



Prepared in cooperation with the Washington State Department of Ecology

# Beach Morphology Monitoring in the Elwha River Littoral Cell, 2004–2009

By Jonathan A. Warrick, Douglas A. George, Andrew W. Stevens, Jodi Eshleman, Guy Gelfenbaum, George M. Kaminsky, Andrew K. Schwartz, and Matt Beirne



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# Beach Morphology Monitoring in the Elwha River Littoral Cell, 2004–2009

By Jonathan A. Warrick<sup>1</sup>, Douglas A. George<sup>1</sup>, Andrew W. Stevens<sup>1</sup>, Jodi Eshleman<sup>1</sup>, Guy Gelfenbaum<sup>1</sup>, George M. Kaminsky<sup>2</sup>, Andrew K. Schwartz<sup>2</sup> and Matt Beirne<sup>3</sup>

## Summary

This report describes the methods used, data collected, and results of the Beach Morphology Monitoring Program in the Elwha River Littoral Cell, starting in 2004. The U.S. Geological Survey and the Washington State Department of Ecology collaborated in the data collection with the support of the local Lower Elwha Klallam Tribe. Beach monitoring efforts consisted of collecting topographic and bathymetric horizontal and vertical position data by using a Real Time Kinematic Differential Global Positioning System (RTK-DGPS). The monitoring program was designed to characterize the littoral system of the Elwha River before the scheduled removal of two large dams in 2012. A primary objective of this work is to quantitatively describe the topography and bathymetry of the Elwha River littoral system so that the effects of dam removal may be quantified. Sediment inputs following dam removal are hypothesized to result in (A) larger amounts of fine sediment grain-sizes entering the littoral system and, (B) a reduction or reversal of coastal erosion.

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1 – U.S. Geological Survey, Santa Cruz, Calif.

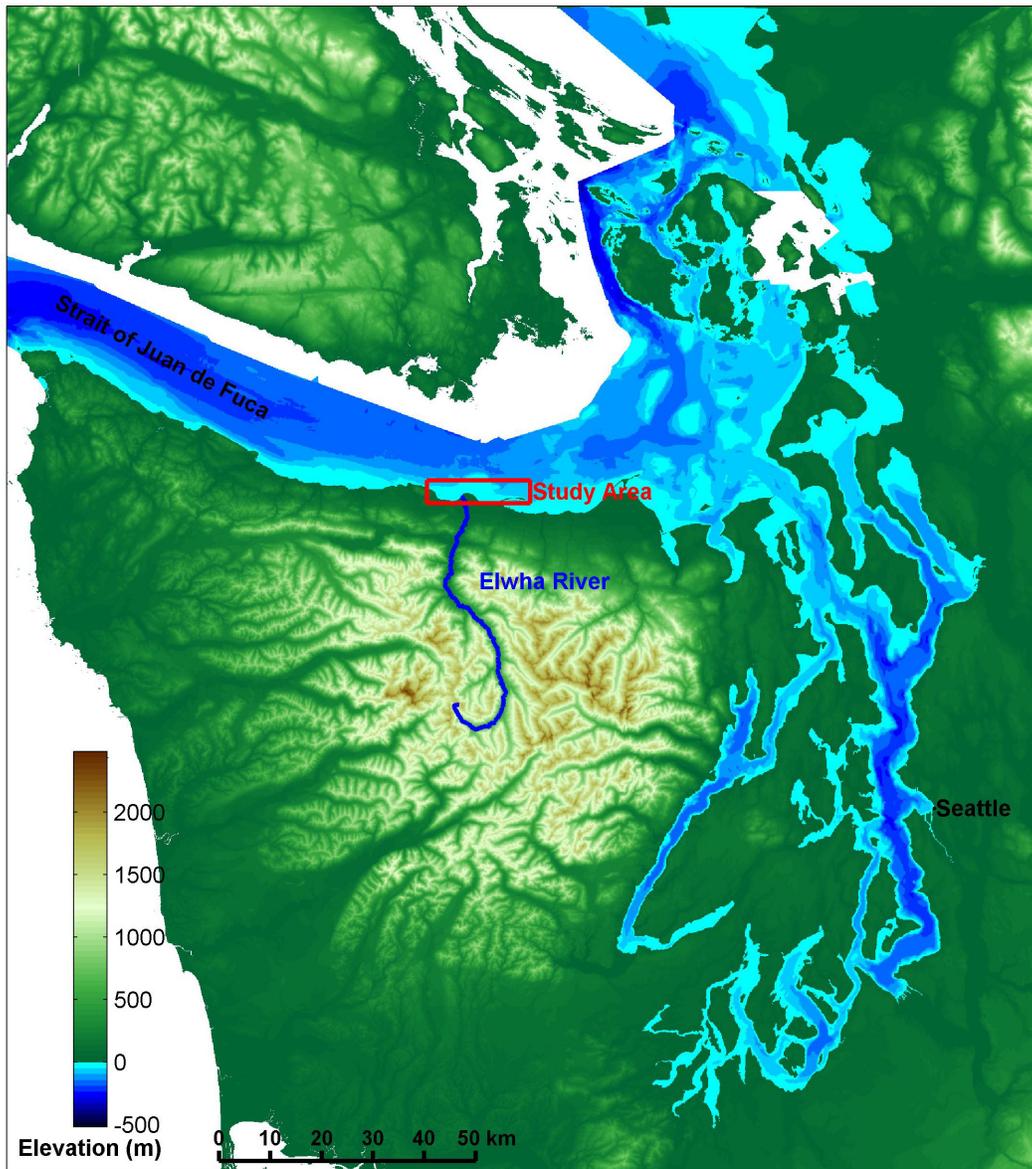
2 – Washington Department of Ecology, Olympia, Wash.

3 – Lower Elwha Klallam Tribe, Port Angeles, Wash.

## Introduction

The Elwha River of the Olympic Peninsula in Washington has two major dams, built in 1910 and 1926, that have significantly reduced sediment flux to the coast and removed most of the historic spawning habitats of native salmonids (Olympic National Park, 1996). Due to these environmental issues, the dams have been scheduled to be removed during a two-year process beginning in 2012. Investigations suggest that 13 million cubic meters of sediment will be released by the dam removal, and that this material will be deposited in the fluvial and coastal systems downstream (Randle and others, 1996; Childers and others, 2000). Coastal sedimentation is expected to reduce, or perhaps reverse, the current trend of beach erosion in the local littoral cell.

The Coastal and Marine Geology Program (CMG) of the U.S. Geological Survey (USGS) has established a scientific program to characterize the littoral system of the Elwha River. A primary objective of this work is to quantitatively describe the topography and bathymetry of the Elwha River littoral system so that the effects of dam removal may be quantified. Sediment inputs following dam removal are hypothesized to result in (A) larger amounts of fine sediment grain-sizes entering the littoral system and, (B) a reduction or reversal of coastal erosion. To test the latter hypothesis, USGS CMG is collecting high-resolution topography and bathymetry data around the Elwha River delta in collaboration with the Washington Department of Ecology and the Lower Elwha Klallam Tribe (fig. 1).



DEM Source: Finlayson and others (2000)

**Figure 1.** Study area on the Olympic Peninsula, northwest Washington.

The purpose of this report is to describe and disseminate the topographic and bathymetric data collected in this program. As described in detail below, beach surveys are conducted twice per year during “summer” and “winter” profiles. High resolution bathymetric/topographic surveys are obtained with RTK-DGPS from both watercraft and hiked backpack systems. Following a presentation of the methods in the body of this report, a summary of each survey campaign and the resulting data are included in the Appendices. Each appendix describes an individual survey, and new editions of this report are issued following the completion of additional surveys and associated appendices.

## **Data Collection**

The field data collection effort at the Elwha River mouth began in September 2004. The goal of data collection prior to the proposed dam removal was (1) to investigate topographic changes on seasonal, annual, and multi-annual periods of time for the region, and (2) to collect data that could be utilized to build and calibrate a numerical model to simulate hydrodynamics and sediment transport. Each field collection is described in an appendix attached to this data series.

### **Nearshore Bathymetry/Topography Data**

The Coastal Profiling System (CPS), a hydrographic surveying system mounted on a Personal Watercraft (PWC), was used to collect bathymetric data along a 16-km stretch of coastline surrounding the mouth of the Elwha River. The CPS provides a fast and accurate method to obtain subaqueous bathymetric profiles by combining the high-accuracy positioning of a Differential Global Positioning System (DGPS), the efficiency of an acoustic echo sounder, and the mobility of a personal watercraft. The data were collected by using RTK-DGPS. Horizontal accuracy of approximately  $\pm 3$  cm and vertical accuracy of  $\pm 5$  cm are reported by the manufacturer of the survey equipment (Trimble Navigation Limited, 1998). Additional factors, such as multipath satellite obstructions, poor satellite geometry and

poor atmospheric conditions, can combine to cause drifts in the vertical GPS by as much as 10 cm (Sallenger, and others 2003). Spatial variations in water temperature and salinity can affect depth estimates by as much as 3 percent of the water depth. Data were initially collected assuming a sound velocity of 1,500 m/s and corrected by using sound-velocity estimates during data processing as detailed below. Combined with the vertical uncertainty described above, a conservative estimate of the total vertical uncertainty for nearshore bathymetry measurements is approximately 15 cm. A more complete discussion of the CPS technology and field techniques is found in MacMahan (2001) and Ruggiero and others (2005).

Topography data was obtained by using two backpack systems consisting of a GPS receiver and mounted antenna. The data also were collected in RTK-DGPS mode and stored in a handheld controller for downloading and data processing.

## Geodetic Control

The Lower Elwha Klallam Tribe maintains a geodetic control network around the Elwha River delta. The coordinates of these benchmarks are included in table 1.

**Table 1.** Benchmark information.

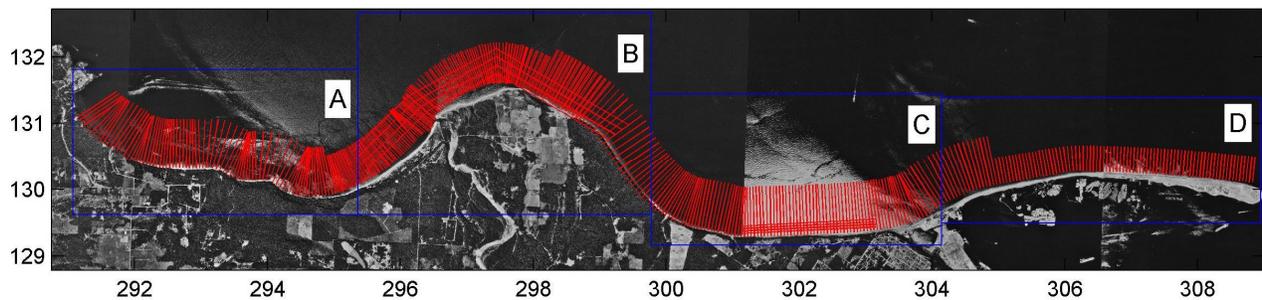
| <b>Benchmark</b> | <b>Northing<sup>1</sup></b> | <b>Easting<sup>1</sup></b> | <b>Elevation<sup>2</sup></b> |
|------------------|-----------------------------|----------------------------|------------------------------|
| 1                | 131004.86                   | 296580.06                  | 4.01                         |
| 2                | 131207.93                   | 296870.88                  | 3.41                         |
| 3                | 131335.42                   | 297184.43                  | 3.34                         |
| 4                | 131452.67                   | 297464.30                  | 3.89                         |
| 5                | 131502.92                   | 297727.64                  | 3.44                         |
| 6                | 131279.86                   | 298095.69                  | 2.76                         |

<sup>1</sup>Wash. State Plane North NAD 83 (m).

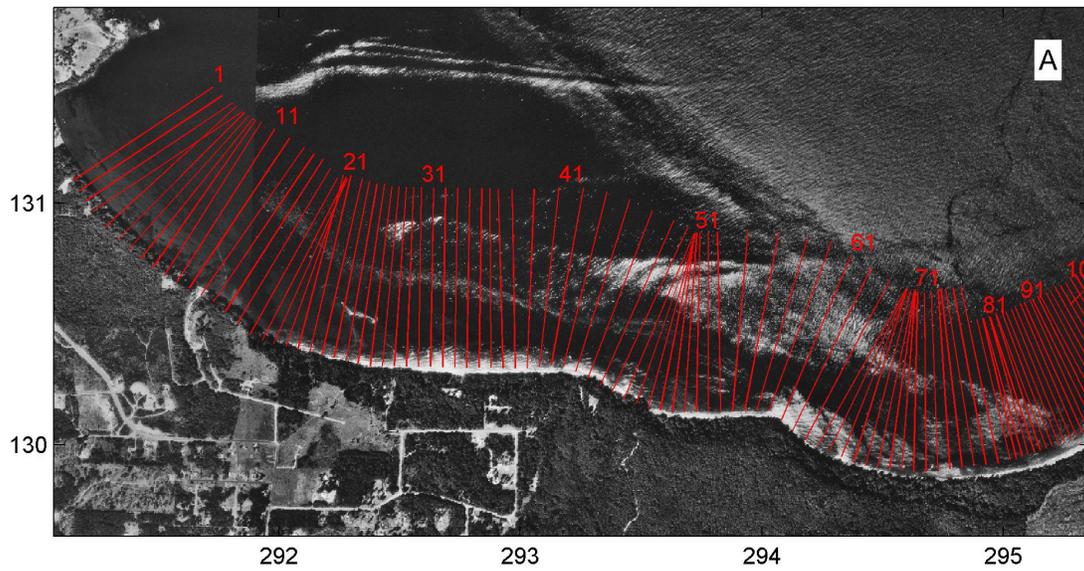
<sup>2</sup>NAVD 88 (m).

## Sampling Design

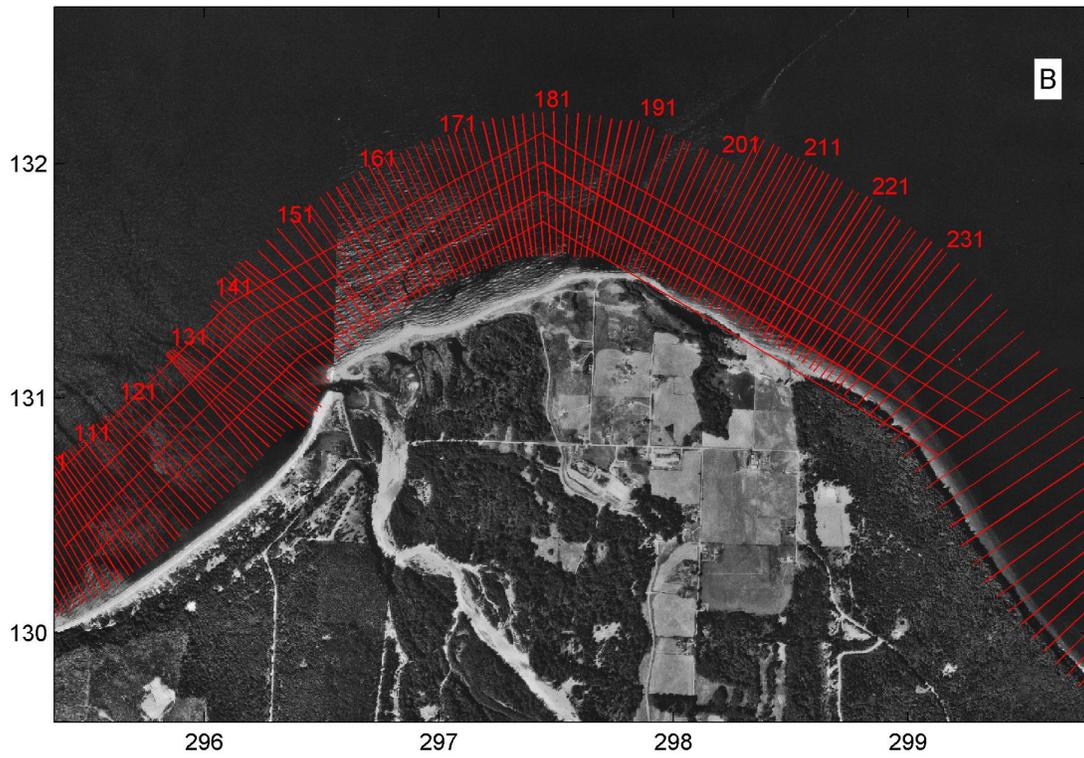
A traditional sampling design for the CPS system consists of planned profile lines that are perpendicular to the shoreline and extend from a project-specific water depth to the beach. A line file was developed with line spacing that varied depending on the relative importance of a region to satisfy the project goals (figs. 2A - E). For example, survey lines were densest in the immediate vicinity of the river mouth as this area was determined to be the highest priority. The depth at the seaward endpoints of the lines varied but in most cases was deeper than 20 m. The topography lines were extensions of the bathymetry lines from the upper portion of the beach berm to as low on the beach face as the tide allowed sampling.



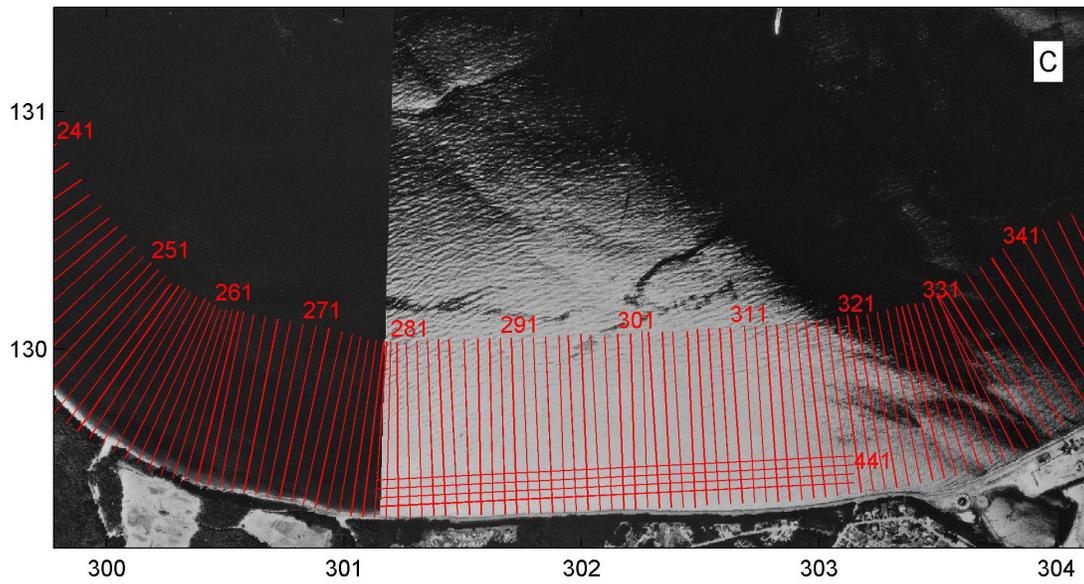
**Figure 2A.** Elwha profile lines shown in red for the entire study area. Inset regions for figures 2B-E are shown with blue boxes and labeled by A-D. Axes are Washington State Plane North (km).



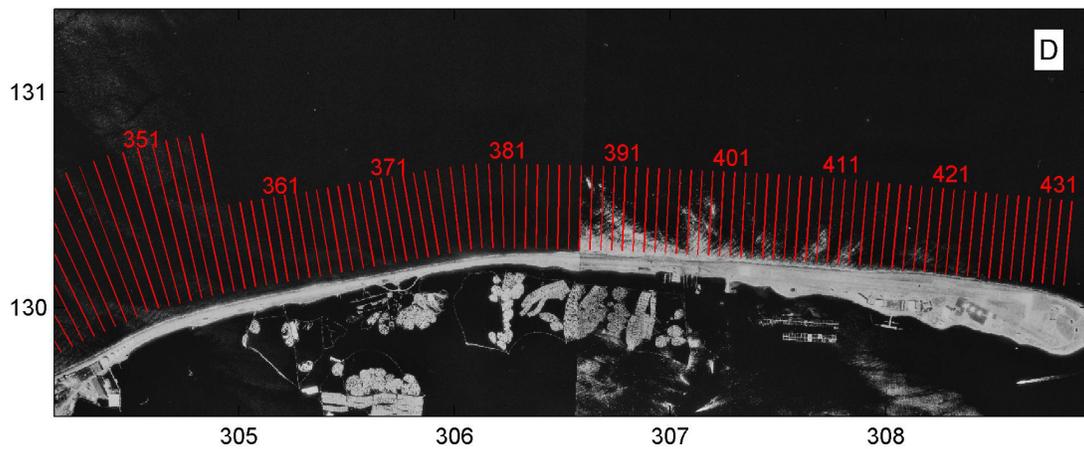
**Figure 2B.** Elwha profile lines for the Freshwater Bay portion of the study area. Every tenth line is labeled with the corresponding line number. Axes are Washington State Plane North (km).



**Figure 2C.** Elwha profile lines for the delta-region portion of the study area. Every tenth line is labeled with the corresponding line number. Axes are Washington State Plane North (km).



**Figure 2D.** Elwha profile lines for the east delta portion of the study area. Every tenth line is labeled with the corresponding line number. Axes are Washington State Plane North (km).



**Figure 2E.** Elwha Planned Lines for the Ediz Hook portion of the study area. Every tenth line is labeled with the corresponding line number. Axes are Washington State Plane North (km).

## **Data Processing**

### **Topography Data**

The topographic profiles were exported from the handheld GPS unit and calibrated into the geodetic network by using Trimble Geomatics Software. Quantities important to data quality were checked for errors during this operation. As the topographic data were much less dense than the bathymetric profiles, no smoothing was required. One data file per transect was saved as an Easting, Northing, Elevation (x, y, z) ASCII triplet in Washington State Plane North (NAD 83) and NAVD 88.

### **Bathymetry Data**

Each individual bathymetric transect was examined to detect and remove any obvious outliers from the raw files that were either shallower than the echo sounder blanking interval or deeper than a user-defined cutoff value. Individual files were then exported in Easting, Northing, Elevation (x, y, z) ASCII triplets with one data file per transect in Washington State Plane North (NAD 83) and NAVD 88.

The sound velocity in seawater varies in the water column depending on water density, which is a function of salinity and temperature. The variability affects the echosounder travel time from the sensor to the bed and hence, the computed elevation. Large variabilities in seawater temperature (~10°C) can affect depth estimates by as much as 20 cm in 12 m of water. To correct for this phenomenon, a constant salinity of 31 practical salinity units (psu) was assumed, and water temperature at the time of data collection was derived from an average of daily temperatures recorded by at National Data Buoy Center (NDBC) Station 46088 in New Dungeness, Wash. This station is the nearest active buoy at approximately 40 km from the Elwha River delta. The water-density correction was conducted by using accepted algorithms for calculation of sound velocity in seawater (Fofonoff and Millard Jr., 1983). In addition to water temperature, other meteorological and marine conditions (for example, wave height

and period, wind speed and direction, air temperature and barometric pressure) also were extracted from NDBC Station 46088 during the dates and times of sampling and saved as spreadsheet files.

A smoothing operation was then performed on the corrected bathymetric data by using a LOWESS (Cleveland, 1979) filter on the z-coordinate in the alongline direction to reduce high-frequency fluctuations from interferences, such as seaweed, and the effect of vehicle pitch and roll on the bed elevation. A moving, non-overlapping window size of seven data points was used, regardless of the length of the profile line. A simple polynomial regression function was used to extrapolate data at both ends of the line where less than seven data points exist. In a small number of profiles, the LOWESS filter could not resolve short segments of the seabed due to poor echosounder returns. The data were removed from these areas of the profiles while the remaining sections were processed with the filtering algorithm.

## **Finished Products**

The following data are supplied on the online USGS Data Series Report at <http://pubs.usgs.gov/ds/288/data/>. Data can be obtained by using an Internet browser and the following directory structure.

### **Bathymetric/Topographic Profile Data Files**

One data file exists for each final collected bathymetry line in the directory structure: data\_{year of survey}/{month of survey}/bathy/ew{year of survey}\_line{number}\_b.xyz. For example, Line 151, collected in September 2006, can be found at data\_06/septb/bathy/ew06\_line151\_b.xyz. Each file contains easting, northing, and elevation values in the coordinate system Washington State Plane North NAD 83 (m). Elevation data are represented in meters, NAVD 88, as this was the datum of the benchmark control point used in the survey. One data file for each collected topography line also is presented in the directory structure: data\_{year of survey}/{month of survey}/topo/ew{year of

survey}\_line{number}\_t.xyz. The topography data files are in the same format and coordinate system as the bathymetric data files.

The individual bathymetric and topographic profiles can be combined to examine how successful the lines align and data overlap. For example, the bathymetric and topographic profiles of Line 151, collected September 2006, show reasonably good alignment and overlap (fig. 3).

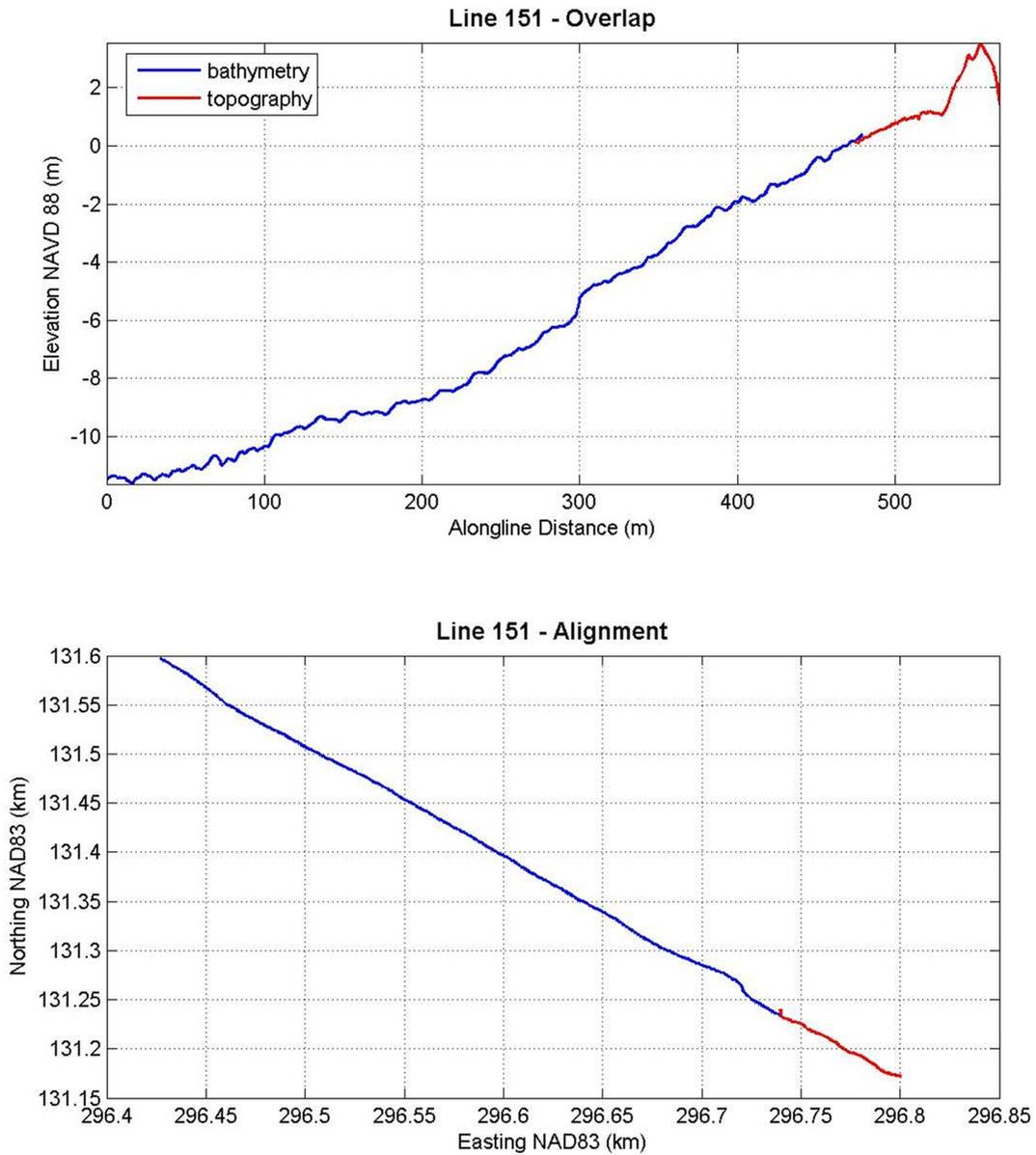
## Metadata

Metadata is included for all bathymetry and topography data collected at the Elwha River mouth. Data for the environmental-condition files were extracted from NDBC, and the headers for the data can be found in table 2.

**Table 2.** Standard meteorological-data headers for NDBC files.

|      |  |
|------|--|
| ATMP | Air temperature (Celsius). For sensor heights on buoys, see <i>Hull Descriptions</i> . For sensor heights at C-MAN stations, see <i>C-MAN Sensor Locations</i>   |
| WTMP | Sea surface temperature (Celsius). For sensor depth, see <i>Hull Description</i> .   |
| DEWP | Dewpoint temperature taken at the same height as the air-temperature measurement.  |
| PRES | Sea-level pressure (hPa). For C-MAN sites and Great Lakes buoys, the recorded pressure is reduced to sea level by using the method described in <i>NWS Technical Procedures Bulletin 291 (11/14/80)</i> .            |
| WSPD | Wind speed (m/s) averaged during an eight-minute period for buoys and a two-minute period for land stations. Reported hourly. See <i>Wind Averaging Methods</i> .  |
| WDIR | Wind direction (the direction the wind is coming from in degrees clockwise from true N) during the same period used for WSPD. See <i>Wind Averaging Methods</i>  |
| GST  | Peak 5- or 8-second gust speed (m/s) measured during the eight-minute or two-minute period. The 5- or 8-second period can be determined by payload. See the <i>Sensor Reporting, Sampling, and Accuracy</i> section. |
| WVHT | Significant wave height (meters) is calculated as the average of the highest one-third of all of the wave heights during the 20-minute sampling period. See the <i>Wave Measurements</i> section.                    |
| DPD  | Dominant wave period (seconds) is the period with the maximum wave energy. See the <i>Wave Measurements</i> section.   |
| MWD  | Mean wave direction corresponding to energy of the dominant period (DOMPD). The units are degrees from true North just like wind direction. See the <i>Wave Measurements</i> section.                                |
| VIS  | Station visibility (statute miles). Note that buoy stations are limited to reports from 0 to 1.9 miles.  |
| PTDY | Pressure tendency is the direction (plus or minus) and the amount of pressure change (hPa) for a three-hour period ending at the time of observation.  |

Source: <http://www.ndbc.noaa.gov/measdes.shtml>



**Figure 3.** Overlap and alignment of bathymetric and topographic Line 151, September 2006.

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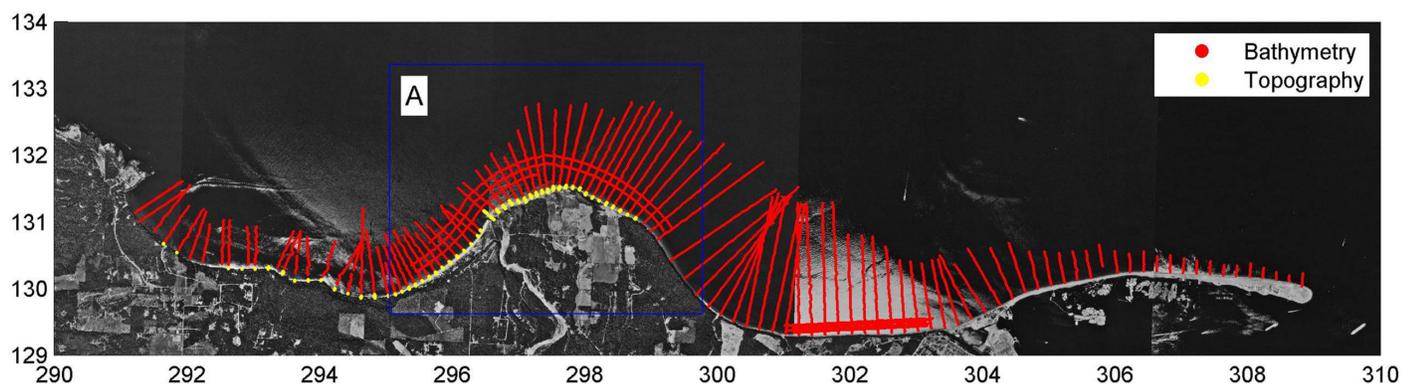
Evaluation of airborne topographic lidar for quantifying beach changes: *Journal of Coastal Research*, v. 19, no. 1, p. 125–133.

Trimble Navigation Limited, 1998, 4700 Receiver operation manual, Version 1.0, Part Number 36238-00, Revision B.

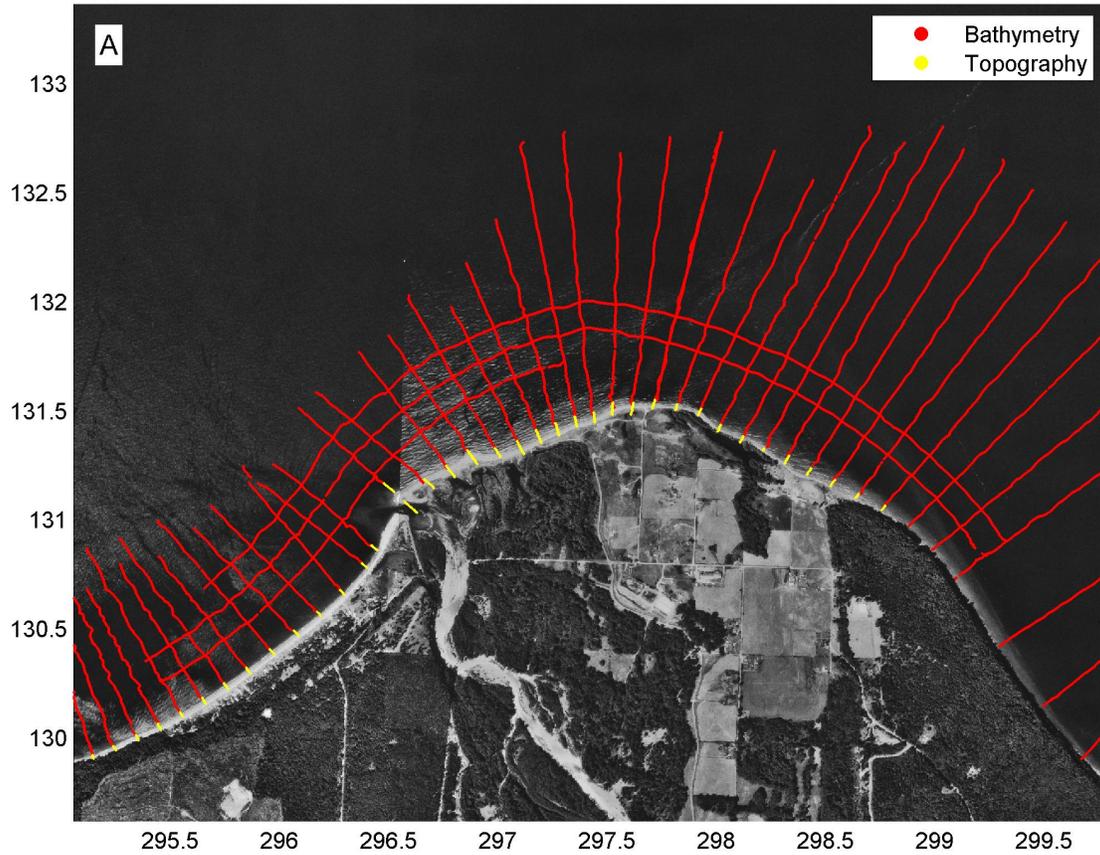
## Appendix A - September 2004 Field Collection

In September 2004, profiles were collected spanning a 16-km stretch from Freshwater Bay to Ediz Hook. Several alongshore bathymetric lines also were driven around the delta to serve as a cross-check for data accuracy. Some additional alongshore lines were collected near Easting 302 km to try to resolve sand waves that were observed in sonar data collected in that region. On September 7–9, 119 bathymetric and 52 topographic profiles were collected between line 1 on the west and line 430 on the east at varying spacing intervals (figs. A1–A2). Bathymetric and topographic lines are enumerated in Table A. Metadata for this field activity (W-2-04-PS) are available at:

<http://walrus.wr.usgs.gov/infobank/w/w204ps/html/w-2-04-ps.meta.html>.



**Figure A1.** Elwha September 2004 surveyed lines.



**Figure A2.** Elwha September 2004 surveyed lines (delta region).

**Table A.** Bathymetric and topographic lines for the September 2004 survey.

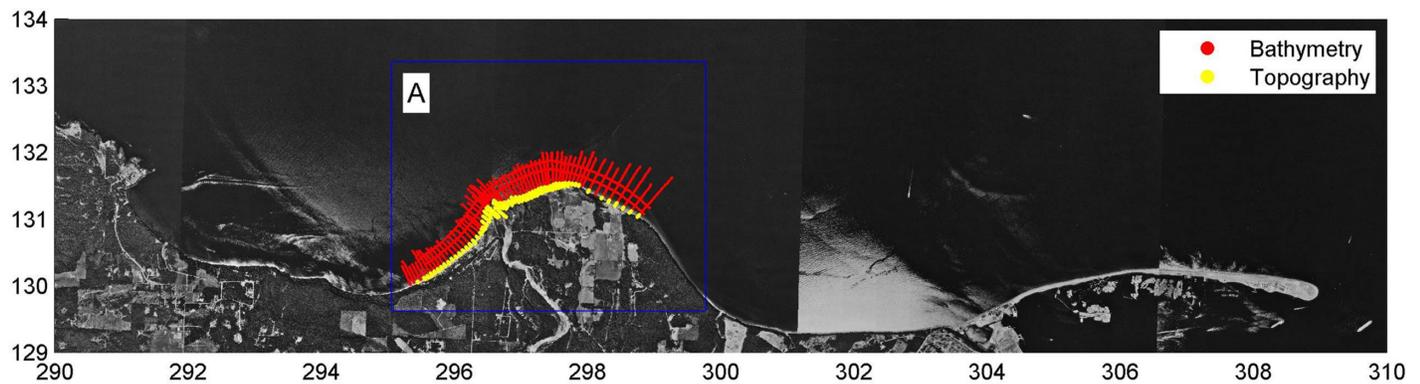
| Bathymetric line    | Topographic line   |
|---------------------|--------------------|
| ew04_line001_b.xyz  |                    |
| ew04_line001_b2.xyz |                    |
| ew04_line004_b.xyz  |                    |
| ew04_line008_b.xyz  |                    |
| ew04_line012_b.xyz  | ew04_line012_t.xyz |
| ew04_line016_b.xyz  | ew04_line016_t.xyz |
| ew04_line020_b.xyz  |                    |
| ew04_line024_b.xyz  |                    |
| ew04_line030_b.xyz  |                    |
| ew04_line032_b.xyz  | ew04_line032_t.xyz |
|                     | ew04_line036_t.xyz |
| ew04_line038_b.xyz  |                    |
| ew04_line040_b.xyz  | ew04_line040_t.xyz |
|                     | ew04_line044_t.xyz |
| ew04_line046_b.xyz  |                    |

|                     |                    |
|---------------------|--------------------|
| ew04_line048_b.xyz  | ew04_line048_t.xyz |
| ew04_line052_b.xyz  | ew04_line052_t.xyz |
| ew04_line056_b.xyz  | ew04_line056_t.xyz |
| ew04_line060_b.xyz  | ew04_line060_t.xyz |
| ew04_line064_b.xyz  | ew04_line064_t.xyz |
| ew04_line068_b.xyz  | ew04_line068_t.xyz |
| ew04_line072_b.xyz  | ew04_line072_t.xyz |
| ew04_line076_b.xyz  | ew04_line076_t.xyz |
| ew04_line080_b.xyz  | ew04_line080_t.xyz |
| ew04_line084_b.xyz  | ew04_line084_t.xyz |
| ew04_line088_b.xyz  | ew04_line088_t.xyz |
| ew04_line092_b.xyz  | ew04_line092_t.xyz |
| ew04_line096_b.xyz  | ew04_line096_t.xyz |
| ew04_line100_b.xyz  | ew04_line100_t.xyz |
| ew04_line104_b.xyz  | ew04_line104_t.xyz |
| ew04_line108_b.xyz  | ew04_line108_t.xyz |
| ew04_line112_b.xyz  | ew04_line112_t.xyz |
| ew04_line116_b.xyz  | ew04_line116_t.xyz |
| ew04_line120_b.xyz  | ew04_line120_t.xyz |
| ew04_line124_b.xyz  | ew04_line124_t.xyz |
| ew04_line128_b.xyz  | ew04_line128_t.xyz |
| ew04_line132_b.xyz  | ew04_line132_t.xyz |
| ew04_line135_b.xyz  | ew04_line135_t.xyz |
| ew04_line144_b.xyz  | ew04_line144_t.xyz |
| ew04_line148_b.xyz  | ew04_line148_t.xyz |
| ew04_line152_b.xyz  | ew04_line152_t.xyz |
| ew04_line156_b.xyz  | ew04_line156_t.xyz |
| ew04_line160_b.xyz  | ew04_line160_t.xyz |
| ew04_line164_b.xyz  | ew04_line164_t.xyz |
| ew04_line168_b.xyz  | ew04_line168_t.xyz |
| ew04_line172_b.xyz  | ew04_line172_t.xyz |
| ew04_line176_b.xyz  | ew04_line176_t.xyz |
| ew04_line180_b.xyz  | ew04_line180_t.xyz |
| ew04_line184_b.xyz  | ew04_line184_t.xyz |
| ew04_line188_b.xyz  | ew04_line188_t.xyz |
| ew04_line192_b.xyz  | ew04_line192_t.xyz |
| ew04_line192_b2.xyz |                    |
| ew04_line196_b.xyz  | ew04_line196_t.xyz |
| ew04_line200_b.xyz  | ew04_line200_t.xyz |
| ew04_line204_b.xyz  | ew04_line204_t.xyz |
| ew04_line208_b.xyz  | ew04_line208_t.xyz |
| ew04_line212_b.xyz  | ew04_line212_t.xyz |
| ew04_line216_b.xyz  | ew04_line216_t.xyz |
| ew04_line220_b.xyz  | ew04_line220_t.xyz |
| ew04_line224_b.xyz  | ew04_line224_t.xyz |
| ew04_line228_b.xyz  | ew04_line228_t.xyz |
| ew04_line232_b.xyz  | ew04_line232_t.xyz |
| ew04_line234_b.xyz  |                    |
| ew04_line236_b.xyz  |                    |
| ew04_line238_b.xyz  |                    |
| ew04_line242_b.xyz  |                    |
| ew04_line246_b.xyz  |                    |
| ew04_line250_b.xyz  |                    |
| ew04_line254_b.xyz  |                    |
| ew04_line258_b.xyz  |                    |

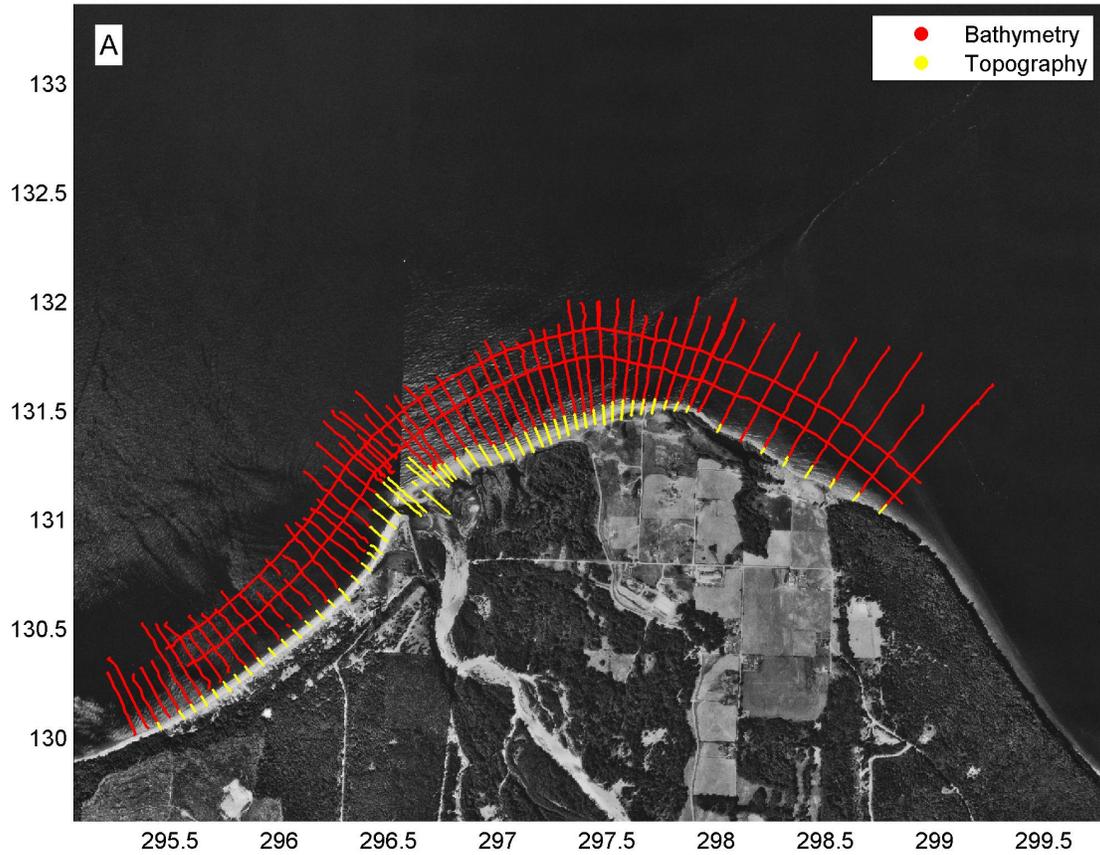
|                    |  |
|--------------------|--|
| ew04_line262_b.xyz |  |
| ew04_line266_b.xyz |  |
| ew04_line270_b.xyz |  |
| ew04_line274_b.xyz |  |
| ew04_line278_b.xyz |  |
| ew04_line282_b.xyz |  |
| ew04_line286_b.xyz |  |
| ew04_line290_b.xyz |  |
| ew04_line294_b.xyz |  |
| ew04_line298_b.xyz |  |
| ew04_line302_b.xyz |  |
| ew04_line306_b.xyz |  |
| ew04_line310_b.xyz |  |
| ew04_line314_b.xyz |  |
| ew04_line318_b.xyz |  |
| ew04_line322_b.xyz |  |
| ew04_line326_b.xyz |  |
| ew04_line330_b.xyz |  |
| ew04_line334_b.xyz |  |
| ew04_line338_b.xyz |  |
| ew04_line342_b.xyz |  |
| ew04_line346_b.xyz |  |
| ew04_line350_b.xyz |  |
| ew04_line354_b.xyz |  |
| ew04_line358_b.xyz |  |
| ew04_line362_b.xyz |  |
| ew04_line366_b.xyz |  |
| ew04_line370_b.xyz |  |
| ew04_line374_b.xyz |  |
| ew04_line378_b.xyz |  |
| ew04_line382_b.xyz |  |
| ew04_line386_b.xyz |  |
| ew04_line390_b.xyz |  |
| ew04_line394_b.xyz |  |
| ew04_line398_b.xyz |  |
| ew04_line402_b.xyz |  |
| ew04_line406_b.xyz |  |
| ew04_line410_b.xyz |  |
| ew04_line414_b.xyz |  |
| ew04_line418_b.xyz |  |
| ew04_line422_b.xyz |  |
| ew04_line426_b.xyz |  |
| ew04_line430_b.xyz |  |
| ew04_line434_b.xyz |  |
| ew04_line435_b.xyz |  |
| ew04_line436_b.xyz |  |
| ew04_line437_b.xyz |  |
| ew04_line439_b.xyz |  |
| ew04_line440_b.xyz |  |
| ew04_line441_b.xyz |  |
| ew04_line442_b.xyz |  |

## Appendix B - March 2005 Field Collection

For the March 2005 survey, the focus was shifted to resolving the delta at the river mouth in greater detail. On March 15-17, 75 bathymetric and 61 topographic profiles were collected between lines 92 on the west and 232 on the east (figs. B1–B2). Two alongshore bathymetric profiles also were collected. Bathymetric and topographic lines are enumerated in table B. Metadata for this field activity (W-1-05-PS) are available at: <http://walrus.wr.usgs.gov/infobank/w/w105ps/html/w-1-05-ps.meta.html>.



**Figure B1.** Elwha March 2005 surveyed lines.



**Figure B2.** Elwha March 2005 surveyed lines (delta region).

**Table B.** Bathymetric and topographic lines for the March 2005 survey.

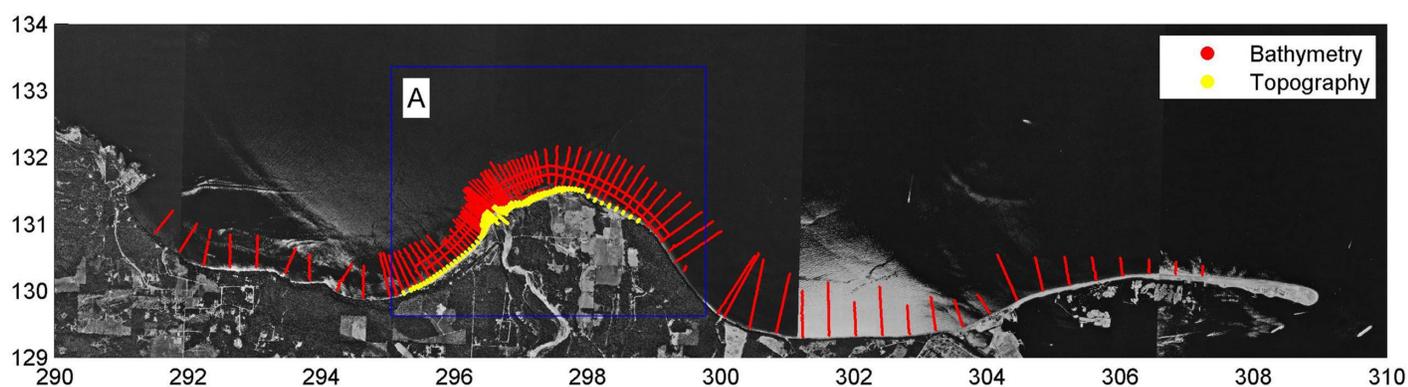
| Bathymetric line   | Topographic line   |
|--------------------|--------------------|
| ew05_line092_b.xyz |                    |
| ew05_line094_b.xyz |                    |
| ew05_line096_b.xyz | ew05_line096_t.xyz |
| ew05_line098_b.xyz |                    |
| ew05_line100_b.xyz | ew05_line100_t.xyz |
| ew05_line102_b.xyz | ew05_line102_t.xyz |
| ew05_line104_b.xyz | ew05_line104_t.xyz |
| ew05_line106_b.xyz | ew05_line106_t.xyz |
| ew05_line108_b.xyz | ew05_line108_t.xyz |
| ew05_line110_b.xyz | ew05_line110_t.xyz |
| ew05_line112_b.xyz | ew05_line112_t.xyz |
| ew05_line114_b.xyz | ew05_line114_t.xyz |
| ew05_line116_b.xyz | ew05_line116_t.xyz |
| ew05_line118_b.xyz | ew05_line118_t.xyz |
| ew05_line120_b.xyz | ew05_line120_t.xyz |

|                     |                    |
|---------------------|--------------------|
| ew05_line122_b.xyz  | ew05_line122_t.xyz |
| ew05_line124_b.xyz  | ew05_line124_t.xyz |
| ew05_line126_b.xyz  | ew05_line126_t.xyz |
| ew05_line128_b.xyz  | ew05_line128_t.xyz |
| ew05_line130_b.xyz  | ew05_line130_t.xyz |
| ew05_line132_b.xyz  | ew05_line132_t.xyz |
| ew05_line134_b.xyz  | ew05_line134_t.xyz |
| ew05_line135_b.xyz  | ew05_line135_t.xyz |
| ew05_line137_b.xyz  | ew05_line137_t.xyz |
| ew05_line140_b.xyz  | ew05_line140_t.xyz |
| ew05_line142_b.xyz  | ew05_line142_t.xyz |
| ew05_line144_b.xyz  | ew05_line144_t.xyz |
| ew05_line145_b.xyz  | ew05_line145_t.xyz |
| ew05_line145_b2.xyz |                    |
| ew05_line146_b.xyz  |                    |
| ew05_line147_b.xyz  | ew05_line147_t.xyz |
| ew05_line148_b.xyz  | ew05_line148_t.xyz |
| ew05_line149_b.xyz  | ew05_line149_t.xyz |
| ew05_line150_b.xyz  | ew05_line150_t.xyz |
| ew05_line150_b2.xyz |                    |
| ew05_line151_b.xyz  | ew05_line151_t.xyz |
| ew05_line152_b.xyz  | ew05_line152_t.xyz |
| ew05_line154_b.xyz  | ew05_line154_t.xyz |
| ew05_line156_b.xyz  | ew05_line156_t.xyz |
| ew05_line158_b.xyz  | ew05_line158_t.xyz |
| ew05_line160_b.xyz  | ew05_line160_t.xyz |
| ew05_line162_b.xyz  | ew05_line162_t.xyz |
| ew05_line164_b.xyz  | ew05_line164_t.xyz |
| ew05_line166_b.xyz  | ew05_line166_t.xyz |
| ew05_line168_b.xyz  | ew05_line168_t.xyz |
| ew05_line170_b.xyz  | ew05_line170_t.xyz |
| ew05_line172_b.xyz  | ew05_line172_t.xyz |
| ew05_line174_b.xyz  | ew05_line174_t.xyz |
| ew05_line176_b.xyz  | ew05_line176_t.xyz |
| ew05_line178_b.xyz  | ew05_line178_t.xyz |
| ew05_line180_b.xyz  | ew05_line180_t.xyz |
| ew05_line182_b.xyz  | ew05_line182_t.xyz |
| ew05_line182_b2.xyz |                    |
| ew05_line184_b.xyz  | ew05_line184_t.xyz |
| ew05_line186_b.xyz  | ew05_line186_t.xyz |
| ew05_line188_b.xyz  | ew05_line188_t.xyz |
| ew05_line190_b.xyz  | ew05_line190_t.xyz |
| ew05_line192_b.xyz  | ew05_line192_t.xyz |
| ew05_line194_b.xyz  | ew05_line194_t.xyz |
| ew05_line196_b.xyz  | ew05_line196_t.xyz |
| ew05_line198_b.xyz  | ew05_line198_t.xyz |
| ew05_line198_b2.xyz |                    |
| ew05_line198_b3.xyz |                    |
| ew05_line200_b.xyz  |                    |
| ew05_line204_b.xyz  | ew05_line204_t.xyz |
| ew05_line208_b.xyz  |                    |
| ew05_line212_b.xyz  | ew05_line212_t.xyz |
| ew05_line216_b.xyz  | ew05_line216_t.xyz |
| ew05_line220_b.xyz  | ew05_line220_t.xyz |
| ew05_line224_b.xyz  | ew05_line224_t.xyz |

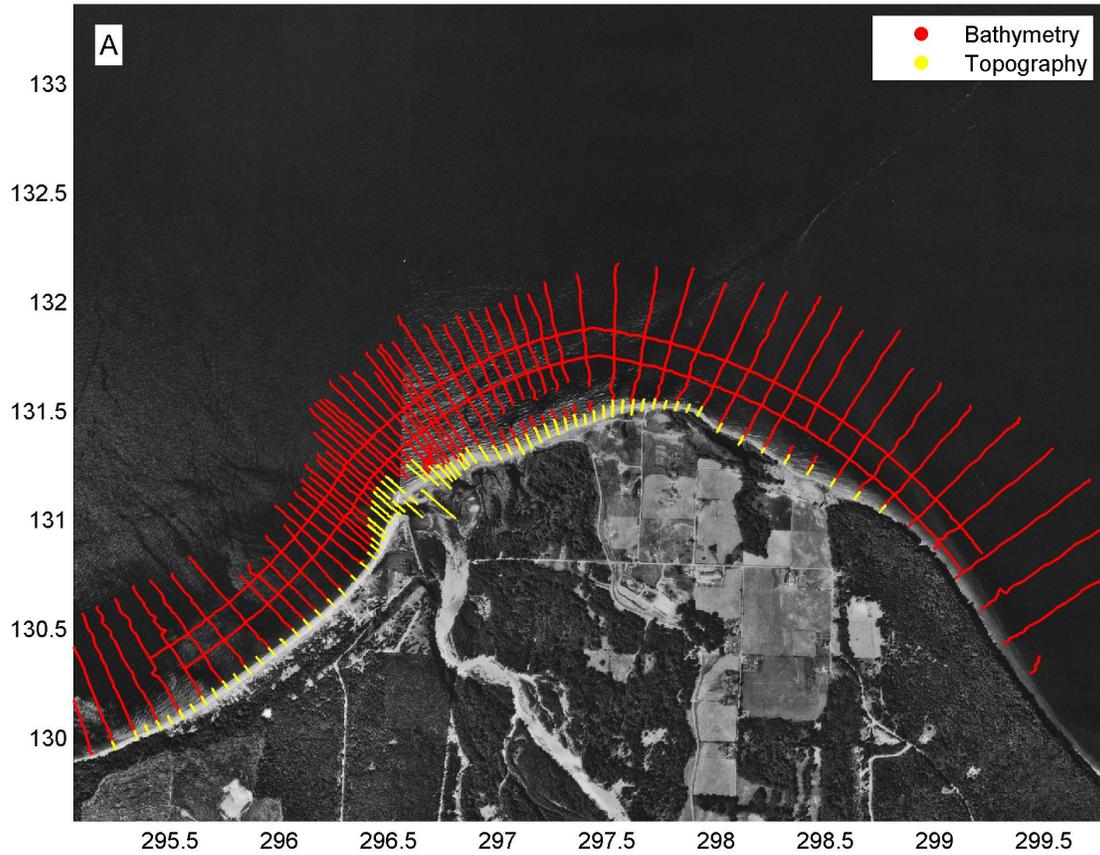
|                     |                    |
|---------------------|--------------------|
| ew05_line228_b.xyz  | ew05_line228_t.xyz |
| ew05_line232_b.xyz  | ew05_line232_t.xyz |
| ew05_line232_b2.xyz |                    |
| ew05_line435_b.xyz  |                    |
| ew05_line436_b.xyz  |                    |

## Appendix C - August–September 2005 Field Collection

In Fall 2005, a broader sampling was attempted. On August 30–September 1, 101 bathymetric profiles and 74 topographic profiles were collected from the Elwha River delta between line numbers 8 to the west and 402 to the east (figs. C1–C2). Two alongshore bathymetric profiles also were collected. Bathymetric and topographic lines are enumerated in table C. Metadata for this field activity (W-2-05-PS) are available at: <http://walrus.wr.usgs.gov/infobank/w/w205ps/html/w-2-05-ps.meta.html>.



**Figure C1.** Elwha August–September 2005 surveyed lines.



**Figure C2.** Elwha August–September 2005 surveyed lines (delta region).

**Table C.** Bathymetric and topographic lines for the August–September 2005 survey.

| Bathymetric line   | Topographic line   |
|--------------------|--------------------|
| ew05_line008_b.xyz |                    |
| ew05_line016_b.xyz |                    |
| ew05_line024_b.xyz |                    |
| ew05_line032_b.xyz |                    |
| ew05_line040_b.xyz |                    |
| ew05_line048_b.xyz |                    |
| ew05_line056_b.xyz |                    |
| ew05_line064_b.xyz |                    |
| ew05_line072_b.xyz |                    |
| ew05_line080_b.xyz |                    |
| ew05_line084_b.xyz |                    |
| ew05_line088_b.xyz | ew05_line088_t.xyz |
| ew05_line092_b.xyz | ew05_line092_t.xyz |
|                    | ew05_line094_t.xyz |
| ew05_line096_b.xyz | ew05_line096_t.xyz |

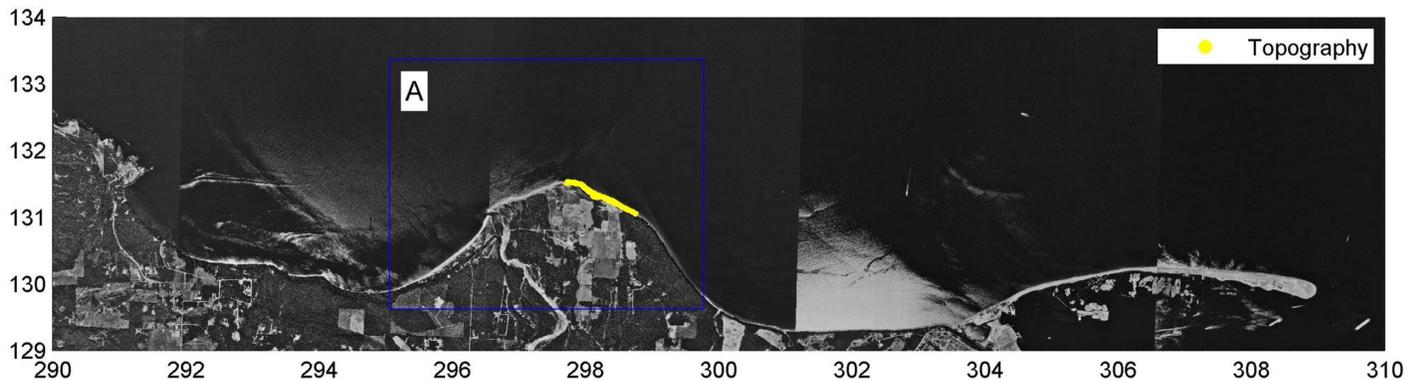
|                     |                     |
|---------------------|---------------------|
|                     | ew05_line098_t.xyz  |
| ew05_line100_b.xyz  | ew05_line100_t.xyz  |
|                     | ew05_line102_t.xyz  |
| ew05_line104_b.xyz  | ew05_line104_t.xyz  |
|                     | ew05_line106_t.xyz  |
| ew05_line108_b.xyz  | ew05_line108_t.xyz  |
|                     | ew05_line110_t.xyz  |
| ew05_line112_b.xyz  | ew05_line112_t.xyz  |
|                     | ew05_line114_t.xyz  |
| ew05_line116_b.xyz  | ew05_line116_t.xyz  |
|                     | ew05_line118_t.xyz  |
| ew05_line120_b.xyz  | ew05_line120_t.xyz  |
| ew05_line122_b.xyz  | ew05_line122_t.xyz  |
| ew05_line124_b.xyz  | ew05_line124_t.xyz  |
| ew05_line126_b.xyz  | ew05_line126_t.xyz  |
| ew05_line128_b.xyz  | ew05_line128_t.xyz  |
| ew05_line130_b.xyz  | ew05_line130_t.xyz  |
| ew05_line132_b.xyz  | ew05_line132_t.xyz  |
| ew05_line134_b.xyz  | ew05_line134_t.xyz  |
| ew05_line135_b.xyz  | ew05_line135_t.xyz  |
| ew05_line136_b.xyz  | ew05_line136_t.xyz  |
|                     | ew05_line136_t2.xyz |
| ew05_line137_b.xyz  | ew05_line137_t.xyz  |
| ew05_line138_b.xyz  | ew05_line138_t.xyz  |
| ew05_line140_b.xyz  | ew05_line140_t.xyz  |
| ew05_line141_b.xyz  | ew05_line141_t.xyz  |
| ew05_line142_b.xyz  | ew05_line142_t.xyz  |
| ew05_line143_b.xyz  | ew05_line143_t.xyz  |
| ew05_line144_b.xyz  | ew05_line144_t.xyz  |
| ew05_line145_b.xyz  | ew05_line145_t.xyz  |
| ew05_line146_b.xyz  |                     |
| ew05_line147_b.xyz  | ew05_line147_t.xyz  |
| ew05_line148_b.xyz  | ew05_line148_t.xyz  |
| ew05_line148_b2.xyz |                     |
| ew05_line149_b.xyz  | ew05_line149_t.xyz  |
| ew05_line150_b.xyz  | ew05_line150_t.xyz  |
| ew05_line151_b.xyz  | ew05_line151_t.xyz  |
| ew05_line152_b.xyz  | ew05_line152_t.xyz  |
| ew05_line153_b.xyz  | ew05_line153_t.xyz  |
| ew05_line154_b.xyz  | ew05_line154_t.xyz  |
| ew05_line155_b.xyz  | ew05_line155_t.xyz  |
| ew05_line156_b.xyz  | ew05_line156_t.xyz  |
| ew05_line158_b.xyz  | ew05_line158_t.xyz  |
| ew05_line160_b.xyz  | ew05_line160_t.xyz  |
| ew05_line162_b.xyz  | ew05_line162_t.xyz  |
| ew05_line164_b.xyz  | ew05_line164_t.xyz  |
| ew05_line166_b.xyz  | ew05_line166_t.xyz  |
| ew05_line168_b.xyz  | ew05_line168_t.xyz  |
| ew05_line170_b.xyz  | ew05_line170_t.xyz  |
| ew05_line172_b.xyz  | ew05_line172_t.xyz  |
| ew05_line174_b.xyz  | ew05_line174_t.xyz  |
| ew05_line176_b.xyz  | ew05_line176_t.xyz  |
|                     | ew05_line178_t.xyz  |
| ew05_line180_b.xyz  | ew05_line180_t.xyz  |
|                     | ew05_line182_t.xyz  |

|                    |                    |
|--------------------|--------------------|
| ew05_line184_b.xyz | ew05_line184_t.xyz |
|                    | ew05_line186_t.xyz |
| ew05_line188_b.xyz | ew05_line188_t.xyz |
|                    | ew05_line190_t.xyz |
| ew05_line192_b.xyz | ew05_line192_t.xyz |
|                    | ew05_line194_t.xyz |
| ew05_line196_b.xyz | ew05_line196_t.xyz |
|                    | ew05_line198_t.xyz |
| ew05_line200_b.xyz | ew05_line200_t.xyz |
| ew05_line204_b.xyz | ew05_line204_t.xyz |
| ew05_line208_b.xyz | ew05_line208_t.xyz |
| ew05_line212_b.xyz | ew05_line212_t.xyz |
| ew05_line216_b.xyz | ew05_line216_t.xyz |
| ew05_line220_b.xyz | ew05_line220_t.xyz |
| ew05_line224_b.xyz | ew05_line224_t.xyz |
| ew05_line228_b.xyz | ew05_line228_t.xyz |
| ew05_line232_b.xyz | ew05_line232_t.xyz |
| ew05_line234_b.xyz |                    |
| ew05_line236_b.xyz |                    |
| ew05_line238_b.xyz |                    |
| ew05_line240_b.xyz |                    |
| ew05_line242_b.xyz |                    |
| ew05_line244_b.xyz |                    |
| ew05_line256_b.xyz |                    |
| ew05_line258_b.xyz |                    |
| ew05_line266_b.xyz |                    |
| ew05_line274_b.xyz |                    |
| ew05_line282_b.xyz |                    |
| ew05_line290_b.xyz |                    |
| ew05_line298_b.xyz |                    |
| ew05_line306_b.xyz |                    |
| ew05_line314_b.xyz |                    |
| ew05_line322_b.xyz |                    |
| ew05_line330_b.xyz |                    |
| ew05_line338_b.xyz |                    |
| ew05_line346_b.xyz |                    |
| ew05_line354_b.xyz |                    |
| ew05_line362_b.xyz |                    |
| ew05_line370_b.xyz |                    |
| ew05_line378_b.xyz |                    |
| ew05_line386_b.xyz |                    |
| ew05_line394_b.xyz |                    |
| ew05_line402_b.xyz |                    |
| ew05_line435_b.xyz |                    |
| ew05_line436_b.xyz |                    |

## Appendix D - January 2006 Field Collection

During January 2006, a special survey was conducted to characterize the coastal response to a large storm. A series of large storms and high tides during December 26, 2005, to January 5, 2006, produced coastal erosion and flooding along the delta east of the river mouth. Following this event, a survey was conducted during the low tides occurring during the nights and early mornings of January 11 and 12, 2006. Because this was a rapid-response survey, the watercraft-based bathymetric surveys could not be included. Further, the survey was conducted only along a 1-km stretch of beach in the region of greatest reported erosion and flooding. A total of 41 topographic profiles were obtained during this survey (USGS Field Activity W-S1-06-PS) at a spacing of 25 m (figure D1–D2). Topographic lines are enumerated in table D. Metadata for this field activity are available at:

<http://walrus.wr.usgs.gov/infobank/w/ws106ps/html/w-s1-06-ps.meta.html>.



**Figure D1.** Elwha January 2006 surveyed lines. Only topography data were collected.



**Figure D2.** Elwha January 2006 surveyed lines (delta region). Only topography data were collected.

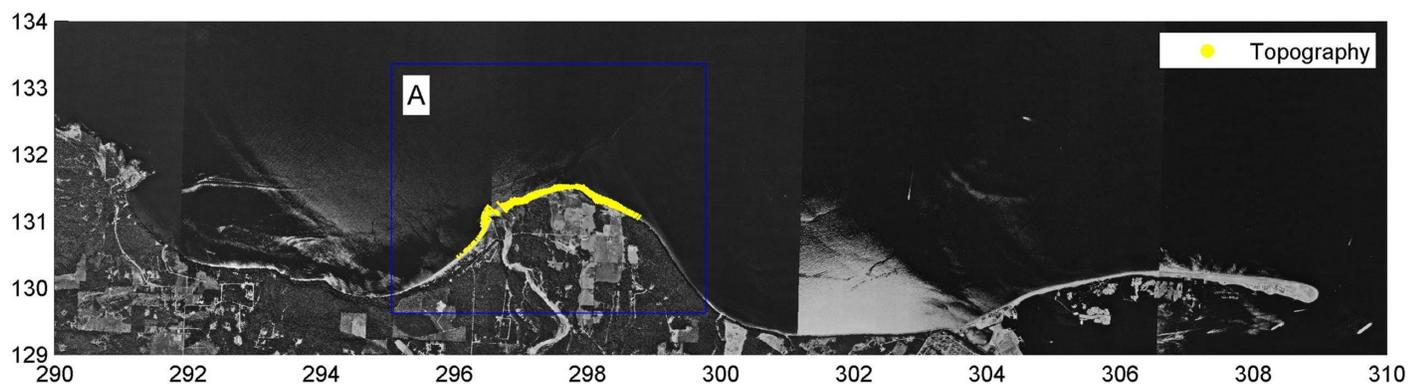
**Table D.** Topographic lines for the January 2006 survey.

| Topographic line   |
|--------------------|
| ew06_line192_t.xyz |
| ew06_line193_t.xyz |
| ew06_line194_t.xyz |
| ew06_line195_t.xyz |
| ew06_line196_t.xyz |
| ew06_line197_t.xyz |
| ew06_line198_t.xyz |
| ew06_line199_t.xyz |
| ew06_line200_t.xyz |
| ew06_line201_t.xyz |
| ew06_line202_t.xyz |
| ew06_line203_t.xyz |
| ew06_line204_t.xyz |
| ew06_line205_t.xyz |
| ew06_line206_t.xyz |

|                    |
|--------------------|
| ew06_line207_t.xyz |
| ew06_line208_t.xyz |
| ew06_line209_t.xyz |
| ew06_line210_t.xyz |
| ew06_line211_t.xyz |
| ew06_line212_t.xyz |
| ew06_line213_t.xyz |
| ew06_line214_t.xyz |
| ew06_line215_t.xyz |
| ew06_line216_t.xyz |
| ew06_line217_t.xyz |
| ew06_line218_t.xyz |
| ew06_line219_t.xyz |
| ew06_line220_t.xyz |
| ew06_line221_t.xyz |
| ew06_line222_t.xyz |
| ew06_line223_t.xyz |
| ew06_line224_t.xyz |
| ew06_line225_t.xyz |
| ew06_line226_t.xyz |
| ew06_line227_t.xyz |
| ew06_line228_t.xyz |
| ew06_line229_t.xyz |
| ew06_line230_t.xyz |
| ew06_line231_t.xyz |
| ew06_line232_t.xyz |

## Appendix E - April 2006 Field Collection

No bathymetric data were collected during this survey due to unsafe weather, as the winds and waves were too large to sample the nearshore by watercraft. Topographic data were collected (table E), however, between lines 119 to 232 for a total of 110 profiles (figs. E1–E2). Metadata for this field activity (W-S2-06-PS) are available at: <http://walrus.wr.usgs.gov/infobank/w/ws206ps/html/w-s2-06-ps.meta.html>.



**Figure E1.** Elwha April 2006 surveyed lines.



**Figure E2.** Elwha April 2006 surveyed lines (delta region).

**Table E.** Topographic lines for the April 2006 survey.

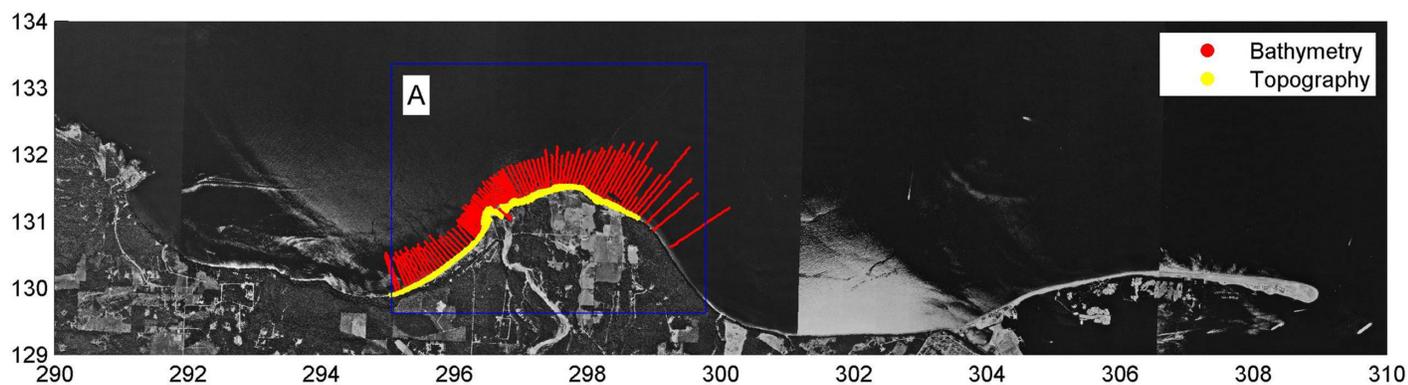
| <b>Topographic line</b> |
|-------------------------|
| ew06_line119_t.xyz      |
| ew06_line121_t.xyz      |
| ew06_line123_t.xyz      |
| ew06_line124_t.xyz      |
| ew06_line125_t.xyz      |
| ew06_line126_t.xyz      |
| ew06_line127_t.xyz      |
| ew06_line128_t.xyz      |
| ew06_line129_t.xyz      |
| ew06_line130_t.xyz      |
| ew06_line131_t.xyz      |
| ew06_line132_t.xyz      |
| ew06_line133_t.xyz      |
| ew06_line134_t.xyz      |
| ew06_line135_t.xyz      |

|                    |
|--------------------|
| ew06_line136_t.xyz |
| ew06_line137_t.xyz |
| ew06_line138_t.xyz |
| ew06_line139_t.xyz |
| ew06_line140_t.xyz |
| ew06_line141_t.xyz |
| ew06_line142_t.xyz |
| ew06_line143_t.xyz |
| ew06_line144_t.xyz |
| ew06_line145_t.xyz |
| ew06_line146_t.xyz |
| ew06_line147_t.xyz |
| ew06_line150_t.xyz |
| ew06_line151_t.xyz |
| ew06_line152_t.xyz |
| ew06_line153_t.xyz |
| ew06_line154_t.xyz |
| ew06_line155_t.xyz |
| ew06_line156_t.xyz |
| ew06_line157_t.xyz |
| ew06_line158_t.xyz |
| ew06_line159_t.xyz |
| ew06_line160_t.xyz |
| ew06_line161_t.xyz |
| ew06_line162_t.xyz |
| ew06_line163_t.xyz |
| ew06_line164_t.xyz |
| ew06_line165_t.xyz |
| ew06_line166_t.xyz |
| ew06_line167_t.xyz |
| ew06_line168_t.xyz |
| ew06_line169_t.xyz |
| ew06_line170_t.xyz |
| ew06_line171_t.xyz |
| ew06_line172_t.xyz |
| ew06_line173_t.xyz |
| ew06_line174_t.xyz |
| ew06_line175_t.xyz |
| ew06_line176_t.xyz |
| ew06_line177_t.xyz |
| ew06_line178_t.xyz |
| ew06_line179_t.xyz |
| ew06_line180_t.xyz |
| ew06_line181_t.xyz |
| ew06_line182_t.xyz |
| ew06_line183_t.xyz |
| ew06_line184_t.xyz |
| ew06_line185_t.xyz |
| ew06_line186_t.xyz |
| ew06_line187_t.xyz |
| ew06_line188_t.xyz |
| ew06_line189_t.xyz |
| ew06_line190_t.xyz |
| ew06_line191_t.xyz |
| ew06_line192_t.xyz |

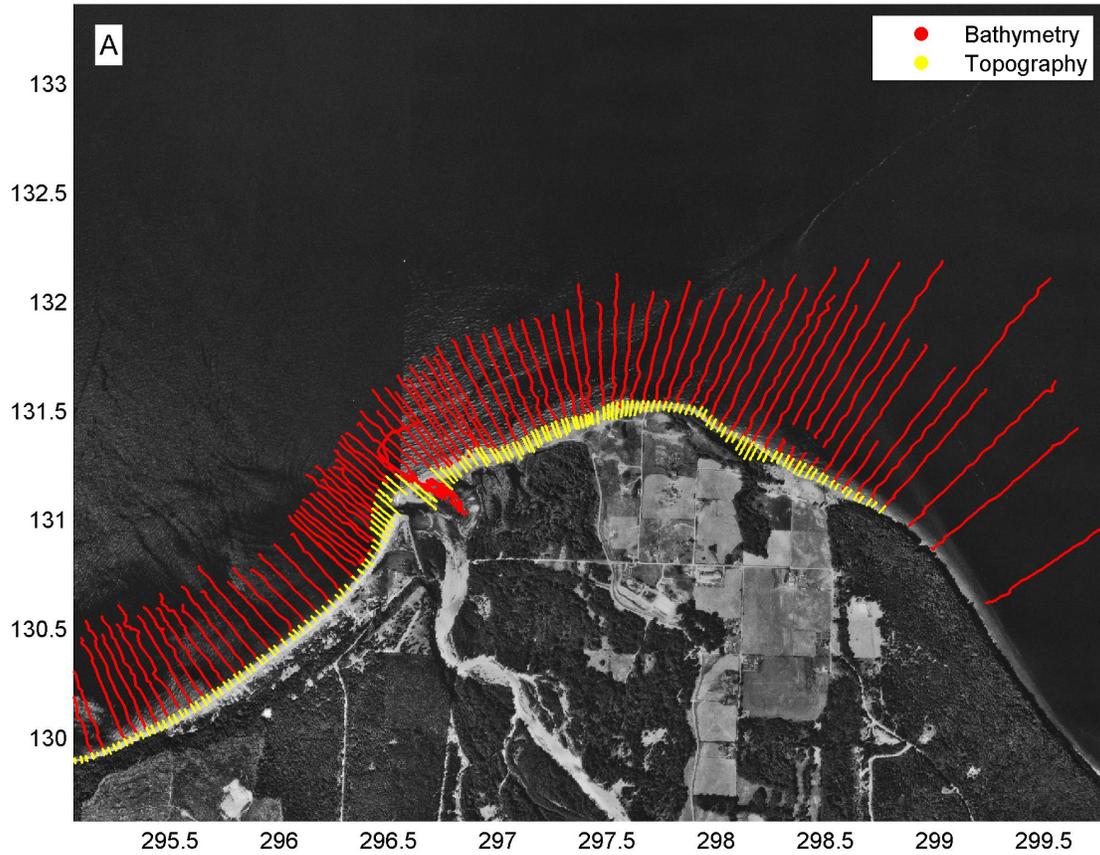
|                    |
|--------------------|
| ew06_line193_t.xyz |
| ew06_line194_t.xyz |
| ew06_line195_t.xyz |
| ew06_line196_t.xyz |
| ew06_line197_t.xyz |
| ew06_line198_t.xyz |
| ew06_line199_t.xyz |
| ew06_line200_t.xyz |
| ew06_line201_t.xyz |
| ew06_line202_t.xyz |
| ew06_line203_t.xyz |
| ew06_line204_t.xyz |
| ew06_line205_t.xyz |
| ew06_line206_t.xyz |
| ew06_line207_t.xyz |
| ew06_line208_t.xyz |
| ew06_line209_t.xyz |
| ew06_line210_t.xyz |
| ew06_line211_t.xyz |
| ew06_line212_t.xyz |
| ew06_line213_t.xyz |
| ew06_line214_t.xyz |
| ew06_line215_t.xyz |
| ew06_line216_t.xyz |
| ew06_line217_t.xyz |
| ew06_line218_t.xyz |
| ew06_line219_t.xyz |
| ew06_line220_t.xyz |
| ew06_line221_t.xyz |
| ew06_line222_t.xyz |
| ew06_line223_t.xyz |
| ew06_line224_t.xyz |
| ew06_line225_t.xyz |
| ew06_line226_t.xyz |
| ew06_line227_t.xyz |
| ew06_line228_t.xyz |
| ew06_line229_t.xyz |
| ew06_line230_t.xyz |
| ew06_line231_t.xyz |
| ew06_line232_t.xyz |

## Appendix F - September 2006 Field Collection

In September 2006, the area around the delta was heavily sampled. On September 18–19, 103 bathymetric profiles and 153 topographic profiles were collected between line numbers 80 to the west and 240 to the east (figs. F1–F2). Additionally, data were collected within the river mouth by driving the PWCs through the river mouth and traversing from one side of the river to the other. Bathymetric and topographic lines collected during this survey (USGS Field Activity W-5-06-PS) are enumerated in table F. Metadata for this activity are available at: <http://walrus.wr.usgs.gov/infobank/w/w506ps/html/w-5-06-ps.meta.html>.



**Figure F1.** Elwha September 2006 surveyed lines.



**Figure F2.** Elwha September 2006 surveyed lines (delta region).

**Table F.** Bathymetric and topographic lines for the September 2006 survey.

| Bathymetric line   | Topographic line   |
|--------------------|--------------------|
|                    | ew06_line080_t.xyz |
|                    | ew06_line081_t.xyz |
|                    | ew06_line082_t.xyz |
|                    | ew06_line083_t.xyz |
| ew06_line084_b.xyz | ew06_line084_t.xyz |
|                    | ew06_line085_t.xyz |
| ew06_line086_b.xyz | ew06_line086_t.xyz |
|                    | ew06_line087_t.xyz |
|                    | ew06_line088_t.xyz |
|                    | ew06_line089_t.xyz |
| ew06_line090_b.xyz | ew06_line090_t.xyz |
|                    | ew06_line091_t.xyz |
| ew06_line092_b.xyz | ew06_line092_t.xyz |
|                    | ew06_line093_t.xyz |
| ew06_line094_b.xyz | ew06_line094_t.xyz |

|                     |                    |
|---------------------|--------------------|
|                     | ew06_line095_t.xyz |
| ew06_line096_b.xyz  | ew06_line096_t.xyz |
|                     | ew06_line097_t.xyz |
| ew06_line098_b.xyz  | ew06_line098_t.xyz |
|                     | ew06_line099_t.xyz |
| ew06_line100_b.xyz  | ew06_line100_t.xyz |
|                     | ew06_line101_t.xyz |
| ew06_line102_b.xyz  | ew06_line102_t.xyz |
|                     | ew06_line103_t.xyz |
| ew06_line104_b.xyz  | ew06_line104_t.xyz |
|                     | ew06_line105_t.xyz |
| ew06_line106_b.xyz  | ew06_line106_t.xyz |
|                     | ew06_line107_t.xyz |
| ew06_line108_b.xyz  | ew06_line108_t.xyz |
|                     | ew06_line109_t.xyz |
| ew06_line110_b.xyz  | ew06_line110_t.xyz |
|                     | ew06_line111_t.xyz |
| ew06_line112_b.xyz  | ew06_line112_t.xyz |
|                     | ew06_line113_t.xyz |
| ew06_line114_b.xyz  | ew06_line114_t.xyz |
|                     | ew06_line115_t.xyz |
| ew06_line116_b.xyz  | ew06_line116_t.xyz |
|                     | ew06_line117_t.xyz |
| ew06_line118_b.xyz  | ew06_line118_t.xyz |
|                     | ew06_line119_t.xyz |
| ew06_line120_b.xyz  | ew06_line120_t.xyz |
|                     | ew06_line121_t.xyz |
| ew06_line122_b.xyz  | ew06_line122_t.xyz |
|                     | ew06_line123_t.xyz |
| ew06_line124_b.xyz  | ew06_line124_t.xyz |
|                     | ew06_line125_t.xyz |
| ew06_line126_b.xyz  | ew06_line126_t.xyz |
|                     | ew06_line127_t.xyz |
| ew06_line128_b.xyz  | ew06_line128_t.xyz |
|                     | ew06_line129_t.xyz |
| ew06_line130_b.xyz  | ew06_line130_t.xyz |
| ew06_line130_b2.xyz |                    |
| ew06_line131_b.xyz  | ew06_line131_t.xyz |
| ew06_line132_b.xyz  | ew06_line132_t.xyz |
| ew06_line133_b.xyz  | ew06_line133_t.xyz |
| ew06_line134_b.xyz  | ew06_line134_t.xyz |
| ew06_line135_b.xyz  | ew06_line135_t.xyz |
| ew06_line136_b.xyz  | ew06_line136_t.xyz |
| ew06_line137_b.xyz  | ew06_line137_t.xyz |
| ew06_line138_b.xyz  | ew06_line138_t.xyz |
| ew06_line139_b.xyz  | ew06_line139_t.xyz |
| ew06_line140_b.xyz  | ew06_line140_t.xyz |
| ew06_line141_b.xyz  | ew06_line141_t.xyz |
| ew06_line142_b.xyz  | ew06_line142_t.xyz |
| ew06_line143_b.xyz  | ew06_line143_t.xyz |
| ew06_line144_b.xyz  | ew06_line144_t.xyz |
| ew06_line145_b.xyz  | ew06_line145_t.xyz |
| ew06_line146_b.xyz  | ew06_line146_t.xyz |
| ew06_line147_b.xyz  | ew06_line147_t.xyz |

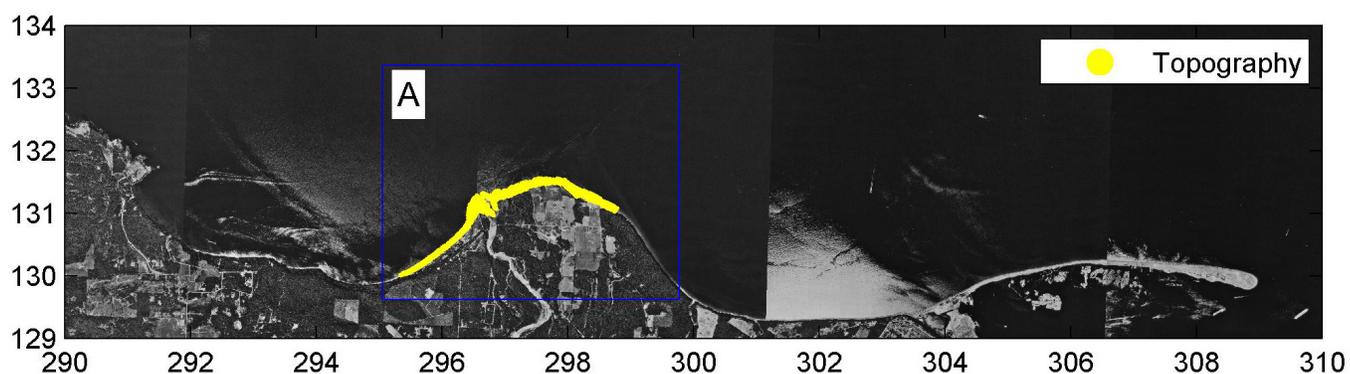
|                     |                    |
|---------------------|--------------------|
| ew06_line147_b2.xyz |                    |
| ew06_line147_b3.xyz |                    |
| ew06_line148_b.xyz  | ew06_line148_t.xyz |
| ew06_line149_b.xyz  | ew06_line149_t.xyz |
| ew06_line150_b.xyz  | ew06_line150_t.xyz |
| ew06_line151_b.xyz  | ew06_line151_t.xyz |
| ew06_line152_b.xyz  | ew06_line152_t.xyz |
| ew06_line153_b.xyz  | ew06_line153_t.xyz |
| ew06_line154_b.xyz  | ew06_line154_t.xyz |
| ew06_line155_b.xyz  | ew06_line155_t.xyz |
| ew06_line156_b.xyz  | ew06_line156_t.xyz |
| ew06_line157_b.xyz  | ew06_line157_t.xyz |
| ew06_line158_b.xyz  | ew06_line158_t.xyz |
| ew06_line159_b.xyz  | ew06_line159_t.xyz |
| ew06_line160_b.xyz  | ew06_line160_t.xyz |
|                     | ew06_line161_t.xyz |
| ew06_line162_b.xyz  | ew06_line162_t.xyz |
|                     | ew06_line163_t.xyz |
| ew06_line164_b.xyz  | ew06_line164_t.xyz |
|                     | ew06_line165_t.xyz |
| ew06_line166_b.xyz  | ew06_line166_t.xyz |
|                     | ew06_line167_t.xyz |
| ew06_line168_b.xyz  | ew06_line168_t.xyz |
|                     | ew06_line169_t.xyz |
| ew06_line170_b.xyz  | ew06_line170_t.xyz |
|                     | ew06_line171_t.xyz |
| ew06_line172_b.xyz  | ew06_line172_t.xyz |
|                     | ew06_line173_t.xyz |
| ew06_line174_b.xyz  | ew06_line174_t.xyz |
|                     | ew06_line175_t.xyz |
| ew06_line176_b.xyz  | ew06_line176_t.xyz |
|                     | ew06_line177_t.xyz |
| ew06_line178_b.xyz  | ew06_line178_t.xyz |
|                     | ew06_line179_t.xyz |
| ew06_line180_b.xyz  | ew06_line180_t.xyz |
|                     | ew06_line181_t.xyz |
| ew06_line182_b.xyz  | ew06_line182_t.xyz |
|                     | ew06_line183_t.xyz |
| ew06_line184_b.xyz  | ew06_line184_t.xyz |
|                     | ew06_line185_t.xyz |
| ew06_line186_b.xyz  | ew06_line186_t.xyz |
|                     | ew06_line187_t.xyz |
| ew06_line188_b.xyz  | ew06_line188_t.xyz |
|                     | ew06_line189_t.xyz |
| ew06_line190_b.xyz  | ew06_line190_t.xyz |
|                     | ew06_line191_t.xyz |
| ew06_line192_b.xyz  | ew06_line192_t.xyz |
|                     | ew06_line193_t.xyz |
| ew06_line194_b.xyz  | ew06_line194_t.xyz |
|                     | ew06_line195_t.xyz |
| ew06_line196_b.xyz  | ew06_line196_t.xyz |
|                     | ew06_line197_t.xyz |
| ew06_line198_b.xyz  | ew06_line198_t.xyz |
|                     | ew06_line199_t.xyz |

|                     |                    |
|---------------------|--------------------|
| ew06_line200_b.xyz  | ew06_line200_t.xyz |
|                     | ew06_line201_t.xyz |
| ew06_line202_b.xyz  | ew06_line202_t.xyz |
|                     | ew06_line203_t.xyz |
| ew06_line204_b.xyz  | ew06_line204_t.xyz |
|                     | ew06_line205_t.xyz |
| ew06_line206_b.xyz  | ew06_line206_t.xyz |
|                     | ew06_line207_t.xyz |
| ew06_line208_b.xyz  | ew06_line208_t.xyz |
|                     | ew06_line209_t.xyz |
| ew06_line210_b.xyz  | ew06_line210_t.xyz |
|                     | ew06_line211_t.xyz |
| ew06_line212_b.xyz  | ew06_line212_t.xyz |
|                     | ew06_line213_t.xyz |
| ew06_line214_b.xyz  | ew06_line214_t.xyz |
| ew06_line214_b2.xyz |                    |
|                     | ew06_line215_t.xyz |
| ew06_line216_b.xyz  | ew06_line216_t.xyz |
| ew06_line216_b2.xyz |                    |
|                     | ew06_line217_t.xyz |
| ew06_line218_b.xyz  | ew06_line218_t.xyz |
| ew06_line218_b2.xyz |                    |
|                     | ew06_line219_t.xyz |
| ew06_line220_b.xyz  | ew06_line220_t.xyz |
| ew06_line220_b2.xyz |                    |
|                     | ew06_line221_t.xyz |
| ew06_line222_b.xyz  | ew06_line222_t.xyz |
|                     | ew06_line223_t.xyz |
| ew06_line224_b.xyz  | ew06_line224_t.xyz |
|                     | ew06_line225_t.xyz |
| ew06_line226_b.xyz  | ew06_line226_t.xyz |
|                     | ew06_line227_t.xyz |
| ew06_line228_b.xyz  | ew06_line228_t.xyz |
|                     | ew06_line229_t.xyz |
| ew06_line230_b.xyz  | ew06_line230_t.xyz |
|                     | ew06_line231_t.xyz |
| ew06_line232_b.xyz  | ew06_line232_t.xyz |
| ew06_line234_b.xyz  |                    |
| ew06_line236_b.xyz  |                    |
| ew06_line240_b.xyz  |                    |

## Appendix G – April 2007 Field Collection

In April 2007, no bathymetric data were collected during this survey due to unsafe weather, as the winds and waves were too large to sample the nearshore by watercraft. Between 18-20 April, 145 topographic profiles were collected between line numbers 92 to the west and 232 to the east (figs. G1-G2). Topographic lines collected during the April 2007 survey (USGS Field Activity W-S1-07-PS) are enumerated in table G. Metadata for this field activity are available at:

<http://walrus.wr.usgs.gov/infobank/w/ws107ps/html/w-s1-07-ps.meta.html>.



**Figure G1.** Elwha April 2007 surveyed lines. Only topography data were collected.



**Figure G2.** Elwha April 2007 surveyed lines (delta region). Only topography data were collected.

**Table G.** Topographic lines for the April 2007 survey.

| Topographic Line   |
|--------------------|
| ew07_line092_t.xyz |
| ew07_line094_t.xyz |
| ew07_line095_t.xyz |
| ew07_line096_t.xyz |
| ew07_line097_t.xyz |
| ew07_line098_t.xyz |
| ew07_line099_t.xyz |
| ew07_line100_t.xyz |
| ew07_line101_t.xyz |
| ew07_line102_t.xyz |
| ew07_line103_t.xyz |
| ew07_line104_t.xyz |
| ew07_line105_t.xyz |
| ew07_line106_t.xyz |
| ew07_line107_t.xyz |

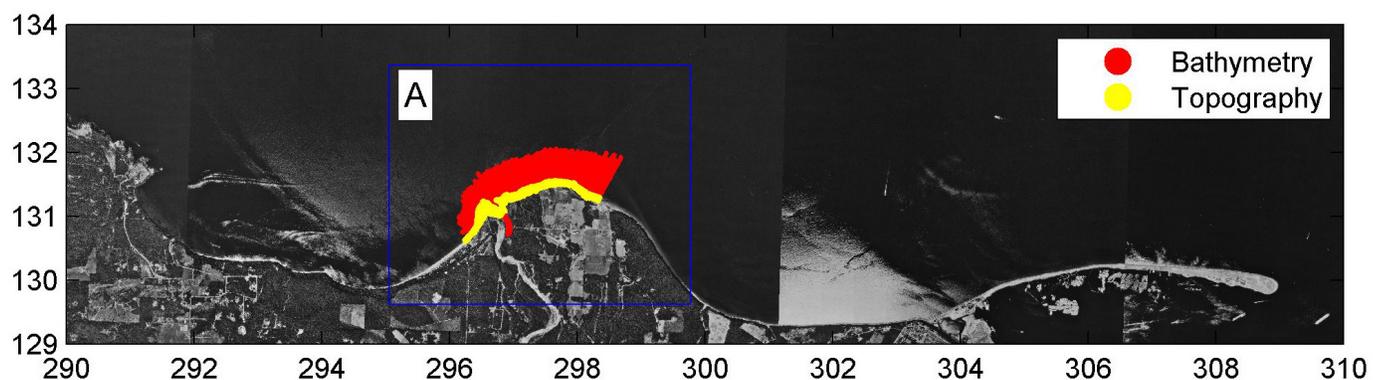
|                    |
|--------------------|
| ew07_line108_t.xyz |
| ew07_line109_t.xyz |
| ew07_line110_t.xyz |
| ew07_line111_t.xyz |
| ew07_line112_t.xyz |
| ew07_line113_t.xyz |
| ew07_line114_t.xyz |
| ew07_line115_t.xyz |
| ew07_line116_t.xyz |
| ew07_line117_t.xyz |
| ew07_line118_t.xyz |
| ew07_line119_t.xyz |
| ew07_line120_t.xyz |
| ew07_line121_t.xyz |
| ew07_line122_t.xyz |
| ew07_line123_t.xyz |
| ew07_line124_t.xyz |
| ew07_line125_t.xyz |
| ew07_line126_t.xyz |
| ew07_line127_t.xyz |
| ew07_line128_t.xyz |
| ew07_line129_t.xyz |
| ew07_line130_t.xyz |
| ew07_line131_t.xyz |
| ew07_line132_t.xyz |
| ew07_line133_t.xyz |
| ew07_line134_t.xyz |
| ew07_line135_t.xyz |
| ew07_line136_t.xyz |
| ew07_line137_t.xyz |
| ew07_line138_t.xyz |
| ew07_line139_t.xyz |
| ew07_line140_t.xyz |
| ew07_line141_t.xyz |
| ew07_line142_t.xyz |
| ew07_line143_t.xyz |
| ew07_line144_t.xyz |
| ew07_line145_t.xyz |
| ew07_line146_t.xyz |
| ew07_line147_t.xyz |
| ew07_line148_t.xyz |
| ew07_line150_t.xyz |
| ew07_line151_t.xyz |
| ew07_line152_t.xyz |
| ew07_line153_t.xyz |
| ew07_line155_t.xyz |
| ew07_line156_t.xyz |
| ew07_line157_t.xyz |

|                    |
|--------------------|
| ew07_line158_t.xyz |
| ew07_line159_t.xyz |
| ew07_line160_t.xyz |
| ew07_line161_t.xyz |
| ew07_line162_t.xyz |
| ew07_line163_t.xyz |
| ew07_line164_t.xyz |
| ew07_line165_t.xyz |
| ew07_line166_t.xyz |
| ew07_line167_t.xyz |
| ew07_line168_t.xyz |
| ew07_line169_t.xyz |
| ew07_line170_t.xyz |
| ew07_line171_t.xyz |
| ew07_line172_t.xyz |
| ew07_line173_t.xyz |
| ew07_line174_t.xyz |
| ew07_line175_t.xyz |
| ew07_line176_t.xyz |
| ew07_line177_t.xyz |
| ew07_line178_t.xyz |
| ew07_line179_t.xyz |
| ew07_line180_t.xyz |
| ew07_line181_t.xyz |
| ew07_line182_t.xyz |
| ew07_line183_t.xyz |
| ew07_line184_t.xyz |
| ew07_line185_t.xyz |
| ew07_line186_t.xyz |
| ew07_line187_t.xyz |
| ew07_line189_t.xyz |
| ew07_line190_t.xyz |
| ew07_line191_t.xyz |
| ew07_line192_t.xyz |
| ew07_line193_t.xyz |
| ew07_line194_t.xyz |
| ew07_line195_t.xyz |
| ew07_line196_t.xyz |
| ew07_line197_t.xyz |
| ew07_line198_t.xyz |
| ew07_line199_t.xyz |
| ew07_line200_t.xyz |
| ew07_line201_t.xyz |
| ew07_line202_t.xyz |
| ew07_line203_t.xyz |
| ew07_line204_t.xyz |
| ew07_line205_t.xyz |
| ew07_line206_t.xyz |

|                    |
|--------------------|
| ew07_line207_t.xyz |
| ew07_line208_t.xyz |
| ew07_line209_t.xyz |
| ew07_line210_t.xyz |
| ew07_line211_t.xyz |
| ew07_line212_t.xyz |
| ew07_line213_t.xyz |
| ew07_line214_t.xyz |
| ew07_line215_t.xyz |
| ew07_line216_t.xyz |
| ew07_line217_t.xyz |
| ew07_line218_t.xyz |
| ew07_line219_t.xyz |
| ew07_line220_t.xyz |
| ew07_line221_t.xyz |
| ew07_line222_t.xyz |
| ew07_line223_t.xyz |
| ew07_line224_t.xyz |
| ew07_line225_t.xyz |
| ew07_line226_t.xyz |
| ew07_line227_t.xyz |
| ew07_line228_t.xyz |
| ew07_line229_t.xyz |
| ew07_line230_t.xyz |
| ew07_line231_t.xyz |
| ew07_line232_t.xyz |
| ew07_001grid_t.xyz |
| ew07_002grid_t.xyz |
| ew07_003grid_t.xyz |
| ew07_004grid_t.xyz |
| ew07_005grid_t.xyz |
| ew07_006grid_t.xyz |
| ew07_007grid_t.xyz |
| ew07_008grid_t.xyz |

## Appendix H – September 2007 Field Collection

In September 2007, data collection focused on the river mouth and adjacent delta. On 6-8 September, 81 bathymetric profiles and 88 topographic profiles between line numbers 126 to the west and 217 to the east (fig. H1-H2). Bathymetric and topographic lines collected during the September 2007 survey (USGS Field Activity W-2-07-PS) are enumerated in table H. Metadata for this field activity are available at: <http://walrus.wr.usgs.gov/infobank/w/w207ps/html/w-2-07-ps.meta.html>.



**Figure H1.** Elwha September 2007 surveyed lines.



**Figure H2.** Elwha September 2007 surveyed lines (delta region).

**Table H.** Bathymetric and topographic lines for the September 2007 survey.

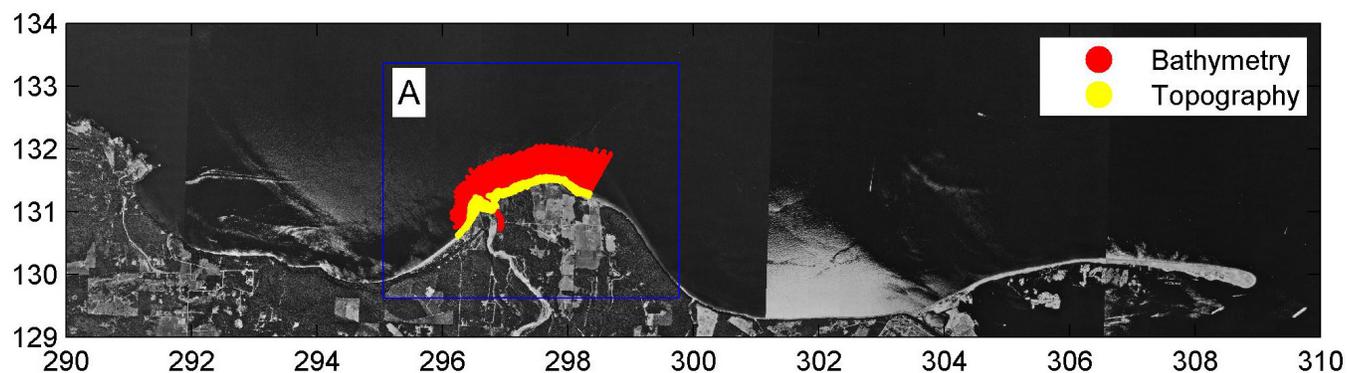
| Bathymetric Line   | Topographic Line   |
|--------------------|--------------------|
|                    | ew07_line126_t.xyz |
|                    | ew07_line127_t.xyz |
|                    | ew07_line128_t.xyz |
|                    | ew07_line129_t.xyz |
| ew07_line130_b.xyz | ew07_line130_t.xyz |
| ew07_line131_b.xyz | ew07_line131_t.xyz |
| ew07_line132_b.xyz | ew07_line132_t.xyz |
| ew07_line133_b.xyz | ew07_line133_t.xyz |
| ew07_line134_b.xyz | ew07_line134_t.xyz |
| ew07_line135_b.xyz | ew07_line135_t.xyz |
| ew07_line136_b.xyz | ew07_line136_t.xyz |
| ew07_line137_b.xyz | ew07_line137_t.xyz |
| ew07_line138_b.xyz | ew07_line138_t.xyz |

|                     |                    |
|---------------------|--------------------|
| ew07_line139_b.xyz  | ew07_line139_t.xyz |
| ew07_line140_b.xyz  | ew07_line140_t.xyz |
| ew07_line141_b.xyz  | ew07_line141_t.xyz |
| ew07_line142_b.xyz  | ew07_line142_t.xyz |
| ew07_line143_b.xyz  | ew07_line143_t.xyz |
| ew07_line144_b.xyz  | ew07_line144_t.xyz |
| ew07_line145_b.xyz  | ew07_line145_t.xyz |
| ew07_line146_b.xyz  | ew07_line146_t.xyz |
| ew07_line147_b.xyz  | ew07_line147_t.xyz |
| ew07_line148_b.xyz  |                    |
| ew07_line149_b.xyz  |                    |
| ew07_line150_b.xyz  |                    |
| ew07_line151_b.xyz  | ew07_line151_t.xyz |
| ew07_line152_b.xyz  | ew07_line152_t.xyz |
| ew07_line153_b.xyz  | ew07_line153_t.xyz |
| ew07_line154_b.xyz  | ew07_line154_t.xyz |
| ew07_line155_b.xyz  | ew07_line155_t.xyz |
| ew07_line156_b.xyz  | ew07_line156_t.xyz |
| ew07_line157_b.xyz  | ew07_line157_t.xyz |
| ew07_line158_b.xyz  | ew07_line158_t.xyz |
| ew07_line159_b.xyz  | ew07_line159_t.xyz |
| ew07_line160_b.xyz  | ew07_line160_t.xyz |
| ew07_line161_b.xyz  | ew07_line161_t.xyz |
| ew07_line162_b.xyz  | ew07_line162_t.xyz |
| ew07_line163_b.xyz  | ew07_line163_t.xyz |
| ew07_line164_b.xyz  | ew07_line164_t.xyz |
| ew07_line165_b.xyz  | ew07_line165_t.xyz |
| ew07_line166_b.xyz  | ew07_line166_t.xyz |
| ew07_line167_b.xyz  | ew07_line167_t.xyz |
| ew07_line168_b.xyz  | ew07_line168_t.xyz |
| ew07_line169_b.xyz  | ew07_line169_t.xyz |
| ew07_line170_b.xyz  | ew07_line170_t.xyz |
| ew07_line171_b.xyz  | ew07_line171_t.xyz |
| ew07_line171_b2.xyz |                    |
| ew07_line172_b.xyz  | ew07_line172_t.xyz |
| ew07_line173_b.xyz  | ew07_line173_t.xyz |
| ew07_line174_b.xyz  | ew07_line174_t.xyz |
| ew07_line175_b.xyz  | ew07_line175_t.xyz |
| ew07_line176_b.xyz  | ew07_line176_t.xyz |
| ew07_line177_b.xyz  |                    |
| ew07_line178_b.xyz  | ew07_line178_t.xyz |
| ew07_line179_b.xyz  | ew07_line179_t.xyz |
| ew07_line180_b.xyz  | ew07_line180_t.xyz |
| ew07_line181_b.xyz  | ew07_line181_t.xyz |
| ew07_line182_b.xyz  | ew07_line182_t.xyz |
| ew07_line183_b.xyz  | ew07_line183_t.xyz |
| ew07_line184_b.xyz  | ew07_line184_t.xyz |
| ew07_line185_b.xyz  | ew07_line185_t.xyz |

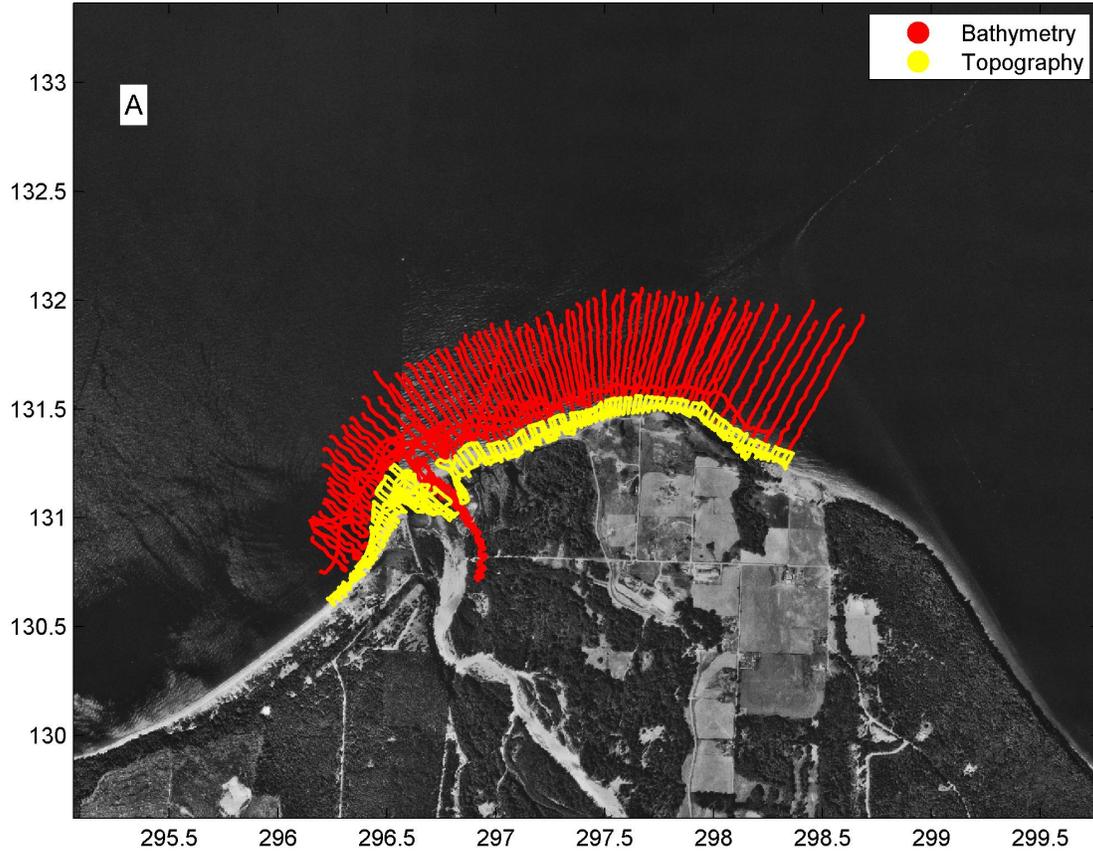
|                    |                    |
|--------------------|--------------------|
| ew07_line186_b.xyz | ew07_line186_t.xyz |
| ew07_line187_b.xyz | ew07_line187_t.xyz |
| ew07_line188_b.xyz | ew07_line188_t.xyz |
| ew07_line189_b.xyz | ew07_line189_t.xyz |
| ew07_line190_b.xyz | ew07_line190_t.xyz |
| ew07_line191_b.xyz | ew07_line191_t.xyz |
| ew07_line192_b.xyz | ew07_line192_t.xyz |
| ew07_line193_b.xyz | ew07_line193_t.xyz |
| ew07_line194_b.xyz | ew07_line194_t.xyz |
| ew07_line195_b.xyz | ew07_line195_t.xyz |
| ew07_line196_b.xyz | ew07_line196_t.xyz |
| ew07_line197_b.xyz | ew07_line197_t.xyz |
| ew07_line198_b.xyz | ew07_line198_t.xyz |
| ew07_line199_b.xyz | ew07_line199_t.xyz |
| ew07_line200_b.xyz | ew07_line200_t.xyz |
| ew07_line201_b.xyz | ew07_line201_t.xyz |
| ew07_line202_b.xyz | ew07_line202_t.xyz |
|                    | ew07_line203_t.xyz |
| ew07_line204_b.xyz | ew07_line204_t.xyz |
|                    | ew07_line205_t.xyz |
| ew07_line206_b.xyz | ew07_line206_t.xyz |
|                    | ew07_line207_t.xyz |
| ew07_line208_b.xyz | ew07_line208_t.xyz |
|                    | ew07_line209_t.xyz |
| ew07_line210_b.xyz | ew07_line210_t.xyz |
|                    | ew07_line211_t.xyz |
| ew07_line212_b.xyz | ew07_line212_t.xyz |
|                    | ew07_line213_t.xyz |
| ew07_line214_b.xyz | ew07_line214_t.xyz |
|                    | ew07_line215_t.xyz |
| ew07_line216_b.xyz | ew07_line216_t.xyz |
|                    | ew07_line217_t.xyz |
| ew07_001grid_b.xyz | ew07_001grid_t.xyz |
| ew07_002grid_b.xyz | ew07_002grid_t.xyz |
| ew07_003grid_b.xyz | ew07_003grid_t.xyz |
| ew07_004grid_b.xyz | ew07_004grid_t.xyz |
| ew07_005grid_b.xyz |                    |
| ew07_006grid_b.xyz |                    |
| ew07_007grid_b.xyz |                    |
| ew07_008grid_b.xyz |                    |
| ew07_009grid_b.xyz |                    |
| ew07_010grid_b.xyz |                    |
| ew07_011grid_b.xyz |                    |

## Appendix I – August 2008 Field Collection

Between 27 and 29 August, 133 bathymetric profiles and 101 topographic profiles between line numbers 130 to the west and 232 to the east (fig. I1-I2). Bathymetric and topographic lines collected during the survey (USGS Field Activity W-2-08-PS) are enumerated in table I. Metadata for this field activity are available at: <http://walrus.wr.usgs.gov/infobank/w/w208ps/html/w-2-08-ps.meta.html>.



**Figure I1.** Elwha August 2008 surveyed lines.



**Figure 12.** Elwha August 2008 surveyed lines (delta region).

**Table I.** Bathymetric and topographic lines for the August 2008 survey.

| <b>Bathymetric Line</b> | <b>Topographic Line</b> |
|-------------------------|-------------------------|
| ew08_line130_b.xyz      | ew08_line130_t.xyz      |
| ew08_line130_b2.xyz     |                         |
| ew08_line131_b.xyz      | ew08_line131_t.xyz      |
| ew08_line132_b.xyz      | ew08_line132_t.xyz      |
| ew08_line133_b.xyz      | ew08_line133_t.xyz      |
| ew08_line134_b.xyz      | ew08_line134_t.xyz      |
| ew08_line135_b.xyz      | ew08_line135_t.xyz      |
| ew08_line136_b.xyz      | ew08_line136_t.xyz      |
| ew08_line137_b.xyz      | ew08_line137_t.xyz      |
| ew08_line138_b.xyz      | ew08_line138_t.xyz      |
| ew08_line139_b.xyz      | ew08_line139_t.xyz      |
| ew08_line140_b.xyz      | ew08_line140_t.xyz      |
| ew08_line141_b.xyz      | ew08_line141_t.xyz      |

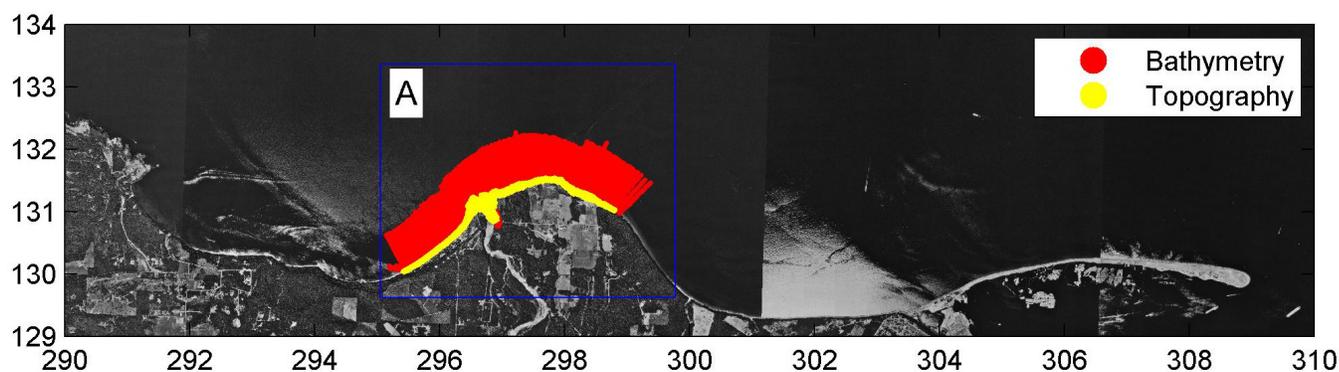
|                     |                     |
|---------------------|---------------------|
| ew08_line142_b.xyz  | ew08_line142_t.xyz  |
| ew08_line143_b.xyz  | ew08_line143_t.xyz  |
| ew08_line144_b.xyz  | ew08_line144_t.xyz  |
| ew08_line145_b.xyz  | ew08_line145_t.xyz  |
| ew08_line146_b.xyz  | ew08_line146_t.xyz  |
| ew08_line147_b.xyz  | ew08_line147_t.xyz  |
| ew08_line148_b.xyz  |                     |
| ew08_line149_b.xyz  |                     |
| ew08_line150_b.xyz  |                     |
| ew08_line151_b.xyz  |                     |
| ew08_line152_b.xyz  |                     |
| ew08_line153_b.xyz  | ew08_line153_t.xyz  |
|                     | ew08_line153_t2.xyz |
| ew08_line154_b.xyz  | ew08_line154_t.xyz  |
| ew08_line155_b.xyz  | ew08_line155_t.xyz  |
| ew08_line156_b.xyz  | ew08_line156_t.xyz  |
| ew08_line157_b.xyz  | ew08_line157_t.xyz  |
| ew08_line158_b.xyz  | ew08_line158_t.xyz  |
| ew08_line159_b.xyz  | ew08_line159_t.xyz  |
| ew08_line160_b.xyz  | ew08_line160_t.xyz  |
| ew08_line161_b.xyz  | ew08_line161_t.xyz  |
| ew08_line162_b.xyz  | ew08_line162_t.xyz  |
| ew08_line163_b.xyz  | ew08_line163_t.xyz  |
| ew08_line164_b.xyz  | ew08_line164_t.xyz  |
| ew08_line165_b.xyz  | ew08_line165_t.xyz  |
| ew08_line166_b.xyz  | ew08_line166_t.xyz  |
| ew08_line167_b.xyz  | ew08_line167_t.xyz  |
|                     | ew08_line168_t.xyz  |
| ew08_line169_b.xyz  | ew08_line169_t.xyz  |
| ew08_line170_b.xyz  | ew08_line170_t.xyz  |
| ew08_line171_b.xyz  | ew08_line171_t.xyz  |
| ew08_line172_b.xyz  | ew08_line172_t.xyz  |
| ew08_line173_b.xyz  | ew08_line173_t.xyz  |
| ew08_line174_b.xyz  | ew08_line174_t.xyz  |
| ew08_line175_b.xyz  | ew08_line175_t.xyz  |
| ew08_line175_b2.xyz |                     |
| ew08_line176_b.xyz  | ew08_line176_t.xyz  |
| ew08_line177_b.xyz  | ew08_line177_t.xyz  |
| ew08_line178_b.xyz  | ew08_line178_t.xyz  |
| ew08_line179_b.xyz  | ew08_line179_t.xyz  |
| ew08_line180_b.xyz  | ew08_line180_t.xyz  |
| ew08_line181_b.xyz  | ew08_line181_t.xyz  |
| ew08_line182_b.xyz  | ew08_line182_t.xyz  |
| ew08_line183_b.xyz  | ew08_line183_t.xyz  |
| ew08_line184_b.xyz  | ew08_line184_t.xyz  |
| ew08_line185_b.xyz  | ew08_line185_t.xyz  |
| ew08_line186_b.xyz  | ew08_line186_t.xyz  |
| ew08_line187_b.xyz  |                     |

|                     |                    |
|---------------------|--------------------|
| ew08_line188_b.xyz  | ew08_line188_t.xyz |
| ew08_line189_b.xyz  |                    |
| ew08_line190_b.xyz  | ew08_line190_t.xyz |
| ew08_line191_b.xyz  | ew08_line191_t.xyz |
| ew08_line192_b.xyz  | ew08_line192_t.xyz |
| ew08_line193_b.xyz  | ew08_line193_t.xyz |
| ew08_line194_b.xyz  | ew08_line194_t.xyz |
| ew08_line195_b.xyz  | ew08_line195_t.xyz |
| ew08_line196_b.xyz  | ew08_line196_t.xyz |
| ew08_line197_b.xyz  | ew08_line197_t.xyz |
| ew08_line198_b.xyz  | ew08_line198_t.xyz |
| ew08_line199_b.xyz  | ew08_line199_t.xyz |
| ew08_line200_b.xyz  | ew08_line200_t.xyz |
| ew08_line201_b.xyz  | ew08_line201_t.xyz |
| ew08_line202_b.xyz  | ew08_line202_t.xyz |
| ew08_line203_b.xyz  | ew08_line203_t.xyz |
| ew08_line204_b.xyz  | ew08_line204_t.xyz |
| ew08_line205_b.xyz  | ew08_line205_t.xyz |
| ew08_line206_b.xyz  | ew08_line206_t.xyz |
| ew08_line207_b.xyz  | ew08_line207_t.xyz |
| ew08_line208_b.xyz  | ew08_line208_t.xyz |
| ew08_line209_b.xyz  | ew08_line209_t.xyz |
| ew08_line210_b.xyz  | ew08_line210_t.xyz |
| ew08_line211_b.xyz  | ew08_line211_t.xyz |
| ew08_line212_b.xyz  | ew08_line212_t.xyz |
| ew08_line213_b.xyz  | ew08_line213_t.xyz |
| ew08_line214_b.xyz  | ew08_line214_t.xyz |
| ew08_line215_b.xyz  | ew08_line215_t.xyz |
| ew08_line216_b.xyz  | ew08_line216_t.xyz |
| ew08_line217_b.xyz  | ew08_line217_t.xyz |
| ew08_line218_b.xyz  | ew08_line218_t.xyz |
| ew08_line219_b.xyz  | ew08_line219_t.xyz |
| ew08_line220_b.xyz  | ew08_line220_t.xyz |
| ew08_line221_b.xyz  | ew08_line221_t.xyz |
| ew08_line221_b2.xyz |                    |
| ew08_line222_b.xyz  | ew08_line222_t.xyz |
| ew08_line222_b2.xyz |                    |
| ew08_line223_b.xyz  | ew08_line223_t.xyz |
| ew08_line224_b.xyz  | ew08_line224_t.xyz |
| ew08_line225_b.xyz  | ew08_line225_t.xyz |
| ew08_line226_b.xyz  | ew08_line226_t.xyz |
| ew08_line227_b.xyz  | ew08_line227_t.xyz |
| ew08_line228_b.xyz  | ew08_line228_t.xyz |
| ew08_line229_b.xyz  | ew08_line229_t.xyz |
| ew08_line230_b.xyz  | ew08_line230_t.xyz |
| ew08_line231_b.xyz  | ew08_line231_t.xyz |
| ew08_line232_b.xyz  | ew08_line232_t.xyz |
| ew08_001grid_b.xyz  | ew08_001grid_t.xyz |

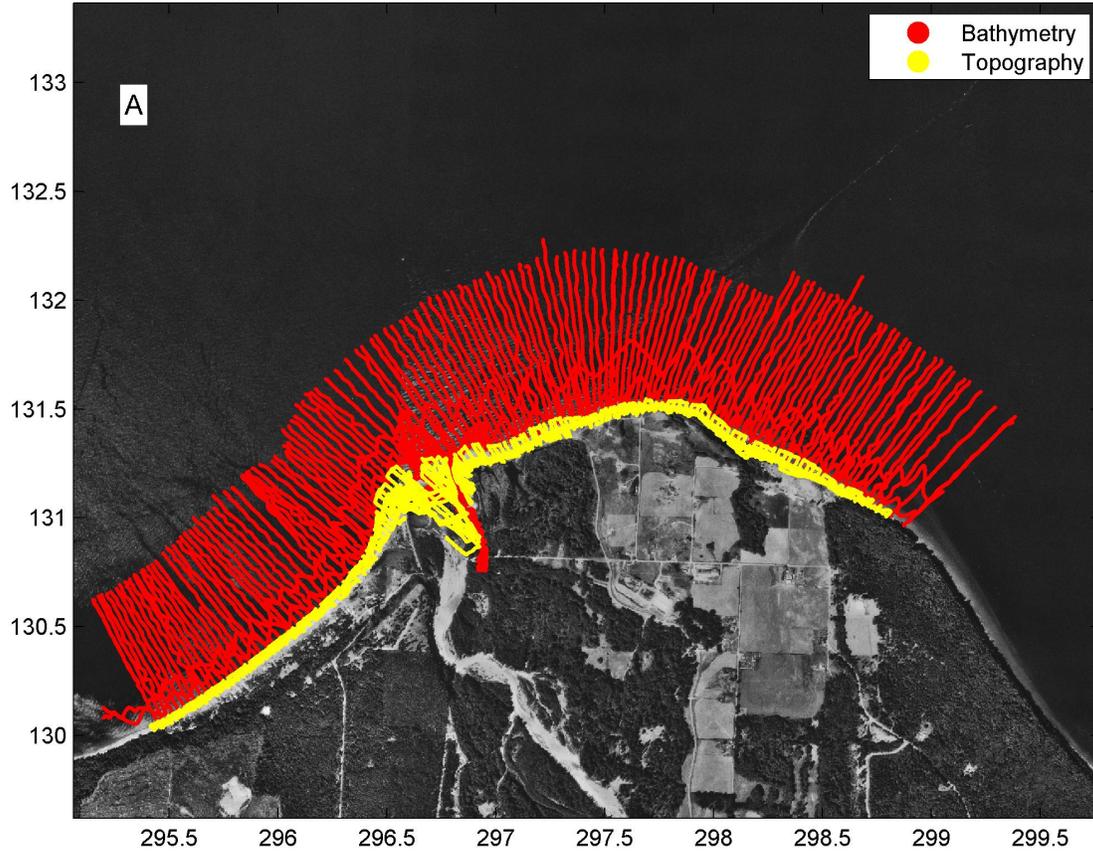
|                    |                    |
|--------------------|--------------------|
| ew08_002grid_b.xyz | ew08_002grid_t.xyz |
| ew08_003grid_b.xyz | ew08_003grid_t.xyz |
| ew08_004grid_b.xyz | ew08_004grid_t.xyz |
| ew08_005grid_b.xyz |                    |
| ew08_006grid_b.xyz |                    |
| ew08_007grid_b.xyz |                    |
| ew08_008grid_b.xyz |                    |
| ew08_009grid_b.xyz |                    |
| ew08_010grid_b.xyz |                    |
| ew08_011grid_b.xyz |                    |
| ew08_012grid_b.xyz |                    |
| ew08_013grid_b.xyz |                    |
| ew08_014grid_b.xyz |                    |
| ew08_015grid_b.xyz |                    |
| ew08_016grid_b.xyz |                    |
| ew08_017grid_b.xyz |                    |
| ew08_018grid_b.xyz |                    |
| ew08_019grid_b.xyz |                    |
| ew08_020grid_b.xyz |                    |
| ew08_021grid_b.xyz |                    |
| ew08_022grid_b.xyz |                    |
| ew08_023grid_b.xyz |                    |
| ew08_024grid_b.xyz |                    |
| ew08_025grid_b.xyz |                    |
| ew08_026grid_b.xyz |                    |
| ew08_027grid_b.xyz |                    |

## Appendix J – September 2009 Field Collection

In September 2009, data collection focused on the river mouth and adjacent delta. On 15-17 September, 186 bathymetric profiles and 148 topographic profiles between line numbers 93 to the west and 234 to the east (fig. J1-J2). Bathymetric and topographic lines collected during the September 2009 survey (USGS Field Activity W-2-09-PS) are enumerated in table J. Metadata for this field activity are available at: <http://walrus.wr.usgs.gov/infobank/w/w209ps/html/w-2-09-ps.meta.html>.



**Figure J1.** Elwha September 2009 surveyed lines.



**Figure J2.** Elwha September 2009 surveyed lines (delta region).

**Table J.** Bathymetric and topographic lines for the September 2009 survey.

| Bathymetric Line    | Topographic Line   |
|---------------------|--------------------|
|                     | ew09_line093_t.xyz |
|                     | ew09_line095_t.xyz |
| ew09_line096_b.xyz  | ew09_line096_t.xyz |
| ew09_line096_b2.xyz |                    |
| ew09_line097_b.xyz  | ew09_line097_t.xyz |
| ew09_line098_b.xyz  | ew09_line098_t.xyz |
| ew09_line099_b.xyz  | ew09_line099_t.xyz |
| ew09_line100_b.xyz  | ew09_line100_t.xyz |
| ew09_line101_b.xyz  | ew09_line101_t.xyz |
| ew09_line102_b.xyz  | ew09_line102_t.xyz |
| ew09_line103_b.xyz  | ew09_line103_t.xyz |
| ew09_line104_b.xyz  |                    |
| ew09_line105_b.xyz  | ew09_line105_t.xyz |

|                     |                    |
|---------------------|--------------------|
| ew09_line106_b.xyz  | ew09_line106_t.xyz |
| ew09_line107_b.xyz  | ew09_line107_t.xyz |
| ew09_line108_b.xyz  | ew09_line108_t.xyz |
| ew09_line108_b2.xyz |                    |
| ew09_line109_b.xyz  | ew09_line109_t.xyz |
| ew09_line110_b.xyz  | ew09_line110_t.xyz |
| ew09_line111_b.xyz  | ew09_line111_t.xyz |
| ew09_line112_b.xyz  | ew09_line112_t.xyz |
| ew09_line113_b.xyz  | ew09_line113_t.xyz |
| ew09_line114_b.xyz  | ew09_line114_t.xyz |
| ew09_line115_b.xyz  | ew09_line115_t.xyz |
| ew09_line116_b.xyz  | ew09_line116_t.xyz |
| ew09_line117_b.xyz  | ew09_line117_t.xyz |
| ew09_line118_b.xyz  | ew09_line118_t.xyz |
| ew09_line119_b.xyz  | ew09_line119_t.xyz |
| ew09_line120_b.xyz  | ew09_line120_t.xyz |
| ew09_line121_b.xyz  | ew09_line121_t.xyz |
| ew09_line122_b.xyz  | ew09_line122_t.xyz |
| ew09_line123_b.xyz  | ew09_line123_t.xyz |
| ew09_line124_b.xyz  | ew09_line124_t.xyz |
| ew09_line125_b.xyz  | ew09_line125_t.xyz |
| ew09_line126_b.xyz  | ew09_line126_t.xyz |
| ew09_line127_b.xyz  | ew09_line127_t.xyz |
| ew09_line128_b.xyz  | ew09_line128_t.xyz |
| ew09_line129_b.xyz  | ew09_line129_t.xyz |
| ew09_line130_b.xyz  | ew09_line130_t.xyz |
| ew09_line131_b.xyz  | ew09_line131_t.xyz |
| ew09_line132_b.xyz  | ew09_line132_t.xyz |
| ew09_line133_b.xyz  | ew09_line133_t.xyz |
| ew09_line133_b2.xyz |                    |
| ew09_line134_b.xyz  | ew09_line134_t.xyz |
| ew09_line135_b.xyz  | ew09_line135_t.xyz |
| ew09_line136_b.xyz  | ew09_line136_t.xyz |
| ew09_line137_b.xyz  | ew09_line137_t.xyz |
| ew09_line138_b.xyz  | ew09_line138_t.xyz |
| ew09_line139_b.xyz  | ew09_line139_t.xyz |
| ew09_line140_b.xyz  | ew09_line140_t.xyz |
| ew09_line141_b.xyz  | ew09_line141_t.xyz |
| ew09_line142_b.xyz  | ew09_line142_t.xyz |
| ew09_line143_b.xyz  | ew09_line143_t.xyz |
| ew09_line144_b.xyz  | ew09_line144_t.xyz |
| ew09_line145_b.xyz  | ew09_line145_t.xyz |
| ew09_line146_b.xyz  | ew09_line146_t.xyz |
| ew09_line147_b.xyz  | ew09_line147_t.xyz |
| ew09_line148_b.xyz  | ew09_line148_t.xyz |
| ew09_line149_b.xyz  | ew09_line149_t.xyz |
| ew09_line150_b.xyz  | ew09_line150_t.xyz |
| ew09_line151_b.xyz  | ew09_line151_t.xyz |

|                     |                     |
|---------------------|---------------------|
| ew09_line152_b.xyz  | ew09_line152_t.xyz  |
| ew09_line153_b.xyz  | ew09_line153_t.xyz  |
|                     | ew09_line153_t2.xyz |
| ew09_line154_b.xyz  | ew09_line154_t.xyz  |
| ew09_line154_b2.xyz | ew09_line154_t2.xyz |
| ew09_line155_b.xyz  | ew09_line155_t.xyz  |
|                     | ew09_line155_t2.xyz |
| ew09_line156_b.xyz  | ew09_line156_t.xyz  |
|                     | ew09_line156_t2.xyz |
| ew09_line157_b.xyz  | ew09_line157_t.xyz  |
|                     | ew09_line157_t2.xyz |
| ew09_line158_b.xyz  | ew09_line158_t.xyz  |
|                     | ew09_line158_t2.xyz |
| ew09_line159_b.xyz  | ew09_line159_t.xyz  |
| ew09_line160_b.xyz  | ew09_line160_t.xyz  |
| ew09_line160_b2.xyz |                     |
| ew09_line161_b.xyz  | ew09_line161_t.xyz  |
| ew09_line162_b.xyz  | ew09_line162_t.xyz  |
| ew09_line163_b.xyz  | ew09_line163_t.xyz  |
| ew09_line164_b.xyz  | ew09_line164_t.xyz  |
| ew09_line165_b.xyz  | ew09_line165_t.xyz  |
| ew09_line166_b.xyz  | ew09_line166_t.xyz  |
| ew09_line167_b.xyz  | ew09_line167_t.xyz  |
| ew09_line168_b.xyz  | ew09_line168_t.xyz  |
| ew09_line169_b.xyz  | ew09_line169_t.xyz  |
| ew09_line170_b.xyz  | ew09_line170_t.xyz  |
| ew09_line171_b.xyz  | ew09_line171_t.xyz  |
| ew09_line172_b.xyz  | ew09_line172_t.xyz  |
| ew09_line173_b.xyz  | ew09_line173_t.xyz  |
| ew09_line174_b.xyz  | ew09_line174_t.xyz  |
| ew09_line175_b.xyz  | ew09_line175_t.xyz  |
| ew09_line176_b.xyz  |                     |
| ew09_line177_b.xyz  | ew09_line177_t.xyz  |
| ew09_line178_b.xyz  | ew09_line178_t.xyz  |
| ew09_line179_b.xyz  | ew09_line179_t.xyz  |
| ew09_line180_b.xyz  | ew09_line180_t.xyz  |
| ew09_line181_b.xyz  | ew09_line181_t.xyz  |
| ew09_line182_b.xyz  | ew09_line182_t.xyz  |
| ew09_line183_b.xyz  | ew09_line183_t.xyz  |
| ew09_line184_b.xyz  | ew09_line184_t.xyz  |
| ew09_line184_b2.xyz |                     |
| ew09_line184_b3.xyz |                     |
| ew09_line185_b.xyz  | ew09_line185_t.xyz  |
| ew09_line186_b.xyz  | ew09_line186_t.xyz  |
| ew09_line187_b.xyz  | ew09_line187_t.xyz  |
| ew09_line188_b.xyz  | ew09_line188_t.xyz  |
| ew09_line189_b.xyz  | ew09_line189_t.xyz  |
| ew09_line190_b.xyz  | ew09_line190_t.xyz  |

|                     |                    |
|---------------------|--------------------|
| ew09_line191_b.xyz  | ew09_line191_t.xyz |
| ew09_line192_b.xyz  | ew09_line192_t.xyz |
| ew09_line193_b.xyz  | ew09_line193_t.xyz |
| ew09_line194_b.xyz  | ew09_line194_t.xyz |
| ew09_line195_b.xyz  | ew09_line195_t.xyz |
| ew09_line196_b.xyz  | ew09_line196_t.xyz |
| ew09_line197_b.xyz  | ew09_line197_t.xyz |
| ew09_line198_b.xyz  | ew09_line198_t.xyz |
| ew09_line199_b.xyz  | ew09_line199_t.xyz |
| ew09_line200_b.xyz  | ew09_line200_t.xyz |
| ew09_line201_b.xyz  | ew09_line201_t.xyz |
| ew09_line202_b.xyz  | ew09_line202_t.xyz |
| ew09_line203_b.xyz  | ew09_line203_t.xyz |
| ew09_line204_b.xyz  | ew09_line204_t.xyz |
| ew09_line205_b.xyz  | ew09_line205_t.xyz |
| ew09_line206_b.xyz  | ew09_line206_t.xyz |
| ew09_line207_b.xyz  | ew09_line207_t.xyz |
| ew09_line208_b.xyz  | ew09_line208_t.xyz |
| ew09_line209_b.xyz  | ew09_line209_t.xyz |
| ew09_line210_b.xyz  |                    |
| ew09_line211_b.xyz  | ew09_line211_t.xyz |
| ew09_line212_b.xyz  | ew09_line212_t.xyz |
| ew09_line213_b.xyz  | ew09_line213_t.xyz |
| ew09_line214_b.xyz  | ew09_line214_t.xyz |
| ew09_line215_b.xyz  | ew09_line215_t.xyz |
| ew09_line216_b.xyz  | ew09_line216_t.xyz |
| ew09_line217_b.xyz  | ew09_line217_t.xyz |
| ew09_line218_b.xyz  | ew09_line218_t.xyz |
| ew09_line219_b.xyz  | ew09_line219_t.xyz |
| ew09_line220_b.xyz  | ew09_line220_t.xyz |
| ew09_line221_b.xyz  | ew09_line221_t.xyz |
| ew09_line222_b.xyz  | ew09_line222_t.xyz |
| ew09_line223_b.xyz  | ew09_line223_t.xyz |
| ew09_line224_b.xyz  | ew09_line224_t.xyz |
| ew09_line225_b.xyz  | ew09_line225_t.xyz |
| ew09_line226_b.xyz  | ew09_line226_t.xyz |
| ew09_line227_b.xyz  | ew09_line227_t.xyz |
| ew09_line228_b.xyz  | ew09_line228_t.xyz |
| ew09_line229_b.xyz  | ew09_line229_t.xyz |
| ew09_line230_b.xyz  | ew09_line230_t.xyz |
| ew09_line231_b.xyz  | ew09_line231_t.xyz |
| ew09_line232_b.xyz  | ew09_line232_t.xyz |
| ew09_line233_b.xyz  |                    |
| ew09_line234_b.xyz  |                    |
| ew09_line234_b2.xyz |                    |
| ew09_001grid_b.xyz  | ew09_001grid_t.xyz |
| ew09_002grid_b.xyz  | ew09_002grid_t.xyz |
| ew09_003grid_b.xyz  | ew09_003grid_t.xyz |

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| ew09_004grid_b.xyz | ew09_004grid_t.xyz |
| ew09_005grid_b.xyz | ew09_005grid_t.xyz |
| ew09_006grid_b.xyz | ew09_006grid_t.xyz |
| ew09_007grid_b.xyz |                    |
| ew09_008grid_b.xyz |                    |
| ew09_009grid_b.xyz |                    |
| ew09_010grid_b.xyz |                    |
| ew09_011grid_b.xyz |                    |
| ew09_012grid_b.xyz |                    |
| ew09_013grid_b.xyz |                    |
| ew09_014grid_b.xyz |                    |
| ew09_015grid_b.xyz |                    |
| ew09_016grid_b.xyz |                    |
| ew09_017grid_b.xyz |                    |
| ew09_018grid_b.xyz |                    |
| ew09_019grid_b.xyz |                    |
| ew09_020grid_b.xyz |                    |
| ew09_021grid_b.xyz |                    |
| ew09_022grid_b.xyz |                    |
| ew09_023grid_b.xyz |                    |
| ew09_024grid_b.xyz |                    |
| ew09_025grid_b.xyz |                    |
| ew09_026grid_b.xyz |                    |
| ew09_027grid_b.xyz |                    |
| ew09_028grid_b.xyz |                    |
| ew09_029grid_b.xyz |                    |
| ew09_030grid_b.xyz |                    |
| ew09_031grid_b.xyz |                    |
| ew09_032grid_b.xyz |                    |
| ew09_033grid_b.xyz |                    |
| ew09_034grid_b.xyz |                    |
| ew09_035grid_b.xyz |                    |
| ew09_036grid_b.xyz |                    |
| ew09_037grid_b.xyz |                    |
| ew09_038grid_b.xyz |                    |
| ew09_039grid_b.xyz |                    |