WATER YEAR 2010

TRINITY RIVER RESTORATION PROGRAM GEOMORPHIC AND RIPARIAN MONITORING−

A SUB-COMPONENT OF THE INTEGRATED HABITAT ASSESSMENT PROJECT

Prepared for the Trinity River Restoration Program

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EXECUTIVE SUMMARY

This monitoring was conducted as a subset of the Integrated Habitat Assessment Project (IHAP). IHAP objectives include evaluating the connections between geomorphic, riparian, and fish habitat, disciplines to better understand restoration effects and possible improvements to restoration activities on the Trinity River. The Integrated Assessment Plan (IAP) identified the priority assessments and programmatic objectives necessary to evaluate the effectiveness of management actions in meeting intended restoration objectives, as well as to evaluate the overall effectiveness of the restoration strategy in meeting Program goals (TRRP and ESSA Technologies 2009). Geomorphic and riparian tasks completed under this investigation plan address a subset of the assessments to address cause-and-effect relationships between physical and riparian processes (this report). Ultimately, these results will be integrated with the results of other disciplines and related to fish habitat creation and availability.

Water Year (WY) 2010 on the Trinity River was classified as Normal using the April 1, 2010, Bulletin 120 unimpaired runoff forecast (DWR 2010). Geomorphic and riparian vegetation monitoring were conducted in response to the winter tributary-generated peak flow and the spring Record of Decision (ROD; DOI 2000) release peak flow. The winter tributary-generated peak flow occurred on February 5, 2010, and was 121 cms (4,280 cfs) at the downstream-most monitoring sites below Canyon Creek. The ROD release began on April 23, peaked at 187 cms (6,610 cfs) on May 3, and then gradually receded to summer baseflows by mid-July 2010.

Geomorphic and riparian monitoring was conducted at sites along the mainstem Trinity River that were selected to evaluate specific objectives identified in the Integrated Assessment Plan. Site selection followed both systemic sampling and site-specific sampling strategies. Systemic sampling employed the generalized random tessellation stratified (GRTS) sampling design to address systemic status and trends within the upper mainstem Trinity River, building on efforts that were initiated in WY 2009. The GRTS sampling design consists of five panels (Panel 1 through Panel 5). Twelve GRTS Panel 2 sites were identified for sampling in WY 2010. Of the 12 sampled sites, construction prevented entry to one site, thereby reducing the number of monitored sites to 11. Riparian monitoring was performed at all 11 of these remaining GRTS sites. Additional restricted property access prevented geomorphic monitoring at an additional site, which reduced the geomorphic GRTS monitoring sites to 10. Site-specific sampling was conducted at a subset of channel rehabilitation sites constructed since 2005. Twelve channel rehabilitation sites were selected for sampling in WY 2010. Riparian mapping was conducted at all 12 channel rehabilitation sites, five of which were coincident with one of the 11 remaining GRTS sites. Geomorphic monitoring was conducted at four of the channel rehabilitation sites, all of which were coincident with one of the remaining 10 GRTS sites.

Work summarized in this report is similar to work performed in WY 2009, but includes new analyses and summaries, such as a summary of bed mobility and scour within the “riparian encroachment risk zone” (13 to 57 cms; 450 to 2,000 cfs), a preliminary estimate of detrimental riparian encroachment thresholds, and changes in plant density related to D_{84} mobility. These analyses are intended to better link geomorphic monitoring results with riparian monitoring results to improve future flow management recommendations.

Geomorphic Monitoring: Geomorphic assessments were performed to evaluate systemic objectives at 10 GRTS Panel 2 sites. Where Panel 2 sites were located within the limits of larger channel rehabilitation sites, geomorphic monitoring results were also used to help evaluate site-specific objectives. Collectively, based on the WY 2010 topographic surveys, most Panel 2 cross sections showed little geomorphic change as a result of the WY 2010 winter peak and the spring ROD release. Bed mobility increased with distance downstream as flow magnitude increased from

tributary accretion during the winter peak, but the range of mobility was reasonably consistent between upstream and downstream sites during the spring ROD release. The spring ROD release partially or fully mobilized tracer rocks at all sites, with the range of mobility reasonably consistent between upstream and downstream sites, ranging from 38% to 100% mobilization. Bed scour results were similar to the bed mobility results for both the winter peak and the spring ROD release. A flow threshold between 57 and 113 cms (2,000 and 4,000 cfs) initiated bed mobility and some bed material reworking and scour. Only 10 of the 44 total chains recorded scour depths ≥ 1.0 $D_{84,}$ and these results were spread over six of the nine sites monitored. Although relatively little geomorphic change was documented along monitoring cross sections, the WY 2010 Normal water year ROD release was largely successful in meeting Trinity River Flow Evaluation (TRFE; USFWS and HVT 1999) bed mobility management objectives for a Normal water year; however, the ROD release did not fully meet the TRFE Normal water year bed scour objective, despite some scour and redeposition occurring at each monitoring site. This suggests the WY 2010 ROD release was large enough to mobilize the bed surface but not scour or redeposit material in sufficient quantity to create geomorphic changes.

Riparian Monitoring: Riparian assessments were performed at 11 GRTS Panel 2 sites (i.e., vegetation mapping, band transect sampling, and large wood mapping) and at 12 channel rehabilitation sites (vegetation mapping only). Since the spring ROD release was higher than the winter peak at all sites, all riparian vegetation monitoring results were related to the spring ROD release. Results of vegetation mapping at both GRTS Panel 2 and channel rehabilitation sites indicated the WY 2010 Normal spring ROD release did not affect patch type frequency or abundance nor species frequency or abundance. Mixed willow, open ground, and white alder were the most frequent patch types mapped.

Band transect sampling at 11 GRTS Panel 2 sites was conducted between 13 cms (300 cfs) and 57 cms (4,500 cfs) water surface elevations. Sampling showed young-of-year + 1-yr old hardwoods to be the most abundant size class of riparian hardwoods below the 127 cms (4,500 cfs) inundation zone, with the majority occurring below 57 cms (2,000 cfs). Surfaces between 8.5 and 13 cms (300 and 450 cfs) had the highest density young-of-year + 1-yr old hardwoods, as well as the highest density of 3-yr old hardwoods. Four riparian hardwood species initiated seedlings in WY 2010: narrowleaf willow/dusky willow, arroyo willow, and red willow. Narrowleaf willow was the most frequent and abundant riparian hardwood that initiated in WY 2010. No seedlings were measured above 127 cms (4,500 cfs) at any site. Based on WY 2010 data, ROD releases during this Normal water year release may not have promoted initiation and establishment of riparian hardwood seedlings on floodplains.

Systemically, 79% of riparian hardwoods 1-yr and younger were scoured by the WY 2010 spring ROD release. Measured plant density correlated well with measured bed mobility; results showed decreased plant density as bed mobility increased. Although some measured scour depths were sufficient to remove riparian hardwoods 1-yr and younger, these scour results were localized on cross sections (i.e., scour depths were variable throughout the sampled sites) and therefore seedling scour was not achieved uniformly at each site. The surviving WY 2010 seedlings may become a greater encroachment threat as they survive each subsequent year; therefore, the seedling scour objectives for a ROD Normal water year spring release were not entirely met. Encroachment risk at each site was assessed based on comparing plant densities measured in WY 2010 to plant densities measured at a site with detrimental riparian encroachment. This analysis showed that most cross sections, even those demonstrating some riparian encroachment, had plant densities below the preliminary detrimental riparian encroachment thresholds.

Large Wood Monitoring: Large wood monitoring was initiated in 2010 and represented the baseline large wood storage to which future samplings can be compared. Below the 57 cms (2,000 cfs) water surface elevation, 493 large wood pieces were mapped at 11 GRTS Panel 2 sites. Over

95% of the large wood measured was smaller than 91 cm (36 in) in diameter. The 20 to 30 cm (8 to 12 in) size class of wood was the most frequent and abundant wood, making up 63% of the sample. White alder was the most abundant type of wood sampled, contributing 35.5%. Wood loading along the Trinity River mainstem, including placed wood at channel rehabilitation sites, currently averages 13 pieces of wood larger than 20 cm (8 in) per 100 m along both banks, based on our sample sites. The number of naturally recruited wood pieces at six GRTS panel 2 sites where no channel rehabilitation had occurred by 2010 (55% of the sites monitored) ranged from 2 to 15 pieces per 100 m and averaged 3 pieces per 100 m.

1 INTRODUCTION AND BACKGROUND

The primary goal of the Trinity River Restoration Program (TRRP) is to restore and sustain natural production of anadromous fish populations downstream of Lewiston Dam to pre-dam levels to facilitate dependent tribal, commercial, and sport fisheries' full participation in the benefits of restoration via enhanced harvest opportunities (TRRP and ESSA Technologies Ltd. 2009, USBR 2009). Actions necessary to restore and maintain the freshwater habitats for anadromous salmonids to achieve this goal are: (1) mechanical rehabilitation of the channel, (2) flow management to restore fluvial processes that create and maintain suitable salmonid habitat and to meet water temperature objectives for juvenile and adult salmonids, (3) coarse and fine sediment management, and (4) watershed restoration (USDOI 2000).

Between 1991 and 1993, nine pilot bank rehabilitation sites were implemented along the mainstem Trinity River. Geomorphic, riparian, fish use, and fish habitat responses were monitored to guide future restoration strategy and management actions that were described in the Trinity River Flow Evaluation Final Report (TRFE; USFWS and HVT 1999) and ultimately adopted in the Trinity River Mainstem Fishery Restoration Record of Decision (ROD) adopted by the Secretary of the Interior in 2000 (USDOI 2000). The TRFE found that fry rearing habitat is limiting salmon production from the Trinity River, particularly over a range of flows between 500 cfs and 2,000 cfs. Correspondingly the TRFE identified, and the ROD adopted, the following restoration strategy:

> *If naturally produced salmonid populations are to be restored and maintained, the habitat on which they depend must be rehabilitated. The most practical strategy to achieve fish habitat rehabilitation is a management approach that integrates riverine processes and instream flow dependent needs. This management approach physically reshapes selected channel sections, regulates sediment input, and prescribes reservoir releases to (1) allow fluvial processes to reshape and maintain a new dynamic equilibrium condition and (2) provide favorable water temperatures. This strategy does not strive to recreate the pre-TRD (Trinity River Division) mainstem channel morphology. Several sediment and flow constraints imposed by the TRD cannot be overcome or completely mitigated. The new alluvial channel will be smaller in scale, but it will exhibit almost all the dynamic characteristics of the 10 alluvial attributes necessary to restore and maintain fisheries resources.*

The TRFE identified 47 proposed channel rehabilitation projects (including three potential side channel rehabilitation projects) between Lewiston Dam and the North Fork Trinity River. The premise of the TRFE is that the mechanical manipulation of the channel, in combination with coarse sediment augmentation and release of geofluvial flows, will dramatically increase riverine habitat availability (via increased habitat quantity and quality) and diversity. Under an Adaptive Environmental Assessment and Management (AEAM) framework, the TRRP has been implementing the channel rehabilitation components of the ROD since 2005; nearly half of the proposed projects in the ROD will have been completed by the end of 2011, with the remainder scheduled to be completed in forthcoming years.

Evaluation of project performance is critical to inform the remaining TRRP channel rehabilitation designs. The Integrated Habitat Assessment Project (IHAP) was an effort to bring together individual assessments in geomorphology, channel complexity, habitat availability, riparian habitat structural evolution, and wildlife as envisioned in the Integrated Assessment Plan (IAP; TRRP and ESSA Technologies Ltd. 2009).

In WY 2009, the IHAP began evaluating the effectiveness of TRRP restoration actions to determine the changes in salmonid habitat resulting from both mechanical channel rehabilitation and restoration of fluvial processes necessary to create and maintain riverine habitats. Assessments at selected channel rehabilitation sites answered specific questions on key physical and biological components of the Trinity River ecosystem (USFWS et al., in preparation) to evaluate how TRRP management actions interact with the current river ecosystem to achieve programmatic goals and objectives.

The same data collection approach used in WY 2009 was used for WY 2010, but a different reporting strategy has been adopted. Rather than preparing geomorphic, riparian, fish habitat, cross-disciplinary integration analyses, and wildlife assessments as a single report, individual assessment reports have been prepared. Once all individual reports are completed, they will be grouped as a single document intended to combine the results. This report presents results of the WY 2010 geomorphic and riparian monitoring component of the 2010 IHAP. The investigation strategy is a hypothesis-based approach founded on the assessments recommended in the IAP. Specific geomorphic and riparian assessments were identified; monitoring methods were then developed to best address those assessment needs.

2 WY 2010 PHYSICAL AND RIPARIAN GOALS, OBJECTIVES, AND HYPOTHESES

The TRFE identified geomorphic and riparian vegetation objectives for different water year classes (Figure 1, Table 1), which were adopted by the ROD. To better understand restoration effects and possible improvements to restoration activities on the Trinity River, the IHAP was developed in part to evaluate the connections between geomorphic, riparian, and fish habitat. The IAP identified the priority assessments and programmatic objectives necessary to evaluate the effectiveness of management actions in meeting intended restoration objectives, as well as to evaluate the overall effectiveness of the restoration strategy in meeting Program goals. Geomorphic and riparian tasks completed under this investigation plan address a subset of the assessments (Table 1) to address cause-and-effect relationships between physical and riparian processes (see hypotheses below). Ultimately, these results will be integrated with the results of other disciplines and related to fish habitat creation and availability.

WY 2010 riparian monitoring will evaluate whether TRFE Normal water year objectives were met, including objectives for seedling scour and mortality, the prevention of riparian encroachment, riparian berm development and channel simplification, and riparian initiation on upper bar and floodplain surfaces. These objectives are essential to ensuring that both natural riverine physical processes are promoting a healthy riparian corridor (and vice versa) and that riparian regeneration is occurring where it is desired on upper bar and floodplain surfaces and not where it is undesired and poses a risk for causing additional riparian encroachment, and that fish and bird habitat is being increased and maintained. The hypotheses we tested were associated with specific geomorphic and riparian IAP sub-objectives (Table 2).

An additional geomorphic task was completed to support the fish habitat assessment of IAP Objective 3.2.1.2: Investigate the relationship between redd distribution, spawning habitat availability (as defined by depth, velocity and substrate) and geomorphic features. Field methods for this task are described in Section 7; however, analyses will be included in a forthcoming 2010 fish habitat monitoring report.

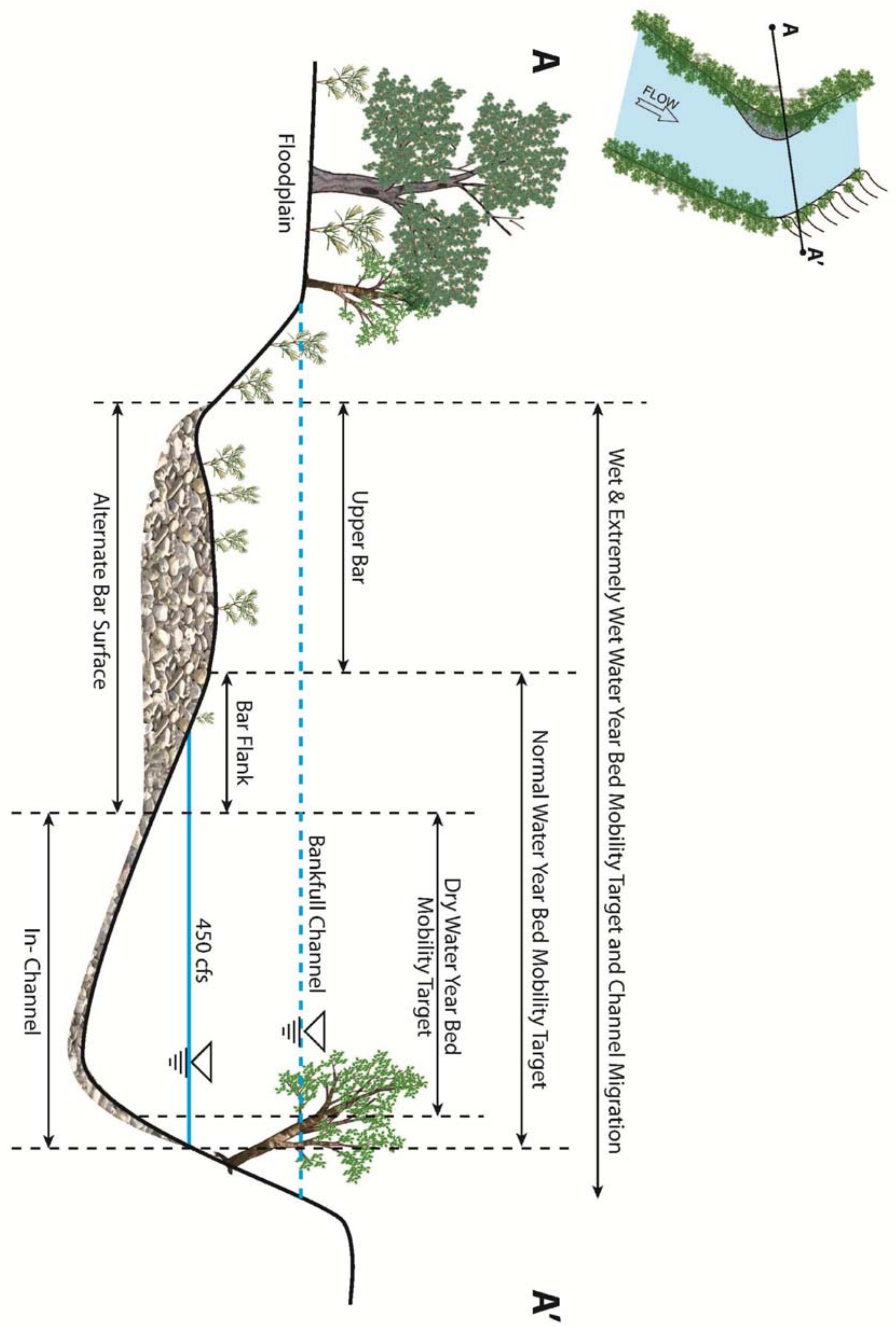


Figure 1. Conceptual cross section showing typical channel features with ROD bed mobility and bed scour objectives for different water year classes.

Table 1. Geomorphic and riparian IAP assessments and their corresponding objectives evaluated for WY 2010.

Discipline	IAP Assessments	IAP Objectives
Geomorphology	• Monitor bed mobility and scour thresholds (IAP Assessment 6P). • Assess design performance of specific design features (IAP Assessment 12P).	• Evaluate whether quantitative TRFE bed mobility and scour management objectives are being achieved during natural tributary-induced flood events and ROD flow releases (Normal and above water year types) (IAP Objective 1.2.2). • Evaluate whether topographic, planform, and geomorphic unit diversity changes with natural tributary-induced flood events and ROD flow releases (Normal and above water year types) (IAP Objective 1.1.1, 1.1.2, 1.2.3, and 1.3.1).
Riparian vegetation	• Map and quantify changes in riparian floodplain vegetation (e.g., species, age-class, initiation success, structural attributes) at GRTS sites (IAP Assessment number 1R). • Map and quantify the state of near-channel riparian vegetation (IAP Assessment number 3R). • Monitor plant induced berm-growth within the active channel (450 cfs-2,000 cfs inundation zone) (IAP Assessment number 4R).	• Evaluate whether TRFE Normal water year riparian seedling scour mortality objectives are being achieved during natural tributary-induced flood events and ROD high flow releases (IAP Objective 5.2.1). • Evaluate whether Normal water year ROD high flow releases are preventing detrimental riparian encroachment, riparian berm development, and channel simplification (IAP Objective 5.2.1). • Evaluate whether TRFE Normal water year riparian initiation and establishment objectives on upper bar and floodplain surfaces are being achieved during ROD high flow releases (IAP Objective 5.1.1 and 5.1.3). • Evaluate whether large wood storage within the active channel is increasing and being maintained (IAP Objective 5.1.2).

Table 2. IAP Sub-objectives and their associated hypotheses. Specific monitoring objectives in shaded cells were not evaluated as part of the WY 2010 monitoring.

IAP Sub-objective	**Specific Monitoring Objective (s)**	**Associated Hypotheses**
Sub-objective 1.1: Increase physical habitat diversity and availability	Objective 1.1.1: Increase the size, frequency and topographic relief of bar/pool sequences	Increased high flows, coarse sediment augmentation, and reduction of erosion resistance at bank rehabilitation locations will increase channel migration rates, thereby increasing sinuosity, active bars, hydraulic complexity, and grain size complexity.
	Objective 1.1.2: Increase channel/thalweg sinuosity	Increased high flow regime and coarse sediment augmentation (1/2" to 4") will increase bed mobility, increase grain size complexity, and increase the size, frequency, and topographic relief of bar/pool sequences.
	Objective 1.1.3: Increase geomorphic unit and substrate patch diversity	Increased high flow regime and coarse sediment augmentation will increase geomorphic unit diversity and frequency, as well as substrate patch diversity.
		Increases in geomorphic complexity will increase physical habitat complexity, availability, and quality.
		Increases in channel complexity will propagate downstream from rehabilitation sites due to the rehabilitation activities, increased high flows, increased coarse sediment supply, and large wood augmentation. As bars form at rehabilitation sites, thalweg sinuosity increases, and hydraulic complexity increases, bars and other forms of geomorphic complexity should propagate downstream of the treated sites
Sub-objective 1.2: Increase coarse sediment transport and channel dynamics	Objective 1.2.1 Increase and maintain target coarse sediment transport rates	The ROD flow releases will prevent further aggradation of the Rush and Indian Creek deltas by transporting, routing, and depositing coarse sediments downstream as bar features that provide complex habitat.
	Objective 1.2.2 Frequently exceed channel migration, bed mobilization, and bed scour thresholds	The ROD flow releases, combined with coarse sediment augmentation, will enable full coarse sediment routing through all reaches (including tributary deltas) over the long-term.
	Objective 1.2.3 Encourage bed-level fluctuations on annual to multi-year time scales	A shorter-term coarse sediment "transfusion" of materials between 5" and 3/8" diameter will greatly increase storage of alluvium of a size capable of transport, routing, and deposition under the ROD flow regime.
	Objective 1.2.4 Route coarse sediment through all reaches	The ROD flow releases will require coarse sediment augmentation of 7,000 to 13,500 yds3/year (or 10,000 tons/year on average) to maintain increased storage in the reach from Lewiston Dam to Rush Creek.
		Coarse sediment transport and deposition due to ROD flow releases and coarse sediment augmentation, will increase magnitude and frequency of channel migration, particularly in areas where the riparian berm has been removed.
		Coarse sediment transport and deposition due to ROD flow releases and coarse sediment augmentation will increase amount of exposed active alluvial bars, and encourage bed-level fluctuations.
		Coarse sediment augmentation and subsequent transport/deposition will increase substrate patch diversity, and increase salmonid spawning and rearing habitat quantity and quality

Table 2 (continued)

IAP Sub-objective	**Specific Monitoring Objective (s)**	**Associated Hypotheses**
Sub-objective 1.3: Increase and maintain coarse sediment storage	Objective 1.3.1 Increase bars, side-channels, alcoves, and other complex alluvial features	The overall hypothesis is that the combination of ROD high flow regime, coarse sediment augmentation, and channel rehabilitation activities will increase and maintain coarse sediment storage of alluvium whose size is commensurate with the ROD high flow regime, and that this increased coarse sediment storage with a grain size smaller than the pre-dam bed material will increase channel complexity and increase coarse sediment transport rates. Additional hypotheses include:
		• A combination of coarse sediment augmentation and subsequent maintenance of that storage via long-term augmentation at a rate equal to or slightly greater than the ROD flow regime transport will increase and maintain coarse sediment storage.
		• The increased flow magnitude, duration, and frequency of the ROD high flow regime will transport tributary-derived coarse sediments downstream at a rate equal to or greater than supply, increasing coarse sediment storage downstream of the tributary confluence and reducing backwater effect of tributary deltas.
		• Increasing coarse sediment storage will increase bars, side-channels, alcoves, and other complex meso-habitats that increase salmonid rearing and spawning habitat.
		• The combination of coarse sediment augmentation and ROD flows will degrade tributary deltas and fill backwaters with sediment to the point that coarse sediment routes through all reaches.
Sub-objective 5.1: Promote diverse native riparian vegetation on different geomorphic surfaces that contributes to complex channel morphology and high quality aquatic and terrestrial habitat	Objective 5.1.1 Increase species, structural, and age diversity of riparian vegetation to improve and maintain wildlife habitat Objective 5.1.2 Encourage establishment of riparian species on surfaces within the future channel migration corridor that will recruit LWD Objective 5.1.3 Encourage establishment of vegetation that provides habitat for anadromous fish, aquatic organisms and aquatic/riparian wildlife	The following flow magnitudes and frequencies, and corresponding hydrologic and fluvial processes were identified in the TRFE as necessary to promote the establishment and maintenance of healthy riparian vegetation (USFWS and HVT 1999):
		A. Peak flow magnitudes in Extremely Wet water year classes are large enough to create gaps in colonizing riparian vegetation less than 3 years old.
		B. Peak flow magnitudes in Extremely Wet, Wet, and Normal water years are sufficient to create and maintain seed beds on upper bars and floodplains.
		C. Peak flow duration in Extremely Wet, Wet, and Normal water years is sufficient to transport water-borne riparian plant seeds to seed beds/nursery sites on upper bars and floodplains.
		D. Peak flow timing in Extremely Wet and Wet water years coincides with the seed dispersal period for riparian plants whose life history success is tied to the snowmelt hydrograph.
		E. Bench flow magnitudes and durations in Extremely Wet, Wet, and Normal water years are sufficient to germinate target riparian plant species seeds on upper bars and floodplains and prevent their germination lower in the channel (Extremely Wet years are priorities).
		F. Flow recession rates from the bench to summer low flow in Extremely Wet, Wet, and Normal water years are sufficient to initiate target riparian plant species' seeds on upper bars and floodplains (Extremely Wet years are priorities).
		G. Peak and recession flows in all water year classes are large enough and late enough to recharge soil moisture and groundwater to establish and maintain initiating riparian vegetation throughout a prolonged hot, dry summer and fall.
		H. Implementation of the ROD streamflows should increase the types and spatial coverage of riparian vegetation on a wide variety of geomorphic surfaces.
		I. Promoting healthy riparian vegetation should establish the plant species necessary to contribute large woody debris to the mainstem Trinity River.
		J. Structurally complex, spatially heterogeneous vegetation provides a greater diversity of habitats for aquatic and terrestrial animals than a dense continuous band of vegetation.

Table 2 (continued)

IAP Sub-objective	Specific Monitoring Objective (s)	Associated Hypotheses
Sub-objective 5.2: Prevent riparian vegetation from exceeding thresholds leading to encroachment that simplifies channel morphology and degrades aquatic habitat quality	Objective 5.2.1 Manage flows, coarse sediment augmentation, and channel rehabilitation that cause sufficient riparian plant mortality along low water margins to prevent channel simplification leading to degraded fish habitat	The following hypotheses were explicitly derived or inferred from the TRFE restoration strategy:
		A. The following water year specific processes are necessary in concert to prevent riparian vegetation seedlings from exceeding detrimental encroachment thresholds:
		• create and maintain patchy, heterogeneous riparian vegetation growing on bars and other complex alluvial features between the 450 cfs and 2,000 cfs inundation zones through scour-induced mortality of riparian hardwoods younger than 3 years old by scouring deeper than 2xD84s on exposed bars during Extremely Wet water years;
		• create and maintain patchy heterogeneous riparian vegetation growing on bars and other complex alluvial features between the 450 cfs and 2,000 cfs inundation zones through scour-induced mortality of riparian hardwoods younger than 2 years old by scouring deeper than 1xD84s on exposed bars during Wet water years; and
		• create and maintain patchy heterogeneous riparian vegetation growing on bars and other complex alluvial features between the 450 cfs and 2,000 cfs inundation zones through scour-induced mortality of riparian hardwoods 1 year old or younger by mobilizing the bar surface on exposed bars during Normal and wetter water years.
		B. The following fluvial processes are necessary in concert to prevent established and maturing riparian vegetation from exceeding detrimental encroachment thresholds:
		• channel migration during normal and wetter water year classes;
		• burial mortality of any age class of riparian vegetation (deposition);
		• local vertical and lateral scour mortality of riparian vegetation of any age class associated with flow obstructions or bar formation during all water year classes;
		• mechanical damage and mortality to riparian vegetation of any age class; and
		• inundation/desiccation mortality in riparian vegetation of any age class.
		C. Riparian hardwood species (specifically narrowleaf willow) are the primary instigators of channel simplification through encroachment and berm formation.
		D. Riparian hardwoods >3 years old growing in the 450-2,000 cfs inundation zone exceed the ability of ROD releases to remove them via vertical scour.
		E. A riparian plant density and contiguousness threshold exists between 450 cfs and 2,000 cfs that, if avoided, could prevent riparian vegetation from crossing the encroachment threshold and simplifying the channel (i.e., if local scour can create gaps in the dense band of colonizing vegetation and spatially lower densities, encroachment can be prevented and high quality fish habitat maintained).

3 WY 2010 HYDROLOGY

Water Year 2010 was classified as Normal using the April 1, 2010, Bulletin 120 unimpaired runoff forecast. Fall streamflows along the mainstem Trinity River were regulated by the baseflow releases from Lewiston Dam. Releases from Lewiston Dam were 13 cms (450 cfs) through October 15, 2009, which were then lowered to 8.5 cms (300 cfs) on October 16, 2009, where they remained until the spring 2010 ROD release. Flow estimates for each monitoring site were calculated using the closest upstream USGS mainstem and tributary gaging stations (Table 3). No additional adjustments were made to scale flows from the gaging stations to the monitoring sites (e.g., by using streamflow accretion models).

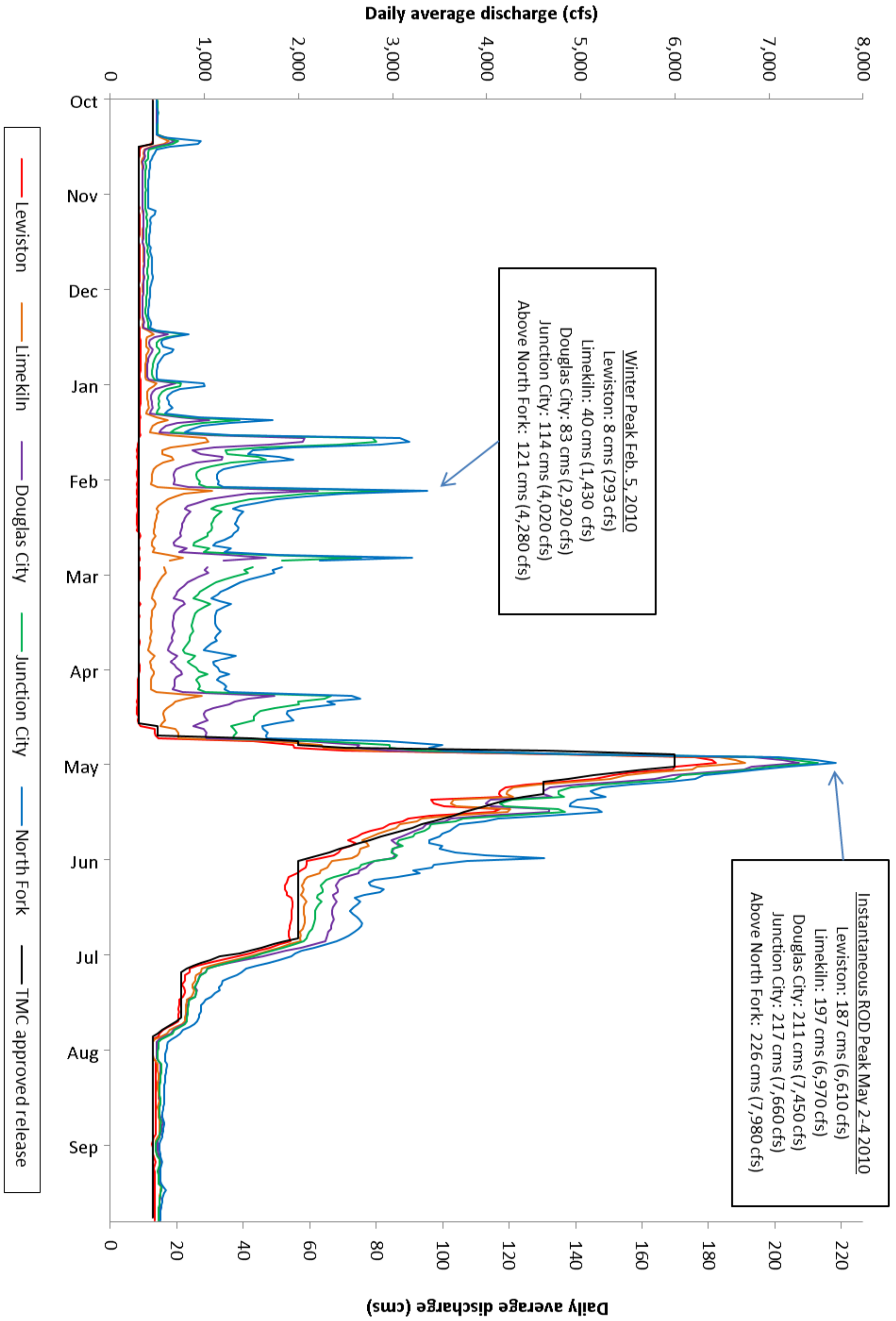
WY 2010 daily average streamflow hydrographs were developed for the five mainstem Trinity River USGS stream gaging stations and illustrated tributary streamflow accretion (Figure 2). Progressing downstream from Lewiston Dam to the North Fork Trinity River, fall flows remained below 28 cms (1,000 cfs) at all monitoring sites until January 2010, when a series of winter storms generated several tributary peak flow events. The largest tributary-generated instantaneous peak flow event, occurring on February 5, 2010, was 121 cms (4,280 cfs) at the downstream-most monitoring sites, as recorded at the USGS Trinity River above North Fork Trinity River gaging station (USGS gaging station #11526400). Additional peak flow events were similar in magnitude and duration: January 19 (108 cms [3,800 cfs]), February 26 (113 cms [3,990 cfs]), and April 12 (73 cms [2,570 cfs]). Between these peak flow events, tributary streamflow accretion kept mainstem Trinity River flows above winter baseflow release levels at Lewiston Dam until the scheduled 170 cms (6,000 cfs) spring 2010 ROD release. The ROD release began on April 23, peaked at 187 cms (6,610 cfs) on May 3, and then gradually receded to summer baseflows by mid-July 2010 (Figure 2).

4 SAMPLING STRATEGY AND STUDY SITE SELECTION

The sampling strategy and framework described in Chapter 4 of the IAP were followed to select study sites. The strategy considered sampling at the following scales: (1) an evaluation of systemic changes in the river channel within the mainstem Trinity River from Lewiston Dam to the North Fork Trinity River confluence (Project Reach), (2) assessments of channel rehabilitation sites, and (3) interdisciplinary integration of assessments to evaluate the restoration strategy proposed in the TRFE and ROD. Based on these, two sampling categories were used for WY 2010: system-wide ("systemic") sampling, and channel rehabilitation site-specific sampling. Both geomorphic and riparian monitoring were completed under the systemic sampling strategy, and additional riparian tasks were completed coincidentally at channel rehabilitation sites. Sampling strategy and site selection for both sampling schemes are described below.

4.1 Study Area

The Trinity River is located in northwestern California within Humboldt and Trinity counties. The watershed has a drainage area of 7,679 km^2 (2,965 mi^2), approximately one quarter of which is upstream of Lewiston Dam. The river's headwaters are in the Salmon-Trinity Mountains of northern California, from which it flows 274 km (170 mi) to its confluence with the Klamath River in Weitchpec, California. This monitoring effort focuses on sites located within the 64 km (40 mi) of the Trinity River located between Lewiston Dam and the confluence of the North Fork Trinity River. This reach occupies two distinct but adjacent geologic provinces: the Coast Range Province and the Klamath Mountain Province. Detailed background information about the study area can be found in the TRFE (USFWS and HVT 1999) and the Master EIR (USBR 2009).



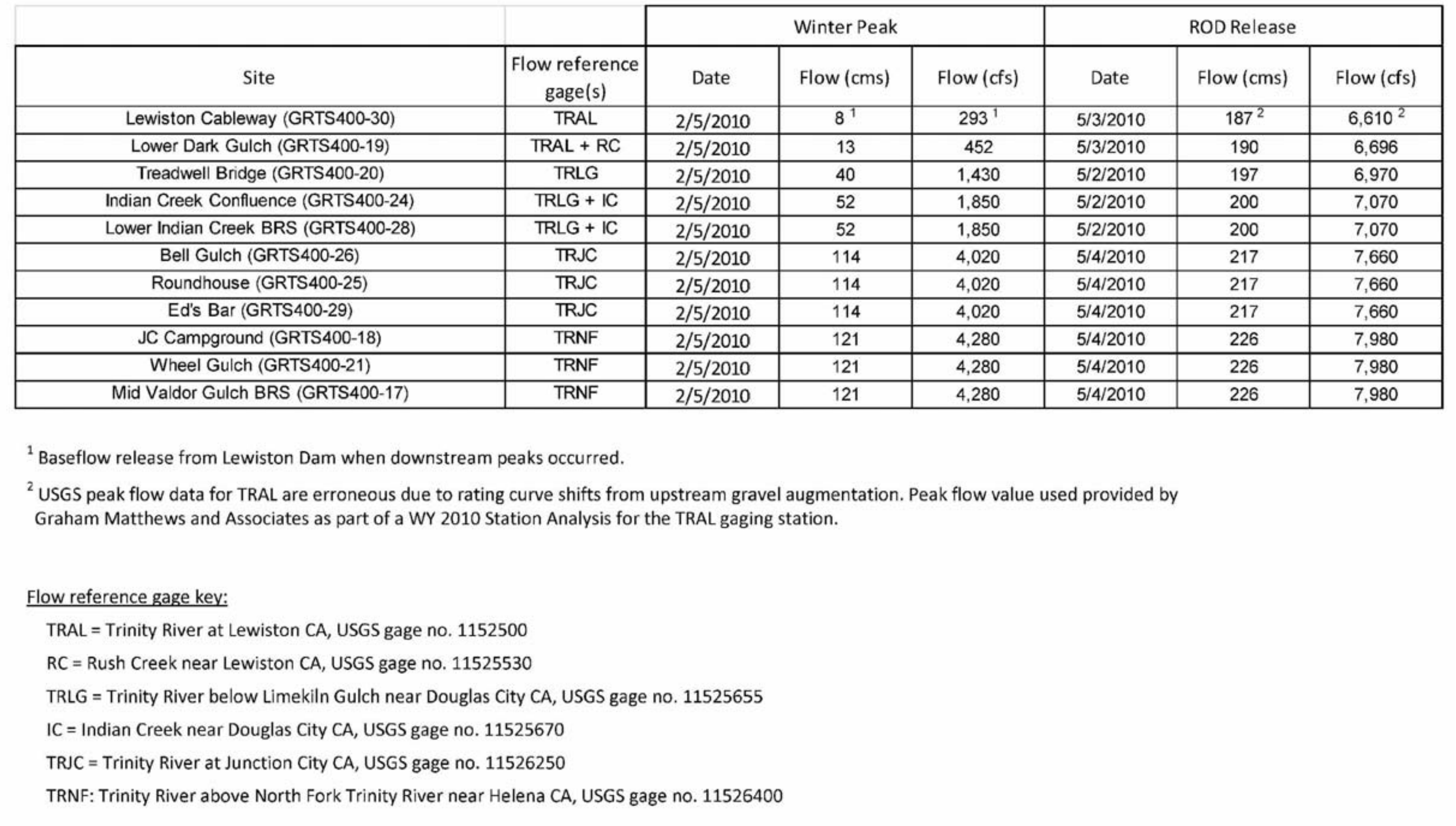
Winter Peak Feb. 5, 2010
Lewiston: 8 cms (293 cfs)
Limekiln: 40 cms (1,430 cfs)
Douglas City: 83 cms (2,920 cfs)
Junction City: 114 cms (4,020 cfs)
Above North Fork: 121 cms (4,280 cfs)

Instantaneous ROD Peak May 2-4 2010
Lewiston: 187 cms (6,610 cfs)
Limekiln: 197 cms (6,970 cfs)
Douglas City: 211 cms (7,450 cfs)
Junction City: 217 cms (7,660 cfs)
Above North Fork: 226 cms (7,980 cfs)

Figure 2. WY 2010 daily average annual hydrograph for the five mainstem USGS gaging stations, including the TMC-approved hydrograph for Lewiston Dam releases. Hydrographs for USGS gaging stations shown, ordered by increasing distance downstream of Lewiston Dam, include the Trinity River at Lewiston (USGS gage # 11525500), Trinity River below Limekiln Gulch (gage # 11525655), Trinity River at Douglas City (gage # 11525854), Trinity River at Junction City (11526250), and Trinity River above North Fork Trinity River (gage # 11526400). WY 2010 geomorphic monitoring was performed over three periods: (1) pre-winter experiment installation in late November and early December 2009, (2) post-winter pre-spring experiment monitoring and re-set in late March and early April 2010, and (3) post-spring ROD release monitoring in July

through August 2010. WY 2010 riparian fall monitoring occurred in August and December 2009, and summer monitoring occurred in August 2010.

Table 3. Estimated winter peak and spring ROD release streamflows at GRTS Panel 2 sites. Flows are estimated using the closest upstream USGS gaging stations in the mainstem and tributaries. No additional adjustments were made to scale flows from the gaging stations to the monitoring sites.



		Winter Peak			ROD Release		
Site	Flow reference gage(s)	Date	Flow (cms)	Flow (cfs)	Date	Flow (cms)	Flow (cfs)
Lewiston Cableway (GRTS400-30)	TRAL	2/5/2010	8 [1]	293 [1]	5/3/2010	187 [2]	6,610 [2]
Lower Dark Gulch (GRTS400-19)	TRAL + RC	2/5/2010	13	452	5/3/2010	190	6,696
Treadwell Bridge (GRTS400-20)	TRLG	2/5/2010	40	1,430	5/2/2010	197	6,970
Indian Creek Confluence (GRTS400-24)	TRLG + IC	2/5/2010	52	1,850	5/2/2010	200	7,070
Lower Indian Creek BRS (GRTS400-28)	TRLG + IC	2/5/2010	52	1,850	5/2/2010	200	7,070
Bell Gulch (GRTS400-26)	TRJC	2/5/2010	114	4,020	5/4/2010	217	7,660
Roundhouse (GRTS400-25)	TRJC	2/5/2010	114	4,020	5/4/2010	217	7,660
Ed's Bar (GRTS400-29)	TRJC	2/5/2010	114	4,020	5/4/2010	217	7,660
JC Campground (GRTS400-18)	TRNF	2/5/2010	121	4,280	5/4/2010	226	7,980
Wheel Gulch (GRTS400-21)	TRNF	2/5/2010	121	4,280	5/4/2010	226	7,980
Mid Valdor Gulch BRS (GRTS400-17)	TRNF	2/5/2010	121	4,280	5/4/2010	226	7,980

[1] Baseflow release from Lewiston Dam when downstream peaks occurred.

[2] USGS peak flow data for TRAL are erroneous due to rating curve shifts from upstream gravel augmentation. Peak flow value used provided by Graham Matthews and Associates as part of a WY 2010 Station Analysis for the TRAL gaging station.

<u>Flow reference gage key:</u>

TRAL = Trinity River at Lewiston CA, USGS gage no. 1152500

RC = Rush Creek near Lewiston CA, USGS gage no. 11525530

TRLG = Trinity River below Limekiln Gulch near Douglas City CA, USGS gage no. 11525655

IC = Indian Creek near Douglas City CA, USGS gage no. 11525670

TRJC = Trinity River at Junction City CA, USGS gage no. 11526250

TRNF: Trinity River above North Fork Trinity River near Helena CA, USGS gage no. 11526400

4.2 Sampling Design

Systemic sampling employed the generalized random tessellation stratified (GRTS) sampling design to address status and trends within the upper mainstem Trinity River Project Reach, building on efforts that were recommended by the IAP (TRRP and ESSA Technologies Ltd. 2009) and initiated in WY 2009 (USFWS et al., in preparation). The sample universe was defined as the Trinity River from Lewiston Dam to the confluence with the North Fork Trinity River (Project Reach). The sample universe contained five Panels (Panel 1 through Panel 5), and each Panel consisted of 16 individual GRTS sites, all spaced uniformly between Lewiston Dam and the North Fork Trinity River confluence. Individual GRTS sample sites were defined as 400 m river segments based on the 142 cms (5,000 cfs) Trinity River centerline. Monitoring was conducted at selected locations within the limits of each GRTS site.

Sites were selected using a rotating panel revisit design, which was initiated in 2009 for fish habitat studies only and adopted in 2010 for geomorphic and riparian studies. The rotating panel design is intended to sample two panels within each year; in the following year of sampling, one of the panels is repeated and one new panel is added until all five panels are sampled. The process is then repeated as the first panel is sampled again and the pattern continues. For WY 2010, geomorphic and riparian studies occupied a single panel – Panel 2. To align schedules and allow results to be integrated with the fish habitat studies, WY 2011 work occupied three panels, and post-2011 work will return to a two panel per year rotation (Table 4).

Water Year 2010 geomorphic and riparian studies were conducted at 12 of the 16 GRTS sample sites within Panel 2 (Figure 3, Table 5); all 16 Panel 2 sites could not be sampled due to cost considerations. The 12 GRTS sample sites initially selected for geomorphic and riparian assessments were the same sites as those identified for two-dimensional (2-D) habitat modeling fish habitat assessments. Of the 12 sampled sites, construction occurring ahead of schedule at Lowden Meadows (GRTS site 400-23) interrupted data collection and prevented entry to the site mid-survey, thereby reducing the number of monitored sites to 11. Riparian monitoring was performed at all 11 of these sites. Additional restricted property access prevented geomorphic monitoring at Wheel Gulch (GRTS 400-21), which reduced the geomorphic monitoring to 10 sites. Aerial photograph basemaps for all 11 of the Panel 2 sites and all 12 channel rehabilitation sites are included in Appendix A.

4.3 Channel Rehabilitation Site-specific Sampling and Study Sites

As of November 2011, 23 of the 47 TRFE-identified channel rehabilitation sites have been constructed (including three side channel rehabilitation sites); these sites are expected to increase habitat quantity and quality as they evolve over time due to restoration of geomorphic and riparian processes. Twelve channel rehabilitation sites were selected to assess their evolution via riparian mapping (Figure 4). In addition, geomorphic monitoring was also conducted at four of these 12 channel rehabilitation sites. As a part of the GRTS sampling site selection, four GRTS panels were coincidentally located within the limits of existing channel rehabilitation sites: Mid-Valdor Gulch, Lower Indian Creek, Lower Dark Gulch, and Lewiston Cableway (Table 5). Cross section topography, bed mobility, and bed scour and deposition monitoring were conducted on constructed surfaces as part of the GRTS systemic sampling; therefore, results were used to evaluate certain design performance objectives. In addition, monitoring results allowed an opportunity to assess design performance of certain features (such as constructed side channels) as part of IAP Assessment 12P.

Table 4. The GRTS sampling design for geomorphic and riparian monitoring, highlighting WY 2010 efforts. The GRTS rotating panel design was initiated in 2009 for fish habitat studies only; in 2010, it was also adopted for geomorphic process and riparian studies. For WY 2010, the IHAP team decided that geomorphic, riparian, and wildlife studies would occupy Panel 2 sites only. To align schedules and allow results to be integrated with the fish habitat studies, WY 2011 work occupies three panels, and post-2011 work returns to a two panel per year rotation. The ellipsis after 2018 indicates the pattern of sampling continues through time.

Panel\Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	…
1					X	X				X	
2		X	X			X	X				
3			X				X	X			
4			X	X				X	X		
5				X	X				X	X	
⋮											⋮

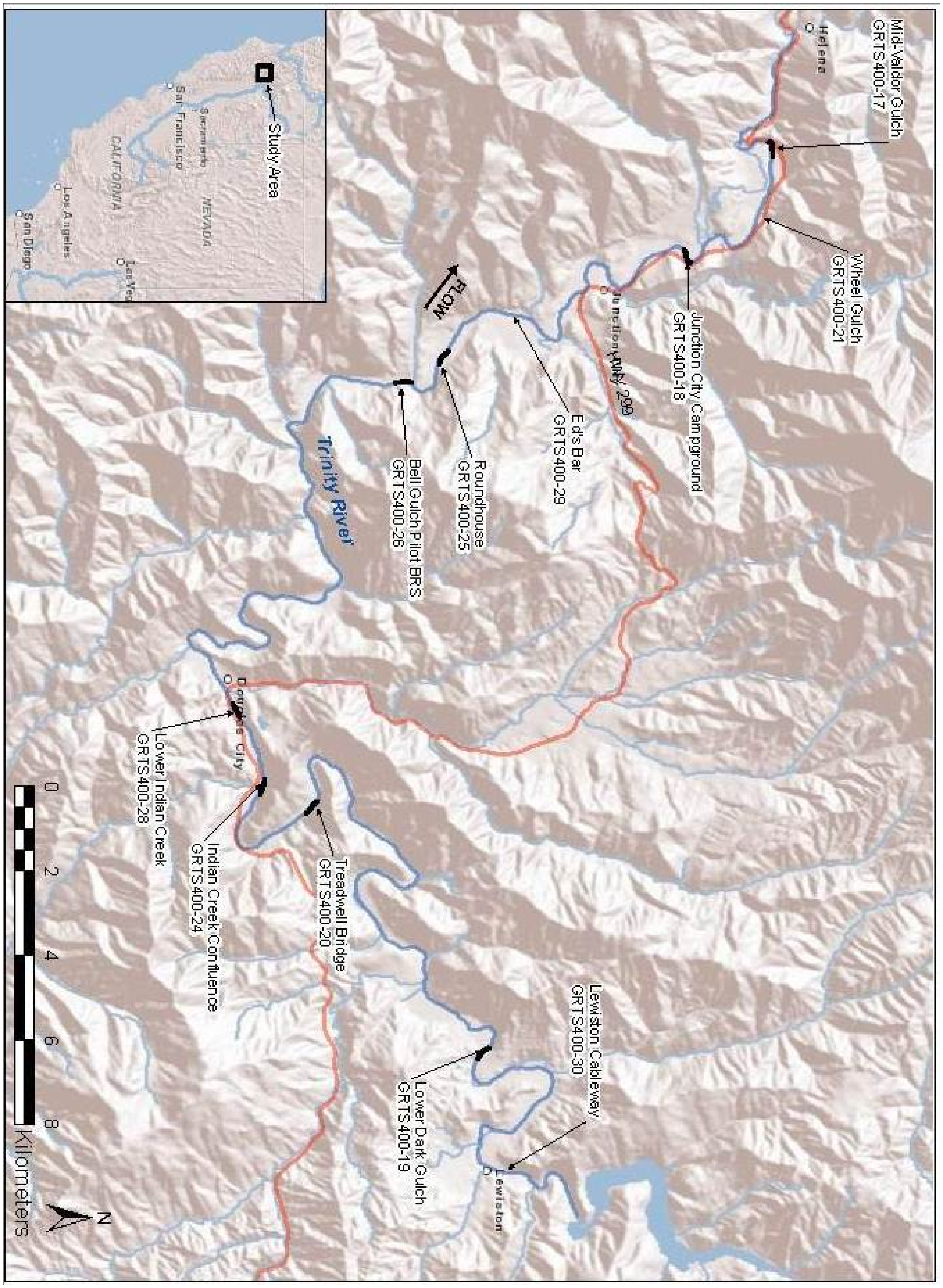
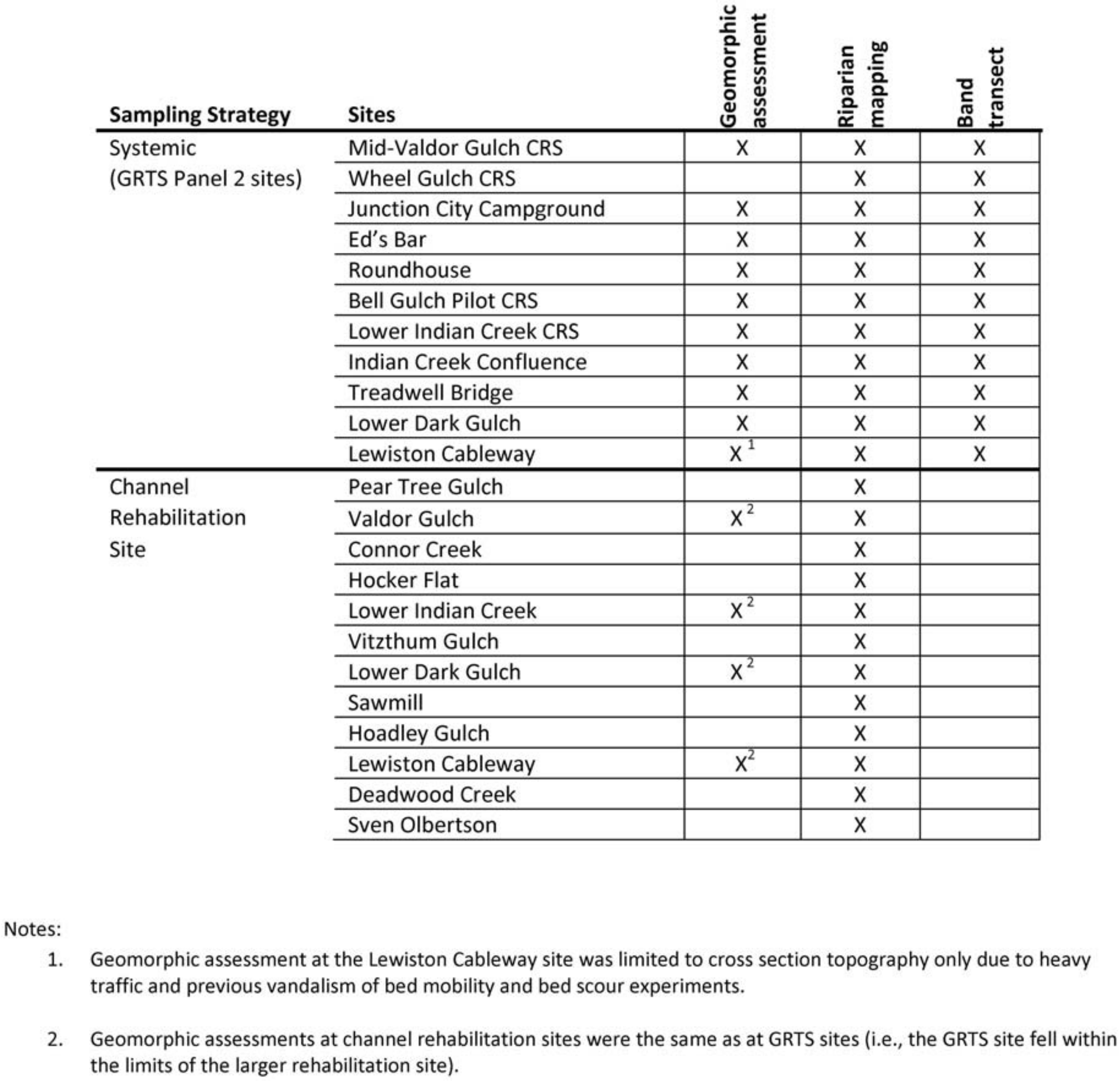


Figure 3. Location of Panel 2 GRTS sites selected for WY 2010 geomorphic and riparian monitoring.

Table 5. Summary of WY 2010 systemic and site level sampling tasks for geomorphic and riparian assessments.



Sampling Strategy	Sites	Geomorphic assessment	Riparian mapping	Band transect
Systemic (GRTS Panel 2 sites)	Mid-Valdor Gulch CRS	X	X	X
	Wheel Gulch CRS		X	X
	Junction City Campground	X	X	X
	Ed's Bar	X	X	X
	Roundhouse	X	X	X
	Bell Gulch Pilot CRS	X	X	X
	Lower Indian Creek CRS	X	X	X
	Indian Creek Confluence	X	X	X
	Treadwell Bridge	X	X	X
	Lower Dark Gulch	X	X	X
	Lewiston Cableway	X[1]	X	X
Channel Rehabilitation Site	Pear Tree Gulch		X	
	Valdor Gulch	X[2]	X	
	Connor Creek		X	
	Hocker Flat		X	
	Lower Indian Creek	X[2]	X	
	Vitzthum Gulch		X	
	Lower Dark Gulch	X[2]	X	
	Sawmill		X	
	Hoadley Gulch		X	
	Lewiston Cableway	X[2]	X	
	Deadwood Creek		X	
	Sven Olbertson		X	

Notes:

1. Geomorphic assessment at the Lewiston Cableway site was limited to cross section topography only due to heavy traffic and previous vandalism of bed mobility and bed scour experiments.

2. Geomorphic assessments at channel rehabilitation sites were the same as at GRTS sites (i.e., the GRTS site fell within the limits of the larger rehabilitation site).

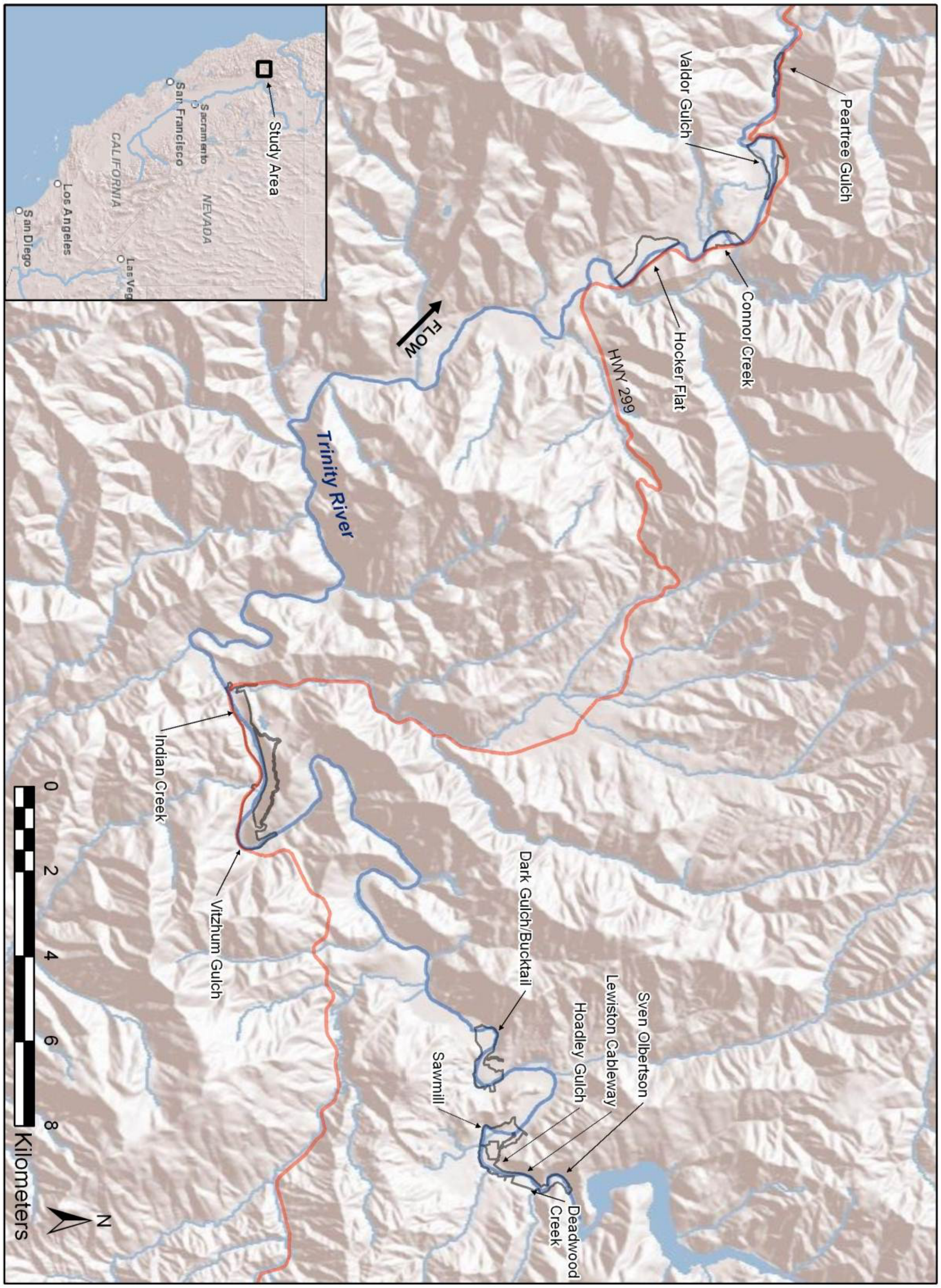


Figure 4. Location of channel rehabilitation sites selected for WY 2010 geomorphic and riparian monitoring.

5 GEOMORPHIC ASSESSMENTS

Water Year 2010 geomorphic assessments measured changes resulting from winter 2010 peak flows and the spring 2010 ROD release. Geomorphic assessments were performed only at selected GRTS Panel 2 sites and results were used to evaluate systemic objectives. In some cases, Panel 2 sites were located within the limits of larger channel rehabilitation sites; where this occurred, geomorphic monitoring results were also used to help evaluate the site-level objectives.

Specific geomorphic monitoring activities completed between October 2009 and November 2010 and their related IAP objectives included:

- Documenting pre-winter and/or pre-spring release topographic conditions and channel morphology at site cross sections, and then documenting topographic changes following the spring 2010 ROD high flow release. Results of this monitoring effort were used to evaluate IAP (and TRFE) floodplain inundation, channel migration, deposition, and scour objectives (Table 1), and also used to corroborate bed mobility and bed scour monitoring results.
- Installing bed mobility and bed scour experiments, and monitoring these experiments following the spring ROD release. The IAP objectives included monitoring bed mobility and bed scour thresholds to evaluate whether quantitative TRFE bed mobility and scour management objectives are being achieved during natural tributary-induced flood events and ROD flow releases for Normal and wetter water year types (Table 1). Since WY 2010 was Normal, the corresponding TRFE Normal water year geomorphic objectives were to: (1) mobilize the D_{84} on most alluvial features (general channel mobility), and (2) cause channelbed scour and redeposition of gravels (TRFE Tables 8.2 and 8.7; Table 6).

5.1 Field and Analytical Methods

Specific geomorphic monitoring activities at Panel 2 sites included cross section surveys to document pre-winter topography and channel morphology, and to document topographic changes following the WY 2010 ROD release. Bed mobility and bed scour experiments were installed on these same cross sections, except in some cases where site conditions prevented experiment placement (such as the channel being too deep when the site was visited, geomorphic features were small or not present, or when vandalism risk was high). The following sections describe topographic surveys, bed mobility, and bed scour monitoring in greater detail.

5.1.1 Cross Section Selection

Cross sections were specifically selected to span alluvial and/or constructed features to meet both geomorphic and riparian vegetation monitoring objectives. Selection priority was given to sites having existing monumented cross sections where previous monitoring has been conducted over the last 20 years (i.e., where Panel 2 sites fell within the limits of channel rehabilitation sites). For Panel 2 sites that did not have existing cross sections, cross section locations were chosen by reviewing aerial photograph-based site maps to identify locations of alluvial features within the GRTS panel (e.g., point bars, medial bars) where both geomorphic and riparian data could be collected specifically to evaluate IAP objectives. Following this selection, property ownership was determined and site access was arranged. Next, a field reconnaissance was made to review data collection feasibility at each cross section and make any adjustments to shift or relocate a cross section within the GRTS panel if necessary.

Table 6. Geomorphic monitoring and experiments by GRTS Panel 2 study site.

Location	River Km	Cross Section	Pre-winter (fall 2009) and post-spring release (summer/fall 2010) cross section topography	Bed mobility experiments	Bed scour experiments	Notes
Mid Valdor Gulch BRS (GRTS 400-17)	120.8	141+20	X			Experiments not installed due to high traffic and previous vandalism.
	121.1	151+80	X	X	X	
JC Campground (GRTS 400-18)	125.1	283+30	X	X	X	
	125.2	286+40	X	X	X	
Ed's Bar (GRTS 400-29)	132.0	511+00	X			Flows too fast and too deep to set experiments on this cross section.
	132.1	516+40	X	X	X	Spring ROD release monitoring only.
Roundhouse (GRTS 400-25)	134.0	576+50	X	X	X	
	134.1	582+10	X	X	X	
Bell Gulch Pilot BRS (GRTS 400-26)	135.6	630+20	X	X	X	
	135.9	641+00	X		X	Small point bar monitored for scour, not wide enough for bed mobility experiments.
Lower Indian Creek BRS (GRTS 400-28)	151.6	1157+90	X	X	X	
	151.8	1166+30	X	X	X	
Indian Creek Confluence BRS (GRTS 400-24)	153.6	1224+50	X	X	X	
	153.8	1231+00	X			Experiments not installed due to high traffic and vandalism risk.
Treadwell Bridge (GRTS 400-20)	157.4	1348+90	X	X	X	
	157.6	1356+80	X	X	X	
Lower Dark Gulch BRS (GRTS 400-19)	170.7	1785+70	X		X	Monitoring on cross section is in a side channel with sand and silt bed, substrate is too small for bed mobility experiments.
	170.9	1791+30	X	X	X	
Lewiston Cableway (GRTS 400-19)	177.6	2012+10	X			Experiments not installed due to high traffic and previous vandalism.
	177.7	2013+94	X			

5.1.2 Cross Section Surveys

Two cross sections were installed at each Panel 2 GRTS site. Cross section end pins were installed perpendicular to flow and spanned the channel to capture confinement of at least a 311 cms (11,000 cfs) flow. Confinement is determined using a TRRP GIS layer for various flow inundations overlaid on a current aerial photograph to obtain 311 cms (11,000 cfs) confinement. A stage discharge relationship is not computed. Channel topography was surveyed twice at each cross section, once in fall 2009 to capture pre-winter flood conditions, and then once in summer or fall 2010 to capture the net changes following the winter flood and spring ROD release.

The cross section end pin elevations were based on the horizontal and vertical control provided by the California Department of Water Resources (DWR). Cross section surveys were performed using an auto-level and were used to document streambed topography and water surface elevations. All cross section surveys followed standard field protocols (Harrelson et al. 1994). During topographic surveys, horizontal spacing across surfaces varied (generally larger spacing is used across broad flat surfaces and closer spacing is used across surfaces with more diverse topography, with survey points always taken at topographic hinge points, or "breaks in slope"). Repeating the same stationing along cross sections can miss key topographic changes between surveys (e.g., if breaks in slope change location), which can suggest greater topographic change when the survey points are interpolated to construct the topographic surface.

After cross section topography was surveyed, the data were plotted and graphically compared to previous surveys to evaluate changes. Survey point spacing on cross sections may be up to several feet, and the exact point spacing was not repeated between surveys, resulting in small but variable changes along the cross section. When comparing surveys, most cross sections showed localized topographic variation caused by these differences in placement and the resulting graphical interpolation (resulting in what was determined to be “survey noise”). The effect of the variation was amplified by particle size, particularly when substrate was large (e.g., cobble, boulder); survey rod placement can be on top of rocks or can be in their interstices, and replicate surveys almost always showed some topographic variation as a result. Variation caused by particle size most commonly ranged up to 0.13 m (substrate up to cobble), and occasionally up to 0.26 m (boulder).Cross section surveys were therefore evaluated on an individual basis, taking particle size, point distribution, and field observations into consideration when determining whether or not results were noise or showed actual lateral (bank erosion, channel migration) or vertical (aggradation or scour) topographic change.

5.1.3 Substrate Characterization

Substrate (i.e., surface sediments) was characterized at all cross sections where bed mobility was monitored. The purpose of the substrate characterization was to document bar material gradation so that tracer rocks representing the D_{84} and D_{50} of the grain size distribution on the bar could be placed. The substrate sampling was not intended to characterize site or reach scale channel grain sizes. At each of these cross sections, individual sedimentary units, or facies, were determined by visually delineating distinct textural populations around areas having little to no spatial variation in bed material size (Lisle and Madej 1992). Within each facies, a modified Wolman-style pebble count of 100 grains was conducted to document the bed surface particle size distribution, and statistical particle sizes (D_{84} and D_{50}) were computed for the bed mobility experiments (Leopold 1970, Bunte and Abt 2001). Tracer rocks with the same D_{84} and D_{50} grain sizes were then gathered for painting and placement on the cross section.

5.1.4 Bed Mobility, Scour, and Deposition

Bed mobility and bed scour experiments were installed in late November through early December 2009, monitored and reset in March 2010 following winter tributary floods but before the spring ROD release, and then monitored again between July and late-August following the spring ROD release. Both bed mobility and bed scour experiments were installed in the fall, prior to the water year designation. If the water year was classified as Normal, Wet, or Extremely Wet, bed scour results could be used to evaluate TRFE objectives; if the water year was classified as Dry or Critically Dry, bed scour experiments could be used to help corroborate other experiments and site observations; the TRFE only specified a bed mobility objective, not a bed scour objective, for Dry or Critically Dry water years. For WY 2010, bed scour monitoring was used to evaluate TRFE Normal WY objectives as well as support and corroborate the bed mobility and cross section topographic monitoring.

5.1.4.1 Bed Mobility

Bed mobility was measured using groups of individually-labeled, brightly-marked tracer rock sets installed along the cross sections; the number of groups ranged from 8 to 33, depending on the section and the location of each rock along the cross section was recorded. Each group contained sets of two sizes of rocks, representing D_{50} and D_{84} size classes determined by the substrate characterization. D_{50} and D_{84} pairs were set at regular intervals spanning the monitoring feature of interest (commonly over a constructed surface, or across a point bar and extending into the low-water channel) (Figure 5). Tracer rocks were placed with particular emphasis on the 13 to 57 cms (450 to 2,000 cfs) band where future detrimental riparian encroachment is of greatest risk; however, tracer rocks were not always able to span this entire band, most commonly due to facies changes from coarser sediment (gravel, cobble, boulder) to fine sediment (sand, silt) and/or due to riparian vegetation. Bed mobility monitoring with tracer rocks cannot be performed in fine sediment, and as a result, no bed mobility experiments were set in sand or silt facies. The position of the 13 to 57 cms (450 to 2,000 cfs) band along monitoring cross sections was determined from water surface elevation surveys, HEC-RAS model results, and/or visual estimates relative to site streamflow.

Where placed, each tracer rock was set on the bed surface so that its exposure mimicked that of the surrounding rocks by removing a similar sized rock from the bed and setting the tracer rock in its place. This technique allowed the tracer rocks to reasonably approximate natural bed surface conditions and avoid unnatural over- or under-exposure. Following the peak flows, the cross sections were revisited to determine which tracer rocks moved. Rocks were defined as “mobilized” if travel distances exceeded the distance between the D_{50} and D_{84} as initially set (typically from 0.3 m to 0.6 m); movement less than this distance was considered a hydraulic adjustment to a more stable position (M&T and HVT 1997). Efforts to relocate marked rocks included looking downstream of the cross section, as well as excavating the bed at each marked rock placement station to see if the rocks remained stationary but were buried by sediments deposited from upstream. Following the winter flood monitoring, tracer rocks found downstream were replaced to their original position for subsequent spring ROD release monitoring; when this was not possible (e.g., if a rock was lost downstream), new tracer rocks were placed.

Peak flow thresholds for bed surface mobilization were estimated by evaluating the percentage of tracer rocks mobilized for the entire bar surface (ideally several flood peaks would be monitored to bracket a range of surface mobility). Individual grain size movement was recorded, but not analyzed individually in order to characterize an aggregated bar movement threshold. A single percentage of tracer rocks mobilized has not been established in the scientific literature as a threshold for ‘significant’ bed surface mobilization, although 50% to 80% has been used (e.g., M&T 2007a; M&T and HVT 1997). For this investigation, rather than establish a threshold percentage that defined whether or not mobility was “significant,” the following threshold criteria were used: any mobilization between 20% and 80% was considered “partial mobility,” and results showing 80% to 100% mobilization were considered “complete mobility” of the monitored surface. Mobilization less than 20% was considered localized and not representative of the entire monitoring surface.

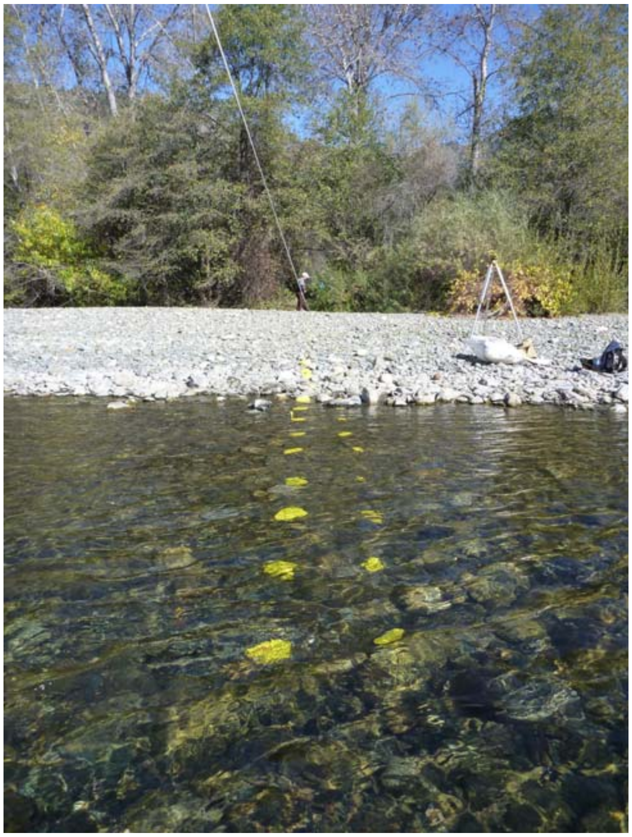


Figure 5. Typical tracer rock installation along a monitoring cross section, showing tracer rock placement beginning below the 13 cms (450 cfs) water surface and extending up onto the bar above the 57 cms (2,000 cfs) water surface. D_{84} rocks are set at equal spacing on the cross section, and the D_{50} rocks are set upstream of the D_{84} rocks, at the same spacing. In this photograph, the D_{84} is 120 mm and the D_{50} is 76 mm. Spacing between the D_{84} rocks is 0.9 m (same for the D_{50} rocks). Flow is from right to left.

5.1.4.2 Bed Scour and Deposition

Bed scour and deposition were measured using scour chains installed at selected locations on cross sections, commonly within or associated with the range of the marked rock sets. As with the tracer rock sets, scour chains were placed with particular emphasis on the 13 to 57 cms (450 to 2,000 cfs) band where future detrimental riparian encroachment is of greatest risk. Each scour chain consisted of a brass chain with approximately 15 mm (0.6 in) links, a duckbill earth anchor affixed on one end, and a stainless steel nut affixed to the other (to aid in relocation). The chain was driven vertically into the channel substrate to a minimum depth of approximately 0.6 m, and a short (10 to 20 cm) length of chain was left lying flat on the bed surface (Emmett and Leopold 1963, Lisle and

Eads 1991). Between one and four scour chains were installed across the monitoring surface at each cross section. Similar to the marked rock monitoring, scour and redeposition were monitored for both winter flood and spring ROD release flows.

To measure scour and deposition, the chain location was reoccupied, its elevation surveyed, and the bed surface carefully excavated by hand until the chain was found. Differences in pre-and post-high flow chain length and changes in surveyed bed surface elevations documented scour and deposition depths. Measurement precision was approximately equal to the dominant size of the bed surface material (Lisle and Eads 1991), calculated to be the D_{84} substrate.

Forty-two chains were installed in fall 2009 and monitored in spring 2010. Two additional chains were installed at the Ed's Bar site (GRTS 400-29) during the spring 2010 winter flood monitoring, bringing the total to 44 for monitoring the spring ROD release. Some scour chains were not monitored in the spring due to high flows (installation took place during fall baseflows and some chains were underwater during spring monitoring). If flows were too deep and/or fast to attempt chain relocation, the bed elevation was surveyed where possible to at least provide an elevation to document net bed elevation changes (and allow for a minimum scour or deposition estimate). All chains were monitored in the summer following the spring 2010 ROD release.

Similar to previous analyses (e.g., 2009 IHAP report; USFWS et al., in preparation), measured scour was normalized by the local D_{84}, allowing for direct inter- and intra-site results comparison. Any chain length increases following a peak flow event were considered to record scour (unless otherwise noted in the field), showing that at a minimum bed matrix particles were mobilized. It is possible for the bed to scour without the D_{84} mobilizing if finer particles are winnowed, although measurement precision is less than if chain length increases are equal to or greater than the diameter of the D_{84}.

5.2 Results and Discussion

5.2.1 GRTS Sites

Geomorphic monitoring at the GRTS Panel 2 sites was conducted relative to IAP Assessment 6P (Table 1). Cross section topography, bed mobility, and bed scour and deposition monitoring results are discussed below on a systemic basis.

5.2.1.1 Cross Section Topography

Plotted cross sections and selected water surface elevations at all monitored GRTS Panel 2 sites are presented in Appendix B. Collectively, based on the WY 2010 topographic surveys, most Panel 2 cross sections showed little change as a result of the WY 2010 winter flood events and the spring ROD release, and are therefore not discussed in this report. Large-scale geomorphic changes, such as new bar formation, lateral migration, or floodplain aggradation did not occur at most Panel 2 monitoring sites.

A few cross sections, however, stood apart from the others by showing notable changes to specific geomorphic features. Three of these cross sections occurred at channel rehabilitation sites (Mid-Valdor Gulch XS 141+20, Lower Indian Creek XS 1157+90, and Lower Dark Gulch XS 1785+70) and are discussed in Section 5.2.2. Topographic changes at GRTS Panel 2 sites included the following:

- Roundhouse XS 582+10: Topographic changes from November 2009 to November 2010 suggested deposition along the right and left sides of the thalweg (approximately 0.30 m and 0.46 m, respectively). The deposition was below the 13 cms (450 cfs) water surface elevation; no topographic changes occurred above the 13 cms (450 cfs) water surface elevation. No changes in planform morphology were observed on the 2009 and 2010 aerial photographs, suggesting these changes were localized and did not occur in response to morphological changes upstream or downstream of the cross section.

- Bell Gulch XS 630+20: This cross section was difficult to survey due to a deep pool along the left bank; field conditions made stringing a tape and tethering a boat challenging, particularly at flows above 13 cms (450 cfs). Topography was surveyed in November 2009 and again in August 2010. Due to swift current, the August 2010 survey had large point spacing through the pool (between station 7.5 and station 20) which resulted in data interpolations that suggested aggradation; however, the few points that were collected were very close in elevation to the previous survey, suggesting the interpolations were inaccurate. Based on this assumed inaccuracy, no change was inferred in pool topography along the cross section. Farther along the cross section, beginning at approximately station 21, the August 2010 survey point spacing became much closer and showed the point bar retreated approximately 4.6 m along the cross section and with a maximum net scour depth of approximately 0.7 m. A review of the 2009 and 2010 aerial photographs showed that the apex of the bar moved approximately 12 m downstream, so although the cross section showed fairly substantial topographic change, the overall site morphology remained similar, but with downstream bar migration.
- Indian Creek Confluence XS 1224+50: Topography at this cross section was surveyed in December 2009 and in August 2010. The cross section spanned a medial bar (which was also monitored for bed mobility and bed scour), and the mainstem flow was split approximately evenly on both sides of the bar. Topographic change was most pronounced in the left channel and along the left bank. The left bank has been actively retreating, suggesting localized lateral migration; from December 2009 to August 2010, the bank retreated approximately 1.8 m along the cross section. In addition, the left channel scoured for most of its width below the 450 cfs water surface elevation, with a maximum scour of 0.8 m occurring at the thalweg.
- Treadwell Bridge XS 1348+90: Topographic changes at this cross section occurred in response to a medial bar that has been steadily growing, causing this cross section to be very dynamic. Topography was surveyed in November 2009 and in August 2010. The most significant change occurred in the left bank side channel, which had a thalweg shift from the right bank to the left bank and deepened by approximately 0.3 m. Additionally, the medial bar above the 13 cms (450 cfs) water surface elevation (between station 22 and station 40) showed both scour (from station 22 to 26) and fill (from station 26 to 40). These results are corroborated by the bed mobility and bed scour experiments.

With the exception of Indian Creek Confluence XS 1224+50, each of these cross sections was established in WY 2010 and results were based on only two surveys. Because of this short data and monitoring history, it was not possible to tell whether the changes described above were reflective of annual scour and fill patterns (i.e., annual topographic fluctuations but the overall cross section shape remains largely the same over time), or whether the changes were trends showing a shift in channel morphology in response to streamflow and sediment management. Additional monitoring in WY 2011, which includes revisiting eight of the WY 2010 GRTS Panel 2 sites, will be used to help evaluate the context of the topographic changes surveyed at these sites.

5.2.1.2 Bed Mobility

Bed mobility was calculated for both the D_{84} and D_{50} rocks at each monitoring site using the total population of tracer rocks installed.

- All tracer rock sets were inundated by the WY 2010 winter peak flow and by the spring ROD release.
- D_{50} mobility almost always exceeded D_{84} mobility at each cross section, with the following exceptions: winter peak monitoring at Treadwell Bridge XS 1356+80 (D_{84} mobility exceeded D_{50} mobility by one tracer rock), and spring ROD release monitoring at Mid-Valdor Gulch XS 151+80 and at Lower Dark Gulch XS 1791+30 (D_{84} mobility exceeded D_{50} mobility by one and four tracer rocks, respectively). These results are not uncommon, as sometimes D_{50} rocks are shielded by upstream obstructions (often larger rocks as they settle into interstitial spaces).
- Winter peak D_{84} mobility averaged 14%, ranging from 0% to 62%, and D_{50} mobility averaged 28%, ranging from 0% to 86%. Complete mobility for D_{84} tracer rock sets (>80% tracer rocks mobilized) did not occur at any site, and complete mobility for D_{50} tracer rock sets occurred at only one site (Table 7).
- Greater mobility was recorded resulting from the spring ROD release; for all Panel 2 sites, D_{84} mobility averaged 66%, ranging from 38% to 100%, and D_{50} mobility averaged 77%, ranging from 17% to 100%. Complete mobility for D_{84} tracer rock sets (>80% tracer rocks mobilized) occurred at four sites, and complete mobility for D_{50} tracer rock sets occurred at seven sites (Table 8).

To provide context relative to flow effectiveness, results were grouped by size class and plotted for both the winter peak and spring ROD release (Figure 6, Figure 7). Because peak discharge increased with distance downstream of Lewiston Dam (Table 3), longitudinal distribution of peak flows was also provided to illustrate mobility results relative to the peak flow gradient. Results with respect to the peak flow gradient were most pronounced for the winter peak, where flows were 13 cms (452 cfs) at Lower Dark Gulch (XS 1791+30) but had increased to 121 cms (4,280 cfs) at Junction City Campground (XS 286+40) due to tributary accretion. Based on this data distribution, the following observations were made about the winter peak:

- Bed mobility increased with distance downstream as flow magnitude increased from tributary accretion.
- There was a notable difference in mobility from Lower Dark Gulch to Lower Indian Creek, where winter peak flows ranged from 13 to 52 cms (452 to 1,850 cfs), compared with mobility results from Bell Gulch to Mid-Valdor Gulch, where winter peak flows ranged from 114 to 121 cms (4,020 to 4,280 cfs). Mobilization at the upper group of sites averaged 3% and 6% (D_{84} and D_{50}, respectively), compared to the lower group of sites, which averaged 25% and 51% (D_{84} and D_{50}, respectively). These results suggested a bed surface mobilization flow threshold occurred between approximately 57 and 113 cms (2,000 and 4,000 cfs).

Table 7. WY 2010 bed mobility results at GRTS Panel 2 sites from the Feb. 5, 2010 winter peak flow.

					Winter bed mobility						
Reach / Site	**Cross section**	**Rock placement range**	**Size class**	**Size (mm)**	**No. rock groups along XS**	**No. of rocks moved**	**Percent moved of total set**	**Percent moved in 13-57 cms band [1]**	**Peak flow (cms)**	**Individual stationing along XS where rocks moved**	**Stations where rocks are missing or otherwise were not reset for Spring release**
Mid Valdor Gulch BRS (GRTS400-17)	151+80	76-108	D84	117	9	1	11%	-	121	108	108
			D50	65	9	2	22%	-	121	104, 108	104, 108
JC Campground (GRTS400-18)	283+30	10-43	D84	80	12	4	33%	20%	121	22, 34, 40, 43	40, 43
			D50	42	12	7	58%	50%	121	19, 22, 25, 28, 31, 40, 43	31, 40, 43
	286+40	12-92	D84	91	21	13	62%	0%	121	44, 48, 52, 56, 60, 64, 68, 72, 76, 80, 84, 88, 92	52, 56, 60, 64, 68, 72, 76, 80, 84, 88, 92
			D50	47	21	14	67%	0%	121	40, 44, 48, 52, 56, 60, 64, 68, 72, 76, 80, 84, 88, 92	44, 48, 52, 56, 60, 64, 68, 72, 76, 80, 84, 88, 92
Ed's Bar (GRTS400-29)	516+40	149 - 224	D84	110	N/A	N/A	N/A	N/A	114	N/A	N/A
			D50	60	N/A	N/A	N/A	N/A	114	N/A	N/A
Roundhouse (GRTS400-25)	576+50	83-105	D84	211	8	0	0%	-	114	N/A	N/A
			D50	109	8	1	13%	-	114	102	N/A
	582+10	11-55	D84	102	12	1	8%	0%	114	47	N/A
			D50	43	12	7	58%	33%	114	27, 31, 39, 43, 47, 51, 55	43, 51
Bell Gulch (GRTS400-26)	630+20	3 - 82	D84	112, 91	21	7	33%	44%	114	19, 31, 43, 47, 55, 59, 63	N/A
			D50	53, 45	21	18	86%	81%	114	15, 19, 23, 27, 31, 35, 39, 43, 47, 51, 55, 59, 63, 67, 71, 75, 79, 82	15, 19, 23, 27, 31, 35, 39, 43, 47, 51, 55, 59, 63, 67, 71, 75, 79, 82
Lower Indian Creek BRS (GRTS400-28)	1157+90	205-223	D84	97	13	0	0%	-	52	N/A	N/A
			D50	44	13	0	0%	-	52	N/A	N/A
	1166+30	149 - 163	D84	74	10	0	0%	-	52	N/A	N/A
			D50	38	10	0	0%	-	52	N/A	N/A
Indian Creek Confluence (GRTS400-24)	1224+50	56 - 180	D84	122	21	1	5%	0%	52	180	N/A
			D50	65	21	2	10%	0%	52	56, 180	56
Treadwell Bridge (GRTS400-20)	1348+90	16 - 134	D84	109, 53	33	0	0%	0%	40	N/A	N/A
			D50	61, 24	33	5	15%	0%	40	25, 34, 37, 40, 43	43
	1356+80	101 - 125	D84	128	9	1	11%	-	40	116	N/A
			D50	62	9	0	0%	-	40	N/A	N/A
Lower Dark Gulch (GRTS400-19)	1791+30	111 - 144	D84	87	12	0	0%	0%	13	N/A	N/A
			D50	48	12	0	0%	0%	13	111	111

[1] The 13-57 cms zone is the area of greatest riparian vegetation encroachment risk. Some tracer rock sets only partially spanned the entire 13 to 57 cms band due to substrate changes (i.e., transitions to fine substrate (sand) prevented tracer rock placement). Results are provided only for cross sections having at least 80% of the tracer rocks spanning the 13 to 57 cms band.

Table 8. WY 2010 bed mobility results at GRTS Panel 2 sites from the May 2010 spring ROD release.

					Spring ROD release bed mobility					
Reach / Site	**Cross section**	**Rock placement range**	**Size class**	**Size (mm)**	**No. rock groups along XS**	**No. of rocks moved**	**Percent moved**	**Percent moved in 13-57 cms band[1]**	**Peak flow (cms)**	**Individual stationing along XS where rocks moved**
Mid Valdor Gulch BRS (GRTS400-17)	151+80	76-108	D84	117	8	6	75%	-	226	84, 88, 92, 96, 100, 104 (108 missing from previous monitoring)
			D50	65	7	5	71%	-	226	80, 84, 92, 96, 100 (104, 108 missing from previous monitoring)
JC Campground (GRTS400-18)	283+30	10-43	D84	80	10	7	70%	70%	226	13, 16, 22, 25, 31, 34, 37 (40, 43 missing from previous monitoring)
			D50	42	9	8	89%	80%	226	13, 16, 19, 22, 25, 28, 34, 37 (31, 40, 43 missing from previous monitoring)
	286+40	12-92	D84	91	10	9	90%	80%	226	12, 16, 24, 28, 32, 36, 40, 44, 48 (52 through 92 missing from previous monitoring)
			D50	47	8	8	100%	100%	226	12, 16, 20, 24, 28, 32, 36, 40 (44 through 92 missing from previous monitoring)
Ed's Bar (GRTS400-29)	516+40	148.7 - 224.7	D84	110	26	22	85%	-	217	148.7, 157.7, 166.7, 169.7, 172.7, 175.7, 178.7, 181.7, 184.7, 187.7, 190.7, 193.7, 196.7, 199.7, 202.7, 205.7, 208.7, 211.7, 214.7, 217.7, 220.7, 223.7
			D50	60	26	26	100%	-	217	148.7, 151.7, 154.7, 157.7, 160.7, 163.7, 166.7, 169.7, 172.7, 175.7, 178.7, 181.7, 184.7, 187.7, 190.7, 193.7, 196.7, 199.7, 202.7, 205.7, 208.7, 211.7, 214.7, 217.7, 220.7, 223.7
Roundhouse (GRTS400-25)	576+50	83-105	D84	211	8	3	38%	-	217	96, 99, 102
			D50	109	8	3	38%	-	217	93, 99, 105 (102 missing from previous monitoring)
	582+10	11-55	D84	102	12	5	42%	33%	217	23, 27, 47, 51, 55
			D50	43	10	7	70%	67%	217	19, 23, 27, 35, 39, 47, 55 (43, 51 missing from previous monitoring)
Bell Gulch (GRTS400-26)	630+20	3 - 82	D84	112, 91	21	19	90%	88%	217	3, 15, 19, 23, 27, 31, 35, 39, 43, 47, 51, 55, 59, 63, 67, 71, 75, 79, 82
			D50	53, 45	3	2	N/A[2]	N/A[2]	217	7, 11 (15 through 82 missing from previous monitoring)
Lower Indian Creek BRS (GRTS400-28)	1157+90	205-223	D84	97	13	9	69%	-	200	205, 206.5, 212.5, 214, 215.5, 217, 218.5, 220, 221.5, 223
			D50	44	13	13	100%	-	200	205, 206.5, 208, 209.5, 211, 212.5, 214, 215.5, 217, 218.5, 220, 221.5, 223
	1166+30	149 - 163	D84	74	10	5	50%	-	200	152, 158, 159.5, 161, 162.5
			D50	38	10	8	80%	-	200	152, 153.5, 155, 156.5, 158, 159.5, 161, 162.5
Indian Creek Confluence (GRTS400-24)	1224+50	56 - 180	D84	122	21	12	57%	57%	200	62, 68, 80, 98, 104, 122, 150, 156, 162, 168, 174, 180
			D50	65	20	19	95%	93%	200	62, 68, 74, 80, 86, 98, 104, 110, 116, 122, 128, 134, 140, 150, 156, 162, 168, 174, 180 (56 missing from previous monitoring)
Treadwell Bridge (GRTS400-20)	1348+90	16 - 134	D84	109, 53	33	13	39%	19%	197	31, 37, 40, 43, 54, 58, 110, 114, 118, 122, 126, 130, 134
			D50	61, 24	32	22	69%	69%	197	31, 34, 37, 40, 46, 50, 54, 58, 62, 66, 70, 74, 98, 102, 106, 110, 114, 118, 122, 126, 130, 134 (43 missing from previous monitoring)
	1356+80	101 - 125	D84	128	9	9	100%	-	197	101, 103, 107, 109.5, 113, 116, 119, 122, 125
			D50	62	9	9	100%	-	197	101, 103, 107, 109.5, 113, 116, 119, 122, 125
Lower Dark Gulch (GRTS400-19)	1791+30	111 - 144	D84	87	12	6	50%	60%	190	111, 114, 120, 123, 135, 141
			D50	48	12	2	17%	20%	190	114, 129

[1] The 13-57 cms zone is the area of greatest riparian vegetation encroachment risk. Some tracer rock sets only partially spanned the entire 13 to 57 cms band due to substrate changes (i.e., transitions to fine substrate (sand) prevented tracer rock placement). Results are provided only for cross sections having at least 80% of the tracer rocks spanning the 13 to 57 cms band.

[2] Bell Gulch marked rocks were not replenished following winter 2010 flood mobility; as a result, only three tracer rocks remained on the cross section for monitoring the Spring ROD release. Although two of the three rocks mobilized, measured mobility occurred over a small portion of the bar and therefore results as percent mobilized are not included.

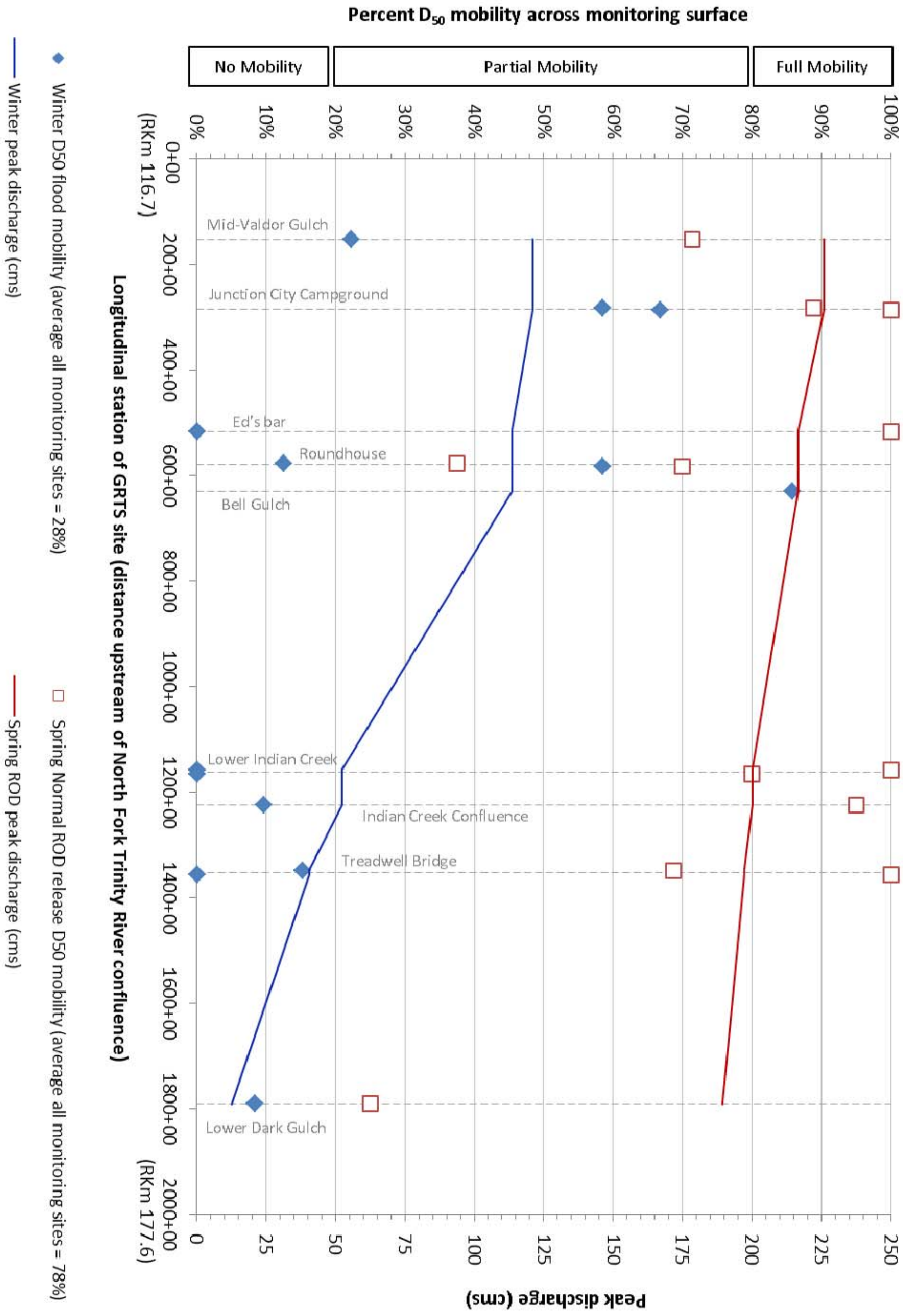


Figure 6. Percent D_{50} mobility across monitoring surfaces in GRTS Panel 2 sites for WY 2010 winter flood and spring ROD release events. Solid lines show peak discharge at each monitoring site (see Table 3).

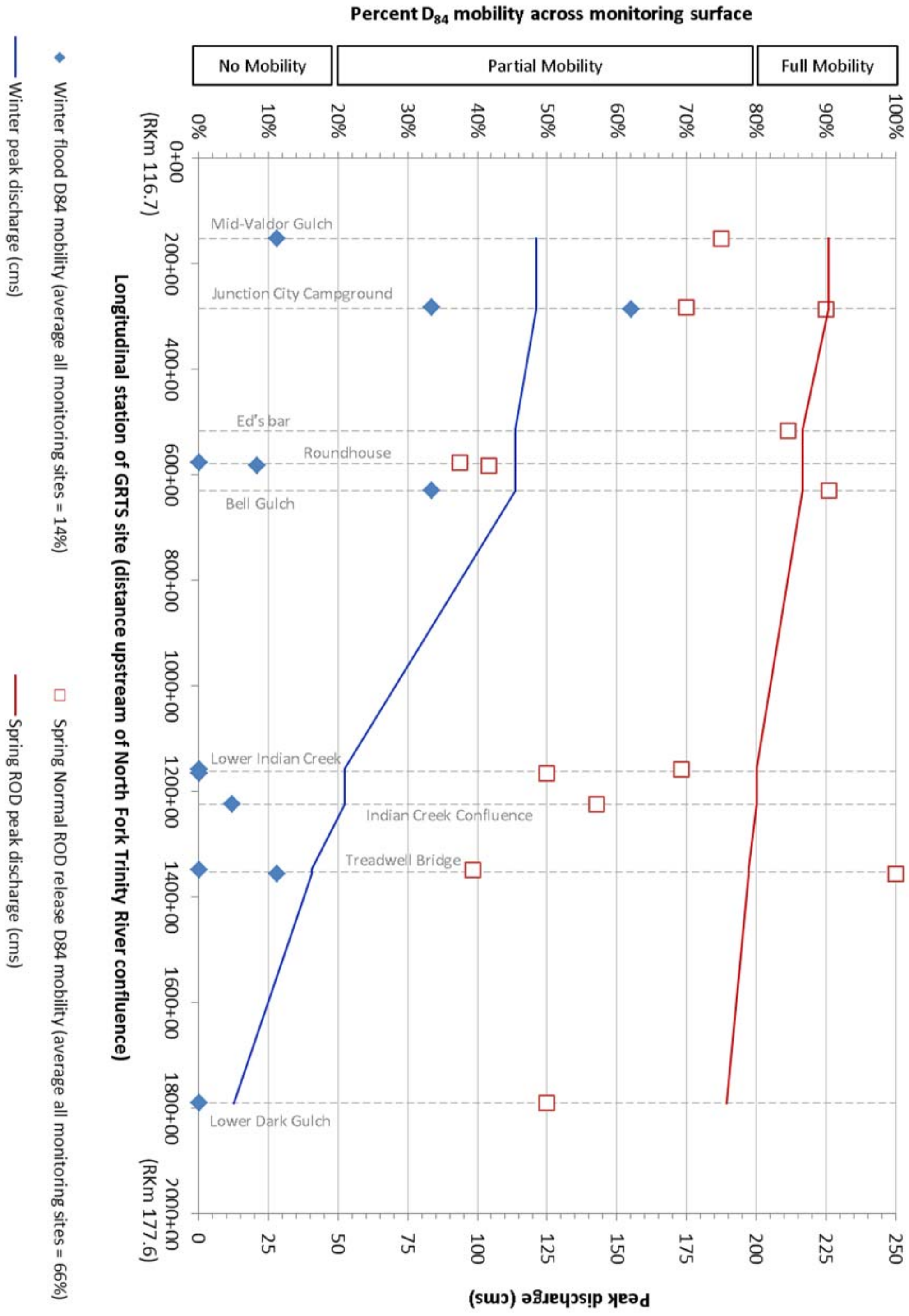


Figure 7. Percent D_{84} mobility across monitoring surfaces in GRTS Panel 2 sites for WY 2010 winter flood and spring ROD release events. Solid lines show peak discharge at each monitoring site (see Table 3).

In contrast to the winter results, results from the spring ROD release showed flows were sufficient to mobilize tracer rocks at all sites. ROD flows were 190 cms (6,696 cfs) at Lower Dark Gulch (XS 1791+30) and increased to 226 cms (7,980 cfs) at Junction City Campground (XS 286+40) due to tributary accretion. The following observations were based on ROD release bed mobility results:

- The bed surface was partially to fully mobilized at all monitoring sites, and the range of mobility was reasonably consistent between upstream and downstream sites.
- Average D_{84} mobility was 66% and average D_{50} mobility was 77%.

5.2.1.3 Bed Mobility in the Riparian Encroachment Risk Zone

Results from the previous section were narrowed to describe bed mobility specifically within the 13 to 57 cms (450 to 2,000 cfs) band. Some tracer rock sets only partially spanned the entire 13 to 57 cms band due to substrate changes (i.e., transitions to fine substrate (sand) prevented tracer rock placement). Results were summarized using cross sections with at least 80% of the tracer rocks spanning the 13 to 57 cms band; of the 13 cross sections where bed mobility was monitored, seven met this criterion.

- Within the 13 to 57 cms band, winter peak D_{84} mobility averaged 9%, ranging from 0% to 44%, and D_{50} mobility averaged 24%, ranging from 0% to 81%. Complete mobility for D_{84} tracer rock sets (>80% tracer rocks mobilized) did not occur at any site, and complete mobility for D_{50} tracer rock sets occurred at only one site (Table 7). Comparing these results to the mobility results of the total tracer rock set showed that the greatest bed mobility occurred within the low-flow wetted channel (<13 cms) and overall, little bed mobility occurred in the 13 to 57 band as a result of the winter peak.
- Greater mobility was recorded resulting from the spring ROD release; D_{84} mobility averaged 58%, ranging from 19% to 88%, and D_{50} mobility averaged 71%, ranging from 20% to 100%. Complete mobility for D_{84} tracer rock sets (>80% tracer rocks mobilized) occurred at two sites, and complete mobility for D_{50} tracer rock sets occurred at three sites (Table 8).
- Although there was less mobility in the 13 to 57 cms band (i.e., lower percentage of tracer rocks mobilized in the 13 to 57 cms band compared to the total bed mobility experiment, which spanned a greater portion of the cross section), the same general longitudinal trend described for the total tracer rock set results remained (i.e., bed mobility increased with distance downstream as flow magnitude increased from tributary accretion).

5.2.1.4 Bed Scour

Bed scour was measured at each monitoring site following winter and spring peak flows (Table 9 and Figure 8), resulting in the following observations:

- The winter peak generated scour depths less than the local D_{84} diameter at all sites except for a single chain at the Junction City Campground site, where scour depth equaled the D_{84} diameter (relative scour = 1.0 D_{84}). Of the 42 total chains installed, 30 were measured: 23 of the 30 recorded no change in scour chain length (no scour) and the other six chains recorded relative scour depths between 0.1 D_{84} and 0.6 D_{84} (Table 9).
- Spring ROD release monitoring recovered all 44 scour chains. The ROD release resulted in six of the nine Panel 2 sites having at least one chain record scour depths ≥ to 1.0 D_{84}. In total, 10 chains recorded scour depths greater than 1.0 D_{84}, 20 chains recorded scour depths between 0.1 D84 and 0.9 D84, and 14 chains recorded no scour (Table 9).

Table 9. WY 2010 bed scour results from winter flood and spring ROD release monitoring. Only 30 of the 44 scour chains were accessible during winter flood monitoring due to high flows (compared with all 44 chains being accessible and recovered for spring ROD release monitoring); this resulted in some of the chains only being measured once, and therefore their results are combined winter + spring scour.

				Winter flood			Spring ROD release			
Site Name & GRTS Panel 2 Site Number	**XS**	**Station**	**D84 (mm)**	**Scour (cm); values in parentheses are minimums[1]**	**Deposition (cm); values in parentheses are minimums[1]**	**Relative scour (dsc/D84); values in parentheses are minimums 1**	**Scour (cm)**	**Deposition (cm)**	**Relative scour (dsc/D84)**	**Monitoring period**
Mid Valdor Gulch BRS (GRTS400-17)	**151+80**	626.3	38	0	0	0.0	5	6	1.3	Spring
		636.5	112	0	0	0.0	0	0	0.0	Spring
		645.9	112	(7)	no data	(0.6)	0	1	0.0	Winter + Spring
		657.0	112	(1)	no data	(0.1)	8	9	0.7	Winter + Spring
JC Campground (GRTS400-18)	**283+30**	238.0	80	8	10	1.0	1	2	0.1	Spring
		255.0	80	no data	no data		0	5	0.0	Winter + Spring
	286+40	480.3	91	0	0	0.0	2	2	0.2	Spring
		501.3	91	0	3	0.0	2	0	0.2	Spring
		518.6	91	(7)	no data	(0.1)	0	0	0.0	Winter + Spring
		538.3	91	no data	no data	no data	8	5	0.9	Winter + Spring
Ed's Bar (GRTS400-29)	**516+40**	185.9	110	Site monitored for Spring ROD release only.			8	13	0.7	Spring
		193.1	110				0	0	0.0	Spring
Roundhouse (GRTS400-25)	**576+50**	268.7	211	0	4	0.0	0	0	0.0	Spring
		282.9	211	0	0	0.0	4	7	0.2	Spring
		292.2	211	no data	no data	no data	4	0	0.2	Winter + Spring
	582+10	97.9	102	0	2	0.0	0	0	0.0	Spring
		112.0	102	no data	(2)	no data	2	7	0.2	Winter + Spring
		126.1	102	0	4	0.0	18	18	1.8	Spring
Bell Gulch Pilot BRS (GRTS400-26)	**630+20**	142.3	91	0	2	0.0	0	0	0.0	Spring
		122.4	91	2	1	0.2	1	8	0.1	Spring
		102.5	91	no data	(2)	no data	0	3	0.0	Winter + Spring
		82.2	112	no data	no data	no data	22	14	2.0	Winter + Spring
	641+00	137.8	91	0	0	0.0	12	12	1.3	Spring
		148.0	91	(3)	no data	(0.3)	6	4	0.7	Winter + Spring
Lower Indian Creek BRS (GRTS400-28)	**1157+90**	198.6	97	0	0	0.0	14	0	1.4	Spring
		192.7	97	0	1	0.0	7	23	0.7	Spring
		185.6	97	0	4	0.0	16	29	1.6	Spring
	1166+30	149.4	74	2	0	0.3	1	1	0.1	Spring
		141.6	74	0	0	0.0	8	14	1.1	Spring
Indian Creek Confluence BRS (GRTS400-24)	**1224+50**	260.5	122	no data	(4)		2	3	0.2	Winter + Spring
		291.1	122	0	0	0.0	0	11	0.0	Spring
		324.3	122	0	0	0.0	2	15	0.2	Spring
		376.3	122	no data	(0)	no data	20	13	1.6	Winter + Spring
Treadwell Bridge (GRTS400-20)	**1348+90**	53.7	53	no data	(0)	no data	0	0	0.0	Winter + Spring
		74.9	109	0	3	0.0	5	0	0.5	Spring
		122.8	109	0	2	0.0	0	12	0.0	Spring
		148.9	109	0	6	0.0	11	2	1.0	Spring
	1356+80	108.9	128	0	3	0.0	5	3	0.4	Spring
		122.9	128	no data	(1)	no data	24	31	1.8	Winter + Spring
		133.5	128	0	0	0.0	5	6	0.4	Spring
Lower Dark Gulch (GRTS400-19)	**1785+70**	358.0	0.4	no data	(0)	no data	0	2	0.0	Winter + Spring
	1791+30	189.2	87	no data	(5)	no data	0	0	0.0	Winter + Spring
		197.1	87	0	0	0.0	2	1	0.2	Spring
		208.1	87	0	1	0.0	3	4	0.3	Spring

[1] Minimum scour and redeposition are calculated when chains could not be measured but the bed elevation could be surveyed. Differences in surveyed bed elevations represent minimum scour and redeposition values.

Bed scour results showed similarities to the bed mobility results. The longitudinal distribution of winter bed scour results (Figure 8) showed a gradient similar to the winter flood bed mobility results (Figures 6 and 7). Most chains recorded no scour between Lower Dark Gulch and Lower Indian Creek, where winter peak flows ranged from 13 to 52 cms (452 to 1,850 cfs). However, increased scour was recorded between Bell Gulch and Mid-Valdor Gulch, where winter peak flows ranged from 114 to 121 cms (4,020 to 4,280 cfs). Although measured scour depths suggested minor bed material reworking (most relative scour depths < 1.0 D_{84}), this identified an important flow threshold between 57 and 113 cms (2,000 and 4,000 cfs) that initiated some bed material reworking more than simply mobilizing the bed surface. Spring 2010 scour results were also similar to the spring 2010 bed mobility results: scour was measured at all monitoring sites, and the range of scour was consistent between upstream and downstream sites.

Maximum deposition was not related to maximum scour. Three depositional conditions were documented: (1) scour followed by deposition, (2) scour only (no deposition), and (3) deposition only (no scour). Deposition thickness from the winter peak ranged from 0 to 10 cm, and deposition thickness resulting from the spring ROD release ranged from 0 to 31 cm. No trends in deposition were found between winter and spring flow events.

5.2.1.1 Bed Scour in the Riparian Encroachment Risk Zone

Similar to the bed mobility results, the bed scour results in the previous section were also narrowed to describe bed scour specifically within the 13 to 57 cms (450 to 2,000 cfs) band. Of the 44 total scour chains installed, 18 fell within the 13 to 57 cms (450 to 2,000 cfs) band, of which we made the following observations about the winter and spring flows:

- The winter peak generated scour depths less than the local D_{84} diameter except for a single chain at the Junction City Campground site, where scour depth equaled the D_{84} diameter (relative scour = 1.0 D_{84}). Of the 17 remaining chains, 12 were measured. Eleven of the 12 recorded no change in scour chain length (no scour) and the single remaining chain recorded a relative scour depth of 0.2 $D_{84.}$
- The spring ROD release resulted in three sites having at least one chain record scour depths greater than or equal to 1.0 D_{84} (Mid-Valdor Gulch XS 151+80, Roundhouse XS 582+10, and Treadwell Bridge XS 1356+80). Of the remaining 15 chains, all were recovered and measured: eight chains recorded scour depths between 0.1 D_{84} and 0.9 D_{84}, and seven chains recorded no scour.
- The range and variability of deposition thicknesses described in the previous section is the same for the 13 to 57 cms (450 to 2,000 cfs) band.

5.2.2 Channel Rehabilitation Sites

Geomorphic monitoring at GRTS Panel 2 sites also fell within the limits of four channel rehabilitation sites. As part of the Panel 2 site effort, monitoring was conducted relative to IAP Assessment 6P (monitoring bed mobility and scour thresholds) but was also conducted relative to IAP Assessment 12P (assess design performance of specific design features; Table 1). Each of the four sites is described in the following sections, which include a brief description of site construction history and design objectives, as well as a description of WY 2010 monitoring activities and results.

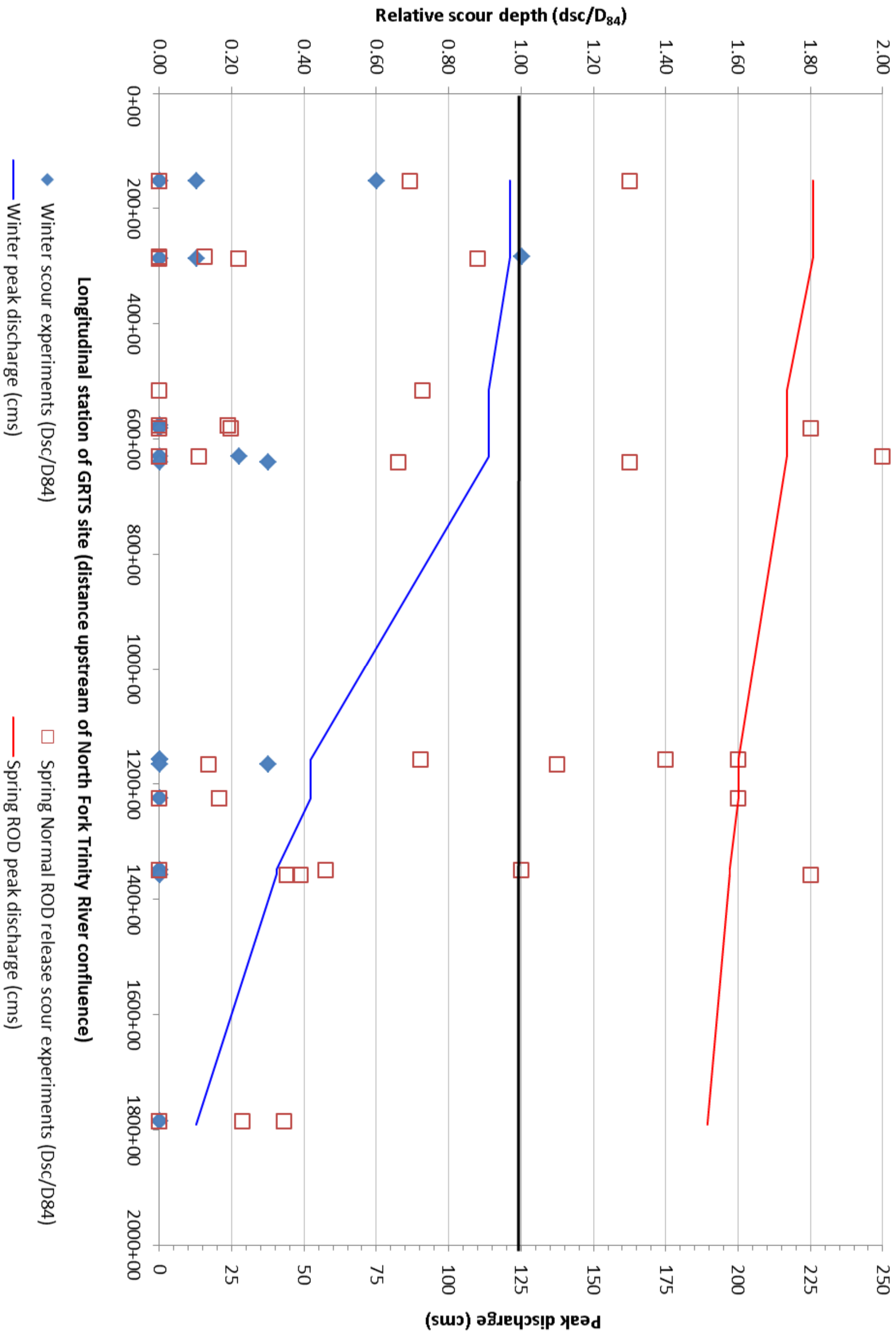


Figure 8. Relative scour measured at GRTS Panel 2 sites for WY 2010 winter flood and spring ROD release events. Solid lines show peak discharge at each monitoring site (see Table 3).

5.2.2.1 Mid-Valdor Gulch

The Mid-Valdor Gulch Channel Rehabilitation Site was constructed in 2006, and the first post-construction site-specific geomorphic monitoring began with cross section surveys in 2007 followed by bed mobility and scour monitoring in WY 2009 (USFWS et al., in preparation). Monitoring was conducted again in WY 2010 as a result of the GRTS sampling coincident with this site. WY 2010 monitoring included two cross sections: XS 141+20, which was monitored for topography only, and XS 151+80, which was monitored for topography, bed mobility, and bed scour and deposition. Channel rehabilitation construction occurred at both cross sections and included removing riparian vegetation to decrease channel confinement and encourage deposition to facilitate an alternate bar morphology. Additional objectives at XS 151+80 included left bank bar growth and right bank scour (M&T 2004).

Surveyed cross section topography showed the channel at XS 141+20 performing as intended. Repeat annual topography surveys following site construction in 2006 showed the thalweg shifting toward the right bank and the channel aggrading as the left bank point bar continued to grow (cross section figure showing this change is included in Appendix B). Since construction, the thalweg has shifted 12.1 m toward the right bank and has steadily aggraded 0.95 m. Farther upstream at XS 151+80, the post-construction thalweg has shifted 2.5 m to the right bank and aggraded 0.36 m; however, this change occurred between 2006 and 2008, and repeat annual surveys since 2008 have shown no change in thalweg position on this cross section. Annual peak flows at Mid-Valdor Gulch have been very similar, ranging from 216 cms to 226 cms (7,640 cfs to 7,980 cfs, respectively), showing XS 141+20 to be more dynamic than XS 151+80.

Site-specific mobility and scour monitoring were also performed at XS 151+80 only, and experiments were set across a narrow point bar (see site maps, Appendix A). The 121 cms (4,280 cfs) winter peak caused little bed mobility across the bar, mobilizing only the streamward-most tracer rocks: one D_{84} and two D_{50} rocks were mobilized, or 11% and 22% of the total marked rock set, respectively (Table 7). These results were within our expectations for a peak flow of this magnitude, and were comparable to the geomorphic objective for a 127 cms (4,500 cfs) ROD release, which was to mobilize the D_{84} on bar flanks. Scour was variable across the entire bar, ranging from 0 to 7 cm. Scaling these depths by the bed surface D_{84} yielded relative scour depths up to 0.6 D_{84} (Table 9), suggesting movement of finer bed matrix materials but not the coarser bed framework material.

The 226 cms (7,980 cfs) spring ROD release peak caused 75% mobility of the D_{84} rocks and 71% of the D_{50} rocks (Table 8). Bed scour was again uneven across the bar surface, occurring near the landward and streamward edges of the bar but not across the middle. Scour ranged from 0 to 8 cm (relative scour of 1.3 D_{84} at the landward edge of the bar and 0.7 D_{84} at the streamward edge; Table 9) showing bed reworking but not scouring.

5.2.2.2 Lower Indian Creek

The Lower Indian Creek Channel Rehabilitation Site was constructed in 2007 to reduce flooding along the mainstem channel between river kilometer (RK) 150.8 and RK 155.3, and to provide a coarse sediment supply for augmentation projects at other channel rehabilitation sites. Construction activities included riparian berm removal, floodplain lowering, and side channel construction (USBR 2006). The first post-construction site-specific geomorphic monitoring began with cross section topography surveys in WY 2009 (USFWS et al., in preparation), which were repeated at XS 1157+90 in WY 2010 and included monitoring at a new cross section (XS1166+30) as a part of the GRTS sampling. WY 2010 monitoring at both of these cross sections included topography, bed mobility, and bed scour and deposition.

Surveyed cross section topography showed the post-construction mainstem channel at both cross sections has not changed (i.e., no bars forming, scour, or thalweg migration), except for bank erosion up to approximately 1 m that occurred along constructed edges. There was also minor but consistent aggradation observed between stations 5 and 35 m. These results suggested the mainstem is performing as desired insofar that channel capacity has not changed and therefore the design hydraulic conditions intended to reduce infrastructure flooding have not been affected. The constructed side channel at XS 1157+90 showed up to 0.2 m aggradation in the thalweg and widening up to 1.5 m. At XS 1166+30, the side channel widened along its left bank only (up to 0.6 m) and no change in thalweg elevation was measured.

Due to a lack of alluvial features in the mainstem channel at both of these cross sections, bed mobility and scour monitoring focused on the constructed side channel (see site maps, Appendix A). Experiments at both cross sections spanned the entire width of the side channel. No bed mobility occurred in the side channel along the monitoring cross sections as a result of the 52 cms (1,850 cfs) winter peak (Table 7), and measured scour was minimal: no scour occurred on XS 1157+90, and scour ranging from 0 to 2 cm deep (0.3 D_{84}) occurred on XS 1166+30 (Table 9).

The 200 cms (7,070 cfs) spring ROD release peak mobilized 69% of the D_{84} rocks and 100% of the D_{50} rocks at XS 1157+90, and mobilized 50% of the D_{84} rocks and 80% of the D_{50} rocks at XS 1166+33. These results showed partial to near complete bed mobility in the side channel. Bed scour in the side channel ranged from 1 to 16 cm, with the greatest scour occurring along XS 1157+90 (7 cm to 16 cm, or 0.7 to 1.6 D_{84}). The TRFE does not have specific bed mobility objectives for side channels. However, the measured channelbed mobility is consistent with a side channel design criterion presented in the Channel Rehabilitation Design Guidelines (HVT et al. 2011) (hereafter referred to as the Channel Design Guide) that side channel sediment transport competency should be equivalent to the mainstem for the upper one-third of the side channel.

5.2.2.3 Lower Dark Gulch

The Lower Dark Gulch Channel Rehabilitation Site was constructed in 2008. Construction within the limits of the GRTS panel included selective riparian vegetation removal, large wood placement, coarse sediment augmentation, and side channel construction. Post-construction geomorphic monitoring began in WY 2009 at XS 1785+70 and XS 1791+30 (USFWS et al., in preparation) and included topography, bed mobility, and bed scour and deposition. The same monitoring was repeated in WY 2010 (see site maps, Appendix A). The design objective in the vicinity of XS 1785+70 was mainstem channel migration toward the right bank (in response to selective vegetation removal and upstream coarse sediment augmentation) (DWR 2007) and low-flow (300 cfs) side channel construction (USBR 2008); the design objectives in the vicinity of XS 1791+30 included channel migration toward the left bank and an increase in channel sinuosity (DWR 2007).

Surveyed cross section topography showed nearly the entire mainstem channel along XS 1785+70 aggraded up to approximately 0.5 m between March 2009 and November 2009, followed by a thalweg shift of approximately 10 m toward the left bank in WY 2010. Topographic surveys showed up to 0.2 m of combined scour and fill but no net change in bed surface elevation (cross section figure showing this change is included in Appendix B). Similar to the main channel, the most change in the side channel measured since construction occurred between March and November 2009, when the side channel was observed to be filling with fine sediment (USFWS et al., in preparation). Additional deposition in the same portion of the side channel was measured in WY 2010. Field observations noted that the side channel was not flowing during 13 cms (450 cfs) baseflows and also noted that this section of the side channel continued to aggrade up- and downstream of the cross section. These changes showed the side channel continued to fill with sediment and perennial flow in the side channel has not been maintained (and thus design objectives have not been met). However, this side channel was constructed prior to the development of the Channel Design Guide (HVT et al. 2011); recommendations provided in the Channel Design Guide are intended to aid future side channel design and construction so that the side channels maintain themselves and their physical and biological design objectives are met. Farther upstream at XS 1791+30, the cross section showed only a very slight (0.1 m) lowering within the 13 cms (452 cfs) channel but no changes in overall width or thalweg position. No changes occurred above the 13 cms (452 cfs) elevation, including across the constructed bar.

Bed scour was monitored on both cross sections. A single scour chain was installed in the side channel at XS 1785+70, and scour at XS 1791+30 was measured across the constructed bar using three scour chains. No changes in scour chain length were recorded on either cross section following the 13 cms (452 cfs) winter flood (Table 9). Bed mobility was also monitored at XS 1791+30 across the constructed bar; no tracer rocks moved (Table 7), suggesting the winter flood did not mobilize the constructed bar.

Following the 190 cms (6,696 cfs) spring ROD release, no scour occurred in the XS 1785+70 side channel but 2 cm of fine sediment deposition was recorded. At XS 1791+30, up to 3 cm of scour was recorded; scour was deepest at the streamward-most chain, and no scour occurred at the landward-most chain (Table 9). Bed mobility monitoring results showed partial mobility of the constructed bar surface: 50% of the D_{84} rocks moved (Table 8) at various locations between the bar crest and the bar flank. At XS 1785+70, scour monitoring results supported the results of the topography survey and suggested the side channel is a depositional area and has not been maintained by flows; this observation was also supported by comparing the 2009 and 2010 aerial photographs which showed deposition for approximately the first 100 m of the side channel (approximately half the constructed side channel length).

5.2.2.4 Lewiston Cableway

The Lewiston Cableway Channel Rehabilitation Site was constructed in 2008. Construction activities included large wood placement, grade control removal, skeletal bar construction, coarse sediment augmentation, and side channel enhancement. The first post-construction site-specific geomorphic monitoring began with cross section topography, bed mobility, and bed scour in WY 2009 at XS 2012+10 and XS 2013+94 (USFWS et al., in preparation). Design objectives in the vicinity of these cross sections included increasing coarse sediment supply and storage, promoting channel migration toward the right bank, natural longitudinal profile adjustment following grade control removal, and increasing channel sinuosity (M&T 2007b). Monitoring at both cross sections continued in WY 2010; however, heavy foot traffic at the site resulted in vandalism to some experiments in WY 2009. To prevent this from happening again, only topographic monitoring was repeated in WY 2010.

Topographic monitoring on both cross sections showed no change in WY 2010. These results suggested WY 2010 flows may have been sufficient in maintaining constructed features but were not sufficient in creating physical changes that suggest certain design objectives are being met (e.g., channel migration toward the right bank).

5.2.3 Linking Results to Objectives

IAP Objective 1.2.2 (under IAP Assessment 6P) is to evaluate whether system-wide TRFE bed mobility and scour objectives are being achieved during natural tributary-induced flood events and ROD flow releases for Normal and wetter water year types. IAP Objective 1.1.1 (under IAP Assessment 12P), as well as objectives 1.1.2, 1.2.3, and 1.3.1, include evaluating site-specific topographic, planform, and geomorphic unit diversity changes from natural tributary-induced flood events and ROD flow releases during Normal and wetter water year types. Monitoring results as they relate to these IAP objectives are discussed below.

5.2.3.1 TRFE Bed Mobility and Scour Objectives

TRFE bed mobility and bed scour management objectives vary by water year. For a Normal water year, the bed mobility objective is to mobilize the D_{84} on general channelbed surfaces and along flanks of alternate bar surfaces (Table 10, Figure 1). The WY 2010 winter peak ranged from 13 to 121 cms (452 to 4,280 cfs) between monitoring sites, less than a 170 cms (6,000 cfs) Normal water year release magnitude. Water year 2010 winter peak bed mobility and bed scour results were therefore not expected to meet Normal water year management objectives (and results show Normal water year objectives were not met). The following discussion focuses solely on WY 2010 spring ROD release results.

The spring 2010 ROD release was successful in partially to fully mobilizing all surfaces monitored, ranging from 38% to 100% mobilization. Using the partial mobility (i.e., 20 to 80% mobility) vs. full mobility (80 to 100% mobility) criteria, complete D_{84} mobility was documented on at least one cross section at four of the nine sites monitored (Treadwell Bridge, Bell Gulch, Ed's Bar, and Junction City Campground). Additionally, although the D_{50} is not specifically described in the TRFE objectives, its mobility can also be considered representative for mobilizing alluvial surface matrix particles. D_{50} mobilization ranged from 25% to 100%; complete mobility was documented on at least one cross section at five of the nine sites monitored (Treadwell Bridge, Indian Creek, Lower Indian Creek, Ed's Bar, and Junction City Campground). Based on these results, the WY 2010 Normal ROD release was largely successful in meeting TRFE bed mobility management objectives.

The Normal water year bed scour objective is described in Table 8.2 of the TRFE as "channelbed scour and redeposition of gravels (Attribute 4)." Attribute 4, Periodic Channelbed Scour and Fill, is more specific and states: "Alternate bars are scoured deeper than their coarse surface layers by floods exceeding 3- to 5-year annual maximum flood recurrences. This scour is typically accompanied by re-deposition, such that net change in channelbed topography following a scouring flood usually is minimal" (USFWS and HVT 1999).

Although only 10 of the 44 total chains recorded scour depths $\geq 1.0\ D_{84}$, these results were spread over six of the nine sites monitored. These six sites had some scour $\geq 1.0\ D_{84}$ deep, but they also had chains on the same cross section that recorded little to no scour at all. Furthermore, there was no pattern to where the deepest scour occurred (the deepest scour did not always occur at the streamward-most chain); rather, scour occurred locally, sometimes in isolated areas across the monitoring surface, as opposed to uniformly across the entire monitoring surface. In addition, measured deposition did not correlate well with the measured scour. Based on these results, the spring 2010 ROD release did not fully meet the TRFE Normal water year bed scour objective, despite some scour and redeposition occurring at each monitoring site.

5.2.3.1 Assessing Design Performance of Specific Design Features

The broad objective of Assessment 12P is to assess the performance of certain design features. Topographic changes and bed mobility and scour results at the four channel rehabilitation sites suggested site design objectives where monitoring was conducted are being met, and similar changes have been documented at all four sites since construction was completed (i.e., change is continuing and not solely a result of WY 2010 flows).

Table 10. Bed mobility, bed scour, riparian seedling scour and riparian seedling initiation and establishment objectives from TRFE Table 8.2 (primary fluvial geomorphic management objectives for the Trinity River by water year class) and TRFE Table 8.7 (recommended releases from Lewiston Dam with management targets, purpose, and benefits during a Normal water year).

	Critically Dry (Q_{peak} = 1,500 cfs)	**Dry (Q_{peak} = 4,500 cfs)**	**Normal (Q_{peak} = 6,000 cfs)**	**Wet (Q_{peak} = 8,000 cfs)**	**Extremely Wet (Q_{peak} = 11,000 cfs)**
Bed Mobility Objective	(None given)	Mobilize the surface of in-channel alluvial features (e.g., spawning gravel deposits).	Mobilize matrix particles (D_{84}) on general channelbed surface and along flanks of alternate bar surfaces.	Mobilize matrix particles (D_{84}) on alternate bar surfaces.	Mobilize matrix particles (D_{84}) on alternate bar surfaces.
Bed Scour Objective	(None given)	(None given)	Channelbed scour and redeposition of gravels.	Channelbed scour greater than 1x D_{84} depth and redeposition of gravels.	Channelbed scour greater than 2x D_{84} depth and redeposition of gravels on face of alternate bars.
Riparian Seedling Scour Objective	Discourage germination of riparian plants on lower bar surfaces for the early portion of the seed release period	Discourage germination of riparian plants on lower bar surfaces for the early portion of the seed release period	Woody riparian vegetation mortality along low water edge of alternate bar surfaces; scour up to 1-yr old woody riparian vegetation along channel margins. Discourage germination of riparian plants on lower bar surfaces for the early portion of the seed release period	Woody riparian vegetation mortality along low water edge of alternate bar surfaces	Woody riparian vegetation mortality along low water edge of alternate bar surfaces
Riparian Establishment on Floodplains Objective	(None given)	(None given)	Woody riparian regeneration on upper alternate bar surfaces and floodplains	Woody riparian regeneration on upper alternate bar surfaces and floodplains	Woody riparian regeneration on upper alternate bar surfaces and floodplains

The series of more specific objectives linked to Assessment 12P are discussed below; however, to evaluate these objectives thoroughly, more study detail than was performed for our monitoring is required. For example, site topography was only surveyed along cross sections, yet most of the specific objectives require planform topography to be thoroughly evaluated. Although this level of survey detail was not performed, results from the data collected can still be used to help evaluate the specific objectives and provide insight on design performance.

- <u>IAP Objective 1.1.1</u> is to increase the size, frequency, and topographic relief of bar/pool sequences. Of the four channel rehabilitation sites, the Mid-Valdor Gulch site between XS 141+20 and XS 151+80 showed the most post-construction (and WY 2010) topographic change related to bar and pool morphology, suggesting Objective 1.1.1 is being met at this site (as was also concluded in WY 2009 using more detailed topographic mapping; USFWS et al., in preparation). Cross section topographic change at Lower Indian Creek was not as pronounced and did not appear to be linked to bar or pool morphology. Cross section topographic change at Lower Dark Gulch was most pronounced at XS 1785+70, where mainstem channel aggradation and side channel filling were measured. The mainstem channel filling and related thalweg shift could indicate new bar formation. The expression of this feature was subtle and may have resulted from the coarse sediment augmentation pile located upstream at XS 1791+30. The lack of topographic change at the Lewiston Cableway site suggested this objective was not met at this site. Re-survey and evaluation as a part of WY 2011 monitoring will help further evaluate topographic changes along this cross section.
- <u>IAP Objective 1.1.2</u> is to increase channel/thalweg sinuosity. This study plan was not designed for a rigorous channel sinuosity evaluation, and methods required to specifically evaluate sinuosity were not used (e.g., thalweg mapping or topography / bathymetry through the GRTS panel); however, cross section topography can provide supportive evidence of sinuosity changes when thalweg shifts accompanied by bank erosion are documented (suggesting channel migration). The topographic changes discussed in Section 5.2.2 (e.g., thalweg shifts at Mid-Valdor Gulch and at Lower Dark Gulch) did not include bank erosion, and thus were not indicative of changing channel sinuosity.
- <u>IAP Objective 1.2.3</u> is to encourage bed level fluctuations on annual to multi-year timescales. Many of the post-construction monitoring cross sections were installed within the last two years, and a long-term record was not available. Over the available short-term record, three channel rehabilitation sites showed bed level fluctuations on at least one of the two monitored cross sections, and where they overlap, these fluctuations were supported by results from bed mobility and bed scour experiments (the Lewiston Cableway site showed no topographic change nor was bed mobility or scour monitoring conducted at that site). These results suggested that this objective was largely met for WY 2010. A longer monitoring period is required to evaluate this objective relative to a multi-year timescale, which will be better evaluated in WY 2014, when these sites are reoccupied as part of the rotating panel sampling design (Table 4).
- <u>IAP Objective 1.3.1</u> is to increase bars, side channels, alcoves, and other complex alluvial features. As with IAP Objective 1.2.3 described above, cross section monitoring at three of the four sites showed geomorphic changes, suggesting this objective may have been met. Sufficient change appeared to have occurred in WY 2010 at Mid-Valdor Gulch and at Lower Indian Creek to suggest site alluvial features are being maintained, and in some cases, new features are being created. Conversely, changes at Lower Dark Gulch have mostly been limited to mainstem aggradation and side channel filling at XS 1785+70.

Additional information upstream and downstream of cross sections is recommended to help evaluate channel complexity (or channel simplification) beyond the cross sections, such as the topographic mapping and isopach analyses performed at selected channel rehabilitation sites in WY 2009 (USFWS et al., in preparation).

Several hypotheses are associated with the above objectives (Table 2). Limitations in the ability to fully evaluate the objectives, as described above, also correspond to testing these hypotheses. Additional factors that further limit our ability to "test" the stated hypotheses include: (1) by 2010 there had been six years of ROD streamflows and the number of channel forming flows has been insufficient to evaluate the stated hypothesis, (2) many of the hypotheses require more than one year of data to evaluate; (3) many sites have been sampled only once; and, (4) WY 2010 monitoring results will provide baseline data from which the stated hypotheses can be evaluated after sites are revisited as a part of planned future monitoring efforts.

6 RIPARIAN ASSESSMENTS

WY 2010 riparian assessments were performed to measure changes in riparian vegetation resulting from winter 2010 peak flows and from the spring 2010 ROD release (Table 3). Monitoring objectives included evaluating whether Normal water year ROD high flow releases are: (1) achieving riparian seedling scour mortality objectives; (2) preventing detrimental riparian encroachment, riparian berm development, and channel simplification; (3) achieving riparian initiation and establishment objectives on upper bar and floodplain surfaces; and (4) increasing and maintaining large wood storage within the active channel (Table 1). Specific riparian monitoring activities that occurred between July 2009 and August 2010 were:

- Planform mapping of riparian vegetation before the winter and/or pre-spring release and after the spring 2010 ROD release to:
    - Quantify the riparian floodplain vegetation at site cross sections and then compare changes in riparian floodplain vegetation area and patch type configuration at each site. Patch types are defined in Appendix C.
    - Quantify the state of near channel vegetation on similar landforms (i.e., bars, islands) and then compare changes in near channel vegetation area and patch type configuration at each site.
- Documenting the following before the winter peak and after the spring 2010 ROD release:
    - Describe riparian vegetation cover types and species composition and then compare species abundance changes at each site.
    - Locate seedlings at site cross sections and then compare seedling density changes.
    - Compare seedling location relative to topographical cross section surveys.
- Evaluating whether quantitative TRFE seedling scour management objectives are being achieved during natural tributary-induced flood events and spring ROD releases for a Normal water year by using the results from the bed mobility and bed scour experiments at selected sites. The TRFE Normal water year riparian objectives are to scour up to 1 year-old woody riparian vegetation along channel edges and to encourage establishment and growth of riparian vegetation on floodplains (TRFE Table 8.7).
- Planform mapping of large wood after the spring 2010 ROD release to document baseline large wood storage conditions at each site.

6.1 Field and Analytical Methods

Riparian vegetation was sampled using two techniques: planform mapping and band transect sampling. Planform mapping allowed an assessment of riparian patch type diversity and abundance and large wood storage at a particular site. Band transect sampling allowed an assessment of riparian hardwood seedling scour, riparian hardwood seedling initiation and establishment on floodplains and upper bars, and potential riparian berm formation. Together, planform mapping and band transect data were used to evaluate whether management actions are: (1) promoting diverse native riparian vegetation on different geomorphic surfaces that contribute to complex channel morphology and (2) preventing riparian vegetation from exceeding thresholds leading to detrimental encroachment that simplifies channel morphology and degrades aquatic habitat quality. Band transects and large wood mapping were conducted only at GRTS Panel 2 sites, whereas planform mapping was conducted at both GRTS Panel 2 and channel rehabilitation sites. Four of the channel rehabilitation sites near Old Lewiston Bridge (Sven Olbertson, Deadwood Gulch, Lewiston Cableway, and Hoadley Gulch) were analyzed together and results are presented as "Lewiston Four."

6.1.1 Vegetation Mapping

Planform mapping of riparian vegetation allowed broad evaluation of changes in riparian floodplain vegetation and near-channel vegetation acreages and patch types. The specific objective for WY 2010 vegetation mapping was to assist in evaluating whether the 2010 Normal water year spring ROD release (1) prevented detrimental riparian encroachment, riparian berm development, and channel simplification; and (2) achieved riparian initiation and establishment objectives on upper bars and floodplains. The mapping also assisted in evaluating whether the TRRP riparian goal of promoting diverse native riparian vegetation on different geomorphic surfaces was being met.

Riparian vegetation was mapped at 12 channel rehabilitation sites and at 11 GRTS Panel 2 sites (Table 5). Mapping conducted during the fall and winter of 2009 documented pre-spring ROD release conditions, and mapping during the fall of 2010 documented post-ROD release conditions. Site vegetation characterization (e.g., baseline location, composition, and structure of riparian vegetation) at Panel 2 sites and channel rehabilitation sites consisted of field-mapping riparian vegetation, exotic hardwoods, and substrate on the most recent ortho-rectified aerial photographs (scaled to 1:1,800) at the same scale as that used in the riparian vegetation inventory (M&T 2005). Units of riparian vegetation, hereafter referred to as patches, were mapped based on similar species composition of the tallest canopy layer. Patches were labeled using an alliance classification system based on Sawyer et al. (2008). Alliance names, called patch types in the current study, were simplified to common names; a crosswalk between Sawyer et al. (2008) and the modified patch type names used in the current study can be found in Appendix D. Sometimes a mapped patch type did not correspond well to an alliance defined in Sawyer et al. (2008); in those instances, a new patch type name based on National Vegetation Classification standards (FGDC 2008) was assigned to the patch based on the dominant species in the tallest vegetation layer. All patches greater than 9.3 m^2 (100 ft^2) were mapped to determine patch type (i.e., alliance) frequency, abundance, and spatial extent. Patch types were grouped into "biohabitats" based on hydrological requirements of the dominant plant species, relative percent cover within the patch, and degree of human influence. Biohabitats in the Project Reach included riparian, upland, open ground, human disturbance, and open water (Table 11). Panel 2 sites were mapped with a 250 m buffer on either side of the 400 m linear site extent; channel rehabilitation sites were mapped within the Ecological Study Limit (ESL), which was defined individually at each site based on the proposed construction activities.

Table 11. Riparian vegetation patch types and their corresponding biohabitats mapped in WY 2010 at GRTS Panel 2 and channel rehabilitation sites.

Biohabitat	**Mapped Patch Type**
Riparian	Arroyo Willow
	Basket Bush*
	Bigleaf Maple
	Black Cottonwood
	California Grape
	Dusky Willow
	Fremont Cottonwood
	Himalaya Berry*
	Large Woody Debris
	Mixed White Alder
	Mixed Willow
	Mugwort
	Narrowleaf Willow
	Narrowleaf-Dusky Willow
	Oregon Ash*
	Red Willow
	Shiny Willow
	Sweet Clover
	White Alder
Open	California Brickellbush
	Open
	Oregon goldenaster
	Oregon goldenaster
Wetland	Aquatic Emergent
	Cattail
	Juncus
	Nut Sedge
	Sedge
Upland	Black Walnut
	Blue Wild Rye
	California Black Oak
	Canyon Live Oak
	Douglas-fir
	Foothill Pine
	Foothill Pine - White Oak
	Incense Cedar
	Madrone
	Mixed Conifer
	Mixed Conifer - Mountain Maple
	Mixed Conifer - White Oak
	Native Grasses
	Non-native Grassland
	Oregon White Oak
	Planted Grasses
	Ponderosa Pine
	Ponderosa Pine - Tree of Heaven
	Rose
	Tailings Pile
	Tree of Heaven*
	Wedgeleaf Ceanothus
	Whiteleaf Manzanita
	Yellow Star Thistle Grassland
Human Disturbance	Human Distubance
	Road
N/A	Unknown
Open water	Open Water
	River

In addition to pre- and post-spring ROD release conditions at 11 GRTS Panel 2 sites and 12 channel rehabilitation sites, post-construction conditions at 12 channel rehabilitation sites were evaluated. The post-construction location, composition, and structure of riparian vegetation were mapped in the field using the same methods described above, with additional riparian vegetation attributes assigned based on origin of the vegetation relative to construction activities according to the following broad categories: (1) remnant vegetation (not removed by construction), (2) regrowth (vegetation that was incompletely removed by construction and is now re-sprouting), (3) regeneration (seedlings), and (4) revegetation (planted following construction as mitigation and to improve long-term riparian habitat). The age of regenerating patch types at channel rehabilitation sites was estimated, up to 3 years old. If more than one type of vegetation was present in a patch, the patch was attributed based on the dominant vegetation first, followed by the sub-dominants. “Young-of-year-root sprouts” indicated a patch that contained mostly young-of-year seedlings, but also had significant regrowth.

Field maps were digitized into GIS-compatible software using a state plane coordinate system. The following performance measures were quantified: (1) aerial extent of all plant stand types and biohabitats; (2) spatial distribution of patch types; (3) patch type frequency and abundance; (4) changes to previously mapped patch areas, types, and locations; and (5) locations and extent of patches dominated by 1, 2, and 3-yr old hardwoods. The GIS database will be updated and queried with each subsequent monitoring event to detect changes in the aerial extent of different patch types.

In addition to patch type abundance and distribution at each GRTS Panel 2 and channel rehabilitation site, riparian colonization and establishment trends were evaluated by focusing on riparian vegetation patches between the 13 and 57 cms (450 and 2,000 cfs) inundation zone.

6.1.2 Band Transect Surveys

On the Project Reach of the Trinity River, riparian hardwood establishment trends and vegetation structure have historically been evaluated using band transects (M&T and HVT 1997, 2004; Bair 2001;M&T 2006). The band transect sampling designs readily associate water surface elevation and discharge relationships with riparian vegetation colonization patterns. Objectives specifically addressed by band transect sampling include evaluating whether Normal water year spring ROD releases are: (1) achieving riparian seedling scour mortality objectives; (2) preventing detrimental riparian encroachment, riparian berm development, and channel simplification; and (3) achieving riparian initiation and establishment objectives on upper bar and floodplain surfaces.

Band transects were sampled along cross sections and were specifically selected to span alluvial and/or constructed features that would meet both geomorphic and riparian vegetation monitoring objectives. At least one band transect was installed at each GRTS Panel 2 site (preferably two), perpendicular to flow, and spanned the channel to capture confinement of at least an Extremely Wet water year flow release. Existing band transects for sites that have had previous monitoring were reoccupied where possible. Specific tasks included:

- Establishing, monumenting, and surveying vegetation band transects following previously defined protocols (Bair 2001);
- Surveying the ground surface along the band transect;
- Sampling plants in 1.5 m, 5 m, and 10 m nested band transects along the selected cross section(s) at a site following previously defined protocols (M&T 2006). Plant variables included species, stem diameter at root collar, stem age, stem height, stem location (cross section station), and stem distance up- or downstream from the cross section;

- Taking digital photos of band transects;
- Entering and completing a QA/QC of data;
- Classifying sampled hardwoods on selected cross sections into size classes that roughly correspond to 1-yr, 2-yr, and 3-yr age classes;
- Associating hardwood densities and bank locations with six ROD discharges[1] and the corresponding water surface elevations;
- Comparing changes in hardwood densities for different size classes to previous monitoring;
- Overlaying geomorphic monitoring results on each cross section to establish the mechanisms that changed hardwood densities; and
- Evaluating whether we are approaching our 3-yr window on riparian hardwoods along the low flow channel.

6.1.2.1 Species and Patch Type Frequency and Abundance

Vegetation patch type boundaries were delineated along each band transect. Patch type frequency was calculated across all band transects (n = 26, 12 transects in fall 2009 and 12 in fall 2010) and for each patch type sampled in WY 2010 (n = 101 patches sampled in fall 2009 and 2010). The two different "scales" allowed a more complete description of patch type frequency; frequency at band transects described us about the systemwide distribution of particular patch types, whereas frequency across all patches described localized distributions of patch types (i.e., allows us to distinguish between patch types that are present only once on a band transect vs. patch types that occur multiple times along a transect). Patch types were grouped into biohabitats based on hydrological requirements of the dominant plant species, relative percent cover within the patch, and degree of human influence. The most common biohabitats in the Project Reach included riparian, upland, open ground, human disturbance, and open water (Table 11).

All species observed within each patch type were identified and assigned percent cover values. Species frequency was calculated across all band transects (n = 26, 12 transects in fall 2009 and 12 in fall 2010). Frequency of patch types and species was compared between fall 2009 and fall 2010 to document change and assess whether changes were due to winter storm events and/or ROD releases for a Normal water year. Plant taxonomy follows the PLANTS database (USDA NRCS 2011).

6.1.2.2 Riparian Hardwood Demographics within Inundation Zones

Individual hardwoods were sampled within nested bands on each cross section. Species, stem height, stem diameter at root collar (DRC), stem age, and stem location were measured. The root collar is the location along a stem where the above ground portion of the stem transitions into the roots. The root collar is characterized in most plants as a welt or slightly raised portion of the hardwood between the stem above ground and the roots. Internally, the stem vascular morphology changes as well. In an environment where there is frequent scour and deposition, the root collar may become exposed or buried and adventitious roots may arise. When the root collar cannot be easily found along a stem, some excavation is conducted around the stem to find the root collar without disturbing surrounding plants or growing roots. The substrate is replaced after the root

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[1] ROD discharges were 13 cms, 57 cms, 127 cms, 170 cms, 241 cms, and 311 cms (450 cfs, 2,000 cfs, 4,500 cfs, 6,000 cfs, 8,500 cfs, and 11,000 cfs, respectively).

collar is measured. If no root collar can be identified, the stem is measured at the soil-air contact. Most shrubs were easily identified as individuals by a single trunk-like stem or centralized point from which multiple stems arose. Stems emerging from the ground singly could represent individual plants or sprouts from an underground horizontally oriented root (i.e., “root sprouts”). Individual stems were distinguished from root sprouts using a pull test: the stem was gently tugged near the root collar; tugging on a root sprout caused other stems growing from the same root to move in response, while individual stems did not cause other stems to move. While the pull test is generally reliable at determining an individual stem from a root sprout, misclassifications sometimes occurred.

The age of individual riparian hardwood stems was estimated during root collar measurement. Riparian hardwood stems were classified into young-of-year, 1 yr-old, 2 yr-old, 3 yr-old, and older than 3 yr. To be considered young-of-year hardwoods, cotyledons or cotyledon scars must be present and stems usually do not exceed 0.25 cm DRC. One year old hardwoods (in the second growing season) may have a broken stem if mechanically damaged by flows, or a terminal bud scar, and/or stem discoloration may be present. Usually 1-yr old hardwoods are small and do not exceed 0.50 cm DRC. Two year old hardwoods (in the third growing season) may have multiple broken stems if mechanically damaged by flows, or two terminal bud scars, and/or stem discoloration between each year’s growths. Two year old hardwoods usually do not exceed 0.75 cm DRC. Three year old hardwoods (in the fourth growing season) may have multiple broken stems if mechanically damaged by flows, or three terminal bud scars, and/or stem discoloration between each year’s growths. Three year old hardwoods usually do not exceed 1.0 cm DRC. Hardwoods older than three years (stems in the fourth growing season) may have multiple broken stems if mechanically damaged by flows, or three terminal bud scars, and/or stem discoloration between each year’s growths. Hardwoods older than three years usually exceed 1.0 cm DRC. The change in the stem density between age classes relies on DRC as the primary variable to estimate an age class. The field estimated age was used as a secondary estimate.

Riparian hardwood demographic trends were analyzed in WY 2010 using the DRC measured for woody plants within the nested bands. Historically in the Project Reach, stem age was used to describe the structural composition of riparian vegetation along the band transect, especially at the low water edge. Stem age, however, has been a problematic metric for evaluating encroachment risk, especially at channel rehabilitation sites where vegetation was removed from the channel edge. For instance, a 1-yr old willow seedling is almost always smaller than a 1-yr old willow stem growing from a pre-existing root structure (i.e., a “root-sprout”); the seedling must create its own new root system from scant resources available in a seed the size of a pepper fleck, whereas a root-sprout has a well-developed root system to draw from. An analysis based on age alone could potentially mischaracterize the encroachment risk from 1-yr old plants, since true seedlings may be scoured by flows that are incapable of scouring the 1-yr root sprouts. At sites where channel rehabilitation has not occurred, this is less of a problem. However, since the GRTS sample universe may include channel rehabilitation sites, riparian hardwood demographic trends are now based on DRC rather than stem age. Fortunately, DRC is strongly correlated with stem age ($R^2 = 0.72$, $p<<0.001$; Figure 9) and thus, size classes based on DRC are roughly equivalent to age classes (Table 12). Diameter at root collar better represents the stem size to be scoured and is a highly repeatable measurement.

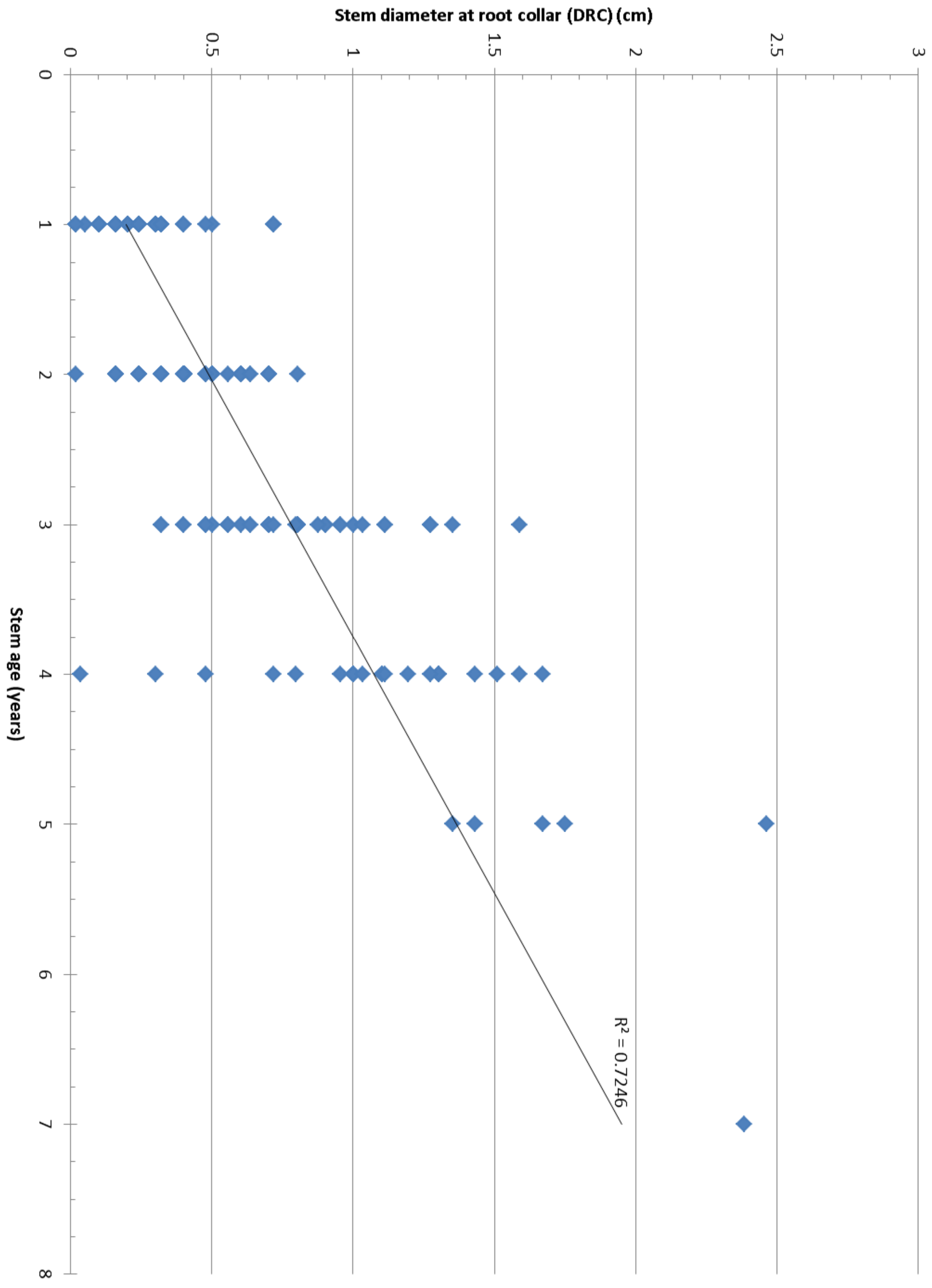


Figure 9. Relationship between stem age and stem diameter at the root collar (DRC).

Table 12. Size classes and associated dominant plant age of hardwoods measured at GRTS Panel 2 sites in WY 2010. The size classes were assigned a risk code as part of the "red-yellow-green" evaluation. The "Q to remove" column details the flows hypothesized to reduce detrimental riparian encroachment.

Size Class	Dominant plant age	Q to remove	WY type to remove	Risk code	Risk description
0.0 to 0.25 cm	Young of Year	≤ 170 cms (6,000 cfs)	Normal and wetter	Green	Moderate risk, these hardwoods should be watched to evaluate if these plants get to the 2-yr old stage; no modification of the hydrograph needed
0.26 to 0.50 cm	1 year old	≤ 170 cms (6,000 cfs)	Normal and wetter	Green	Moderate risk, these hardwoods should be watched to evaluate if these plants get to the 2-yr old stage; no modification of the hydrograph needed
0.51 to 0.75 cm	2 year old	≤ 241 cms (8,500 cfs)	Wet and wetter	Yellow	High risk, 241 cms (8,500 cfs) suggested for that year; may recommend subtle adjustments to hydrograph release for that given water year
0.76 to 1.0 cm	3 year old	≥ 311 cms (11,000 cfs)	Extremely Wet	Red	Extreme Risk, 311 cms (11,000 cfs) suggested that year; may need to modify hydrograph release for that given water year
1.01 to 1.50	4 year old	Unlikely to remove with flows alone	N/A	Grey	Beyond what ROD streamflows are expected to remove
1.51 to 2.0 cm	5 year old	Unlikely to remove with flows alone	N/A	Grey	Beyond what ROD streamflows are expected to remove

Analyzing riparian recruitment trends occurred in the following sequence: (1) the hardwood data were sorted into size classes using DRC (Table 12), (2) sampled hardwoods were plotted onto the cross sections by DRC size classes, (3) the location, DRC size class, and species of successful initiating hardwoods was sorted into inundation categories (< 13, 13 to 57, 57 to 127, 127 to 170, 170 to 241, 241 to 311, and >311 cms [<450, 450 to 2,000, 2,000 to 4,500, 4,500 to 6,000, 6,000 to 8,500, 8,500 to 11,000, and >11,000 cfs, respectively]), (4) hardwood densities within each inundation category were calculated for each nested band on the transect (1.5 m, 5 m, and 10 m bands; Bonham 1989, Kent and Coker 1992), (5) changes in hardwood densities for different DRC size classes between fall 2009 and fall 2010 monitoring were quantified and the physical causal mechanisms that caused the changes in DRC size class distribution were assessed, and (6) encroachment risk and floodplain regeneration was evaluated using the density of seedlings of each DRC size class within inundation categories along the low flow channel.

Encroachment refers to the occurrence of vegetation along the low water channel. Encroachment may be non-detrimental, providing stream shade and nutrients to the aquatic ecosystem, diverse structural habitat for terrestrial and amphibious wildlife, and vegetative heterogeneity across the landscape, or it may be detrimental. The IAP defines detrimental riparian encroachment as occurring within the 13 to 57 cms (450 to 2,000 cfs) inundation zone and being most prone to the re-establishment of dense continuous bands of perennial vegetation that reduce flow velocity, induce fine sediment deposition, and form berms. Detrimental riparian encroachment has been shown to lead to channel simplification, which subsequently changes the quality of fish habitat (HVT and USFWS 1999). For sites where an encroachment risk was identified, the type of encroachment was described as “non-detrimental” or “detrimental.”

Encroachment risk and floodplain regeneration were assessed using a “red-yellow-green” evaluation for different size classes of hardwoods growing above 8.5 cms (300 cfs). The red-yellow green evaluation assigned risk categories, based on stem diameter, to riparian hardwoods measured on band transects (M&T and HVT 2004). Hardwoods growing on lower bars between 13 cms and 57 cms (450 cfs and 2,000 cfs, respectively) pose the greatest encroachment risk, whereas hardwoods growing on upper bars and floodplains contribute to desirable floodplain vegetation. Hardwoods between 0.76 and 1.0 cm DRC growing on bars pose the greatest threat of becoming permanently established below 57 cms (2,000 cfs) but could be totally or partially removed by Wet year streamflows achieving deep subsurface scour (e.g., streamflows near or exceeding 311 cms [11,000 cfs]); these hardwoods were coded red. Hardwoods 0.51 to 0.75 cm DRC were coded yellow, because they may induce encroachment but are still vulnerable to channelbed surface scour caused by ROD streamflows of 241 cms (8,500 cfs) or greater. Hardwoods ranging from 0 to 0.50 cm DRC were coded green, because they are highly susceptible to channelbed surface scour induced by flows of 170 cms (6,000 cfs) or greater. Hardwoods larger than 1.0 cm DRC growing below 57 cms (2,000 cfs) were coded grey, as they have passed beyond the threshold of scour that can be induced by managed streamflow releases alone (and should continue to grow to maturity). Although hardwoods greater than 1.0 cm DRC may not be considered vulnerable to vertical scour, it is important to include them in the analysis to understand whether other factors that were originally considered in the TRFE or management actions could induce mortality to larger size woody plants (e.g., lateral scour). Hardwoods growing above 57 cms (2,000 cfs) were coded green because the establishment of riparian hardwoods on upper bars and floodplain surfaces is considered to be beneficial.

In order to determine whether detrimental riparian encroachment was a threat at each GRTS Panel 2 site, densities of riparian hardwoods were compared to preliminary encroachment thresholds calculated at the Sheridan Creek Pilot Channel Rehabilitation Site XS 02+35 (Table 13). Sheridan Creek was constructed in 1993 and consisted of riparian berm removal. Extensive monitoring between 1995 and 2003 showed the riparian berm had re-formed by WY 1998 as a result of riparian hardwood initiation and establishment that began in WY 1995. Preliminary encroachment thresholds were based on plant densities calculated for all plants measured below 57 cms (2,000 cfs) as described above. This analysis was limited by sample size (n = 1 site); however, it provided a preliminary range of known stem densities that led to detrimental riparian encroachment and subsequent berm formation.

Table 13. Plant densities measured at Sheridan Creek Pilot Channel Rehabilitation Site (XS 02+35) in 1997, the year before detrimental riparian encroachment occurred. These plant densities represent preliminary detrimental riparian encroachment thresholds.

Plant Size (DRC, cm)	Plant Age	Plant Density Encroachment Threshold (plants/hectare)
0 – 0.25	Young-of-Year (YOY)	1,721,000
0.26 – 0.50	1 year	
0.51 – 0.75	2 year	70,389
0.76 – 1.0	3 year	16,582
> 1.0	> 3 year	12,265

In addition, cross section topography at each band transect was compared between years to evaluate channel morphology changes induced by plant establishment trends (e.g., sand berm development). Changes in channel morphology, especially along the low water edge, were related to seedling initiation and establishment locations.

6.1.3 Long Term Response

For five GRTS Panel 2 sites where more than one year of vegetation band transect data were available, long term responses to ROD release flows and channel rehabilitation were assessed to evaluate whether ROD flow releases are (1) preventing riparian encroachment, riparian berm development, and channel simplification; and (2) achieving riparian initiation and establishment objectives on upper bars and floodplains. Specific evaluations included comparison of cross section morphological trends, evaluation of seedling success, and changes in demographics and vegetation patch types. In all cases, the GRTS Panel 2 sites with long-term data were also channel rehabilitation sites. Long term responses were evaluated at Mid-Valdor Gulch (GRTS400-17), Bell Gulch Pilot Rehabilitation Site (GRTS400-26), Lower Indian Creek (GRTS400-28), Lower Dark Gulch (GRTS400-19), and Lewiston Cableway (GRTS400-30).

6.1.4 Large Wood Storage

Large wood planform mapping was conducted to establish a baseline condition for large wood storage conditions. Future monitoring of GRTS Panel 2 sites will enable an evaluation of whether large wood storage in the active channel is increasing and being maintained.

At GRTS Panel 2 sites, all pieces of large wood greater than 8 cm in contact with the 8.5 cms (300 cfs) water surface (within the channel) were mapped, up to an elevation of approximately the 57 cms (2,000 cfs) water surface elevation. Live trees or dead trees that have not fallen into the channel were not counted in the survey. Mapping used a Trimble GeoXH handheld GPS unit and a Zephyr antenna to locate large wood location and elevation; attributes of each piece of wood, such as species and stem diameter, were recorded. The large wood piece was located spatially and elevationally to enable prediction of when the large wood piece is inundated and thus available as fish habitat. Debris piles were mapped as a single point. Dominant size class of debris (see below) was noted, as well as general number (e.g., >20 pieces); however, number of wood pieces within each debris pile was not counted. This method only focused on changes in large wood storage at a site, and does not assess large wood routing or budgeting throughout the 64-km (40-mile) Project Reach. Therefore, individual large wood was not tagged nor tracked if it routed downstream. Post-processing of the data was conducted using GPS Pathfinder Office (Trimble), ArcMap (ESRI), and Excel (Microsoft).

Large wood mapping occurred once during fall 2010 after flows receded to 8.5 cms (300 cfs). When each large wood piece was surveyed, the location was entered into a data logger and attributes were assigned that described the piece of wood. Survey attributes included:

- GRTS site number,
- a unique identification number,
- date,
- origin (i.e., natural, placed, unknown),
- location of wood relative to stream bank,
- diameter measured at root collar (DRC), assigned to one of six size classes (20 to 30, 30 to 46, 46 to 61, 61 to 91, 91 to 122, and >122 cm [8 to 12, 12 to 18, 18 to 24, 24 to 36, 36 to 48, and >48 in]).
- root wad width (i.e., total and wet widths; measured at widest point of root wad),
- stem length total and wetted lengths measured from root collar to tip of stem,
- orientation of stem relative to magnetic north measured with compass from root collar,
- species,
- status of large wood decay (adapted from Wohl et al. 2010),
- streamflow on date of data collection, and
- additional comments or ancillary information.

Data from the first large wood survey conducted at GRTS sites were analyzed to quantify the number of large wood pieces, the number of pieces per mile, the proportion of different size classes sampled and number of large wood pieces contributed by species. When large wood data are collected a second time in five years, changes in large wood storage will be evaluated. Large wood data will be explored for correlations and trends that may be useful for the TRRP Design Team in future large wood installation design processes and in refining the overall Trinity River wood budget (Cardno ENTRIX and CH2M Hill 2010).

6.2 Results and Discussion

6.2.1 GRTS Sites

6.2.1.1 Vegetation Mapping

Approximately 387 acres were mapped at 11 GRTS Panel 2 sites in 2009 and 2010. Fifty patch types were mapped at Panel 2 sites in 2009 and 2010 (Table 14). White alder, mixed willow, open ground, and roads were the most frequent patch types. Roads accounted for approximately 4% of the total mapped area; only 9 of the 50 mapped patch types accounted for more mapped area than roads (Table 14).

The frequency of the most frequent patch types mapped in fall 2010 did not change when patches were sorted into inundation zones; however, abundance did not necessarily translate into frequency. For example, white alder, mixed willow, and open ground were all most frequent above and below 57 cms (2,000 cfs). These patches were also the most abundant patches sampled below 2,000 cfs (Table 15).

Table 14. Frequency and abundance of vegetation patch types mapped at 11 GRTS Panel 2 sites in WY 2010.

Patch Type	2009 % Frequency	2009 % Abundance	2010 % Frequency	2010 % Abundance
Mixed Willow	100.0%	7.3%	100.0%	7.7%
Open	100.0%	4.4%	100.0%	2.4%
River	100.0%	8.3%	100.0%	8.3%
Road	90.9%	3.5%	100.0%	3.7%
White Alder	100.0%	3.2%	100.0%	3.6%
Human Distubance	81.8%	10.3%	90.9%	8.9%
Mixed Conifer	81.8%	9.0%	90.9%	8.3%
Mixed Conifer - White Oak	90.9%	13.7%	90.9%	15.4%
Narrowleaf Willow	90.9%	2.8%	90.9%	2.8%
Non-native Grassland	90.9%	8.3%	90.9%	9.6%
Ponderosa Pine	90.9%	1.0%	90.9%	1.0%
Foothill Pine	81.8%	3.8%	81.8%	3.4%
Large Woody Debris	63.6%	0.1%	81.8%	0.1%
Yellow Star Thistle Grassland	81.8%	5.4%	81.8%	6.6%
Black Cottonwood	72.7%	1.5%	72.7%	1.0%
Himalaya Berry*	81.8%	1.0%	72.7%	1.2%
Arroyo Willow	63.6%	1.0%	63.6%	1.0%
Canyon Live Oak	72.7%	0.9%	63.6%	0.9%
Narrowleaf-Dusky Willow	63.6%	1.5%	63.6%	1.2%
Wedgeleaf Ceanothus	72.7%	1.0%	63.6%	1.0%
California Grape	54.5%	0.3%	45.5%	0.3%
Oregon White Oak	63.6%	1.8%	45.5%	1.4%
Oregon Ash*	45.5%	0.3%	36.4%	0.2%
Mixed White Alder	36.4%	0.7%	27.3%	0.9%
Open Water	36.4%	0.0%	27.3%	0.1%
Tailings Pile	27.3%	2.1%	27.3%	2.7%
Unknown	36.4%	1.4%	27.3%	1.4%
Whiteleaf Manzanita	36.4%	2.4%	27.3%	2.4%
Black Walnut	27.3%	0.1%	18.2%	0.1%
California Black Oak	-	-	18.2%	0.0%
Dusky Willow	27.3%	0.0%	18.2%	0.0%
Red Willow	36.4%	0.0%	18.2%	0.0%
Sedge	36.4%	0.1%	18.2%	0.2%
Tree of Heaven*	9.1%	0.7%	18.2%	0.8%
Basket Bush*	27.3%	0.3%	9.1%	0.3%
California Brickellbush	27.3%	0.0%	9.1%	0.0%
Cattail	18.2%	0.0%	9.1%	0.1%
Douglas Fir	18.2%	0.0%	9.1%	0.0%
Incense Cedar	27.3%	0.0%	9.1%	0.0%
Juncus	18.2%	0.2%	9.1%	0.2%
Madrone	-	-	9.1%	0.0%
Nut Sedge	18.2%	0.0%	9.1%	0.0%
Planted Grasses	-	-	9.1%	0.5%
Ponderosa Pine-Tree of Heaven	-	-	9.1%	0.2%
Rose	18.2%	0.0%	9.1%	0.0%
Aquatic Emergent	18.2%	0.0%	-	-
Blue Wild Rye	18.2%	0.1%	-	-
Mixed Conifer - Mountain Maple	9.1%	0.1%	-	-
Shiny Willow	18.2%	0.0%	-	-
Sweet Clover	27.3%	1.2%	-	-

Table 15. Summary of patch types mapped above and below 57 cms (2,000 cfs) at 11 GRTS sites in fall 2010.

	< 57 cms (<2,000 cfs)		> 57 cms (>2,000 cfs)		Total Acreage	
Patch Type	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**
White Alder	10.05	27.7%	8.72	12.3%	18.8	17.5%
Mixed Willow	5.29	14.6%	15.40	21.7%	20.7	19.3%
Open	5.26	14.5%	6.98	9.9%	12.2	11.4%
Mixed White Alder	4.41	12.2%	2.07	2.9%	6.5	6.0%
Narrowleaf-Dusky Willow	2.44	6.7%	4.23	6.0%	6.7	6.2%
Narrowleaf Willow	2.24	6.2%	5.49	7.7%	7.7	7.2%
Human Distubance	1.51	4.2%	3.93	5.5%	5.4	5.1%
Open Water	0.89	2.5%	0.15	0.2%	1.0	1.0%
Mixed Conifer - White Oak	0.88	2.4%	1.63	2.3%	2.5	2.3%
Mixed Conifer	0.59	1.6%	1.07	1.5%	1.7	1.5%
Large Woody Debris	0.39	1.1%	0.25	0.3%	0.6	0.6%
Non-native Grassland	0.26	0.7%	11.85	16.7%	12.1	11.3%
Dusky Willow	0.23	0.6%	0.57	0.8%	0.8	0.7%
Black Cottonwood	0.21	0.6%	2.05	2.9%	2.3	2.1%
Himalaya Berry*	0.19	0.5%	0.86	1.2%	1.0	1.0%
Oregon White Oak	0.18	0.5%	0.27	0.4%	0.4	0.4%
Arroyo Willow	0.17	0.5%	0.37	0.5%	0.5	0.5%
Juncus	0.16	0.4%	0.65	0.9%	0.8	0.8%
Sedge	0.16	0.4%	0.14	0.2%	0.3	0.3%
Cattail	0.16	0.4%	0.23	0.3%	0.4	0.4%
Oregon Ash*	0.11	0.3%	0.18	0.3%	0.3	0.3%
Nut Sedge	0.08	0.2%	0.05	0.1%	0.1	0.1%
Road	0.07	0.2%	0.99	1.4%	1.1	1.0%
Canyon Live Oak	0.06	0.2%	0.09	0.1%	0.2	0.1%
Fremont Cottonwood	0.06	0.2%	0.32	0.4%	0.4	0.4%
California Grape	0.06	0.2%	0.18	0.2%	0.2	0.2%
Wedgeleaf Ceanothus	0.03	0.1%	0.05	0.1%	0.1	0.1%
Whiteleaf Manzanita	0.03	0.1%	0.04	0.1%	0.1	0.1%
Foothill Pine	0.02	0.1%	0.26	0.4%	0.3	0.3%
Open Ground	0.02	0.1%	0.10	0.1%	0.1	0.1%
Yellow Star Thistle Grassland	0.02	0.0%	0.76	1.1%	0.8	0.7%
California Black Oak	0.02	0.0%	0.01	0.0%	0.0	0.0%
Black Locust*	0.01	0.0%		0.0%	0.0	0.0%
Red Willow	0.01	0.0%	0.04	0.1%	0.1	0.1%
Sweet Clover	0.01	0.0%	0.20	0.3%	0.2	0.2%
Ponderosa Pine	0.00	0.0%	0.32	0.5%	0.3	0.3%
Emergent Aquatic	0.00	0.0%	0.04	0.1%	0.0	0.0%
Basket Bush	0.00	0.0%	0.03	0.0%	0.0	0.0%
Black Walnut	0.00	0.0%	0.00	0.0%	0.0	0.0%
Oregon Goldenaster	0.00	0.0%	0.28	0.4%	0.3	0.3%

However, above 2,000 cfs, non-native grassland was more abundant (i.e., covered more area) than all the frequent patch types except for mixed willow (Table 15). This illustrates what can clearly be seen in the field: riparian patches are more frequent and abundant below 57 cms (2,000 cfs), and a mosaic of upland and riparian patches exists above 57 cms (2,000 cfs). Riparian patches were frequent above 57 cms (2,000 cfs), but they were not the most abundant. Drier upland patches accounted for more area above 57 cms (2,000 cfs), as would be expected.

The system-wide diversity of riparian vegetation in the Project Reach is high, but much of that diversity exists in very small, unique patch types. Approximately 68% of the patch types (34 of the 50) mapped at GRTS Panel 2 sites each accounted for 1% or less of the mapped area. Results from the Panel 2 sampling suggested that the bulk of riparian vegetation in the Project Reach was not very diverse and that the most frequent riparian patch types (white alder, mixed willow, open, and to a lesser extent, narrowleaf willow) were also typically the most abundant riparian patch types. A typical monitoring site consisted of a white alder or narrowleaf willow patch near the channel edge, a mixed willow patch upslope of that, and a non-native grassland patch further upslope, with open patches at the immediate channel edge and perhaps between the willow-dominated patches and the non-native grassland.

6.2.1.1 Band Transects

Patch Type Frequency and Abundance

Patch type frequency and abundance were compared between the fall 2009 (pre-winter) and fall 2010 (post-winter and post-spring ROD release) conditions at 11 GRTS Panel 2 sites (Table 16). Common species within each patch type can be found in Appendix C. Riparian patches accounted for approximately 45% of all patches sampled, open patches accounted for approximately 25%, and upland patches accounted for approximately 30% of all patches sampled at Panel 2 sites (Figure 10). Systemically, mixed willow, open ground, and white alder were the most frequent patch types. The six most frequent patch types (Table 16) occurred more than once on at least one transect, suggesting that they were also the most abundant patch types, a result that was corroborated by the systemic mapping results (see Section 6.2.1.1). The coincidence of the most frequent and abundant patch types indicated that the majority of the riparian vegetation in the Project Reach was composed of only a few patch types.

Table 16. Frequency of vegetation patch types sampled on band transects at 11 GRTS Panel 2 sites in WY 2010.

Patch Type	Frequency by band transect (n=26)	Frequency by total number of patches (n=101)
Open ground	65.4%	17.8%
Non-native grassland	53.8%	15.8%
Narrowleaf willow	46.2%	15.8%
Mixed willow	38.5%	14.9%
Human disturbance	26.9%	8.9%
White alder	23.1%	7.9%
Yellow star-thistle grassland	19.2%	5.0%
Black cottonwood	19.2%	5.0%
Sweetclover	7.7%	3.0%
Himalya berry	7.7%	2.0%
Gray pine	7.7%	2.0%
Oregon ash	3.8%	1.0%

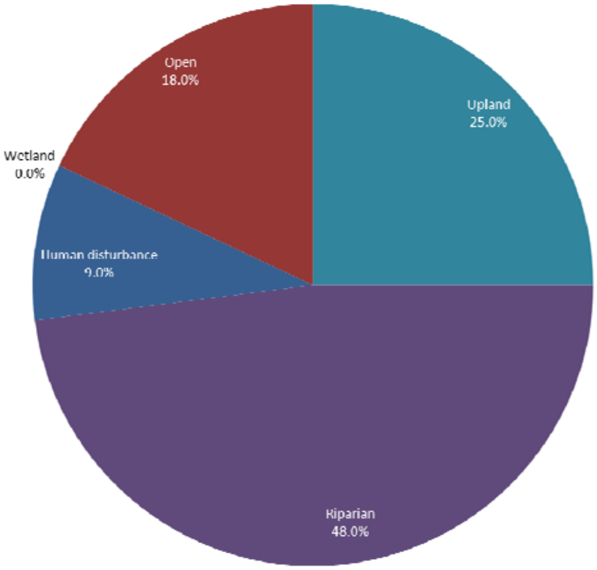


Figure 10. Systemic (GRTS-based) frequency of biohabitats sampled on band transects at 11 GRTS Panel 2 sites in WY 2010.

Species Frequency and Abundance

Species frequency and abundance was also compared between the fall 2009 (pre-winter) and fall 2010 (post-winter and post-spring ROD release) condition. Of the 269 species previously sampled in the Project Reach, 123 species were sampled at band transects in WY 2010 (Appendix C). The 39 most frequent species sampled are shown in Table 17. Results between 2009 and 2010 indicated changes in species frequency and/or abundance when no real changes occurred because the 2009 sampling occurred in December, when many plants were dormant. This was considered during data analysis based on site conditions (i.e., was the site constructed?), cross section location (i.e., did flows reach the patch type in which changes were indicated?), and field notes. Only those species where true changes occurred were presented. Arroyo willow (*Salix lasiolepis*) was sampled at the most band transects, followed by open ground, Himalaya blackberry (*Rubus armeniacus*), and narrowleaf willow (*S. exigua*; Table 17). Additional species responses are summarized below:

- No species increased in frequency between pre-winter flood and ROD release monitoring and post-ROD release monitoring over the course of WY 2010.
- Several species decreased in frequency, including mullein (*Verbascum thapsus*), white sweetclover (*Melilotus officinalis*), and common plantain (*Plantago major*). Both mullein and common plantain are found in many patch types in the riparian zone and tend to be disturbance oriented. They prefer open, disturbed sites. Their decreased frequency suggests that open ground may be transitioning to vegetated surfaces. White sweetclover is also found in many patch types in the riparian zone, especially open bars and newly constructed floodplains. The declining abundance is little cause for management concern, however, because white sweetclover is an exotic species that is widespread throughout the Project Reach. Further discussion of white sweetclover trends is included in Section 6.2.2, because this patch type was particularly common at channel rehabilitation sites.
- Oregon goldenaster (*Heterotheca oregona*) abundance increased at Indian Creek, likely in response to the decreasing abundance of white sweetclover. Oregon goldenaster typically

grows on open cobble bars that tend to become hydraulically disconnected from the main channel and transition into non-native grassland patches, where it persists in grasslands.

- Most plant species abundances did not change in response to the 2010 spring ROD release.

Table 17. Frequency of the 39 most frequent species sampled on band transects at 11 GRTS Panel 2 sites in WY 2010. Non-native species are shown in red.

Species Name	**Fall 2009 # transects where sampled**	**Fall 2010 # transects where sampled**	**Fall 2009 Frequency**	**Fall 2010 Frequency**	**Riverwide Frequency**
Salix lasiolepis	12	11	1.00	0.92	0.88
OPEN GROUND	11	12	0.92	1.00	0.88
Rubus discolor	11	12	0.92	1.00	0.88
Salix exigua	11	11	0.92	0.92	0.85
Hirschfeldia incana	10	9	0.83	0.75	0.73
Heterotheca oregona	9	9	0.75	0.75	0.69
Plantago lanceolata	8	10	0.67	0.83	0.69
Trifolium arvense	8	10	0.67	0.83	0.69
Centaurea solstitialis	9	9	0.75	0.75	0.69
Linaria genistifolia	8	9	0.67	0.75	0.65
Bromus tectorum	9	8	0.75	0.67	0.65
Equisetum hyemale	9	7	0.75	0.58	0.62
Phalaris arundinacea	7	8	0.58	0.67	0.58
Vitus californica	7	8	0.58	0.67	0.58
Verbascum thapsus	10	4	0.83	0.33	0.54
Fraxinus latifolia	7	7	0.58	0.58	0.54
Alnus rhombifolia	7	6	0.58	0.50	0.50
Avena barbata	3	9	0.25	0.75	0.46
vegetative grass	6	6	0.50	0.50	0.46
Melilotus alba	8	3	0.67	0.25	0.42
Artemesia douglasiana	5	6	0.42	0.50	0.42
Rubus ursinus	4	7	0.33	0.58	0.42
Aira caryophyllea	3	7	0.25	0.58	0.38
Cyperus eragrostis	6	4	0.50	0.33	0.38
Hypericum perforatum	5	5	0.42	0.42	0.38
Xanthium strumarium	6	4	0.50	0.33	0.38
Pinus ponderosa	5	5	0.42	0.42	0.38
Populus balsamifera ssp. *trichocarpa*	5	5	0.42	0.42	0.38
Salix laevigata	5	5	0.42	0.42	0.38
Bromus secalinus	9	0	0.75	0.00	0.35
Carex nudata	9	0	0.75	0.00	0.35
Conyza canadensis	2	7	0.17	0.58	0.35
Poa bulbosa	6	3	0.50	0.25	0.35
Plantago major	5	3	0.42	0.25	0.31
Rumex crispus	2	6	0.17	0.50	0.31
Festuca arundinacea	1	6	0.08	0.50	0.27
Conium maculatum	5	2	0.42	0.17	0.27
Cynodon dactylon	6	0	0.50	0.00	0.23
Epilobium brachycarpum	6	0	0.50	0.00	0.23
Equisetum telmateia	5	1	0.42	0.08	0.23

Riparian Hardwood Demographics within Inundation Zones

Hardwood densities were calculated for riparian hardwoods sampled in fall 2010 (Figure 10), based on DRC size classes as a proxy for stem age (Table 12). The <0.5 cm DRC size class, which corresponds approximately to young-of-year and 1-yr old seedlings, was the most abundant size class, especially on the 8.5 to 13 cms (300 to 450 cfs), 13 to 57 cms (450 to 2,000 cfs), and 57 to 127 cms (2,000 to 4,500 cfs) inundation surfaces (Figure 10). No hardwoods less than 0.5 cm DRC were sampled above 127 cms (4,500 cfs) at any of the GRTS Panel 2 sites, and the majority (89%) were sampled below 57 cms (2,000 cfs). Additional demographic trends included:

- All hardwoods sampled above 127 cms (4,500 cfs) were greater than 1.0 cm DRC, which corresponded approximately to >3-yr old plants.
- Surfaces between 8.5 and 13 cms (300 to 450 cfs) had the highest density of hardwoods less than 0.5 cm DRC (young-of-year and 1-yr old seedlings), as well as the highest density of hardwoods 0.75 to 1.0 cm DRC (3-yr old) (Figure 10). No 0.50 to 0.75 cm DRC (2-yr old) plants were measured on these surfaces.
- The dominant height class of riparian hardwoods on increasing inundation surfaces followed a predictable pattern. Hardwoods less than 1.5 m (5.0 ft) tall dominated inundation surfaces less than 127 cms (4,500 cfs). Between 127 and 311 cms (4,500-11,000 cfs), hardwoods greater than 5.0 m (15.0 ft) tall dominate; above 311 cms (11,000 cfs), hardwoods between 1.5 and 5.0 m (5.0-15.0 ft) tall dominate.
- All planted hardwoods sampled were <1.5 m tall (i.e., they were still in the herb layer). Planted hardwoods occurred on the 57 to 127 cms (2,000 to 4,500 cfs) and the 127 to 170 cms (4,500 to 6,000 cfs) surfaces.

To examine how riparian hardwood age class densities and distributions within inundation zones may have responded to the spring ROD release, 2009 and 2010 band transect seedling data were compared. At four band transects (out of 12 total), discrepancies occurred between measured plant numbers, and therefore those data were excluded from the following discussion. The following observations were made for the remaining eight band transects:

- Approximately 79% of the 2009 hardwoods <0.25 cm DRC (i.e., the young-of-year cohort) were scoured by the 2010 spring ROD release (170 cms, 6,610 cfs). Scour of riparian hardwoods <0.25 cm DRC (young-of-year) was lowest at Junction City Campground XS 286+40 (10%) and highest at Lower Indian Creek XS 1157+90 (97%).
- At four band transects (Indian Creek Confluence XS 1224+50, Lower Dark Gulch XS 1791+30, and Lewiston Cableway XS 2012+10 and XS 2013+94), no seedlings were sampled in 2009 or 2010.

The red-yellow-green evaluation included 11 GRTS Panel 2 sites and was based on plant densities, ground surface topography, and field notes (Table 18, Figure 11). Most cross sections, even those demonstrating riparian encroachment, had plant densities below the preliminary riparian encroachment thresholds (Figure 12). Because preliminary riparian encroachment thresholds were based on plant densities at a single site, not all sites were accurately risk-coded based on plant density alone. Roundhouse XS 582+10 was coded yellow because densities of 0.76 to 1.0 cm DRC (3-yr) plants may lead to fine sediment deposition, which may encourage berm formation and more stem recruitment. Five sites were coded gray because they are already encroached: two sites had non-detrimental riparian encroachment (Mid-Valdor Gulch XS 151+80 and Wheel Gulch XS 195+00), whereas three sites had detrimental riparian encroachment (Ed’s Bar XS 516+40, Bell Gulch XS 641+00, and Treadwell Bridge XS 1356+80).

Table 18. Riparian hardwood densities measured below 57 cms (2,000 cfs) at one pilot channel rehabilitation site (Sheridan Creek XS 02+35) and 11 GRTS Panel 2 sites. Sheridan Creek densities were used in a preliminary analysis to establish detrimental riparian encroachment thresholds. Red numbers indicate densities upon which risk code designations were based.

Site	Size Class (cm)	Approximate Age Class	<13 cms (450 cfs)	13-57 cms (450-2,000 cfs)	57-127 cms (2,000-4,500 cfs)	Site Risk Code	Notes
Sheridan Creek 02+35 1997	<0.50	Young-of-year + 1-yr	273,403	1,447,599	7,323	red	Densities of 2-yr and 3-yr age classes led to detrimental riparian encroachment
	0.51-0.75	2-yr	11,392	59,998	2,441		
	0.76-1.0	3-yr	6,510	10,073	0		
	>1.0	>3-yr	6,510	5,756	0		
Sheridan Creek 02+35 1998	<0.50	Young-of-year + 1-yr	18,432	195,288	591,588	gray	Site encroached (detrimental) with berm formation
	0.51-0.75	2-yr	6,144	36,454	0		
	0.76-1.0	3-yr	9,216	19,529	2,357		
	>1.0	>3-yr	3,072	5,208	0		
Mid-Valdor Gulch 151+80	<0.50	Young-of-year + 1-yr	60,756	34,666	5,681	gray	Site is already encroached (non-detrimental)
	0.51-0.75	2-yr	0	11,555	2,130		
	0.76-1.0	3-yr	0	5,778	710		
	>1.0	>3-yr	24,303	19,809	7,812		
Wheel Gulch 195+00	<0.50	Young-of-year + 1-yr	24,303	0	0	gray	Site is already encroached (non-detrimental)
	0.51-0.75	2-yr	0	0	0		
	0.76-1.0	3-yr	72,908	2,769	3,586		
	>1.0	>3-yr	0	5,537	0		
Junction City Campground 286+40	<0.50	Young-of-year + 1-yr	0	19,248	15,414	green	
	0.51-0.75	2-yr	0	2,625	734		
	0.76-1.0	3-yr	0	3,500	734		
	>1.0	>3-yr	0	8,749	734		
Ed's Bar 516+40	<0.50	Young-of-year + 1-yr	0	2,804	0	gray	Site is already encroached (detrimental)
	0.51-0.75	2-yr	0	0	0		
	0.76-1.0	3-yr	0	2,804	3,771		
	>1.0	>3-yr	0	0	0		
Roundhouse 582+10	<0.50	Young-of-year + 1-yr	0	13,620	0	yellow	Density of 3-yr plants not at encroachment levels but may lead to further stem recruitment and future encroachment
	0.51-0.75	2-yr	0	10,415	0		
	0.76-1.0	3-yr	0	5,608	0		
	>1.0	>3-yr	0	4,807	1,032		
Bell Gulch 630+20	<0.50	Young-of-year + 1-yr	0	1,208	0	green	
	0.51-0.75	2-yr	0	906	0		
	0.76-1.0	3-yr	0	604	0		
	>1.0	>3-yr	0	3,323	1,430		
Bell Gulch 641+00	<0.50	Young-of-year + 1-yr	38,039	0	0	gray	Site is already encroached (detrimental)
	0.51-0.75	2-yr	0	0	0		
	0.76-1.0	3-yr	9,510	0	0		
	>1.0	>3-yr	0	3,771	1,032		
Lower Indian Creek 1157+90	<0.50	Young-of-year + 1-yr	0	2,553	0	green/ gray	Risk code applies to the constructed side channel. The main channel margin is already encroached.
	0.51-0.75	2-yr	0	2,553	312		
	0.76-1.0	3-yr	0	851	0		
	>1.0	>3-yr	0	1,702	623		

Table 18 (continued)

Site	Size Class	Approximate Age Class	<13 cms (450 cfs)	13-57 cms (450-2,000 cfs)	57-127 cms (2,000-4,500 cfs)	Site Risk Code	Notes
Indian Creek Confluence 1224+50	<0.50	Young-of-year + 1-yr	0	0	0	green	
	0.51-0.75	2-yr	0	0	0		
	0.76-1.0	3-yr	0	0	0		
	>1.0	>3-yr	0	0	816		
Treadwell Bridge 1356+80	<0.50	Young-of-year + 1-yr	4,755	3,569	4,021	gray	Site is already encroached (detrimental)
	0.51-0.75	2-yr	0	3,059	3,217		
	0.76-1.0	3-yr	2,377	510	2,412		
	>1.0	>3-yr	7,132	5,353	4,021		
Lower Dark Gulch 1791+30	<0.50	Young-of-year + 1-yr	0	0	0	green	
	0.51-0.75	2-yr	0	0	0		
	0.76-1.0	3-yr	0	0	0		
	>1.0	>3-yr	0	3,518	0		
Lewiston Cableway 2012+10	<0.50	Young-of-year + 1-yr	0	0	0	green	
	0.51-0.75	2-yr	0	0	0		
	0.76-1.0	3-yr	0	0	0		
	>1.0	>3-yr	0	0	0		
Lewiston Cableway 2013+94	<0.50	Young-of-year + 1-yr	0	0	0	green	
	0.51-0.75	2-yr	0	0	0		
	0.76-1.0	3-yr	0	0	0		
	>1.0	>3-yr	0	0	0		

6.2.1 Channel Rehabilitation Sites

Twelve channel rehabilitation sites were mapped in WY 2010. Three were pilot bank rehabilitation sites constructed by the TRRP between 1991 and 1993 to provide salmonid fry habitat via gently sloping channel edges (“feathered edges”). The remaining nine were constructed after 2005.

A total of 46 patch types and 237.3 acres were mapped at channel rehabilitation sites (Table 19). Biohabitats included riparian, wetland, upland, open, human disturbance, and open water biohabitats (Figure 13). Approximately 39% of the patches were riparian biohabitats, 11% were wetlands, and 33% were upland patches. Similar to GRTS Panel 2 mapping results, mixed willow was the most abundant patch type at channel rehabilitation sites (Table 19), followed by open ground, white alder, and non-native grassland. Patch type trends at individual channel rehabilitation sites may have differed from these collective trends, but one consistent pattern was that at least half the patch types mapped at any given site accounted for less than 2% of the total mapped area (i.e., each site was dominated by one or two abundant patch types, 5 to 10 less abundant patch types, and 20+ small and often uncommon patch types).

Remnant vegetation was the most abundant origin class mapped at channel rehabilitation sites, accounting for approximately 23% of the total mapped area. This makes sense because a portion of each channel rehabilitation site was undisturbed. Herbaceous was the second most abundant origin class (approximately 19%), followed by open water (14%), human disturbance (9%), and open ground (9%). Regrowth accounted for approximately 1% of the mapped area, and regeneration accounted for less than 1%. Revegetation accounted for approximately 1%.

Mapping results from all channel rehabilitation sites were separated into inundation zones to examine colonization and establishment trends of riparian vegetation patches. A total of 57.1 acres and 42 patch types were mapped below 57 cms (2,000 cfs) (Table 19). Sixteen of the patch types were riparian biohabitat types and five were wetland biohabitats. Approximately 59% of the patch types mapped below 57 cms (2,000 cfs) each covered less than 0.3 acres (<0.5% cover).

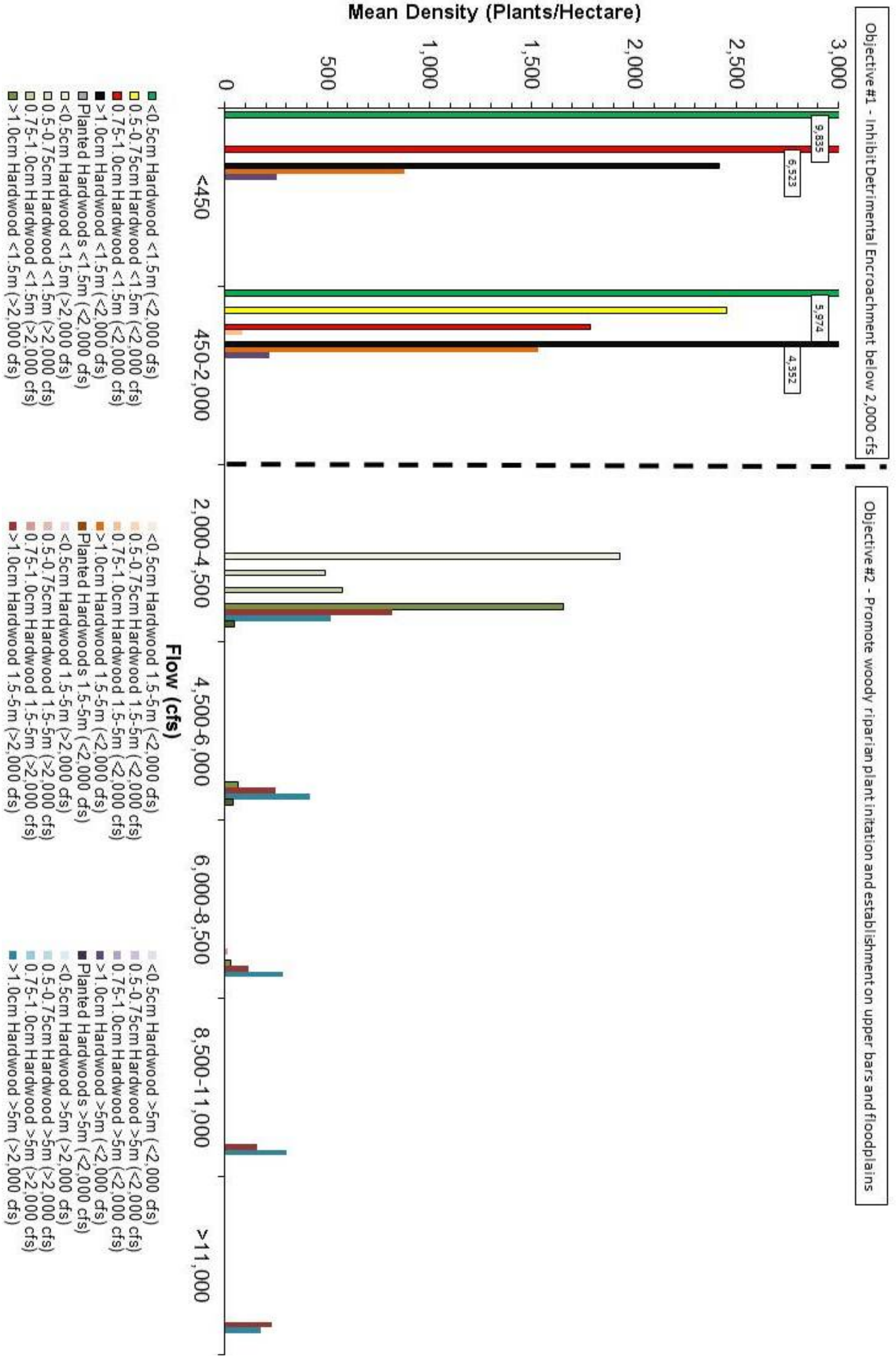


Figure 11. "Red-yellow-green" evaluation of average density of riparian hardwoods sampled on band transects at GRTS Panel 2 sites in WY 2010. See Table 12 for complete description of size classes and risk description.

Table 19. Summary of patch types mapped above and below 57 cms (2,000 cfs) at 12 channel rehabilitation sites in WY 2010.

	< 57 cms (<2,000 cfs)		**>57 cms (>2,000 cfs)**		**Total**	
Patch Type	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**
Mixed Willow	11.7	20.44%	43.52	24.15%	55.2	23.25%
Open	10.7	18.71%	23.55	13.07%	34.2	14.43%
White Alder	10.0	17.42%	18.04	10.01%	28.0	11.79%
Narrowleaf-Dusky Willow	4.9	8.63%	10.49	5.82%	15.4	6.49%
Mixed White Alder	4.4	7.62%	5.76	3.20%	10.1	4.26%
River	3.5	6.13%	0.61	0.34%	4.1	1.73%
Narrowleaf Willow	3.0	5.28%	10.53	5.84%	13.6	5.71%
Human Distubance	2.0	3.42%	9.11	5.05%	11.1	4.66%
Non-native Grassland	0.9	1.51%	27.30	15.15%	28.2	11.87%
Mixed Conifer - White Oak	0.7	1.19%	2.51	1.39%	3.2	1.34%
Native Grasses	0.6	1.09%	1.09	0.60%	1.7	0.72%
Mixed Conifer	0.5	0.93%	1.91	1.06%	2.4	1.03%
Foothill Pine	0.5	0.93%	2.61	1.45%	3.1	1.32%
Sedge	0.4	0.67%	0.14	0.08%	0.5	0.22%
Black Cottonwood	0.4	0.63%	4.85	2.69%	5.2	2.20%
Himalaya Berry*	0.3	0.50%	1.89	1.05%	2.2	0.92%
Cattail	0.3	0.47%	0.27	0.15%	0.5	0.23%
Juncus	0.3	0.46%	0.80	0.44%	1.1	0.45%
Large Woody Debris	0.2	0.39%	0.45	0.25%	0.7	0.29%
Oregon White Oak	0.2	0.37%	0.64	0.36%	0.9	0.36%
Nut Sedge	0.2	0.37%	0.31	0.17%	0.5	0.22%
Aquatic Emergent	0.2	0.36%	0.16	0.09%	0.4	0.15%
Road	0.2	0.32%	2.73	1.51%	2.9	1.23%
Telegraph weed*	0.2	0.28%	2.26	1.25%	2.4	1.02%
Arroyo Willow	0.2	0.27%	1.31	0.73%	1.5	0.62%
Wedgeleaf Ceanothus	0.1	0.25%	0.13	0.07%	0.3	0.11%
Sweet Clover	0.1	0.24%	0.36	0.20%	0.5	0.21%
Open Water	0.1	0.24%	0.51	0.28%	0.6	0.27%
Dusky Willow	0.1	0.23%	0.69	0.38%	0.8	0.35%
Canyon Live Oak	0.1	0.18%	0.20	0.11%	0.3	0.13%
Oregon Ash*	0.1	0.12%	0.35	0.19%	0.4	0.17%
Fremont Cottonwood	0.1	0.10%	0.32	0.18%	0.4	0.16%
Yellow Star Thistle Grassland	0.0	0.08%	2.33	1.29%	2.4	1.00%
California Grape	0.0	0.05%	0.12	0.07%	0.1	0.06%
California Brickellbush	0.0	0.03%	0.11	0.06%	0.1	0.05%
Parry's Rabbit Brush	0.0	0.03%	1.13	0.63%	1.1	0.48%
Foothill Pine - White Oak	0.0	0.02%	0.07	0.04%	0.1	0.03%
Tree of Heaven*	0.0	0.01%	0.10	0.06%	0.1	0.05%
Red Willow	0.0	0.01%	0.06	0.03%	0.1	0.03%
Ponderosa Pine	0.0	0.01%	0.84	0.46%	0.8	0.36%
California Black Oak	0.0	0.00%	0.00	0.00%	0.0	0.00%
Bigleaf Maple	0.0	0.00%	0.00	0.00%	0.0	0.00%
Tailings Pile	N/A	N/A	0.03	0.02%	0.03	0.01%
Basket Bush*	N/A	N/A	0.03	0.02%	0.03	0.01%
Mugwort	N/A	N/A	0.01	0.01%	0.01	0.00%
Whiteleaf Manzanita	N/A	N/A	0.00	0.00%	0.00	0.00%

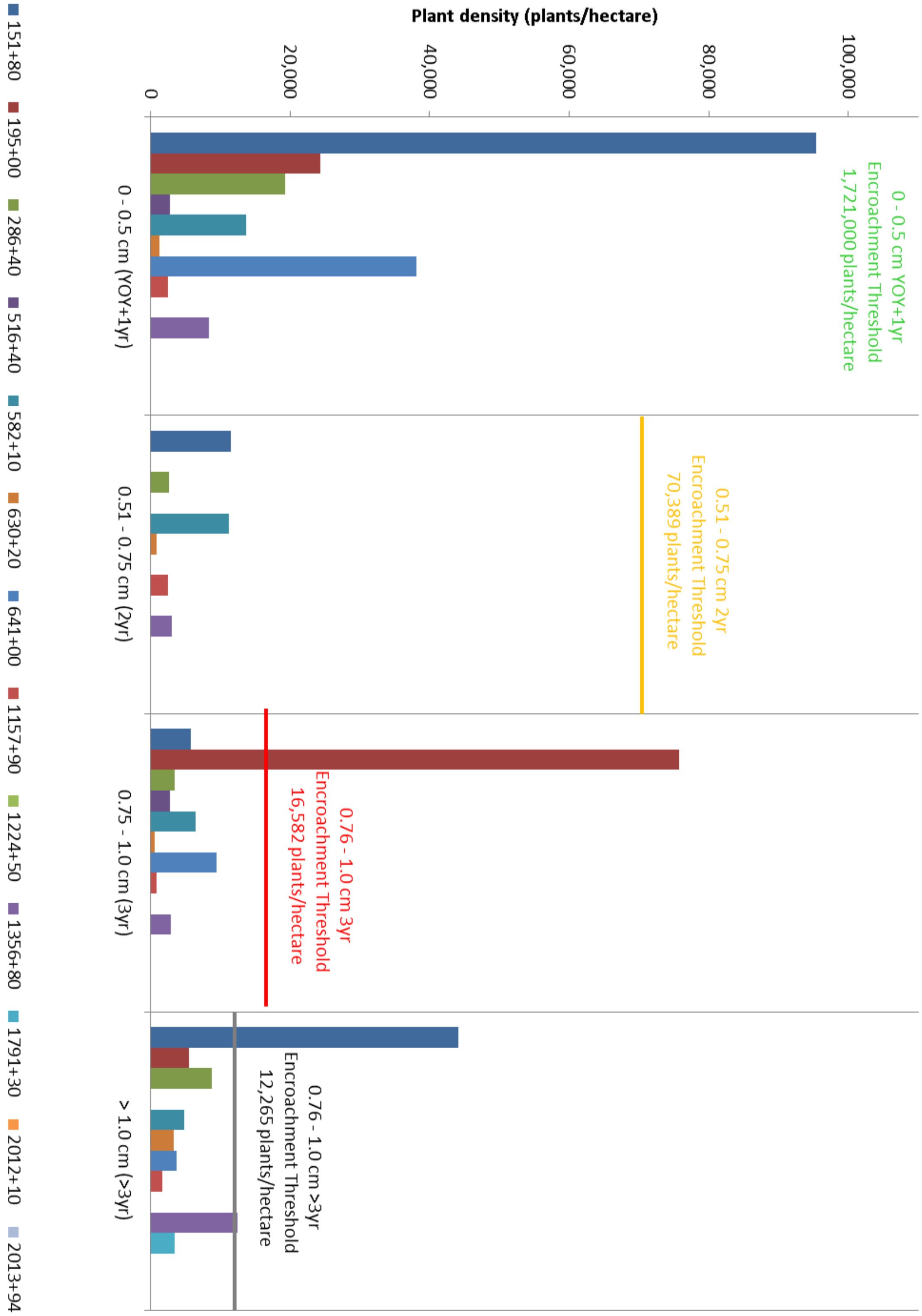


Figure 12. Detrimental riparian encroachment risk at 11 GRTS Panel 2 sites in WY 2010 based on preliminary detrimental riparian encroachment thresholds.

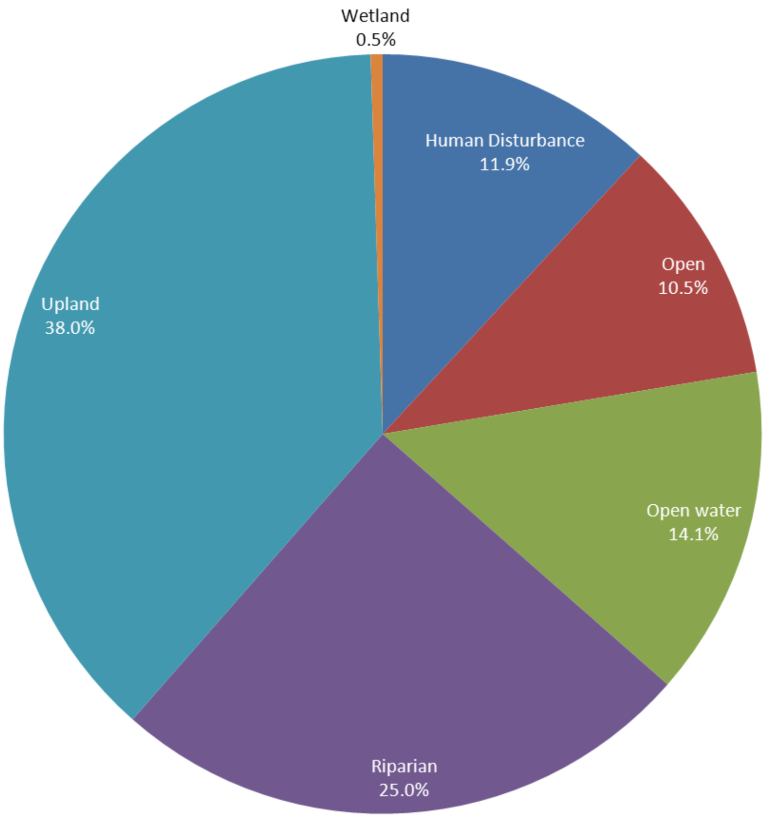


Figure 13. Frequency of biohabitats sampled at 12 channel rehabilitation sites in WY 2010.

Above 57 cms (2,000 cfs), 180.2 acres and 46 patch types were mapped (Table 19). All patch types mapped below 57 cms (2,000 cfs) were also mapped above 57 cms (2,000 cfs). The additional patch types occurring above 57 cms (2,000 cfs) were basket bush, mugwort, tailings piles, and whiteleaf ceanothus.

The relative abundance of patch types differed below 57 cms (2,000 cfs) and above 57 cms (2,000 cfs). For instance, mixed willow was more abundant above 57 cms (2,000 cfs) than below; open patches and white alder patches were more abundant below 57 cms (2,000 cfs) (Table 19). Non-native grassland was much more abundant above 57 cms (2,000 cfs) than below (Table 19).

Specific results for each channel rehabilitation site are summarized below.

6.2.1.1 Pear Tree Gulch

Pear Tree Gulch has been studied extensively since 1993. It was a pilot bank rehabilitation site where the riparian berm was removed and a feathered edge was constructed. It was subsequently studied as part of the TRFE (USFWS and HVT 1999). It was constructed again in 2006 to include ahigh flow scour channel and alcove. A total of 20.7 acres was mapped within the Environmental Study Limit (ESL). Twenty-one patch types were mapped at Pear Tree in 2010 (Appendix A). Approximately 33% of the area mapped was riparian biohabitats and 33% was upland biohabitats (Appendix E). Narrowleaf-dusky willow was the most abundant patch type at Pear Tree in 2010 (Appendix E). Herbaceous patch types accounted for approximately 19% of the mapped area in the ESL. Regrowth and revegetation each accounted for approximately 1%, while regeneration accounted for much less than 1% (Appendix E).

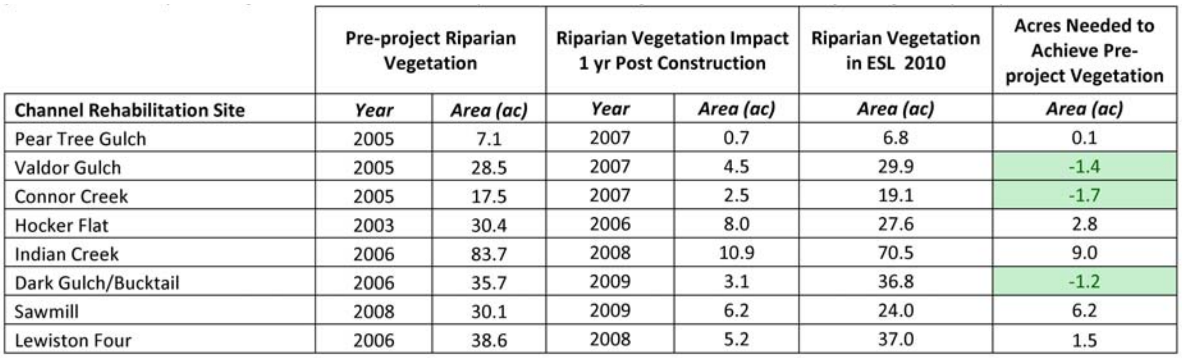
Four years following construction, the proportion of biohabitats at Pear Tree Gulch has shifted slightly. There is less cover of upland patch types and more cover of open ground. Cover of riparian patch types has also decreased slightly. Riparian vegetation has not recovered to pre-construction abundance (Table 20). By 2010, the area of mapped riparian vegetation had not changed since the 1-yr post-construction mapping. The riparian vegetation recovery rate has been flat, and it is uncertain whether more riparian vegetation will colonize this site (Appendix F).

6.2.1.2 Mid-Valdor Gulch

Mid-Valdor Gulch was constructed in 2006. A total of 120.8 acres was mapped within the ESL. Thirty patch types were mapped at Mid-Valdor Gulch in 2010 (Appendix A). Approximately 25% of the area mapped was riparian biohabitats and 50% was upland biohabitats (Appendix E). Non-native grassland was the most abundant patch type at Mid-Valdor Gulch in 2010 (Appendix E). Herbaceous patches accounted for approximately 28% of the mapped area in the ESL. Regrowth accounted for approximately 3%, revegetation accounted for approximately 1%, and regeneration accounted for 0.5% of the site (Appendix E).

Following construction, the proportion of biohabitats at Mid-Valdor Gulch shifted: open ground increased in cover while riparian and upland biohabitats decreased. Four years post construction, however, the site has returned to pre-construction abundances. Riparian vegetation has already recovered to pre-construction abundance (Table 20). Riparian vegetation acreage impacted during construction was almost recovered one year after construction (Appendix F).

Table 20. Pre- and post-construction riparian vegetation acreages mapped at 12 channel rehabilitation sites. Green cells indicate sites where post-construction riparian vegetation area has exceeded pre-construction vegetation area and therefore regulatory compliance has been met.



	Pre-project Riparian Vegetation		Riparian Vegetation Impact 1 yr Post Construction		Riparian Vegetation in ESL 2010	Acres Needed to Achieve Pre-project Vegetation
Channel Rehabilitation Site	***Year***	***Area (ac)***	***Year***	***Area (ac)***	***Area (ac)***	***Area (ac)***
Pear Tree Gulch	2005	7.1	2007	0.7	6.8	0.1
Valdor Gulch	2005	28.5	2007	4.5	29.9	-1.4
Connor Creek	2005	17.5	2007	2.5	19.1	-1.7
Hocker Flat	2003	30.4	2006	8.0	27.6	2.8
Indian Creek	2006	83.7	2008	10.9	70.5	9.0
Dark Gulch/Bucktail	2006	35.7	2009	3.1	36.8	-1.2
Sawmill	2008	30.1	2009	6.2	24.0	6.2
Lewiston Four	2006	38.6	2008	5.2	37.0	1.5

6.2.1.3 Connor Creek

Connor Creek was constructed in 2006. A total of 56.9 acres was mapped within the ESL. Thirty patch types were mapped at Connor Creek in 2010 (Appendix A). Approximately 34% of the mapped area was riparian biohabitats and 31% was upland biohabitats (Appendix E). Non-native grassland was the most abundant patch type at Connor Creek in 2010 (Appendix E). Herbaceous patches accounted for approximately 25% of the mapped area in the ESL. Regrowth accounted for approximately 2% of the site, regeneration accounted for approximately 1%, and revegetation accounted for slightly more than 0%.

Four years following construction, the proportion of biohabitats at Connor Creek has dramatically changed from pre-construction conditions. The amount of riparian and upland habitats has increased while the amount of open ground has decreased. Riparian vegetation has already surpassed pre-construction abundance (Table 20). Riparian vegetation steadily increased at the site and exceeded the pre-construction amount in 2010 (Appendix F).

6.2.1.4 Hocker Flat

Hocker Flat is a large site that includes a pilot channel rehabilitation site (Jim Smith). Hocker Flat was constructed in 2005; the Jim Smith site was included in the 2005 construction and therefore was constructed "again." A total of 151.3 acres was mapped within the ESL. Thirty patch types were mapped at Hocker Flat in 2010 (Appendix A). Approximately 18% of the mapped area was riparian biohabitats and 43% was upland biohabitats (Appendix E). Non-native grassland was the most abundant patch type at Hocker Flat in 2010 (Appendix E). Herbaceous patches accounted for approximately 25% of the mapped area in the ESL. Regrowth accounted for approximately 3%, revegetation accounted for approximately 1%, and regeneration accounted for less than 1% of the site (Appendix E).

Four years following construction, the proportion of biohabitats at Hocker Flat has changed from pre-construction conditions. The amount of riparian and upland biohabitats increased while open ground decreased. However, riparian vegetation has not recovered to pre-construction abundance (Table 20). Based on the current recovery rate, Hocker Flat should recover sufficient riparian vegetation to meet or exceed the amount of riparian vegetation disturbed by construction by 2015, at the end of 10 years following construction (Appendix F).

6.2.1.5 Indian Creek (includes Lower Indian Creek, Indian Creek Confluence, and Vitzthum Gulch)

Indian Creek was constructed in 2007. A total of 251.6 acres was mapped within the ESL. Thirty-two patch types were mapped at Indian Creek in 2010 (Appendix A). Approximately 28% of the mapped area was riparian biohabitats and 32% was upland biohabitats (Appendix E). Human disturbance was the most abundant patch type at Indian Creek in 2010 and was more abundant at this site than at any other (Appendix E). The prevalence of houses and other human infrastructure, as well as increased roads and spoils areas within the ESL, likely contributed to the large human disturbance area. Herbaceous patches accounted for approximately 11% of the area. Revegetation accounted for approximately 1%, and regrowth and regeneration each accounted for less than 1% of the site (Appendix E).

The proportion of biohabitats at Indian Creek has changed from pre-construction conditions. Riparian patch types have slightly decreased in abundance. While open ground and upland biohabitats have returned to pre-construction abundance, human disturbance has increased slightly since construction. The increased prominence of roads, especially at the Indian Creek Confluence, and the construction of a new house accounted for the increased human disturbance area.

Riparian vegetation has not recovered to pre-construction abundance (Table 20). The area of riparian vegetation at Indian Creek was lower in 2010 than the first year following construction. Based on the current recovery rate, which is based on only two years of post-construction data, Indian Creek is likely to recover riparian vegetation to pre-construction abundance by 2015 (Appendix F).

6.2.1.6 Lower Dark Gulch

Lower Dark Gulch is located on the left bank just upstream of a pilot bank rehabilitation site (Bucktail) located on the right bank of the mainstem Trinity River. Lower Dark Gulch was constructed in 2008. A total of 152.0 acres was mapped within the ESL. Thirty-three patch types were mapped at Dark Gulch in 2010 (Appendix A). Approximately 23% of the mapped area was riparian biohabitats and 41% was upland biohabitats (Appendix E). Non-native grassland was the most abundant patch type at Dark Gulch in 2010 (Appendix E). Herbaceous patches accounted for approximately 23% of the area mapped in the ESL. Regrowth accounted for approximately 2%, revegetation accounted for approximately 1%, and regeneration accounted for less than 1% (Appendix E).

Following construction, the proportion of biohabitats at Dark Gulch has changed from pre-construction conditions. Upland patch types have decreased in abundance; riparian patch types, open water, and human disturbance have increased slightly. The percent cover of human disturbance has decreased from 14% post-construction to 11% two years post-construction. Although construction occurred only two years ago, riparian vegetation at Dark Gulch has already exceeded pre-construction abundance (Table 20, Appendix F).

6.2.1.7 Sawmill

Sawmill was constructed in 2009, and a total of 102.1 acres was mapped within the ESL. Thirty patch types were mapped at Sawmill in 2010 (Appendix A). Approximately 24% of the mapped area was riparian biohabitats and 41% was upland biohabitats (Appendix E). Open ground was the most abundant patch type at Sawmill in 2010 (Appendix E). Herbaceous patches accounted for approximately 9% of the area. Revegetation accounted for approximately 4%. Regrowth and regeneration were not mapped at Sawmill (Appendix E).

Following construction, the proportion of biohabitats at Sawmill has changed from pre-construction conditions. The amount of open ground increased after construction. Riparian and upland cover decreased. Riparian vegetation has not recovered to pre-construction abundance (Table 20). Since 2010 represented the post-construction mapping, there is not enough information to speculate about the recovery rate of riparian vegetation.

6.2.1.8 Lewiston Four (includes Hoadley Gulch, Lewiston, Deadwood Gulch, and Sven Olbertson)

The Lewiston Four sites, constructed in 2008, had a total of 131.5 acres mapped within the ESL. Thirty-two patch types were mapped at Lewiston Four in 2010 (Appendix A). Approximately 28% of the mapped area was riparian biohabitats and 28% was upland biohabitats (Appendix E). Human disturbance was the most abundant patch type (Appendix E). Herbaceous patch types accounted for approximately 14% of the area mapped in the ESL. Regrowth, regeneration, and revegetation each accounted for less than 1% of the area mapped at the sites (Appendix E).

Following construction, the proportion of biohabitats at the Lewiston Four sites has not changed much from pre-construction conditions. Human disturbance has increased somewhat at the sites mainly due to increased prominence of roads.

Riparian vegetation has not recovered to pre-construction abundance (Table 20). Based on the current rapid recovery rate, the Lewiston Four sites will likely recover riparian vegetation to pre-construction abundance by 2011 at the earliest (Appendix F).

6.2.2 Long Term Response at Five GRTS Panel 2 Sites

Five GRTS Panel 2 sites were randomly located within larger channel rehabilitation sites where historical riparian vegetation mapping and band transect data were available. Long term riparian vegetation responses to site-level designs are summarized below.

6.2.2.1 Long Term Response at Mid-Valdor Gulch

Mid-Valdor Gulch was constructed in 2006. Riparian vegetation was removed from the low water channel edge along much of the site, and several floodplains with various design inundations were constructed. Upstream of the GRTS Panel 2 site, a side channel was constructed and additional vegetation was removed to create a floodplain. The long term response evaluation at Mid-Valdor Gulch was based on data primarily collected from 2008 to 2010, although pre-construction mapping data from 2005 were also used. At parts of the Mid-Valdor Gulch site, riparian vegetation, and especially narrowleaf willow, was regrowing in areas where it was removed during construction. The density of riparian vegetation along the main channel and constructed side channel edges has steadily increased since construction. Riparian vegetation has encroached the low water channel edge at XS 151+80; however, a small point bar is aggrading immediately upstream and downstream of the cross section (i.e., the encroached vegetation occurs on the point bar). Additionally, there appeared to be bank erosion on the opposite (right) bank, and sinuosity throughout the GRTS Panel 2 site may be increasing. Therefore, the encroachment at XS 151+80 was designated non-detrimental rather than detrimental.

At the downstream point bar near XS 141+20, the bar aggraded after the WY 2008 spring ROD release of 195 cms (6,890 cfs; Figure 14). Narrowleaf willow initiation at the channel edge was approximately 0.9 m (3 ft) lower than it was prior to construction (Figure 13), and the predicted 13 cms (450 cfs) water surface was approximately 0.7 m (2.3 ft) lower. Narrowleaf willow regeneration has responded to changes in elevation of water surfaces relative to changes in channel geometry and now grows lower in the channel than prior to construction.

No natural regeneration was seen on upper bars and constructed floodplains at Mid-Valdor Gulch. The upstream constructed floodplain at XS 166+75 transitioned from Oregon goldenaster to non-native grassland to yellow star-thistle grassland and was too vegetated for riparian hardwood seedling initiation and recruitment. Dry water years (e.g. 2007 and 2009) following construction allowed floodplain surfaces to become colonized by non-native and yellow star-thistle grasslands. Channel geometry at XS 151+80 lacked an upper bar/floodplain; therefore no regeneration occurred or should be expected to occur. The floodplain at XS 141+20 retained a fairly open substrate with substantial fine sediments; this is the most likely place for future natural regeneration to occur at Mid-Valdor Gulch. Overall, since 2007, constructed floodplains above 6,000 cfs at Valdor Gulch have had little, if any, woody riparian hardwood regeneration from seeds. In 2008 and 2010 the lack of regeneration was due to the short period of time that floodplains were exposed (~5-7 days).

Streamflow duration and recession rates were inadequate to promote riparian vegetation regeneration on constructed floodplains in 2010. Once floodplains were exposed, the moisture at the ground surface on constructed floodplains was not maintained long enough for seeds to germinate and grow roots that could tie into and follow receding groundwater/soil moisture. Most constructed floodplains were designed to be inundated at 6,000 cfs and were exposed at streamflows of 57 cms to 127 cms (2,000 to 4,500 cfs). Constructed floodplain surfaces were exposed during the receding limb when streamflows were receding at least 3 cm (0.10 ft) per day. Soil surface moisture would not last much longer than five days at the ground surface assuming a 15 cm (0.5 ft) capillary fringe. Based on black cottonwood root growth and seed germination data experiments conducted in the office and the field during WY 2006, it would take 28 days for seedlings to reach 0.5 ft of rooting depth (McBain and Trush, Inc. 2006).

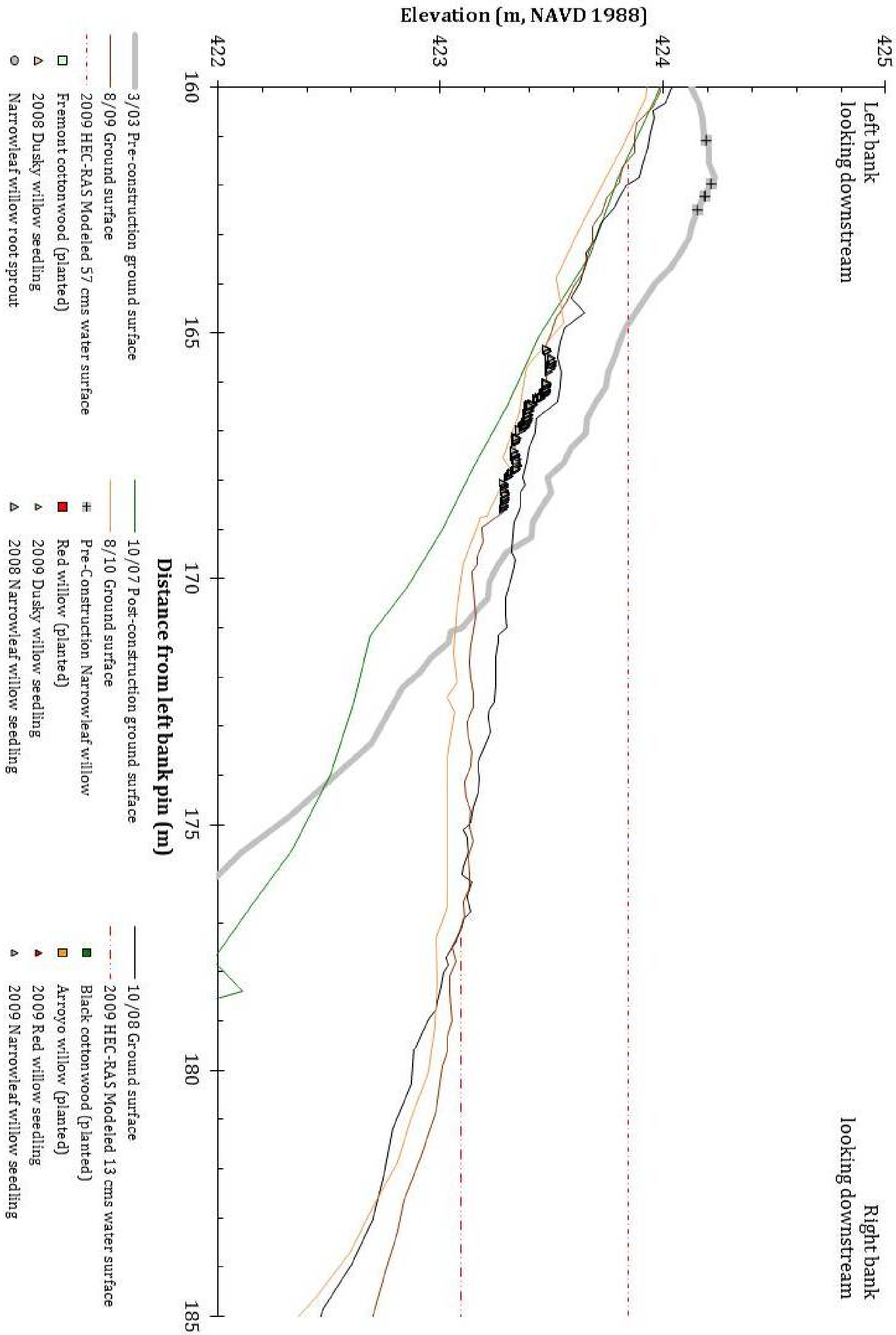


Figure 14. Pre-construction topography and hardwood locations, current (2009) hardwood locations, and aggradation of point bar since 2007 at Mid-Valdor Gulch XS 141+20.

6.2.2.1 Long Term Response at Bell Gulch Pilot Channel Rehabilitation Site

Bell Gulch was a pilot bank rehabilitation site constructed in 1993. Construction involved removing the existing riparian berm down to the historical cobble surface and constructing a "feathered edge." The long term response evaluation at Bell Gulch was based on band transect and cross section surveys conducted as part of the pilot rehabilitation monitoring, as well as WY 2010 band transects and mapping.

Hardwood seedlings initiated in 1996, 1997, 1998, and 2002 but have not been sampled since. Interestingly, the seedlings sampled prior to 2000 were white alder, Oregon ash, or black cottonwood. Beginning in 2002, narrowleaf and dusky willow seedlings were sampled at the site to the exclusion of other species. By 2002, encroachment along the low water edge was documented but had not yet formed a continuous band. By 2010, the encroachment band had become denser, although it is not entirely continuous throughout the site. Hardwoods along the low water edge appear to have encouraged deposition and the berm has re-formed (Figure 15). Because the riparian vegetation inhibits bar surface mobility and encourages fine sediment deposition (leading to berm formation), the encroachment was designated detrimental at XS 641+00.

6.2.2.1 Long Term Response at Lower Indian Creek Channel Rehabilitation Site

Lower Indian Creek was constructed in 2007. Similar to other channel rehabilitation sites, much of the existing riparian vegetation was removed during floodplain construction. A small number of mature female black cottonwood trees were incorporated into the floodplain design to provide seed sources for the new floodplains. A side channel and series of medial bars were also constructed. The long term response at Lower Indian Creek was based on post-construction band transect and mapping data from 2008 to 2010. Based on aerial photographs, white alder dominated the riparian vegetation along the main channel edge prior to construction. The white alder overstory was removed when the side channel was constructed. Much of the understory was cleared, but not removed, so it has been growing back since. Major changes to the riparian vegetation at Indian Creek since construction have resulted from the increased growth and vigor of pre-construction willows (i.e., regrowth). Since site design did not include modifications to the main channel, no berm formation or channel widening was observed at Indian Creek. In addition, no encroachment was observed along the main channel or constructed side channel.

The constructed floodplain and side channel edges at Indian Creek (XS 1157+90 and XS 1171+20) had a large seedling initiation event in 2008, the first growing season following construction (USFWS et al., in preparation). Large numbers of black cottonwood and red willow seedlings were observed, and the germination response was the best of any channel rehabilitation site constructed to date. By October 2008 when the seedlings were sampled, at least 79% of the seedlings growing on floodplains had already died; this is a low estimate because not all dead seedlings were sampled due to time constraints. By 2009, only 6% of the seedlings were still alive and sampled as 1-yr old plants. By 2010, all but one of the remaining seedlings had died. Since most seedlings in 2008 had already died by the time they were sampled, and since sampling occurred prior to WY 2009 winter floods or spring ROD releases, lack of seedling survival was likely due to rapid draw-down rates associated with the fall 2008 ramp down to baseflows rather than scour. However, groundwater investigations were not undertaken at Indian Creek, so the direct cause is unknown.

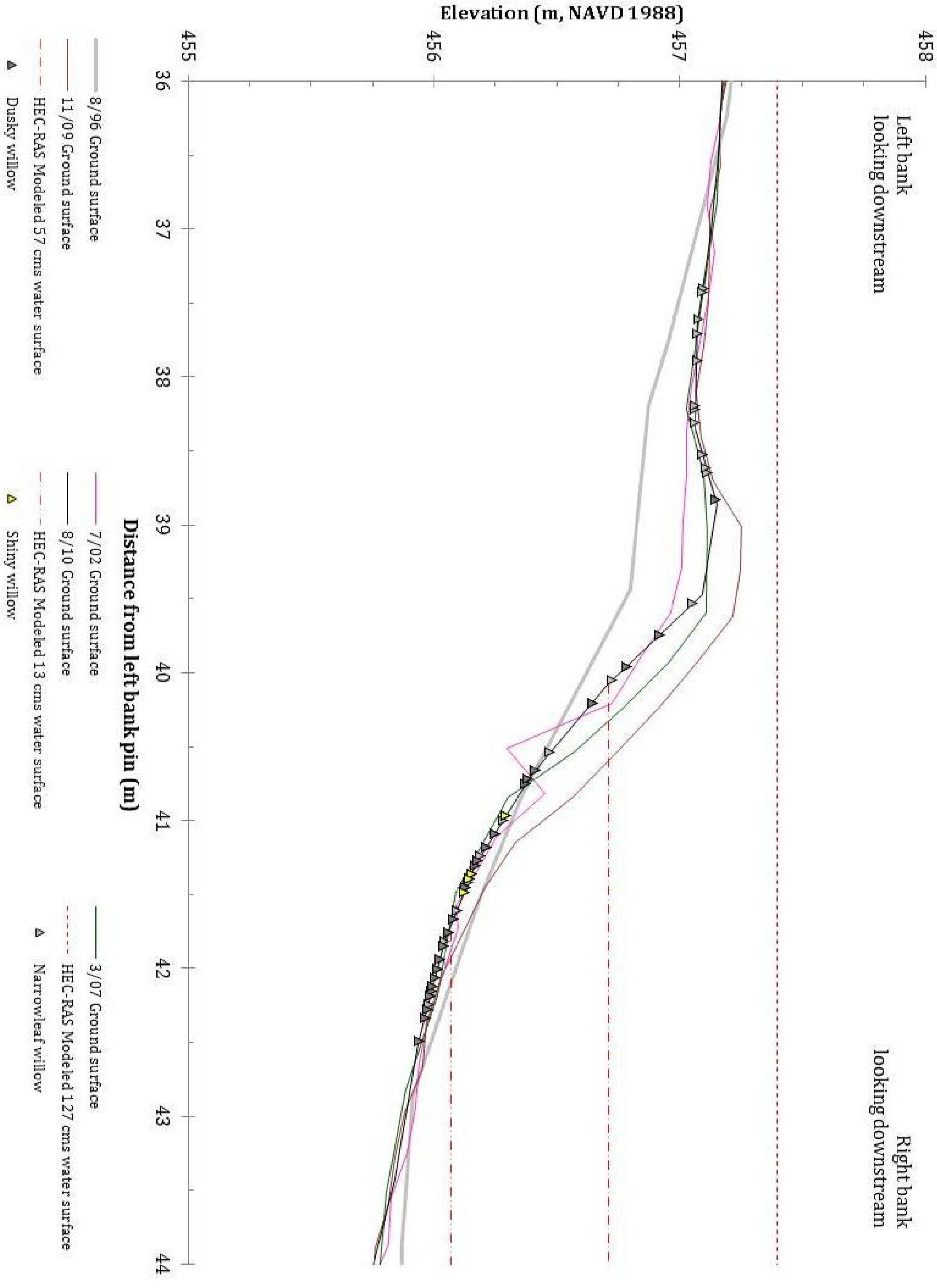


Figure 15. Pre-construction and post-construction topography at Bell Gulch Pilot Channel Rehabilitation Site XS 641+00, as well as re-formation of the riparian berm in relation to current hardwood locations.

The constructed floodplain at Indian Creek also demonstrated a common trend observed at many channel rehabilitation sites: the open constructed floodplains became dominated by white sweetclover the year following construction. The second year following construction, the sweetclover patches evolved into grasslands or Oregon goldenaster patches. Sweetclover is a sun-loving annual/biennial whose seeds are easily water-dispersed. It can re-seed itself at a site if the substrate is open enough. The fact that it did not re-seed itself at Indian Creek suggests that the 2010 spring ROD release of 200 cms (7,070 cfs) at Indian Creek was unable to scour the floodplain surface of existing vegetation to provide adequate seed germination conditions. Future riparian recruitment on these now densely vegetated floodplain surfaces is unlikely.

6.2.2.2 Long Term Response at Lower Dark Gulch Channel Rehabilitation Site

Lower Dark Gulch was constructed in 2008 and extends upstream of the GRTS Panel 2 site. A lateral point bar and several side channels and floodplains were constructed throughout the Lower Dark Gulch site. The long term response evaluation at Lower Dark Gulch was based on post-construction band transects and mapping, as well as some pre-construction transect data from the downstream end of the site. The most notable changes at Lower Dark Gulch occurred at XS 1785+70, including aggradation of the constructed side channel entrance and the rapid regrowth of narrowleaf willow that was removed during construction along the right bank of the main channel (between the main channel and the constructed side channel). The side channel itself was filling in with fine sediments. The side channel edges provided favorable nursery sites for riparian hardwoods and high quality herpetofauna habitat.

6.2.2.3 Long Term Response at Lewiston Cableway Channel Rehabilitation Site

Lewiston Cableway was constructed in 2008 and consisted largely of coarse sediment and alternate bar sequences to mimic and encourage channel migration. The long term response evaluation for two Lewiston Cableway band transects was based on riparian vegetation sampling from 2009 and 2010 and geomorphic monitoring dating back to 2001. The coarse sediment augmentation bar constructed at XS 2012+10 in 2008 did not recruit riparian hardwood seedlings. It scoured approximately 23 cm (0.75 ft) as a result of the WY 2009 spring ROD release (Q = 131 cms [4,630 cfs] at Lewiston). No changes in riparian vegetation were sampled at the Lewiston Cableway sites. No seedlings were observed, probably because the constructed bars were designed as coarse sediment sources and thus lacked the suitable fine particles needed to support riparian hardwood initiation. No encroachment or berm formation was observed on the bar surfaces.

6.2.3 Large Wood Storage

Large wood was mapped in fall 2010 after streamflows had receded to 8.5 cms (300 cfs). Below the 57 cms (2,000 cfs) water surface elevation, 493 large wood pieces were mapped at 11 Panel 2 sites. Lewiston Cableway, a channel rehabilitation site constructed in 2008, had the highest number of wood pieces surveyed (n = 141). Most of the wood surveyed at Lewiston Cableway was located around the side channel and was placed during site construction; therefore, it did not represent naturally recruited pieces. Ed’s Bar had the second highest number of wood pieces (n = 60) surveyed and was located in an unrehabilitated section of river. All of the wood pieces surveyed at Ed’s Bar were naturally recruited and often located close to the bank where they fell in. Wood pieces were often associated with locations where overbank streamflows returned to the main channel, cutting perpendicular across riparian patches and scouring trees, and where they could fall into the mainstem channel. At the two sites with the highest number of pieces surveyed, approximately 70% of the wood pieces measured were in the 20 to 30 cm (8 to 12 in) diameter size class. Where GRTS Panel 2 segments overlapped at four channel rehabilitation sites, higher quantities of wood and larger diameter wood were measured. The data collected at the channel rehabilitation sites overlapping with GRTS segments measured wood that was placed during construction and did not necessarily reflect the wood loading of the mainstem Trinity River in unrehabilitated reaches.

Additional large wood statistics included:

- All sites had wood pieces in the 20 to 61 cm (8 to 24 in) range (Figure 16). Four sites had wood pieces larger than 91 cm (36 in) (Figure 15). Two pieces of wood larger than 122 cm (48 in) were measured at the Lower Indian Creek Channel Rehabilitation Site and presumably were placed during construction (Figure 15).
- Over 95% of the wood measured was smaller than 91 cm (36 in) in diameter (Table 21). The 20 to 30 cm (8 to 12 in) size class of wood was the most frequent and abundant wood making up 63% of the sample (Table 21). Wood larger than 91 cm (36 in) made up 1% of the sample (Table 21).
- White alder was the most abundant type of wood sampled, contributing 35.5% (Figure 17). Willow wood made up 18.7% of the sampled wood pieces (Figure 17). Conifer wood (including Douglas fir, ponderosa pine, and incense cedar) made up 8.2% of the sampled pieces (Figure 17).
- The number of naturally recruited wood pieces at six GRTS panel 2 sites where no channel rehabilitation had occurred by 2010 (55% of the sites monitored) ranged from 2 to 15 pieces per 100 m and averaged 3 pieces per 100 m. The number of pieces surveyed in unrehabilitated sites in 2010 was slightly higher than the number of naturally recruited wood pieces per 100 m reported in the Trinity River Large Wood Analysis and Recommendation Report (i.e., 0 to 5 pieces wood per 100 m and of 2 pieces per 100 m; Cardno ENTRIX and CH2M Hill 2011).
- The number of naturally recruited pieces per 100 m surveyed in 2010 at unrehabilitated sites is far below the 50-60 pieces of wood per 100 m that was recommended in the Trinity River Large Wood Analysis and Recommendation Report, which was based on estimates developed from wood loading quantified on the Cedar, Lower Elwha and Queets rivers (Cardno ENTRIX and CH2M Hill 2011).

6.2.4 Linking Results to Objectives

Band transect data and planform mapping were used in concert with geomorphic monitoring results to evaluate riparian seedling scour, riparian initiation and establishment objectives, and detrimental riparian encroachment objectives (Table 1, Table 10).

6.2.4.1 Riparian Seedling Scour

IAP Objective 5.2.1 includes evaluating whether Normal spring ROD releases and natural tributary-induced flood events are scouring riparian seedlings 1-yr old and younger along the channel edge. Relative scour depths < 1.0 D_{84} (i.e., mobilization of exposed bar surfaces) are hypothesized to remove seedlings <0.50 cm DRC (1-yr and younger; Table 2 Hypothesis A). Since the winter 2010 peak flows were less than the spring 2010 ROD release (187 cms [6,610 cfs]) at all sites (Table 3), this discussion focuses on the spring ROD release as the mechanism driving the riparian results measured at GRTS Panel 2 sites. Although some Panel 2 sites coincided with channel rehabilitation sites, band transects were only monitored at Panel 2 sites in WY 2010; therefore, this discussion does not include channel rehabilitation sites.

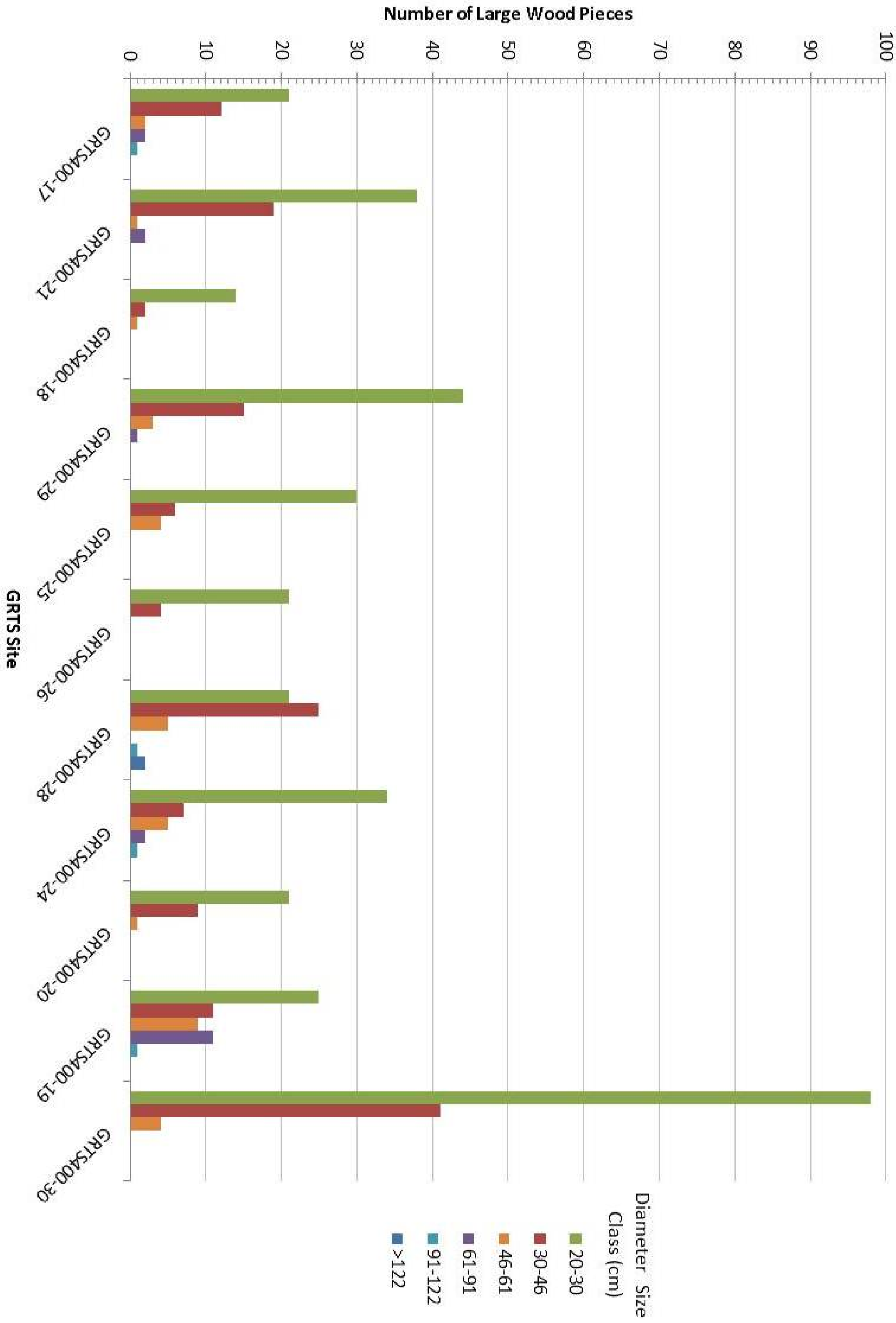


Figure 16. Size class distribution of large wood mapped at 11 GRTS Panel 2 sites in WY 2010 (n=493 pieces).

Table 21. Proportion of large wood sampled within different diameter size classes at 11 GRTS Panel 2 sites in WY 2010 (n=493 pieces).

Diameter Size Class (cm)	Number of Pieces	Proportion
20 to 30 cm	315	63.6%
30 to 46 cm	125	26.2%
46 to 61 cm	33	6.1%
61 to 91 cm	16	3.1%
91 to 122 cm	3	0.7%
>122 cm	1	0.3%

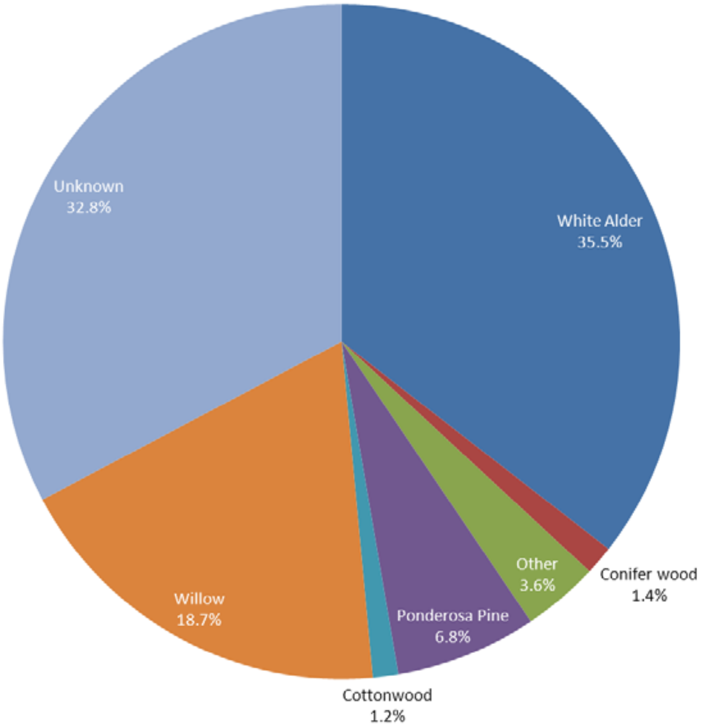


Figure 17. Proportion of large wood mapped at 11 GRTS Panel 2 sites in WY 2010 contributed by species.

The WY 2010 geomorphic monitoring occurred at nine GRTS Panel 2 sites. Bed mobility and scour results were summarized for the “riparian encroachment risk zone” (13 to 57 cms [450 to 2,000 cfs) for those sites with >80% of the marked rock set and for all scour chain within the riparian encroachment risk zone. Only six sites (seven cross sections total) had tracer rock sets that spanned >80% of the riparian encroachment risk zone (Table 8). Results from the subset of monitored cross sections were used to evaluate riparian hardwood responses to the spring ROD release.

Bed mobility and scour were achieved on bar flanks by the WY 2010 spring ROD release (Figure 7). Bed mobility was measured at all six sites (and all seven cross sections) within the riparian encroachment risk zone, with a range of 19% to 88% of the D_{84} tracer rocks mobilized. Bed scour occurred at all nine sites (15 of 16 cross sections). Of the 15 cross sections where scour was achieved, 10 scoured within the riparian encroachment risk zone. The average scour depth was 0.4 D_{84}, with a range of 0.0 to 1.8 D_{84}. No scour was achieved at Roundhouse XS 576+50 or Indian Creek Confluence XS 1224+50. Scour >1.0 D_{84} was achieved at three sites: Mid-Valdor Gulch XS 151+80, where approximately 68% of the riparian hardwoods <0.50 cm DRC (1-yr and younger) were scoured; Roundhouse XS 582+10, where 89% of the riparian hardwoods 1-yr and younger were scoured; and Treadwell Bridge XS 1356+80, where scour data were inconclusive due to data discrepancies. Re-encroachment has already occurred at Mid-Valdor Gulch XS 151+80. Encroachment has occurred at Treadwell Bridge XS 1356+80 and is beginning at Roundhouse XS 582+10 (Table 18). Localized scour depths at a single chain each at Roundhouse and Treadwell Bridge were 1.8 D_{84}, a depth that is almost sufficient to remove riparian hardwood stems 0.76 to 1.0 cm (approximately 3-yr; M&T and HVT 1997, USFWS and HVT 1999, Bair 2001).

Systemically (i.e., across all GRTS Panel 2 sites), 79% of riparian hardwoods <0.50 cm DRC (1-yr and younger) were scoured by the WY 2010 spring ROD release, thus supporting an underlying hypothesis of IAP Objective 5.2.1 (Table 2). As would be expected, plant density decreased as bed mobility increased (Figure 18). Although localized scour depths were more than sufficient to remove riparian hardwoods <0.50 cm DRC (1-yr and younger), scour depths were inconsistent throughout the sampled sites and therefore seedling scour was not achieved uniformly at each site. For instance, at Roundhouse XS 576+50, two scour chains occurred within the riparian encroachment risk zone. One chain showed a relative scour depth of 1.8 D_{84} and the other showed a relative scour depth of 0.2 D_{84}. Spring ROD release flows were sufficient through much of the Project Reach to achieve seedling scour objectives at the low water edge. However, they were not 100% effective to scour all seedlings that established in WY 2010. The surviving seedlings will become a greater encroachment threat as they survive each subsequent year; therefore, the seedling scour objectives for a ROD Normal water year spring release were not entirely met.

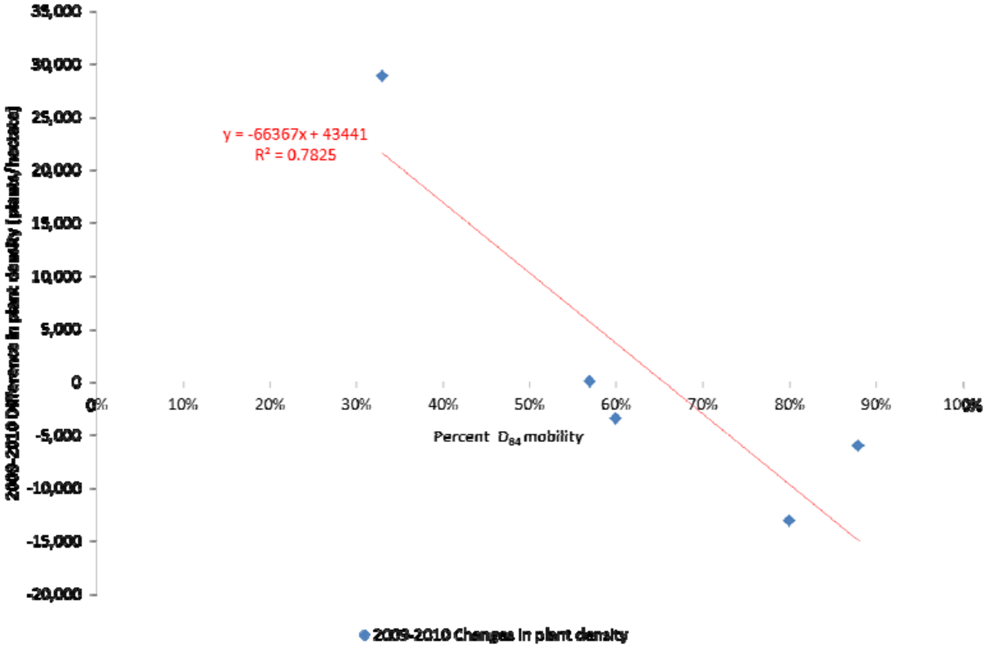


Figure 18. Plant density as a function of bed mobility. Mobility of the D_{84} can result in scour of riparian hardwood seedlings up to 0.50 cm diameter at root collar (DRC), or approximately 1-yr and younger plants.

Scour-induced mortality is not the only mechanism by which <0.5 cm DRC riparian hardwood seedlings may be removed from the Project Reach. Four GRTS Panel 2 sites lacked seedling initiation in either fall 2009 or 2010. Three of the sites were channel rehabilitation sites that included coarse sediment augmentation bars, which had a grain size ranging from 2.5 to 12.7 cm (1 to 5 in – no sand or silts). Indian Creek Confluence, while not a channel rehabilitation site, had an open, coarse-grained medial bar. Grain size and lack of fine sediment at these sites were at least partially responsible for the lack of seedling initiation. Thus, the absence of hardwoods <0.5 cm DRC cannot be directly attributed to scour induced by the spring ROD release but rather large substrate size and lack of suitable seed nursery sites at sites where no seedlings were sampled.

6.2.4.2 Detrimental riparian encroachment, berm development, and channel simplification

IAP Objective 5.2.1 includes evaluating whether Normal spring ROD releases are preventing detrimental riparian encroachment, riparian berm development, and channel simplification. This evaluation includes GRTS Panel 2 and channel rehabilitation sites. Most sites already had detrimental riparian encroachment as a result of the pre-ROD flow regime. Riparian monitoring focused on the remaining exposed bars at the sites.

High densities of <0.5 cm diameter (young-of-year and 1-yr old), 0.75 to 1.0 cm diameter (3-yr old) and >1.0 cm diameter (>3-yr old) hardwoods were measured below 57 cms (2,000 cfs) in fall 2010 (Figure 12). The presence of >1.0 cm DRC (>3-yr old) hardwoods suggests that recent ROD releases (i.e., 2007 = 4,750 cfs, 2008 = 6,470 cfs, 2009 = 4,410 cfs, and 2010 = 6,840 cfs) have not been sufficient to scour the establishing hardwoods in this inundation zone. Since WY 2007 and WY 2009 were classified as Dry water years and WY 2008 was a Normal year, we can infer that a series of Dry water years spaced close together can create conditions in which hardwoods are allowed to reach diameters beyond what is expected to be manageable with Normal water year ROD flow releases (Table 2 Hypothesis D and Hypothesis E).

Four GRTS Panel 2 sites had riparian hardwoods <0.50 cm DRC (1-yr and younger) below 13 cms; interestingly, all four sites were already encroached (Table 18). Seven sites had riparian hardwoods <0.50 cm DRC (1-yr and younger) in the riparian encroachment risk zone (13 to 57 cms [450 to 2,000 cfs]; Table 18). Three sites had riparian hardwoods <0.50 cm DRC (1-yr and younger) above 57 cms (Mid-Valdor Gulch XS 151+80, Junction City Campground XS 286+40, and Treadwell Bridge XS 1356+80; Table 18).

The red-yellow-green evaluation indicated that detrimental riparian encroachment was not currently a problem when considered systemwide (i.e., averaged across all GRTS Panel 2 sites). Of the 13 GRTS Panel 2 cross sections, seven were “green” (not a management concern for WY 2011), one was “yellow” (high risk with a strong need for management in WY 2011 to prevent detrimental encroachment), and five were “gray” (already encroached and thus beyond our ability to manage with streamflows alone). Two of the five gray cross sections had non-detrimental riparian encroachment: Mid-Valdor Gulch XS 151+80, part of a channel rehabilitation site constructed in 2007, and Wheel Gulch XS 195+00, a channel rehabilitation site scheduled for construction in 2011. The encroachment at Mid-Valdor Gulch XS 151+80 resulted from regrowth of remnant roots not removed during construction; however, the stems did not form a continuous band and provided cover considered beneficial to fish habitat. The encroachment at Wheel Gulch XS 195+00 represented pre-construction plant densities, which met the preliminary encroachment thresholds proposed in this report. Three of the gray cross sections had detrimental riparian encroachment: Ed’s Bar XS 516+40, Bell Gulch XS 641+00, and Treadwell Bridge XS 1356+40. Additionally, detrimental riparian encroachment may occur at Roundhouse XS 582+10 if stems in the 0.76 to 1.0 cm DRC size class (3-yr age class) encourage fine sediment deposition, additional stem recruitment via root-sprouts, and berm formation.

6.2.4.3 Initiation and establishment of riparian vegetation on upper bars and floodplains

IAP Objectives 5.1.1 and 5.1.3 include evaluating whether Normal spring ROD releases are promoting riparian initiation and establishment on upper bars and floodplains (Figure 1, Table 10). Seedling data from band transect samples and planform mapping data from GRTS Panel 2 sites were used to evaluate floodplain vegetation. It should be noted that most Panel 2 sites lacked open (i.e., unvegetated) floodplains and therefore initiation and establishment were not expected at many of the sites.

Successful initiation and establishment of riparian hardwood seedlings on surfaces above 57 cms (2,000 cfs) relies on a combination of factors, including seed dispersal period, availability of suitable seed nursery sites (e.g., moist open sites with fine sediments), and accessibility of groundwater to growing roots. During spring ROD releases, high flows should inundate potential seedling initiation sites on upper bars and floodplains. As streamflows recede, moist open surfaces become available for dispersing seeds to colonize. If streamflow recession does not coincide with seed dispersal for a given species, that species will not initiate that year. Once a seed occupies a suitable nursery site, it must have access to groundwater for at least 21 consecutive days in order to survive (HVT et al. 2011). Since riparian hardwood seedling roots can grow up to 0.1 ft/day (Segelquist et al. 1993, Mahoney and Rood 1991, Mahoney and Rood 1998, Amlin and Rood 2002, Stella et al. 2010), streamflow recession rates of 0.1 ft/day or less should allow growing roots adequate access to groundwater. If the receding limb of the hydrograph is too steep, groundwater drops faster than roots can grow and any seedlings that initiated will die.

In WY 2010, interactions between the spring ROD release peak, seed dispersal periods, and streamflow recession rate affected the species and bank locations of initiating riparian hardwoods (Figure 19). The spring ROD release peak measured on May 3, 2010, at Lewiston occurred in the middle of the black cottonwood seed dispersal period (approximately April 25 to June 5). Although streamflows receded fast enough to enable black cottonwood seeds access to nursery sites, the recession rate was too rapid for growing roots to access receding groundwater (Figure 19). The TMC-approved release and the actual ROD Normal release hydrographs had receding limbs that exceeded 0.1 ft/day during the black cottonwood seed dispersal period. The first and only time period where at least 21 consecutive days of streamflow recession did not exceed 0.1 ft/day occurred from approximately June 5 through July 2, totaling 28 consecutive days of root access to groundwater (Figure 19). The lack of coincidence between black cottonwood seed dispersal and sufficient access to groundwater contributed to the lack of black cottonwood initiation on floodplains in WY 2010 (Table 2 Hypotheses D, E, and F). Red willow seed dispersal occurs in the Project Reach from approximately May 1 to June 25; therefore suitable conditions (i.e., availability of nursery sites and adequate streamflow recession rates) were available for about half the red willow dispersal period. Suitable conditions were available for the entire seed dispersal period of narrowleaf willow (Figure 19).

Four riparian hardwood species initiated seedlings in WY 2010: narrowleaf willow, dusky willow, red willow, and arroyo willow. Since the seed dispersal periods and seeding requirements of narrowleaf willow and dusky willow are similar, they will be discussed together and referred to simply as “narrowleaf willow” in the following discussion. Narrowleaf willow was the most frequent and abundant riparian hardwood that initiated in WY 2010, initiating in three inundation zones: <13 cms (<450 cfs), 13 to 57 cms (450 to 2,000 cfs), and 57 to 127 cms (2,000 to 4,500 cfs).

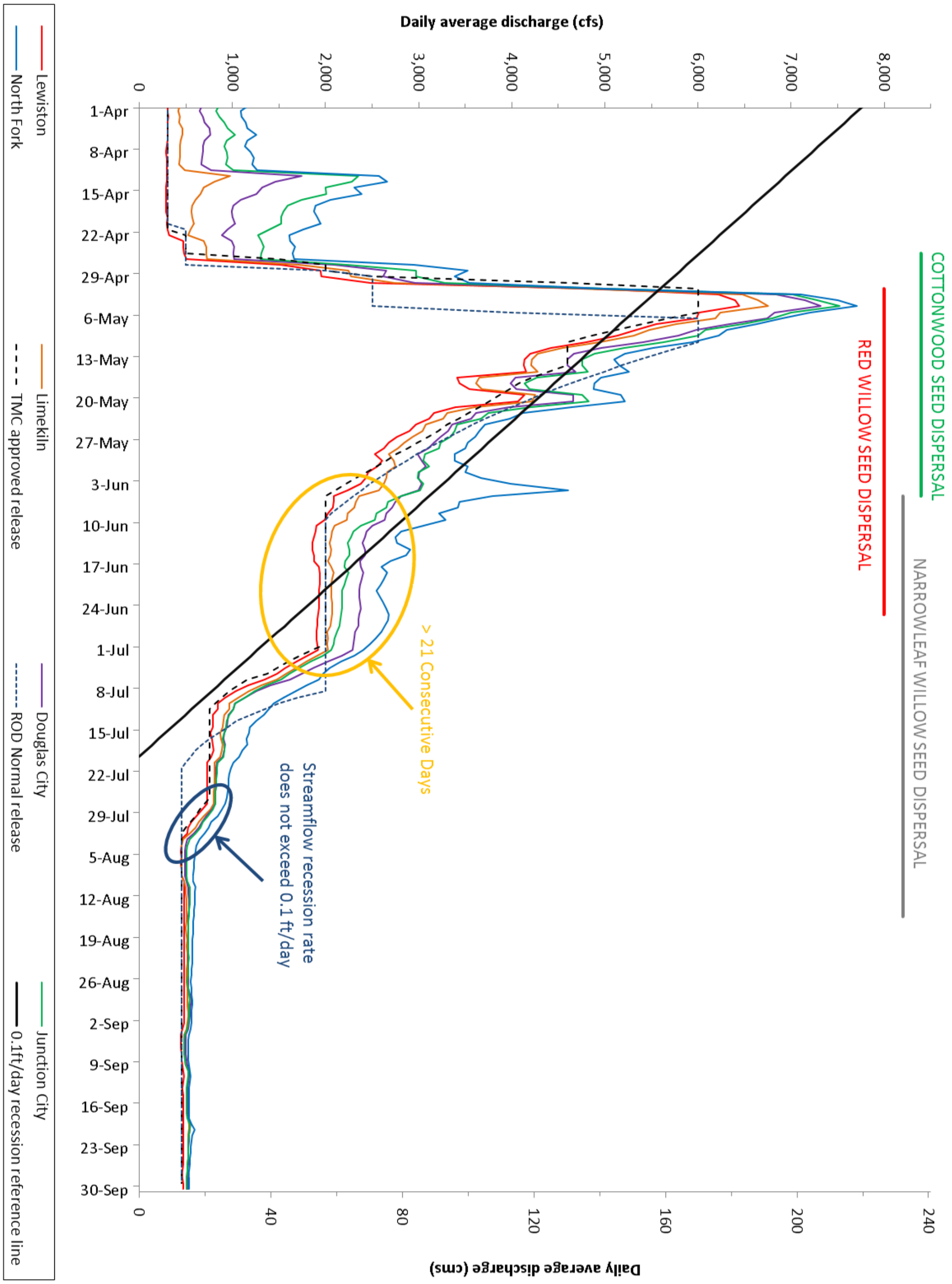


Figure 19. Daily average hydrographs at five gages between Lewiston Dam and the North Fork Trinity River, the recommended ROD release for a Normal water year, and the TMC approved release for WY 2010. Seed dispersal periods for black cottonwood, red willow, and narrowleaf willow are also shown, as are time periods where streamflow recession rates do not exceed 0.1 ft/day for at least 21 consecutive days.

The long seed dispersal period coincident with the late-season access to groundwater and slower streamflow recession rates allowed narrowleaf willow to exploit diverse geomorphic surfaces in the Project Reach. Arroyo willow initiated below 13 cms (450 cfs) at a single band transect (Mid-Valdor Gulch XS 151+80); red willow initiated between 13 and 57 cms (450 and 2,000 cfs) at a single band transect (Lower Indian Creek XS 1157+90).

An additional factor influencing riparian hardwood initiation and establishment on upper bars and floodplains is availability of open sites. Most GRTS Panel 2 sites were unrehabilitated sites where upper bars and floodplains have been disconnected from main channel flows by detrimental riparian encroachment and/or berms resulting from the pre-ROD flow regime. As a result, these upper surfaces were no longer scoured and thus supported dense herbaceous and/or woody vegetation. Riparian hardwood seedlings require open sunny surfaces for germination and establishment (Roe 1958, Bradley and Smith 1986, Young and Young 1992); they should not be expected to grow on vegetated surfaces.

No seedlings were measured on surfaces above 127 cms (4,500 cfs) in 2010. It appears that ROD releases during this Normal water year may not have promoted the initiation and establishment of riparian hardwood seedlings on floodplains. However, due to lack of open sites for seedling initiation, coupled with discrepancies in data collection between 2009 and 2010, it was difficult to draw conclusions about floodplain vegetation. The historical flow conditions that created stable, densely vegetated floodplains (e.g, non-native grasslands) at many of the GRTS Panel 2 sites may be more responsible for the lack of riparian initiation and establishment than any shortcomings in the WY 2010 Normal spring ROD release.

6.2.4.4 Large wood storage

IAP Objective 5.1.2 includes evaluating whether large wood storage in the active channel is increasing and being maintained. GRTS sampling was instituted in 2009 for fish habitat assessments and in 2010 for geomorphic and riparian assessment. Therefore, WY 2010 monitoring represented the baseline large wood storage to which future samplings will be compared. It is still too early to evaluate the underlying hypotheses relating to large wood for IAP Objective 5.1.2 (Table 2). This IAP objective will be evaluated starting in WY 2011, when GRTS Panel 2 sites are revisited. Previous large wood surveys focused on placed wood at channel rehabilitation sites; therefore, they cannot be compared to WY 2010 large wood data because the methodology changed and thus the data are not comparable.

7 GEOMORPHIC MAPPING

Geomorphic feature mapping was conducted at 11 GRTS Panel 2 sites to support GRTS-based fish habitat assessments conducted by the Fish Habitat Team. Geomorphic features were mapped at each site to be incorporated with fish habitat modeling efforts as a means to help understand and predict spawning and rearing habitat preferences. This section describes mapping methods only; analyses and results will be included in a forthcoming fish habitat assessment report.

Mapping features were developed following previous Trinity River geomorphic mapping work (M&T 2003) in conjunction with multi-disciplinary review and input by TRRP scientists. Geomorphic mapping unit delineations, mapping convention, and symbology are provided in Appendix G.

Mapping was performed on enlarged aerial photograph base maps at a 1:600 scale. The mapping limits extended up- and downstream of the GRTS panel to ensure map units were not left open-ended (i.e., the mapping unit boundary was closed, or its distance upstream or downstream from the GRTS panel boundary noted so unit areas could be calculated). Following the field mapping, maps were digitized and geomorphic unit areas were computed.

8 SUMMARY AND RECOMMENDATIONS

The IAP identifies priority assessments and programmatic objectives necessary to evaluate the effectiveness of the restoration efforts (management actions) in meeting intended objectives, as well as evaluating the overall effectiveness of the restoration strategy in meeting Program goals. Hypotheses associated with the objectives were defined in the IAP (Table 2). There are limitations to our ability to "test" the stated hypotheses, including: (1) by 2010 there had been six years of ROD streamflows and the number of channel forming flows has been insufficient to evaluate the stated hypothesis, (2) many of the hypotheses require more than one year of data to evaluate; (3) many sites have been sampled only once; and (4) WY 2010 monitoring results will provide baseline data from which the stated hypotheses can be evaluated after sites are revisited as a part of planned future monitoring efforts.

Water Year 2010 was classified as Normal. Geomorphic and riparian monitoring was performed to evaluate cause-and-effect relationships between physical (geomorphic) and riparian processes. Accordingly, WY 2010 geomorphic and riparian monitoring followed systemic (GRTS) sampling and channel rehabilitation site-specific sampling strategies. Results from each investigation are summarized below with respect to the year-specific management objectives; a longer-term, systemic evaluation will come at a later date once multiple years of data have been collected.

8.1 Geomorphic Monitoring Summary

Two geomorphic IAP Assessments were identified for this study: IAP Assessment 6P (monitor bed mobility and bed scour thresholds), and IAP Assessment 12P (assess design performance of specific design features). For these assessments, WY 2010 geomorphic monitoring was performed to measure changes resulting from winter 2010 peak flows and from the spring 2010 ROD release. Geomorphic monitoring was performed at 10 GRTS Panel 2 sites to measure cross section topography, bed mobility, and bed scour (topography was monitored at 10 sites, bed mobility and scour at nine). Results were used to evaluate systemic and site-specific bed mobility and bed scour objectives. Four Panel 2 sites fell within the limits of larger channel rehabilitation sites; at these locations, geomorphic monitoring results were also used to help evaluate site-level design performance objectives. WY 2010 cross section topography, bed mobility, and bed scour monitoring results included:

- Topographic survey results showed large-scale geomorphic changes, such as new bar formation, lateral migration, or floodplain aggradation did not occur at most of the Panel 2 monitoring sites as a result of the 2010 flows. Of the 20 cross sections monitored, seven did show notable changes: Mid-Valdor Gulch XS 141+20 (lateral migration), Roundhouse XS 582+10 (channel narrowing), Bell Gulch XS 630+20 (point bar downstream migration), Lower Indian Creek XS 1157+90 (side channel widening by constructed bank erosion), Indian Creek Confluence XS 1224+50 (channel migration and bank erosion), Treadwell Bridge XS 1348+40 (medial bar growth); and Lower Dark Gulch XS 1785+70 (mainstem channel aggradation and side channel filling).
- Bed mobility monitoring results showed that for the winter 2010 peak flow, bed mobility of monitored alluvial features increased with distance downstream as flow magnitude increased from tributary accretion (a similar trend was reported for WY 2009 monitoring). Results showed a notable decrease in mobility from Lower Dark Gulch to Lower Indian

Creek, where winter peak flows ranged from 13 to 52 cms (452 to 1,850 cfs) compared with mobility results from Bell Gulch to Mid-Valdor Gulch, where winter peak flows ranged from 114 to 121 cms (4,020 to 4,280 cfs). These results suggested a bed surface mobilization flow threshold occurred between approximately 57 and 113 cms (2,000 and 4,000 cfs). In contrast to the winter 2010 results, the spring 2010 ROD release flows were sufficient to mobilize the bed at all sites. The bed surface was partially to fully mobilized at all monitoring sites, and the range of mobility was reasonably consistent between upstream and downstream sites.

- Bed mobility results were also summarized for the portion of each cross section within the 13 to 57 cms (450 to 2,000 cfs) "riparian encroachment risk zone," the part of the cross section at greatest risk for future detrimental riparian encroachment. This evaluation was conducted at seven cross sections where at least 80% of the bed mobility experiment fell within the 13 to 57 cms elevation range. For the winter 2010 peak, only two sites had partial mobility in the riparian encroachment risk zone, and most bed mobility occurred within the low-flow wetted channel (<13 cms). The 2010 spring ROD release resulted in greater bed mobility in the detrimental riparian encroachment risk zone, where flows partially to fully mobilized the bed at all seven sites evaluated.
- Bed scour results for the 2010 winter peak were similar to the winter 2010 bed mobility results. Measured scour depths suggested minor bed material reworking (most relative scour depths were $< 1.0\ D_{84}$), supporting our observation that a flow threshold between 57 and 113 cms (2,000 and 4,000 cfs) initiated some bed material reworking beyond simply mobilizing the bed surface. Spring 2010 scour results were also similar to the spring 2010 bed mobility results, showing that scour was measured at all monitoring sites, with relative scour depths ≥ 1.0 at six of the nine sites where scour monitoring was conducted. Although the range of scour resulting from the spring 2010 release was consistent between upstream and downstream sites, scour patterns along the cross section were variable. Deposition recorded by the scour chains showed that maximum deposition was not related to maximum scour.
- Bed scour results were also narrowed to describe bed scour within the 13 to 57 cms (450 to 2,000 cfs) riparian encroachment risk zone. Scour from the 2010 winter peak in this zone was only measured at two sites, suggesting most bed material reworking described above may be occurring below the 13 cms elevation. The spring 2010 ROD release resulted in greater scour depths, with at least half of the scour chains in the detrimental riparian encroachment risk zone recording scour ≥ 0.1 D84 and two chains recording scour ≥ 1.0 D84.

In evaluating Assessment 6P, results showed that overall, the bed mobility and scour objective was largely met for the spring ROD release. Partial to complete bed mobility was documented at all GRTS Panel 2 sites monitored, therefore suggesting the WY 2010 Normal water year ROD release was largely successful in meeting TRFE bed mobility management objectives by mobilizing the bed on most of the alluvial features monitored. Bed scour monitoring, however, showed variable results along the monitoring cross sections. Despite some scour chains recording scour depths that met TRFE objectives (relative scour depths $\geq 1.0\ D_{84}$), variable scour depths and patterns across monitoring cross sections, as well as measured deposition that did not correlate well with the measured scour, suggested the 2010 spring ROD release did not fully meet the TRFE Normal water year bed scour objective.

Assessment 12P was conducted at four channel rehabilitation sites using results of data collection at the GRTS Panel 2 sites (Assessment 6P). In most cases, evaluating specific design performance objectives was limited because monitoring tasks were not designed to comprehensively address these specific objectives. For example, IAP Objective 1.1.2 is to increase channel thalweg sinuosity, which is informed by cross section monitoring, but a more thorough assessment would require channel topography to be surveyed over a length of channel. Results suggest that channel rehabilitation site objectives were partially met in WY 2010.

Because the current monitoring methodology limits our ability to evaluate IAP objectives, additional data collection beyond that currently used at GRTS sites for both systemic and site-specific sampling will be needed for a better evaluation of the IAP objectives. We make the following recommendations:

- Modify monitoring methods at GRTS sites to better quantify changes in channel width/geometry and geomorphic features within the wetted channel (including sinuosity, radius of curvature, thalweg crossings, controls, length of edge). Cross section-based monitoring should still be used to monitor bed mobility and bed scour (Assessment 6P), but additional surveying such as thalweg profile and location (using a Total Station), and/or reviewing site aerial photographs, would help better evaluate changes in site topographic, planform, and geomorphic unit diversity.
- Monitor channel rehabilitation sites differently than the GRTS sites to use planform mapping instead of monitoring on two cross sections. Mapping in the channel and across constructed surfaces will provide substantially better information to quantify changes in channel width/geometry and geomorphic features within the wetted channel (including sinuosity, radius of curvature, thalweg crossings, controls, length of edge) and provide better information to help evaluate design performance (Assessment 12P).

8.2 Riparian Monitoring Summary

Three riparian IAP Assessments were identified for this study: IAP Assessment 1R (map and quantify changes in riparian floodplain vegetation), IAP Assessment 3R (map and quantify the state of near-channel riparian vegetation), and IAP Assessment 4R (monitor plant-induced berm growth within the active channel (13 to 57 cms [450 to 2,000 cfs] inundation zone). For these assessments, WY 2010 riparian assessments measured riparian hardwood responses to winter 2010 peak flows and the spring 2010 Normal ROD release. Riparian vegetation mapping was performed at 11 GRTS Panel 2 sites and 12 channel rehabilitation sites to describe site vegetation and to document changes in area of near channel and floodplain vegetation. Riparian band transects were performed at 11 GRTS Panel 2 sites to quantify changes in riparian hardwood density and plant species composition of patch types in response to WY 2010 flows. Results were used to evaluate systemic riparian seedling scour and riparian seedling establishment objectives. Five Panel 2 sites fell within the limits of larger channel rehabilitation sites; at these locations, riparian monitoring results were also used to describe the long-term response of riparian vegetation to physical channel modifications.

A Normal water year ROD release is expected to transport sediment at a rate equal to or greater than input from tributaries and achieve mobility of alluvial features, thereby scouring riparian hardwoods 1-yr and younger. It should also induce fine sediment deposition on upper bars and floodplains to create seedbeds for germinating riparian hardwoods. The receding limb should promote riparian hardwood initiation on these new seedbeds by providing adequate soil moisture on the surface and a drawdown rate that does not exceed root growth of initiating hardwoods. The spring 2010 Normal ROD release largely achieved the seedling scour objective but did not appear to achieve the seedling initiation and establishment on floodplains objective.

A summary of WY 2010 results of riparian floodplain vegetation, near-channel vegetation, and plant-induced berm growth within the active channel included:

- Mixed willow was the most frequent patch type mapped above 57 cms (2,000 cfs). Riparian patch types are the most frequent biohabitats above 57 cms (2,000 cfs), with mixed willow being the most frequent of the riparian patches. However, riparian patch types are not the most abundant above 57 cms (2,000 cfs). Drier upland patch types, especially non-native grassland, account for more area above 57 cms (2,000 cfs). The mapping results indicated that the systemwide diversity of riparian vegetation in the Project Reach is high, but much of that diversity exists in very small, unique patch types. Changes in patch type frequency and abundance resulting from the WY 2010 flows were not detected in our mapping results.
- All hardwoods sampled above 127 cms (4,500 cfs) were >1.0 cm DRC (>3-yr). Riparian hardwoods less than 0.50 cm DRC (1-yr and younger) were not observed on surfaces between 57 and 127 cms (2,000 and 4,500 cfs), with the exception of Mid-Valdor Gulch XS 151+80, Junction City Campground XS 286+40, and Treadwell Bridge XS 1356+80. Most GRTS Panel 2 sites that have not been rehabilitated lacked open, unvegetated surfaces within the 57 to 127 cms (2,000 to 4,500 cfs) inundation zone, and therefore riparian seedling recruitment on these surfaces was not systemically widespread. In addition, the timing of spring ROD releases and seed dispersal periods, combined with streamflow recession rates that allow adequate groundwater access to growing roots (i.e., ≤0.1 ft/day) inhibited the successful initiation and establishment of riparian hardwoods on surfaces above 57 cms (2,000 cfs).
- In WY 2010, the interaction between the spring ROD release peak, seed dispersal periods, and streamflow recession rate affected the species and bank locations of initiating riparian hardwoods. The lack of coincidence between black cottonwood seed dispersal and sufficient access to groundwater contributed to the lack of black cottonwood initiation on upper bars and floodplains in WY 2010. Narrowleaf willow was the most frequent and abundant riparian hardwood that initiated in WY 2010. It initiated in three inundation zones: < 13 cms (<450 cfs), 13 to 57 cms (450 to 2,000 cfs), and 57 to 127 cms (2,000 to 4,500 cfs). The long seed dispersal period coincident with the late-season access to groundwater and slower streamflow recession rates allowed narrowleaf willow to exploit diverse geomorphic surfaces in the Project Reach.
- Mixed willow, open ground, and white alder were the most frequent and abundant patch types mapped below 57 cms (2,000 cfs). Riparian patch types were more frequent and abundant below 57 cms (2,000 cfs) than upland patch types.
- Surfaces between 8.5 and 13 cms (300 to 450 cfs) had the highest density of riparian hardwoods less than 0.5 cm DRC (young-of-year and 1-yr old seedlings), as well as the highest density of riparian hardwoods between 0.75 and 1.0 cm DRC (3-yr old). Approximately 79% of the hardwoods <0.25 cm DRC (young-of-year seedlings) measured in 2009 were scoured by the ROD Normal spring release, with a range of 10% scoured (Junction City XS 286+40) to 97% scoured (Lower Indian Creek XS 1157+90).
- As the geomorphic results showed, the winter 2010 peak and spring ROD release flows were able to mobilize and scour the channelbed to various degrees within the 13 to 57 cms

(450 to 2,000 cfs) “riparian encroachment risk zone.” Plant density decreased as bed mobility increased. Scour depths sufficient to remove hardwoods ≤0.50 cm DRC (1-yr and younger) were measured at three cross sections (Mid-Valdor Gulch XS 151+80, Roundhouse XS 582+10, and Treadwell Bridge XS 1356+80). Although localized scour depths were more than sufficient to remove riparian hardwoods <0.50 cm DRC (1-yr and younger), scour depths were inconsistent throughout the sampled sites and therefore seedling scour was not achieved uniformly at each site. Spring ROD release flows were sufficient through much of the Project Reach to achieve seedling scour objectives at the low water edge. However, they were not 100% effective to scour all seedlings that established in WY 2010. The surviving seedlings will become a greater encroachment threat as they survive each subsequent year; therefore, the seedling scour objective for a ROD Normal water year spring release was not entirely met.

- Large wood mapping was conducted to establish baseline conditions of large wood storage upon which to compare future large wood storage data. Four hundred ninety-three large wood pieces were mapped below 57 cms (2,000 cfs) at GRTS Panel 2 sites. The 20 to 30 cm (8 to 12 in) diameter size class was the most abundant. Over 95% of the wood sampled was less than 91 cm (36 in) diameter. White alder was the most abundant species of large wood mapped. Conifer wood (including Douglas fir, ponderosa pine, and incense cedar) made up 8.2% of the sampled pieces. The number of naturally recruited wood pieces at six GRTS panel 2 sites where no channel rehabilitation had occurred by 2010 (55% of the sites monitored) ranged from 2 to 15 pieces per 100 m and averaged 3 pieces per 100 m.
- The red-yellow-green evaluation indicated that detrimental riparian encroachment was not currently a problem when considered systemwide (i.e., averaged across all GRTS Panel 2 sites). Detrimental riparian encroachment was present at three Panel 2 sites: Ed’s Bar XS 516+40 (a proposed Phase II channel rehabilitation site), Bell Gulch XS 641+00 (a pilot channel rehabilitation site), and Treadwell Bridge XS 1356+40. Detrimental riparian encroachment may occur at Roundhouse XS 582+10 (a proposed Phase II channel rehabilitation site) if stems in the 0.76 to 1.0 cm DRC size class (3-yr age class) encourage fine sediment deposition, additional stem recruitment via root-sprouts, and berm formation. Non-detrimental riparian encroachment was present at two Panel 2 sites: Mid-Valdor Gulch XS 151+80 (a channel rehabilitation site constructed in 2007) and Wheel Gulch XS 195+00 (a channel rehabilitation site scheduled for construction in 2011).

The long term response at five GRTS Panel 2 sites that occurred within the larger ESL of channel rehabilitation sites was evaluated. At Lewiston Cableway, no changes in riparian vegetation were observed. The riparian vegetation at Lower Dark Gulch XS 1785+70 was regrowing in a pattern similar to pre-construction conditions; the side channel entrance was filling in with fine sediments and the former narrowleaf willow thicket that was removed during construction was rapidly re-growing along the side channel edges. The constructed floodplain at Lower Indian Creek (XS 1157+90) had a large seedling initiation event in 2008 following construction; however, the majority did not survive through the first growing season, and only one hardwood may have survived from the 2008 seedling initiation event. The riparian berm at Bell Gulch XS 641+00 was removed during construction of the pilot channel rehabilitation site in 1993. When revisited in 2009, the berm had re-formed and detrimental riparian encroachment had occurred at the site. At Mid-Valdor Gulch, a large point bar has aggraded near XS 141+20; the elevation at which riparian hardwoods currently initiate on the point bar was approximately 0.9 m lower than pre-construction. A small point bar was aggrading near XS 151+80, although the riparian vegetation has encroached the low water edge on the cross section. Because the bar was aggrading and there was evidence of some channel migration on the opposite bank, with a subsequent increase in sinuosity, the riparian vegetation initiating at XS 151+80 was considered non-detrimental.

Based on results of riparian monitoring, the following are recommended:

- Map only once each water year, following the spring ROD release and after flows have returned to summer baseflow conditions.
- The prevalence and increase of roads in the riparian zone and potential effects needs to be addressed.
- Based on the red-yellow-green evaluation, active bars at most of the 11 GRTS Panel 2 sites are either “green” (no modification of the hydrograph is needed to manage riparian hardwood density) or “gray” (riparian hardwood densities have increased beyond our ability to manage them with streamflows alone). One exception is Roundhouse XS 582+10, which is “yellow” (high risk for detrimental riparian encroachment; subtle changes to the WY 2011 spring ROD release may be necessary to manage and reduce stem densities). Potential changes to the hydrograph should be evaluated to determine whether stem densities at Roundhouse XS 582+10 can be managed within the parameters of the water year type. Since Roundhouse is a proposed Phase II channel rehabilitation site, stem densities may also be managed via removal during construction; however, as an untreated site, Roundhouse provides an opportunity to adaptively manage vegetation via streamflows prior to construction.
- The preliminary riparian encroachment thresholds developed from data collected at one pilot bank rehabilitation site during the 1990’s could be improved by the addition of more data from cross sections where encroachment was documented during that same time period. Future riparian monitoring should be scoped to include review of existing monitoring data for sites where berm formation and/or detrimental riparian encroachment were documented. Measured plant densities at the site(s) should be used to improve the riparian encroachment thresholds presented in this report.
- Streamflow duration and recession rates were inadequate to promote riparian vegetation regeneration on constructed floodplains in 2010. Once floodplains were exposed, the moisture at the ground surface on constructed floodplains was not maintained long enough for seeds to germinate and grow roots that could tie into and follow receding groundwater/soil moisture. It is recommended that streamflow magnitudes and duration that achieve approximately 28 consecutive days where recession rates do not exceed 3 cm (0.1 ft) per day be targeted for promoting floodplain regeneration.

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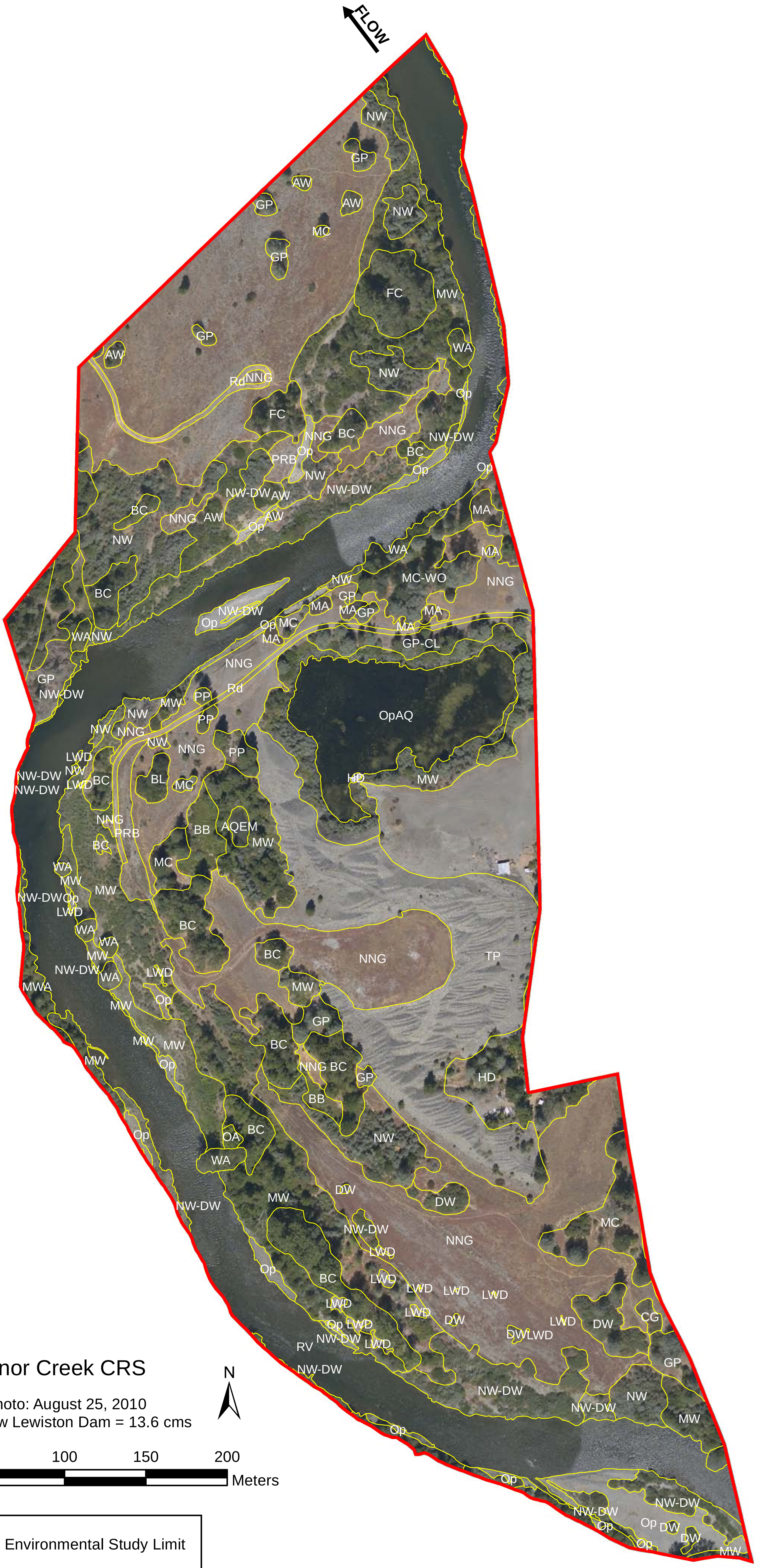
Appendix A. Site Maps of 12 GRTS Panel 2 and 12 Channel Rehabilitation Sites Sampled in WY 2010.

Bucktail/Dark Gulch CRS

Date of Photo: August 25, 2010
Flow below Lewiston Dam = 13.6 cms



Connor Creek CRS

Date of Photo: August 25, 2010
Flow below Lewiston Dam = 13.6 cms

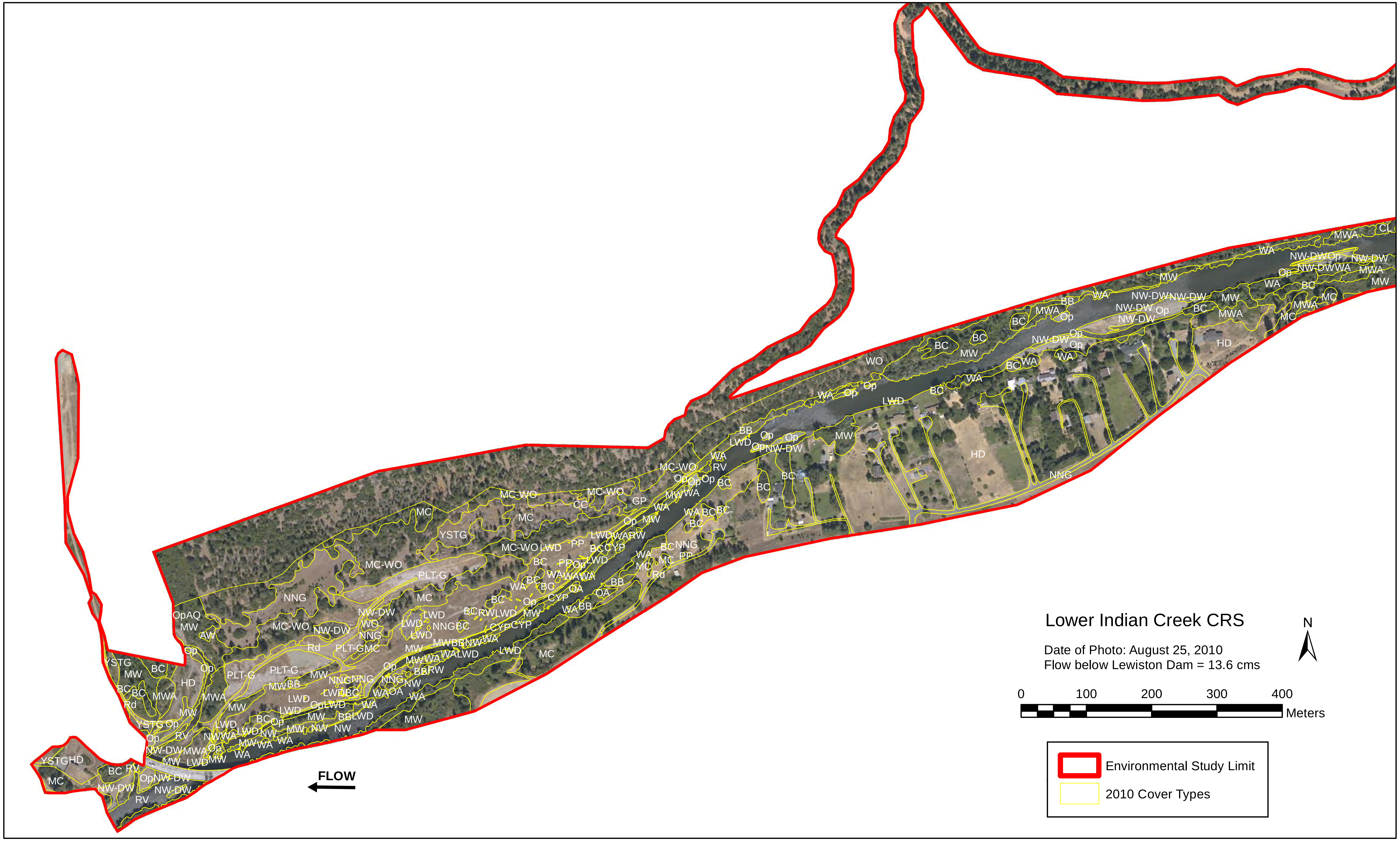
0 50 100 150 200
Meters

🟥	Environmental Study Limit
☐	2010 Cover Types

Hocker Flat CRS

Date of Photo: August 25, 2010
Flow below Lewiston Dam = 13.6 cms

Environmental Study Limit
2010 Cover Types

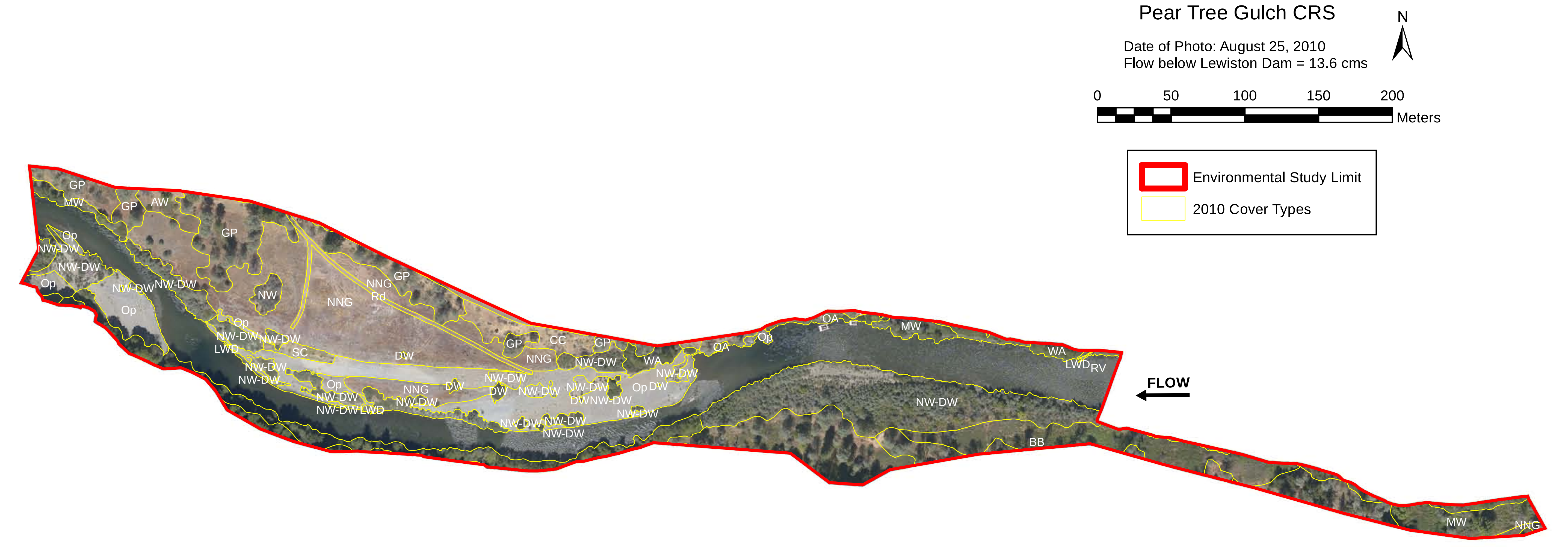


Lower Indian Creek CRS

Date of Photo: August 25, 2010
Flow below Lewiston Dam = 13.6 cms

Lewiston Four CRS

Date of Photo: August 25, 2010
Flow below Lewiston Dam = 13.6 cms



Pear Tree Gulch CRS

Date of Photo: August 25, 2010
Flow below Lewiston Dam = 13.6 cms

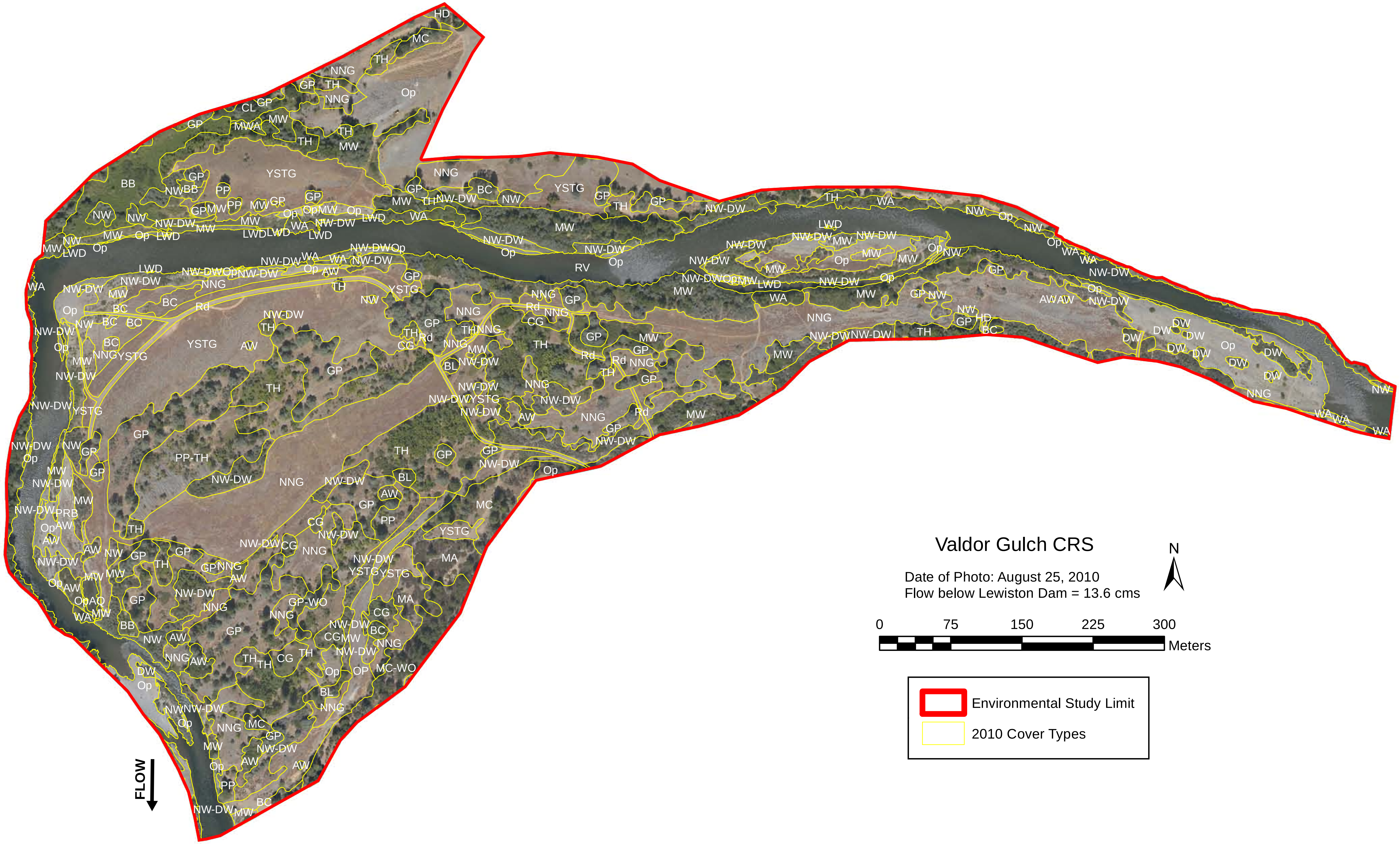
Sawmill CRS

Date of Photo: August 25, 2010
Flow below Lewiston Dam = 13.6 cms

N

0 60 120 180 240
Meters

🟥 Environmental Study Limit
▢ 2010 Cover Types



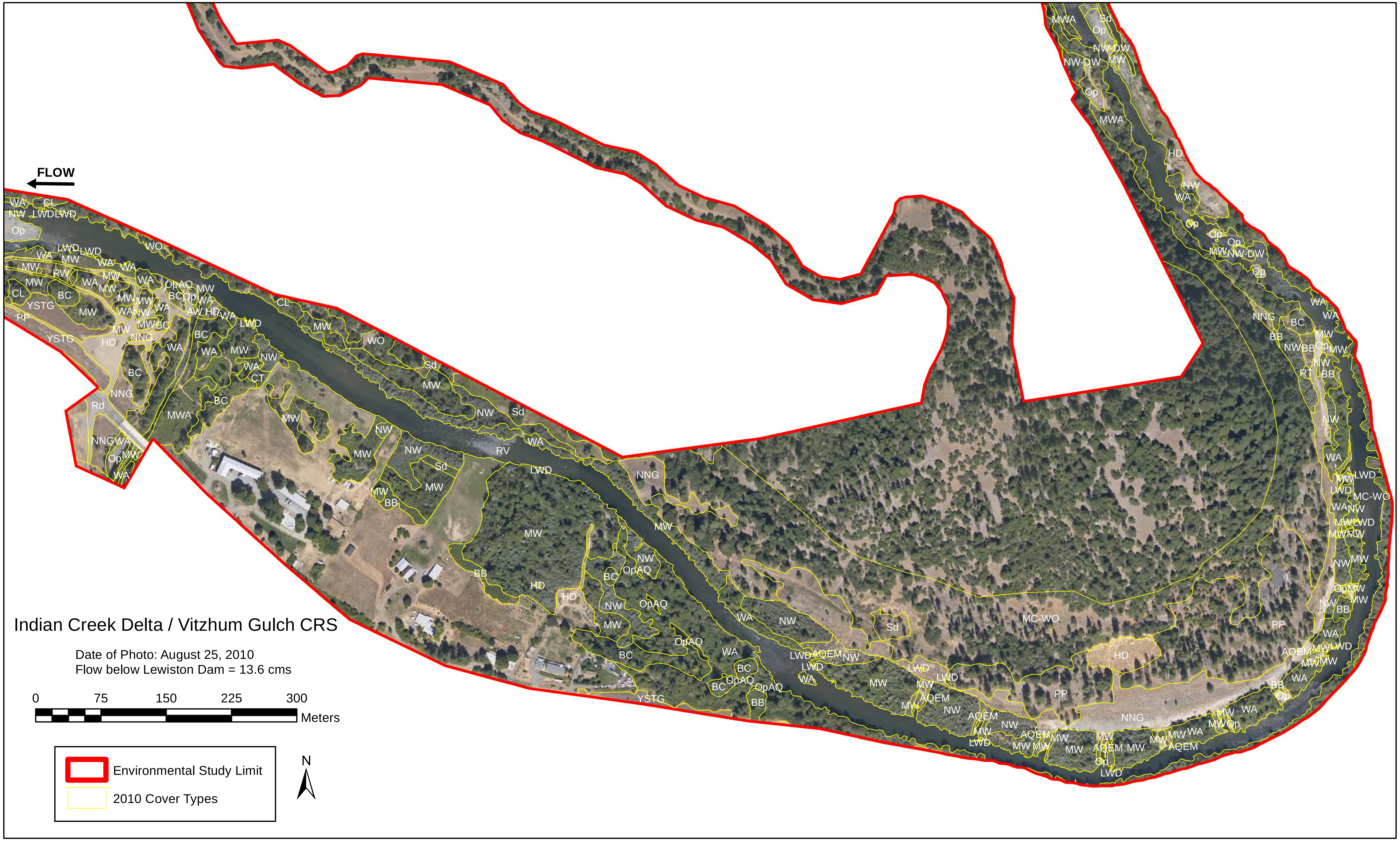
Valdor Gulch CRS

Date of Photo: August 25, 2010
Flow below Lewiston Dam = 13.6 cms

N

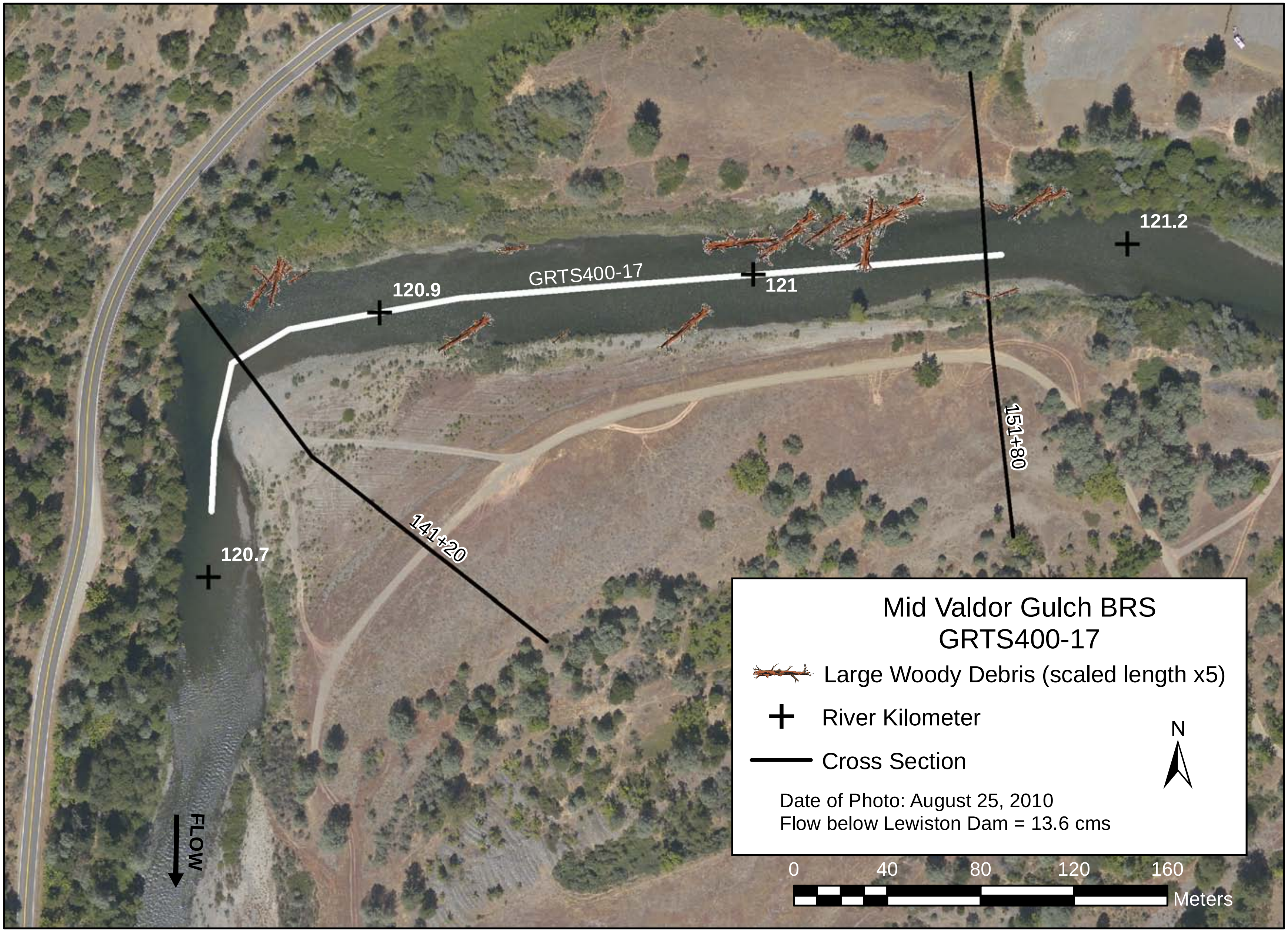
0 75 150 225 300
Meters

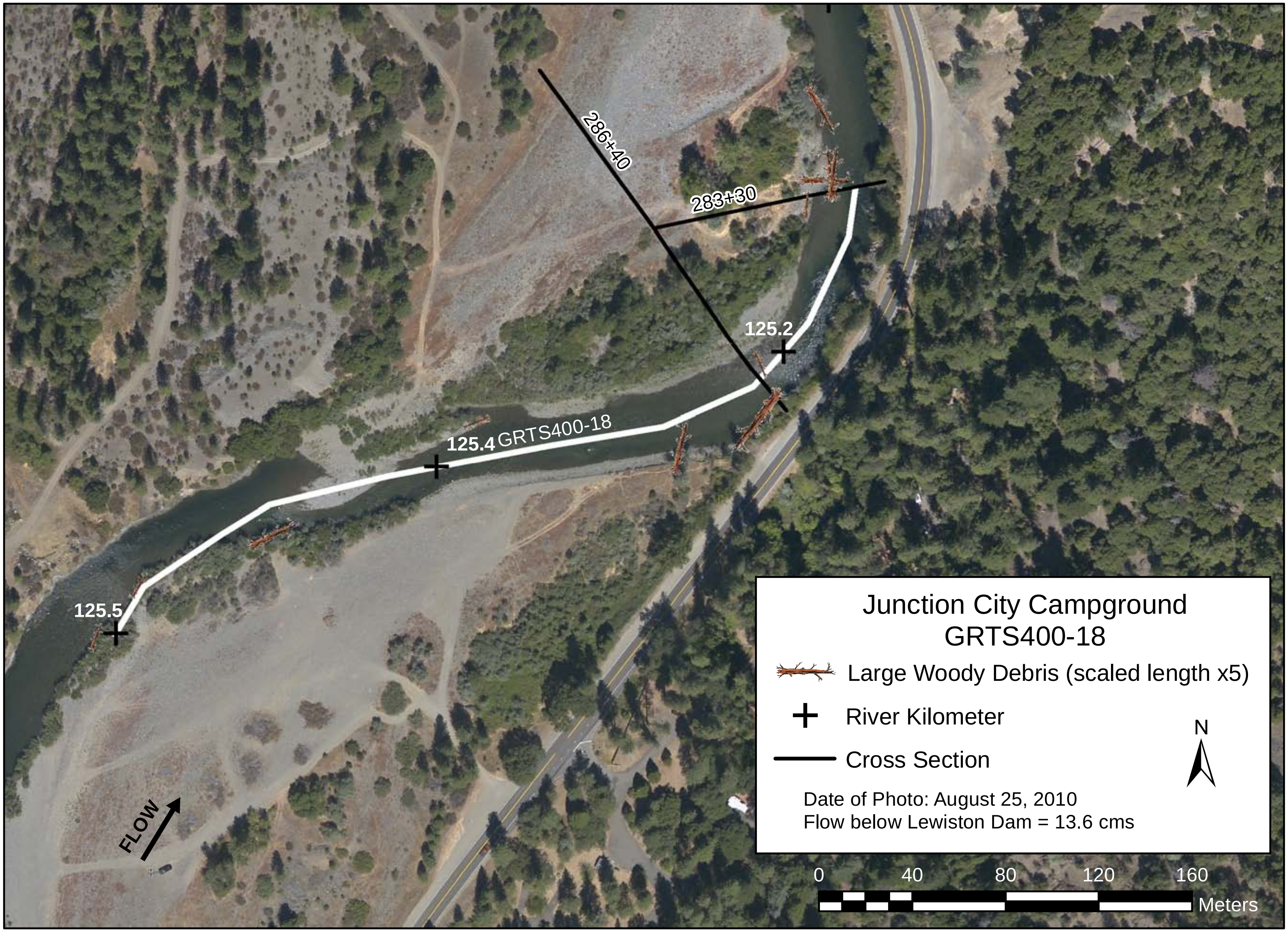
🟥 Environmental Study Limit
▭ 2010 Cover Types



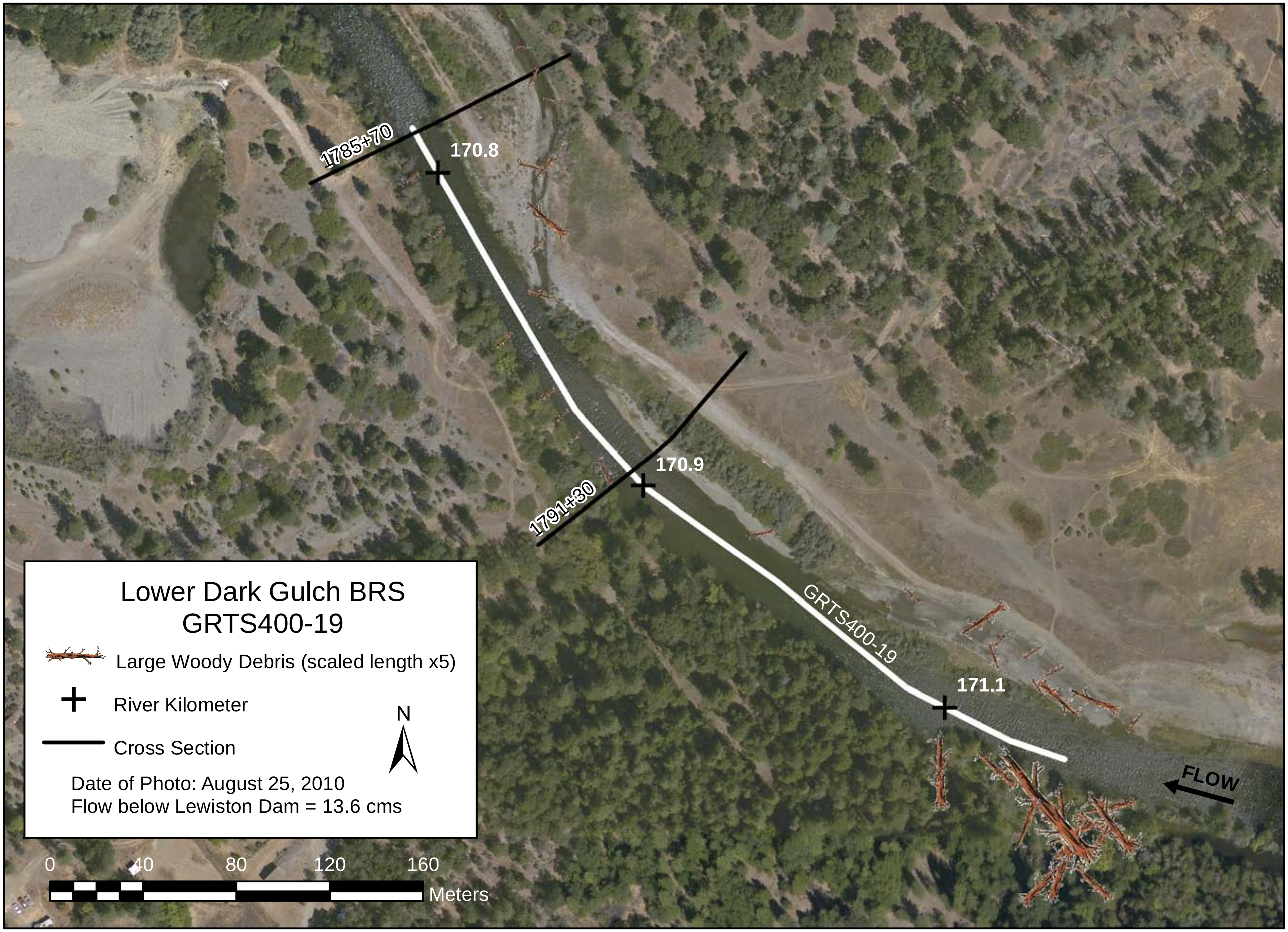
Indian Creek Delta / Vitzhum Gulch CRS

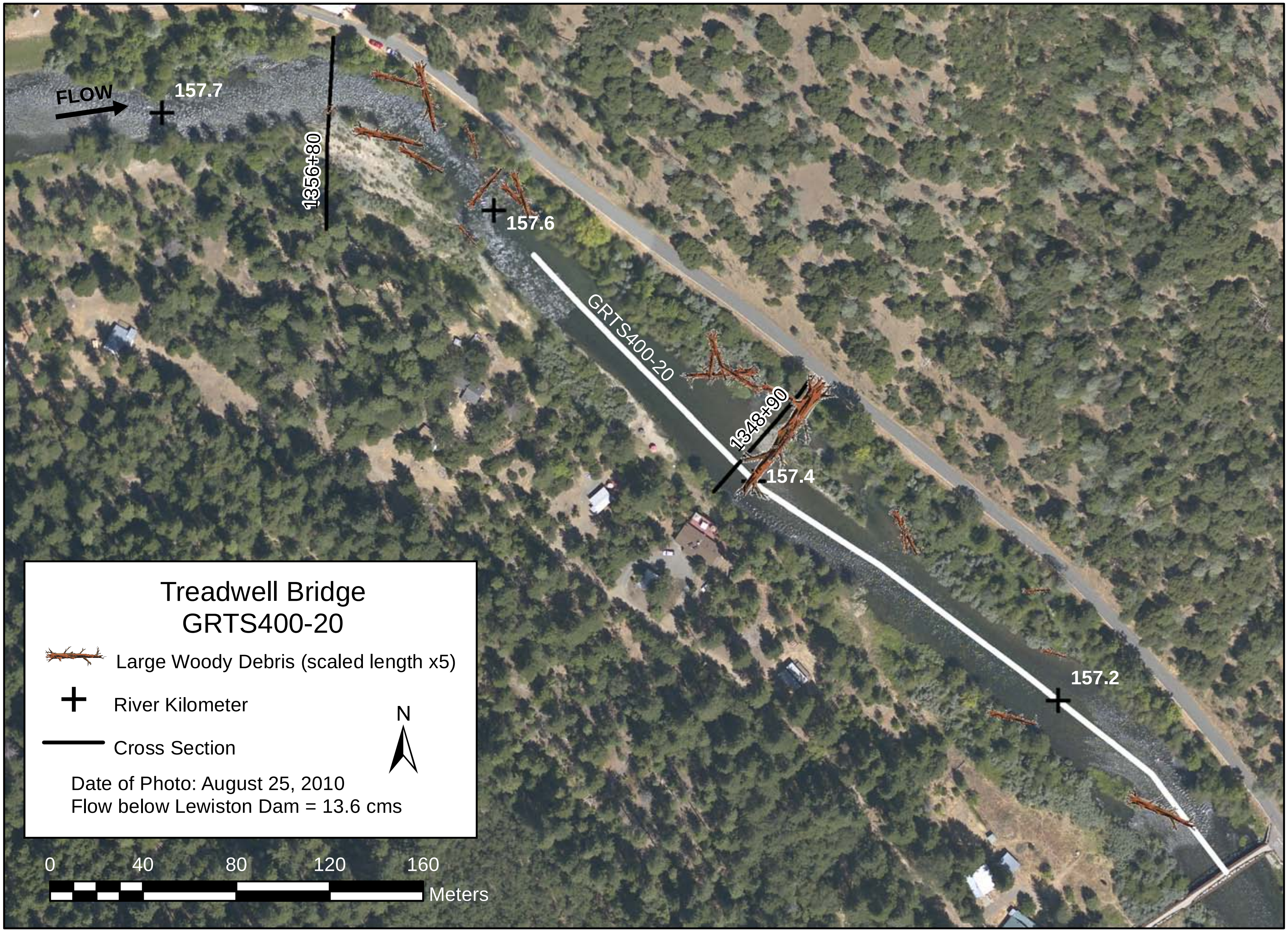
Date of Photo: August 25, 2010
Flow below Lewiston Dam = 13.6 cms


GRTS400-17
120.9
121
121.2
120.7
141+20
151+80
FLOW
Mid Valdor Gulch BRS
GRTS400-17
Large Woody Debris (scaled length x5)
River Kilometer
Cross Section
N
Date of Photo: August 25, 2010
Flow below Lewiston Dam = 13.6 cms
0
40
80
120
160
Meters



Junction City Campground
GRTS400-18


Lower Dark Gulch BRS
GRTS400-19
Large Woody Debris (scaled length x5)
River Kilometer
Cross Section
Date of Photo: August 25, 2010
Flow below Lewiston Dam = 13.6 cms
N
0
40
80
120
160
Meters
1785+70
170.8
1791+30
170.9
GRTS400-19
171.1
FLOW



Treadwell Bridge
GRTS400-20

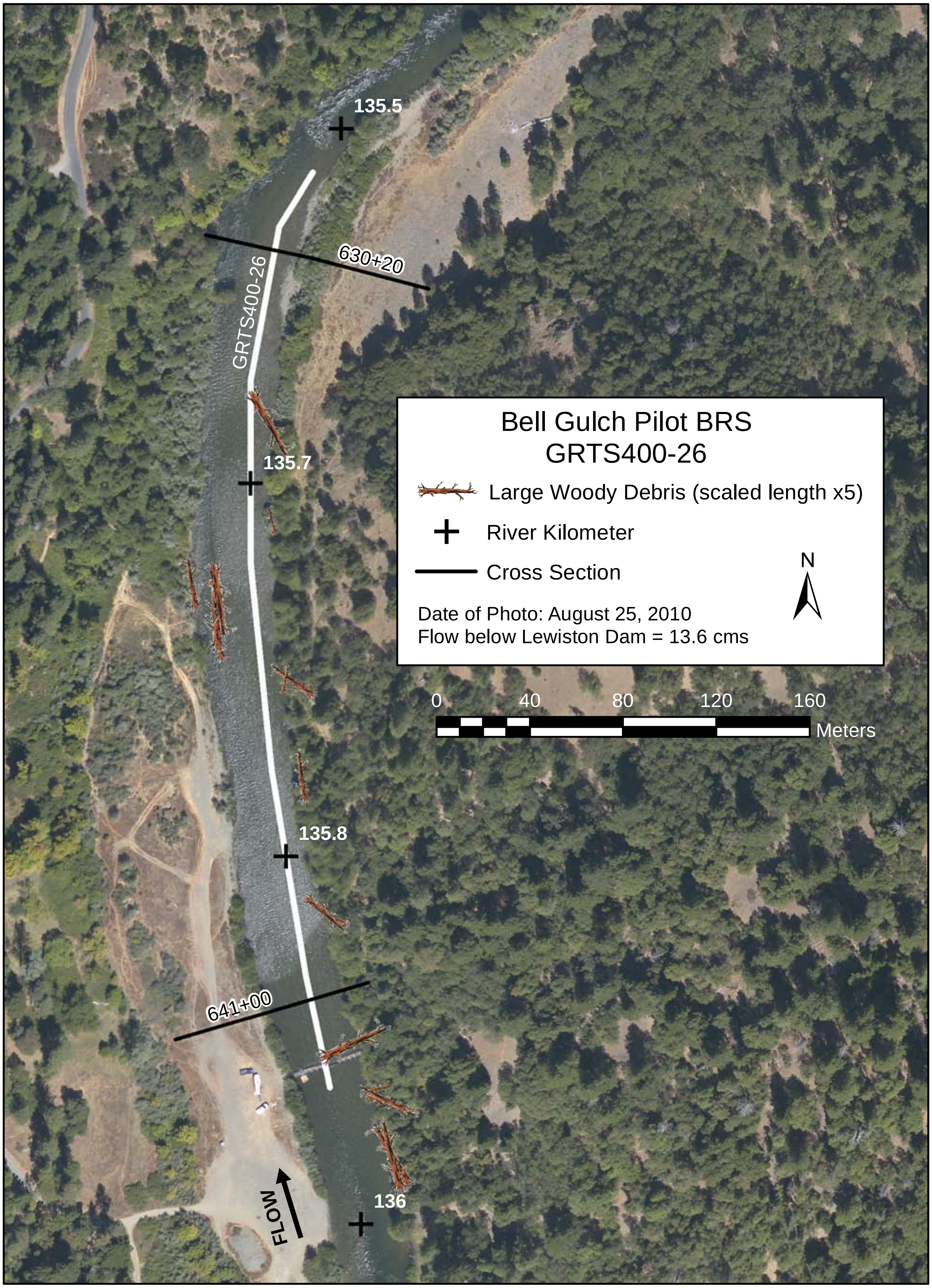
Date of Photo: August 25, 2010
Flow below Lewiston Dam = 13.6 cms

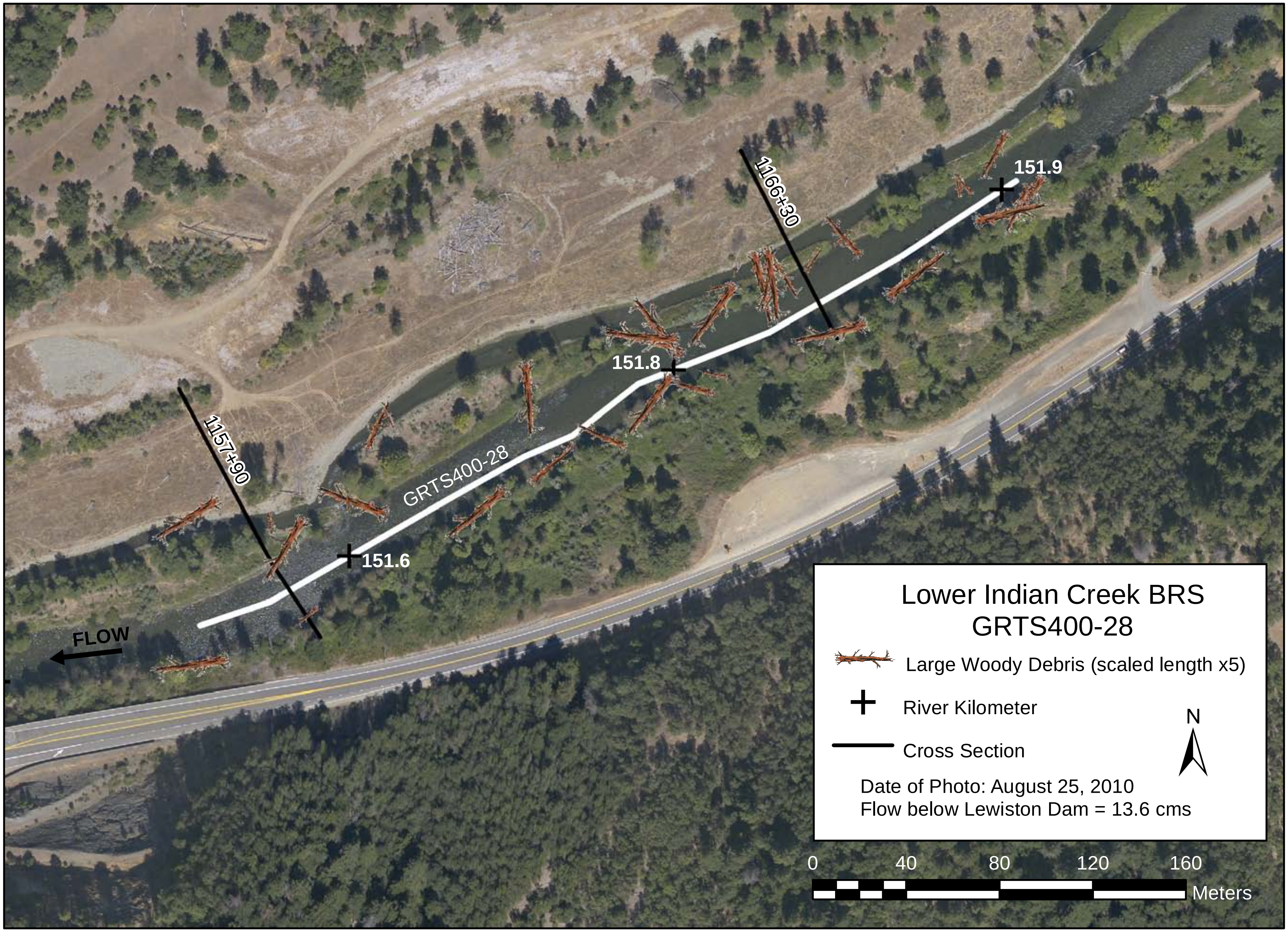

FLOW
122.3
195+00
GRTS400-21
122.5
122.6
122.8
Wheel Gulch BRS
GRTS400-21
Large Woody Debris (scaled length x5)
River Kilometer
Cross Section
Date of Photo: August 25, 2010
Flow below Lewiston Dam = 13.6 cms
N
0
40
80
120
160
Meters

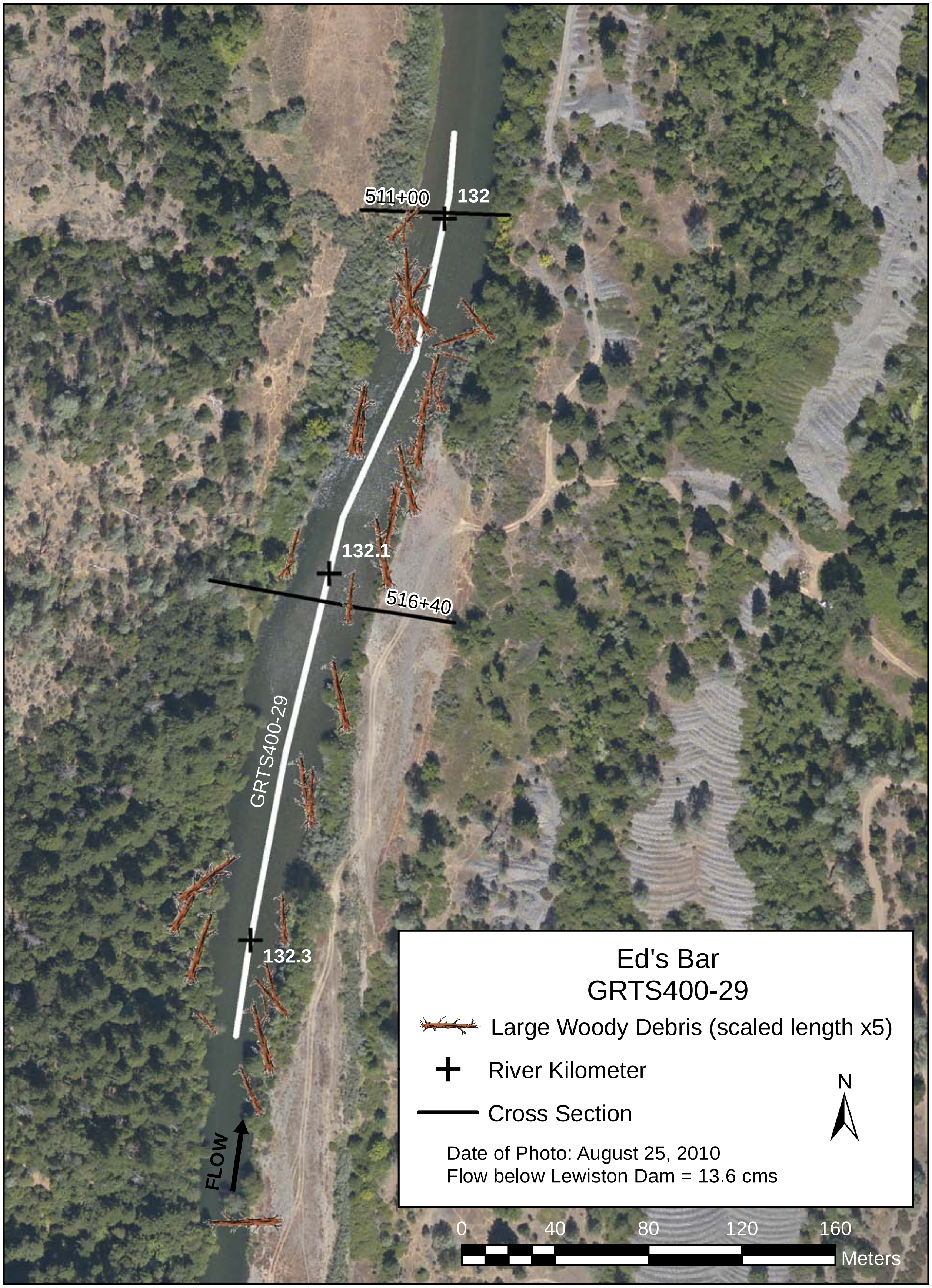
Indian Creek Confluence BRS
GRTS400-24

Date of Photo: August 25, 2010
Flow below Lewiston Dam = 13.6 cms

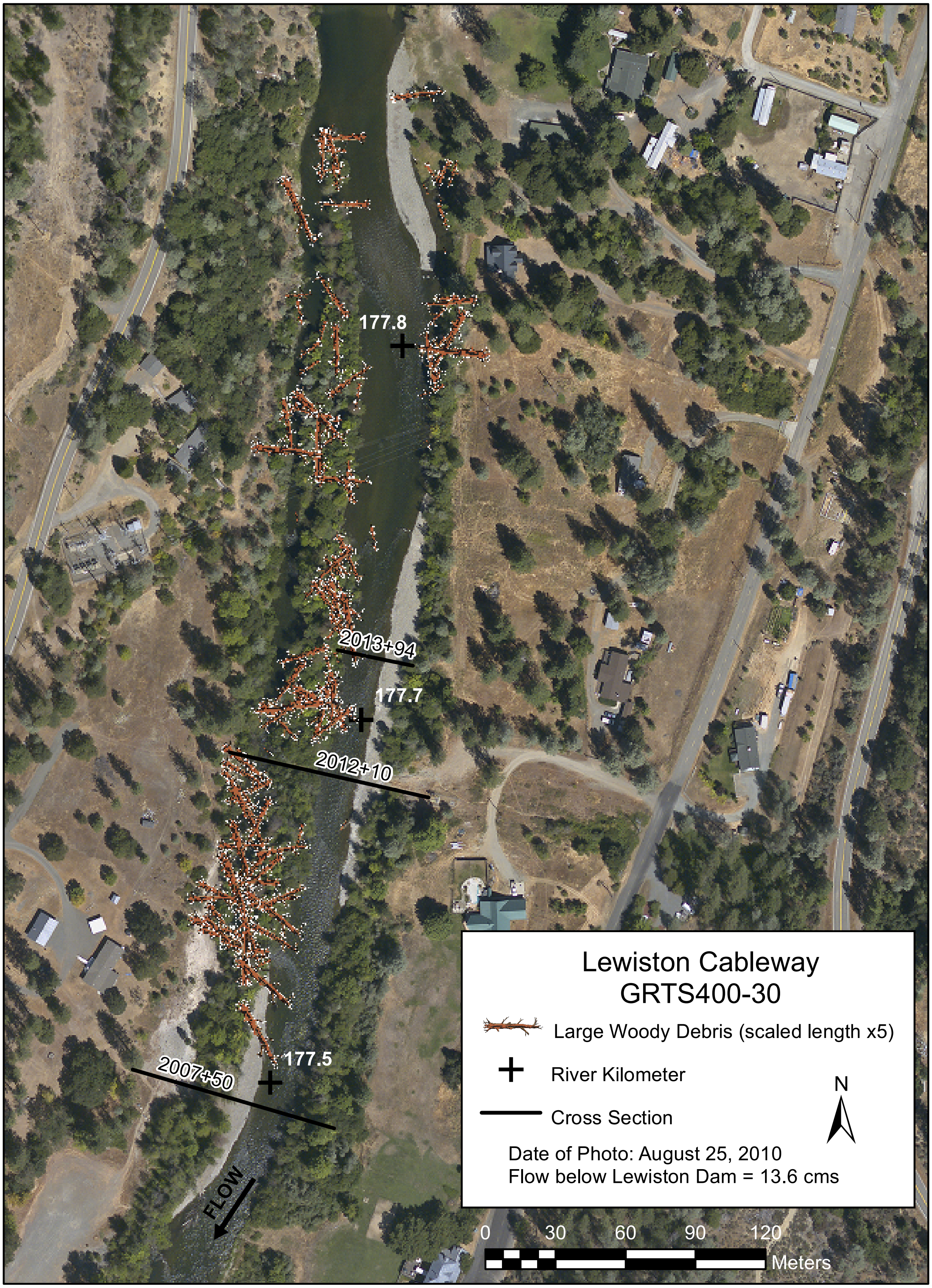

FLOW
133.9
576+50
134.1
582+10
GRTS400-25
134.2
134.4
Roundhouse
GRTS400-25
Large Woody Debris (scaled length x5)
River Kilometer
Cross Section
N
Date of Photo: August 25, 2010
Flow below Lewiston Dam = 13.6 cms
0
40
80
120
160
Meters


135.5
630+20
GRTS400-26
135.7
Bell Gulch Pilot BRS
GRTS400-26
Large Woody Debris (scaled length x5)
River Kilometer
Cross Section
N
Date of Photo: August 25, 2010
Flow below Lewiston Dam = 13.6 cms
0
40
80
120
160
Meters
135.8
641+00
FLOW
136

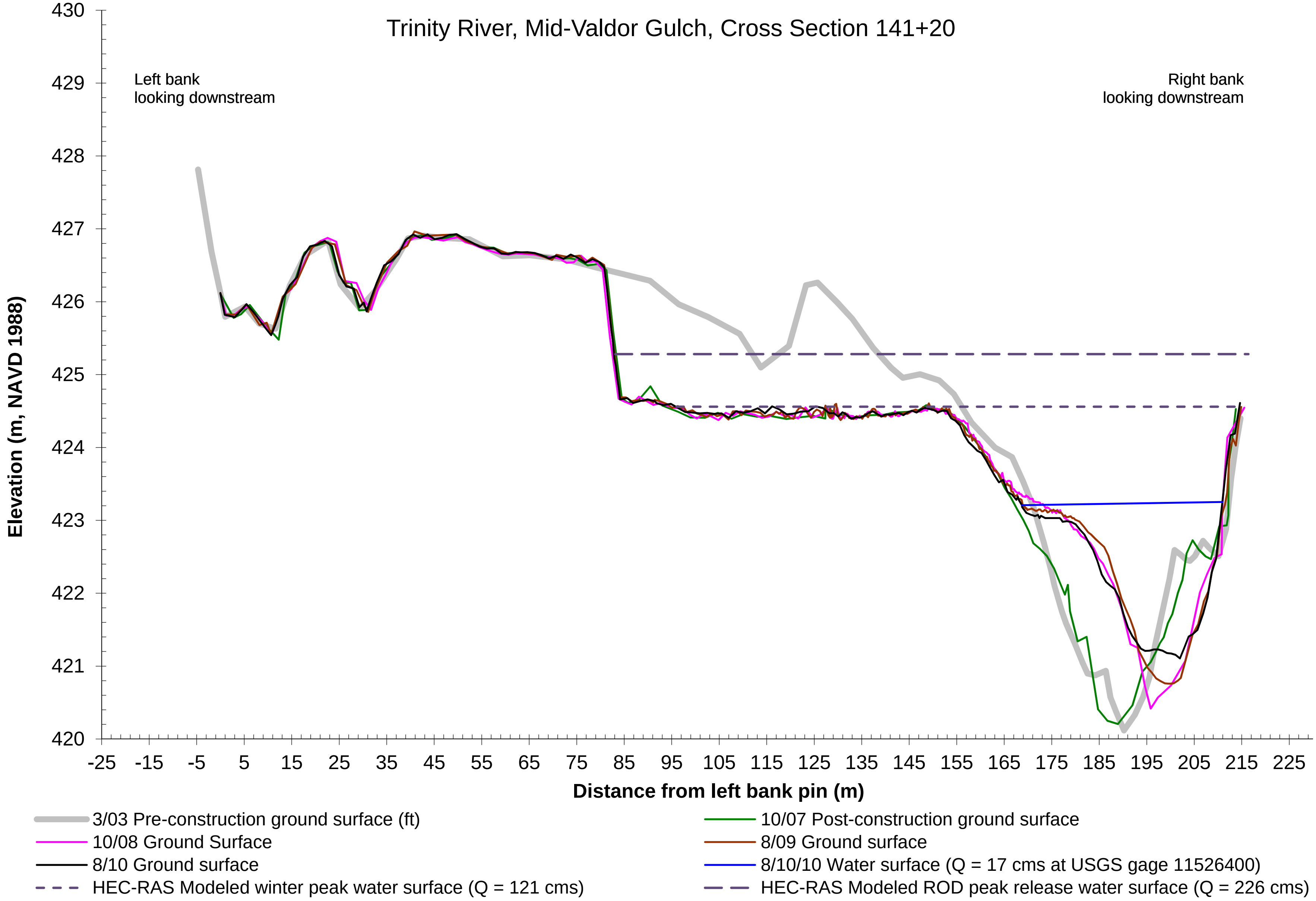

Lower Indian Creek BRS
GRTS400-28
Large Woody Debris (scaled length x5)
River Kilometer
Cross Section
N
Date of Photo: August 25, 2010
Flow below Lewiston Dam = 13.6 cms
0
40
80
120
160
Meters
151.9
1166+30
151.8
1157+90
GRTS400-28
151.6
FLOW

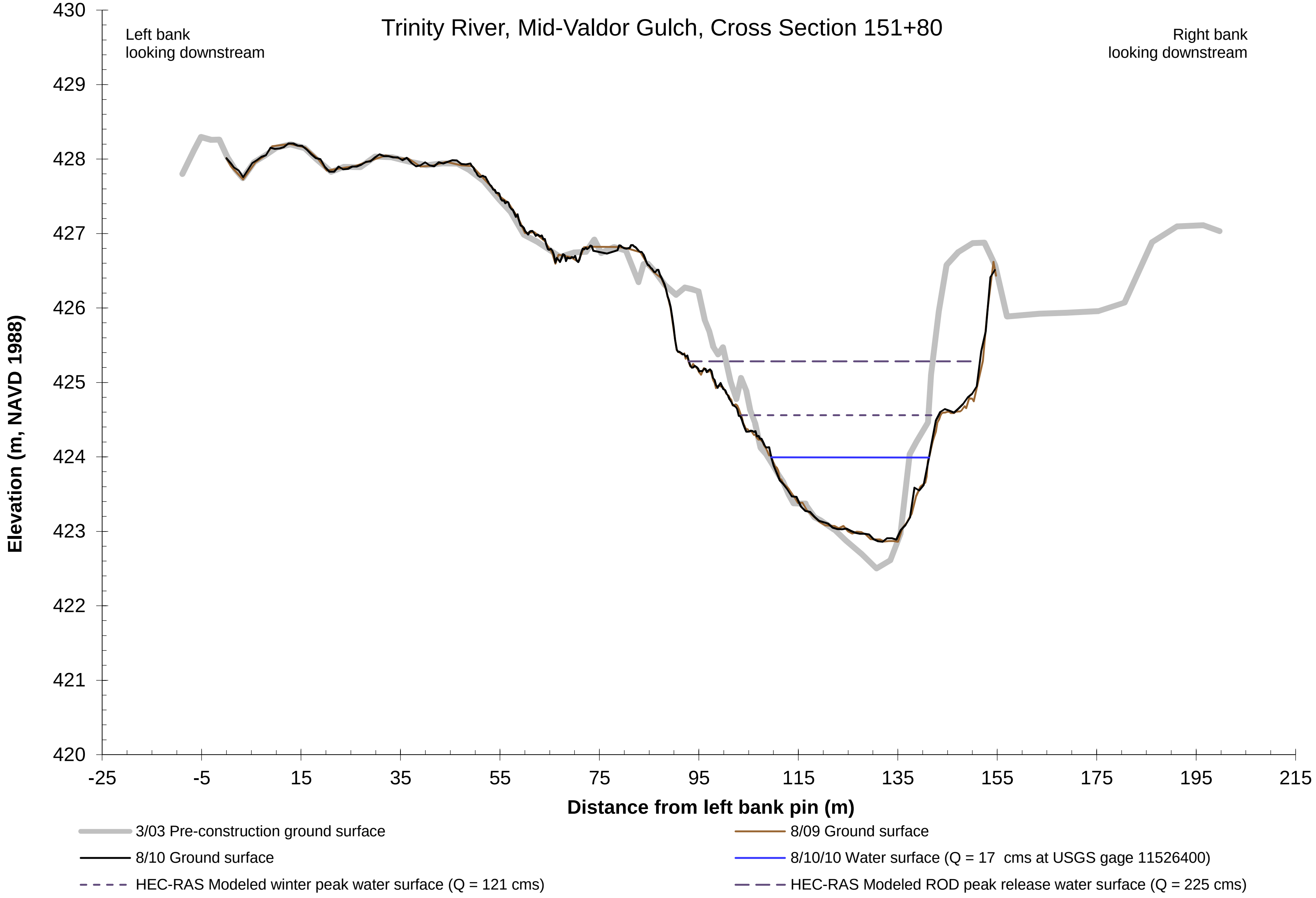


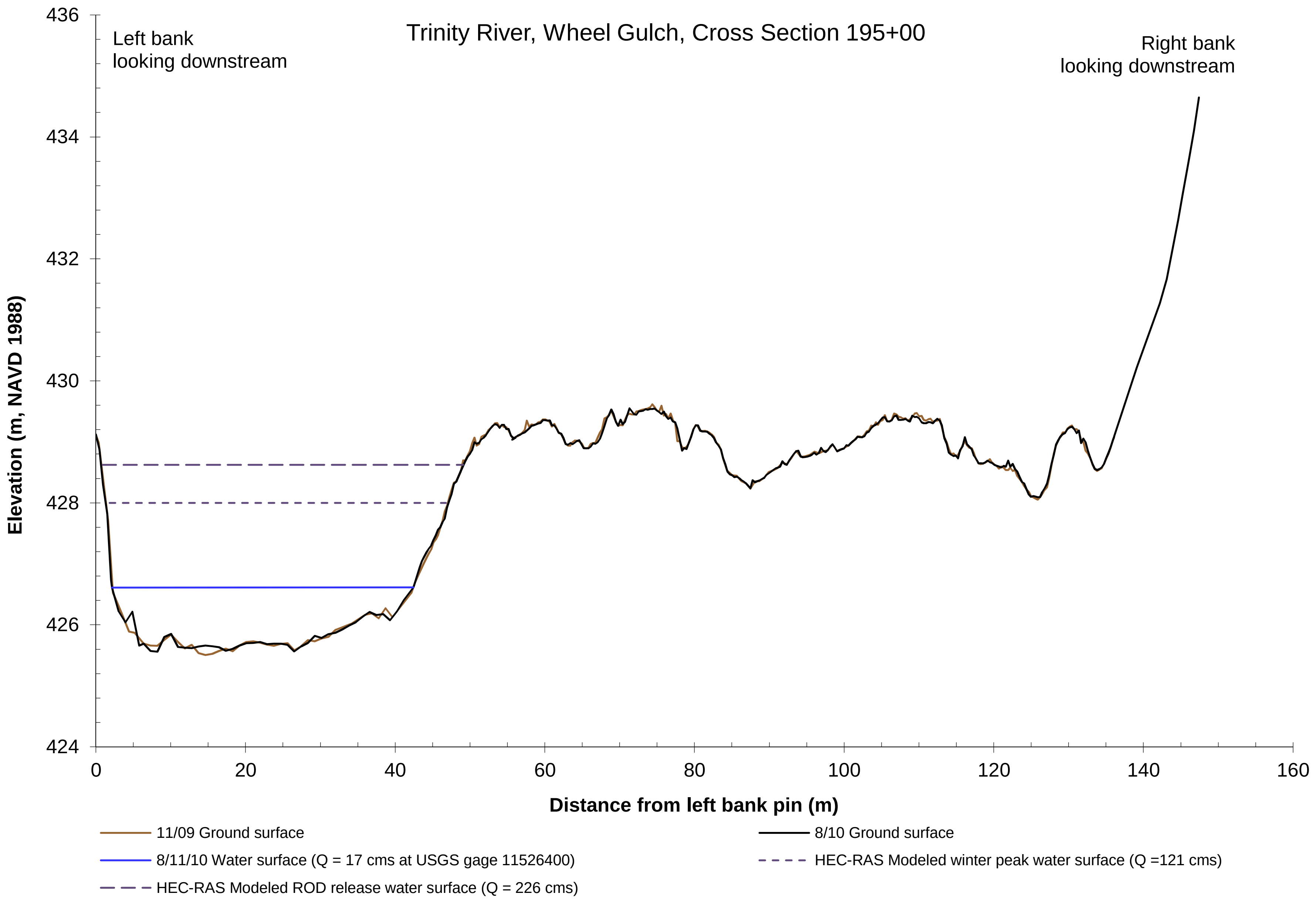
511+00
132
132.1
516+40
GRTS400-29
132.3
FLOW
Ed's Bar
GRTS400-29
Large Woody Debris (scaled length x5)
River Kilometer
Cross Section
N
Date of Photo: August 25, 2010
Flow below Lewiston Dam = 13.6 cms
0
40
80
120
160
Meters

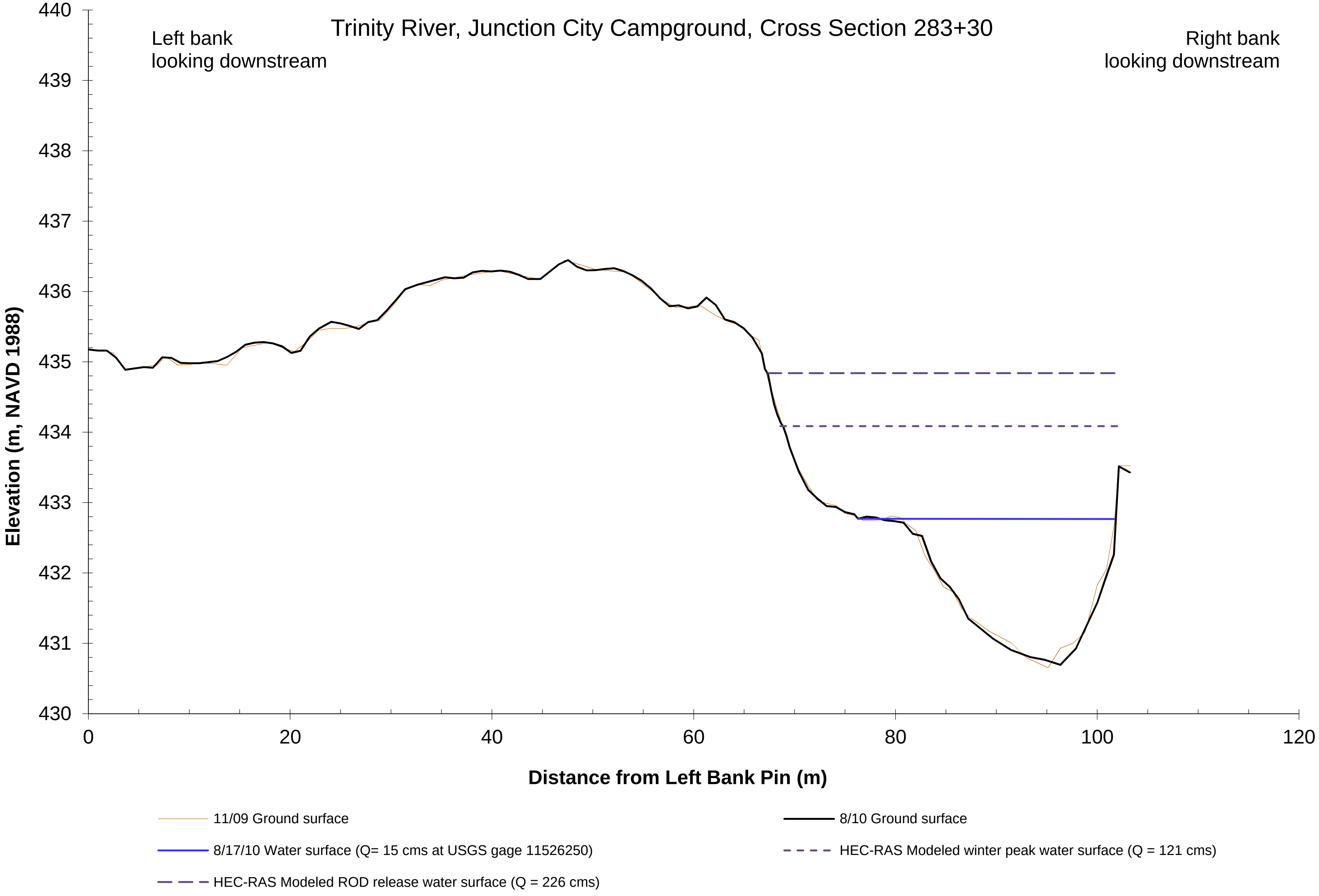

177.8
2013+94
177.7
2012+10
177.5
2007+50
FLOW
Lewiston Cableway
GRTS400-30
Large Woody Debris (scaled length x5)
River Kilometer
Cross Section
N
Date of Photo: August 25, 2010
Flow below Lewiston Dam = 13.6 cms
0
30
60
90
120
Meters

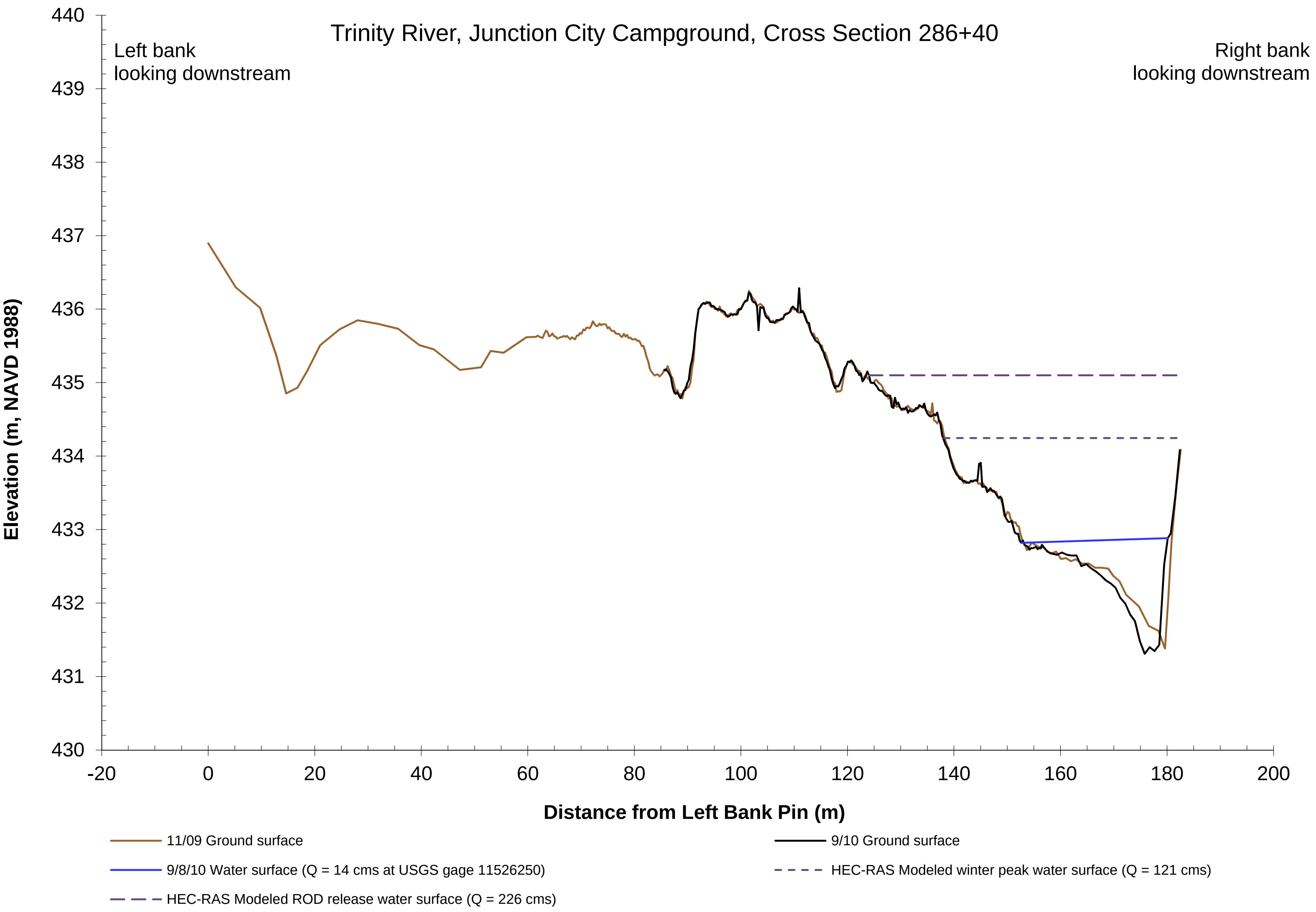
Appendix B. Cross Section Surveys of 12 GRTS Panel 2 Sites Sampled in WY 2010.

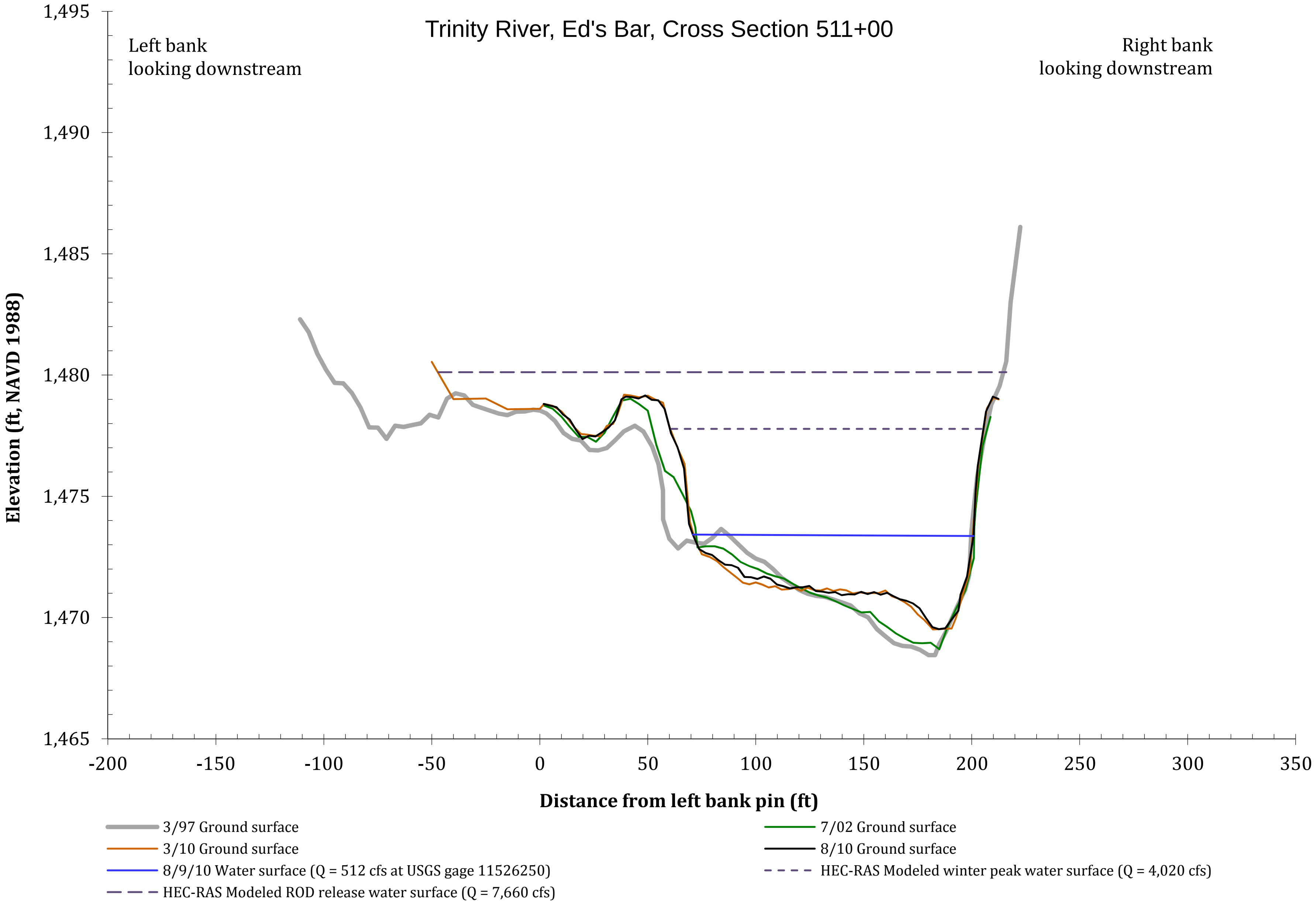

Trinity River, Mid-Valdor Gulch, Cross Section 141+20
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
430
429
428
427
426
425
424
423
422
421
420
-25
-15
-5
5
15
25
35
45
55
65
75
85
95
105
115
125
135
145
155
165
175
185
195
205
215
225
Distance from left bank pin (m)
3/03 Pre-construction ground surface (ft)
10/07 Post-construction ground surface
10/08 Ground Surface
8/09 Ground surface
8/10 Ground surface
8/10/10 Water surface (Q = 17 cms at USGS gage 11526400)
HEC-RAS Modeled winter peak water surface (Q = 121 cms)
HEC-RAS Modeled ROD peak release water surface (Q = 226 cms)

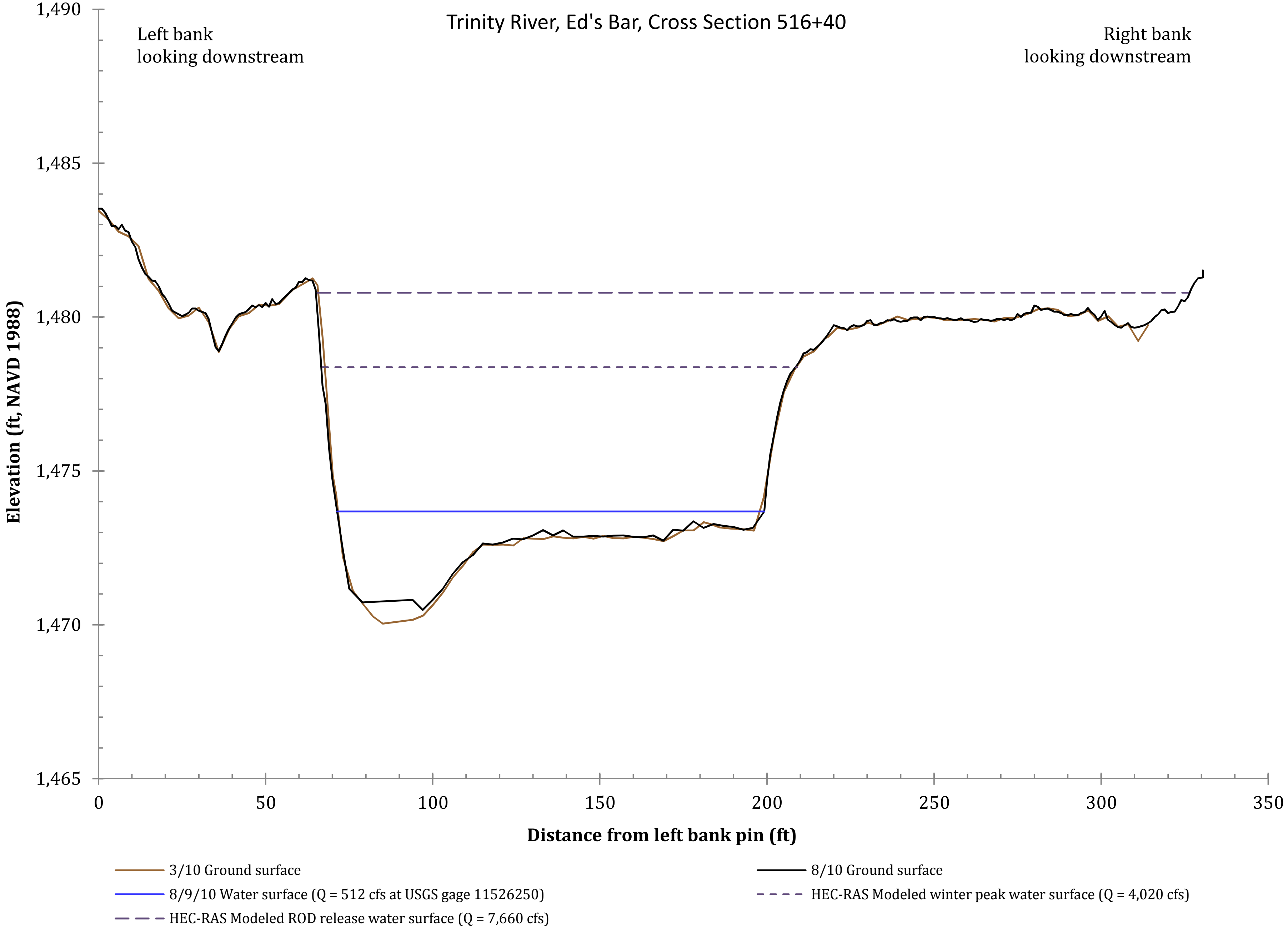

Trinity River, Mid-Valdor Gulch, Cross Section 151+80
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
430
429
428
427
426
425
424
423
422
421
420
-25
-5
15
35
55
75
95
115
135
155
175
195
215
Distance from left bank pin (m)
3/03 Pre-construction ground surface
8/09 Ground surface
8/10 Ground surface
8/10/10 Water surface (Q = 17 cms at USGS gage 11526400)
HEC-RAS Modeled winter peak water surface (Q = 121 cms)
HEC-RAS Modeled ROD peak release water surface (Q = 225 cms)

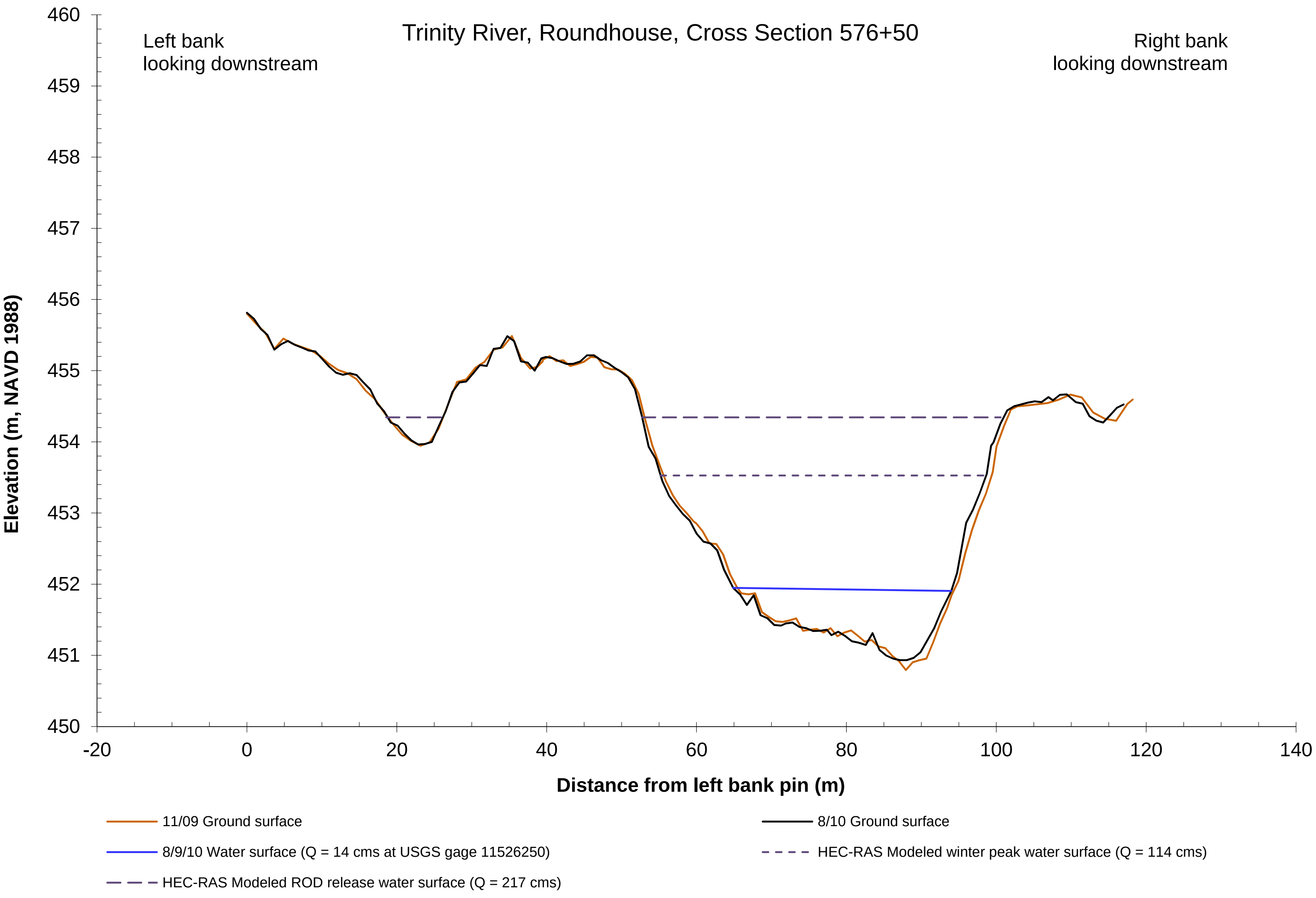

Trinity River, Wheel Gulch, Cross Section 195+00
Left bank looking downstream
Right bank looking downstream
Elevation (m, NAVD 1988)
436
434
432
430
428
426
424
0
20
40
60
80
100
120
140
160
Distance from left bank pin (m)
11/09 Ground surface
8/10 Ground surface
8/11/10 Water surface (Q = 17 cms at USGS gage 11526400)
HEC-RAS Modeled winter peak water surface (Q =121 cms)
HEC-RAS Modeled ROD release water surface (Q = 226 cms)

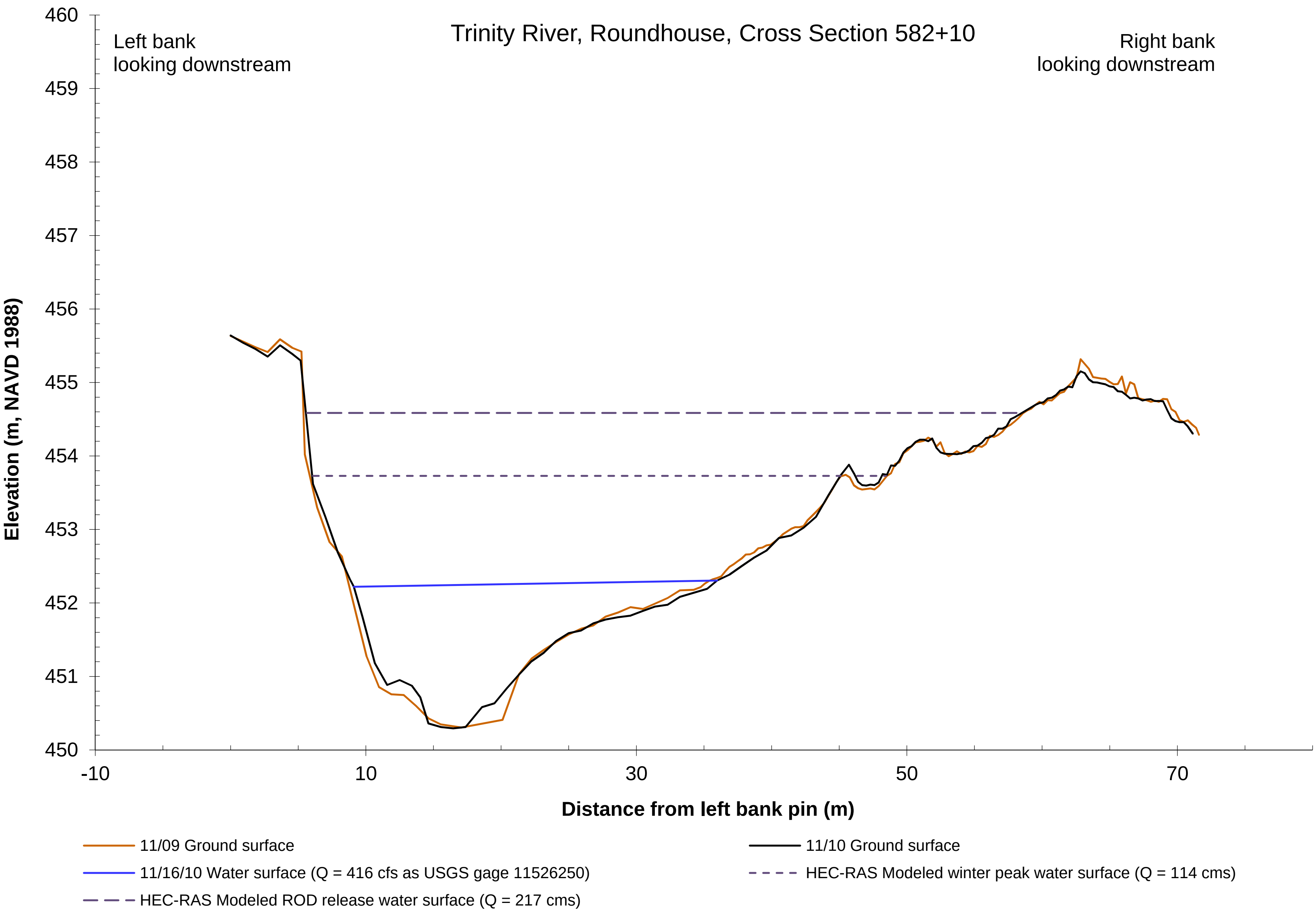

Trinity River, Junction City Campground, Cross Section 283+30
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
440
439
438
437
436
435
434
433
432
431
430
0
20
40
60
80
100
120
Distance from Left Bank Pin (m)
11/09 Ground surface
8/10 Ground surface
8/17/10 Water surface (Q= 15 cms at USGS gage 11526250)
HEC-RAS Modeled winter peak water surface (Q = 121 cms)
HEC-RAS Modeled ROD release water surface (Q = 226 cms)

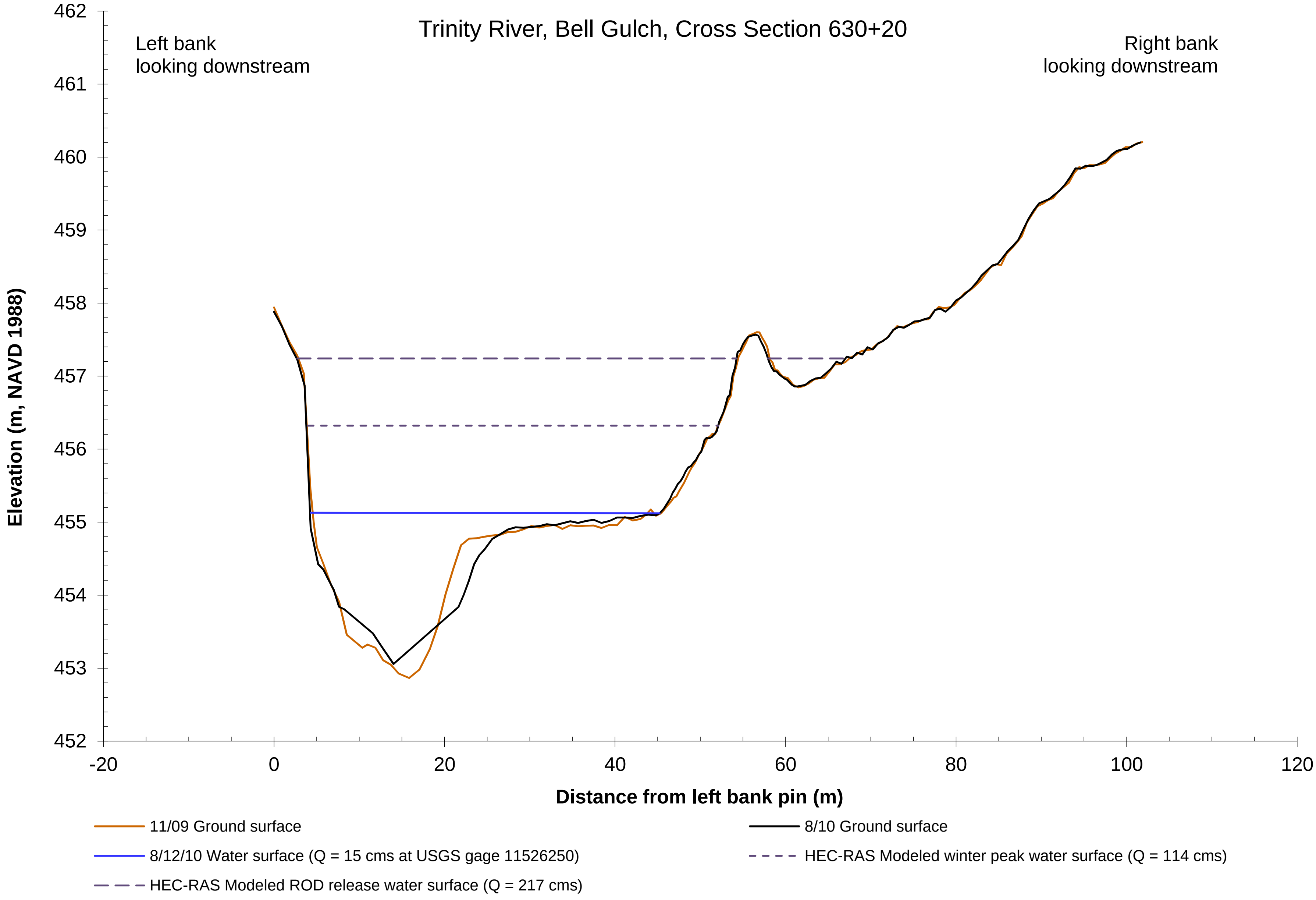

Trinity River, Junction City Campground, Cross Section 286+40
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
440
439
438
437
436
435
434
433
432
431
430
-20
0
20
40
60
80
100
120
140
160
180
200
Distance from Left Bank Pin (m)
11/09 Ground surface
9/10 Ground surface
9/8/10 Water surface (Q = 14 cms at USGS gage 11526250)
HEC-RAS Modeled winter peak water surface (Q = 121 cms)
HEC-RAS Modeled ROD release water surface (Q = 226 cms)

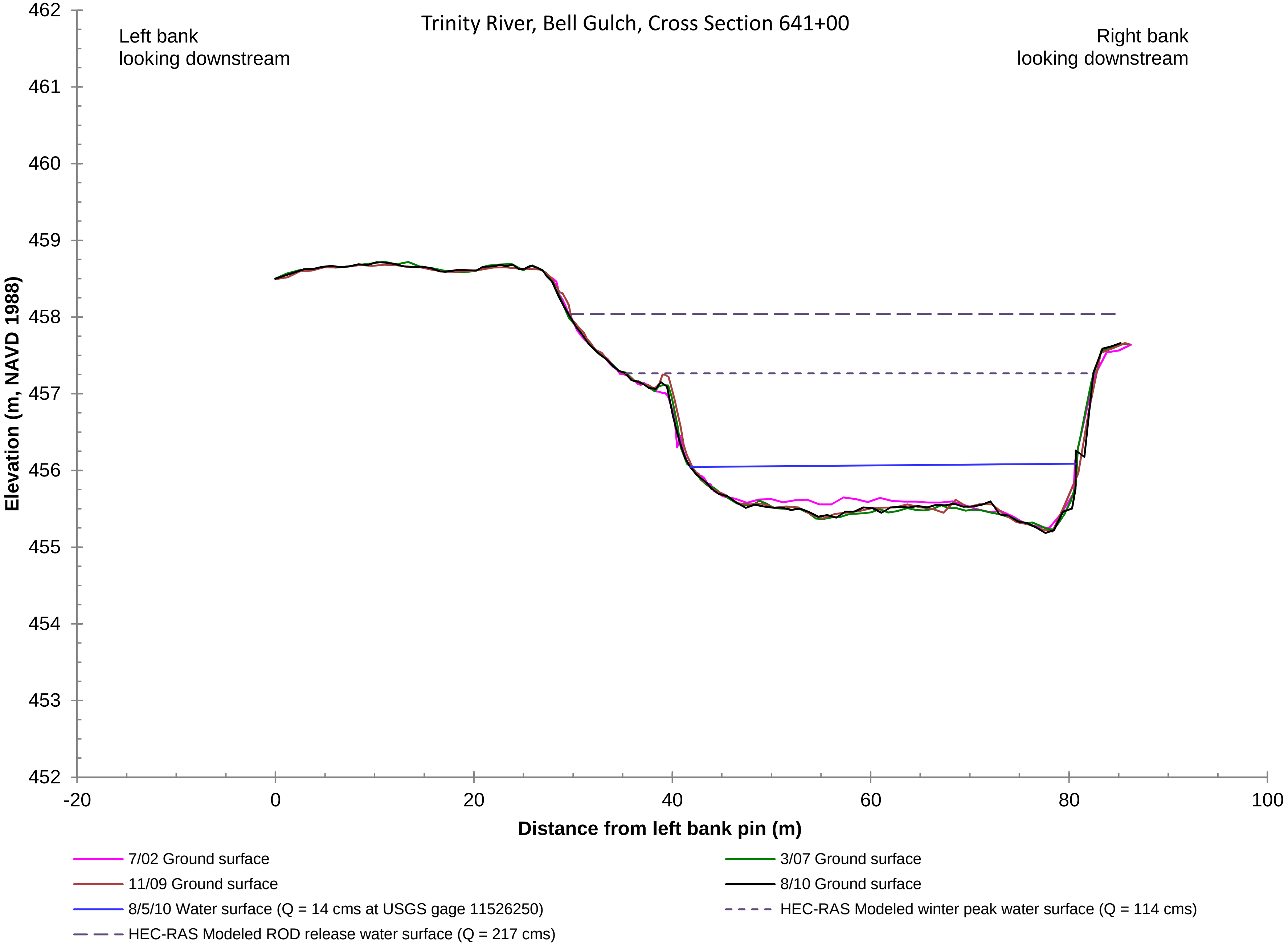

Trinity River, Ed's Bar, Cross Section 511+00
Left bank
looking downstream
Right bank
looking downstream
Elevation (ft, NAVD 1988)
1,495
1,490
1,485
1,480
1,475
1,470
1,465
-200
-150
-100
-50
0
50
100
150
200
250
300
350
Distance from left bank pin (ft)
3/97 Ground surface
3/10 Ground surface
8/9/10 Water surface (Q = 512 cfs at USGS gage 11526250)
HEC-RAS Modeled ROD release water surface (Q = 7,660 cfs)
7/02 Ground surface
8/10 Ground surface
HEC-RAS Modeled winter peak water surface (Q = 4,020 cfs)

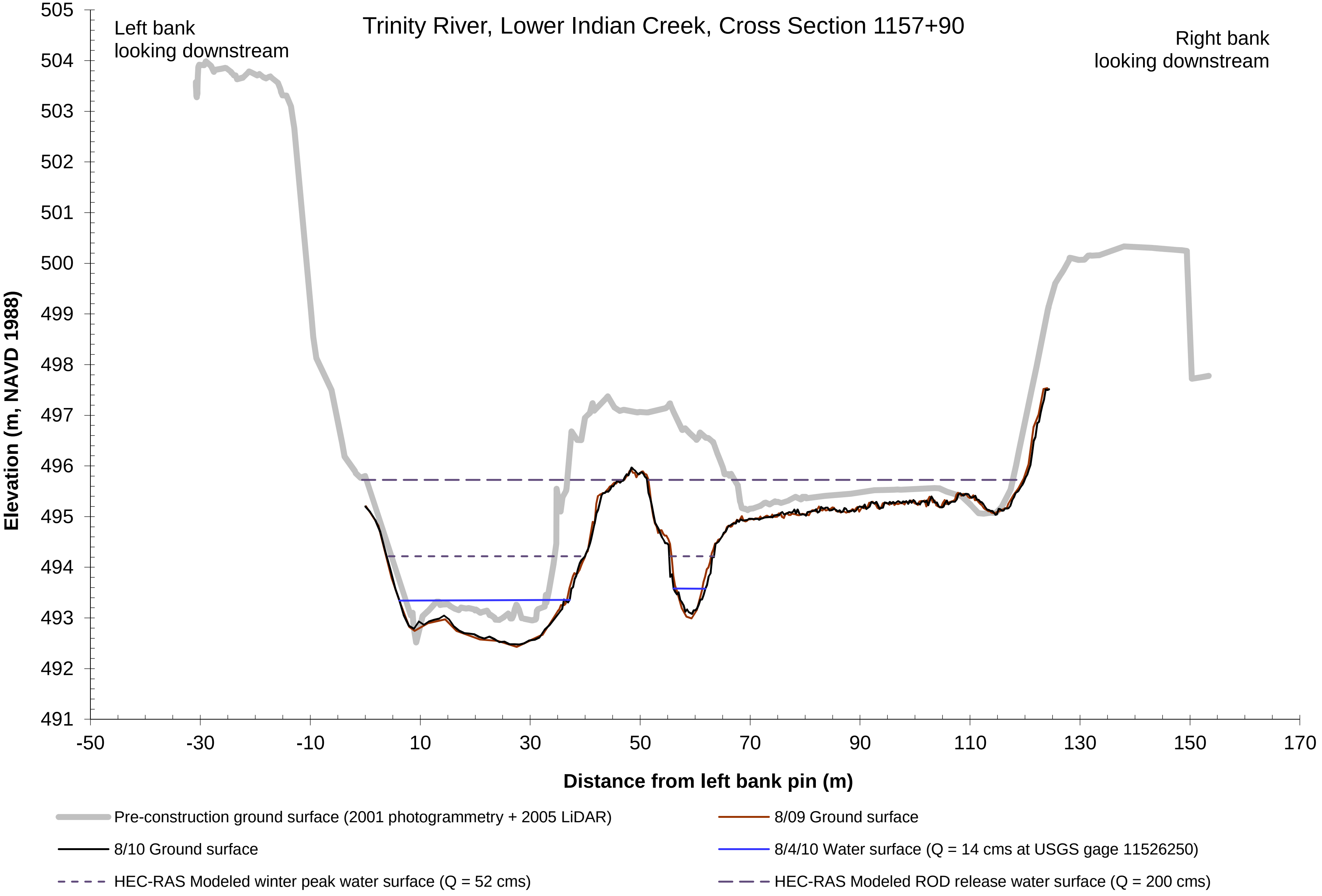

Trinity River, Ed's Bar, Cross Section 516+40
Left bank
looking downstream
Right bank
looking downstream
Elevation (ft, NAVD 1988)
1,490
1,485
1,480
1,475
1,470
1,465
0
50
100
150
200
250
300
350
Distance from left bank pin (ft)
3/10 Ground surface
8/10 Ground surface
8/9/10 Water surface (Q = 512 cfs at USGS gage 11526250)
HEC-RAS Modeled winter peak water surface (Q = 4,020 cfs)
HEC-RAS Modeled ROD release water surface (Q = 7,660 cfs)

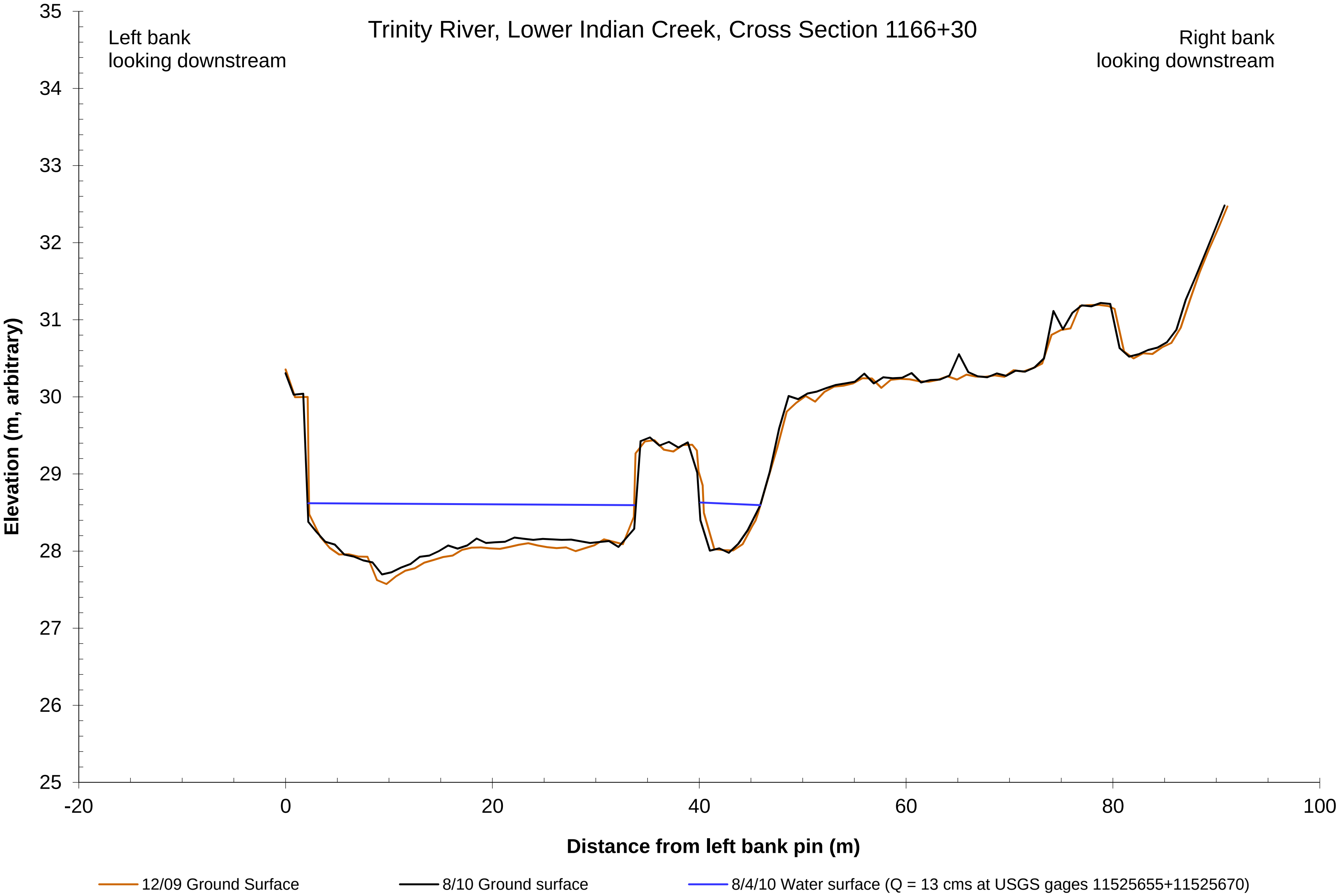

Trinity River, Roundhouse, Cross Section 576+50
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
460
459
458
457
456
455
454
453
452
451
450
-20
0
20
40
60
80
100
120
140
Distance from left bank pin (m)
11/09 Ground surface
8/10 Ground surface
8/9/10 Water surface (Q = 14 cms at USGS gage 11526250)
HEC-RAS Modeled winter peak water surface (Q = 114 cms)
HEC-RAS Modeled ROD release water surface (Q = 217 cms)

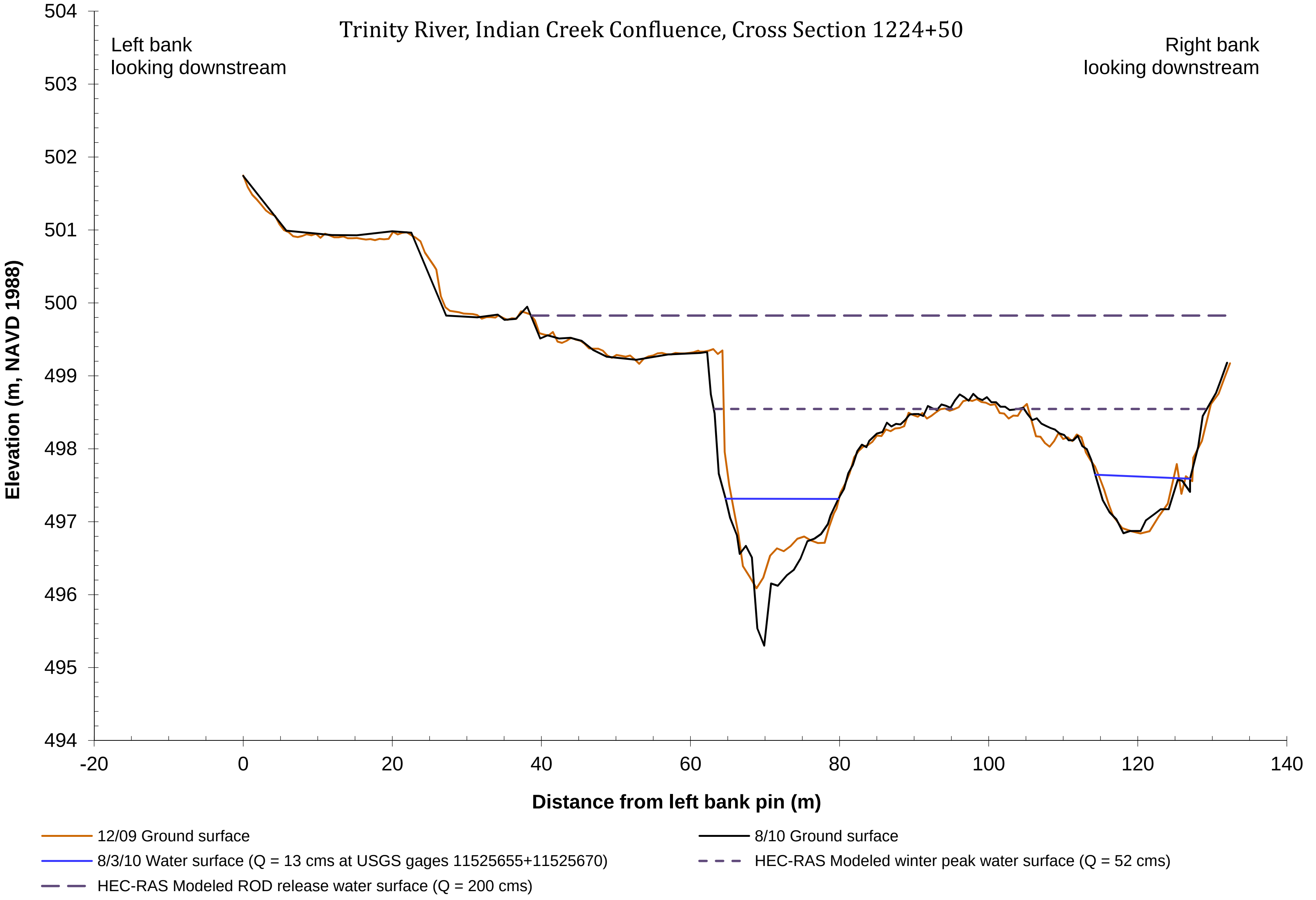

Trinity River, Roundhouse, Cross Section 582+10
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
460
459
458
457
456
455
454
453
452
451
450
-10
10
30
50
70
Distance from left bank pin (m)
11/09 Ground surface
11/10 Ground surface
11/16/10 Water surface (Q = 416 cfs as USGS gage 11526250)
HEC-RAS Modeled winter peak water surface (Q = 114 cms)
HEC-RAS Modeled ROD release water surface (Q = 217 cms)

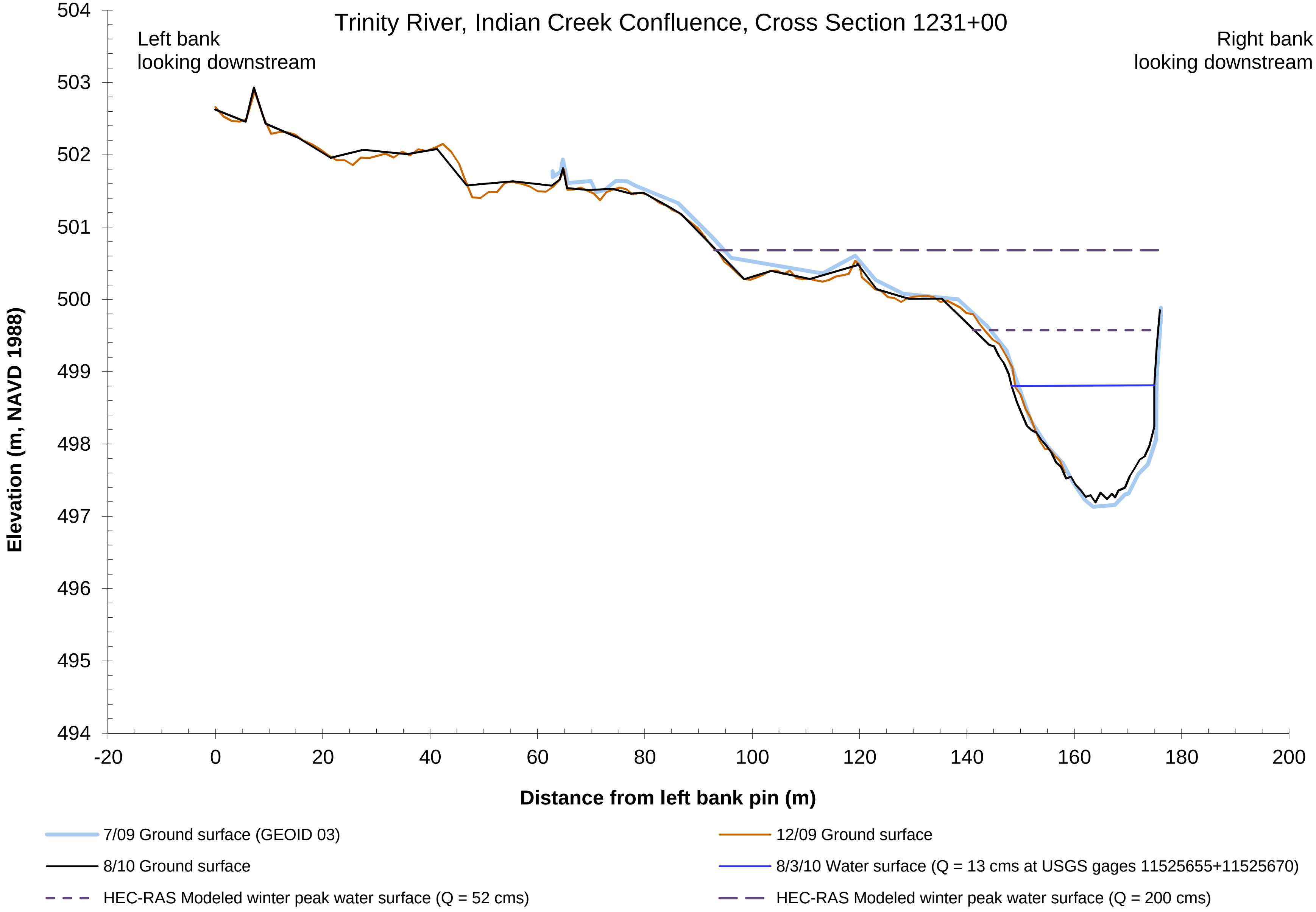

Trinity River, Bell Gulch, Cross Section 630+20
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
462
461
460
459
458
457
456
455
454
453
452
-20
0
20
40
60
80
100
120
Distance from left bank pin (m)
11/09 Ground surface
8/10 Ground surface
8/12/10 Water surface (Q = 15 cms at USGS gage 11526250)
HEC-RAS Modeled winter peak water surface (Q = 114 cms)
HEC-RAS Modeled ROD release water surface (Q = 217 cms)

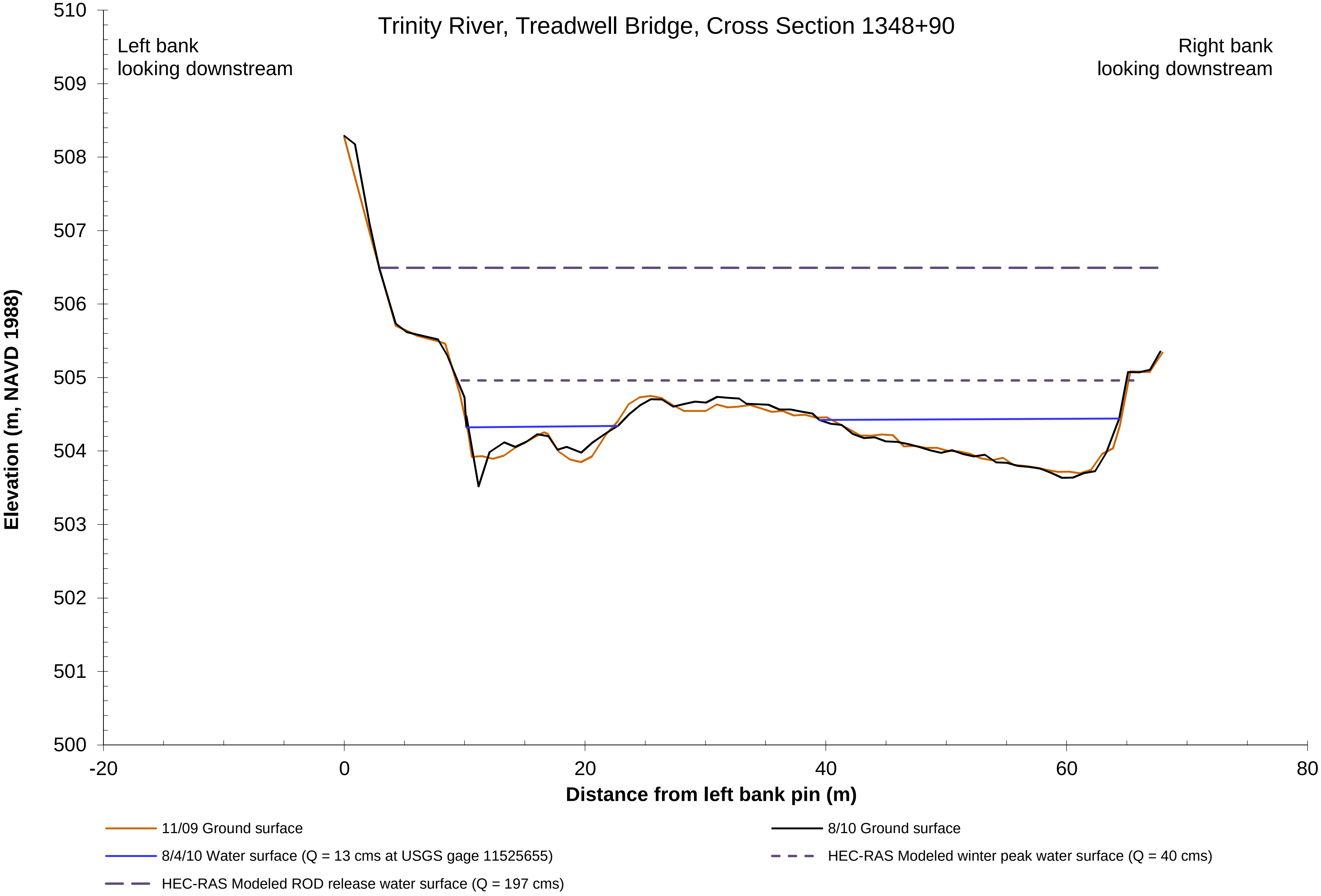

Trinity River, Bell Gulch, Cross Section 641+00
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
462
461
460
459
458
457
456
455
454
453
452
-20
0
20
40
60
80
100
Distance from left bank pin (m)
7/02 Ground surface
3/07 Ground surface
11/09 Ground surface
8/10 Ground surface
8/5/10 Water surface (Q = 14 cms at USGS gage 11526250)
HEC-RAS Modeled winter peak water surface (Q = 114 cms)
HEC-RAS Modeled ROD release water surface (Q = 217 cms)

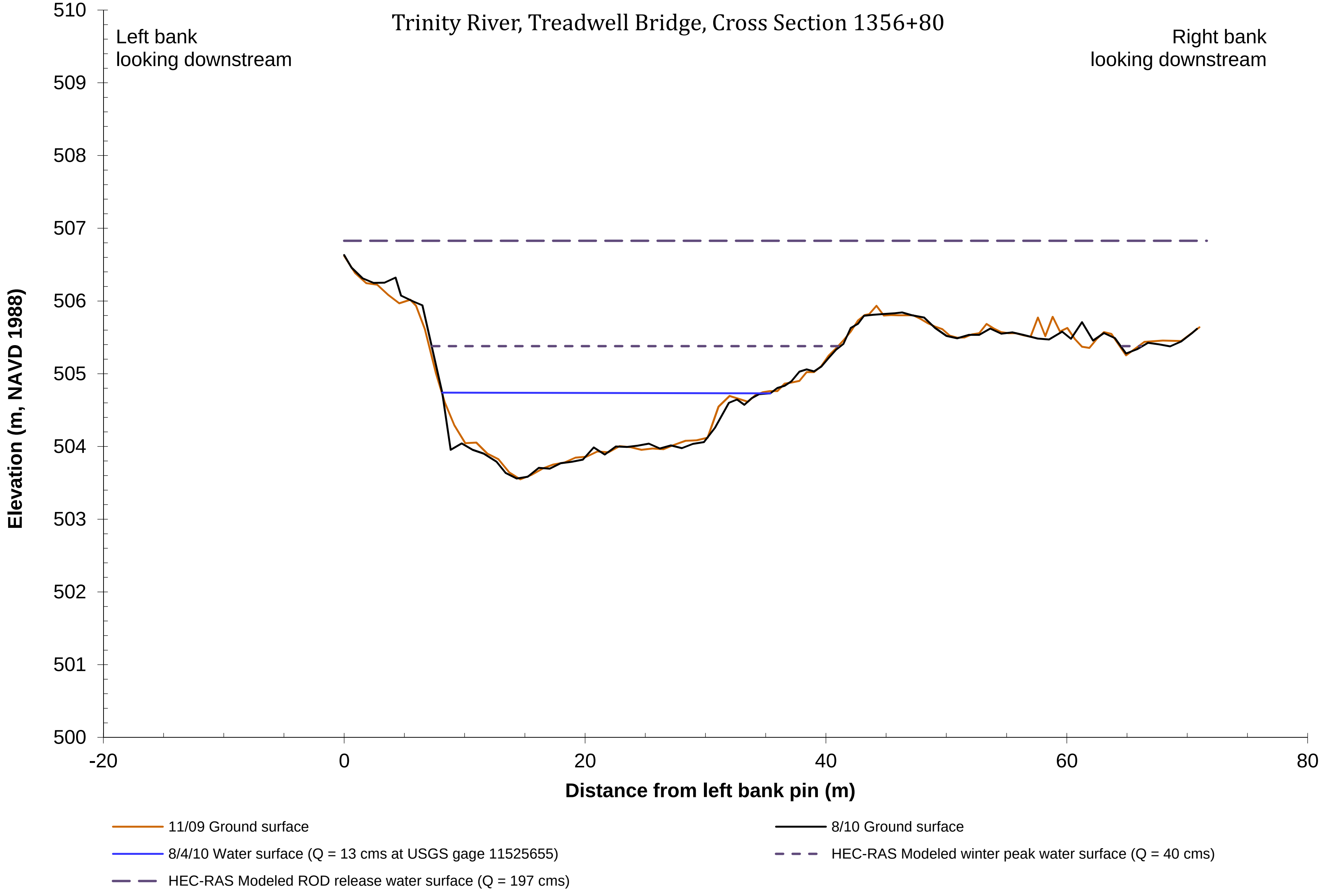

Trinity River, Lower Indian Creek, Cross Section 1157+90
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
505
504
503
502
501
500
499
498
497
496
495
494
493
492
491
-50
-30
-10
10
30
50
70
90
110
130
150
170
Distance from left bank pin (m)
Pre-construction ground surface (2001 photogrammetry + 2005 LiDAR)
8/09 Ground surface
8/10 Ground surface
8/4/10 Water surface (Q = 14 cms at USGS gage 11526250)
HEC-RAS Modeled winter peak water surface (Q = 52 cms)
HEC-RAS Modeled ROD release water surface (Q = 200 cms)

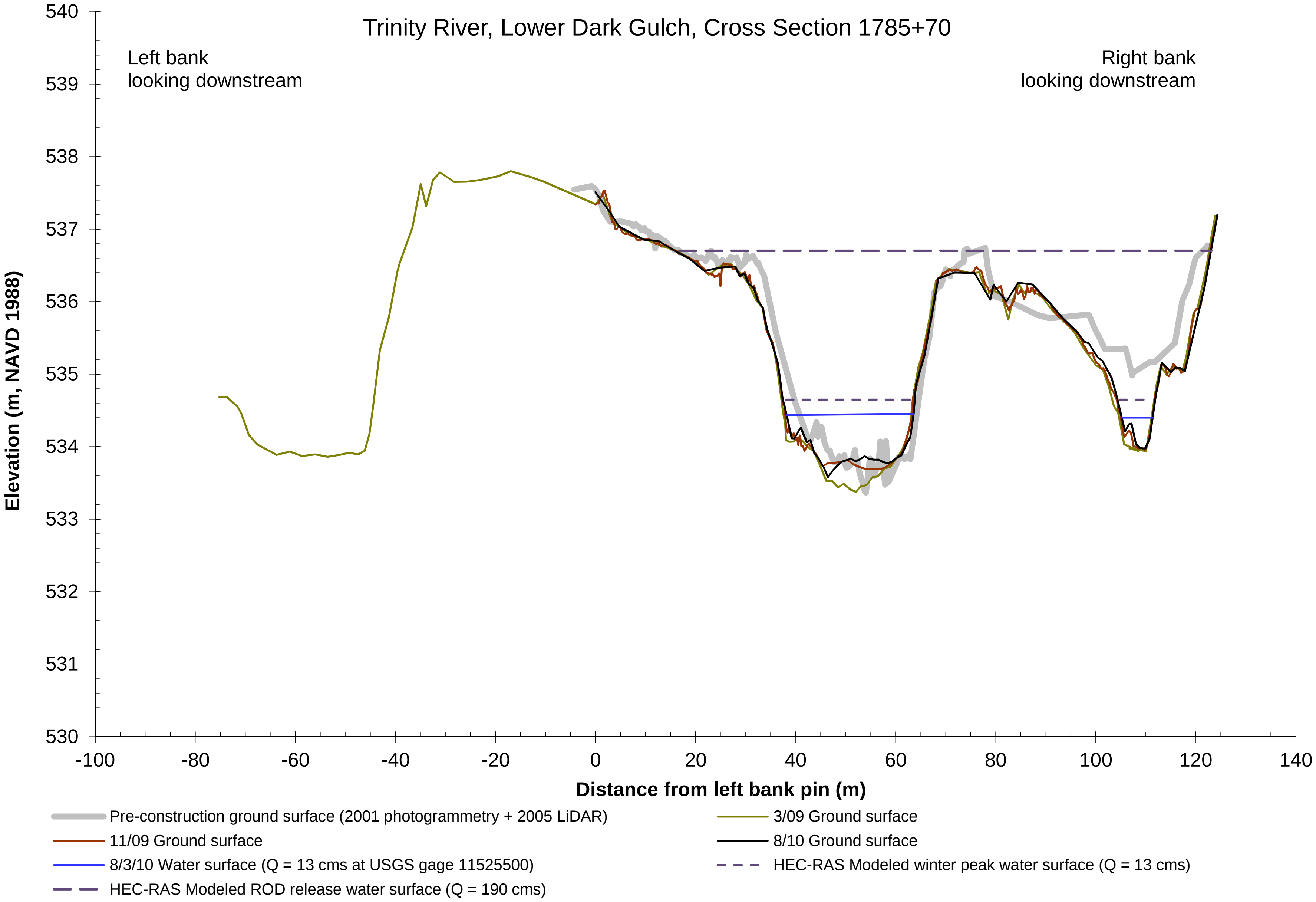

Trinity River, Lower Indian Creek, Cross Section 1166+30
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, arbitrary)
35
34
33
32
31
30
29
28
27
26
25
-20
0
20
40
60
80
100
Distance from left bank pin (m)
12/09 Ground Surface
8/10 Ground surface
8/4/10 Water surface (Q = 13 cms at USGS gages 11525655+11525670)

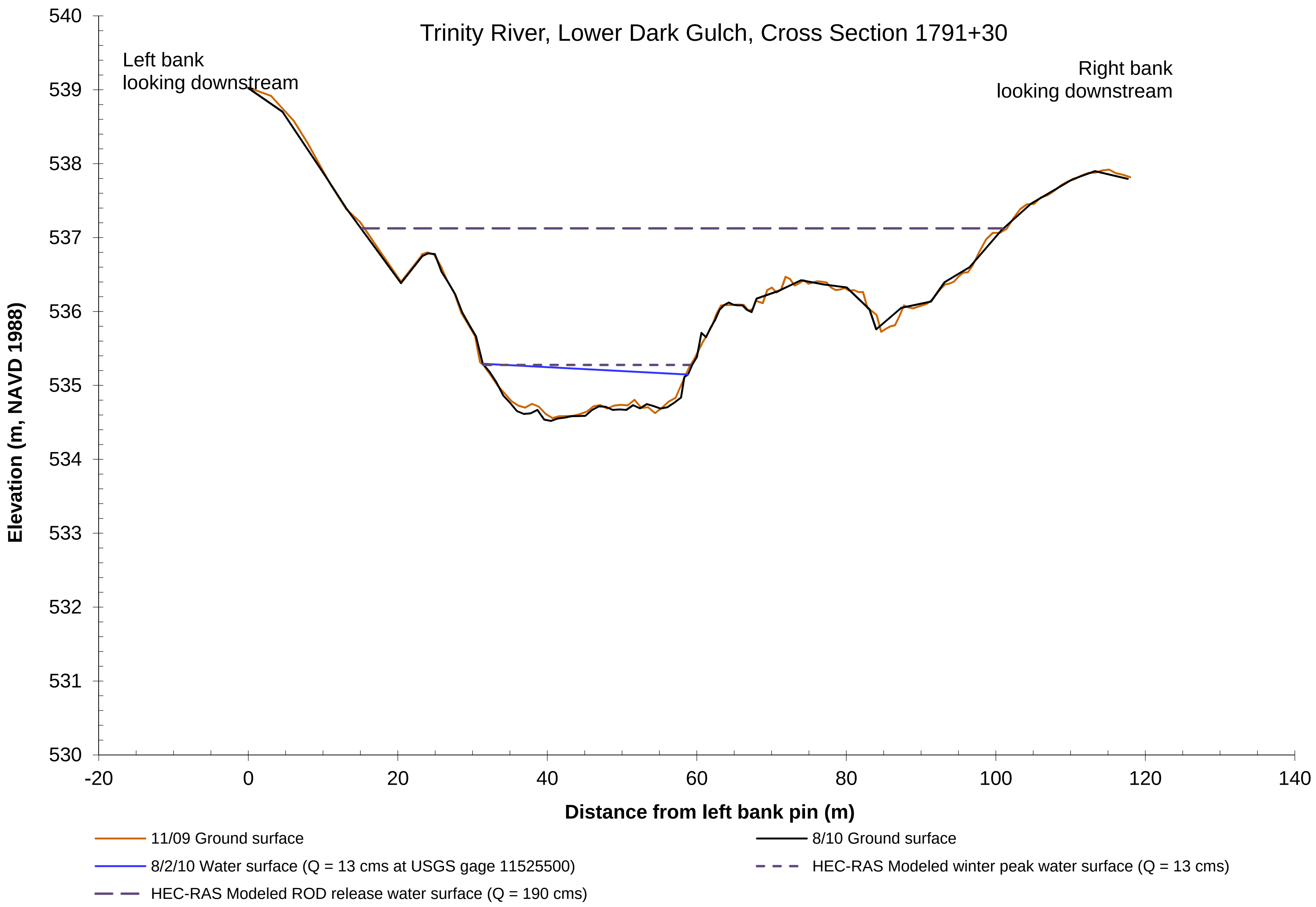

Trinity River, Indian Creek Confluence, Cross Section 1224+50
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
504
503
502
501
500
499
498
497
496
495
494
-20
0
20
40
60
80
100
120
140
Distance from left bank pin (m)
12/09 Ground surface
8/10 Ground surface
8/3/10 Water surface (Q = 13 cms at USGS gages 11525655+11525670)
HEC-RAS Modeled winter peak water surface (Q = 52 cms)
HEC-RAS Modeled ROD release water surface (Q = 200 cms)

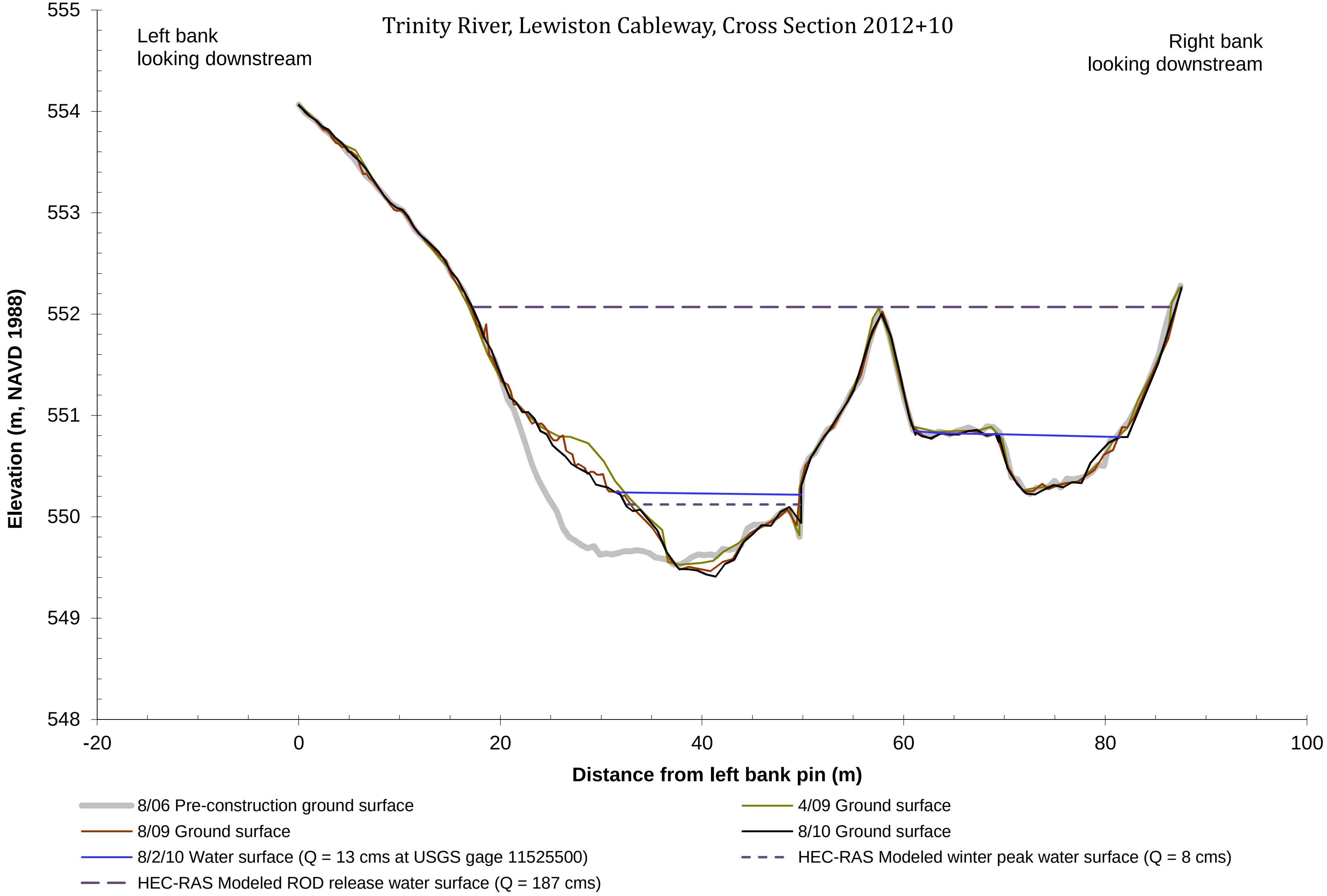

Trinity River, Indian Creek Confluence, Cross Section 1231+00
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
504
503
502
501
500
499
498
497
496
495
494
-20
0
20
40
60
80
100
120
140
160
180
200
Distance from left bank pin (m)
7/09 Ground surface (GEOID 03)
12/09 Ground surface
8/10 Ground surface
8/3/10 Water surface (Q = 13 cms at USGS gages 11525655+11525670)
HEC-RAS Modeled winter peak water surface (Q = 52 cms)
HEC-RAS Modeled winter peak water surface (Q = 200 cms)

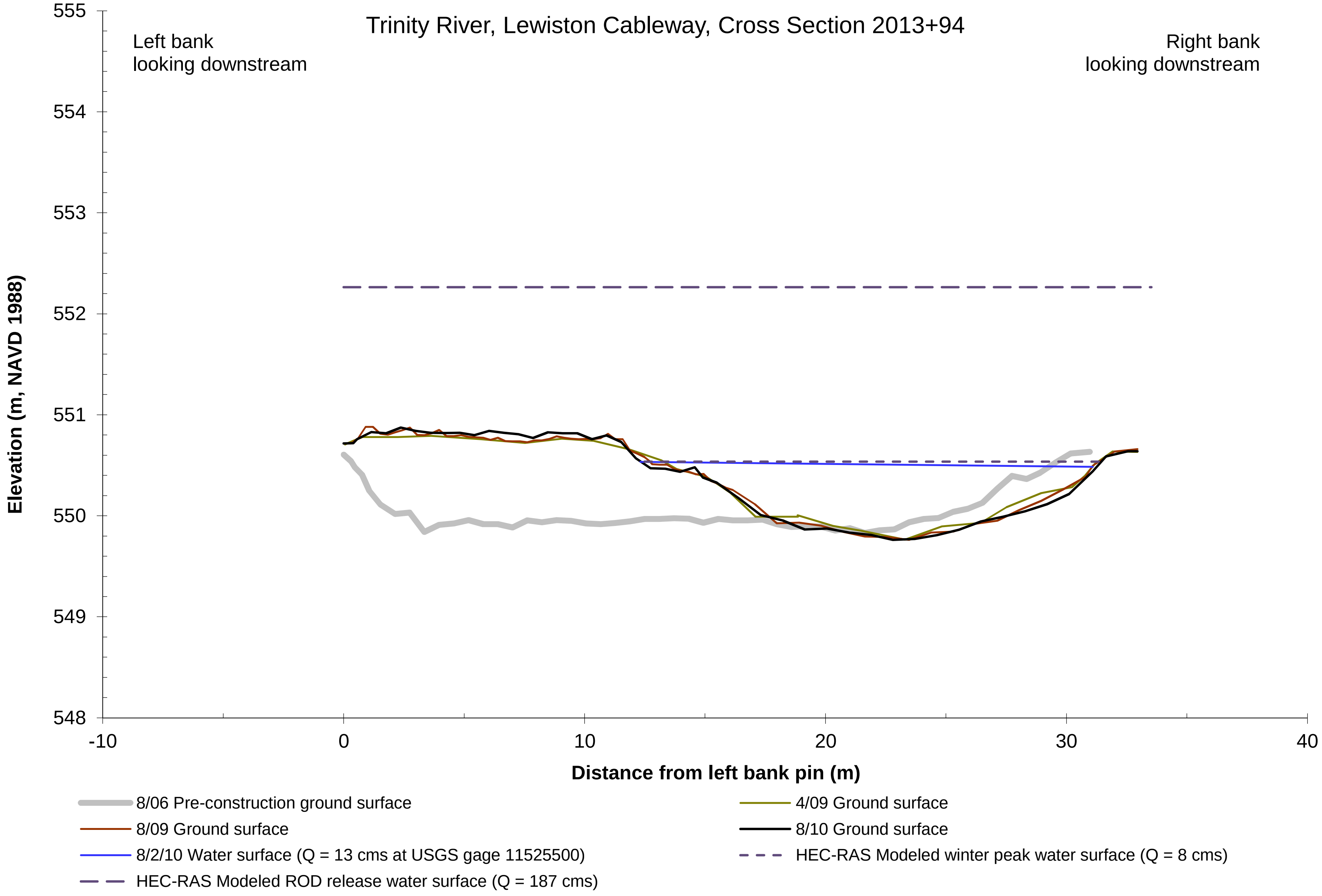

Trinity River, Treadwell Bridge, Cross Section 1348+90
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
510
509
508
507
506
505
504
503
502
501
500
-20
0
20
40
60
80
Distance from left bank pin (m)
11/09 Ground surface
8/10 Ground surface
8/4/10 Water surface (Q = 13 cms at USGS gage 11525655)
HEC-RAS Modeled winter peak water surface (Q = 40 cms)
HEC-RAS Modeled ROD release water surface (Q = 197 cms)


Trinity River, Treadwell Bridge, Cross Section 1356+80
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
510
509
508
507
506
505
504
503
502
501
500
-20
0
20
40
60
80
Distance from left bank pin (m)
11/09 Ground surface
8/10 Ground surface
8/4/10 Water surface (Q = 13 cms at USGS gage 11525655)
HEC-RAS Modeled winter peak water surface (Q = 40 cms)
HEC-RAS Modeled ROD release water surface (Q = 197 cms)


Trinity River, Lower Dark Gulch, Cross Section 1785+70
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
540
539
538
537
536
535
534
533
532
531
530
-100
-80
-60
-40
-20
0
20
40
60
80
100
120
140
Distance from left bank pin (m)
Pre-construction ground surface (2001 photogrammetry + 2005 LiDAR)
3/09 Ground surface
11/09 Ground surface
8/10 Ground surface
8/3/10 Water surface (Q = 13 cms at USGS gage 11525500)
HEC-RAS Modeled winter peak water surface (Q = 13 cms)
HEC-RAS Modeled ROD release water surface (Q = 190 cms)


Trinity River, Lower Dark Gulch, Cross Section 1791+30
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
540
539
538
537
536
535
534
533
532
531
530
-20
0
20
40
60
80
100
120
140
Distance from left bank pin (m)
11/09 Ground surface
8/10 Ground surface
8/2/10 Water surface (Q = 13 cms at USGS gage 11525500)
HEC-RAS Modeled winter peak water surface (Q = 13 cms)
HEC-RAS Modeled ROD release water surface (Q = 190 cms)


Trinity River, Lewiston Cableway, Cross Section 2012+10
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
555
554
553
552
551
550
549
548
-20
0
20
40
60
80
100
Distance from left bank pin (m)
8/06 Pre-construction ground surface
4/09 Ground surface
8/09 Ground surface
8/10 Ground surface
8/2/10 Water surface (Q = 13 cms at USGS gage 11525500)
HEC-RAS Modeled winter peak water surface (Q = 8 cms)
HEC-RAS Modeled ROD release water surface (Q = 187 cms)


Trinity River, Lewiston Cableway, Cross Section 2013+94
Left bank
looking downstream
Right bank
looking downstream
Elevation (m, NAVD 1988)
555
554
553
552
551
550
549
548
-10
0
10
20
30
40
Distance from left bank pin (m)
8/06 Pre-construction ground surface
4/09 Ground surface
8/09 Ground surface
8/10 Ground surface
8/2/10 Water surface (Q = 13 cms at USGS gage 11525500)
HEC-RAS Modeled winter peak water surface (Q = 8 cms)
HEC-RAS Modeled ROD release water surface (Q = 187 cms)

Appendix C. Vascular Plant Species Sampled at 11 GRTS Panel 2 and 12 Channel Rehabilitation Sites in WY 2010.

Narrowleaf willow frequent species*				
Botanical name	**Common name**	**field estimated % cover**	**2009 Statistical Rank**	**2010 Statistical Rank**
Aira caryophyllea	European hairgrass	0.5%	21	26
Alnus rhombifolia	white alder	0.5%	12	26
Bromus secalinus		0.5%	5	47
Bromus tectorum	cheatgrass	0.5 - 18%	3	26
Conyza canadensis	horseweed	0.50%	33	4
Melilotus alba	white sweetclover	0.5 - 4%	5	26
Plantago lanceolata	English plantain	0.5 - 1%	5	4
Rubus discolor	Himalaya blackberry	1 - 83%	1	1
Rubus ursinus	California blackberry	3 - 41%	12	4
Salix exigua	narrowleaf willow	1 - 72%	2	2
Salix lasiolepis	arroyo willow	0.5 - 14%	5	3
Salix melanopsis	dusky willow	2 - 36%	3	7
Verbascum thapsus	mullein	0.5%	5	47
Vitus californica	California grape	0.5 - 18%	5	7

** This includes patches mapped as dusky willow and narrowleaf-dusky willow*

White alder frequent species				
Botanical name	**Common name**	**field estimated % cover**	**2009 Statistical Rank**	**2010 Statistical Rank**
Alnus rhombifolia	white alder	3 - 97%	1	1
Carex nudata	river sedge	0.50%	5	19
Equisetum hyemale	scouring rush	0.5 - 1%	5	7
Phalaris arundinacea	reed canary grass	0.5 - 19%	9	4
Rosa eglanteria	sweet-briar	0.5 - 11%	5	7
Rubus discolor	Himalya blackberry	6 - 91%	1	1
Rubus ursinus	California blackberry	4 - 8%	5	4
Salix exigua	narrowleaf willow	3 - 46%	1	3
Salix lasiolepis	arroyo willow	2 - 9%	4	4

Mixed willow frequent species				
Botanical name	**Common name**	**field estimated % cover**	**2009 Statistical Rank**	**2010 Statistical Rank**
Salix lasiolepis	*arroyo willow*	1 - 57%	1	1
Salix laevigata	*red willow*	4 - 36%	2	3
Salix exigua	*narrowleaf willow*	11 - 39%	2	3
Alnus rhombifolia	*white alder*	2 - 67%	4	9
Equisetum hyemale	*scouring rush*	0.5 - 19%	4	1
Rubus discolor	*Himalaya blackberry*	0.5 - 76%	4	5
Populus balsamifera ssp. *trichocarpa*	*black cottonwood*	0.5 - 11%	4	17

Black cottonwood frequent species				
Botanical name	**Common name**	**field estimated % cover**	**2009 Statistical Rank**	**2010 Statistical Rank**
Populus balsamifera ssp. *trichocarpa*	black cottonwood	23 - 92%	1	1
Rubus discolor	Himalaya blackberry	8 - 29%	1	1
Pinus ponderosa	Ponderosa pine	0.5 - 4%	3	1
Salix exigua	narrowleaf willow	3 - 8%	3	1
Salix lasiolepis	arroyo willow	1 - 6%	3	6
Linaria genistifolia	dalmation toadflax	0.50%	3	6
Melilotus officinale	white sweetclover	9 - 12%	3	26
Equisetum hyemale	scouring rush	0.5 - 7%	3	6
Vitus californica	California grape	0.5 - 9%	9	1
Aira caryophyllea	European hairgrass	0.50%	30	1

Sweet-clover frequent species

Botanical name	**Common name**	**Field estimated % cover**	**2009 Statistical rank**	**2010 Statistical rank**
Salix lasiolepis	arroyo willow	2-4%	1	10
Cirsium vulgare	bull thistle	0.5%	1	10
Melilotus officinale	white sweetclover	76-89%	1	10
Salix laevigata	red willow	2-3%	4	1
Salix lucida ssp. *lasiandra*	shiny willow	4%	40	1
Rubus discolor	Himalaya blackberry	6-9%	4	1
Salix exigua	narrowleaf willow	1-4%	4	1
Conyza canadensis	horseweed	16-42%	4	1
Sonchus asper	prickly sow-thistle	1%	40	1
Equisetum hyemale	scouring rush	0.50%	4	1
Avena barbata	slender wild oat	0.50%	40	1
Phalaris arundinacea	reed canary grass	0.50%	4	1
Chrysothamnus parryi	Parry's rabbitbrush	0.50%	4	10

Non-native grassland frequent species

Botanical name	**Common name**	**field estimated % cover**	**2009 Statistical Rank**	**2010 Statistical Rank**
Avena barbata	slender wild oat	0.5 - 1%	36	7
Bromus secalinus		0.5 - 8%	6	41
Bromus tectorum	cheatgrass	1 - 24%	10	3
Centaurea solstitialis	yellow star-thistle	0.5 - 36%	1	2
Chrysothamnus parryii	stinky aster	0.5 - 36%	1	3
Cichorium intybus	chickory	0.5%	13	18
Conyza canadensis	horseweed	0.5-1%	13	18
Epilobium brachycarpum	dense flowered willowherb	0.5 - 16%	6	41
Grindelia hirsutula	hairy gumweed	0.5-1%	13	15
Hirschfeldia incana	tumble mustard	0.5 - 1%	6	3
Linaria genistifolia	dalmation toadflax	0.5 - 1%	4	3
Lupinus albifrons var. *albifrons*	silver lupine	0.5-1%	13	27
Plantago lanceolata	English plantain	0.5-8%	13	10
Poa bulbosa	bulbous bluegrass	9 - 37%	10	18
Salix exigua	narrowleaf willow	0.5-16%	36	7
Trifolium arvense	white clover	4 - 68%	1	1
Verbascum thapsus	mullein	0.5 - 1%	6	18

Yellow star-thistle grassland frequent species

Botanical name	**Common name**	**field estimated % cover**	**2009 Statistical Rank**	**2010 Statistical Rank**
Artemisia douglasiana	mugwort	0.5-1%	11	4
Avena barbata	slender wild oat	1 - 2%	8	15
Bromus secalinus		0.5 - 1%	3	15
Bromus tectorum	cheatgrass	0.5 - 37%	3	15
Centaurea solstitialis	yellow star-thistle	31 - 86%	1	1
Chrysothamnus parryii	stinky aster	0.5 - 1%	3	15
Elymus elymoides	squirreltail	0.5 - 3%	8	15
Grindelia hirsutula	hairy gumweed	0.5-12%	11	4
Hirschfeldia incana	tumble mustard	0.5 - 16%	3	1
Plantago lanceolata	English plantain	0.5%	11	4
Salix exigua	narrowleaf willow	2 - 9%	8	15
Trifolium arvense	white clover	0.5 - 68%	1	1
Trifolium hirtum	rose clover	3 - 17%	3	15

Open frequent species

Botanical name	**Common name**	**field estimated % cover**	**2009 Statistical Rank**	**2010 Statistical Rank**
Phalaris arundinacea	reed canary grass	0.5 - 3%	1	17
Chrysothamnus parryii	rabbitbrush	1 - 26%	4	4
Salix exigua	narrowleaf willow	0.5 - 24%	2	4
Hirschfeldia incana	tumblemustard	0.5 - 24%	4	4
Melilotus alba	white sweetclover	0.5 - 6%	2	17
Verbascum thapsus	mullein	0.5 - 1%	4	4
Rubus discolor	Himalaya blackberry	0.5 - 1%	4	2
Trifolium arvense	rabbitfoot clover	1 - 3%	8	4
Bromus tectorum	cheat grass	0.5 - 7%	8	1
Salix lasiolepis	arroyo willow	2 - 3%	8	2
Open ground		24 - 99%		
Aira caryophyllea	European hairgrass	0.50%	29	14

SPECIES LIST OF ALL SPECIES SAMPLED AT GRTS PANEL 2 SITES IN WY 2010

Scientific Name	Common Name	Family	Habit	Exotic	USFWS Wetland Indicator Code	Sampled in WY 2010
TREES						
Abies concolor	white fir	Pinaceae	Tree	N		X
Ailanthus altissima	Tree of Heaven	Simaroubaceae	Tree	EX	FACU	X
Alnus rhombifolia	white alder	Betulaceae	Tree	N	FACW	X
Arbutus menziesii	Pacific madrone	Ericaceae	Tree	N		X
Fraxinus latifolia	Oregon ash	Oleaceae	Tree	N	FACW	X
Juglans californica	California black walnut	Juglandaceae	Tree	N	FAC	X
Pinus ponderosa	ponderosa pine	Pinaceae	Tree	N	UPL	X
Pinus sabiniana	grey pine	Pinaceae	Tree	N		X
Populus balsamifera ssp. *trichocarpa*	black cottonwood	Salicaceae	Tree	N	FACW	X
Populus fremontii	Fremont cottonwood	Salicaceae	Tree	N	FAC+*	X
Quercus chrysolepis	canyon live oak	Fagaceae	Tree	N		X
Quercus garryana	Oregon white oak	Fagaceae	Tree	N		X
Quercus kelloggii	California black oak	Fagaceae	Tree	N		X
Quercus wislizenii	interior live oak	Fagaceae	Tree	N		
Robinia pseudoacacia	black locust	Fabaceae	Tree	EX	FACU	
Salix laevigata	red willow	Salicaceae	Tree	N	FACW	X
Salix lucida ssp. *lasiandra*	shiny willow	Salicaceae	Tree	N	OBL	X
SHRUBS						
Amelanchier alnifolia	western serviceberry	Rosaceae	Shrub	N	FACU	
Arctostaphylos manzanita	whiteleaf manzanita	Ericaceae	Shrub	N		
Arctostaphylos sp.	manzanita	Ericaceae	Shrub	N		
Brickellia californica	California bricklebush	Asteraceae	Shrub	N	FACU	
Cercocarpus betuloides	mountain-mahogany	Rosaceae	Shrub	N		
Ceanothus cuneatus	buck brush	Rhamnaceae	Shrub	N		
Ceanothus integerrimus	deer brush	Rhamnaceae	Shrub	N		
Chrysothamnus parryii	Parry's rabbitbrush	Asteraceae	Shrub	N		X
Clematis ligusticifolia	virgin's bower	Ranunculaceae	Shrub	N	FAC	X
Cornus sericea	redtwig dogwood	Cornaceae	Shrub	N	FACW	
Cytisus scoparius	Scotch broom	Fabaceae	Shrub	EX		
Datisca glomerata	durango root	Datiscaceae	Shrub	N	FACW	X
Garrya fremontii	Fremont silktassel	Garryaceae	Shrub	N		X
Lupinus albifrons var. *albifrons*	silverleaf lupine	Fabaceae	Shrub	N		X
Physocarpus capitatus	ninebark	Rosaceae	Shrub	N	FACW	
Rhamnus ilicifolia	hollyleaf redberry	Rhamnaceae	Shrub	N		
Rhus trilobata	skunkbrush	Anacardiaceae	Shrub	N	FACU*	
Ribes inerme	white-stemmed gooseberry	Grossulariaceae	Shrub	N	FAC+	X
Ribes menziesii	canyon gooseberry	Grossulariaceae	Shrub	N		
Rosa nutkana	Nutka's rose	Rosaceae	Shrub	N	FAC*	
Rosa eglanteria	sweet-briar	Rosaceae	Shrub	EX	FACU*	X
Rubus discolor	Himalayan blackberry	Rosaceae	Shrub	EX	FAC+	X
Rubus laciniatus	cutleaf blackberry	Rosaceae	Shrub	EX	FAC+	
Rubus ursinus	California blackberry	Rosaceae	Shrub	N	FAC+	X
Salix exigua	narrowleaf willow	Salicaceae	Shrub	N	FACW	X
Salix lasiolepis	arroyo willow	Salicaceae	Shrub	N	FACW	X
Salix melanopsis	dusky willow	Salicaceae	Shrub	N	FACW	X
Smilax californica	California greenbriar	Liliaceae	Shrub	N		
Spiraea douglasii	western spiraea, hardhack	Rosaceae	Shrub	N	OBL	
Symphoricarpos albus var. *laevigatus*	snowberry	Caprifoliaceae	Shrub	N	FACU	
Toxicodendron diversilobum	poison oak	Anacardiaceae	Shrub	N		
Vitus californica	California grape	Vitaceae	Vine	N	FACW	X
HERBS						
Amaranthus watsonii	Watson's amaranth	Amaranthaceae	Herb	N	FACW*	X
Amsinckia tessellata	devil's lettuce	Boraginaceae	Herb	N		X
Anthemis arvensis	corn chamomile	Asteraceae	Herb	EX	FACU	
Anthriscus caucalis	bur-chervil	Apiaceae	Herb	EX		X
Artemisa douglasiana	mugwort	Asteraceae	Herb	N	FAC+	X
Asclepias fascicularis	narrowleaf milkweed	Asclepiadaceae	Herb	N	FAC	
Asclepias speciosa	showy milkweed	Asclepiadaceae	Herb	N	FAC	

Scientific Name	Common Name	Family	Habit	Exotic	USFWS Wetland Indicator Code	Sampled in WY 2010
Madia sp.	tarweed	Asteraceae	Herb	N		
Marrubium vulgare	horehound	Lamiaceae	Herb	EX	FACU	X
Medicago sp.	burclover	Fabaceae	Herb	EX		
Melilotus officinale	white sweet clover	Fabaceae	Herb	EX	FACU	X
Mentha arvensis	wild mint	Lamiaceae	Herb	EX	FACW	
Mentha pulegium	pennyroyal	Lamiaceae	Herb	EX	OBL	X
Mentha spicata	spearmint	Lamiaceae	Herb	EX	OBL	
Mimulus cardinalis	scarlet monkeyflower	Scrophulariaceae	Herb	N	OBL	X
Mimulus dentatus	toothed monkeyflower	Scrophulariaceae	Herb	N	OBL	
Mimulus guttatus	stream monkeyflower	Scrophulariaceae	Herb	N	FACW+	
Mimulus pilosus	downy monkeyflower	Scrophulariaceae	Herb	N		
Myosotis latifolia	forget-me-not	Boraginaceae	Herb	EX		
Myosotis laxa	bay forget-me-not	Boraginaceae	Em Herb	N	OBL	
Navarretia squarrosa	skunkweed	Polemoniaceae	Herb	N	FACU	
Nicotiana sylvestris		Solanaceae	Herb	EX		
Oenothera elata	evening primrose	Onagraceae	Herb	N	FACW	X
Petrorrhagia dubia	hairypink	Caryophyllaceae	Herb	EX		X
Phacelia corymbosa	phacelia	Hydrophyllaceae	Herb	N		
Plantago lanceolata	English plantain	Plantaginaceae	Herb	EX	FAC-	X
Plantago major	common plantain	Plantaginaceae	Herb	EX	FAC	X
Polygonum arenastrum	common knotweed	Polygonaceae	Herb	EX	FAC	X
Polygonum hydropiper	waterpepper	Polygonaceae	Em Herb	EX	OBL	
Polygonum hydropiperoides	waterpepper	Polygonaceae	Em Herb	N	OBL	X
Polygonum persicaria	lady's thumb	Polygonaceae	Em Herb	EX	FACW	
Polygonum sp.	knotweed	Polygonaceae	Herb			
Prunella vulgaris	self-heal	Lamiaceae	Herb	EX	FAC*	X
Ranunculus californicus	California buttercup	Ranunculaceae	Herb	N	FAC	
Reseda lutea	yellow mignonette	Resedacaeae	Herb	EX	UPL	
Rumex acetosella	sheep-sorrel	Polygonaceae	Herb	EX	FAC-	
Rumex conglomeratus	clustered dock	Polygonaceae	Herb	EX	FACW	
Rumex crispus	curly dock	Polygonaceae	Herb	EX	FACW-	X
Rumex hymenosepalus	wild rhubarb	Polygonaceae	Herb	N		X
Rumex obtusifolius	bitter dock	Polygonaceae	Herb	EX	FACW	
Rumex salicifolius	willow dock	Polygonaceae	Herb	N	OBL	X
Rumex sp.	dock	Polygonaceae	Herb			X
Sanguisorba minor ssp. *muricata*	garden burnett	Rosaceae	Herb	EX	FACU*	
Sanguisorba occidentalis	western burnett	Rosaceae	Herb	N		
Saponaria officinalis	soapwort	Caryophyllaceae	Herb	EX	FACU	
Silene californica	Indian pink	Caryophyllaceae	Herb	N		
Solidago multiradiata	northern goldenrod	Asteraceae	Herb	N	FACU	X
Sonchus asper	prickly sow-thistle	Asteraceae	Herb	EX	FAC	X
Sonchus oleracea	common sow-thistle	Asteraceae	Herb	EX	NI*	
Spergula arvensis	corn spurry	Caryophyllaceae	Herb	EX		
Spergularia rubra	red sand-spurry	Caryophyllaceae	Herb	EX	FAC-	
Stachys ajugoides	hedgenettle	Lamiaceae	Herb	N	OBL	X
Taraxacum officinale	dandelion	Asteraceae	Herb	EX	FACU	
Torilis arvense	torilis	Apiaceae	Herb	EX		X
Tragopogon sp.	goat's-beard	Asteraceae	Herb	EX		X
Tragopogon dubius	goat's-beard	Asteraceae	Herb	EX		
Tragopogon porrifolius	salsify	Asteraceae	Herb	EX		
Tribulus terrestris	puncture-vine	Zygophyllaceae	Herb	EX		
Trichostema laxum	turpentine weed	Lamiaceae	Herb	N		X
Trifolium arvense	rabbitfoot clover	Fabaceae	Herb	EX		X
Trifolium dubium	shamrock	Fabaceae	Herb	EX	FACU*	
Trifolium hirtum	rose clover	Fabaceae	Herb	EX		X
Trifolium microcephalum	maiden clover	Fabaceae	Herb	N	FACU	
Trifolium pratense	red clover	Fabaceae	Herb	EX	FACU+	X
Trifolium repens	white clover	Fabaceae	Herb	EX	FAC	
Trifolium subterraneum	subterranean clover	Fabaceae	Herb	EX		
Trifolium wildenovii	tomcat clover	Fabaceae	Herb	N	NI	
Triphysaria eriantha	butter and eggs	Scrophulariaceae	Herb	EX		

Scientific Name	Common Name	Family	Habit	Exotic	USFWS Wetland Indicator Code	Sampled in WY 2010
Asparagus officinalis	domestic asparagus	Liliaceae	Herb	EX		
Brassica nigra	black mustard	Brassicaceae	Herb	EX		
Calycadenia spicata	spiked western rosinweed	Asteraceae	Herb	N		
Capsella bursa-pastoris	shepherd's purse	Brassicaceae	Herb	EX	FAC-	
Centaurea solstitialis	star thistle	Asteraceae	Herb	EX		X
Centaurium muehlenbergia	centaury	Gentianaceae	Herb	N	FAC	
Chamaesyce maculata	spotted spurge	Euphorbiaceae	Herb	EX	FACU*	X
Chamerion angustifolium ssp. *circumvagum*	fireweed	Onagraceae	Herb	N	FAC	
Chamomilla suaveolens	pineapple weed	Asteraceae	Herb	EX		
Chenopodium ambrosioides	Mexican tea	Chenopodiaceae	Herb	EX	FAC	X
Chenopodium botrys	Jerusalem oak	Chenopodiaceae	Herb	EX	FACU	X
Cichorium intybus	chickory	Asteraceae	Herb	EX		X
Cirsium vulgare	Bull thistle	Asteraceae	Herb	EX	FAC	X
Clarkia sp.		Onagraceae	Herb	N		X
Collomia grandiflora	collomia	Polemoniaceae	Herb	N		
Conium maculatum	poison hemlock	Apiaceae	Herb	EX	FAC	X
Convolvulus arvensis	bindweed	Convolvulaceae	Herb	EX		X
Conyza canadensis	horseweed	Asteraceae	Herb	N	FAC	X
Conyza floribunda	asthmaweed	Asteraceae	Herb	EX		
Cryptantha flaccida	weakstem cryptantha	Boraginaceae	Herb	N		
Cuscuta sp.	dodder	Cuscutaceae	Herb			
Daucus carota	Queen Anne's Lace	Apiaceae	Herb	EX		X
Daucus pusillus	wild carrot	Apiaceae	Herb	N		
Dipsacus fullonum	wild teasel	Dipasaceae	Herb	EX	FACW-	
Epilobium brachycarpum	tall annual willowherb	Onagraceae	Herb	N		X
Epilobium ciliatum	fringed willowherb	Onagraceae	Herb	N	FACW	X
Epilobium sp.		Onagraceae	Herb			
Eremocarpus setigerus	turkey mullein	Euphorbiaceae	Herb	N		X
Eriogonum nudum	naked buckwheat	Polygonaceae	Herb	N		
Eriogonum roseum	wand buckwheat	Polygonaceae	Herb	N		
Eriogonum umbellatum	yellow buckwheat	Polygonaceae	Herb	N		
Eriogonum vimineum	wicker buckwheat	Polygonaceae	Herb	N		
Eriogonum sp.	buckwheat	Polygonaceae	Herb	N		X
Eriophyllum lanatum	woolly sunflower	Asteraceae	Herb	N		
Erodium botrys	longbeak stork's bill	Geraniaceae	Herb	EX	FACU*	
Erodium cicutarium	redstem stork's bill	Geraniaceae	Herb	EX		
Eschscholzia californica	California poppy	Papaveraceae	Herb	N		
Euthamia occidentalis	western goldenrod	Asteraceae	Herb	N	OBL	
Galium parisiense	wall bedstraw	Rubiaceae	Herb	EX	FACU	
Galium trifidum		Rubiaceae	Herb	N		
Gnaphalium palustre	western marsh cudweed	Asteraceae	Herb	N	FACW	X
Grindelia hirsutula	hairy gumweed	Asteraceae	Herb	N	FACW	X
Hirschfeldia incana	tumblemustard	Brassicaceae	Herb	EX	UPL	X
Hypericum perforatum	St. John's wort	Hypericaceae	Herb	EX		X
Hypochaeris radicata	rough cat's-ear	Asteraceae	Herb	EX	FACU	X
Lactuca serriola	prickly lettuce	Asteraceae	Herb	EX	FAC	X
Lathyrus latifolius	perennial sweet-pea	Fabaceae	Herb	EX		X
Lepidium densiflorum	common pepperweed	Brassicaceae	Herb	N	FAC	
Lepidium latifolium	pepperweed	Brassicaceae	Herb	EX	FACW	X
Lessingia nemaclada	threadstem lessingia	Asteraceae	Herb	N		
Leucanthemum vulgare	Shasta daisy	Asteraceae	Herb	EX	NI	
Linaria genistifolia	dalmation toadflax	Fabaceae	Herb	EX		X
Lotus corniculatus	bird's-foot trefoil	Fabaceae	Herb	EX	FAC	
Lotus humistratus	lotus	Fabaceae	Herb	N		X
Lotus micranthus	small-flowered lotus	Fabaceae	Herb	N		X
Lotus purshianus	pink lotus	Fabaceae	Herb	N		
Lupinus bicolor	miniature lupine	Fabaceae	Herb	N		X
Lythrum hyssopifolium	hyssop loosestrife	Lythraceae	Herb	EX	FACW	
Madia elegans	common madia	Asteraceae	Herb	N		
Madia exigua	threadstem madia	Asteraceae	Herb	N		
Madia gracilis	slender tarweed	Asteraceae	Herb	N		

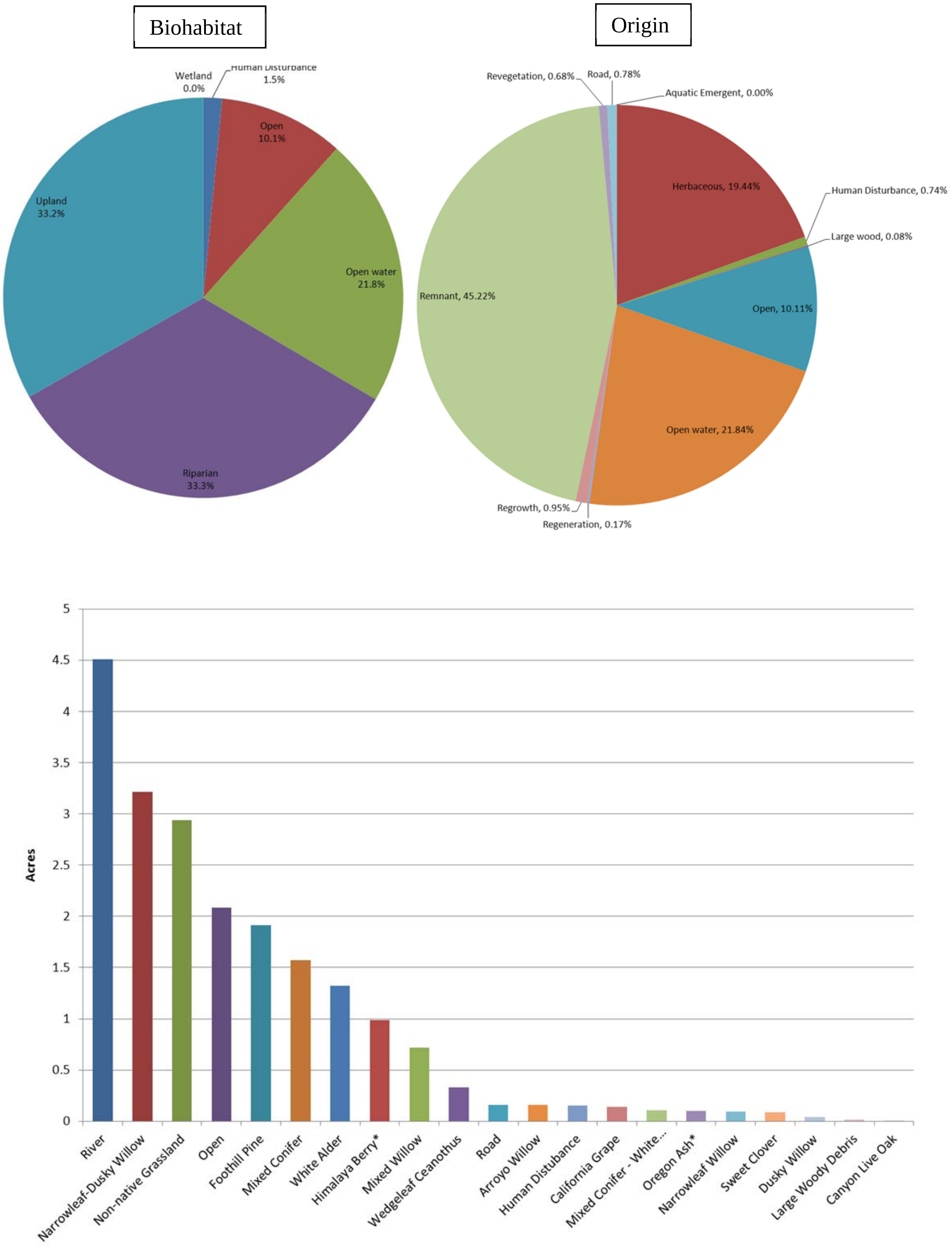
Scientific Name	Common Name	Family	Habit	Exotic	USFWS Wetland Indicator Code	Sampled in WY 2010
Urtica dioica	stinging nettle	Urticaceae	Herb	N	FACW	
Verbascum blattaria	moth mullein	Scrophulariaceae	Herb	EX	FACU*	X
Verbascum thapsus	common mullein	Scrophulariaceae	Herb	EX	NI	X
Verbena lasiostachys	western vervain	Verbenaceae	Herb	N	FAC-	X
Veronica americana	American brooklime	Scrophulariaceae	Herb	N	OBL	X
Veronica anagallis-aquatica	water speedwell	Scrophulariaceae	Herb	EX	OBL	
Vicia sativa	vetch	Fabaceae	Herb	EX	FACU	
Xanthium strumarium	cocklebur	Asteraceae	Herb	N	FAC+	X
EMERGENT AQUATICS						
Carex deweyana	Dewey's sedge	Cyperaceae	Herb	N		
Carex nudata	riverbar sedge	Cyperaceae	Em Herb	N	FACW	X
Carex obnupta	slough sedge	Cyperaceae	Em Herb	N	OBL	
Carex pachystachya	chamisso sedge	Cyperaceae	Em Herb	N	FACW	
Carex phaeocephala	dunhead sedge	Cyperaceae	Em Herb	N	FACU*	
Carex utriculata	beaked sedge	Cyperaceae	Em Herb	N	NI	
Cyperus eragrostis	umbrella sedge	Cyperaceae	Em Herb	N	FACW	X
Cyperus esculentus	yellow nutsedge	Cyperaceae	Em Herb	EX	FACW	X
Darmera peltata	Indian rhubarb	Saxifragaceae	Em Herb	N	OBL	
Elodea canadensis	common waterweed	Hydrocharitaceae	Aq Herb	N	OBL	
Equisetum arvense	common horsetail	Equisetaceae	Em Herb	N	FAC	X
Equisetum hyemale	common scouring rush	Equisetaceae	Em Herb	N	FACW	X
Equisetum telmateia	giant horsetail	Equisetaceae	Em Herb	N	OBL	
Juncus articulatus	jointleaf rush	Juncaceae	Em Herb	N	OBL	
Juncus balticus	Baltic rush	Juncaceae	Em Herb	N	FACW+	
Juncus bolanderi	Bolander's rush	Juncaceae	Em Herb	N	OBL	X
Juncus bufonius	toad rush	Juncaceae	Em Herb	N	FACW+	
Juncus covillei	Coville's rush	Juncaceae	Herb	N	FACW	X
Juncus effusus	common rush	Juncaceae	Herb	N	FACW+	X
Juncus patens	spreading rush	Juncaceae	Herb	N	FAC	X
Juncus xiphioides	irisleaf rush	Juncaceae	Herb	N	OBL	X
Juncus sp.		Juncaceae	Herb	N		
Lemna sp.	duckweed	Lemnaceae	Em Herb	N	OBL	
Myriophyllum aquaticum	parrot's feather	Haloragaceae	Aq Herb	EX	OBL	
Potamogeton crispus	cripate-leaved pondweed	Potamogetonaceae	Aq Herb	EX	OBL	
Potamogeton foliosus var. *foliosus*	leafy pondweed	Potamogetonaceae	Aq Herb	N	OBL	
Potamogeton nodosus	long-leaved pondweed	Potamogetonaceae	Aq Herb	N	OBL	
Ranunculus aquatilus	whitewater crowfoot	Ranunculaceae	Aq Herb	N	OBL	
Rorippa curvipes	bluntleaf yellowcress	Brassicaceae	Em Herb	N	OBL	
Rorippa nasturtium-aquaticum	watercress	Brassicaceae	Herb	N	OBL	
Scirpus acutus var. *occidentalis*	tule	Cyperaceae	Em Herb	N	OBL	
Scirpus cernuus	fiber optic grass	Cyperaceae	Em Herb	N	OBL	
Scirpus microcarpus		Cyperaceae	Herb	N	OBL	
Sparganium sp.	bur-reed	Typhaceae	Em Herb	N	OBL	
Typha latifolia	cattail	Typhaceae	Em Herb	N	OBL	X
GRASSES						
Achnatherum lemmonii	Lemmon's needlegrass	Poaceae	Grass	N		
Agrostis capillaris	colonial bent	Poaceae	Grass	EX	FAC	X
Agrostis stolonifera	bent grass	Poaceae	Grass	EX	FACW	
Agrostis sp.	bent grass	Poaceae	Grass			X
Aira caryophyllea	european hairgrass	Poaceae	Grass	EX	NI	X
Avena barbata	slender wild oat	Poaceae	Grass	EX		
Avena fatua	wild oat	Poaceae	Grass	EX		X
Briza minor	rattlesnake grass	Poaceae	Grass	EX	FACU	
Bromus carinatus	California brome	Poaceae	Grass	N		
Bromus diandrus	ripgut grass	Poaceae	Grass	EX		X
Bromus hordeaceous	soft chess	Poaceae	Grass	EX	FACU-	X
Bromus madritensis ssp. *rubens*	foxtail chess	Poaceae	Grass	EX	UPL	
Bromus secalinus		Poaceae	Grass	EX		X
Bromus tectorum	cheat grass	Poaceae	Grass	EX		X
Cynodon dactylon	bermuda grass	Poaceae	Grass	EX	FACU	X
Cynosurus echinatus	hedgehog dogtail	Poaceae	Grass	EX		X

Scientific Name	Common Name	Family	Habit	Exotic	USFWS Wetland Indicator Code	Sampled in WY 2010
Dactylis glomerata	orchard grass	Poaceae	Grass	EX	FACU	
Echinochloa crus-galli	barnyard grass	Poaceae	Grass	EX	FACW	
Elymus elymoides	squirreltail	Poaceae	Grass	N	FACU-	X
Elymus glaucus	blue wildrye	Poaceae	Grass	N	FACU	X
Elytrigia pontica ssp. *pontica*	tall wheatgrass	Poaceae	Grass	EX		
Eragrostis pectinacea var. *pectinacea*	tufted lovegrass	Poaceae	Grass	N	FAC	
Festuca arundinacea	tall fescue	Poaceae	Grass	EX	FAC-	X
Festuca californica	California fescue	Poaceae	Grass	N	FACU*	
Glyceria elata	fowl mannagrass	Poaceae	Grass	N	OBL	X
Holcus lanatus	velvet grass	Poaceae	Grass	EX	FAC	X
Hordeum jubatum	foxtail barley	Poaceae	Grass	N	FAC+	
Leersia oryzoides	rice cutgrass	Poaceae	Grass	N	OBL	
Leymus triticoides	creeping wildrye	Poaceae	Grass	N	FAC+	X
Lolium perenne	perennial ryegrass	Poaceae	Grass	EX	FAC*	
Panicum capillare	witchgrass	Poaceae	Grass	N	FAC	X
Phalaris arundinacea	reed canary grass	Poaceae	Grass	N	OBL	X
Phalaris aquatica	Harding grass	Poaceae	Grass	EX	FAC	
Phleum pratense	cultivated timothy	Poaceae	Grass	EX	FAC	X
Pleuropogon californicus	California semaphore grass	Poaceae	Grass	N		
Poa annua	annual bluegrass	Poaceae	Grass	EX	FAC	
Poa bulbosa	bulbous bluegrass	Poaceae	Grass	EX		X
Poa pratensis	Kentucky bluegrass	Poaceae	Grass	EX	FAC	X
Polypogon monspeliensis	annual beard grass	Poaceae	Grass	EX	FACW+	X
Setaria sp.	bristlegrass	Poaceae	Grass	EX		
Sorghum halepense	Johnsongrass	Poaceae	Grass	EX	FACU	
Taeniatherum caput-medusae	medusahead	Poaceae	Grass	EX		X
Triticum aestivum	cultivated wheat	Poaceae	Grass	EX		
Vulpia microstachys	annual fescue	Poaceae	Grass	N		
Vulpia myuros	annual fescue	Poaceae	Grass	EX	FACU	X

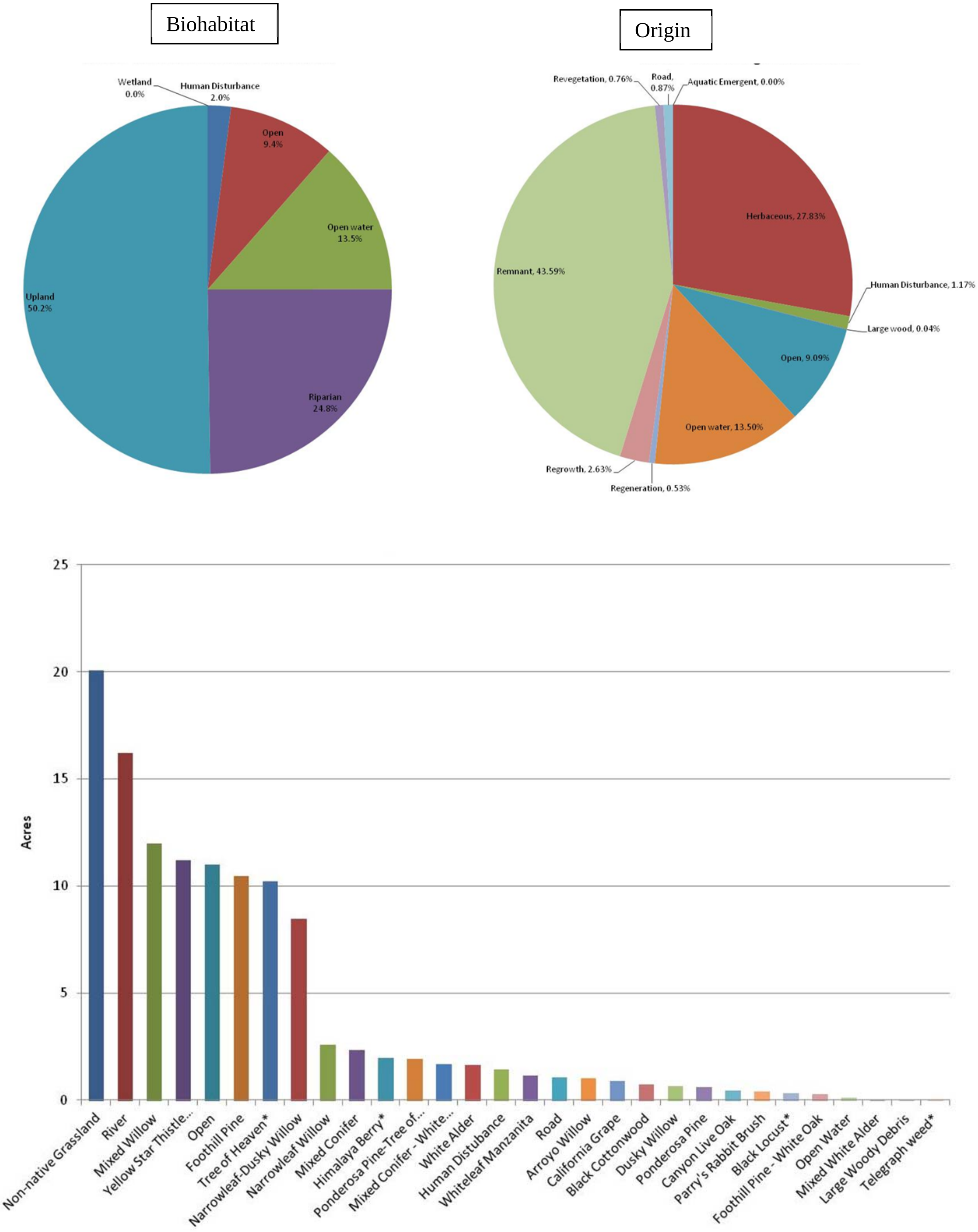
Appendix D. Crosswalk Between Vegetation Patch Types Used in the Current WY 2010 Study and Alliances in Sawyer et al. (2008).

Patch Type Used in Current Study	**Corresponding Sawyer et al. (2008) Alliance**
Aquatic Emergent	several corresponding Alliances
Arroyo Willow	*Salix lasiolepis* Shrubland Alliance
Basket Bush	*Rhus trilobata* Provisional Alliance
Bigleaf Maple	*Acer macrophyllum* Forest Alliance
Black Cottonwood	*Populus trichocarpa* Forest Alliance
Black Locust	no corresponding Alliance
Black Walnut	*Juglans hindsii* and Hybrids Special and Semi-Natural Woodland Stands
California Black Oak	*Quercus kelloggii* Forest Alliance
California Grape	no corresponding Alliance
Canyon Live Oak	*Quercus chrysolepis* Forest Alliance
Cattail	*Typha (angustifolia, domingensis, latifolia)* Herbaceous Alliance
Dog Fennel	no corresponding Alliance
Douglas-fir	*Pseudotsuga menziesii* Forest Alliance
Dusky Willow	*Salix exigua* Shrubland Alliance
Foothill Pine	*Pinus sabiniana* Woodland Alliance
Foothill Pine-Canyon Live Oak	*Pinus sabiniana* Woodland Alliance
Foothill Pine-White Oak	*Pinus sabiniana* Woodland Alliance
Fremont Cottonwood	*Populus fremontii* Forest Alliance
Himalaya Berry	*Rubus armeniacus* Semi-Natural Shrubland Stands
Human Distubance	no corresponding Alliance
Incense Cedar	*Calocedrus decurrens* Forest Alliance
Indian Rhubarb	several corresponding Alliances
Juncus	*Juncus effusus* Herbaceous Alliance
Large Woody Debris	no corresponding Alliance
Madrone	*Arbutus menziesii* Forest Alliance
Mixed Conifer	several corresponding Alliances
Mixed Conifer - White Oak	several corresponding Alliances
Mixed White Alder	*Alnus rhombifolia* Forest Alliance
Mixed Willow	several corresponding Alliances
Mugwort	no corresponding Alliance
Narrowleaf Willow	*Salix exigua* Shrubland Alliance
Narrowleaf-Dusky Willow	*Salix exigua* Shrubland Alliance
Native Grasses	several corresponding Alliances
Non-native Grassland	several corresponding Alliances
Nut-sedge	no corresponding Alliance
Open	no corresponding Alliance
Open Water	no corresponding Alliance
Oregon Ash	*Fraxinus latifolia* Forest Alliance
Oregon goldenaster	no corresponding Alliance
Oregon White Oak	*Quercus garryana* Woodland Alliance
Planted Grasses	no corresponding Alliance
Ponderosa Pine	*Pinus ponderosa* Forest Alliance
Ponderosa Pine-Tree of Heaven	*Pinus ponderosa* Forest Alliance
Red Willow	*Salix laevigata* Woodland Alliance
River	no corresponding Alliance
Road	no corresponding Alliance
Rose	no corresponding Alliance
Scotch Broom	Broom (*Cytisus scoparius* and Others) Semi-natural Shrubland Stands
Sedge	several corresponding Alliances
Shiny Willow	*Salix lucida* Woodland Alliance
Straggly Gooseberry	no corresponding Alliance
Sweetclover	no corresponding Alliance
Sweetbriar Rose	no corresponding Alliance
Tailings Pile	no corresponding Alliance
Tree of Heaven*	no corresponding Alliance
Wedgeleaf Ceanothus	*Ceanothus cuneatus* Shrubland Alliance
Western Chokecherry	*Prunus virginiana* Provisional Shrubland Alliance
White Alder	*Alnus rhombifolia* Forest Alliance
Whiteleaf Manzanita	*Arctostaphylos manzanita* Provisional Shrubland Alliance
Yellow Star-thistle Grassland	*Centaurea (solstitialis, melitensis)* Semi-natural Stands

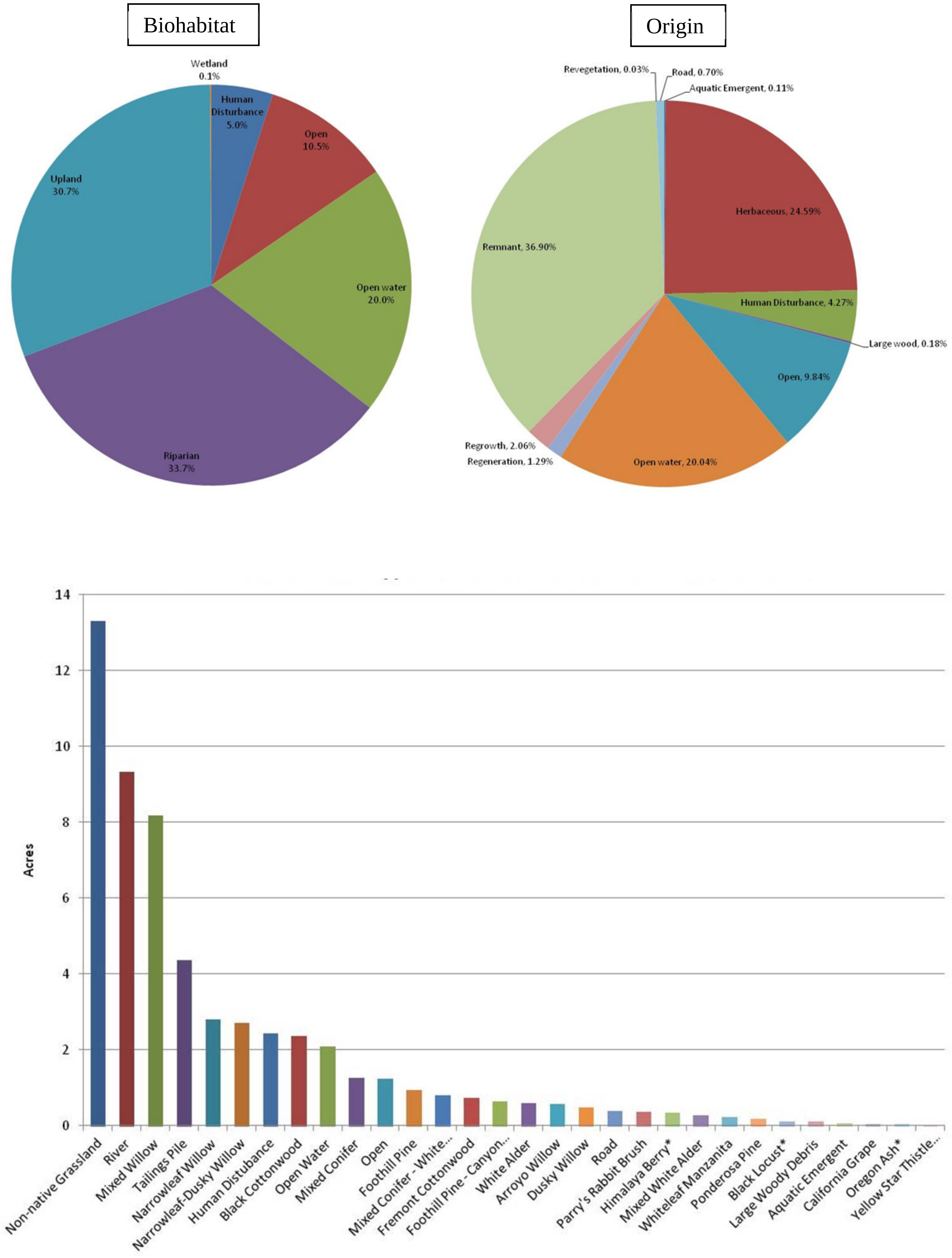
Appendix E. Abundance of Biohabitats, Patch Type Origins, and Individual Patch Types Mapped at 12 Channel Rehabilitation Sites in WY 2010.



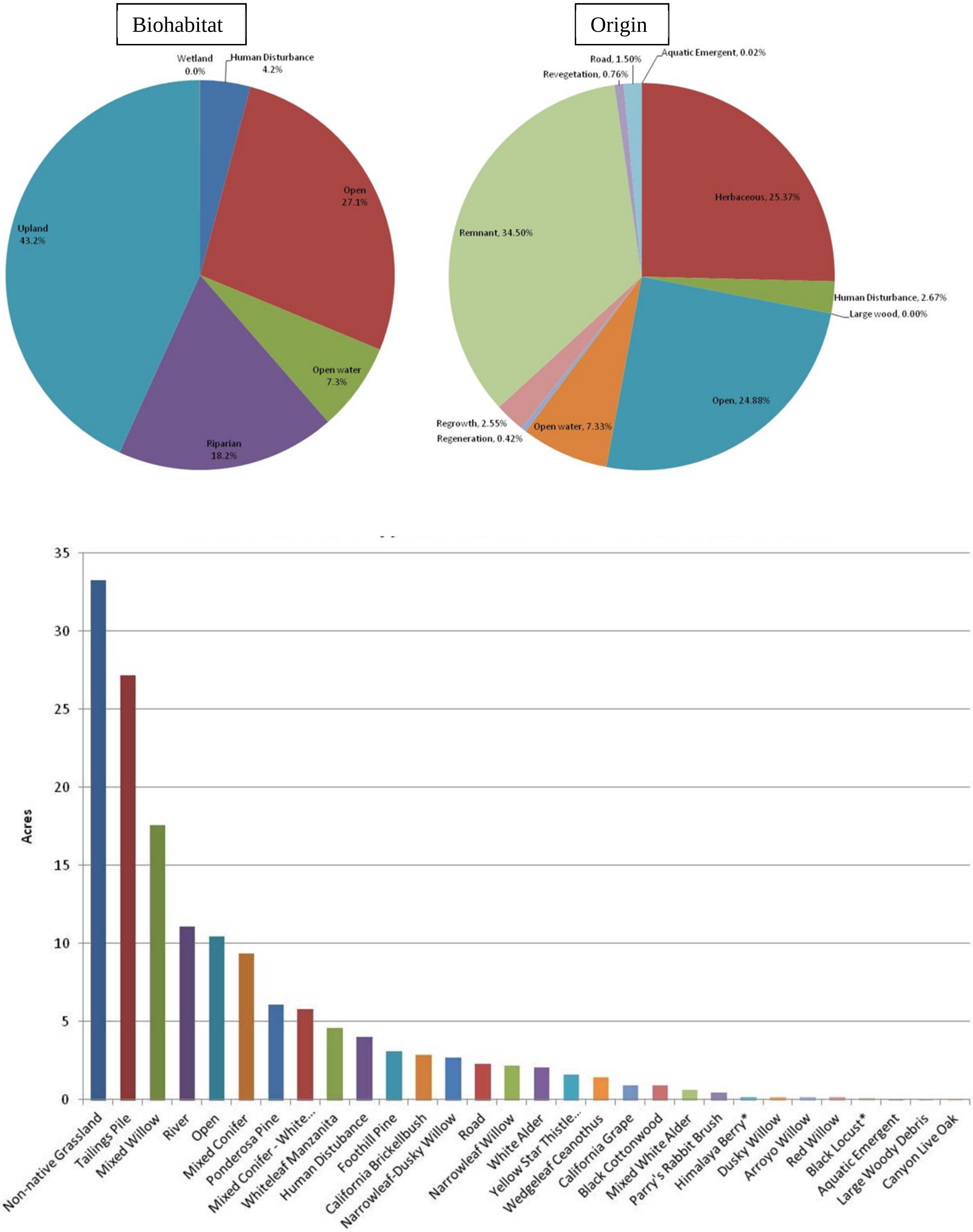
Pear Tree Gulch channel rehabilitation site: abundance of biohabitats, patch type origins, and individual patch types mapped in WY 2010.



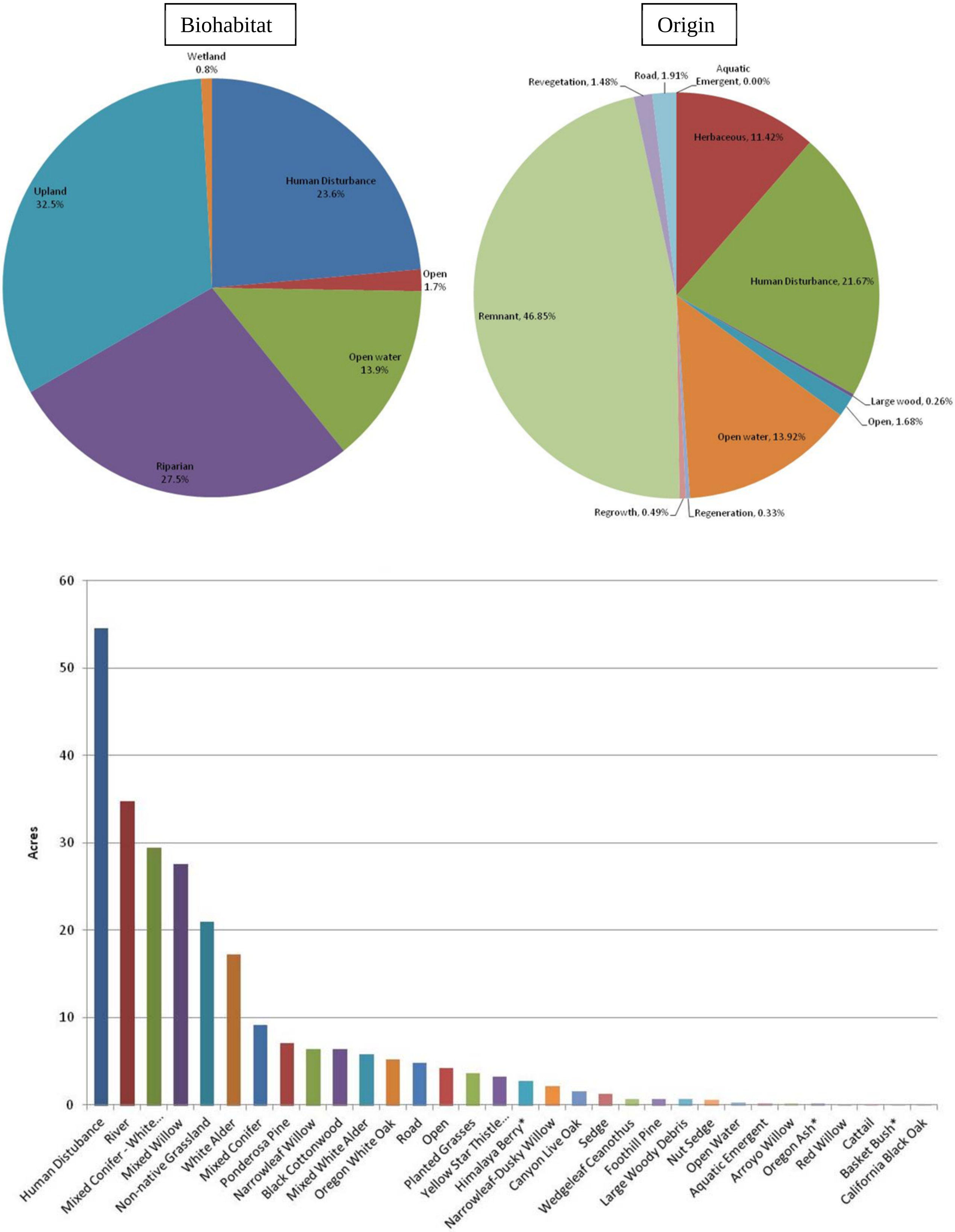
Mid Valdor Gulch channel rehabilitation site: abundance of biohabitats, patch type origins, and individual patch types mapped in WY 2010.



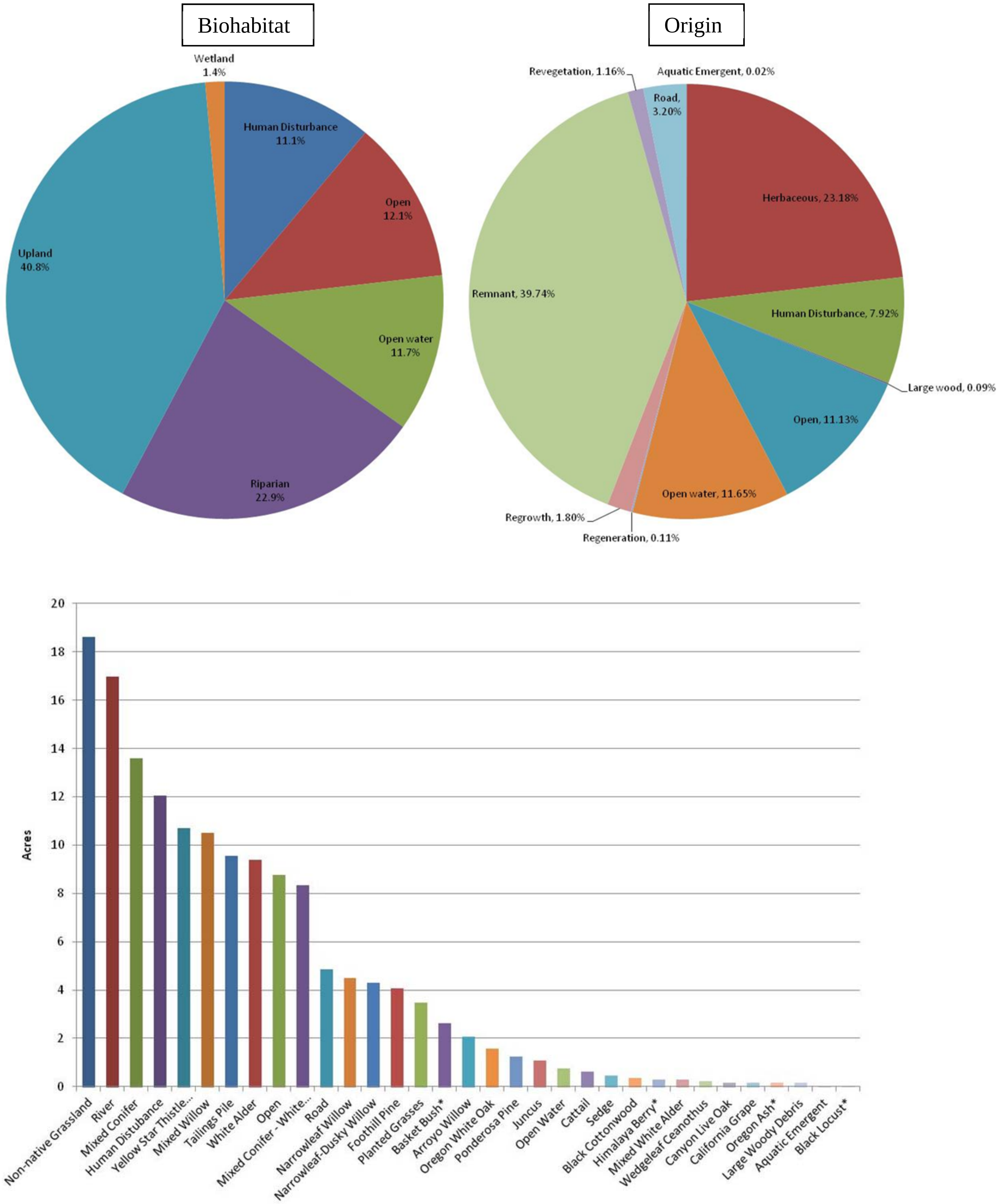
Connor Creek channel rehabilitation site: abundance of biohabitats, patch type origins, and individual patch types mapped in WY 2010.



Hocker Flat channel rehabilitation site: abundance of biohabitats, patch type origins, and individual patch types mapped in WY 2010.



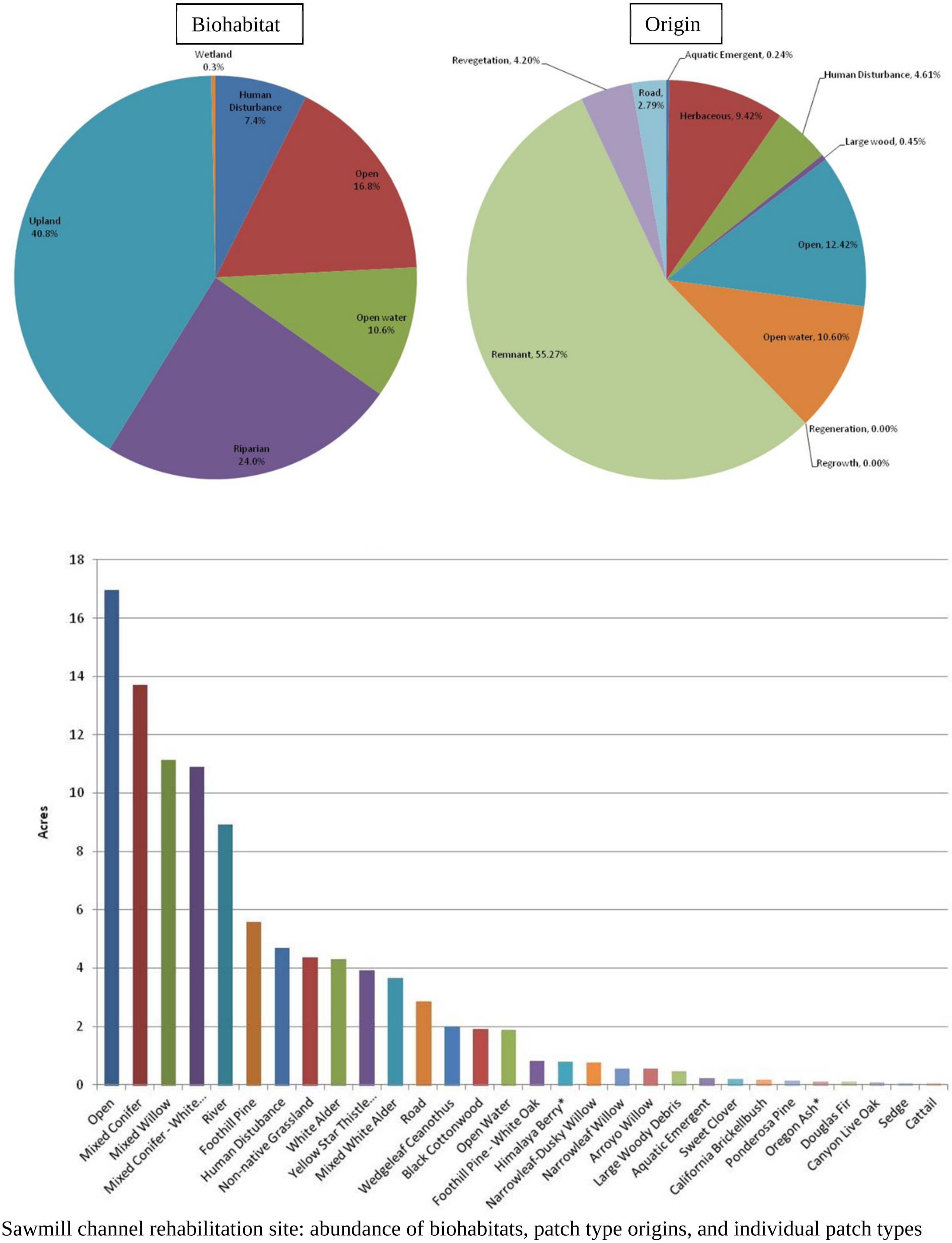
Indian Creek (includes Vitzthum Gulch) channel rehabilitation site: abundance of biohabitats, patch type origins, and individual patch types mapped in WY 2010.



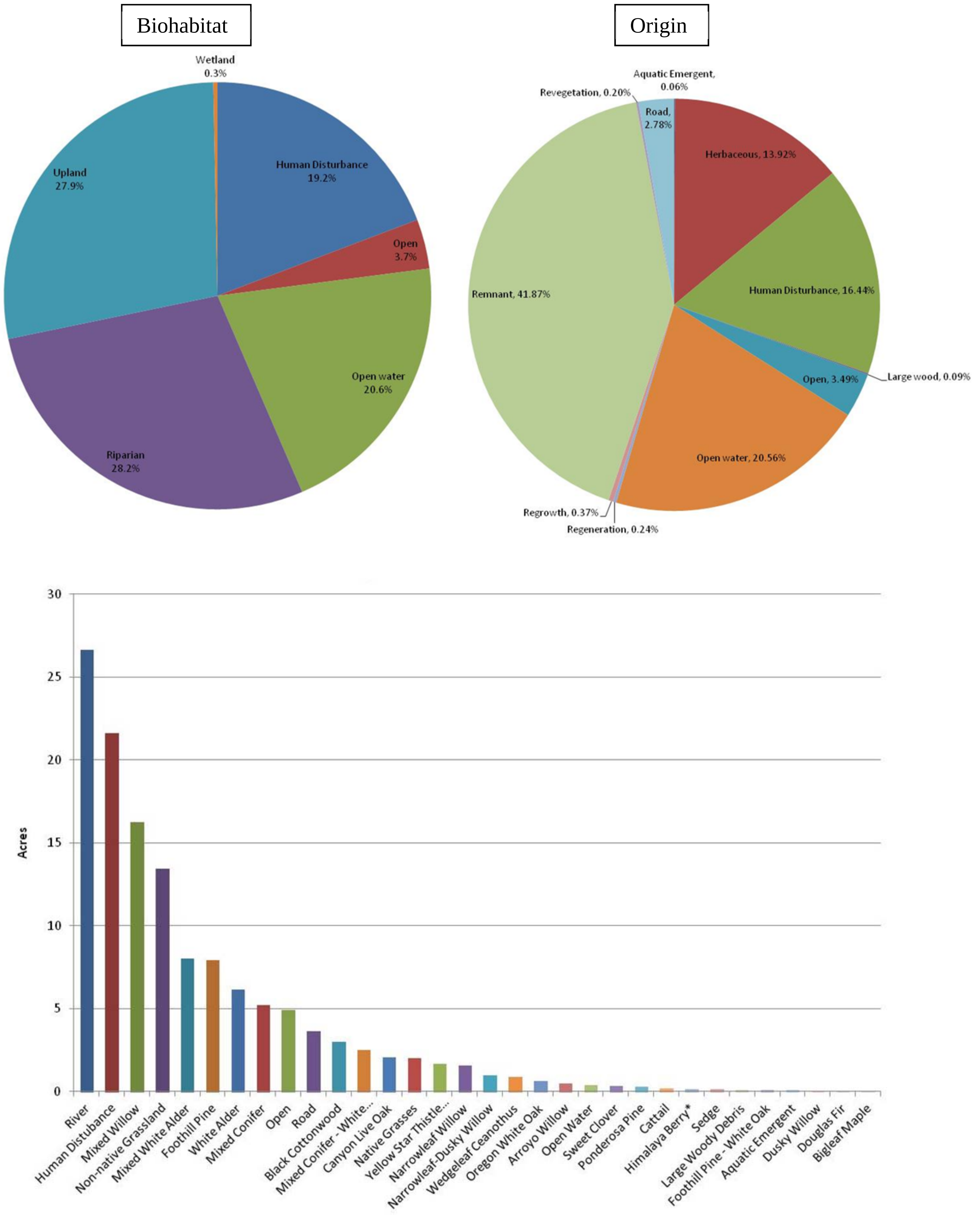
Biohabitat

Origin

Lower Dark Gulch channel rehabilitation site: abundance of biohabitats, patch type origins, and individual patch types mapped in WY 2010.



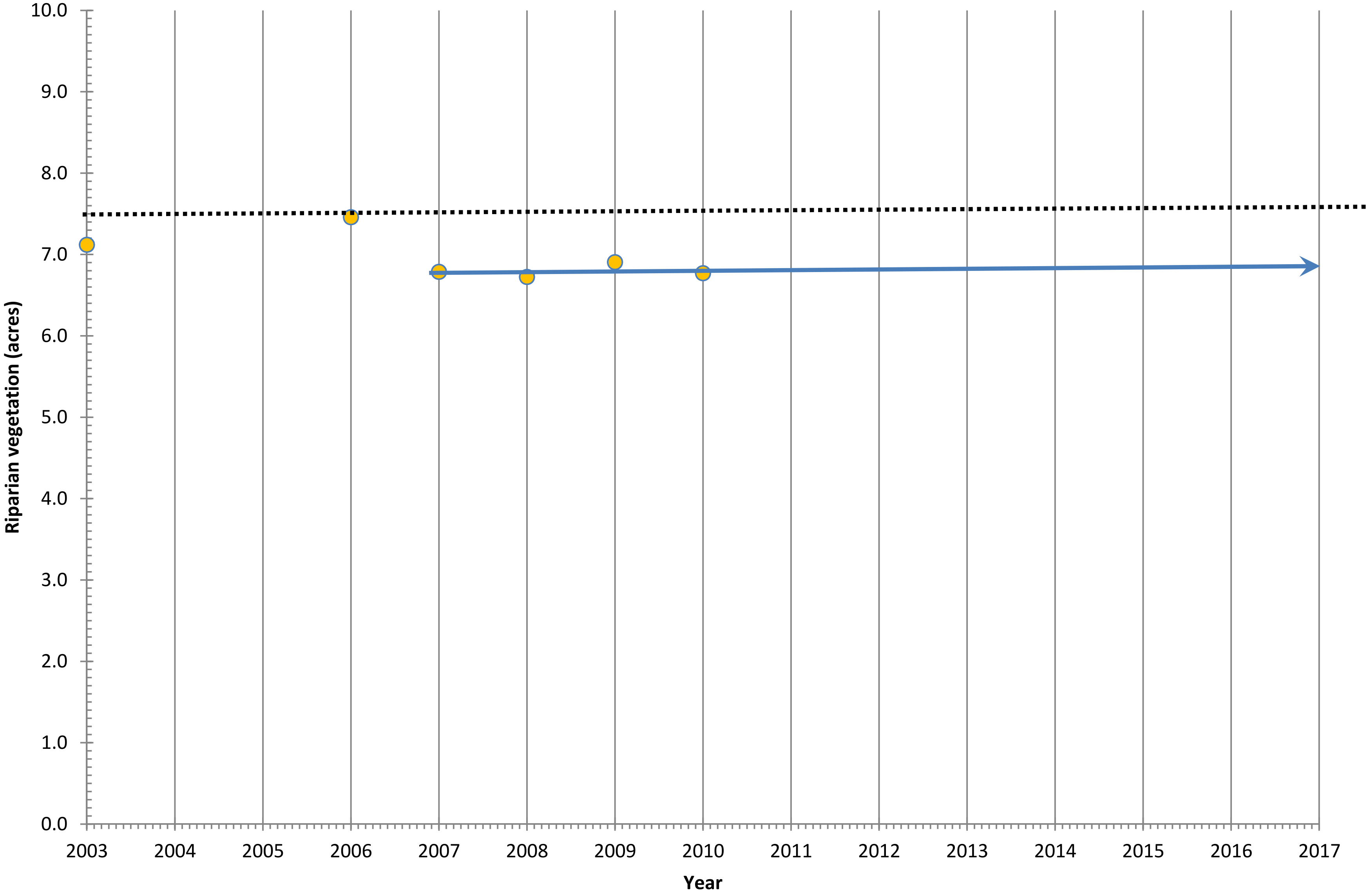
Sawmill channel rehabilitation site: abundance of biohabitats, patch type origins, and individual patch types mapped in WY 2010.



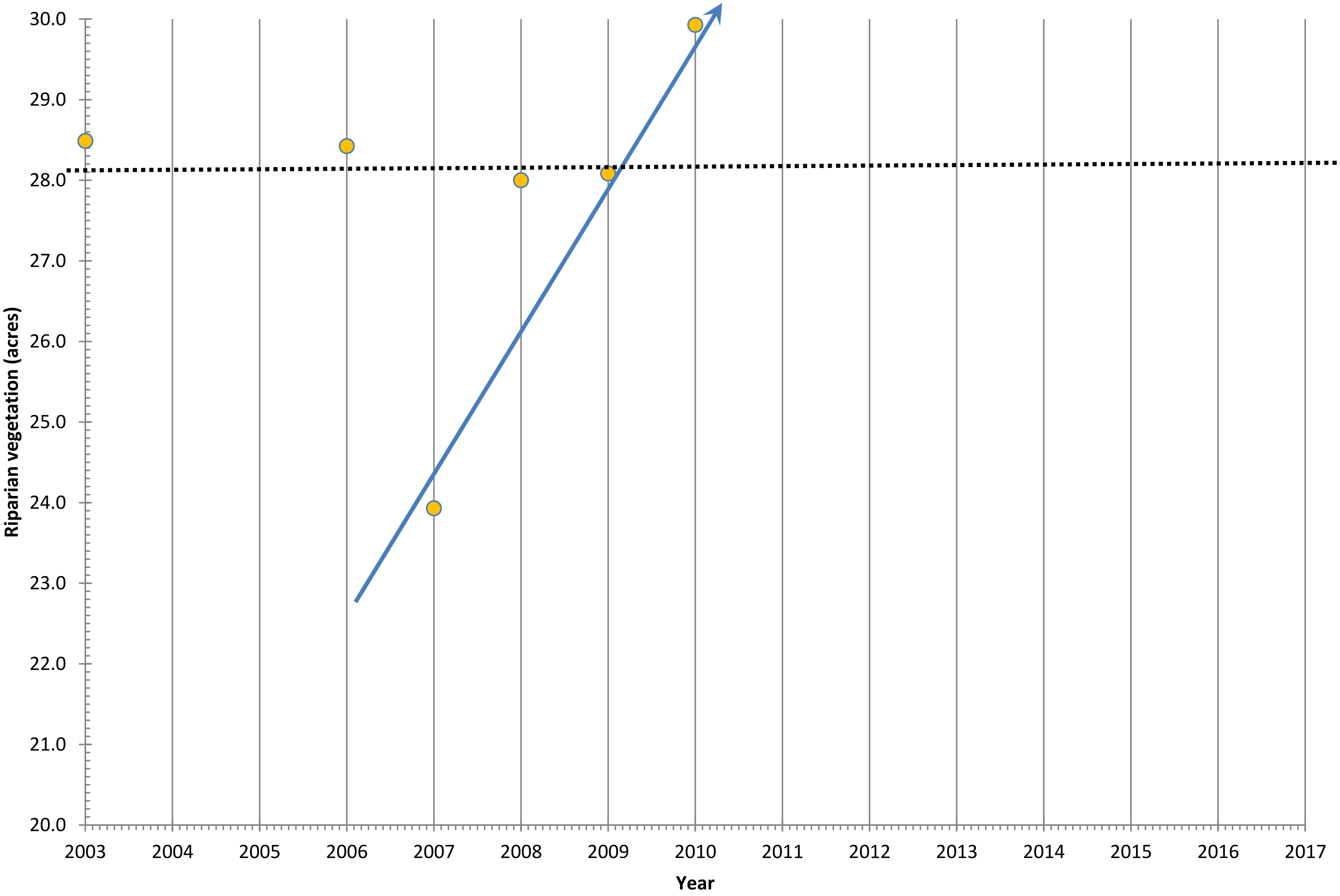
Lewiston Four channel rehabilitation site: abundance of biohabitats, patch type origins, and individual patch types mapped in WY 2010.

Appendix F. Riparian Vegetation Recovery at 12 Channel Rehabilitation Sites Mapped in WY 2010.

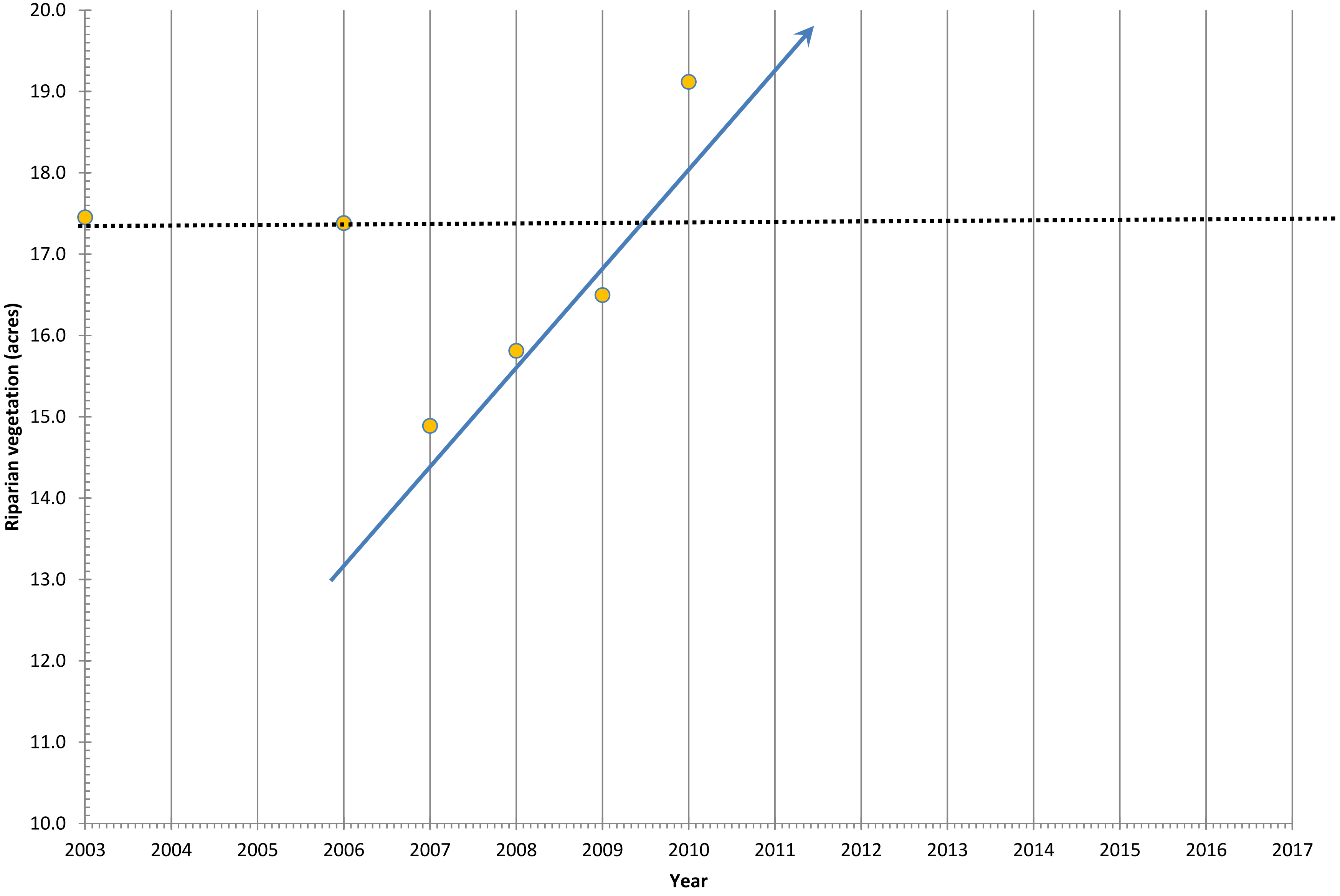
Pear Tree Gulch Recovery Rate



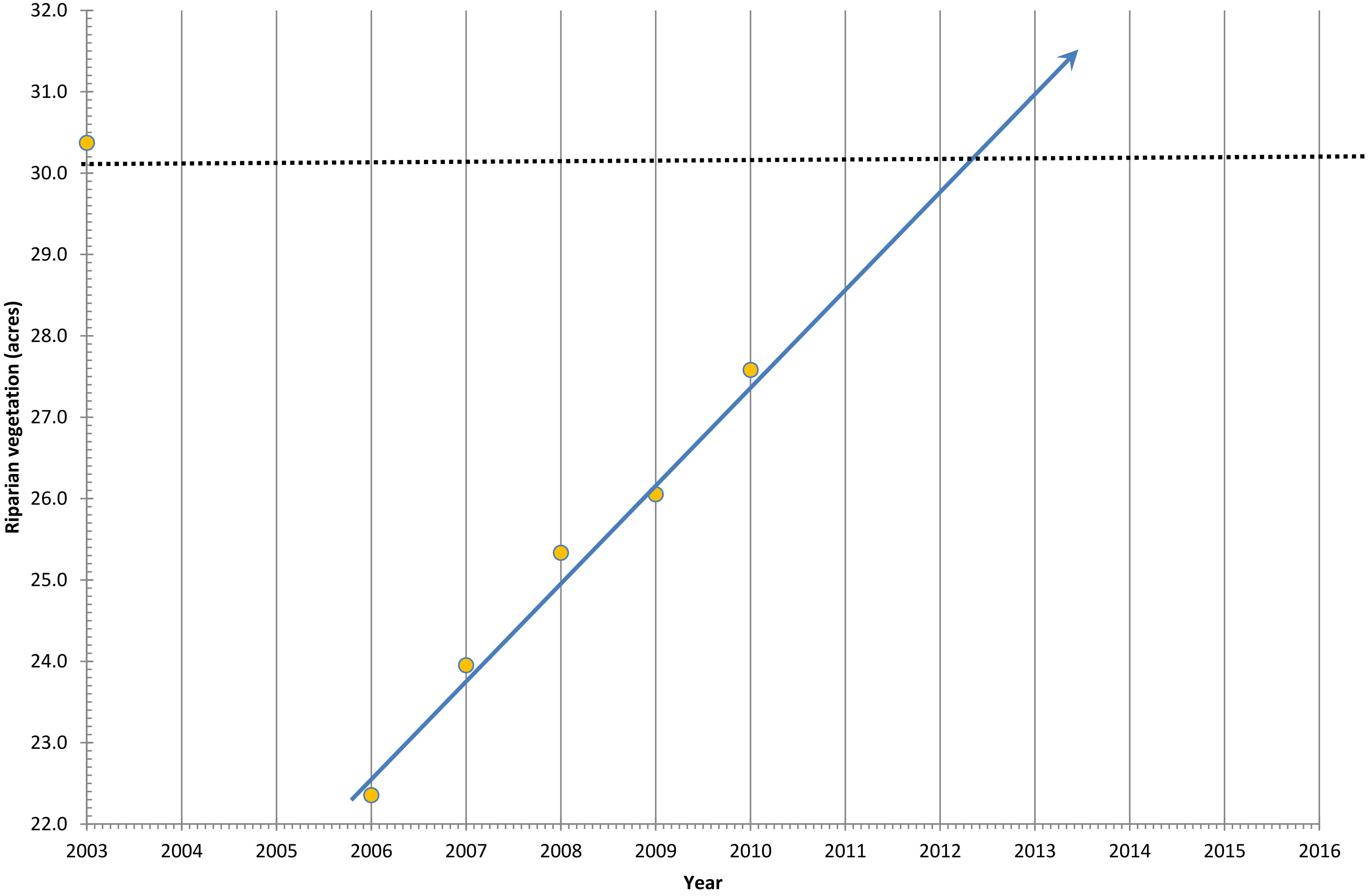
Valdor Gulch Recovery Rate



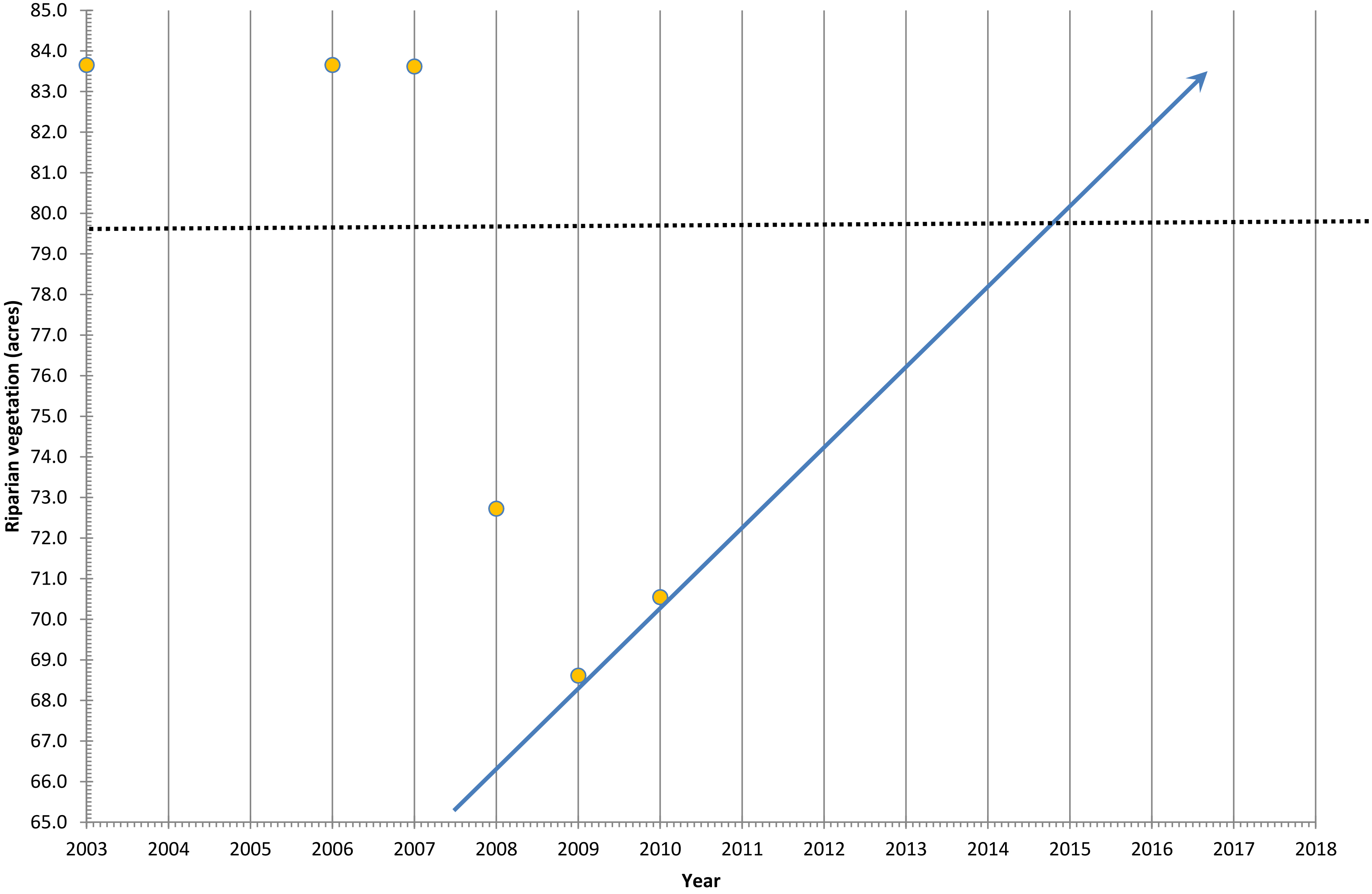
Connor Creek Recovery Rate



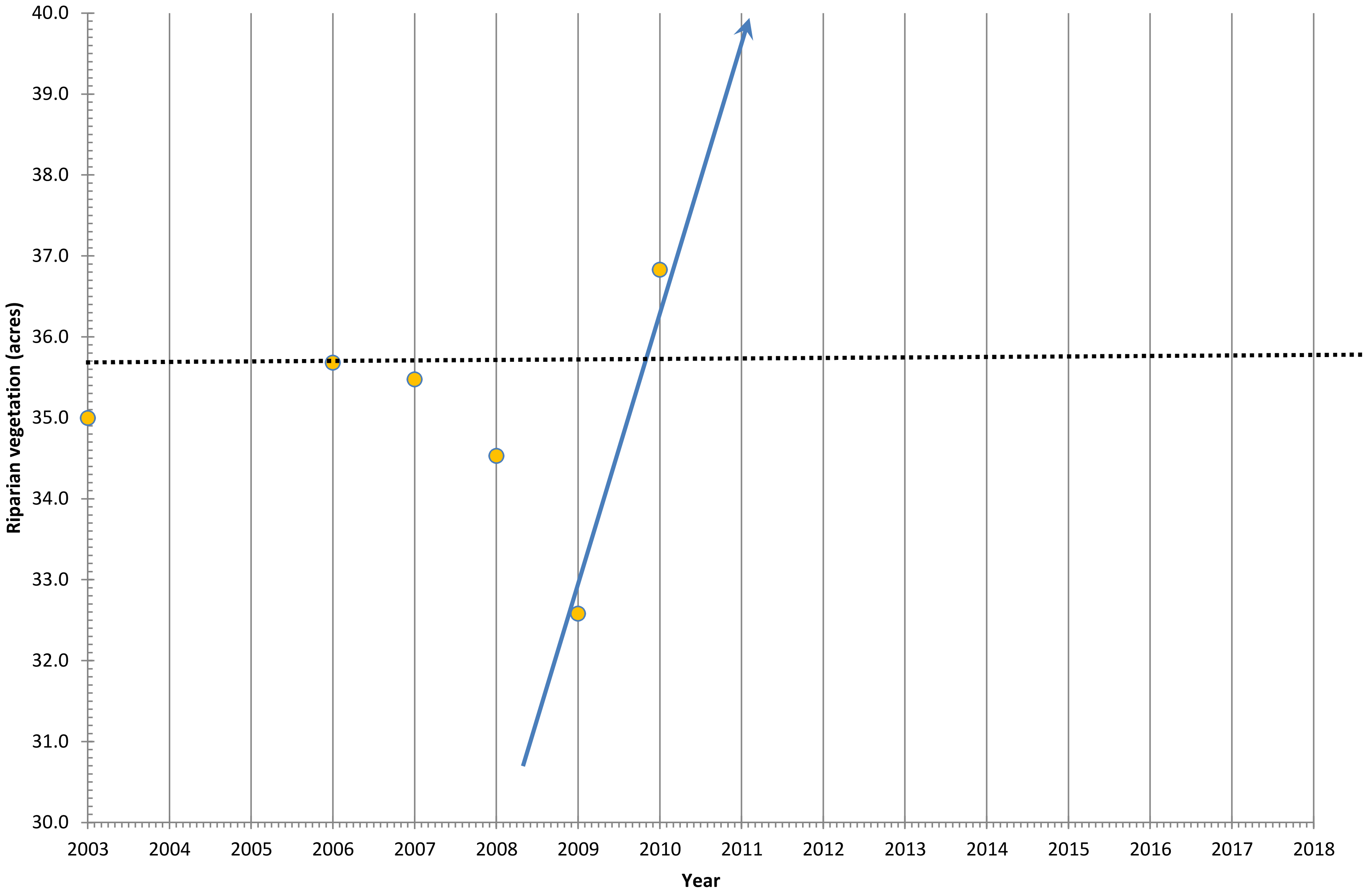
Hocker Flat Recovery Rate



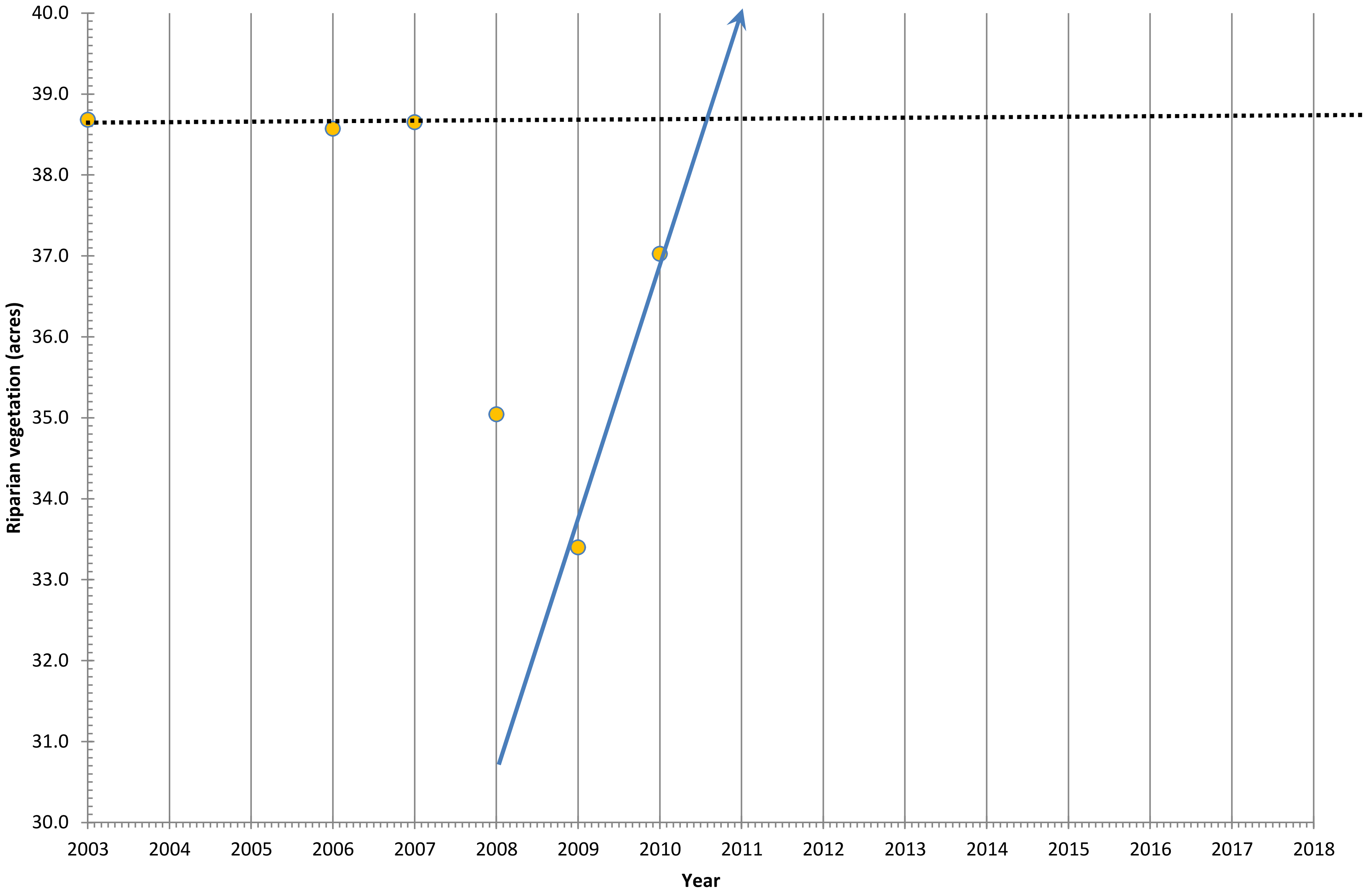
Indian Creek Recovery Rate



Lower Dark Gulch Recovery Rate



Lewiston Four Recovery Rate



Appendix G. 2010 Geomorphic Mapping for GRTS Panel 2 Sites.

2010 GEOMORPHIC MAPPING FOR GRTS PANEL 2 SITES

Revised version based on comments received by D. Goodman, A. Martin, and A. Krause, June 2011.

Mapping objective:

Identify and delineate fluvial geomorphic units at GRTS Panel 2 sites to correlate with spawning and rearing habitat and use mapped by the USFWS, Hoopa Valley Tribe, and the Yurok Tribe.

Terminology

A group of geomorphic units are proposed below to achieve mapping objectives. The majority of unit definitions are from the current draft Channel Rehabilitation Design Guidelines for the Mainstem Trinity River; those not included in the Channel Design Guide are from other sources (e.g., the CDFG California Salmonid Stream Habitat Restoration Manual). The proposed geomorphic map units are as follows:

Alcove: An off-channel habitat feature that can be important to fish rearing. Alcoves have quiescent water with a diverse range of physical, chemical and biological characteristics distinct from those of the main river channel.

Bar: A bar in a river is an elevated region of sand or gravel that has been deposited by the flow. Four subtypes are selected for this mapping exercise:

> *Point bar*: A depositional area formed on the inside bank of a meander that sometimes remains bare of vegetation due to the frequent recurrence of the bankfull discharge.
>
> *Lateral bar*: Bars located on the river channel margin downstream of an obstruction in the bank.
>
> *Mid-channel bar*: A bar formed between a split channel (also known as a medial bar).
>
> *Obstruction bar*. Bar formed upstream or downstream of an obstruction (boulder, bedrock, and/or large wood) with sufficient gradient to provide suitable depths and velocities for spawning. Bars formed on the downstream end of an obstruction will be qualified as *lee*, and bars formed on the downstream end of an obstruction will be qualified as *stoss*.

Pool: The area in a natural channel deeper and somewhat narrower than the average channel section, often creating with eddies. For this exercise, pool subunits will not be identified (e.g., main channel pool, scour pool, backwater pool).

Run: A wide, relatively uniform channel bottom lacking pronounced turbulence. For this exercise, a run and a glide will be considered the same.

Tailout: Topographic rise in channel gradient at the transition from deeper water to a riffle, most commonly associated with pools and runs.

Riffle: The area in a natural channel that is wider and shallower than the average channel section. Also called a *transverse bar* where the riffle connects two point bars in an alternate bar sequence. Two riffle subtypes are selected for this mapping exercise:

> *High-gradient riffle*: Per riffle definition above, with channel gradients typically > 0.25%. Field mapping criteria to classify a high-gradient riffle will be based on observed turbulent flow.
>
> *Low-gradient riffle* Per riffle definition above, with channel gradients typically < 0.25%. Field mapping criteria to classify a low-gradient riffle will be based on observed laminar flow.

Tributary delta: A localized fan-shaped deposit at the mouth of a tributary.

Mapping units and convention

From the list of terms above, the following map units will be used:

Primary unit	Secondary qualifier	Map symbol
Alcove		A
Bar	Point bar Lateral bar Mid-channel bar Obstruction bar, lee Obstruction bar, stoss	Bp Bl Bm Bol Bos
Pool		P
Run		R
Tailout	Pool Run	Tp Tr
Riffle (transverse bar)	Low-gradient High-gradient	Rlg Rhg
Tributary delta		TD

At bank rehabilitation sites where geomorphic features have been constructed (e.g., coarse sediment recruitment piles placed as large lateral bars), the map symbol will be modified to show this attribute by noting it parenthetically. The following mapping convention will be used:

Ps(a)

Where: P = Primary unit (capitalized), s = secondary qualifier (lower case), a = attribute, if applicable (lower case, in parentheses).

Mapping rules:

1. Upstream and downstream mapping limits will focus on GRTS panel boundaries as shown on field base maps, but map units will be extended to the closest upstream and downstream hydraulic controls where feasible.
2. Lateral boundaries will be confined to within the wetted channel (approximately the 450 cfs water surface elevation). After mapping is completed, mapped units will be matched with 2003 terrestrial geomorphic mapping where possible.
3. Mapping will be performed on 1:600-scale aerial photograph basemaps (1 inch = 50 ft).
4. Substrate (particle size) will not be mapped or included as mapping criteria (it will be inventoried separately by USFWS).

Schedule:

Field mapping is scheduled to be performed by Geoff Hales (McBain & Trush, Inc), September 10 – 13, 2010.

Sites:

Geomorphic mapping will be conducted at the following Panel 2 sites:

- Mid Valdor Gulch (GRTS400-17)
- Wheel Gulch (GRTS400-21)
- Junction City Campground (GRTS400-18)
- Ed’s Bar (GRTS400-29)
- Roundhouse (GRTS400-25)
- Bell Gulch Pilot BRS (GRTS400-26)
- Lower Indian Creek (GRTS400-28)
- Indian Creek Confluence (GRTS400-24)
- Treadwell Bridge (GRTS400-20)
- Lower Dark Gulch (GRTS400-19)
- Lewiston Cableway (GRTS400-30)

Geomorphic mapping will not be conducted at:

- Upper Valdor Gulch (GRTS400-81); site abandoned
- Upper Lowden Meadows (GRTS400-23); site under construction