Introduction

The Tucannon River Large Wood (LW) Restoration efforts started in 2005 after the School Fire burned over 50,000 acres of forest and riparian along the Tucannon River. Large sections of the Washington State Wooten Wildlife Area were badly burned during the fire. LW restoration areas include the Tucannon River and headwater tributaries Cummins Creek, Tumalum Creek, Little Tucannon, and various smaller tributaries located on Washington State land within the W.T. Wooten Wildlife Area (WLA).

The Tucannon River Large Wood Restoration Project Area 10 (PA10), completed in the summer 2012, is located from Beaver/Watson Lake (RM 42) upstream almost to Big 4 Lake (RM 44) on the Wooten WLA. The project area includes portions of T9N, R41E, Sections 3, 10, and 15. The project reach is approximately 1.8 miles in existing river channel, with an additional 800 to1000 feet of old channel that is designed to be recaptured for perennial flows, as a primary or secondary channel. The primary access route to the project area is: from Hwy 12, take the Tucannon River Road to the Wooten W.A. and Campground #6. The south end of the campground is the uppermost end of the project.

The Tucannon River LWD Restoration PA10 is a cooperative project between, Washington Dept. of Fish and Wildlife (WDFW), United States Forest Service (USFS), the Washington State Salmon Recovery Funding Board (SRFB), the Snake Region Salmon Recovery Board (SRSRB), Bonneville Power Administration (BPA), Tri-State Steelheaders, and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). Funding for this project is largely provided by grants awarded through the SRFB and BPA. Project partners have all provided technical assistance to the project development and final project design. The Umatilla National Forest USFS staff made this project possible by identifying the tree materials for the project, and coordinating a plan to secure the trees for the project.

Project Design and Development

Large Wood is natural and critical to stream processes and habitat complexity. For decades, human influences have undermined the natural recruitment and availability of LW in the
Tucannon River. The consequences of limiting LW in the Tucannon River, combined with anthropomorphic changes to the river channel following flood events and human land use practices, have resulted in an oversimplified channel planform, with poor habitat complexity, and a river channel that has become isolated from its floodplain (Photo 1.). The Tucannon River LW Restoration Project is designed to improve river habitat for ESA listed Spring Chinook, Steelhead, and Bull trout, by restoring the natural benefits that come from LW and Large Woody Debris (LWD). There are four main project objectives; Increase in-stream habitat complexity and cover, maximize linkages between the river and its floodplain, increase the number and length of ephemeral and perennial channels, and improve riparian health and function.

(Phos 1.) Typical stream habitat found within the project reach prior to restoration. The stream lacks LW structure, pools, and habitat complexity. Juvenile salmonid habitat is limited to the river edges that lack structure and cover, leaving those juvenile fish more vulnerable to predation.

During 2011 an interagency team worked together to develop concepts for project design and individual structures within the project design. The project design was developed to be site specific and each structure is designed to perform functions specific to that location. Using Low elevation Ortho Photography and LiDAR, we mapped out a general conceptual plan for the project reach. Some of the structures are simply roughness features design to create localized pool and cover habitat, while other structures are designed to cause the river channel to agrade and capture channels that are currently isolated up on the floodplain. The individual structures are designed to function collectively by increasing roughness and providing structure within the channel for the river to work with. The data gathered at each site included a GPS location, photographs, and a field sketch of each structure.
The general conceptual plan was focused on opportunities to use LWD structures in natural configurations to achieve the main project goals. For example, the design team used LiDAR to identify isolated secondary channels within the project reach. In the field, a site specific conceptual LWD structure was developed that would function to reconnect the river with those secondary channels. Depending on site conditions, the resulting design could be a simple structure that would accomplish a localized function, such as divert some flow into the secondary channel or a large structure designed to aggressively aggrade the channel to reconnect the isolated channels/floodplain.

At a few sites, the design was simply adding LWD to existing log jams to increase stability. In this way, the “total” design, is essentially a series of individual LWD structures designed for an expressed site specific function or functions. Within the 2 mile reach there were four segments identified for a total station survey. These segments are reaches that the engineers wanted additional data to complete the LWD structure designs.

The full design has 8 types of LWD structures, Bar Apex Jam (BAJ), Triangle (TRI), “T – Structure” (T), Meander Jam (MJ), Chevron (CH), Channel Spanner (SP), Single (S), Plug (PL), and a few areas with boulder placement. Several of the LWD structures include racking material (smaller trees), slash, and boulders as part of the overall design. There are 57 LWD (and Boulder) structures designed to be placed by helicopter and there are 4 Engineered Log Jams (ELJ’s) that will be constructed at the bottom end of the project reach. The engineered log jams will be constructed using heavy equipment (excavator, front loader) and are designed to function as regulators or control structures for unanchored LWD moving through the project reach during flood events.

Generally speaking, the different types of structures can be separated into two functional groups. Structures designed to agrade the channel to reconnect floodplain and activate secondary channels (i.e. BAJ, SP, and PL) and structures to build localized habitat complexity and channel enhancement (T, TRI, CH, MJ, S, and boulder placement). Nevertheless, the larger Bar Apex Jams and Spanning LWD structures will also enhance localized habitat complexity, the smaller structures could potentially change over time (grow) and potentially have major effects on the channel and floodplain connectivity.

The majority of the LW structures were not designed in the traditional engineering sense, but are expected to be relatively stable in moderate flood flows such as a 10-yr event. This stability is based on several facts, particularly the use of whole trees including root wads and limbs. Another stabilizing factor is the length of trees, with a goal to use many trees with lengths of >1.5x bankfull width (BFW). Trees may move but the effects of length and attached root wads will tend to limit movement to short distances before becoming lodged on a gravel bar, bank or other LW.
Other techniques employed to increase stability of typical LW structures includes stacking trees several layers high, using large boulders to brace the trees, placing a significant portion of the tree above bankfull depth, and bracing the trees against or between riparian trees. No cabling, chains, pins or similar hardware were used to anchor the general (helicoptered) LW structures.

The project includes two channel plugs (see drawings) that are intended to raise the water surface elevation over a short distance in order to activate high flow or secondary channels. The downstream plug is expected to eventually redirect the entire bankfull channel into an abandoned channel meander rather than leave it in its current incised channel. Their design is an experimental concept of somewhat chaotic orientation of trees spread out over a length of channel (approximately 2-4 BFW’s). A number of large boulders (4-6 ft. dia.) will be placed in the matrix of the structure as buttresses for the logs. Logs will also be stacked up to 4 layers high to provide ballast, particularly along the channel fringes. The expectation is that the combination of ballast, multiple friction points, buttresses, and eventual burial of some spanning logs with gravel, will act together to produce a stable structure.

At the downstream end of the reach the design includes six structures that are intended to capture some floating logs during floods, limiting potential impacts to downstream infrastructure. Four of the six were constructed using heavy equipment rather than by helicopter. These include two ELJ’s and two floodplain debris catchers. ELJ1 and the floodplain structures included buried log pilings and cabling to create long term stability. In addition to pilings, ELJ1 is stabilized by stacked layers of logs, boulder ballast, and gravel/cobble backfill. ELJ2 is not stabilized using pilings because its location on a gravel bar was too close to the active channel to feasibly excavate deep enough for piling stability. Stability of ELJ2 is based on cabling to large buried boulders, burying roughly 2/3 of the structure in the bar. Placing the logs in a complex geometry will also help them lock together and act as a single structure rather than as individual logs.

There is a range of habitat benefits for each of the LWD structures in the overall design. For example, Structure #11 (BAJ-1) (Figure 1.) has short term goals to increase pool frequency and habitat complexity in the project area, and long term goals to activate an isolated side channel on the left bank and grade the channel to reconnect the right bank floodplain. Structure #4 (CH-2) (Figure 1.) is designed to create pool habitat and cover, provide more structure to the existing bar island that has formed, and increase flows into the existing side channel. There are multiple isolated historic channels towards the right bank that could become captured over time as the channel starts to migrate more actively. The single spanning tree SP-1 is designed to become a spanning plunge pool while creating improved spawning habitat on the upstream side of the tree. However, the tree is unanchored and could become mobile during high flows before it becomes partially buried. This is the intended dynamic nature of the overall design.
The final project was designed to install 61 individual structures, 4 engineered LW structures with approximately 100 trees w/rootball/logs and 57 Helicopter installed LW structures with approximately 250+ whole trees (key pieces), 500 smaller diameter (6-10”DBH) “racking trees”, and 25 boulders (3’-4’) within a two mile reach (RM42 to RM44).

Project Construction

The four engineered/constructed LW structures were built during the first phase of the project. In-water project construction started July 16\textsuperscript{th}, 2012. All of the constructed log jams were built in a dry channel, on an existing gravel bar, and up on the floodplain, and therefore, it was not necessary to dewater the project sites during construction. However, construction of the Floodplain Debris Structure #2 and Engineered Log Jam (ELJ) #2 required crossing the stream at two locations. We limited the number of stream crossings by passing material across the stream using two excavators. This method worked well and significantly reduced impacts to the river channel and bank stability. The construction of the four structures took seven days, one day ahead of schedule. The project was constructed by the WDFW construction crew with Bruce Heiner, WDFW Engineer, on site each day (Photos 2-4). We experienced no problems during construction.
Active construction of ELJ#1, the structure is located at the downstream end of an old river channel designed to be captured as a result of the restoration project. A large helicopter placed structure was subsequently placed in the main channel approximately 300 meters upstream.

ELJ #2 was constructed on an existing gravel bar; construction was completed in a very tight space, the construction crew made the extra effort to minimize impacts.
The second phase of the project was the Helicopter LW installations; this phase of the project was delayed due to a major helicopter malfunction. The helicopter implementation was scheduled for August 20th to August 25th. On August 15th we were contacted by Columbia Helicopters, Inc., informing us that the S64 Sky Crane had a major malfunction and required at least 10 days to repair. Fortunately, we were able to coordinate the changes with our partners and the helicopter was fixed on time. The helicopter arrived August 26th, and we started implementing the helicopter phase of the project on August 27th. The lowest reach of the project has a power line running along the stream in a few places where we would be flying trees with the helicopter. Day 2, through coordination with the local power company (REA) we had the power lines dropped for the day and completed the LW installations in that reach. The lines and power was restored the following morning. The project proceeded according to plan without any problems.

The helicopter phase took 4 days and we achieved our goal of completing the project design with 35 hours of helicopter flight time. The helicopter placed 58 LW installations consisting of 291 individual trees in the project reach (Photos 5-9). The helicopter also placed over 500 smaller diameter “racking trees” in bundles, some placed by design, and others “salted” throughout the project reach (Photo 10).
The smaller diameter material is designed to function as the course woody debris that accumulates on “key” tree pieces. The course debris provides cover and complexity to the stream. There were also 25 boulders (@15K lbs.) that were placed by helicopter to provide additional buttress for some of the structures, as well as two designed habitat boulder structures. The boulders were staged and prepped with a 3” hole so that we could use the choker to move them by helicopter (Photo 11). One of the benefits of using a helicopter for this type of project is the limited impacts of the project. Some of the reaches of the project would have been difficult to access to build conventional constructed log jams.

The overall project is fundamentally a LW replenishment project; the intent is for the river to do the major work developing habitat complexity and floodplain connectivity. The structures were designed to establish short-term habitat benefits and long term benefits for the floodplain and river function. Future stream flows will play a large role in how the project develops over time. We estimate that it could take 5-10 years for the project to be fully functioning. We intend on monitoring the progress of the project and have a lot of data (LiDAR, Low elevation photos, habitat assessment) to utilize as the project matures. In addition, we have tagged, measured, and have GPS locations for all of the trees placed by helicopter. We intend on monitoring movement of the unanchored trees over time to assess project implementation success and improve our understanding of LW movement in the Tucannon River. We have also placed 3 time lapse cameras on a few major structures to monitor project implementation success and to have imagery for future presentations and outreach.

(Phot 5.) This photo shows helicopter placement of “key” tree on the Tucannon River, construction of Structure #42 (TRI-4).
Structure #20 (BAJ-2) is a bar apex structure designed to capture an existing ephemeral channel towards the left bank and develop pool habitat and cover for salmonids (Bruce Heiner, WDFW engineer providing scale).

Structure #16 (PL-1) is a cascading “plug designed to aggrade the channel and reconnect the floodplain on the seen across the river, note the large boulder in the center of the photo, four boulders were placed in the structure to provide a buttress for the LW.
(Photo 8.) Structure #16 (SP-2) is a spanning LW structure, the photo illustrates the average LW material transported by the helicopter for the project (Kris Buelow, SRSRB provides scale).

(Photo 9.) Construction of structure #27 (SP-5) the spanning structure features the channel spanning log seen on the river bed, designed to aggrade the channel to collect spawning gravel and create a plunge pool downstream of the log.
(Photo 10.) This photo illustrates the size of the small diameter “racking material” used for the project, Columbia Helicopters, Inc. (Izzy) ground crew removing choker from racking bundle. The main structure (top left) is #1 (TRI-1) located at the upstream end of the project reach.

(Photo 11.) Boulder habitat structure #35 (B-1), the boulder structure was placed to create pool habitat and capture LW material moving through the reach.
Public Involvement

Tucannon River LW Restoration PA 10 was presented to the Tucannon River Citizens Advisory Group on March 15th, 2012.

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