2012-2013 Olympic Peninsula Open Coast Beach Data Collection, Analysis, and Archiving For Washington State Department of Natural Resources Coastal and Marine Spatial Planning Project: In Support of the Quinault and Quileute Indian Nations

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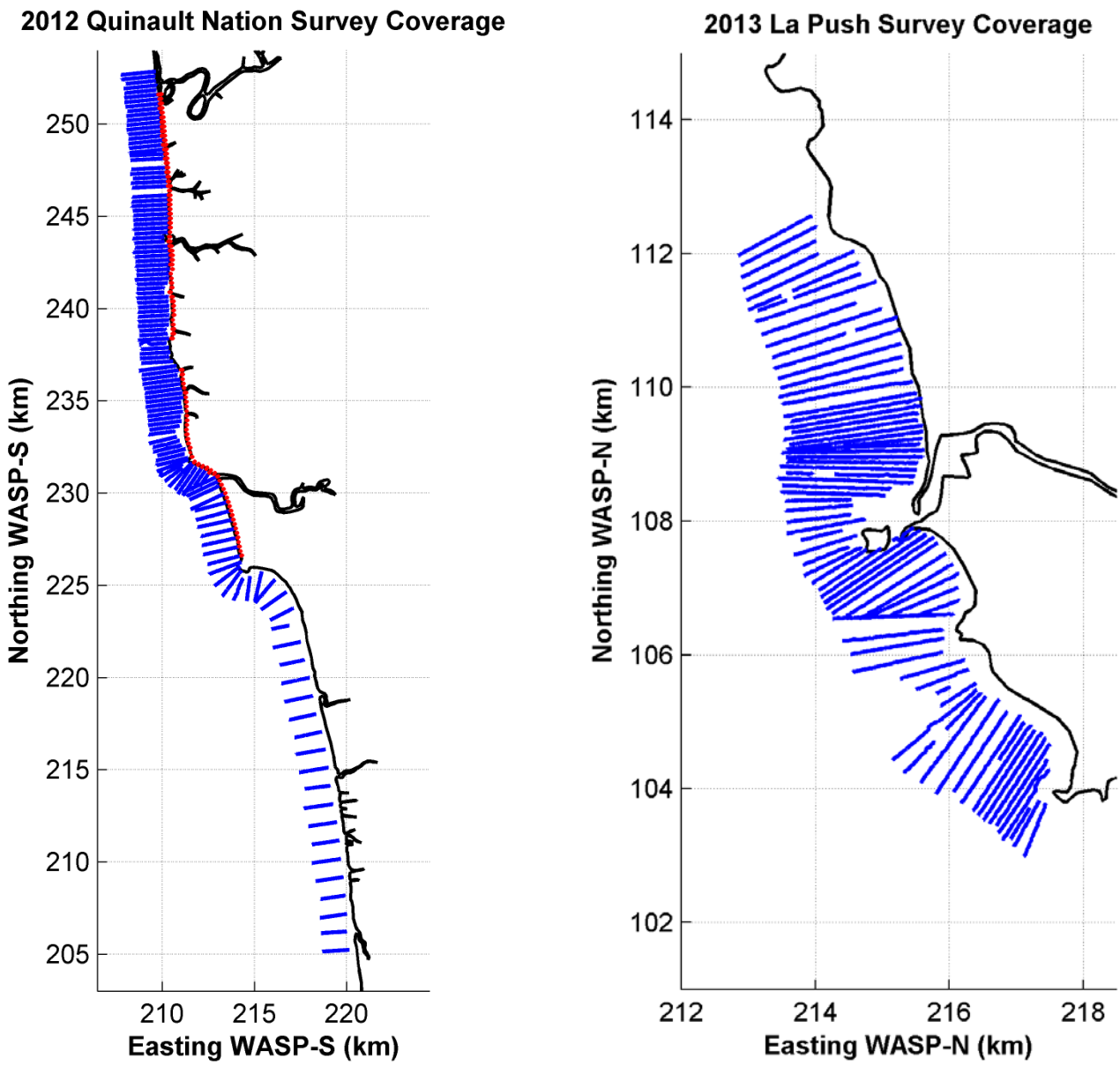
Photo by Andrew Stevens

Nearshore Bathymetry Survey

During the weeks of 17 July 2012 and 6 June 2013, Oregon State University (OSU), with assistance from the U.S. Geological Survey (USGS) and the Washington State Department of Ecology's Coastal Monitoring & Analysis Program (CMAP), performed nearshore bathymetric and topographic surveys on Washington's Olympic Peninsula's outer coast along the territories of the Quinault and Quileute Indian Nations. The Quinault Territory survey ranged from the southern boundary at Moclips north to the Queets River, with bathymetric and topographic data collected during 17-20 July 2012 (Figure 1a). The Quileute Territory survey was performed on the beaches surrounding the Quileute River at La Push, WA during 6-7 June 2013 on Rialto Beach, First Beach, and Second Beach (Figure 1b). Bathymetric Data was collected using the Coastal Profiling Systems of OSU and the USGS (high-speed maneuverable personal water-craft (PWC) equipped with an echo-sounder and Global Positioning System, see Figure 2). Each daily survey was performed with 2 to 3 PWCs and 2-4 backpack rover units depending on available personnel and equipment. The surveying program served to provide nearshore bathymetric and topographic data to the Washington State Department of Natural Resources (WA-DNR) Coastal and Marine Spatial Planning Project in support of the Northwest Indian Fisheries Commission (NIFC) for the Quinault and Quileute Indian Nations. The survey data provided to the WA-DNR is needed for GIS data compilation and analysis for Marine Spatial Planning for coastal tribes. The primary goals of this report are to provide data that will serve as influence in decision making for marine spatial planning for the Indian Nations of Washington's Olympic Coast, as well as outline procedures for data collection, processing and archiving.



(a) (b)

Figure 1: (1a) Quinault Nation nearshore bathymetry (blue) and topographic (red) survey profiles collected during the July 2012 survey. (*1b)* Quileute Nation nearshore bathymetry (blue) and topographic (red) survey profiles collected during the June 2013 survey at La Push.

Table 1. The 17-20 July 2012 Quinault Nation survey participants and their affiliations.

Participant	Responsibility	Affiliation
Peter Ruggiero	Chief Scientist	Oregon State University
Jeff Wood	Faculty Research Assistant	Oregon State University
Karl Schmidt	Undergraduate Research Assistant	Oregon State University
Diana Di Leonardo	Graduate Research Assistant	Oregon State University
Katy Serafin	Graduate Research Assistant	Oregon State University
Guy Gelfenbaum	Chief Scientist	U.S. Geological Survey
Andrew Stevens	Oceanographer	U.S. Geological Survey
Josh Logan	Geographer	U.S. Geological Survey
George Kaminsky	Chief Scientist	Wash. State Dept. of Ecology
Diana McCandless	Coastal Scientist	Wash. State Dept. of Ecology
Heather Baron	Coastal Scientist	Wash. State Dept. of Ecology
Rebecca Sexton	Field Technician	Wash. State Dept. of Ecology

Table 2. The 6-7 June 2013 Quileute Nation survey participants and their affiliations.

Participant	Responsibility	Affiliation
Jeff Wood	Faculty Research Assistant	Oregon State University
Gabriel Garcia	Faculty Research Assistant	Oregon State University
Katy Serafin	Graduate Research Assistant	Oregon State University
Heather Baron	Coastal Scientist	Wash. State Dept. of Ecology
Rebecca Sexton	Field Technician	Wash. State Dept. of Ecology
Steve Eykelhoff	Field Technician	Wash. State Dept. of Ecology

Field Equipment and Data Quality

The Coastal Profiling System (CPS), mounted on a Personal Watercraft (PWC), consists of a single beam echo sounder, survey grade GPS receiver and antenna, and an onboard computer system running Hypack hydrographic survey software (Figure 2). This system is capable of measuring water depths from approximately 0.5m to approximately 50m. The survey-grade GPS equipment to be used in this project have manufacturer reported RMS accuracies of approximately ±3cm + 2ppm of baseline length (typically 10km or less from the base station) in the horizontal and approximately ±5cm + 2ppm in the vertical while operating in Real Time Kinematic (RTK) surveying mode. These reported accuracies are, however, additionally subject to multi-path errors, satellite obstructions, poor satellite geometry, and atmospheric conditions that can combine to cause a vertical GPS drift that can be as much as 10cm.

While the horizontal uncertainty of individual data points is approximately 0.05*m*, the CPS operators cannot stay "on line" in waves and currents to this level of accuracy. Typically, mean offsets are less than 2.0*m* from the preprogrammed track lines and maximum offsets along the approximately 2*km* long transects are typically less than 10.0*m*. While repeatability tests and merges with topographic data collected with an all-terrain survey vehicle or a backpack rover unit (with the same GPS equipment as the CPS) suggest sub-decimeter vertical accuracy, significant variability in seawater temperature (~10 degrees Celsius) can affect depth estimates by as much as 20*cm* in 12*m* of water. However, water temperatures usually remain within a few degrees of the temperature associated with the preset sound velocity estimate of 1500 *m/s* and attempts are made to correct for variations in sound velocity depending on environmental conditions. Therefore, a conservative estimate of the total vertical uncertainty for these nearshore bathymetry measurements is approximately 0.15*m*.

For more information regarding equipment, field techniques, and data quality please refer Ruggiero et al., 2005 and Ruggiero et al., 2007.

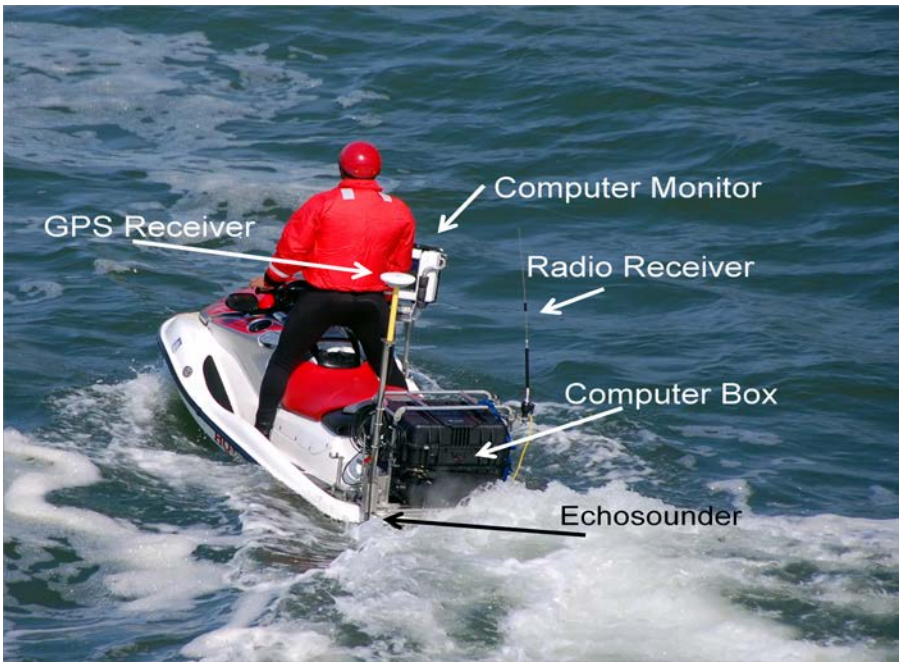
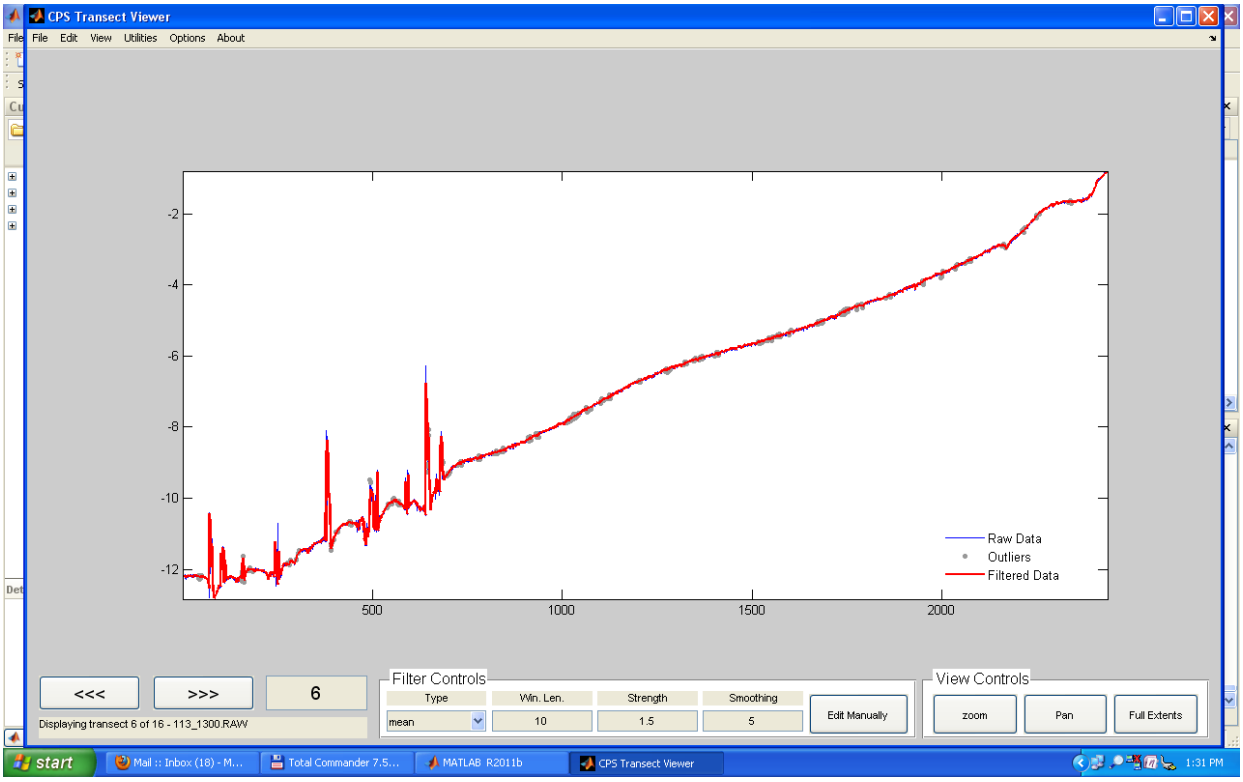


Figure 2) Data acquisition vessel and onboard equipment (Coastal Profiling System).

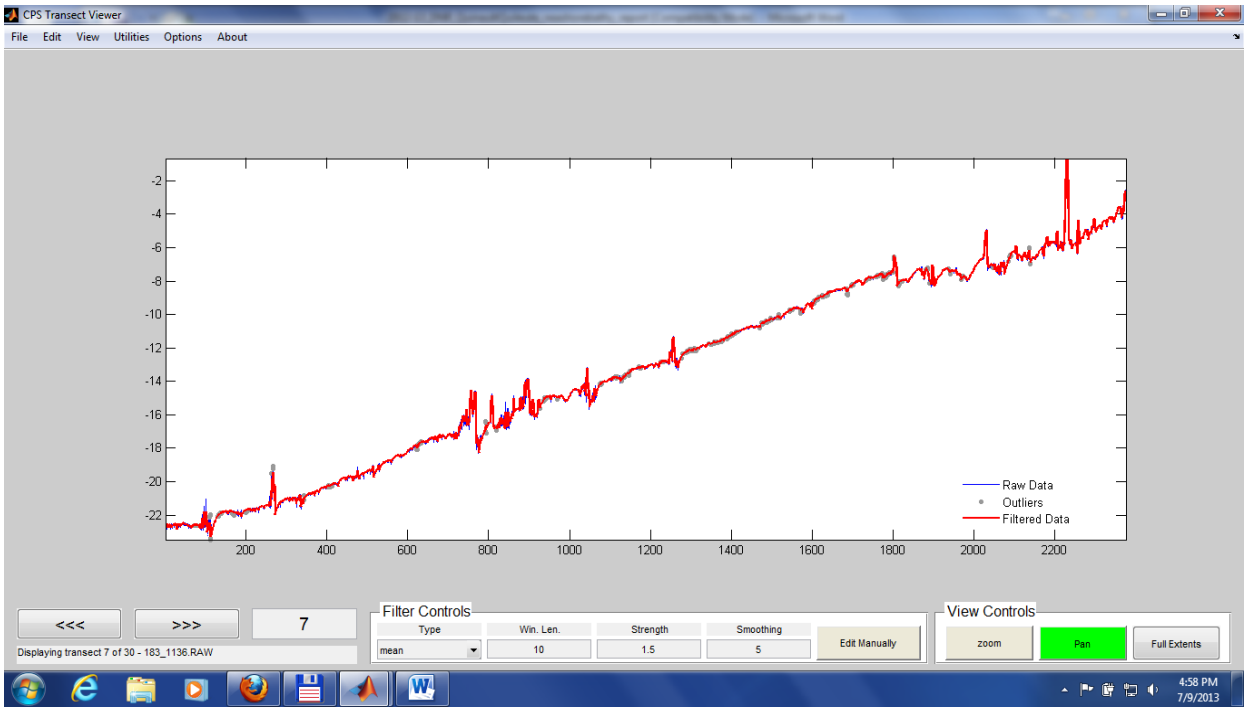
Data Processing and Archiving

Our survey data was collected in the horizontal datum NAD83 (m) in Washington State Plane South for the Quinault Survey and Washington State Plane North for the Quileute Survey, and the vertical datum NAVD88 (m) using the Southwest Washington Coastal geodetic control network, and a series of newly established geodetic monuments within the Quinault and Quileute Indian Nations, which provided differential RTK measurements to be made relative to a base station positioned on a geodetically measured landmark.

Data processing was carried out using the Matlab script *transectViewer.m* developed by Andrew Stevens from the US Geological Survey in coordination with Peter Ruggiero of OSU. This code loads and displays the digitized data files and allows the user to navigate through the data and perform appropriate filtering and smoothing. Echosounder digitized depths can be compared to the raw acoustic backscatter signal, collected by the echosounder, to ensure accuracy of the data and proper digitization of the bottom profile. Obvious bad, or noisy, data due to echosounder dropouts or poor returns can be easily eliminated from the data record, which is common while collecting data in shallow depths. Various smoothing operations can be applied to eliminate scales of morphological variability below which the user is not interested. Small variations in depth measurements due to the pitch and roll of the CPS vessel from wave activity are also eliminated through data smoothing. Due to the high quality of the raw data and the rocky bathymetry of the regions, moderate smoothing was performed (5 point median average, Figure 3).



(a)



(b)

Figure 3a) Example profile collected off of the Quinault region displayed in transectViewer. *3b)* Example profile collected off of the Quileute region displayed in transectViewer.

N*earshore Bathymetry and Topography*

In order to maximize coverage of each transect, bathymetric profiles were collected during high tides while topographic profiles were collected during low tides. Surveying in the summer months during spring tides allowed the largest degree of overlap between the bathymetric and topographic profiles for each line collected. Figures 4 and 5 show typical merged nearshore bathymetric and topographic profiles from both the Quinault survey and Quileute Survey, respectively. Figures 6 and 7 show processed elevation data from the bathymetric and topographic measurements collected during the surveys for both the Quinault survey and the Quileute survey at La Push, WA. All elevations reported are with respect to NAVD88 (m).

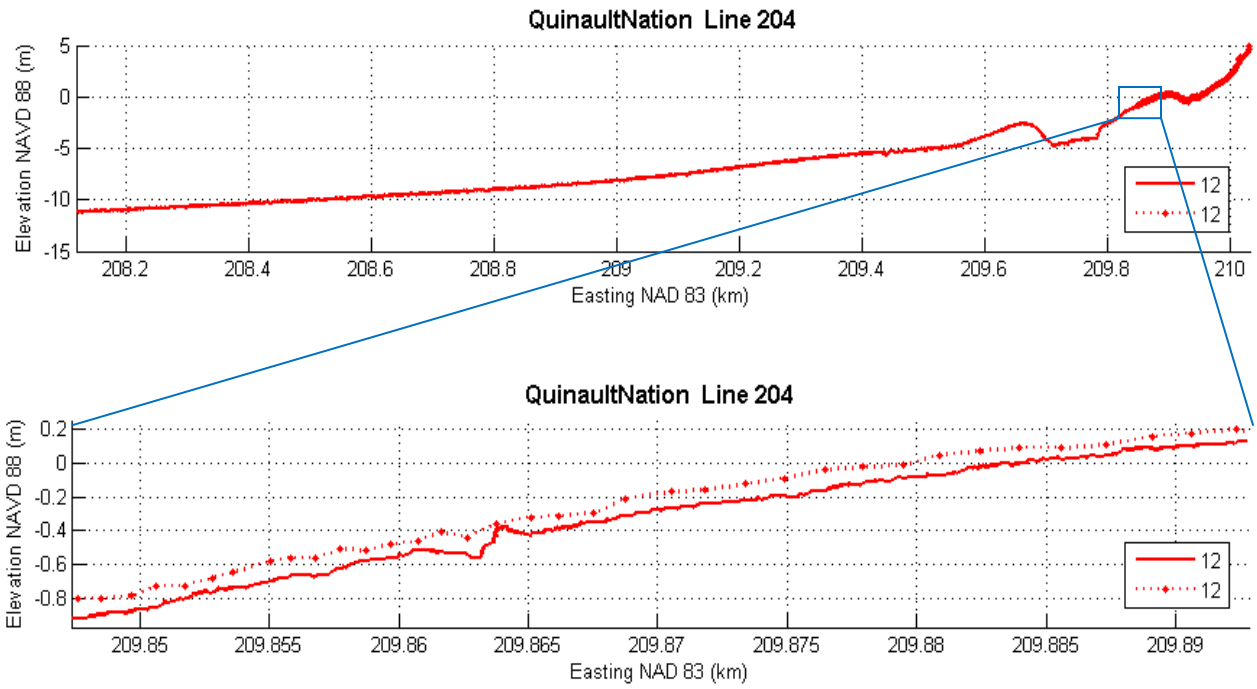


Figure 4) Example cross-shore transect from the bathymetric survey within the Quinault region (above). Bathymetric profiles are plotted as a solid line and topographic profiles are plotted as a dashed line with diamond shaped markers. A close-up view of overlapping bathymetric and topographic profiles is provided (below).

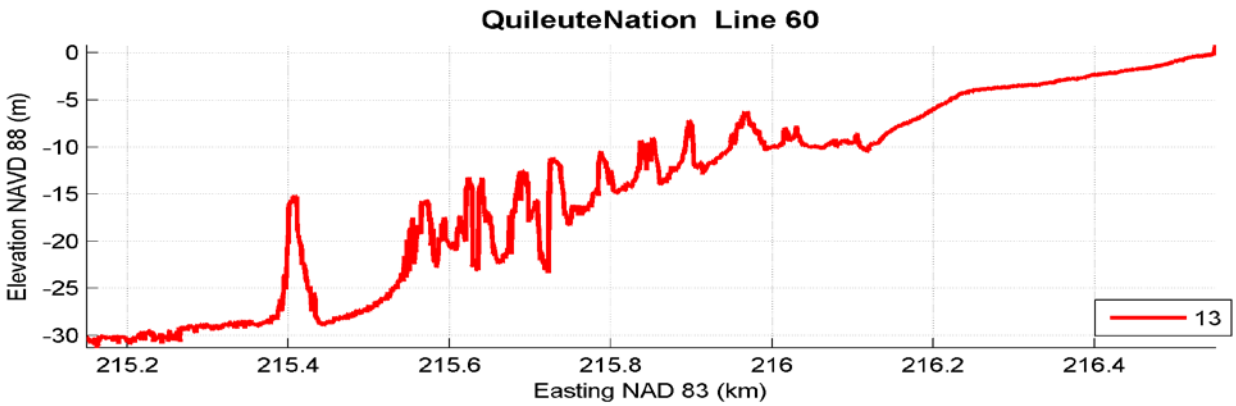


Figure 5) Example cross-shore transect from the bathymetric survey within the Quileute region (above).

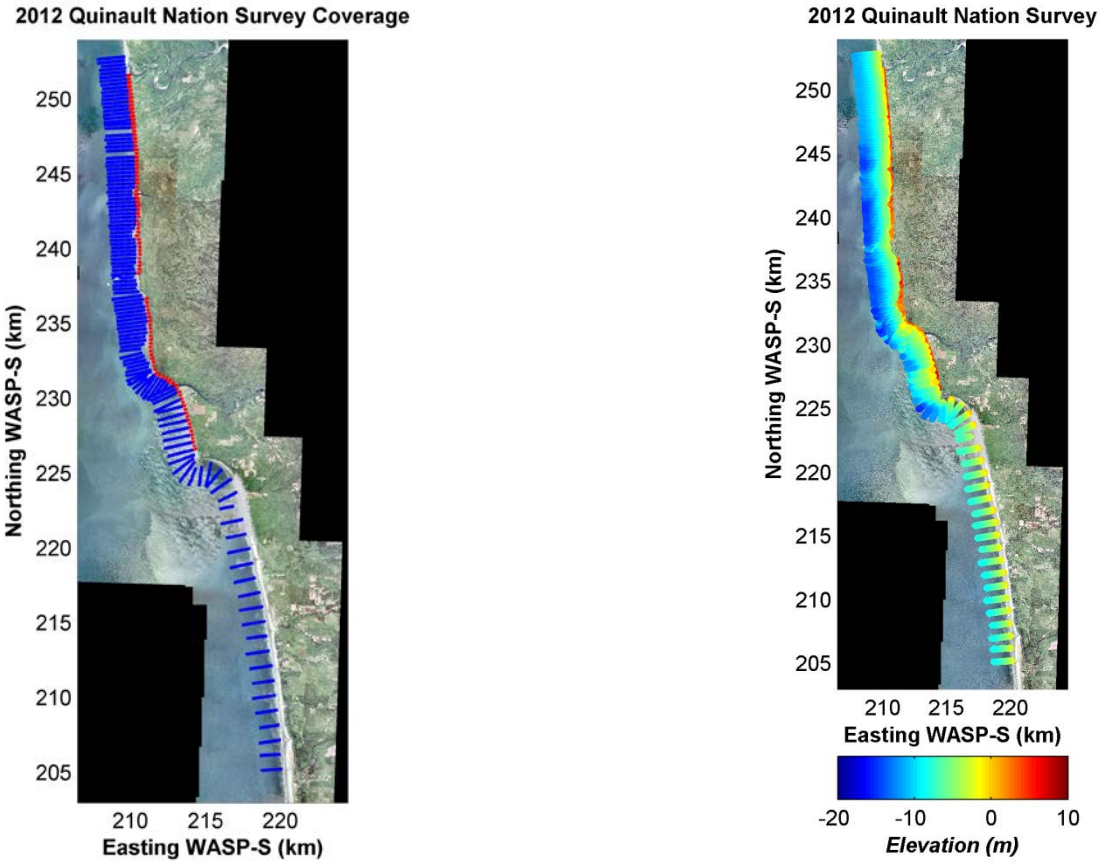


Figure 6) (LEFT) Aerial image of survey region with bathymetric (blue) and topographic (red) profiles shown. (RIGHT) Combined bathymetric and topographic elevation data collected during the Quinault Indian Nation survey. The survey extended from the southern boundary at Moclips, north to the mouth of the Queets River. Elevations are reported in meters and the vertical datum is NAVD88.

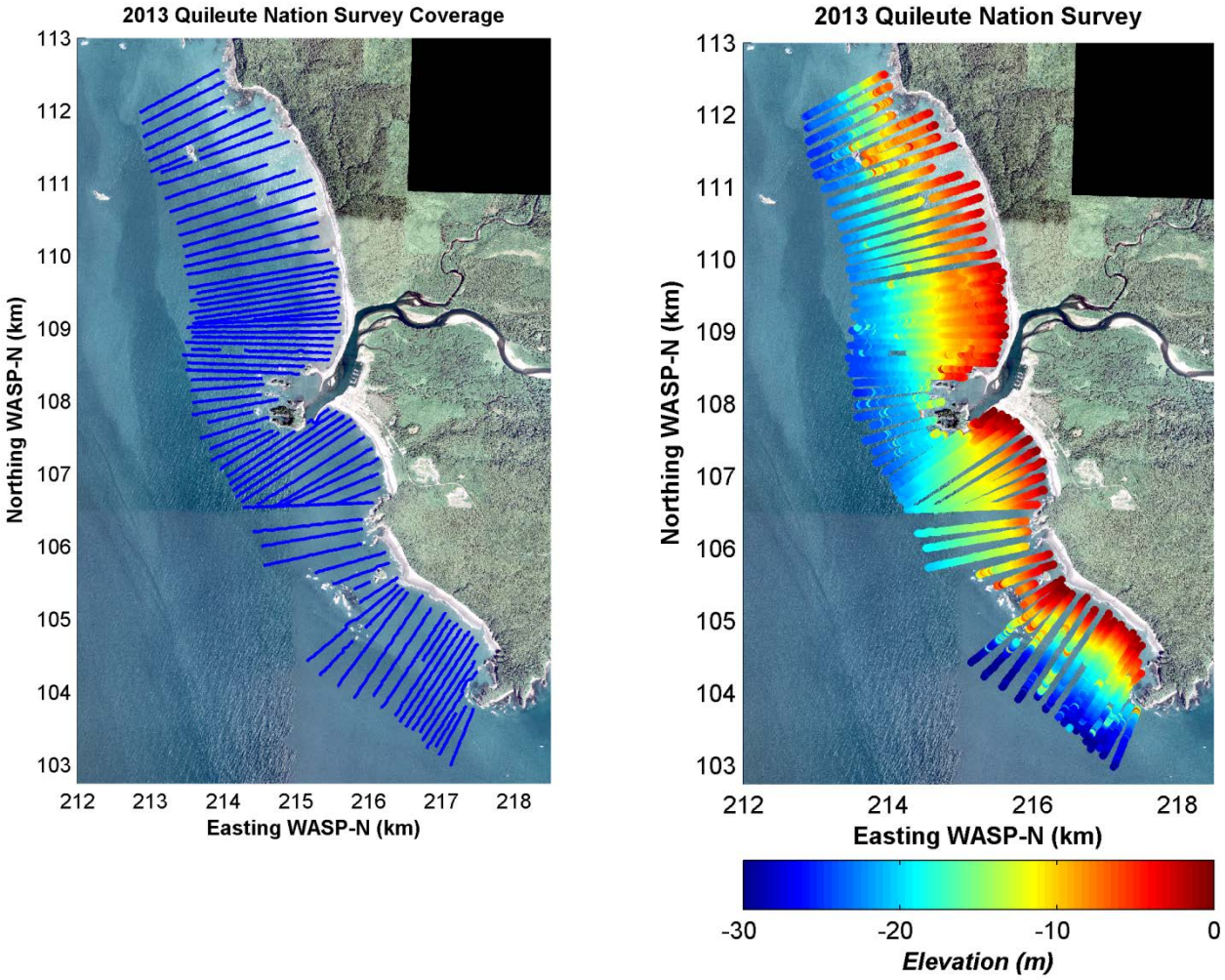


Figure 7) (LEFT) Aerial image of survey region. (RIGHT) Combined bathymetric and topographic elevation data collected during the Quileute Indian Nation survey. The survey extended from the southern boundary at Teawhit Head, north through Rialto Beach. Elevations are reported in meters and the vertical datum is NAVD88.

Deliverables

DNR survey data are provided in 2 folders: bathy and topo for each of the 2 survey locations. Bathymetry data is provided in four different formats within the 'bathy' folder: the 'GoogleEarth' folder contains Google Earth files (.kml) for each transect collected; the 'InfoBank' folder contains text files (.txt) with elevation data reported corresponding to geographic coordinates; the 'Meta' folder contains spreadsheet style metadata files (.meta)

with various information for each individual transect; the 'output_fin' folder contains ASCII text files (.xyz) with the final elevation measurements reported corresponding to the state plane coordinates in which the data were collected.

The naming format for bathymetric data is qn12_line###_b.xyz for the Quinault region and ql13_line###_b.xyz for the Quileute region. The naming format for topographic data is qn12_line###_t.xyz and ql13_line###_t.xyz respectively. "###" corresponds to the three digit transect number for each profile collected. Each transect file, in the 'output_fin' folder for bathymetry and the 'topo' folder for topography, is composed of 3 columns of data: Eastings, Northings, and elevation (depth in meters) with reference to NAD 88(m) in the horizontal and NAVD 88(m) in the vertical. Survey data in the Quinault Region were collected in Washington State Plane South coordinates, and the survey data for the Quileute Region were collected in Washington State Plane North coordinates.

References:

Ruggiero, P., Eshleman, J., Kingsley, E., Kaminsky, G., Thompson, D.M , Voigt, B., Kaminsky, G., and Gelfenbaum, G., 2007. Beach monitoring in the Columbia River littoral cell: 1997-2005., U. S. Geological Survey Data Series 260.

Ruggiero, P., Kaminsky, G.M., Gelfenbaum, G., and Voigt, B., 2005. Seasonal to interannual morphodynamics along a high-energy dissipative littoral cell, *Journal of Coastal Research*, 21(3), 553-578.