoration in the estuary and its associated habitats. Therefore, the restorative alternatives presented in this report for the Hunter-Salt valley are only conceptual at this stage.

Upslope Enhancement

There is a critical need to increase the amount of upslope restoration occurring annually in the LKRSB. The Yurok Tribe will need to continue to work with GDRC and other stakeholders to complete and update road assessments in Hunter Creek. All high and medium priority roads identified in past and future upslope assessments should be addressed in the next five to ten years. A sediment budget should also be constructed to quantify the dominant hillslope sediment sources in the watershed and improve on-going restoration planning and monitoring efforts. Assessing historic and current rates of sediment delivery to the fluvial corridor of Hunter Creek is a priority restoration measure to guide management and restoration of this critically important off-estuary tributary of the Klamath River.

Stream and Floodplain Stored Wood

Increasing recruitment of large wood to stream and floodplain habitats in the Hunter Creek watershed is another top priority restorative measure. YTFP is moving forward to obtain the funding necessary to begin adding large wood and constructing wood accumulations in priority mainstem and tributary habitats. The addition of large wood to the fluvial corridor of this watershed should be considered a long-term effort until natural recruitment rates increase as a result of watershed protection and improved timber harvest practices. We identified several sources of wood along the roads in lower Hunter Creek. Most of the wood was in a fairly degraded state, less than 20 feet in length, and without rootwads. However, incorporating these pieces in floodprone habitats promotes improved riparian growing conditions. In the last few years, YTFP has been fairly successful obtain quality wood sources for stream and floodplain enhancement projects in several LKRSB tributaries.

East Fork Hunter Creek is a third order tributary entering the east side of Hunter Creek ~four miles upstream of the confluence with the Klamath River Estuary. The entire sub-watershed is managed for industrial timber harvest with forests comprised of coastal redwood, Sitka spruce, western red cedar, red alder, big-leaf maple, and willow species. The anadromous reach of the East Fork has a fair amount of instream and floodplain stored wood relative to most Lower Klamath River tributaries. Several CCC/CDFG large wood structures in the East Fork still influence pool habitat formation and provide limited cover for juvenile salmonids. However, a majority of the structures are disassembling and leaving remnant pieces of rebar and cable in the creek; or are not effective at trapping mobile wood sources.

Wood accumulations consisting of key pieces (i.e. logs 24+ inches in diameter, $\geq$ 40 feet in length with intact rootwads) interlinked with small pieces are required to truly influence stream and riparian habitats in this sub-watershed. Extensive riparian rehabilitation is also recommended in this sub-watershed to promote wood recruitment to the fluvial corridor to facilitate long-term benefits to fish and wildlife populations. Therefore, YTFP has written several grants to CDFG and BOR to construct multiple large wood structures in the fluvial corridor of lower East Fork Hunter Creek and plant riparian habitats with native conifers (Figures 30 – 31). YTFP anticipates implementing this project in summer of 2010 and will continue pursuing the funding to locate wood sources and construct habitat improvement structures in mainstem and tributary habitats of Hunter Creek.

Development of a Watershed Group

A local watershed group should be established in Hunter Creek given the number of residents living along the creek and the importance of this tributary to anadromous fish populations of the Klamath Basin. The group should be comprised of private residents with support from stakeholders such as the Yurok Tribe and GDRC. YTFP and FGS will work over the next year to bring local residents together to introduce the watershed group concept and discuss the option of forming one for Hunter Creek. The most important issues to be addressed by such a group include 1) channel instability and riparian dysfunction in the vicinity of the residential community; and 2) how to address watershed problems in a manner that results in benefits to Hunter Creek residents and natural resources. Other issues include reduction of invasive plant species (i.e. giant knotweed, reed canary grass, and pampass grass) from fluvial and riparian habitats. CDFG and other resource organizations offer operational funding for watershed groups that focus on improving conditions for fish and wildlife.

Lower Hunter Creek

Hunter Creek downstream of U.S. Highway 101 has been significantly impacted by historic and current land management activities. Lower Hunter Creek is severely confined by

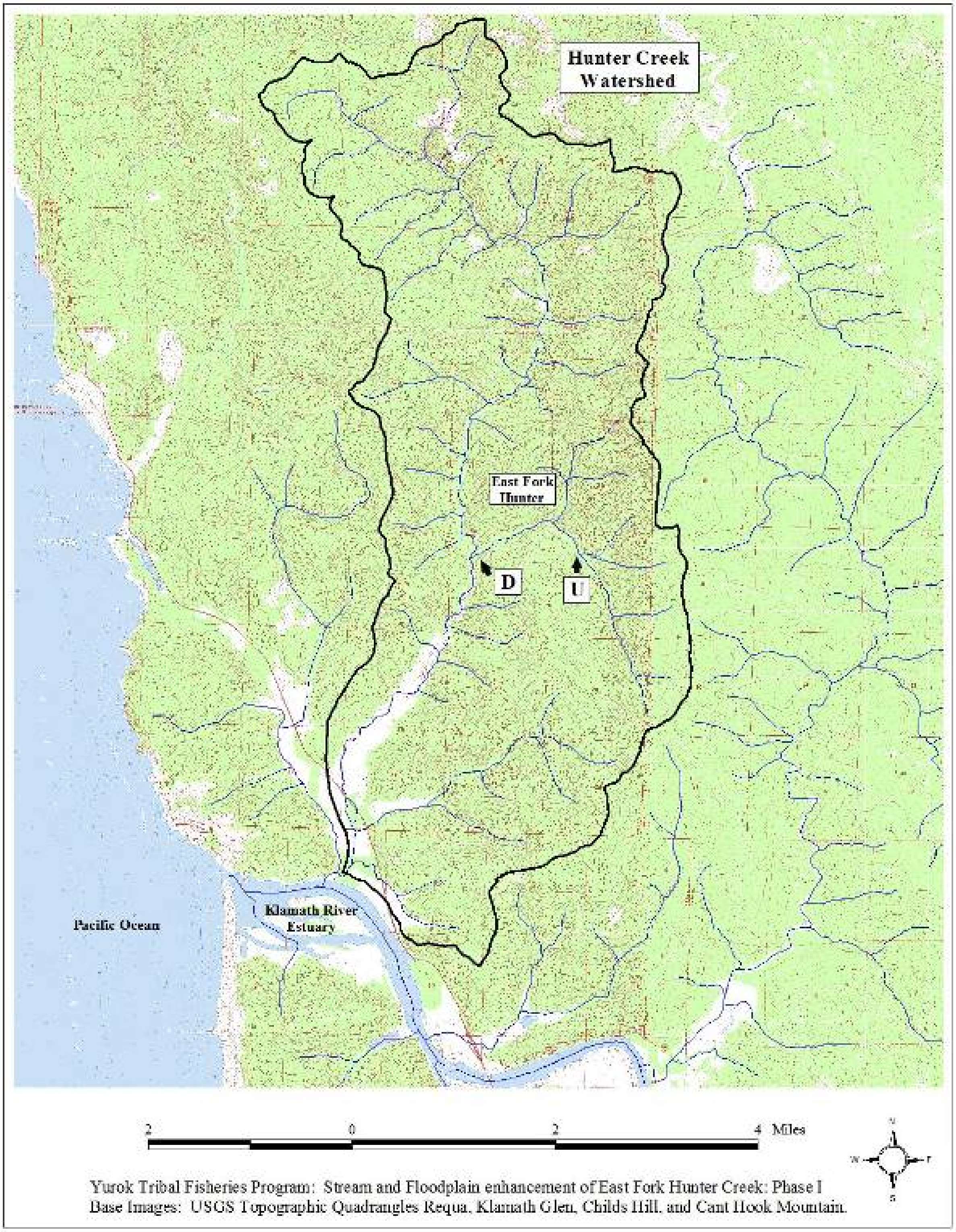


Figure 30. Map depicting a proposed restoration reach in East Fork Hunter Creek, Lower Klamath River Sub-basin, California.

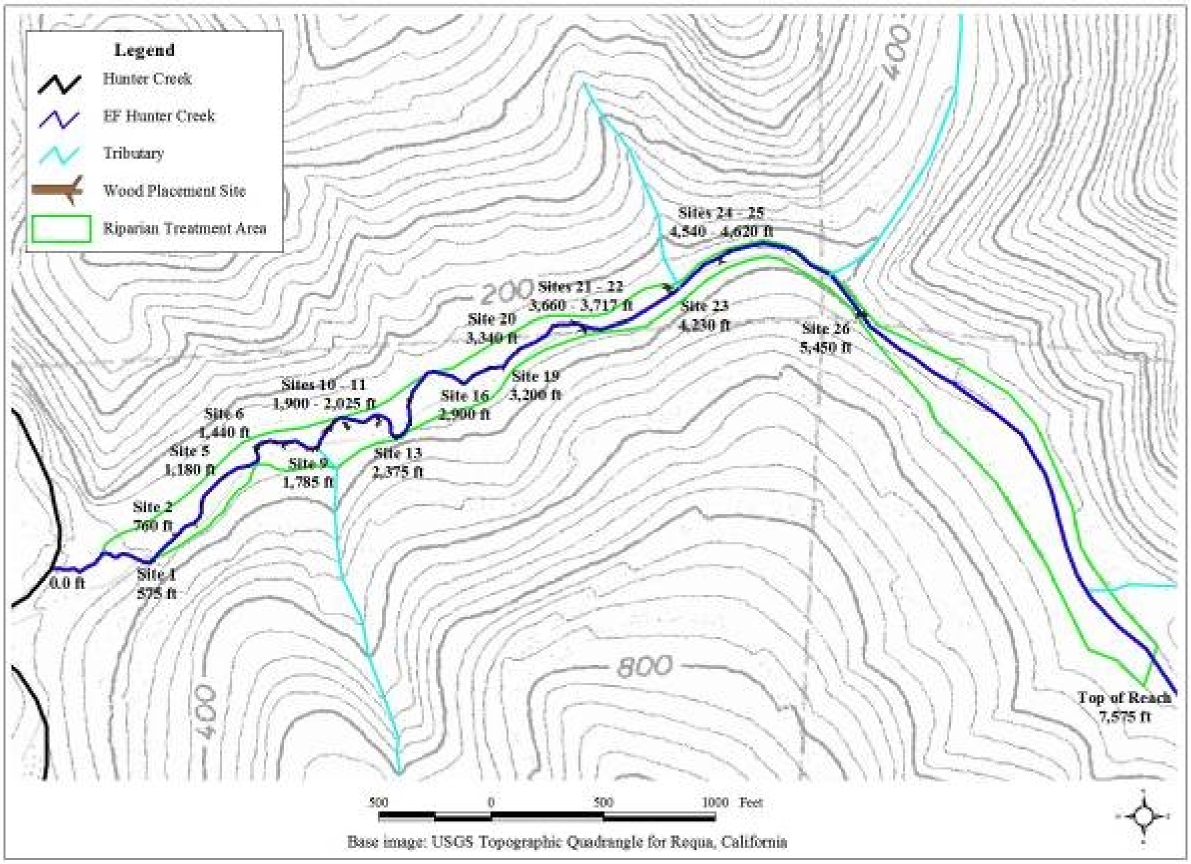


Figure 31. Map depicting potential large wood structure sites and riparian enhancement area proposed for East Fork Hunter Creek, Lower Klamath River Sub-basin, California.

extensive levees and road related infrastructure. This reach also contains several tributary junctions including Panther Creek, Mynot Creek, and Spruce Creek (Figure 17). Panther Creek enters Hunter Creek directly upstream of the Requa Road bridge. Panther Creek is a critically valuable off-estuary tributary that provides high quality open and emergent wetland habitats to multiple fish species and wildlife (Figures 32 – 33) (YTFP In Progress). This unique drainage should be protected from future development and enhancement efforts undertaken. Priority enhancement measures for Panther Creek include reducing the number of invasive aquatic and riparian plants in the drainage and improving hydrologic function in the vicinity of its confluence with Hunter Creek. Requa Road and the associated bridge severely constricts Hunter Creek and concentrates flow through an area that would naturally allow overbank flows to spread onto adjacent floodplains. The DTM we are constructing of the Klamath River estuary will greatly enhance our ability to develop geomorphically sound design concepts for Requa Road and the Salt Creek and Hunter Creek stream crossings.

YTFP needs to continue assessing watershed conditions and conducting landowner outreach in both Mynot Creek and Spruce Creek. CDFG and the CCC have conducted numerous instream and riparian enhancement projects in lower Mynot Creek including a major culvert replacement that resulted in improved fish passage and geomorphic function at that site.

Figure 32. Yurok Tribal Fisheries Program crews monitoring salmonid populations in Panther Creek pond, Lower Klamath River Sub-basin, California (Spring 2008).

Figure 33. Photographs of a beaver hut in Panther Creek (left photograph) and a juvenile chinook salmon captured in a Panther Creek migrant trap (right photograph), Lower Klamath River Sub-basin, California (Spring 2008).

However, lower Mynot Creek provides very limited juvenile rearing capacity due to a lack of surface flows occurring from summer – fall in the lowest few miles of the creek. Major channel reconstruction and riparian restoration efforts would be required to increase juvenile rearing capacity in lower Mynot Creek. YTFP and FGS will continue to investigate the potential resource benefits and cost effectiveness associated with this type of approach.

Spruce Creek enters Hunter Creek just upstream of the Klamath River estuary and therefore is greatly influenced by mainstem flow events and the Pacific Ocean. The channel between U.S. Highway 101 and Hunter Creek is comprised of open and emergent wetlands and braided channel reaches formed primarily by backwater processes. Agricultural operations occurring upstream of U.S. Highway 101 severely impact lower Spruce Creek. A minimal treatment option would be to build cattle exclusion fences and construct off-channel drinking areas. YTFP is in the process of discussing such options with pertinent landowners. The ultimate goal would be to get lower Spruce Creek into some type of conservation easement that would allow the construction of extensive off-estuary wetland and slough habitats (Figure 34). This type of effort will require strong landowner commitment and support as well as a substantial amount of implementation, maintenance, and monitoring funding. YTFP considers enhancement of lower Spruce Creek as a top restoration priority.

Constructing complex off-estuary wetland and slough habitats in the lower tributaries of Hunter Creek would be a great first step towards improving hydrologic function and increasing salmonid staging and rearing capacity in off-estuary habitats of the Klamath River. Larger-scale efforts such as removing or pulling back the levees from lower Hunter Creek and reconstructing the channel through that reach would result in significant resource and Public Trust benefits. Allowing overbank flows to spread onto adjacent floodplains will increase soil forming processes and over time will slowly raise the elevations of these surfaces. Promoting these types of processes will likely become increasing more important as mean sea level continues to rise in response to global climate change.

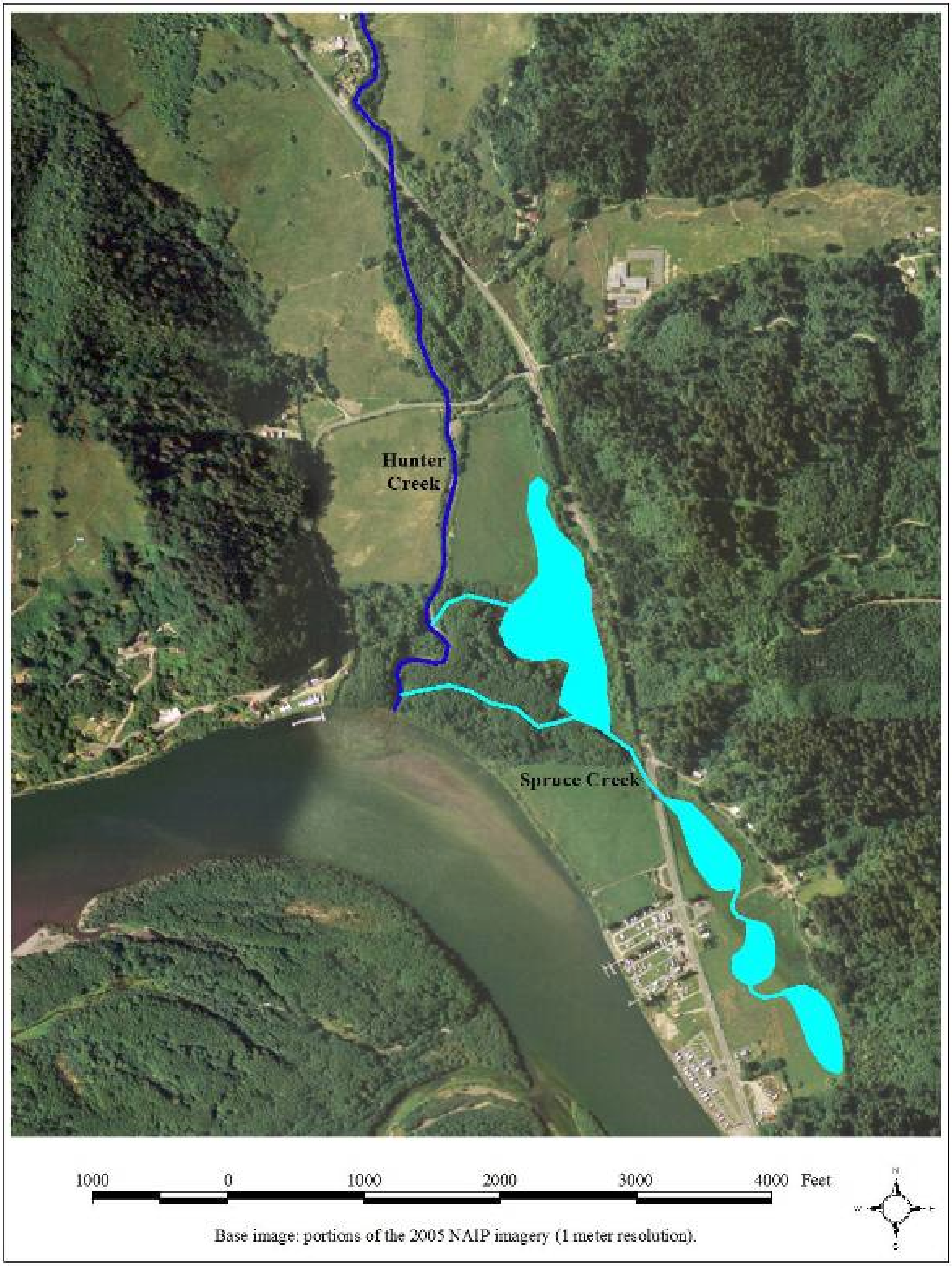


Figure 34. Map depicting conceptual salmonid habitat enhancement options for Spruce Creek and an unnamed Hunter Creek tributary, Lower Klamath River Sub-basin, California.