EXECUTIVE SUMMARY

Effectiveness Monitoring for LWD Placement in South Slough Tidal Wetlands

Final Report Summary Submitted to the Oregon Watershed Enhancement Board by:

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Background

The Coos Watershed Association (CoosWA), South Slough National Estuarine Research Reserve (SSNERR) and Oregon Department of Fish and Wildlife (ODFW) collaborated on an Oregon Watershed Enhancement Board (OWEB)-funded project to evaluate the effectiveness of placing large woody debris (LWD) in estuarine channels to provide improved habitat for juvenile salmonids. The two year project (2005-2006) was designed to address the need for more and better information associated with the placement and function of LWD in estuaries. The study was made possible in 2004 when SSNERR partnered with CoosWA to coordinate a project in which 40 large (18-36” DBH) Sitka spruce trees with root wads attached were placed (by helicopter) into tidal reaches of Winchester Creek in South Slough’s upper estuary. The trees, donated by Oregon Parks and Recreation Department (OPRD) as part of an Oregon Department of Transportation (ODOT) road realignment, were placed in specific locations and configurations designed to facilitate an effectiveness monitoring program to address a series of questions about juvenile salmon use and behavior as well as habitat development associated with LWD in tidal channels. CoosWA, SSNERR and ODFW staff were guided by SSNERR’s Estuarine Wetland Restoration Advisory Group (Restoration Advisory Group) in finalizing tree placement locations and configurations as well as the development of effectiveness monitoring questions and protocols. The Restoration Advisory Group includes restoration specialists from academic research institutions, state and federal agencies, non-profit organizations, and private consulting firms.

Research and restoration monitoring projects from Pacific Northwest estuaries have clearly established the importance of estuaries in the life histories of Pacific salmon, boosting the priority of estuarine wetland restoration activities in Oregon. Many coastal restoration projects focus on the re-establishment of tidal channel complexity and place LWD in mainstem and tributary channels. However, few studies have focused on quantifying the effects of these LWD placements. Current understanding of LWD as habitat structure is primarily from non-tidal streams and river studies which have established LWD as critical components of quality juvenile salmon foraging habitat that creates cover, produces beneficial hydrological changes, and increases prey resources.

This project offered a unique opportunity to address key habitat recovery questions associated with LWD in estuarine habitats.

Project Description

Effectiveness monitoring of LWD placed in South Slough's upper estuary was designed to accomplish the following:

- Determine presence/absence and behavior of juvenile salmonids (i.e., coho and cutthroat trout) in and around LWD using underwater videography and acoustic tagging methods (a late addition to the project);
- Monitor abundance and species composition of juvenile salmonids in tidal creeks with (and without) LWD using fyke nets;
- Monitor fish use of other subtidal habitats with beach seines;
- Track changes in invertebrate abundance and composition;
- Detect wood movement with sub-meter GPS tracking;
- Record changes in channel profile around LWD with detailed elevation surveys; and,
- Track water temperature and flow in locations near and away from LWD.

Large woody debris was placed in 29 locations in South Slough's upper estuary. The effectiveness monitoring project focused on 12 sites, six pairs based on configuration and location (see Figures 1 and 2). The study area for this project is referred to as the "wood zone".

The main questions addressed were the following:

1) Are there higher densities of fish near LWD compared with habitats lacking LWD?
2) Does placing LWD at the mouths of tidal creeks create a staging area for fish to hold before foraging up tributary tidal creeks during flood or ebb tide?
3) Is the presence of LWD increasing fish prey resources?
4) Does the presence of LWD change the percentage of fish using the tidal creeks over time?
5) Does placing LWD in tidal channels create changes in channel morphology (i.e., scour pools) which are associated with increased habitat quality for juvenile salmonids?
6) What significant changes in temperature or water flow occurs with the placement of LWD?
7) Does the LWD move?

Materials and Methods

This OWEB-supported project, *Effectiveness Monitoring for LWD Placement in South Slough Tidal Wetlands*, was implemented as six related tasks including, 1) Juvenile salmonid use/behavior near LWD; 2) Determining the use of LWD by juvenile salmonids using acoustic tagging methods; 3) Fish use monitoring of estuarine marshes associated with LWD; 4) Benthic invertebrate abundance and composition in wood and no-wood habitats; 5) Channel morphological change in "Wood Zone"; and 6) LWD movement. Tasks underlined were completed by project contractors. Reports completed by project contractors were appended to the final report.

Project Conclusions

This project was designed to address a series of questions focused on determining the effects of large woody debris placements in tidal channels on the development of instream habitat for juvenile salmonids. The study duration was two years. Since many ecological processes occur over much longer time frames, additional project monitoring will be needed to fully understand the processes associated with LWD placement and the development of productive fish habitat. Preliminary conclusions organized by project questions are described below.

Are there higher densities of juvenile salmonids near LWD compared with habitats lacking LWD?
Answer: A qualified "Yes"

This monitoring project used two methods, underwater videography and acoustic tagging, to determine whether estuarine fishes, juvenile salmonids in particular, would actually use the LWD placed in the Winchester Creek tidal channel.

Underwater Videography
Despite the frustratingly low numbers of salmonids observed in the channel, the underwater videography suggested some interesting patterns indicating some fish use of LWD structures. Some additional observations shed light on the results and set the stage for further LWD monitoring in tidal channels:

- The absence of age-1+ fish at the Lower, Middle and Upper Winchester Creek wood sites in 2005 may have been explained by the 2006 analysis showing the majority of juveniles were not using the flow paths in which the Winchester Creek complex wood structures were located. The majority of the 2006 migrants moved along the inside/bank camera stations and near the channel bottom and would have been out of sight of the cameras placed around the LWD structures in 2005.

- The 2006 results also suggest habitat attributes other than the new Winchester Creek LWD structures could have been influencing the 2006 age-1+ presence/absence patterns. For example, the lower wood polygon monitored in 2006 was shown to have significant retention of age-1+ salmonids across portions of the full tidal cycle, while the other polygons did not. The channel morphology in the lower polygon appears to have been affected by historically-placed pilings and revetments (west bank), and a dike (east bank). These elements appear to have created scour and fill patterns not seen in the other polygons. The new LWD, placed two years prior to the 2006 monitoring, has not yet exerted significant influence on channel morphology, creating one scour hole 0.5 m deep and areas of sediment accumulation near LWD structures (likely due to reduced velocity during seasonal peak flow periods with high suspended sediments loads). We suggest that the migration retention observed for the lower wood polygon reflects more of an attraction to the historic pool habitat in the lower polygon (as well as the overall increased bed complexity) than an attraction to the newly placed LWD in that polygon.
- Observations made in other estuaries indicate that when LWD has created stream current velocity refugia and cover in the form of larger scour pools and bars, juvenile salmonids that migrate into the sampling polygon are more likely to be retained longer than in polygons without this complex habitat. For this project, we suggest the observed channel velocities in Winchester Creek (1-3 ft $^{-sec}$) were not great enough to require current velocity refugia like that observed in the lower Siletz Estuary (4-5 ft $^{-sec}$). We also suggest that if the newly placed LWD were to create a grid of significant scour and fill in future years (likely to take some time due to low current velocities), the retention would increase at that time.
- We have hypothesized that fish migration lanes are determined by fish finding the right balance between optimizing feeding opportunities and limiting their energy expenditure. The presence and drift of available prey may be an additional factor influencing our Winchester Creek flow path and migration path observations.

Observations of fish movement patterns were consistent with observations from previous studies. At the lower polygon, fish movement during flood tide occurred at the upper transect indicating fish were leaving the deeper pool area and moving upstream with the current into shallower water then returning downstream to the polygon again. This return movement was against the flood current and was repeated (but to a lesser degree) near the high slack period. The final pulse of movement seen late in the ebb tide occurred through the lower transect as fish moved upstream into the polygon from below the lower transect**.** Observations made in the Siletz River Estuary (van de Wetering 2003) suggest tidal migration of juvenile salmonids in larger non-complex channels includes two components:

1) small scale (0.5 m distance) upstream-downstream milling behavior exhibited by a limited number of individuals; and, 2) fish migrating greater distances upstream or downstream, exhibiting similar larger-scale milling behavior influenced by current direction.

We treated the Winchester Creek wood polygons, Dalton mouth, and Dalton marsh channel observations, as separate analyses. The results for Dalton mouth when compared to the results for the Winchester Creek wood polygons showed some interesting patterns. Although the Winchester data were not modeled for retention rates, one can see from the raw data that very little migration occurred in either the upstream or downstream direction. When comparing that to the activity measured within the wood complex at Dalton mouth, one can see the comparatively higher level of activity at the Dalton mouth LWD structure. Taking that one step further and comparing the into/out-of results for the Dalton salt marsh estimates, one can see that the Dalton mouth LWD structures also had comparatively more activity than the Dalton salt marsh channel (e.g. see Figures 3-5). We suggest the wood located at the mouth of Dalton Creek was providing the most optimal habitat for both age-0+ and age-1+ salmonids during 2005. We suggest this increased activity is a response to increased complexity of hard structures, flow paths, current velocities and feeding opportunities. These are a result of a salt marsh tributary that experiences significant tidal exchange (~ 4.5 ft) interacting with hard structures at the junction where the mainstem and tributary currents join. To expand on this ideal habitat hypothesis, we highlight the age-0+ raw counts for Dalton Creek mouth which showed increased activity at the beginning of the flood, the beginning of the ebb and the end of the ebb. Results from other salt marsh research sites (van de Wetering, S. 2005, unpublished results) suggest marsh channels with complex habitats near the mouths result in juvenile migration patterns into tidal currents during the early period of both the flood and the ebb tides. We think this upstream movement may be feeding activity. This more common pattern was not quite as obvious in the age-1+ results. Considering the present age-0+ results, these early and late activity peaks might be occurring at times during which age-1+ predators are not as likely to be in or near the LWD habitat. Considering the present age-1+ results, the late flood and early ebb activity peaks might be occurring at times during which optimal prey resource drift occurs, and the age-1+ are not as susceptible to predation themselves mainly because there is more cover habitat. When comparing the peaks in activity around the Dalton Creek mouth LWD and the Dalton salt marsh migration, our results suggest the velocities were a limiting factor. That is to say, age-0+ fish were observed migrating into and out of the salt marsh only during those periods when the velocities were at a minimum. This corresponds, to some extent, with our anecdotal observations of very high velocities in the Dalton salt marsh channel during both the flood and ebb tides. Although high slack typically offers a few minutes of limited velocity flows, we suggest in this case the time was too limiting to allow for age-0+ migration.

In summary, we suggest the most preferred juvenile salmonid habitat was that of the Dalton Creek mouth LWD, due to its complexity and position within a tributary junction with strong tidal fluctuations. We hypothesize this habitat allowed for optimal cover, prey availability, feeding lanes, and velocity refugia. Looking at the full study zone, as well as habitat upstream and downstream of it, one can see that fish have to migrate more than ten channel widths upstream, and six downstream (van de Wetering, S., unpublished results) before they encounter similar pool-bar-complex wood habitats. We suggest the study zone-wide composition of habitat has a greater likelihood of retaining fish on that scale than any one polygon nested within the study zone.

Acoustic Tagging

For the fish presence monitoring using acoustic tagging methods, there was a clear overall trend showing juvenile cutthroat trout presence in zones with LWD present. Like the findings discussed above, the preference for the juvenile trout was the Cox natural wood reach, which contained old, naturally-occurring LWD. While channel morphology was not measured in this reach, anecdotal evidence (observations during low tide receiver deployment, removal, and data retrieval) strongly suggests that, like the historically-placed structures in the lower polygon described above, the natural LWD has formed much more complex scour pool and bar habitat for fish than the newly placed LWD structures have so far- simply due to the difference in time necessary for these habitat elements to develop. In addition, interesting behavioral patterns of habitat use were observed with some fish exhibiting strong fidelity to one or two sites ("stayers") and while others used many different habitats ("movers")(e.g. see Figures 6 and 7).

<u>Does placing LWD at the mouths of tidal creeks create a staging area for fish to hold before foraging up tributary tidal creeks during flood or ebb tide?</u>
Answer: A qualified "Yes"

See discussion above...

<u>Is the presence of wood increasing fish prey resources?</u>
Answer: A qualified "Yes"

Investigations into changes in invertebrate communities associated with LWD placement were targeted at the infaunal benthic community. Replicate samples were taken from eight paired sites throughout the wood zone. Data were analyzed to compare total density, taxonomic richness, and changes in composition. Total density of benthic invertebrates was found to be significantly greater at LWD sites compared with paired sites lacking LWD. In addition, taxonomic richness was found to be significantly higher in May 2006 (see Figure 8). No differences in community composition were detected. Estuarine processes that translate LWD placement into increased invertebrate abundance likely occur over longer time frames. Potential mechanisms include increased edge-water interface, source of organic matter, collection of wrack and other potential food sources, etc. Additional sampling is necessary to fully determine the increase to fish prey resources due to LWD placements. Anecdotal field reports suggest active invertebrate communities exist on the LWD surface (SSNERR, unpublished notes), as well as epifauna in the scour pools near LWD. Additional sampling efforts for invertebrates should use an epibenthic pump, or similar sampling device, to obtain a fully view of the estuarine invertebrate community in complex LWD environments.

<u>Does the presence of wood change the percentage of fish using the tidal creeks over time?</u>
Answer: "Inconclusive"

In 2006 sampling, the presence of LWD appeared to influence the presence of both salmonid and non-salmonid estuarine fishes in the study area: all the juvenile salmonids observed in the tidal tributaries were found in the Dalton Creek treatment reach enhanced with LWD, and no salmonids were observed in the Tom's Creek control reach (LWD placed only at its mouth); Pacific staghorn sculpin were more abundant in the Dalton Creek treatment reach and were larger than those in the Tom's Creek control reach. However, in 2005 sampling, juvenile coho salmon and cutthroat trout were present at both sites in May, and in June sampling, juvenile coho were found at both sites, but cutthroat trout were found only in Dalton Creek. More than the presence of LWD, it is likely that the sites relative position in the estuarine gradient, in addition to some adjustments in sampling methods, and the natural year-to-year variation of salmonid populations had more to do with where fish were found than LWD during the study period. The study was further complicated by overall low abundances of juveniles salmonids. Our results are inconclusive on whether the presence of LWD is having on fish presence in tributary, tidal streams.

<u>Does placing LWD in tidal channels create changes in channel morphology (i.e., scour pools) which are associated with increased habitat quality for juvenile salmonids?</u>
Answer: "Inconclusive"

We detected significant changes in channel morphology between channel profile surveys conducted in 2006 and 2007 that were mainly due to sediment deposition and some channel bottom scour, likely due to hydraulic changes of the LWD. However, site conditions are highly dynamic. Three relatively large scour holes detected in 2006 were filled by the time of the 2007 the survey. In two cases (Dalton Creek and Winchester Creek at transect 40), the filling of the scour hole was due to LWD movement- the cause of channel scour shifted away from the site. It is less clear what was involved with the third scour hole fill (Winchester Creek at transect 55)(Figure 9). Channel scour detected in Winchester Creek just downstream from the mouth of Dalton Creek LWD structures was also likely related to the presence of LWD structures. So, while the presence or absence the LWD structures was notably influencing channel morphology, how these changes "increase habitat quality" for salmonids is far from clear. We can say that the LWD structures cause changes in channel morphology, but since, stable subtidal and intertidal channel habitat around LWD will take years to develop (wherever the LWD structures remain in place- see below), it is too soon to make judgments about the quality of the habitat.

<u>What significant changes in temperature or water flow occurs with the placement of LWD?</u>
No change in water temperatures; detectable changes in flow.

Water temperature data was collected using Onset TidBit temperature data loggers deployed around various LWD structures. Data collection for this part of the project was not completed, in part because many of the TidBit loggers were buried under shifting LWD logs. What little data was retrieved indicated that water temperature was no different near or under LWD structures than water temperature in areas with no LWD. Rapid exchange of tides through the study area may act to mix waters and keep temperatures similar across microhabitats. However, the potential seasonality of water temperature fluctuations in wood and no-wood areas was not determined.

Water velocity measurements were taken by CTSI contractors as part of their underwater videography fish monitoring (see CTSI reported submitted with this document). Current velocities in Winchester Creek were found to vary between LWD structures and between habitats around the LWD structures. Winchester Creek stream velocities are lower than the measured by the CTSI contractors in other coastal Oregon mainstem channels. Higher velocities were recorded during ebb tide flows.

<u>Does the wood move?</u>
Answer: "Yes"

Several LWD structures moved, as expected, during extreme winter high tides and moved both upstream and downstream, with the net direction of movement being downstream (Figure 10).

Citations

Van de Wetering, S. 2003. American Fisheries Society Meeting, Oregon Chapter. Large Wood and Juvenile Salmonid Migration Patterns in the Siletz River Estuary.

Watershed Sciences, Inc. 2007. RTK Data Collection and LiDAR Integration, South Slough Estuarine Reserve, OR. Watershed Sciences, Inc. 111 NW Second St Unit One, Corvallis OR 97330.

Figures

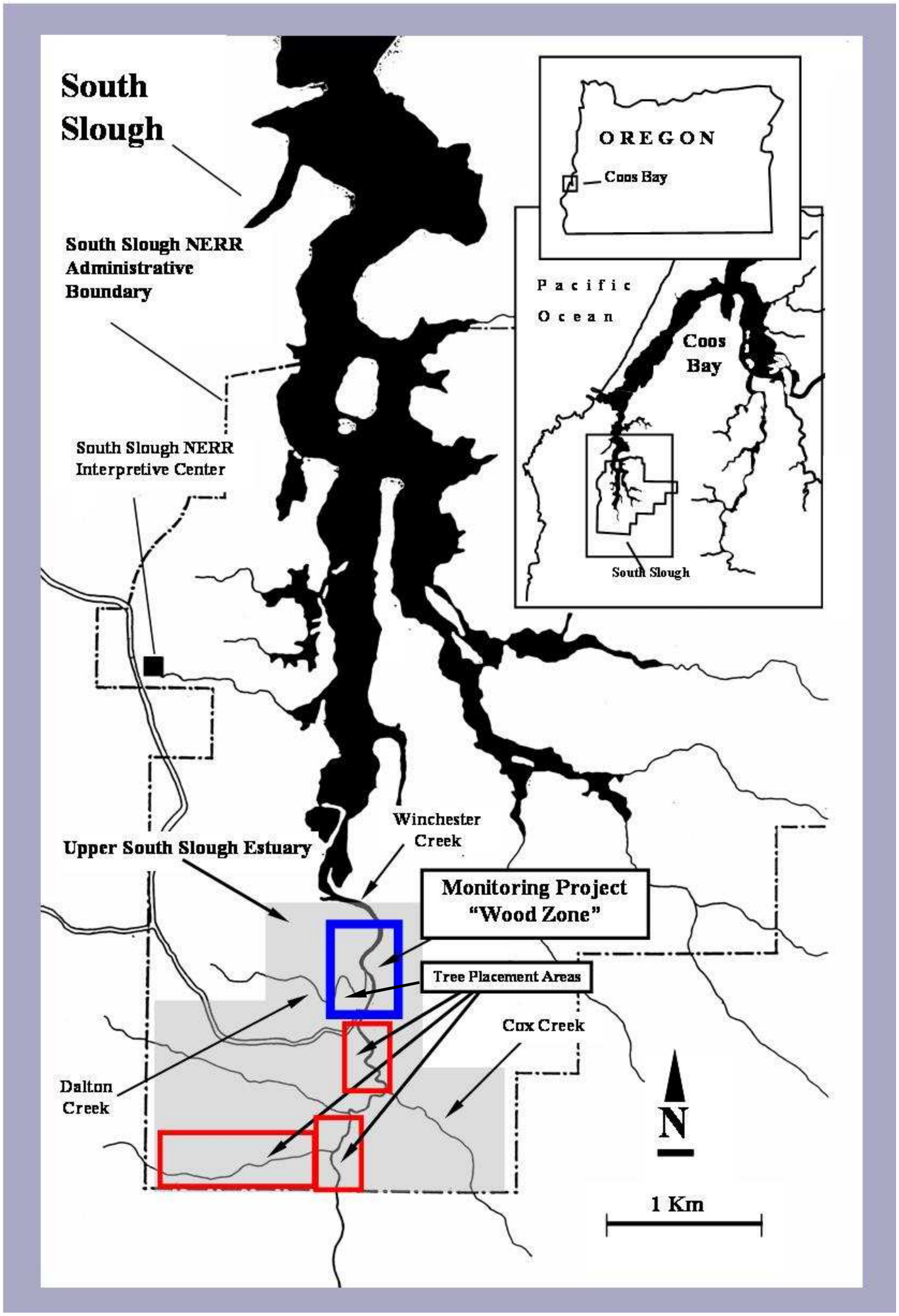


Figure 1. Location of the South Slough estuary, South Slough National Estuarine Research Reserve, the upper South Slough estuary, LWD placement areas and the project "Wood Zone".

South Slough NERR LWD Placement Project: “Wood Zone”

Six paired project monitoring sites are located in areas A1-A4 along Winchester Creek in South Slough’s upper estuary, as shown at right. Pairs are located as follows:

1. Mouth of tributary tidal channel:
   Sites 1 and 2
2. Single tree in tributary tidal channel
   Sites 3 and 6
3. Single tree in tributary tidal channel
   Sites 4 and 5
4. Single tree in main tidal channel
   Sites 7 and 8
5. Double trees in main tidal channel:
   Sites 9 and 10
6. Double trees in main tidal channel:
   Site 11 and 12

N

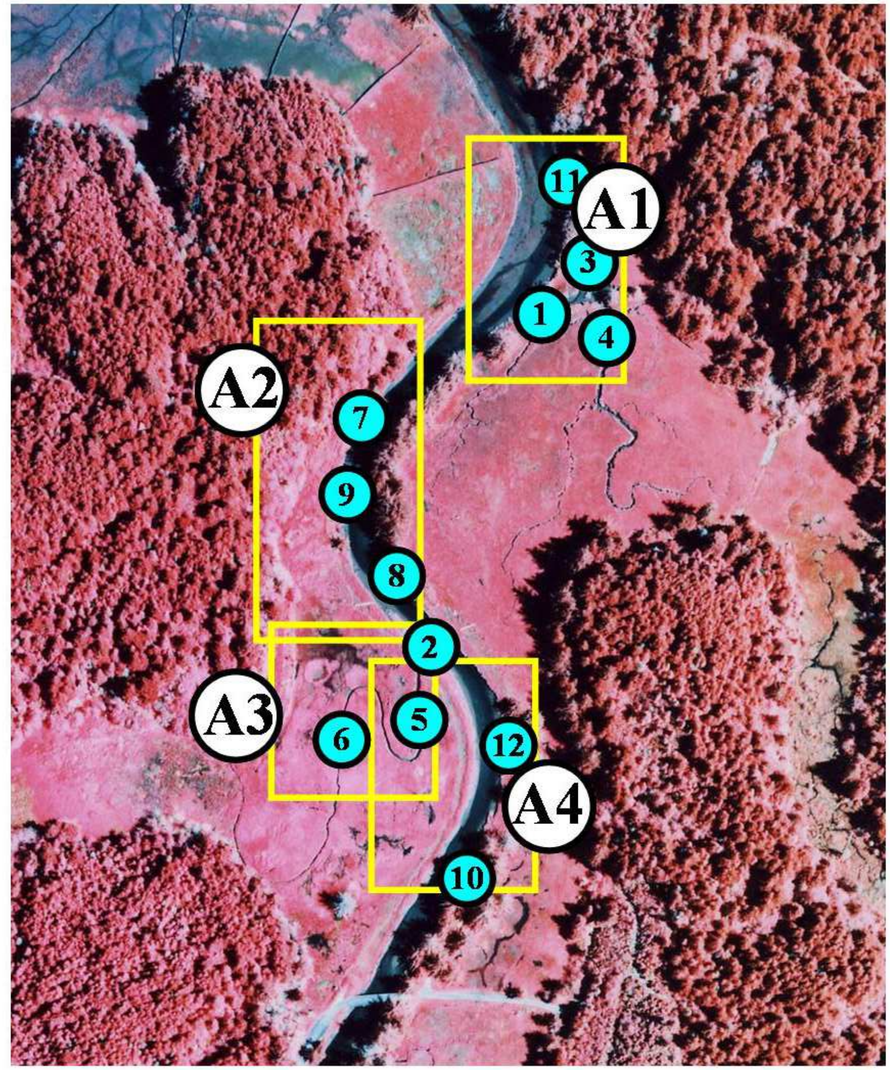


Figure 2. Location LWD monitoring sites in the project “Wood Zone”.

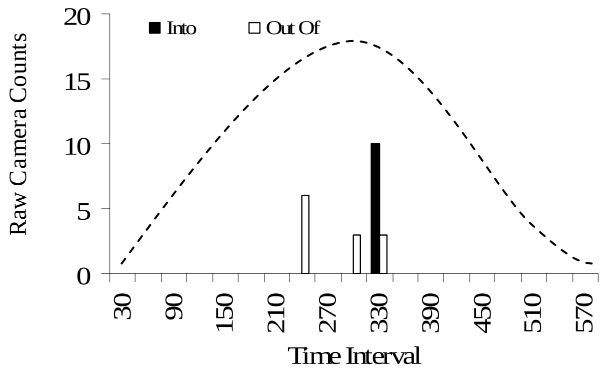


Figure 3. Winchester Creek 2006 Middle Wood Polygon fish migration patterns relative to movement into and out of the polygon (raw camera counts used) and tide height (dashed line).

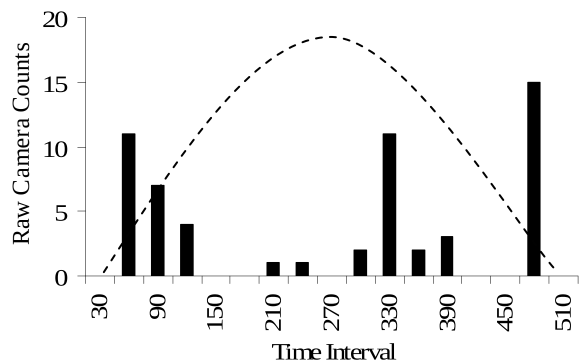


Figure 4. Age 0+ activity patterns (all stations and cameras pooled) within the wood structure at Dalton Mouth. Relative tide elevation shown as dashed line.

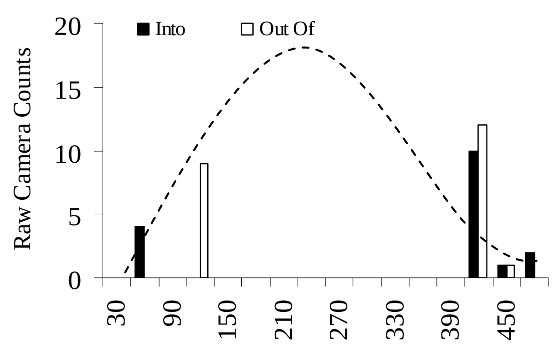


Figure 5. Age 0+ migration patterns (all stations and cameras pooled) for Dalton Salt Marsh channel 2005. Relative tide elevation shown as dashed line.

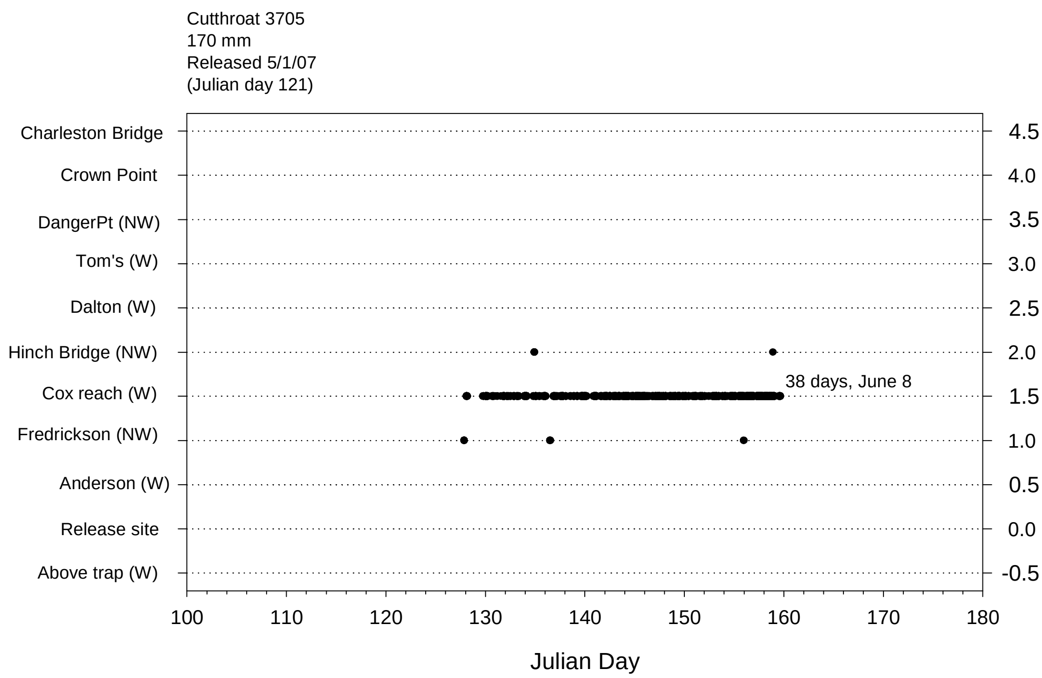


Figure 6. Typical pattern of acoustic tag detections for a "stayer" (NW = no wood site; W = wood site). Each black dot represents one detection. (Figure courtesy of Bruce Miller, ODFW)

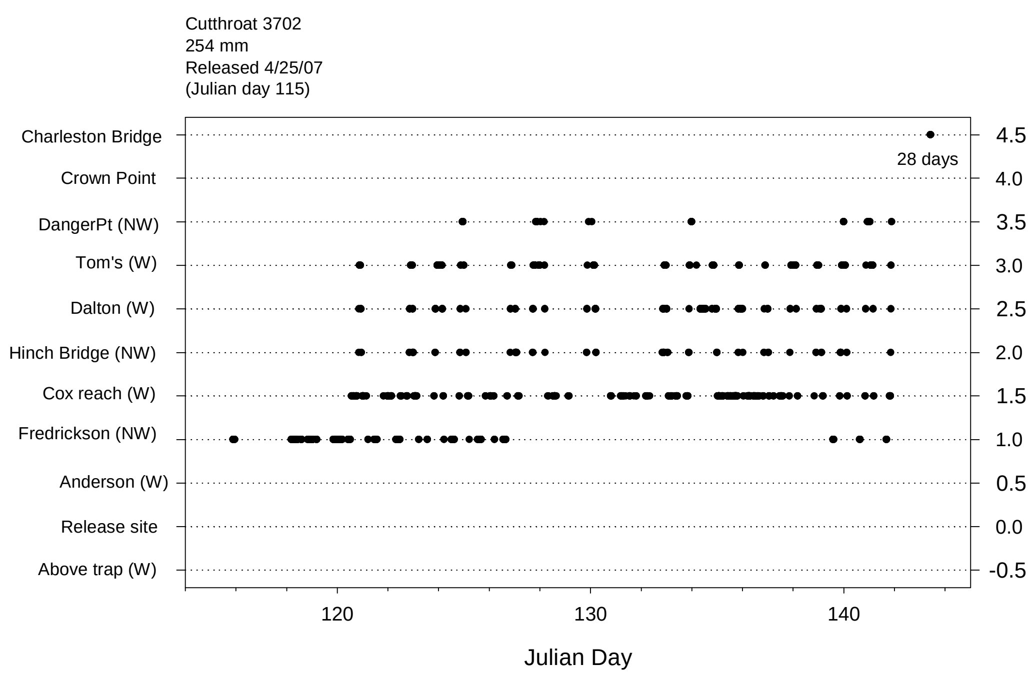


Figure 7. Typical pattern of acoustic tag detections for a "mover" fish (NW = no wood site; W = wood site) Each black dot represents one detection. (Figure courtesy of Bruce Miller, ODFW)

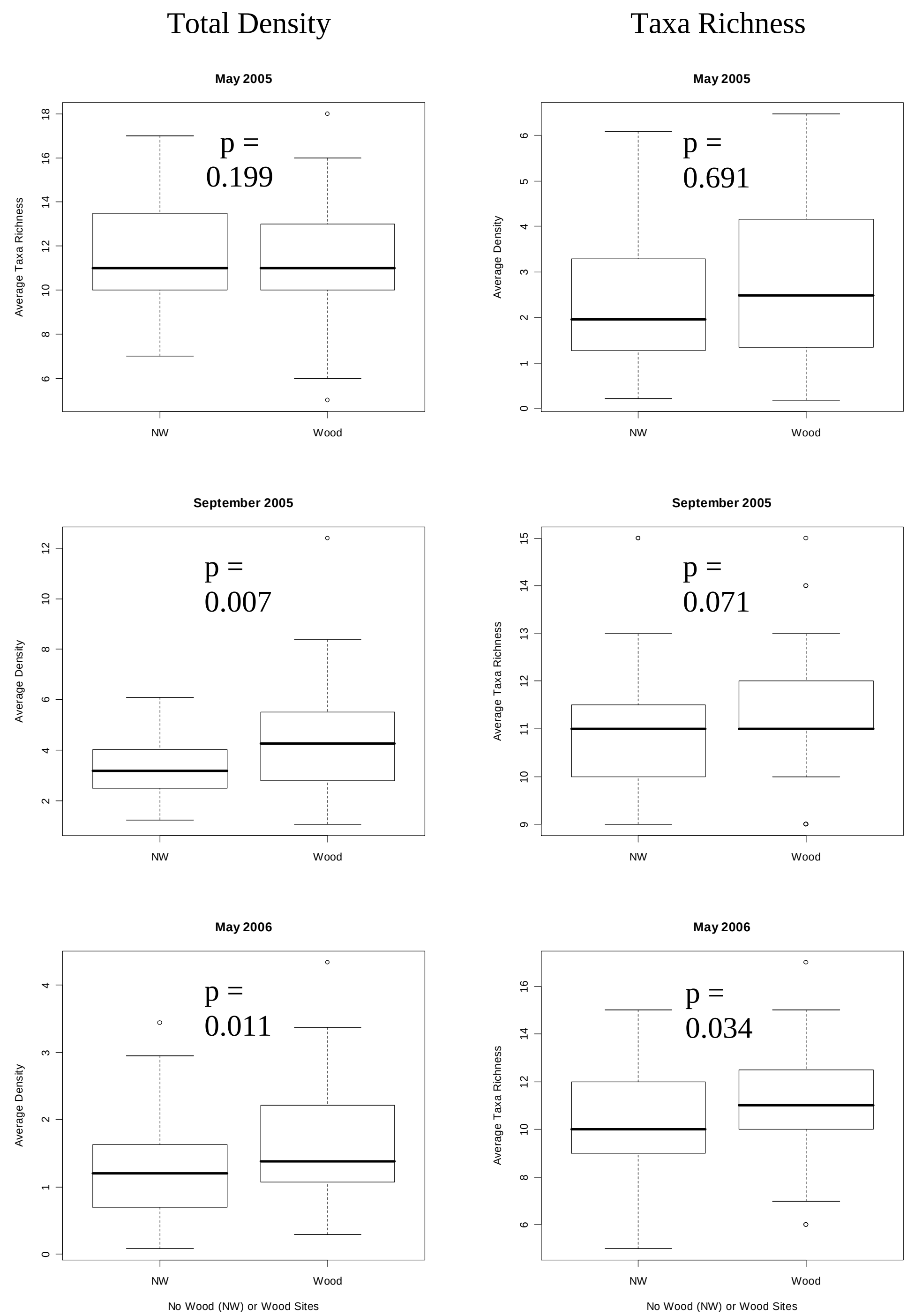


Figure 8. Comparison of total abundance and taxonomic richness by sampling period. Note, NW and Wood refer to paired sampling sites with no wood and LWD placements, respectively.

Change Without Locations of LWD Indicated **Change With Locations of LWD Indicated**

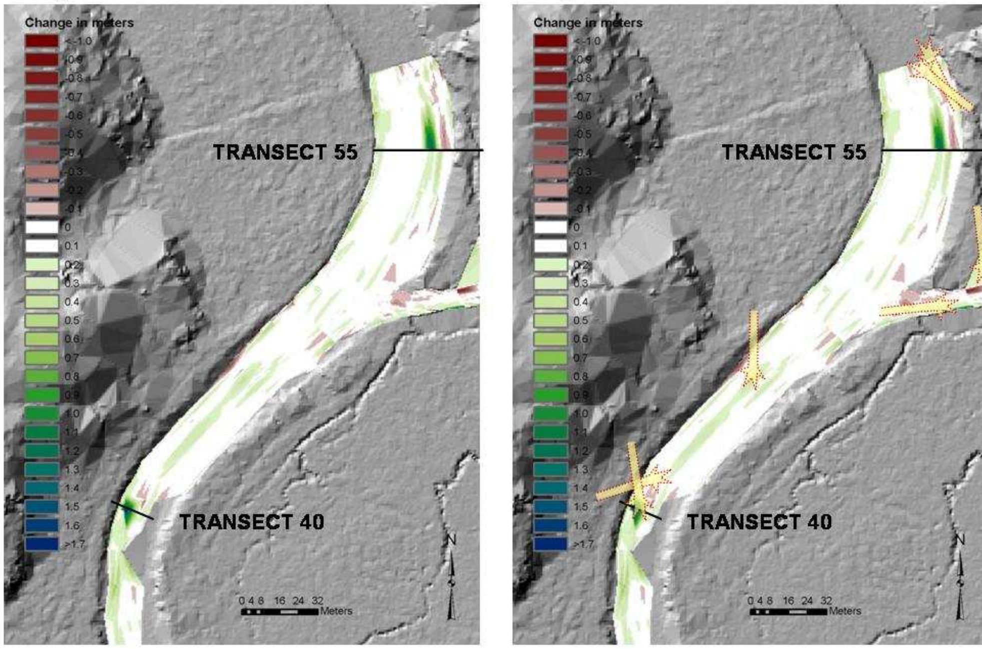
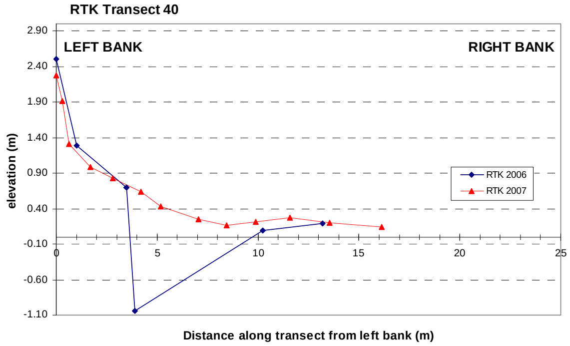
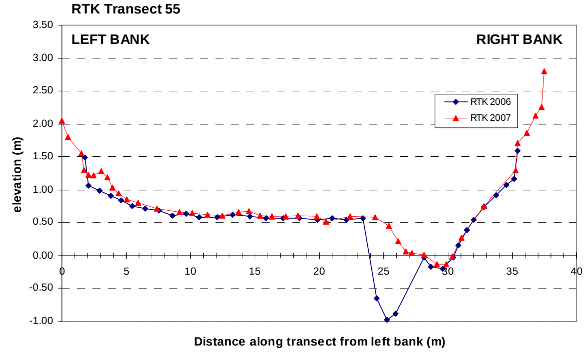


Figure 9. In the northern half of the survey area, at transects 40 and 55, two significant areas of deposition have occurred. In both cases, large holes seen in the 2006 surveys were no longer there. Transect 40 occurred on the edge of the GPS dead zone, but the magnitude of the 1.5 meter change far exceeds the uncertainty in the survey. The magnitude of the change seen at transect 55 is similar at 1.2 meters.





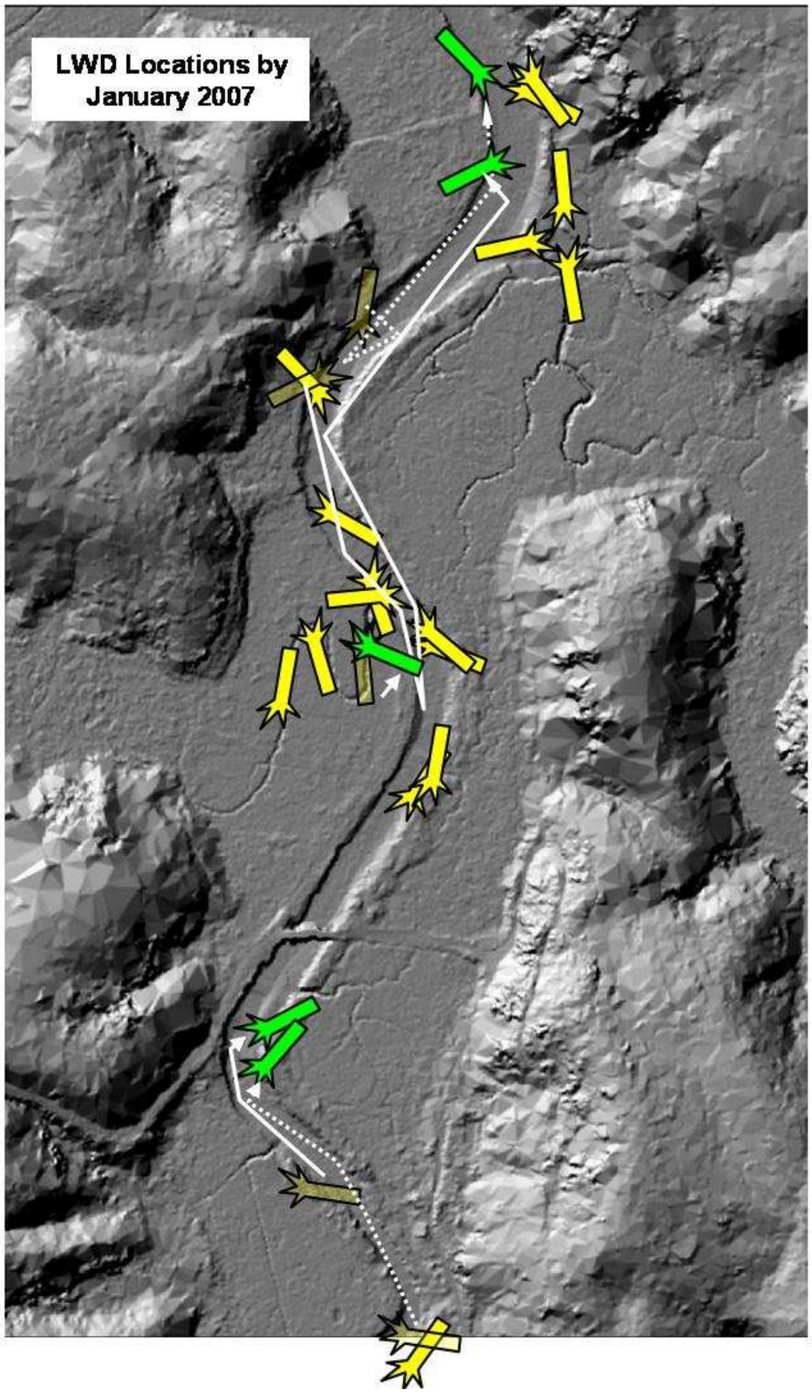


Figure 10. LWD locations as of January 2007 in the project wood zone indicated by yellow and green LWD graphics. Orientation of root wad and tree top is indicated by the orientation of the graphics. Green graphics indicated new location of LWD that moved beyond shifting and rolling in place. White solid and dotted lines indicated approximate movement path (both upstream and downstream for two pieces).