Elwha River Restoration Project: The Dynamics and Downstream Impacts of Fine Sediments Released after Dam Removal

Status of Study on Sept. 30, 2011

Prepared Dec. 6, 2011, by

Chris Magirl, Jeff Duda, Jon Warrick

U.S. Geological Survey

and Matt Beirne

Lower Elwha Klallam Tribe

http://www.usgs.gov/elwha

STUDY TASKS

1. Determine suspended sediment discharge from the Elwha River
2. Determine rate of sediment accretion in the Elwha River estuary
3. Determine fate of fine sediments near the Elwha River mouth and marine nearshore zone
4. Document benthic marine nearshore habitats and biological communities

TASK 1: Determine suspended sediment discharge from the Elwha River

(Investigator: Chris Magirl; magirl@usgs.gov)

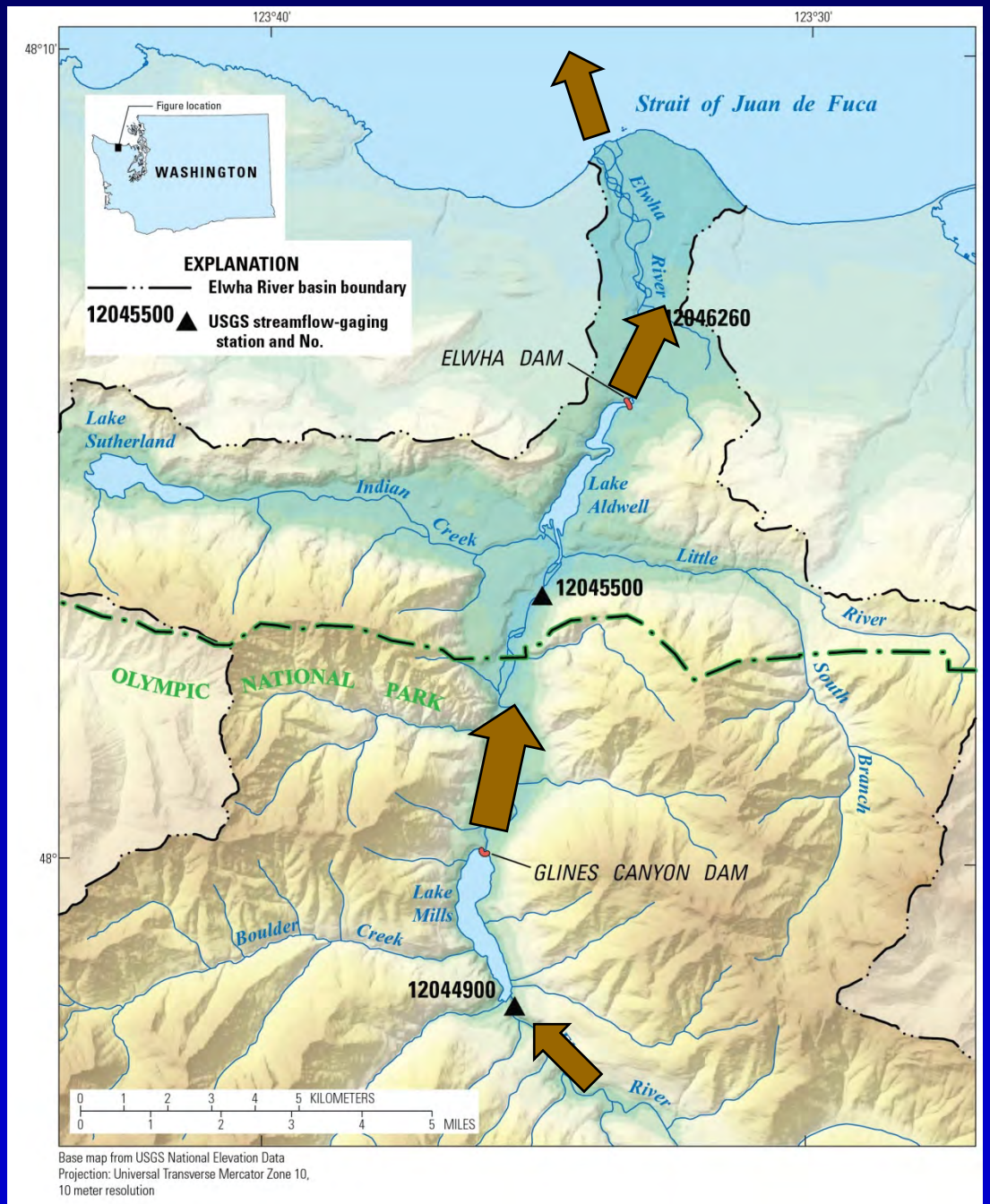
Accomplished:

Instrument installation

Ongoing:

Instrument operation and maintenance; quality assurance of data and entry in USGS National Water Information System (NWIS)

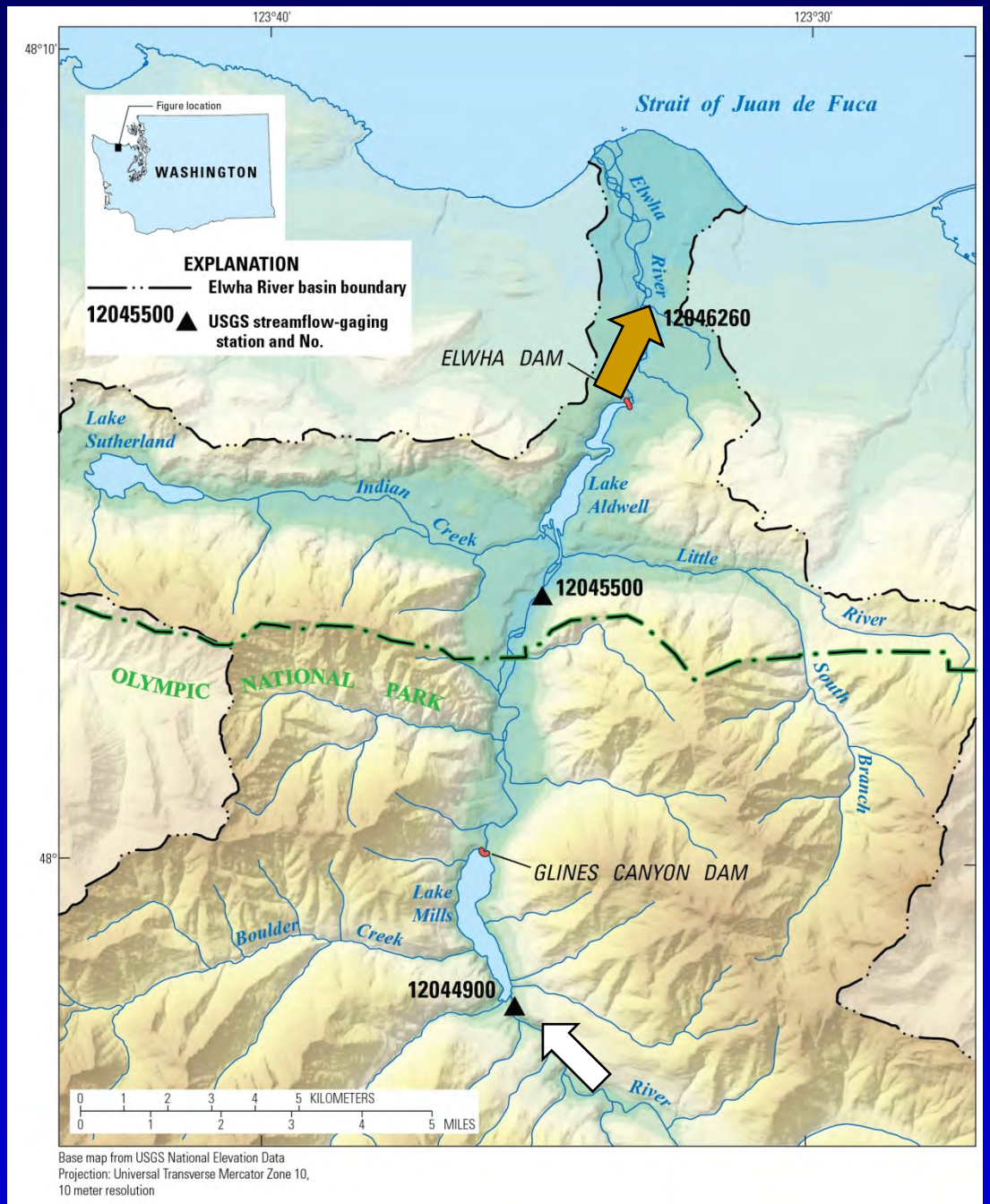
USGS
science for a changing world



IDEAL STRATEGY:

Determine sediment budget by measuring <u>suspended load</u> and <u>bedload</u> continuously for 10 years

USGS
science for a changing world



USGS ACTIVITY:

Estimating <u>suspended-sediment load continuously for 2 years</u> using turbidity*, hydroacoustic, and LISST instruments, all proxy technologies for suspended-sediment concentration

*Turbidity measurements funded by National Park Service

USGS
science for a changing world

USGS
science for a changing world

Hydroacoustic Instrument Installation

USGS
science for a changing world

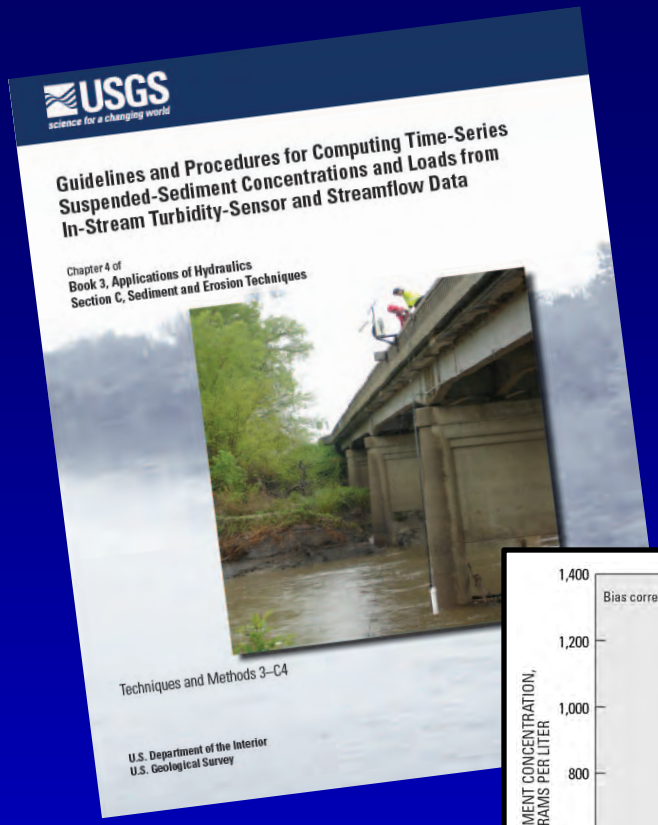
Sediment-Gage Installation

Sediment Monitoring

USGS station no. 12046260

DTS-12; Turbidity (NPS funded)

USGS
science for a changing world



Surrogate Sediment Technologies Used to Estimate Sediment Load:

* Turbidity (NPS funded)
* Hydroacoustics
* LISST

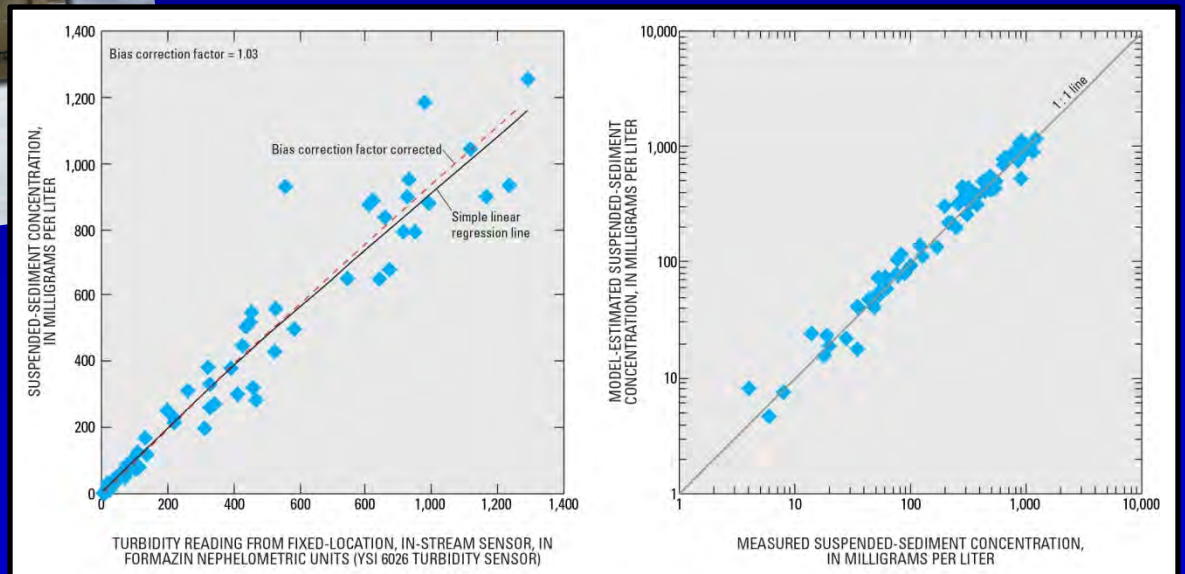


Figure 12. Comparison of turbidity and suspended-sediment concentration model-calibration data and uncorrected and bias-corrected simple linear regression lines for U.S. Geological Survey streamgage on Little Arkansas River near Sedgwick, Kansas, 1999–2005.

Figure 13. Comparison of measured and model-estimated suspended-sediment concentrations for U.S. Geological Survey streamgage on Little Arkansas River near Sedgwick, Kansas, 1999–2005.

USGS
science for a changing world

Bike path from where suspended-sediment samples are collected
USGS
science for a changing world

Sampling Suspended Sediment

USGS
science for a changing world

Measuring water velocity and discharge at the sediment sampling site
USGS
science for a changing world

Measuring Sediment Transport during Floods:

one of the bigger project challenges

USGS
science for a changing world

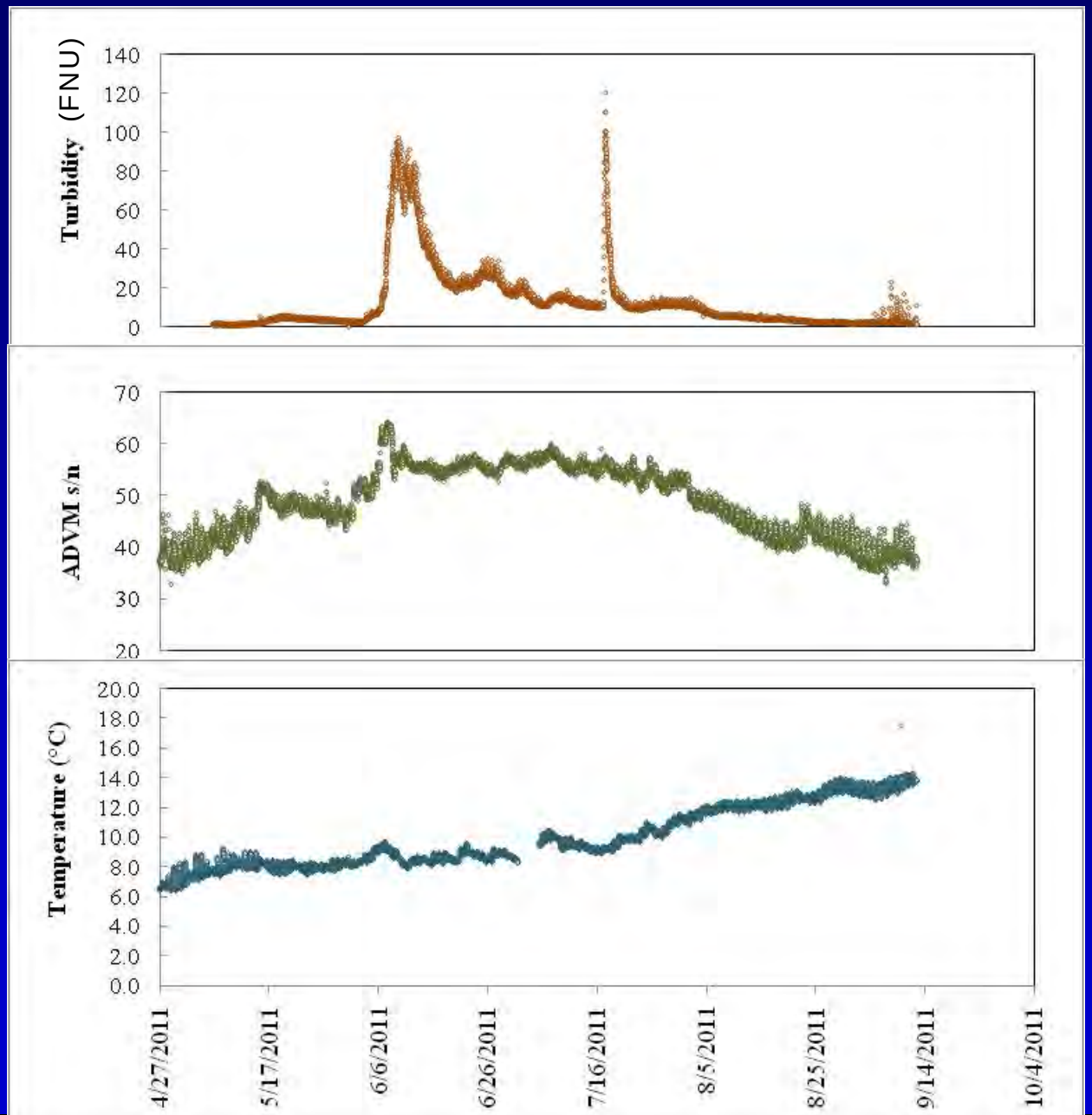
Data Collected at Multiple Elwha River USGS Stations

Preliminary , Subject to Revision

Turbidity at Diversion Weir (station no. 12046260)

ADVM s/n ratio at Diversion Weir (station no. 12046260)

Water temperature at Diversion Weir (station no. 12046260)

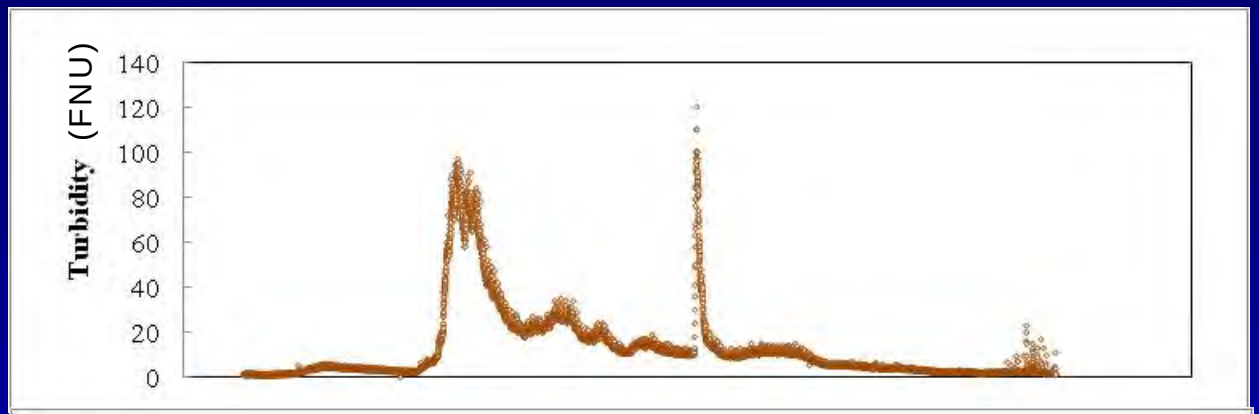


USGS
science for a changing world

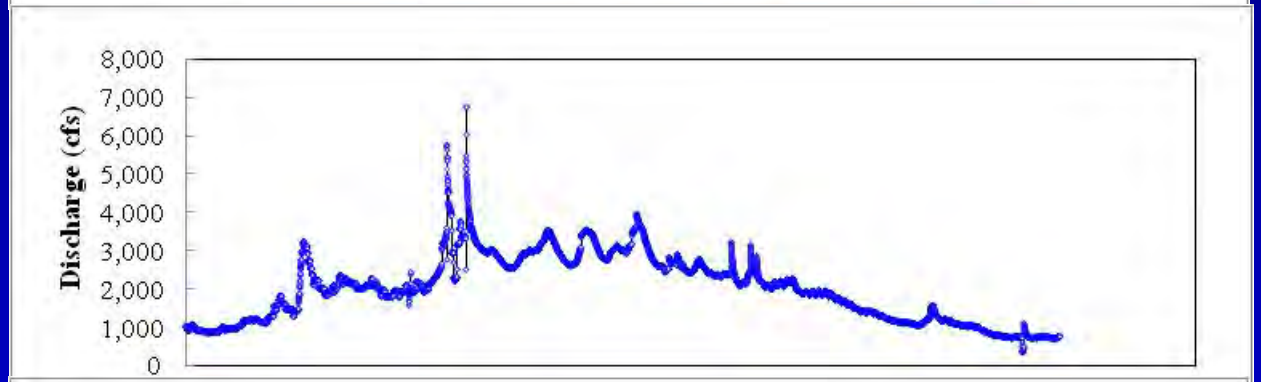
Data Collected at Multiple Elwha River USGS Stations, cont'd

Preliminary , Subject to Revision

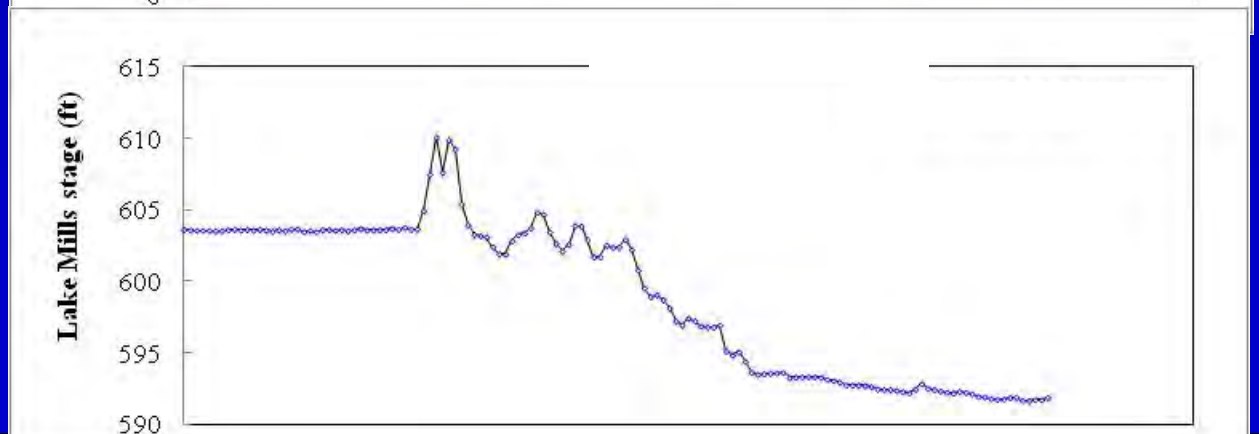
Turbidity at Diversion Weir (station no. 12046260)



Discharge at McDonald Bridge (station no. 12045500)



Stage at Lake Mills (Data from Bureau of Reclamation)

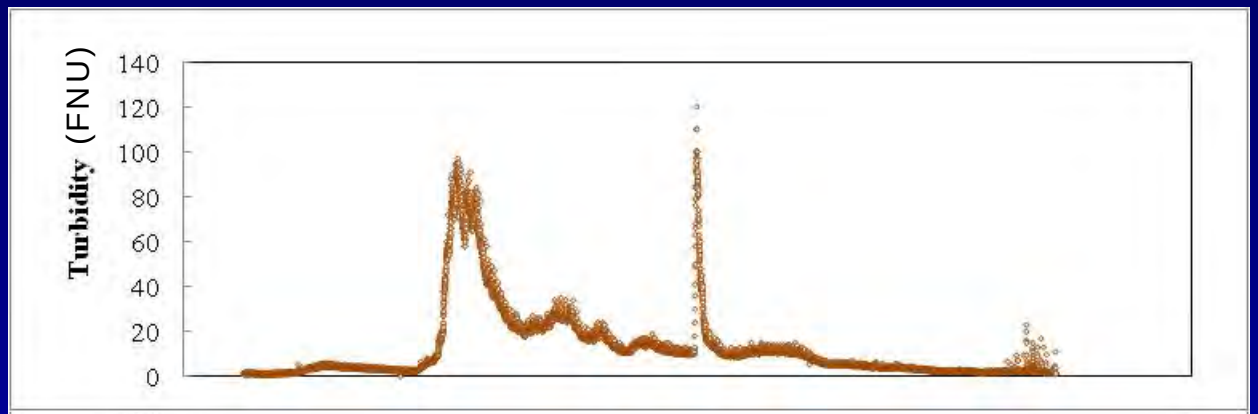


USGS
science for a changing world

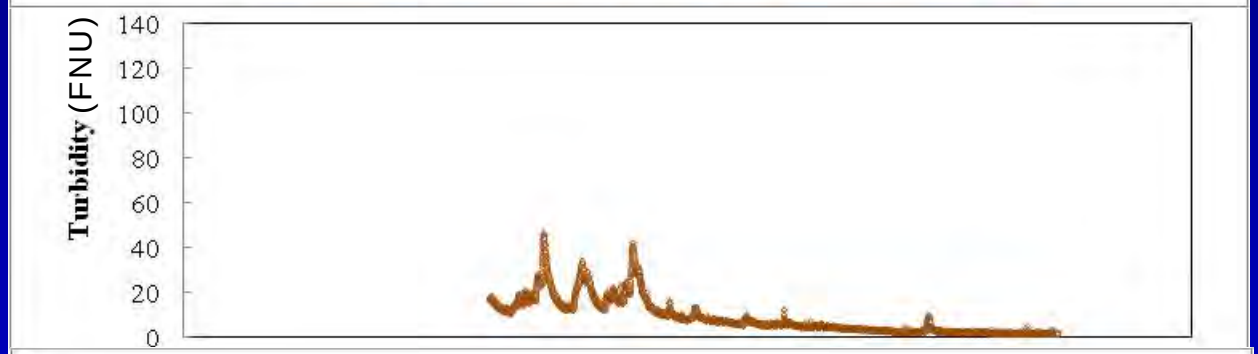
Data Collected at Multiple Elwha River USGS Stations, cont'd

Preliminary , Subject to Revision

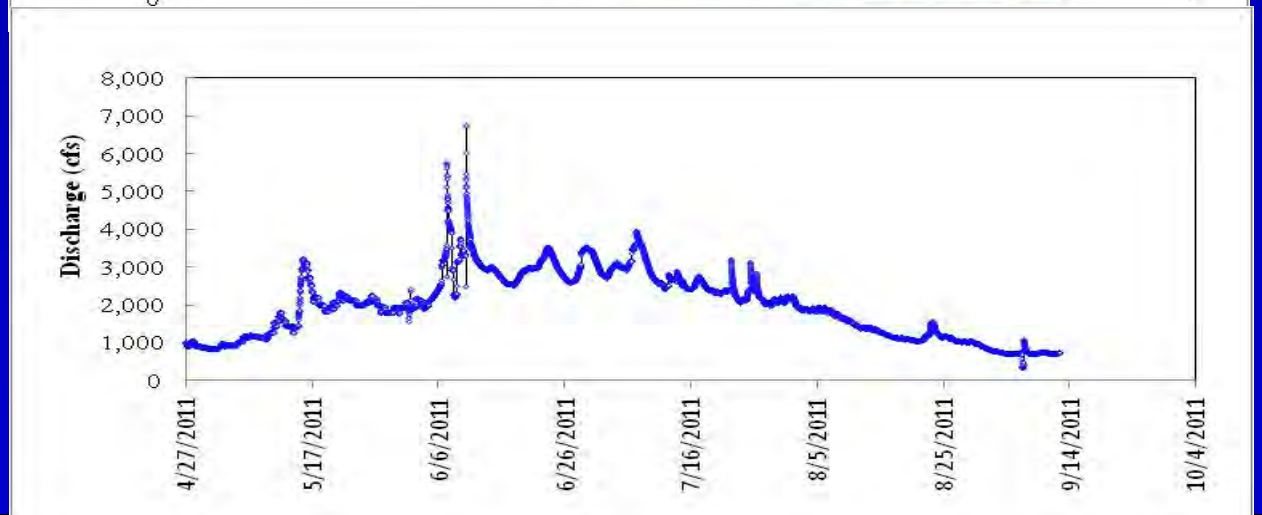
Turbidity at Diversion Weir (station no. 12046260)



Turbidity at Lake Mills (station no. 12044900)



Discharge at McDonald Bridge (station no. 12045500)

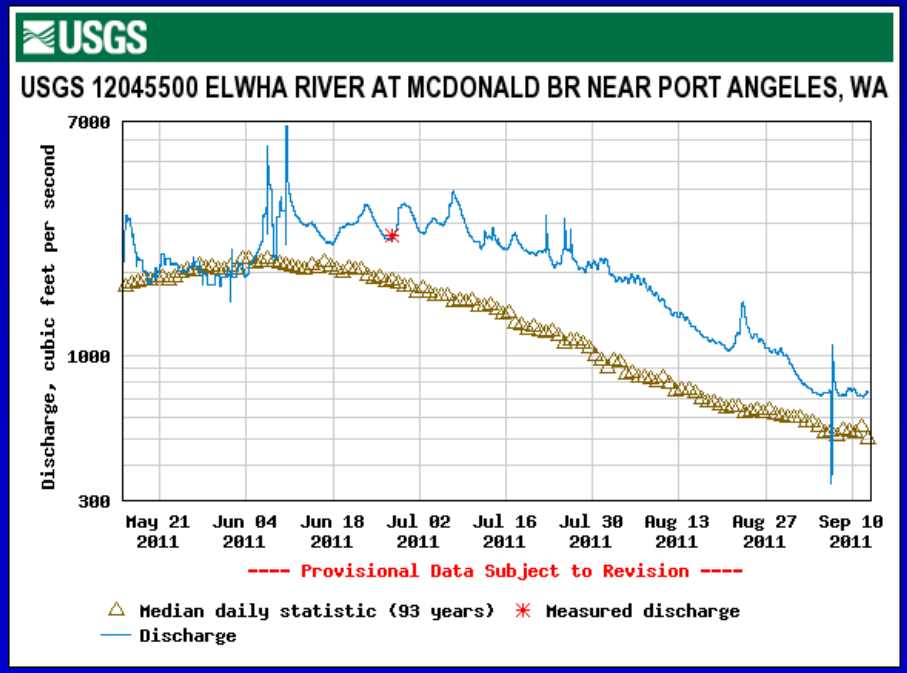


USGS
science for a changing world

Real-time data from all Elwha River USGS gaging stations and Webcam feeds at the Diversion Weir are online

For Webcam, see http://wa.water.usgs.gov/projects/elwhasediment/webcams.htm

For gaging stations, see http://waterdata.usgs.gov/usa/nwis/uv?site_no=12044900 or 12045500 or 12046260



USGS
science for a changing world

TASK 2: Determine rate of sediment accretion in the Elwha River estuary

(Investigator: Matt Beirne; matt.beirne@elwha.nsn.us)

<u>Accomplished:</u>
Instrument installation

<u>Ongoing:</u>
Instrument operation and maintenance

USGS
science for a changing world

Fine Sediment Monitoring in the Elwha River Estuary

USGS
science for a changing world

ELWHA KLALLAM TRIBE

SURFACE ELEVATION TABLES (SETs)

Installed 15 SETs throughout the Elwha River estuary in September 2011. Sampling Protocol:

- Sediment elevations at each SET site are measured every two months over a period of 10 years to monitor the effects of sediment release following the removal of the Elwha River Dams
- The SET apparatus is placed on each SET monument and nine fiberglass pins are placed through the SET arm to the ground surface. Measurements are taken in the four cardinal directions

USGS
science for a changing world

INSTALLING SETs

USGS
science for a changing world

ELWHA KLALLAM TRIBE

SET LOCATIONS

SET MEASUREMENT

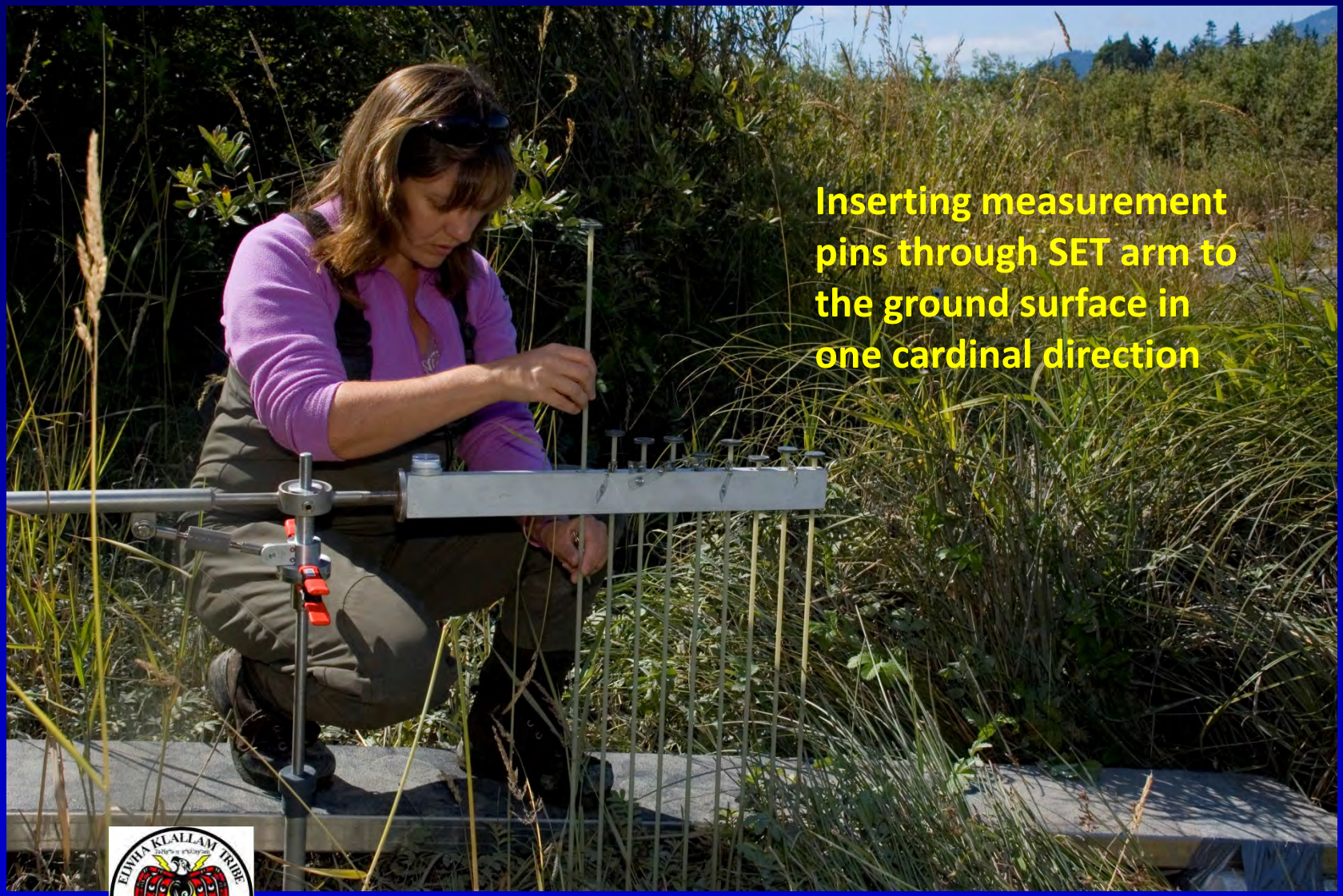


Photo by Tiffany Royal, Northwest Indian Fisheries Commission

USGS
science for a changing world

ELWHA KLALLAM TRIBE

SET MEASUREMENT, cont'd

Measuring height of pins above SET arm. This height is expected to increase as sediment deposition occurs over time

Photo by Tiffany Royal, Northwest Indian Fisheries Commission

USGS
science for a changing world

ELWHA KLALLAM TRIBE

WORK COMPLETED

Installed ISCO Automated Surface-Water Collection Sampler:

- Carousel of 24 sample bottles
- Programmable for two recurring sampling events
- Samples will be analyzed for total sediment concentration
- Protocol involves daily sample collection and event-based (e.g., floods) sampling

USGS
science for a changing world

ELWHA KLALLAM TRIBE

ISCO Automated Surface-Water Sampler

WORK COMPLETED, cont'd

Installed two YSI 600 OMS multi-parameter instruments (a 3rd was already in place)

- Two sensors are located on the east side of the Elwha River estuary, and one on the west side
- Sensors measure temperature, salinity, conductivity, turbidity, and depth

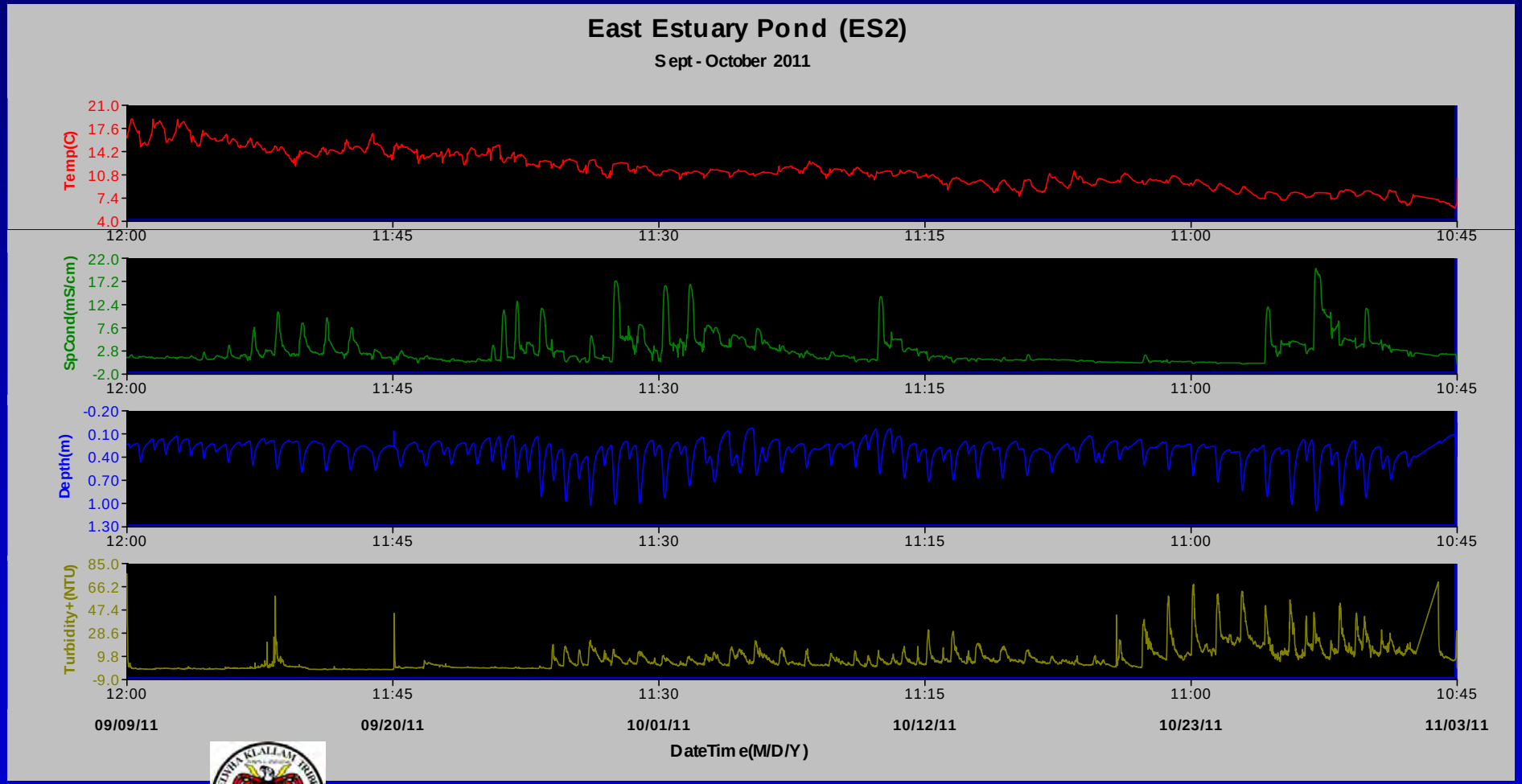
ELWHA KLALLAM TRIBE

USGS
science for a changing world

YSI CTD* Sensor, Data Sample

Preliminary , Subject to Revision

*Conductivity, Temperature, Depth



TASK 3: Determine fate of fine sediments near the Elwha River mouth and marine nearshore zone

(Investigator: Jon Warrick; jwarrick@usgs.gov)

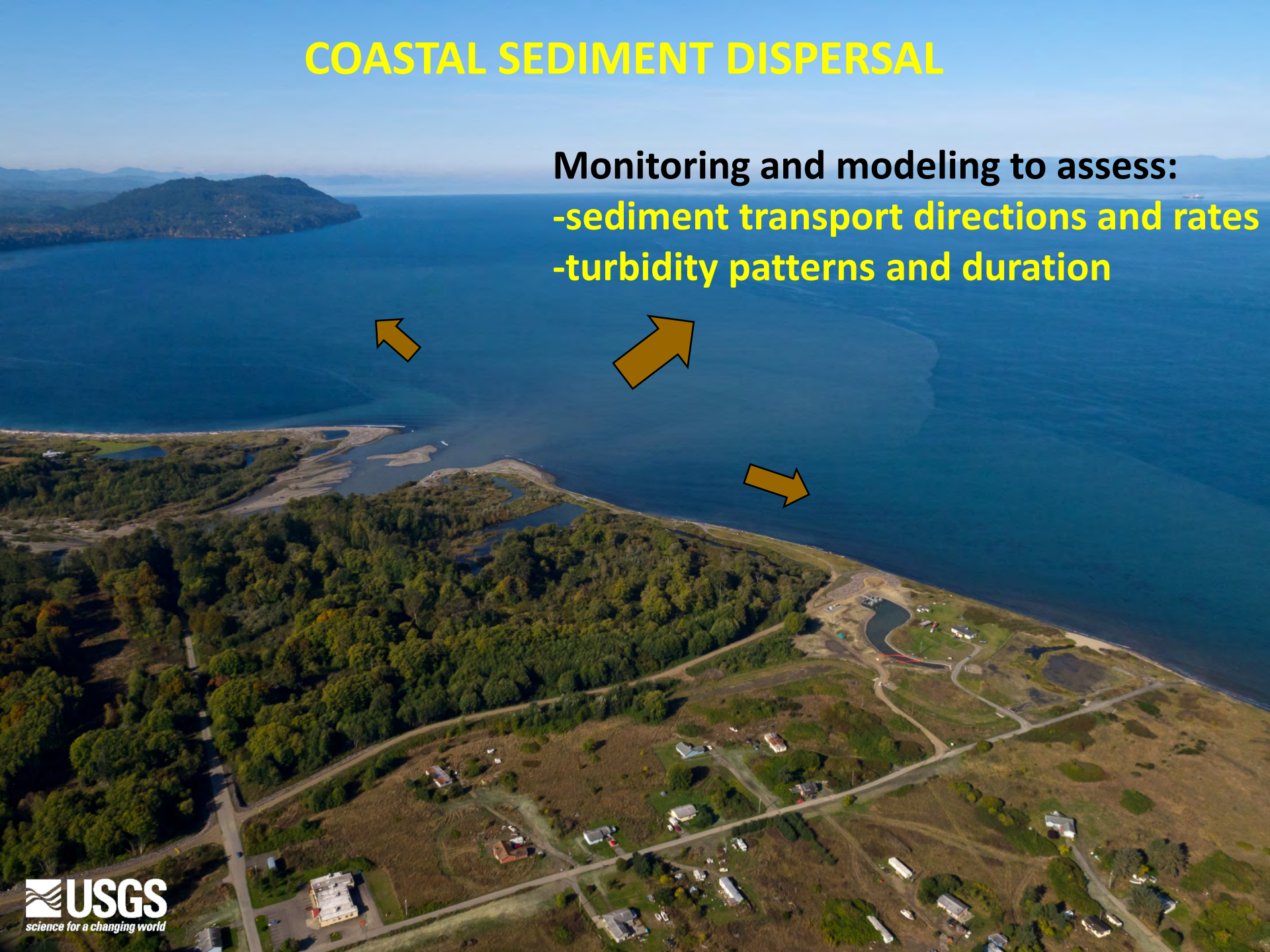
Accomplished:

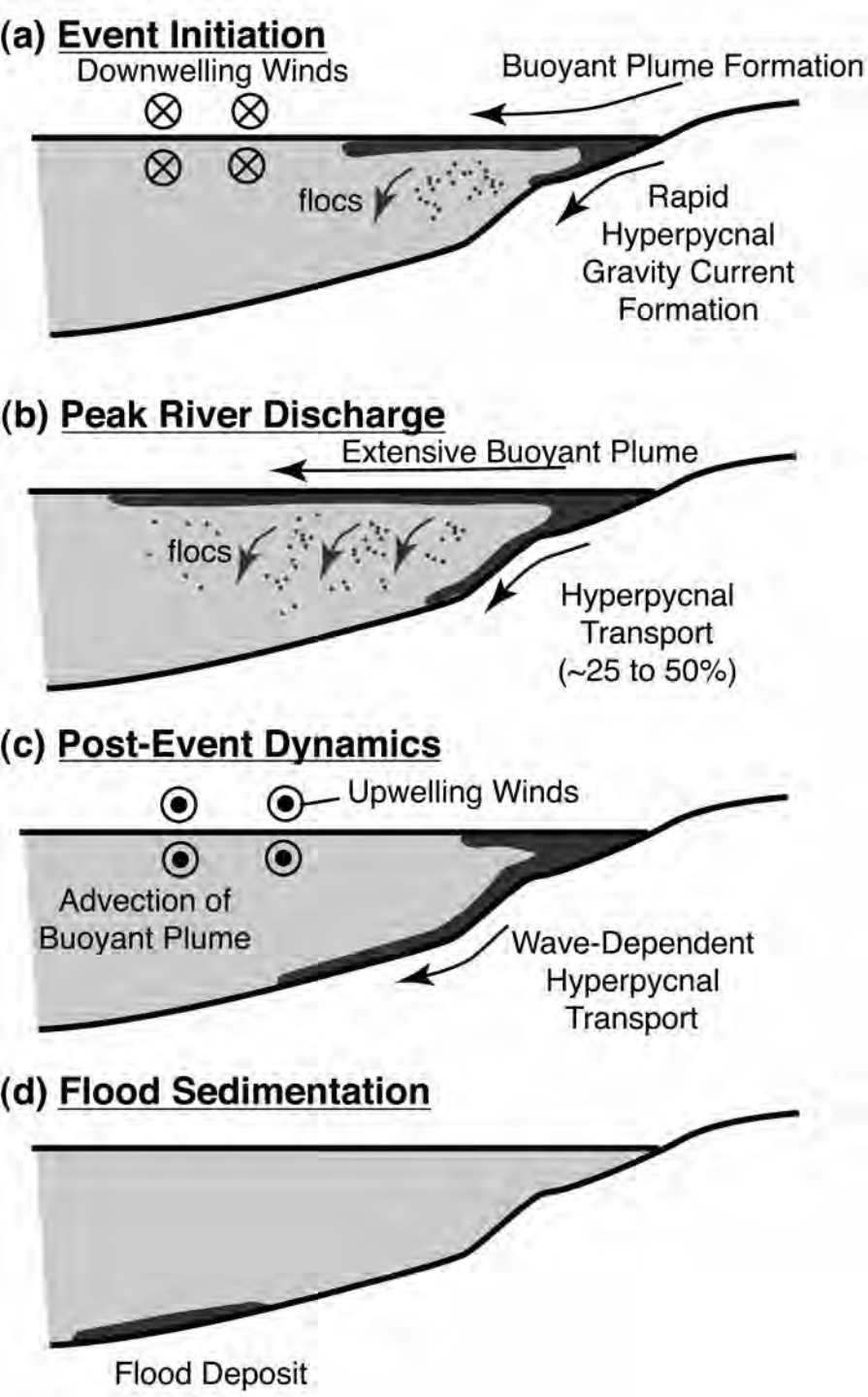
Instrument installation

Ongoing:

Instrument operation and maintenance; development of numerical model of off-shore sediment transport

COASTAL SEDIMENT DISPERSAL





COASTAL SEDIMENT DISPERSAL, cont'd

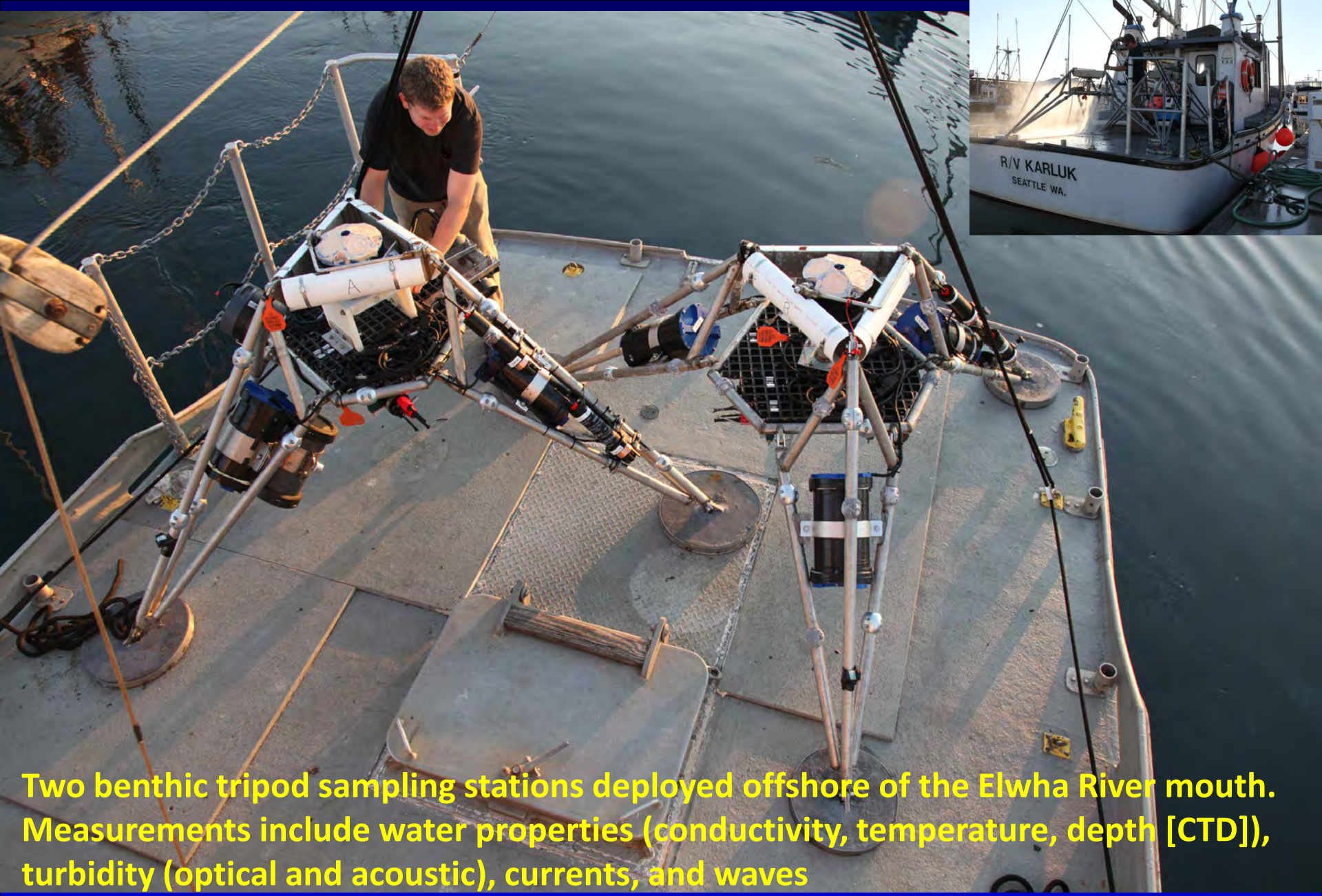
Turbidity and sediment transport are expected in both:

- **buoyant plume**
- **hyperpycnal plume along seafloor**

Thus, sampling needs to be focused in both surface and bottom waters offshore of the Elwha River

Warrick et al. (2008) Continental Shelf Research

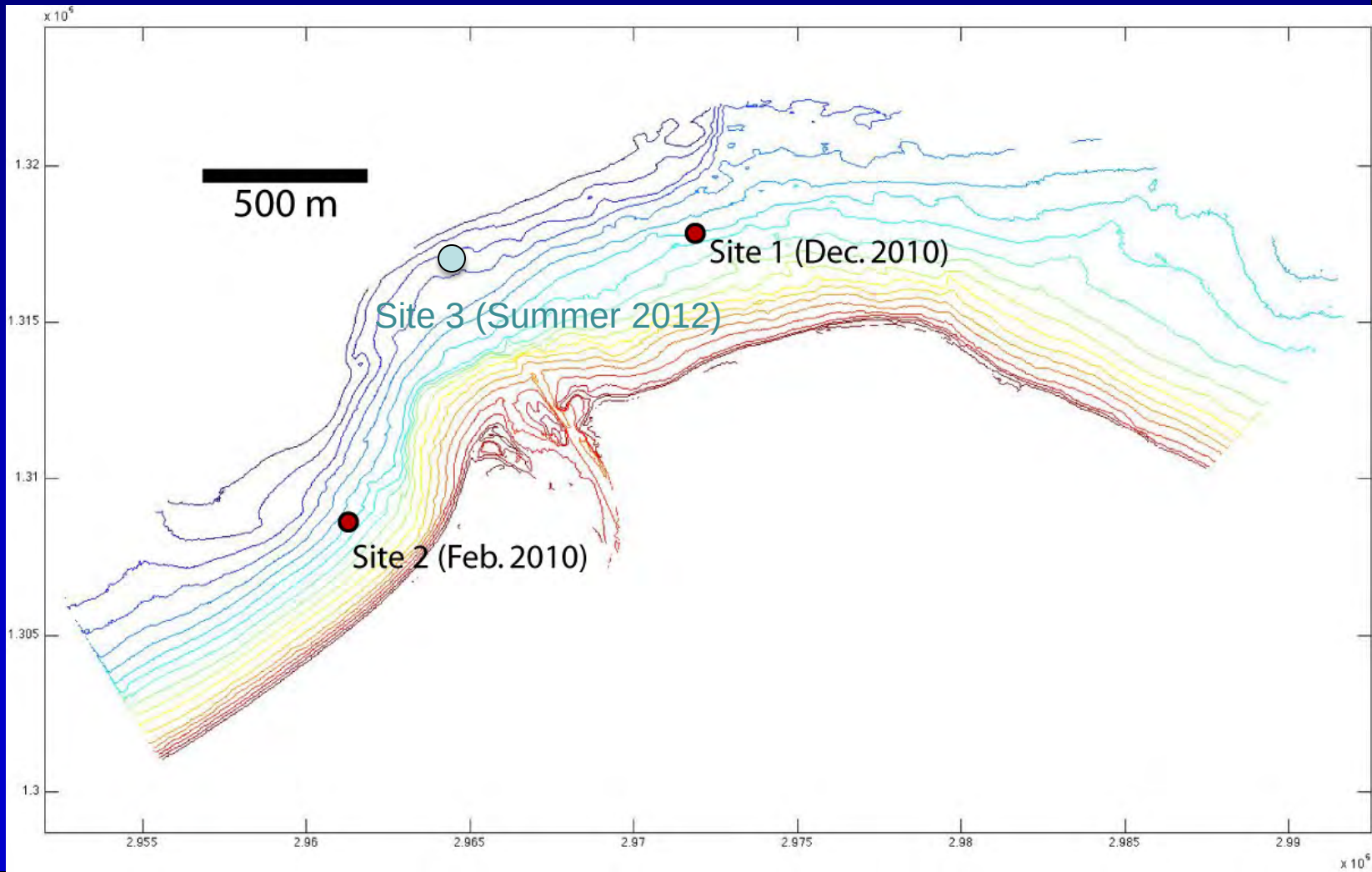
USGS science for a changing world



Two benthic tripod sampling stations deployed offshore of the Elwha River mouth. Measurements include water properties (conductivity, temperature, depth [CTD]), turbidity (optical and acoustic), currents, and waves

Locations and installation dates of two benthic tripod stations deployed offshore of the Elwha River mouth

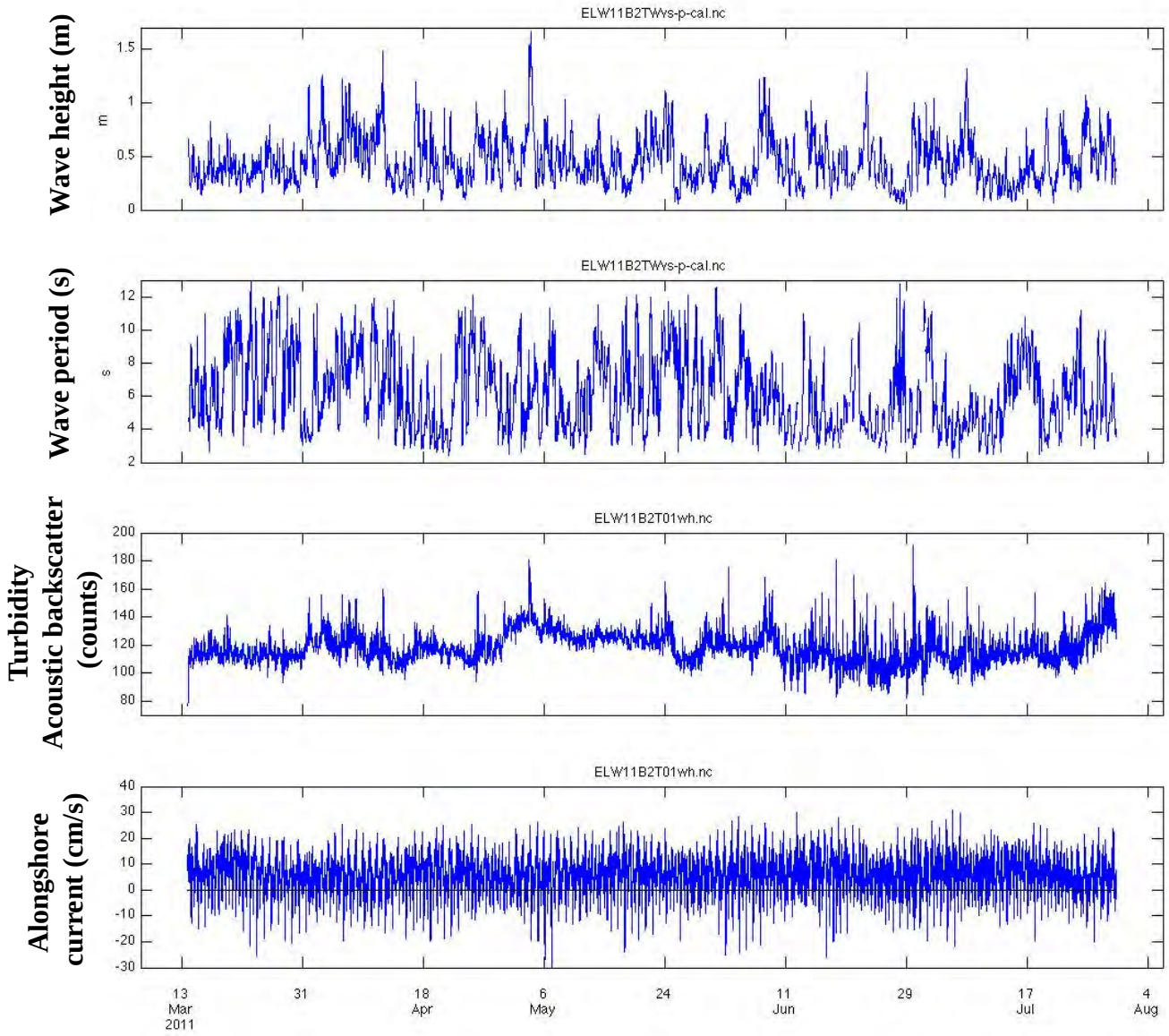
A final and third station will be installed at the location with the blue symbol



USGS
science for a changing world

EXAMPLE TRIPOD ADCP DATA

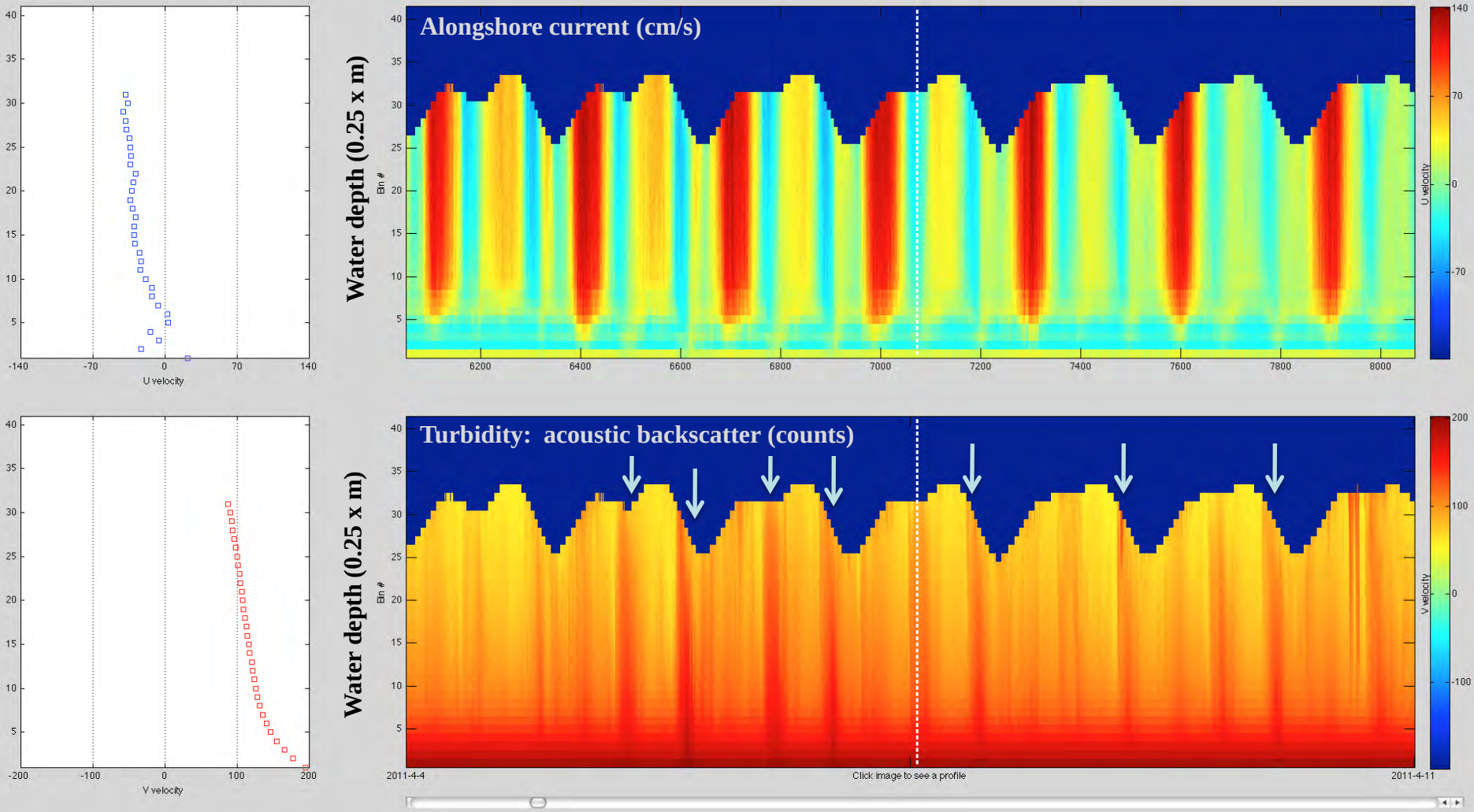
Preliminary , Subject to Revision



USGS
science for a changing world

EXAMPLE TRIPOD ADCP DATA, cont'd

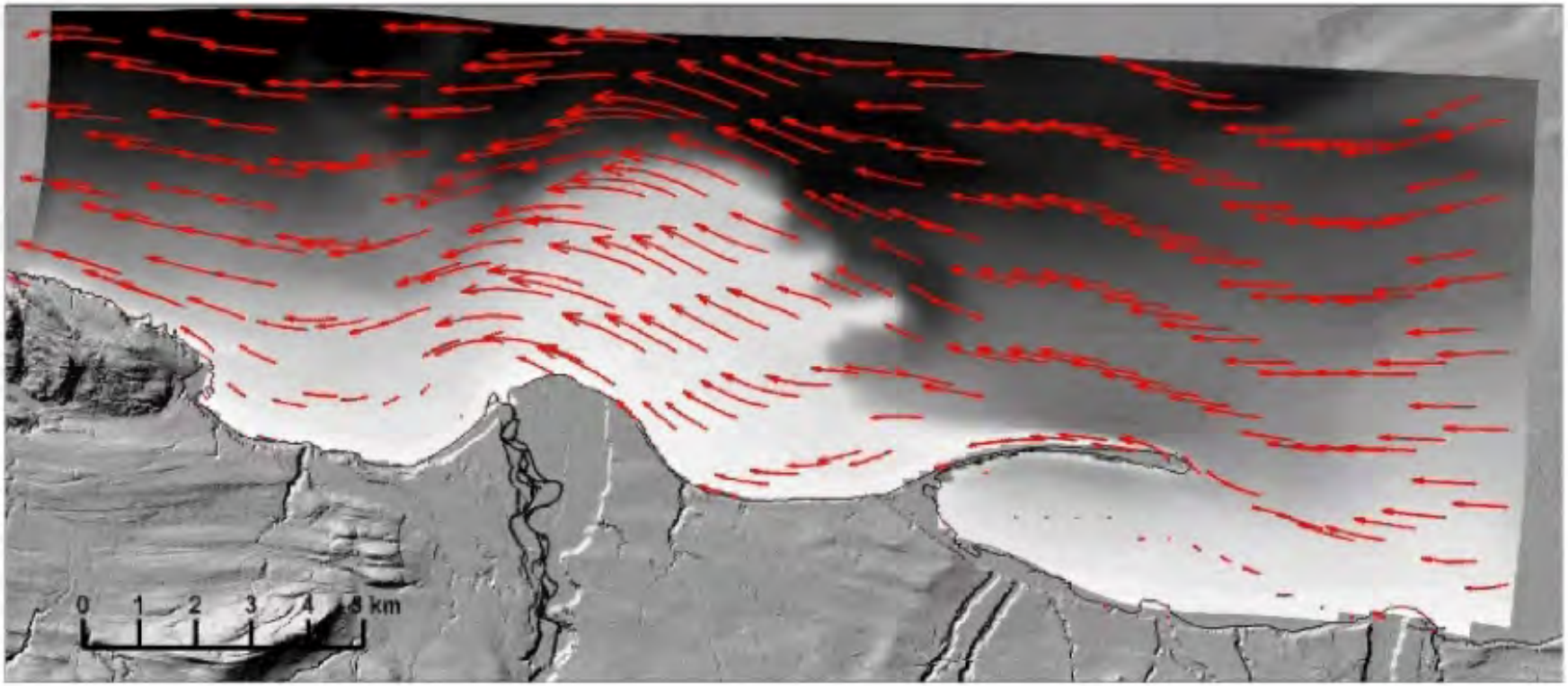
Preliminary , Subject to Revision



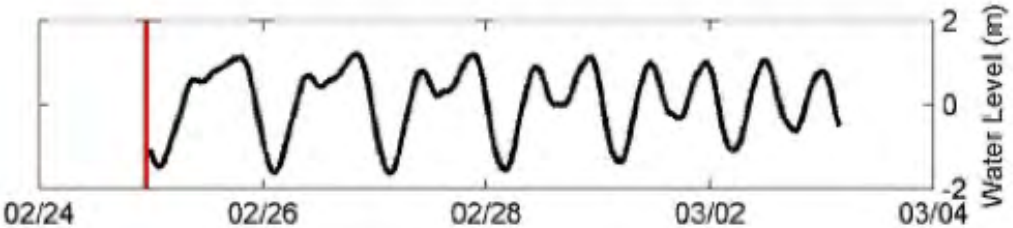
Prior to dam removal, coastal turbidity events near the Elwha River mouth (arrows) occur when currents are directed away from the river mouth. This suggests that coastal turbidity generally does not originate from the Elwha River, a pattern that may change during and after dam removal.

USGS
science for a changing world

NUMERICAL MODEL: example of simulated currents during ebb tide



Preliminary , Subject to Revision

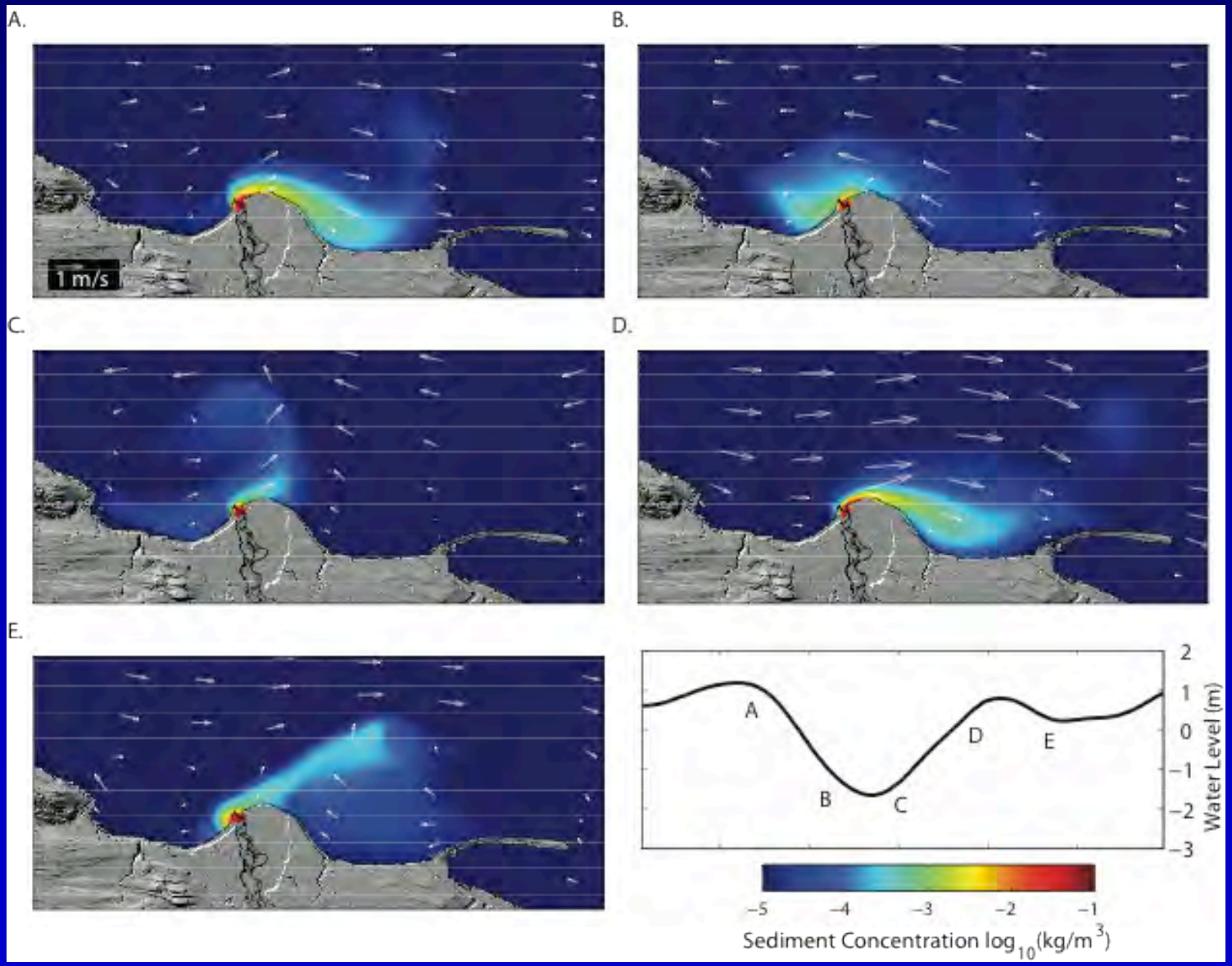


USGS
science for a changing world

A numerical model has been developed that incorporates coastal currents and sediment transport near the Elwha River delta

NUMERICAL MODEL: example of simulated suspended-sediment concentrations offshore of the Elwha River mouth during a moderate river flood

Preliminary , Subject to Revision

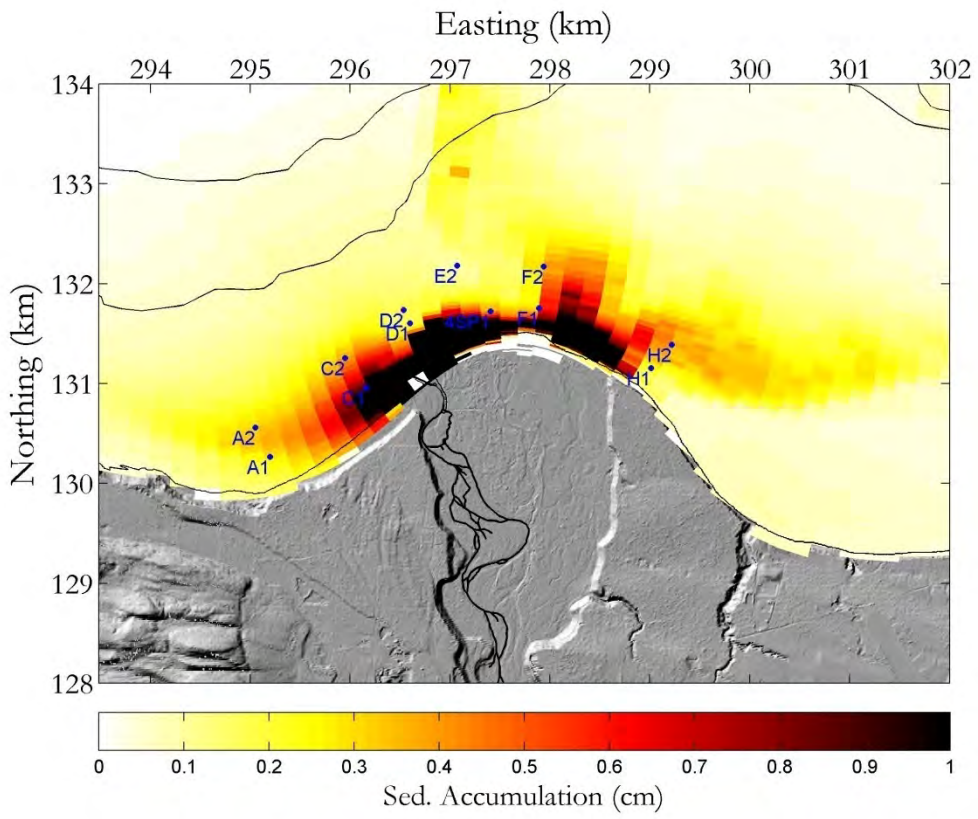


USGS
science for a changing world

NUMERICAL MODEL: example of simulated sediment deposition offshore of the Elwha River mouth during dam removal after a moderate river flood

Labeled points offshore refer to scuba dive sites (see Task 4)

Preliminary , Subject to Revision



USGS
science for a changing world

TASK 4: Document benthic marine nearshore habitats and biological communities

(Investigator: Jeff Duda; jduda@usgs.gov)

Accomplished:

Multiple high-resolution benthic scuba dive surveys of marine nearshore habitat

Ongoing:

Additional scuba dive surveys

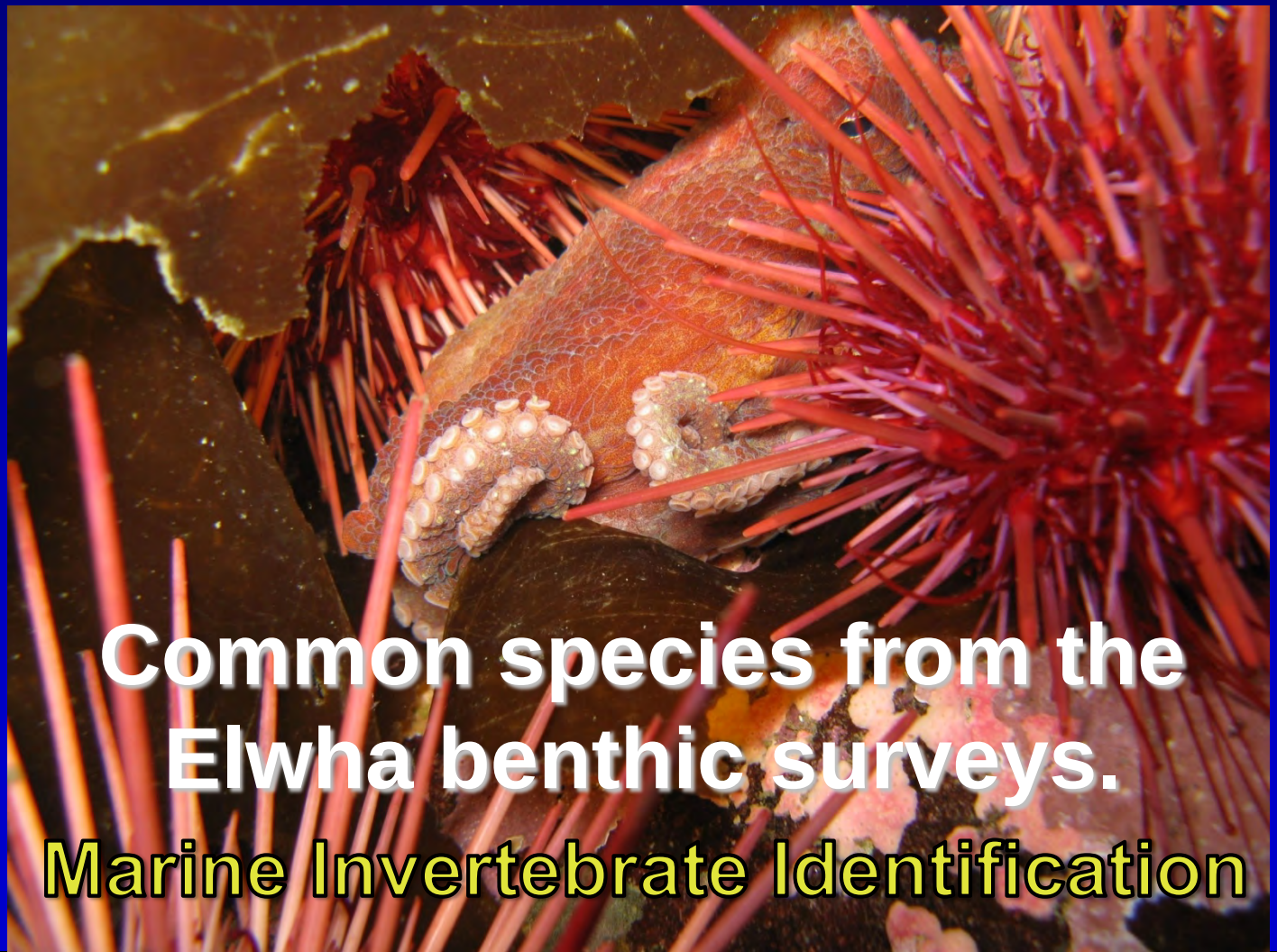
USGS
science for a changing world

HIGHLIGHTS

1) Developed USGS dive safety plan
2) Developed reciprocity agreement with EPA and Lower Elwha Klallam Tribe scuba dive survey teams
3) Developed and conducted species identification workshop for collaborators
4) Established fixed transect stations in Elwha River marine nearshore zone and east reference location (Green Point)
   - →12 locations in Elwha River marine nearshore zone (24 transects)
   - →2 locations in Green Point (4 transects)
5) Conducted first set of surveys of fixed transects in Elwha River marine nearshore zone

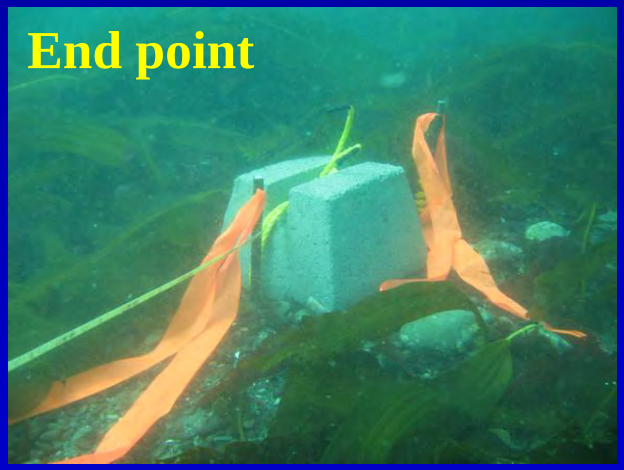
SPECIES IDENTIFICATION WORKSHOP

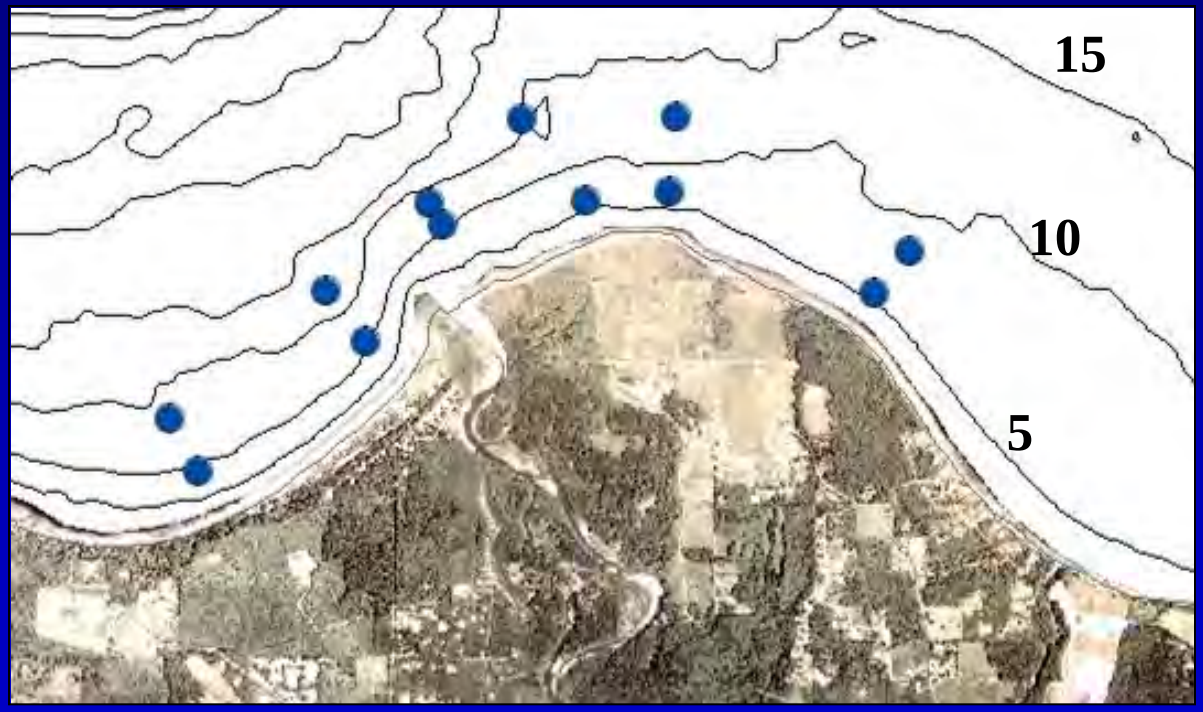
Reviewed species taxonomic identification with EPA and Lower Elwha Klallam Tribe scuba dive survey teams



USGS
science for a changing world

FIXED TRANSECT STATIONS NEAR ANGELES POINT

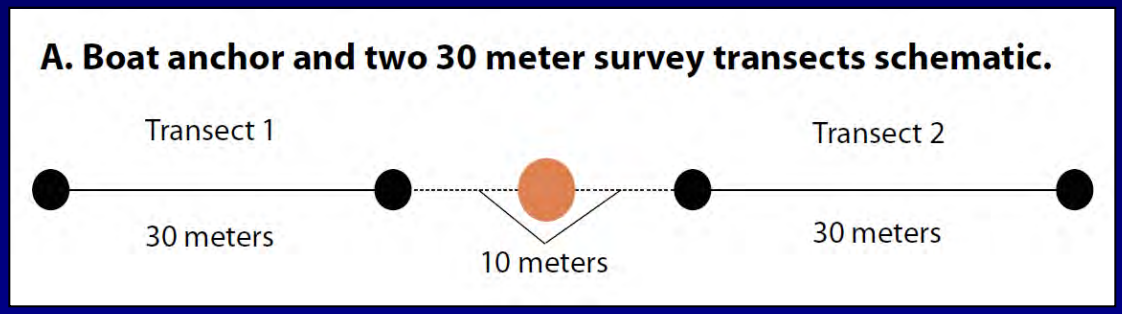


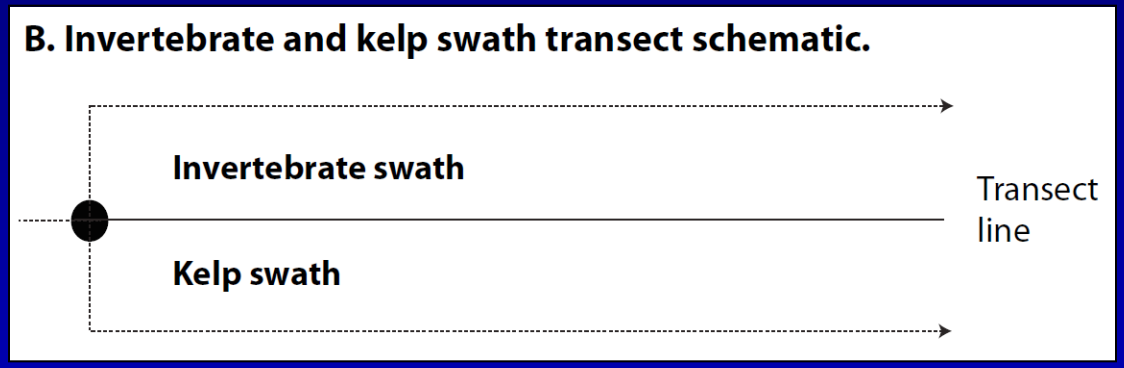


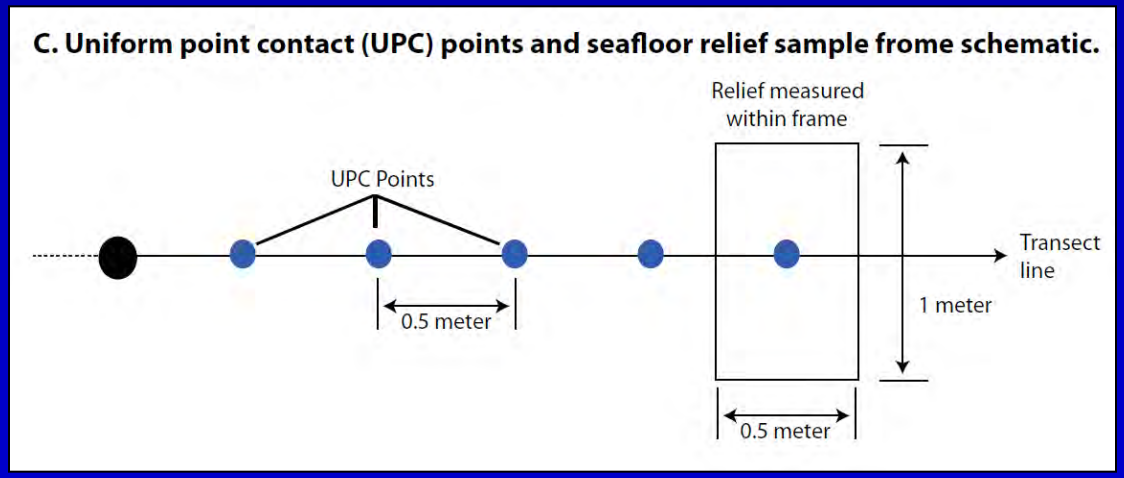
Locations to the east and west of the Elwha River mouth, in zone expected to be affected by sediment delivery after dam removal

USGS
science for a changing world

SCUBA DIVE SURVEYS, AUGUST & SEPTEMBER, 2011







USGS
science for a changing world

For more information, see Rubin et al., 2011, at http://pubs.usgs.gov/sir/2011/5120

OUTREACH ACTIVITIES

Multiple News Releases: http://walrus.wr.usgs.gov/elwha/media.html

TV Coverage: "World's largest dam removal project on the Elwha River," King 5 News, 8/8/2011, http://www.king5.com/news/local/In-The-Mouth-Of-The-Elwha-127278693.html

Preliminary results of all study components were presented at the Elwha River Science Symposium, Port Angeles, Washington, September 15-16, 2011

Comprehensive Website: "USGS Science to Support the Elwha River Restoration Project," http://www.usgs.gov/elwha

USGS
science for a changing world

For additional information, please contact

Chris Magirl, magirl@usgs.gov

(https://profile.usgs.gov/magirl);

Jeff Duda, jduda@usgs.gov

(https://profile.usgs.gov/jduda);

Jon Warrick, jwarrick@usgs.gov

(http://walrus.wr.usgs.gov/staff/jwarrick) ; or

Matt Beirne, matt.beirne@elwha.nsn.us

http://www.usgs.gov/elwha

USGS science for a changing world

ELWHA KLALLAM TRIBE

EPA