Ni-les'tun Tidal Wetland Restoration Effectiveness Monitoring: *Progress Report, January 2013*

Video sampling for juvenile salmonid tidal migration, mouth of NoName Creek. Photo by Stan van de Wetering.

January 2013

Prepared by:

Laura Brophy	Green Point Consulting Estuary Technical Group, Institute for Applied Ecology, Corvallis, Oregon
Stan van de Wetering	Confederated Tribes of Siletz Indians, Siletz, Oregon

Prepared for:

Ducks Unlimited, Vancouver, Washington
U.S. Fish and Wildlife Service, Oregon Coast National Wildlife Refuge Complex, Newport, Oregon
Oregon Watershed Enhancement Board, Salem, Oregon

This project was funded by the Oregon Watershed Enhancement Board.

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This progress report is a joint effort of Green Point Consulting, the Estuary Technical Group of the Institute for Applied Ecology, and the Confederated Tribes of Siletz Indians.

Contact information for authors:

- Laura Brophy, Green Point Consulting and the Estuary Technical Group of the Institute for Applied Ecology, Laura@GreenPointConsulting.com, (541) 752-7671
- Stan van de Wetering, Confederated Tribes of Siletz Indians, stanvandewetering@yahoo.com, (541) 351-0126

Additional project team members and roles:

- Craig Cornu[1]: field data collection, equipment installations, data management
- Ayesha Gray[2]: field data collection, data analysis (macroinvertebrates)
- Michael Ewald[3,4]: field data collection, equipment installations, data analysis

Institutional affiliations for additional project team members:

[1] Estuary Technical Group, Institute for Applied Ecology, Corvallis, Oregon
[2] Cramer Fish Sciences, Coos Bay, Oregon
[3] Oregon State University, Corvallis, Oregon
[4] Green Point Consulting, Corvallis, Oregon

Recommended citation: Brophy, L.S., and S. van de Wetering. 2012. Ni-les'tun Tidal Wetland Restoration Effectiveness Monitoring: Progress report, January 2013. Corvallis, Oregon: Green Point Consulting, the Institute for Applied Ecology, and the Confederated Tribes of Siletz Indians.

Acknowledgments: We are grateful to the staff of the Oregon Coast National Wildlife Refuge Complex and Ducks Unlimited for their ongoing participation and support for this monitoring program.

Funding for this project was provided by the Oregon Watershed Enhancement Board.

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REPORT ORGANIZATION: MONITORING OBJECTIVES

Monitoring at Ni-les'tun is designed to allow evaluation of restoration effectiveness, and provide information to help guide other restoration projects. The information we gain through monitoring at this landmark project helps advance restoration science in Oregon, the Pacific Northwest, and beyond.

This document reports on scoping activities conducted during 2012. The goal of scoping was to evaluate site changes during Year 1 after restoration, and use that information to plan 2013 monitoring activities. In addition, we conducted effectiveness monitoring for some parameters during 2012, as described below.

This report is organized by the "big picture" **monitoring objectives** listed below. These objectives relate our monitoring activities to the project's **restoration objectives**. Each monitoring objective encompasses several specific **monitoring questions**, which were answered by measuring **monitoring parameters** ("**metrics**"). This report contains those measurements, as well as interpretation and comparison to other projects.

Monitoring Objective 1: Measure restoration of tidal hydrology, tidal wetland vegetation, and the physical attributes that control tidal wetland functions across the 418-acre marsh.

Associated Restoration Objective: Restoration of coastal tidally influenced wetlands through hydrological reconnection

Monitoring Questions:

Q1a) Was tidal hydrology successfully restored?

Metrics: Tidal hydrology (inundation frequency, duration, and depth) at restored and reference sites; elevation of wetland surface and instrumentation; tidal channel morphology (cross-sections, longitudinal sections, length, density, and sinuosity)

Q1b) Are tidal wetlands developing, with physical and biological characteristics trending towards reference conditions?

Metrics: Wetland plant community composition and extent; soil characteristics (stored organic carbon, salinity, pH, texture); groundwater levels; surface water salinity and temperature.

Monitoring Objective 2: Measure habitat recovery and habitat utilization by at-risk and endangered species.

Associated Restoration Objective: Restoration of coastal and marine habitat to recover listed and at-risk species, particularly estuary dependent and anadromous fishes

Monitoring Questions:

Q2a) Did restoration result in increased salmonid habitat opportunity (availability)?

Metrics: Surface area, volume, duration and frequency of salmonid habitat availability (using channel morphology measurements and tidal elevations); surface water salinity and temperature; locations, quantities, and descriptions of large wood habitat restored.

Q2b) Did restoration result in increased salmonid habitat capacity?

Metrics: Benthic macroinvertebrate abundance and community structure within the largest of the three restored basins (Fahys Creek).

Q2c) Did restoration result in increased salmonid habitat utilization?

Metrics: Salmonid standing stock, habitat utilization and migration patterns in restored *vs*. reference basins; salmonid utilization of large wood habitat.

Monitoring Objective 3: Measure extent of resiliency to storm-related flooding and climate change.

Associated Restoration Objective: Improve coastal resiliency to storms, flooding and climate change

Monitoring Questions:

Q3a) Did restoration improve the site's capacity to moderate storm-related flooding?

Metrics: Channel volume (cross-sections, length); water levels.

Q3b) Do post-restoration site conditions show potential for improved resilience to climate change?

Metrics: Plant community composition and extent; soil characteristics (% organic matter, texture, pH, and salinity); groundwater levels.

METHODS AND SAMPLE LOCATIONS

Methods and sample locations were described in the baseline monitoring report (Brophy and van de Wetering 2012) and are not repeated here, except where needed to describe results of 2012 scoping.

RESULTS AND DISCUSSION

1. Tidal wetland restoration

Monitoring Objective 1: Measure tidal wetland restoration

In this objective, we are measuring the restoration of tidal hydrology, tidal wetland vegetation, and the physical attributes that control tidal wetland functions across the 418-acre marsh and adjacent forested wetlands.

1a. Tidal hydrology

Monitoring Question 1a: Was tidal hydrology successfully restored?

Metrics for evaluating tidal hydrology:

Tidal hydrology (inundation frequency, duration, and depth) at restored and reference sites; elevation of wetland surface and instrumentation; tidal channel morphology

(cross-sections, longitudinal sections, length, density, and sinuosity). *(Rationale: Elevation measurements allow linkage of tide heights to physical and biological site characteristics; tidal channel morphology strongly affects water movement across a large tidal wetland. Channel morphology data will also be used to quantify salmonid habitat availability.)*

2012 Scoping Activities, Findings, and Relevance:

Tidal inundation frequency, duration and depth

- Tidal water levels were monitored during spring, summer and fall 2012 using automated water level loggers (Onset HOBO® loggers, model U20-001-01) programmed to collect data at 15min intervals. Water levels were logged inside the Ni-les'tun site, and outside the site in the mainstem Coquille River. A barometric pressure logger was operated continuously during 2012 water level data collection. The barometric pressure data are used for barometric pressure compensation, which improves the accuracy of water level logger output.
    - Analysis during 2012 showed that the 2011 "outside" level logger (on a piling just outside the old Fahys Creek tide gates) was too high to capture low tides.
        - To capture the full tidal cycle and allow more thorough analysis and correlation of tidal water levels with other parameters, we constructed a new, full-range stilling well in the mainstem Coquille River channel on pilings in deep water (Appendix A, Photo A1). Subsequent data downloads have confirmed that this installation is capturing all low and high tides.
    - The 2011 "inside" water level logger in Lower Fahys Creek was swept away by floating logs during a winter storm in early 2012 (after the November 2011 download).
        - To provide post-restoration data inside the Ni-les'tun site, we installed a new logger in May 2012 in a more protected location at the confluence of Channel 5 and lower Fahys. However, by August 2012 it was apparent that floating woody debris threatened this logger as well (Appendix A, Photo A2).
        - To provide a backup in case of damage to the Lower Fahys logger, we installed a second "inside" water level logger, at the confluence of Channel 7 and Fahys.

Elevation of wetland surface and instrumentation

- During 2012, a USGS team surveyed elevations at 1725 points on a grid at the Bandon Marsh Unit (reference site). Data were collected in 40 east-west transects spaced 50m apart, with data points approximately every 12m along each transect (Appendix A, Photo

A3). These data have been made available to our team for refuge management purposes (John Takekawa and Kat Powelson, USGS, personal communication).

  - Informal comparison of the USGS RTK-GPS data with our team's surveyed elevations at sample transects shows that the two datasets match very closely (generally within 10cm).
    - During 2013 we will analyze the USGS RTK-GPS data to support monitoring and management efforts at the reference site. The data will be valuable for interpreting plant community patterns, groundwater, fish use, and other monitoring data.

- During 2012, we surveyed the elevations of water level loggers (tide gauges) using RTK-GPS and laser level methods.

  - Results show that the tide gauges remained stable during 2012.
    - During 2013 we will resurvey tide gauge elevations to allow ongoing analysis of water levels relative to site elevations, channel features, salinity loggers, and groundwater level loggers. This information will be used to interpret results for all monitored parameters.

Channel morphology

- Channel forming processes, channel morphology, and flow conditions were observed during spring, summer and fall 2012.

  - Observations showed that sheet flow events now occur regularly within the lower Fahys and NoName subbasins; in-channel flow velocities are substantial; and sediment scour and deposition are occurring. Despite these velocities and sheet flows, tributary channels are not yet visibly forming, although nick points are forming in many locations (Appendix A, Photo A4). The nick points are expected to head-cut to form tributary channels in the future, but probably not by 2013.
    - Channel morphology monitoring in 2013 will focus on in-channel morphology changes that relate closely to fish habitat, such as scour and fill, bank erosion, and effects of large woody debris on those processes.
    - We are collaborating with fluvial geomorphologists from the USGS Portland Field Operations Office to develop a GIS-based channel flow model for the marsh. The model will be used to select channel monitoring locations and to interpret channel morphology changes. Model output will also help us interpret other monitoring results, especially plant community development and fish use (see **Salmonid habitat functions** below).

1b. Physical and biological conditions at Ni-les'tun

Monitoring Question 1b: Are tidal wetlands developing, with physical and biological characteristics trending towards reference conditions?

Metrics for evaluating physical and biological conditions:

Wetland plant community composition and extent; soil characteristics (stored organic carbon, salinity, pH, texture); groundwater levels; surface water salinity and temperature. *(Rationale: Soil characteristics, groundwater levels and surface water characteristics are controlling factors in tidal wetland plant community development and many other wetland functions.)*

2012 Scoping Activities, Findings, and Relevance:

Emergent wetland plant communities

Plant community composition

- Emergent wetland plant community changes were observed during field work in spring, summer and fall 2012.
    - Observations during 2012 showed rapid change in plant communities in the lower Fahys subbasin, where daily saline tidal flows are causing shifts in species dominance. In upper Fahys, the slough sedge (*Carex obnupta*) that dominates wetlands around Transect 4 is dying back due to the introduction of brackish water. In the nearby forested wetlands, saline waters are causing shifts in shrub composition, with die-back of willows along the forest margin closest to the pasture.
        - The baseline monitoring methods will be used to document these changes in 2013; using consistent methods allows comparison of results across years.

Forested wetland plant communities

- Scoping observations of forested wetland plant communities were made during field work in spring, summer and fall 2012.
    - In forested wetlands near Transect 4, restoration of brackish tidal flow is causing shifts in shrub cover, with die-back of willows along the forest margin closest to the pasture. Based on our observations in other Oregon tidal swamps, willows are less salt-tolerant than some other shrubs such as black twinberry and Pacific crabapple (Brophy 2009, Brophy *et al*. 2011).

        - The baseline monitoring methods will be used to document these changes in 2013; using consistent methods allows comparison of results across years.

Plant community mapping

- During 2012 we developed plans, technical specifications and contacts for acquisition of 2013 aerial photographs to support plant community mapping and other monitoring activities.

    - Reviewing our communications with the 2010 aerial photo contractors, we determined that a more efficient process was needed in 2013. 2010 aerials were georeferenced using existing orthophotos (NAIP imagery). Although image quality was high (15cm ground sample distance), the georeferencing process was very slow and inefficient; results were not very accurate, with up to 5m offsets.
        - Plans for 2013 aerials include use of current technology for automated georeferencing (aircraft inertial measurements and onboard GPS receiver during the flight), greatly streamlining the process. Specified accuracy of georeferencing is 4m, but the contractors state that 2m accuracy is typical in flat areas. Aerials will be flown in May 2013.

Soils

- Soil conditions were observed during 2012 scoping activities and during groundwater logger deployments in fall 2012

    - 2012 observations showed increased soil surface inundation and saturation in most parts of the site. Increased saturation was obvious in the lower Fahys sub-basin (subject to daily tidal inundation), but also noticeable in freshwater input areas such as upper Fahys near North Bank Road and upper NoName near the overlook.
        - Soil sampling during 2013 will proceed as planned. Analysis of soil salinity, channel water salinity, and groundwater levels will help determine the relative contributions of freshwater and brackish tidal inputs in the sub-basins.

Groundwater

- In August 2012, we redeployed groundwater loggers at the same 22 sample locations used in 2010-2011. These sample locations were selected to track groundwater patterns related to both tides and freshwater flows, providing data for interpreting plant community development, soil characteristics, and other monitoring results. Loggers will be operated through August 2013, providing a full year of post-restoration groundwater data.

- During the 2012 redeployment we observed some sediment accumulation inside the shallow observation wells, particularly those in the lower Fahys subbasin where sheet flow velocities are highest and winds are strongest.
    - All shallow observation wells were checked for sediment and pumped out if necessary, following standard operating procedures (Sprecher 2000).

Channel water salinity and temperature

- Secondary indicators of likely water salinity and temperature were observed during field work in 2012.
    - Plant community changes and tidal flow patterns in 2012 suggest that salinities have increased substantially at Ni-les'tun. The magnitude of the increase is expected to depend on tidal inundation regime, relative levels of tidal inundation and freshwater inputs, and channel development (which affects speed of tidal outflow and potential for evaporative concentration of salts in summer). These factors vary between and within subbasins, requiring multiple sample stations to interpret restoration trajectories across Ni-les'tun. Reference data from the Bandon Marsh Unit and Coquille River mainstem will provide information on least-disturbed conditions in the lower estuary, as well as river inputs.
        - In December 2012, we constructed housings for 18 conductivity/ temperature loggers to be deployed at Ni-les'tun and the Bandon Marsh Unit. Loggers will be deployed at nearly all of the sample sites used in 2010-2011, but some loggers in the lower channels will be moved upstream to avoid damage from floating logs (see Appendix A, Photo A2).
        - New loggers will be deployed in the middle and/or upper sections of Fahys, East Fahys and NoName channels to provide improved resolution of post-restoration salinity patterns.
        - Loggers will be deployed from January through August 2013.

2. Salmonid habitat functions

Monitoring Objective 2: Measure habitat recovery and habitat utilization by at-risk and endangered species

2a. Salmonid habitat opportunity (availability)

Monitoring Question 2a: Did restoration result in increased salmonid habitat opportunity (availability)?

Metrics for evaluating habitat availability:

Surface area, volume, duration and frequency of salmonid habitat availability (using channel morphology measurements and tidal elevations); surface water salinity and

temperature; locations, quantities, and descriptions of large wood habitat restored. *(Rationale: Habitat availability is determined by analyzing water levels and channel volumes; surface water salinity and temperature affect habitat utilization; large wood location and size correlate strongly to salmonid behavior and habitat use.)*

Surface Area, Volume, Duration, and Frequency

2012 Scoping Activities, Findings, and Relevance:

- Day and night time tides were observed during the spring and summer months to better understand the new patterns of tidal inundation.
    - Observations suggest significant tidal sheet flow events now occur in the lower Fahys and NoName systems, during both lower and higher river levels.
        - This information will be used to inform the monitoring plan used to describe shifts in channel network development specific to tidal elevation data patterns and the development of an Arc GIS channel flow model to be used in the channel network restoration assessment.
- Snorkeling in constructed and historical channels was completed during the spring and summer months to evaluate where changes were occurring and at what relative rate.
    - Snorkel results from various channel reaches in Fahys, NoName, and Redd marshes suggest sediments were both aggrading and scouring. Conclusions based on this anecdotal information were that this response was correlated to As-Built-Channel-Morphology and presence of restoration wood structures.
        - These findings of scour and fill distribution patterns along with winter 2012-13 velocity measurements will in part be used to inform the monitoring plan that will evaluate channel development and shifts in channel habitat in the three restored marshes.

Temperature and salinity

- Restoration channel temperatures were taken during snorkeling and fish sampling events at various spring and summer tides but daily data were not budgeted for 2012.
    - The post-restoration pattern of daily tidal intrusion has significantly shifted water temperatures and salinities within the interior portions of the three marshes – especially during the late spring and summer period.
        - New sites will be added to the seasonal temperature and salinity monitoring plan to allow for an improved description of these post restoration changes.

Large Wood

- Wood structures were observed during the spring and summer months for general condition, potential for movement and presence of bed scour patterns.
    - In general the wood structures placed in the various channels remained in place during the first year of post restoration. Exceptions were those structures located in mid and upper Fahys where the percent of sands in the soils and deeper substrates increased and was obvious to the naked eye. This was noted during wood installation and resulted in increased difficulty in anchoring the wood stems – getting them to penetrate the substrate well enough to be secured during high water. An estimate of structures that pulled away from their substrate "anchor" is approximately 12 from the total of 193.
        - The scour seen to date has been significant at several sites and will be used to inform our 2013 efforts toward assessing and describing shifts in channel habitats. This number of structures lost will be accurately described during the 2013 work period.

2b. Salmonid habitat capacity

Monitoring Question 2b: Did restoration result in increased salmonid habitat capacity?

Metrics for evaluating habitat capacity:

Benthic macroinvertebrate abundance and community structure within the largest of the three restored basins (Fahys Creek). *(Rationale: benthic macroinvertebrates constitute a large proportion of salmonid prey; prey availability is a controlling factor in salmonid growth rate and ocean survival.)*

Macroinvertebrate abundance and community structure

No macroinvertebrate monitoring was budgeted for during the scoping period of 2012.

Monitoring Question 2c: Did restoration result in increased salmonid habitat utilization?

Metrics for evaluating salmonid habitat utilization:

Salmonid standing stock, habitat utilization and migration patterns in restored *vs*. reference basins; salmonid utilization of large wood habitat. *(Rationale: Direct measurements of salmonid use of the variety of habitats at Ni-les'tun will provide valuable information on restoration effectiveness and value of large wood placement.)*

2012 Scoping Activities, Findings, and Relevance:

Tidal Migrations and Fish Use of the Marshes

- Tidal exchange during May and June for day and night tides was observed to better understand the effects of full tidal exchange on evaluating fish migration during post restoration.

    - Observations suggest very high velocity tidal exchanges now occur as well as sheet flow in lower Fahys and NoName channel networks, during both lower and higher river levels.
        - This information will be used to select final fish sampling sites specific to both camera tidal migration observations as well as low tide distribution sampling. Extensive flooding in lower Fahys is going to require a special camera equipment support structure to allow for a near Fahys mouth migration estimate (Appendix A, Photos A5-A7). In addition a second estimate is planned for a site upstream of the current mouth.

- Video sampling occurred in lower Fahys and lower NoName in May and June (Appendix A, Photos A5, A6, A8).

    - Channel velocities were too great to allow for the evaluation of fish passage at the point where Fahys crosses the old north south dike and enters the mud flats. Fish were seen during both day and night sampling but night ebb tides proved too powerful to hold equipment in place for several hours– large logs continually drifted into and out of the marsh removing camera poles and fish identification became difficult at the highest velocities.
        - Fahys mouth sampling during 2013 will involve a subset of the overall channel mouth and will be located further downstream in the more open mud flat where velocities are somewhat reduced (Appendix A, Photo A7). In addition sampling will also occur upstream of the mouth in the historic channel area where velocities are somewhat lower as well. Lastly new camera poles and supports have been constructed to allow for logs to pass over the tops of the poles without damage to the poles themselves.

    - Channel velocities were high as well in lower NoName due to constriction of channel widths during years of diking. Day and night sampling was successful here and used to evaluate the value of night tide data. Fish were seen during both day and night sampling.
        - Video data gathered during May and June showed higher rates of marsh use by age 0+ Chinook during May. Age 1+ coho are still available as well in May. Marsh camera sampling will target May rather than June during the post restoration period.

        - Day and night sampling will be used at NoName to allow for an estimate of relative differences in the two.
        - Day sampling only will occur in the middle and upper portions of NoName 2013 to allow for estimates of overall penetration/use of the more interior portions of the marsh.

Fish Use of Large Wood Structures

- Day and night time tides were sampled during May and June to better understand the relative ability of the research team to access and gather data at a range of wood sites. Sites were also sampled to determine the potential use rates of large wood structures by various species.

    - Observations suggest current velocities are too great to measure during the full tidal cycle in the lowest Fahys reach wood sites but the middle and upper sites appear adequate for sampling with cameras.
        - Wood habitat camera sampling will focus on the middle, upper and tributary reaches of Fahys – specific to Fahys post restoration monitoring.

    - Observations suggest large wood habitat use is higher than in non-wood habitats in lower and middle NoName – upper NoName not sampled.
        - Video data gathered during May and June showed higher rates of use by age 0+ Chinook during May. Age 1+ coho are still available in May. Large wood camera sampling will target May rather than June during the post restoration period.

    - The lowest portions of Fahys appear to hold large numbers of juvenile salmonids and they are associated with the deep holes created by the scour associated with the wood structures. We were not effective at sampling these habitats relative to absolute tidal elevation changes and associated velocities.
        - Future efforts will be made to enumerate these fish by using seining methods although the data will only be useful for relative abundance estimates and sampling will continue to focus on underwater videography to enumerate wood habitat use.

Fish Use of the Mainstem River

- Seining occurred in the mainstem river during May, June and August.

    - Distribution of age 0+ and 1+ salmonids and a review of historic data suggests mid-May as a typical peak period of use.
        - Peak use month for seine sampling will target May in the future.
    - Good numbers of juvenile chinook and coho were available during the 2012 sampling period.

- Pre-restoration sampling regimes should continue to allow for a statistically sound comparison to post-restoration sampling.

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Appendix A. Photographs

Photo A1. New tide gauge stilling well on pilings opposite the restored mouth of Fahys Creek. Stilling well is tall white PVC pipe; Fahys Creek mouth is in the left background.

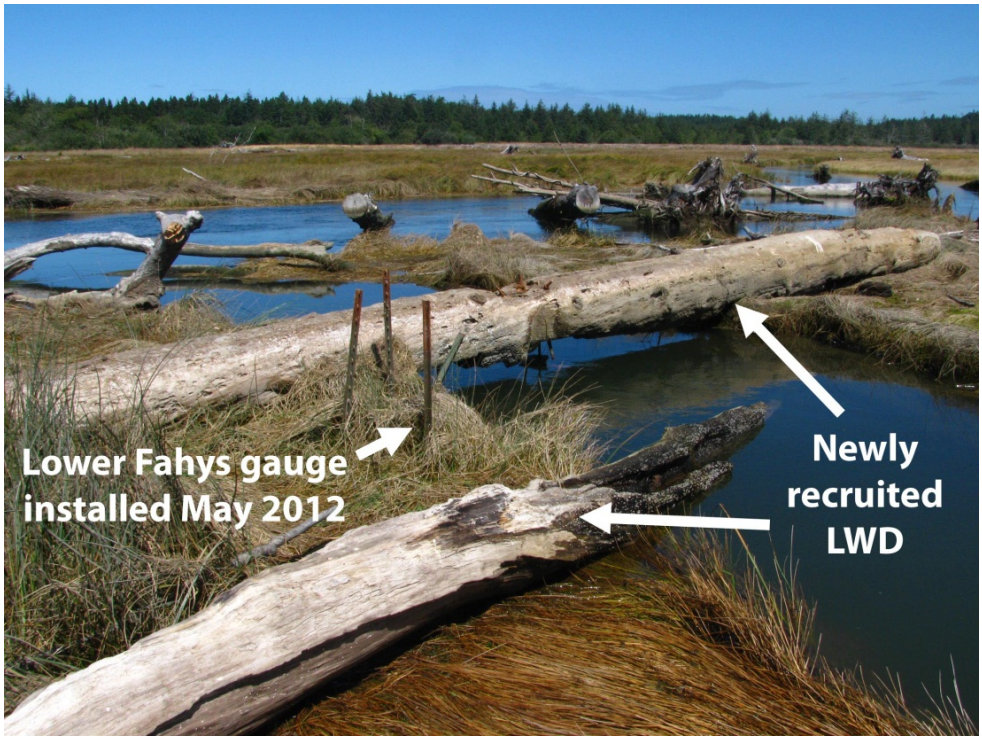

Photo A2. Lower Fahys gauge installed May 2012, showing surrounding large woody debris deposited during high tides (foreground and middle ground). Large woody debris in background was installed during restoration.

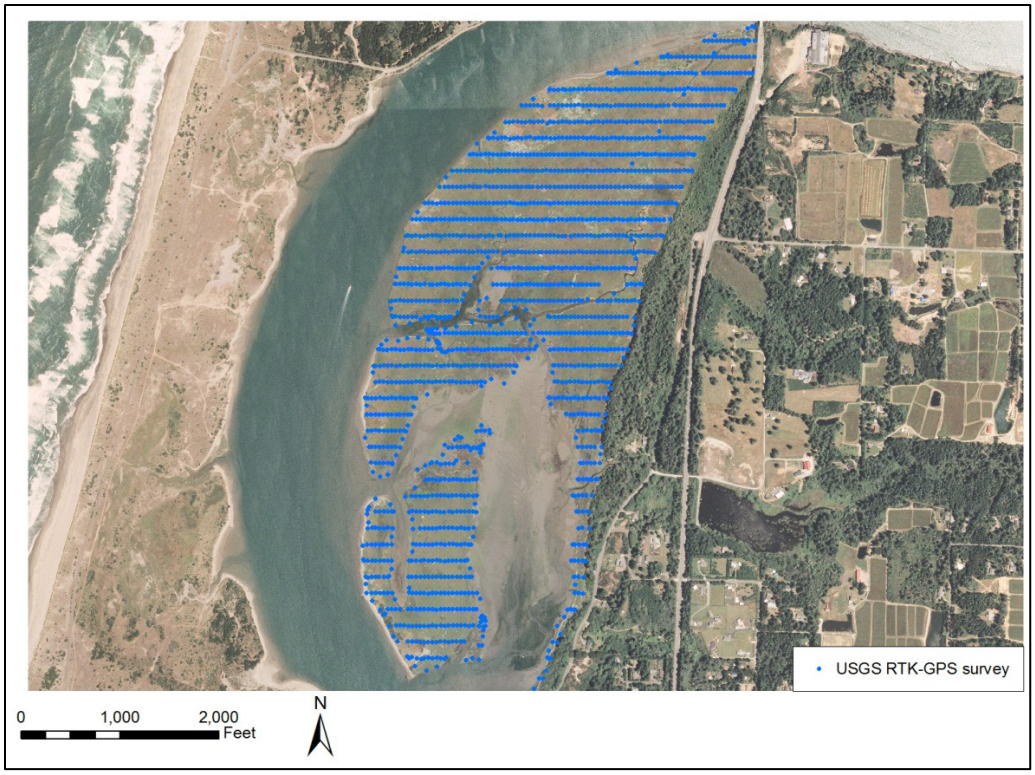

Photo A3. USGS RTK-GPS survey of Bandon Marsh Unit. Blue dots represent individual survey points.

Photo A4. Example of a nick point (center of photo) that will most likely head-cut to form a tributary channel during future years.

Photo A5. Lowers Fahys site showing setup to allow for sampling during sheet flow conditions.

Photo A6. Lowers Fahys camera site where tidal velocities and depths proved difficult to sample full tidal period.

Photo A7. Proposed lower Fahys mud flat camera site with lower velocities due to wider shallower profile.

Photo A8. Camera sampling site at mouth of NoName.

Photo A9. Wood camera sampling site in mid NoName channel network.