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Managing Water in the West

Stream Restoration Technical Perspectives

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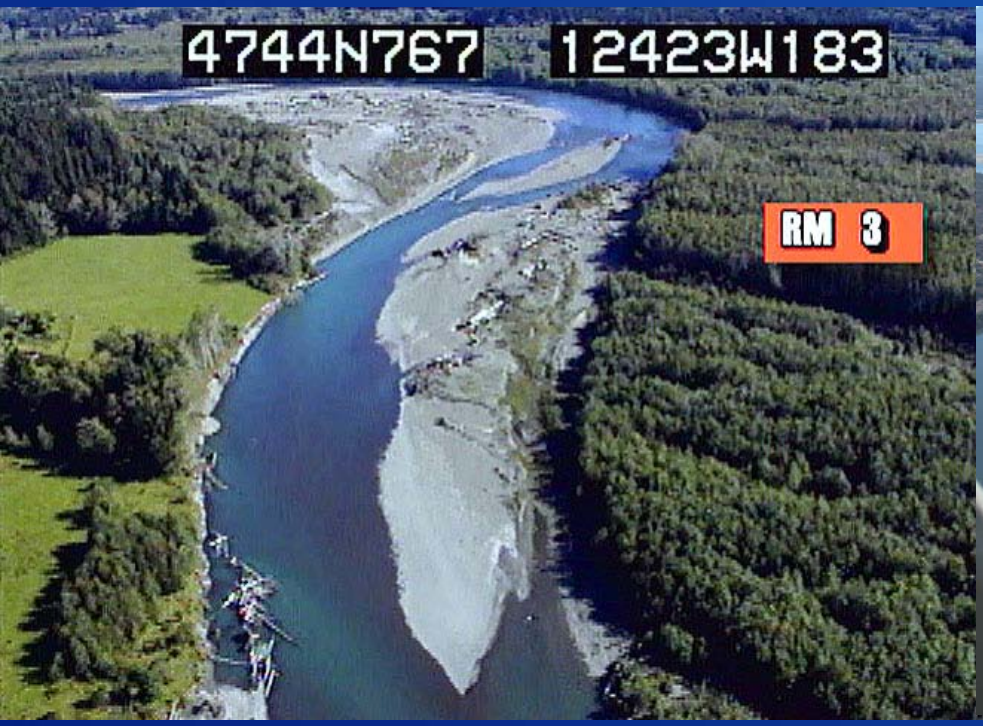
Bureau of Reclamation

Dynamic River Channels

- The width, depth, and alignment of a river are a function of the water flow, sediment load, vegetation, and geologic constraints.



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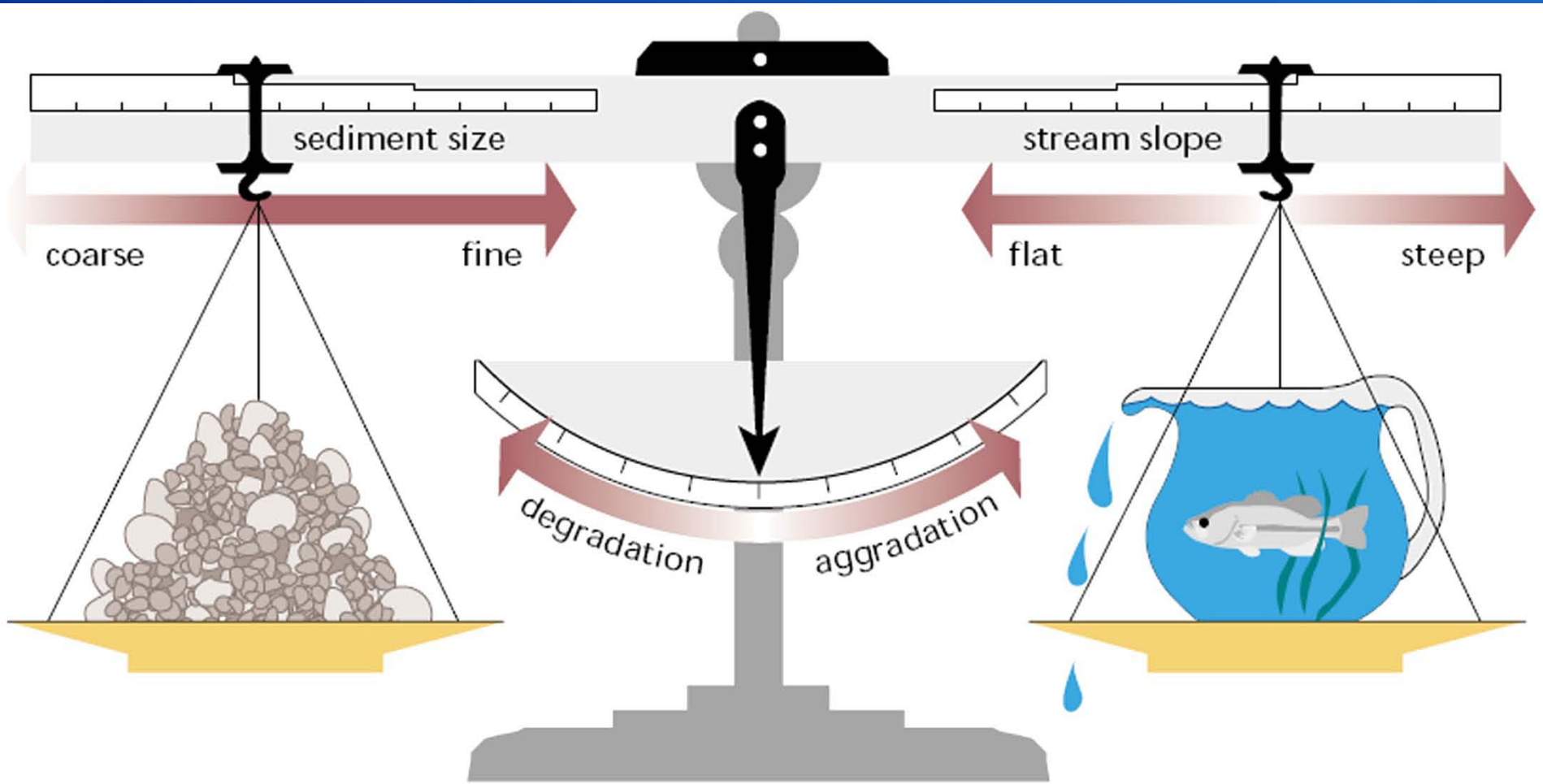
Stable Channel Balance



$$Q_s \cdot D_{50} \propto Q_w \cdot S$$

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How Science Can Better Inform Decisions

- Understand what has happened to a stream and what processes have been affected.
- Understand what process can be restored and to what extent.
- Understand what form and function can be achieved.
- Understand what actions will be successful.

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Stream Restoration Objectives

- Objectives that are consistent with natural processes have a better chance of being achieved and sustained.
- Natural processes include:
  - Hydrology
  - Sediment transport
  - Vegetation growth and mortality
  - Channel migration
  - Life cycles of aquatic and terrestrial organisms

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Stream Restoration Approach

- Utilize existing knowledge
- Seek independent peer review
- Monitoring and research

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Convene Restoration Workshops:
Share Ideas on Practice and Research

- Interdiciplinary participation:
  - biologists, engineers, geomorphologists
- Government, universities, consultants

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Example Workshop Topics:

- Authorities and funding
- Stream restoration objectives
- Engineering criteria for in-stream structures
- Dam removal and sediment management
- Fish passage
- Invasive species
- Riparian habitat restoration
- Monitoring and adaptive management
- Large wood

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Example Workshop Recommendations

- Establish an interagency working group to facilitate coordination and collaboration.
- Conduct at least one workshop each year.
- Conduct a joint review of on-going and planned R&D activities.
- Coordinate R&D roadmaps.
- Publish a stream restoration newsletter and establish a web site.

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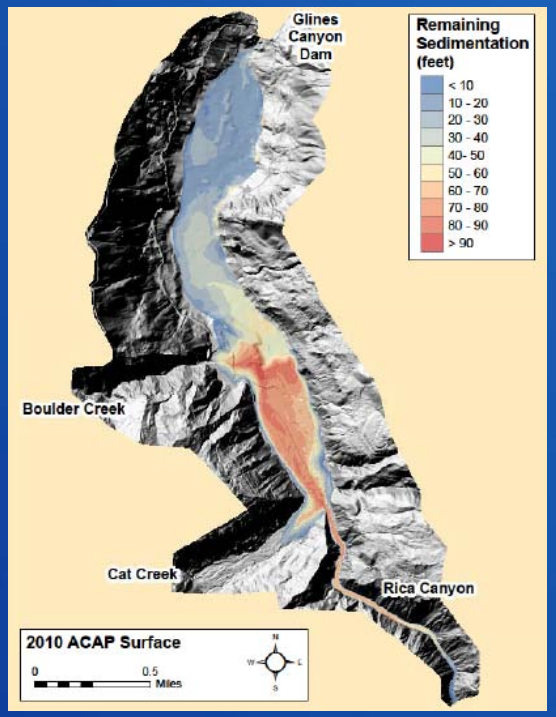
Stream Restoration Analysis

- Get past the politics and local mythology
- Determine the study questions
  - What are the physical and biological processes influencing the stream?
  - How have the natural processes been affected by human activities?
  - What future management actions can help restore natural processes and habitat?

Stream Restoration Analysis

- Formulate a set of hypotheses
- Develop and apply models as a set of linked hypotheses
  - Conceptual
  - Numerical
  - Physical



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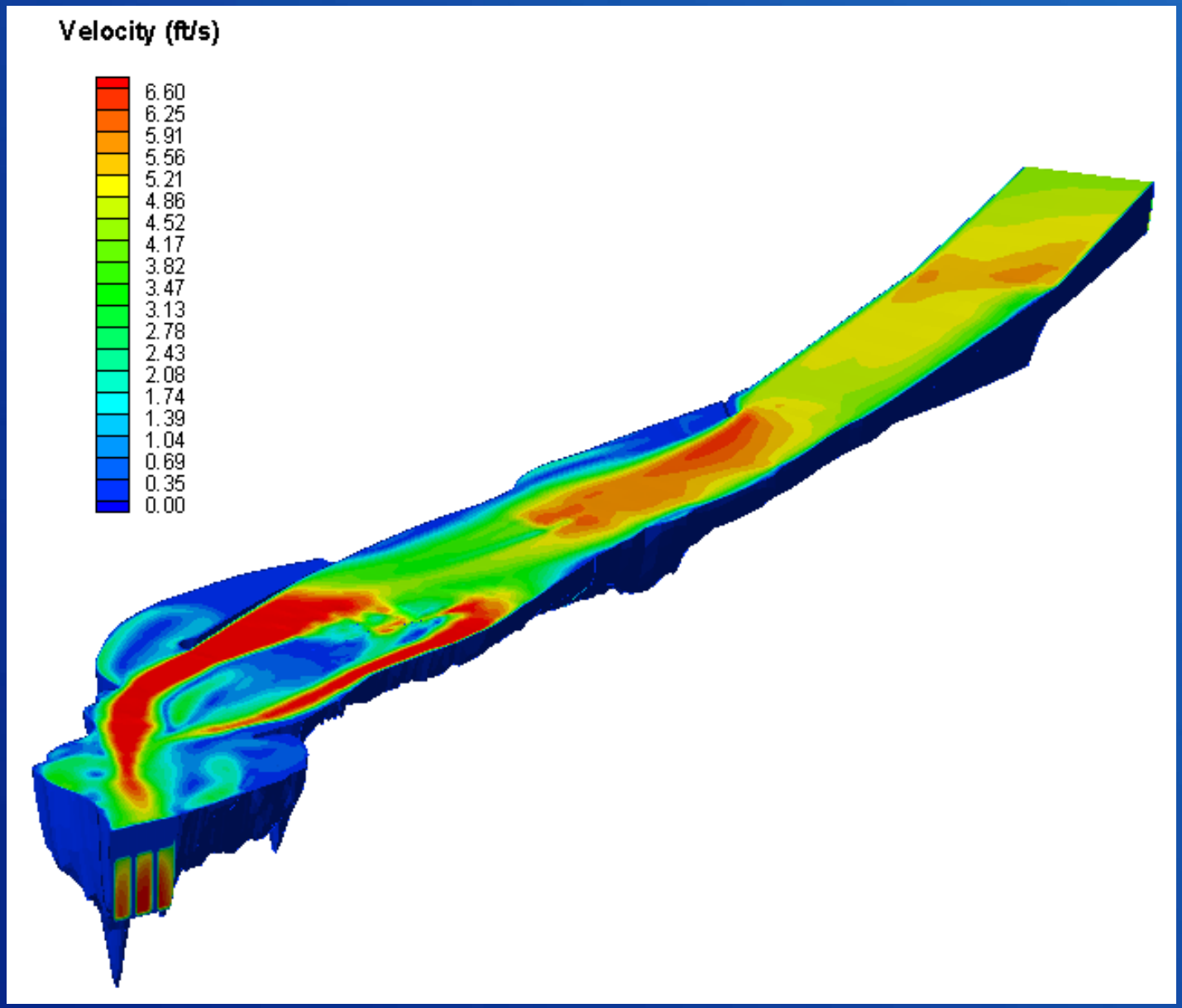
Numerical Models

- If properly designed and applied, models can be powerful predictive tools that can simulate important process linkages.
- Model results must be supported by the conceptual model and the geomorphic data.



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Stream Restoration Analysis (continued)

- Determine the type of data and analyses needed to test the hypotheses
- Understand the processes and resources linkages
- Develop restoration plans

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Restoration Actions

- Preservation

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Restoration Actions

- Modify reservoir operations

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Restoration Actions

- Modify reservoir operations

Short-duration high flows

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Restoration Actions

- Modify reservoir operations

Sandbar deposition

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Restoration Actions

- Sediment augmentation

Gravel injection

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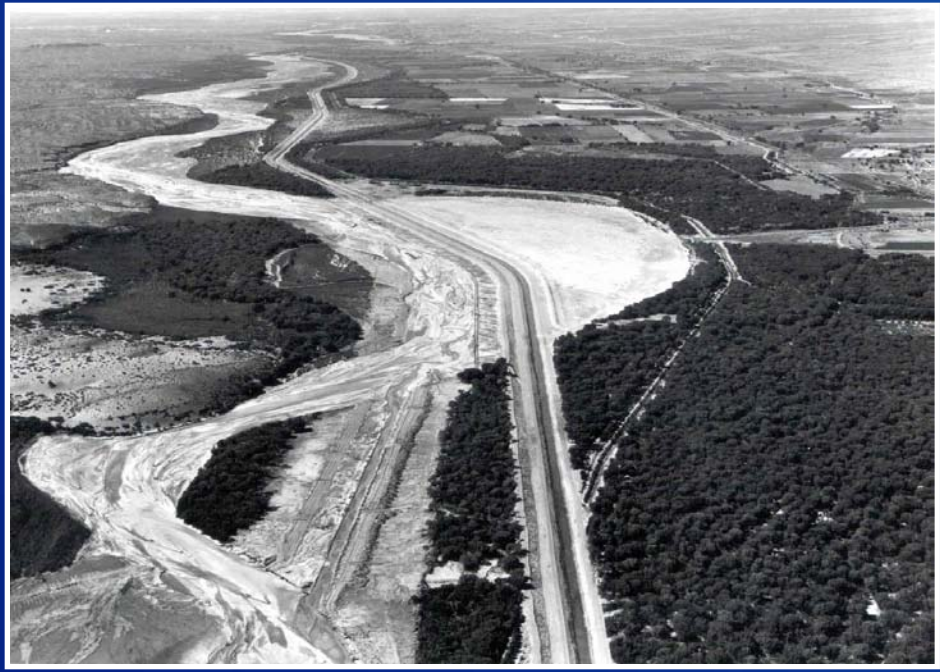
Restoration Actions

- Setback or removal of structures from the floodplain



Levee setback

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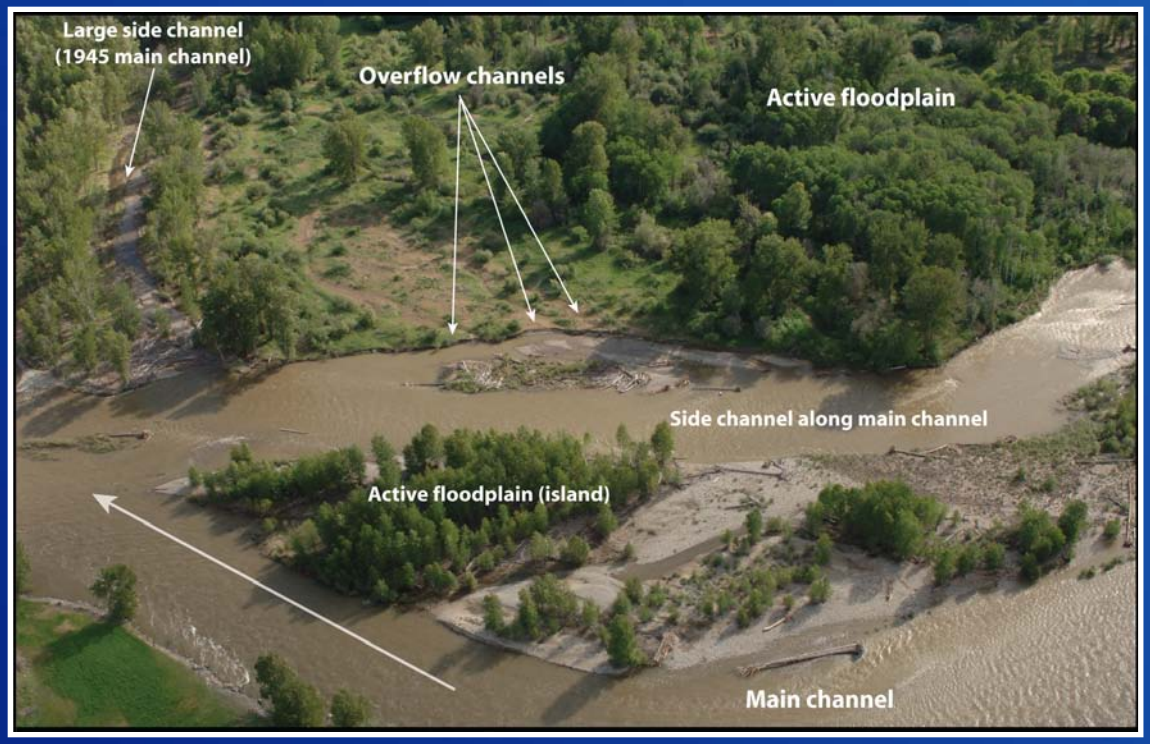
Restoration Actions

- Restore side channel and floodplain connections



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Restoration Actions

- Slow bank erosion to natural rates

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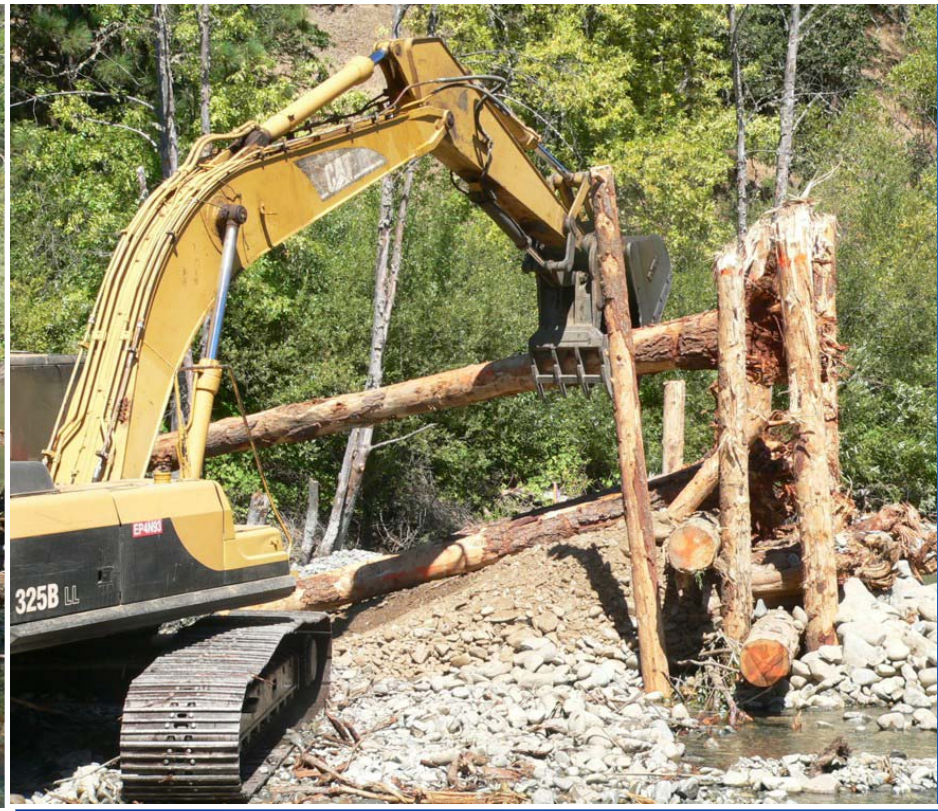
Restoration Actions

- Construct engineered log jams



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Restoration Actions

- Channel reconstruction

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Restoration Actions

- Passive to Active Actions:
  - Preservation
  - Modify reservoir operations
  - Setback or removal of structures from the floodplain
  - Restore side channel and floodplain connections
  - Slow bank erosion to natural rates
  - Channel reconstruction

Monitoring

- Adaptive Management
- Improved scientific understanding

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Adaptive Management

- Reduce risk and uncertainty of management actions through monitoring and adjustment.
- Make processed-based predictions of management actions that are measureable.
- Monitor outcomes (near real time)
- If outcomes are different than predictions, then determine why and if adjustments to management actions are needed.

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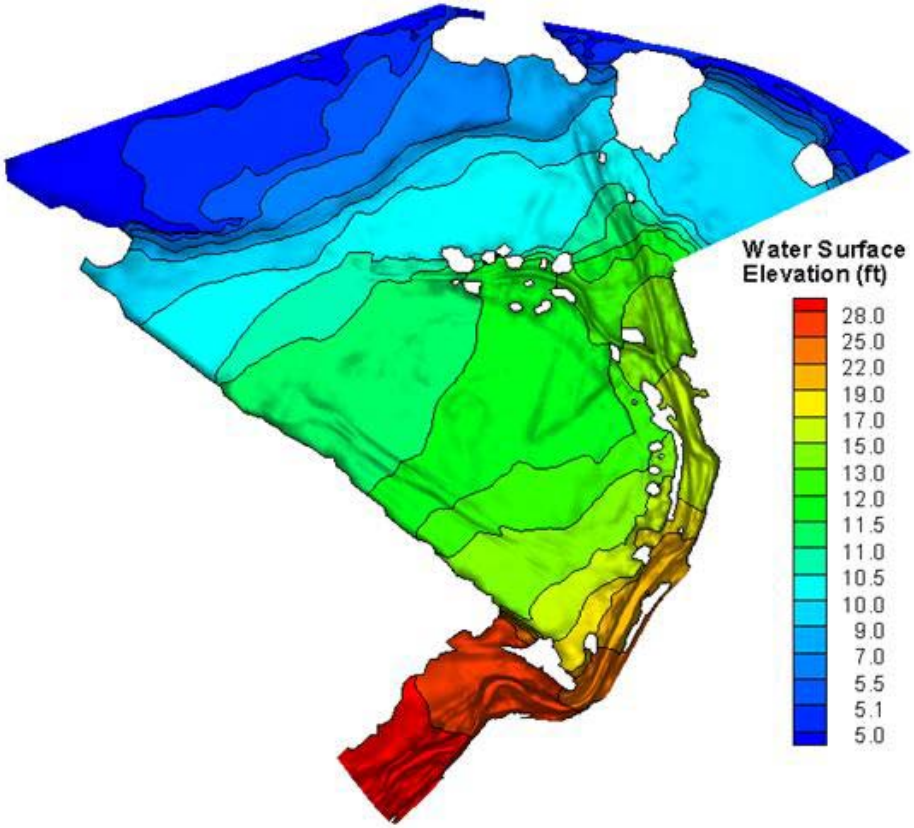
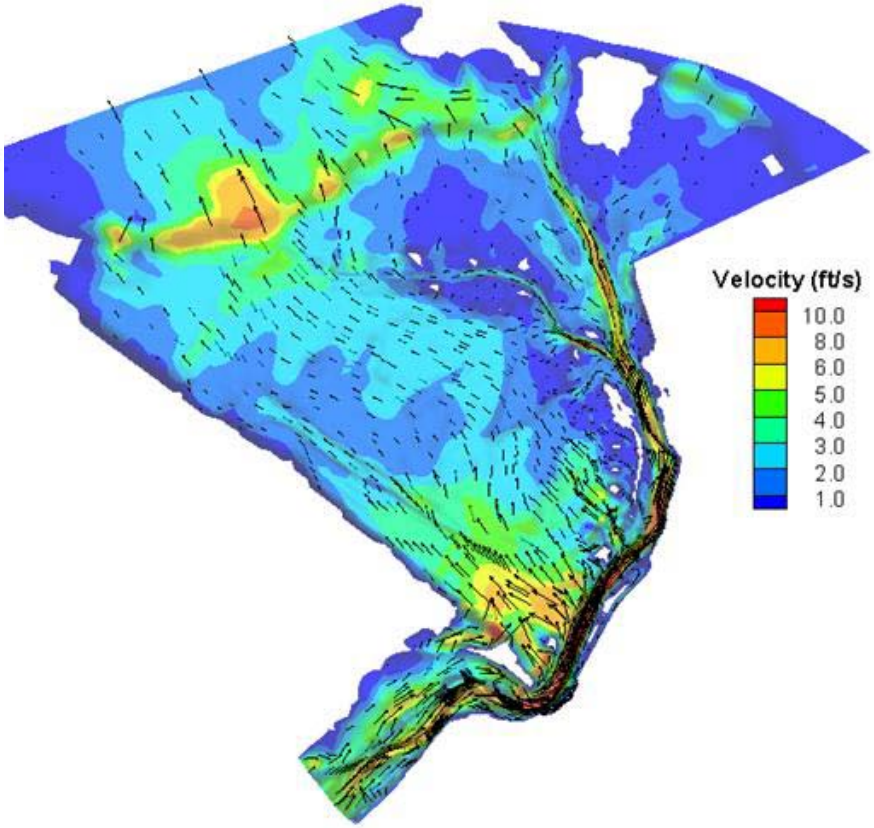
State of Modeling Science





2D Model Animation

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Science Prediction Challenges

- Channel migration and sudden changes in course (avulsion).
- Changes from multiple braided channels to a single meandering channel.
- Limiting factors for species.
- Habitat needs for altered systems.
- Species response to restoration actions.
- Outcome of species competition.
- Impact of invasive species.

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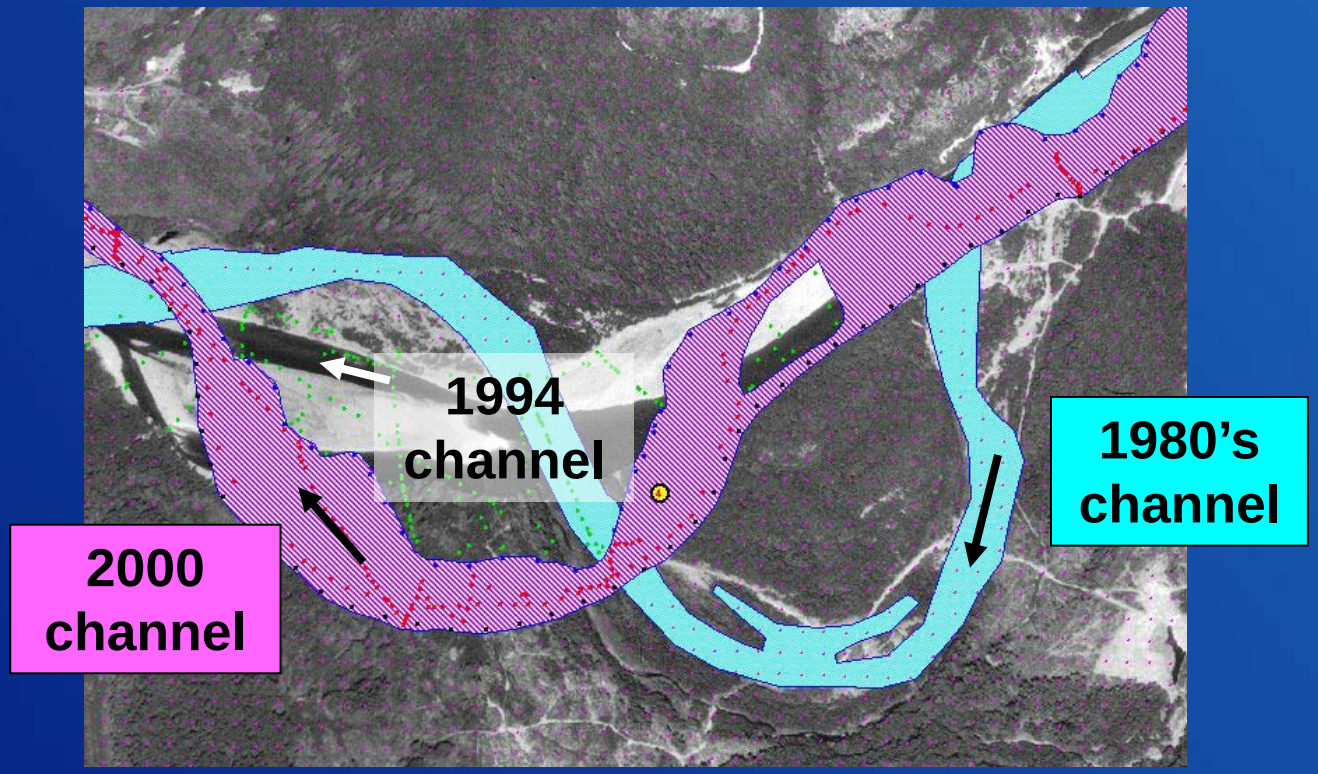
Science Prediction Challenges

- Channel migration and sudden changes in course (avulsion).



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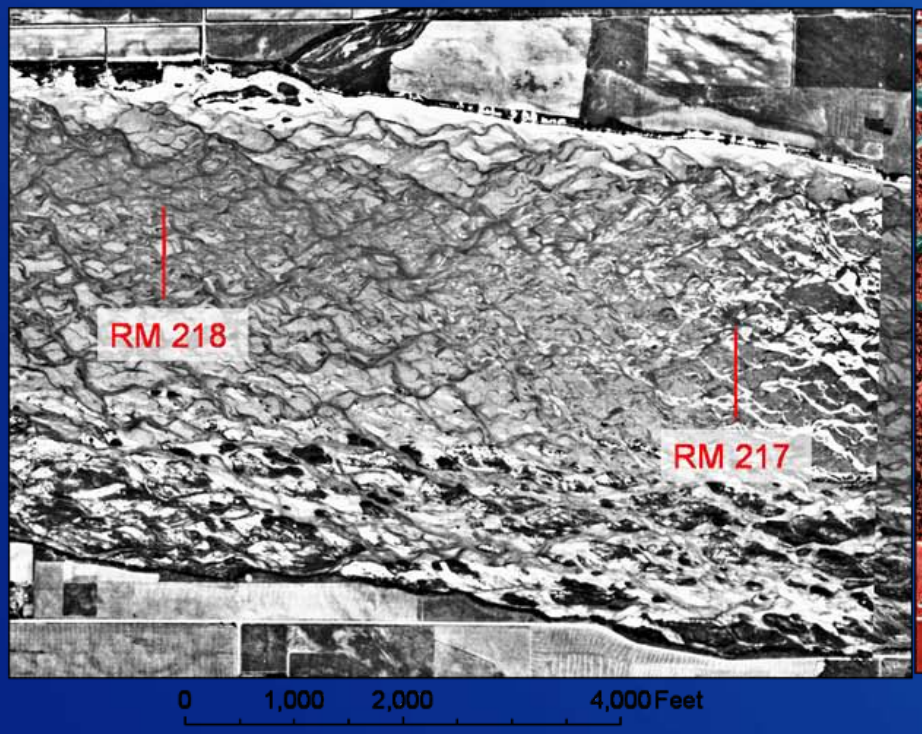
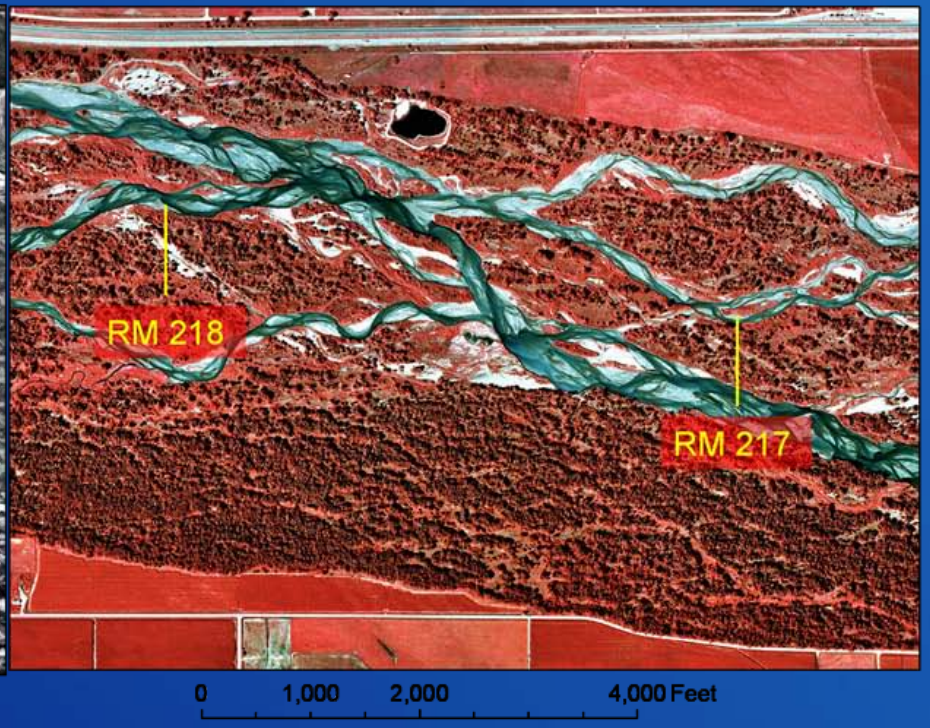
Science Prediction Challenges

- Changes in channel plan form.





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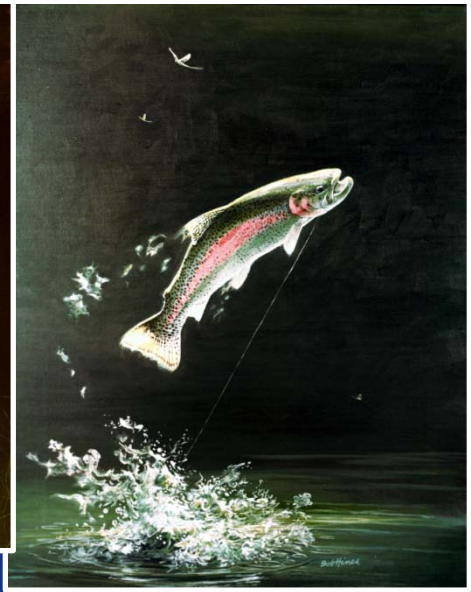
Science Prediction Challenges

- Limiting factors for species.



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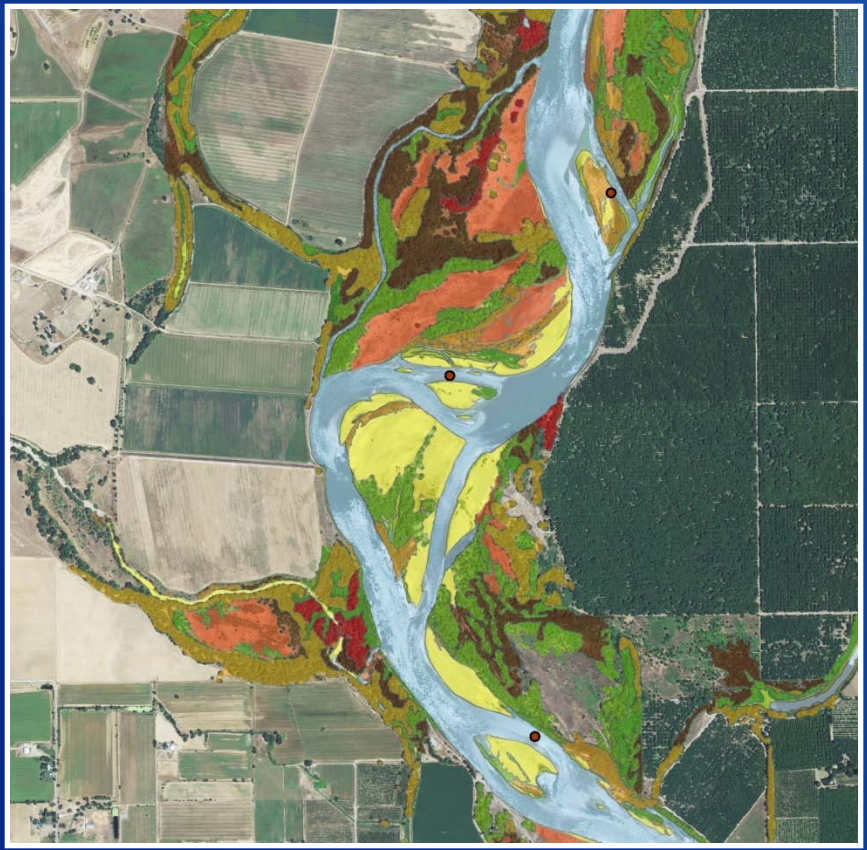
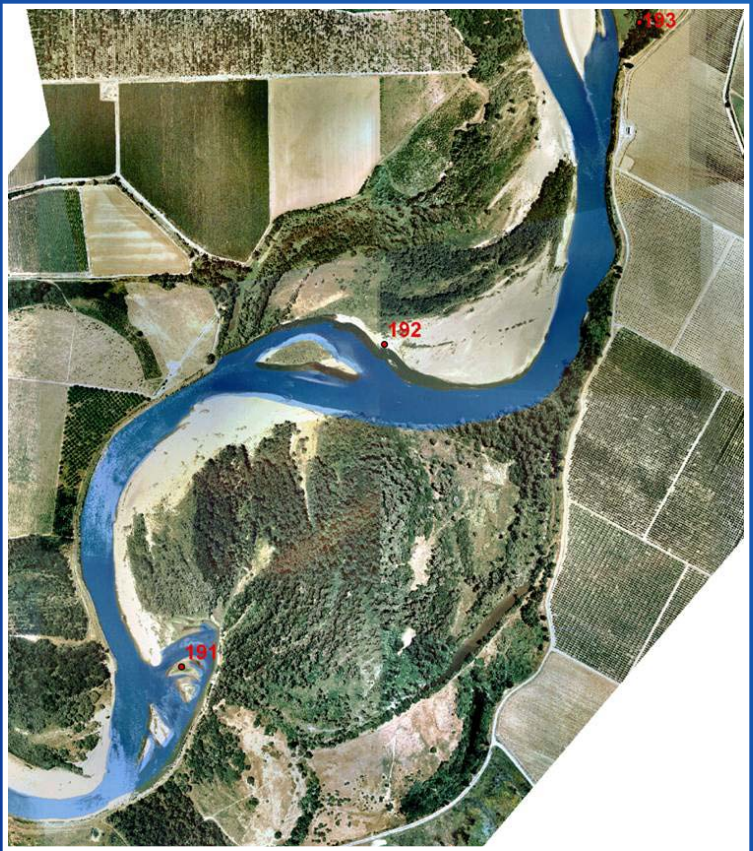
Science Prediction Challenges

- Habitat needs for altered systems





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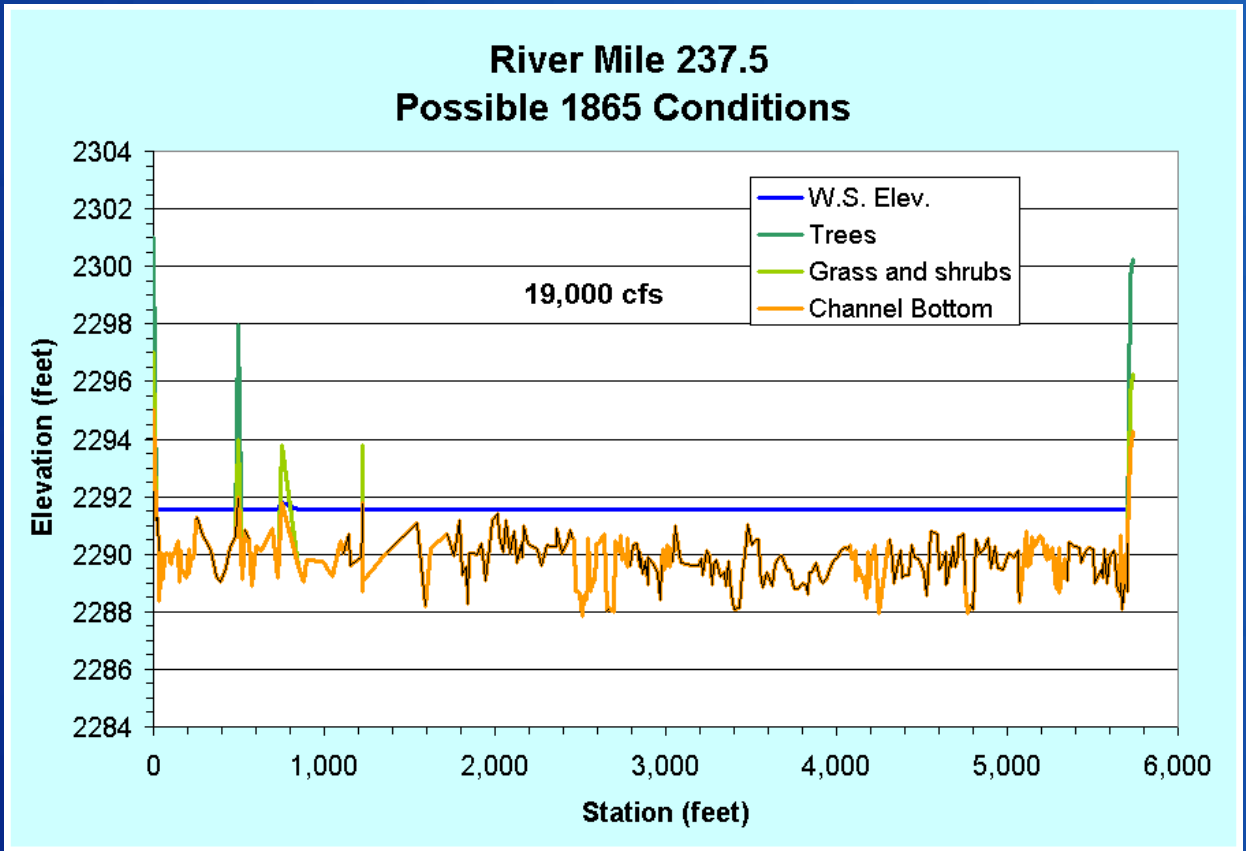
Science Prediction Challenges

- Species response to restoration actions.



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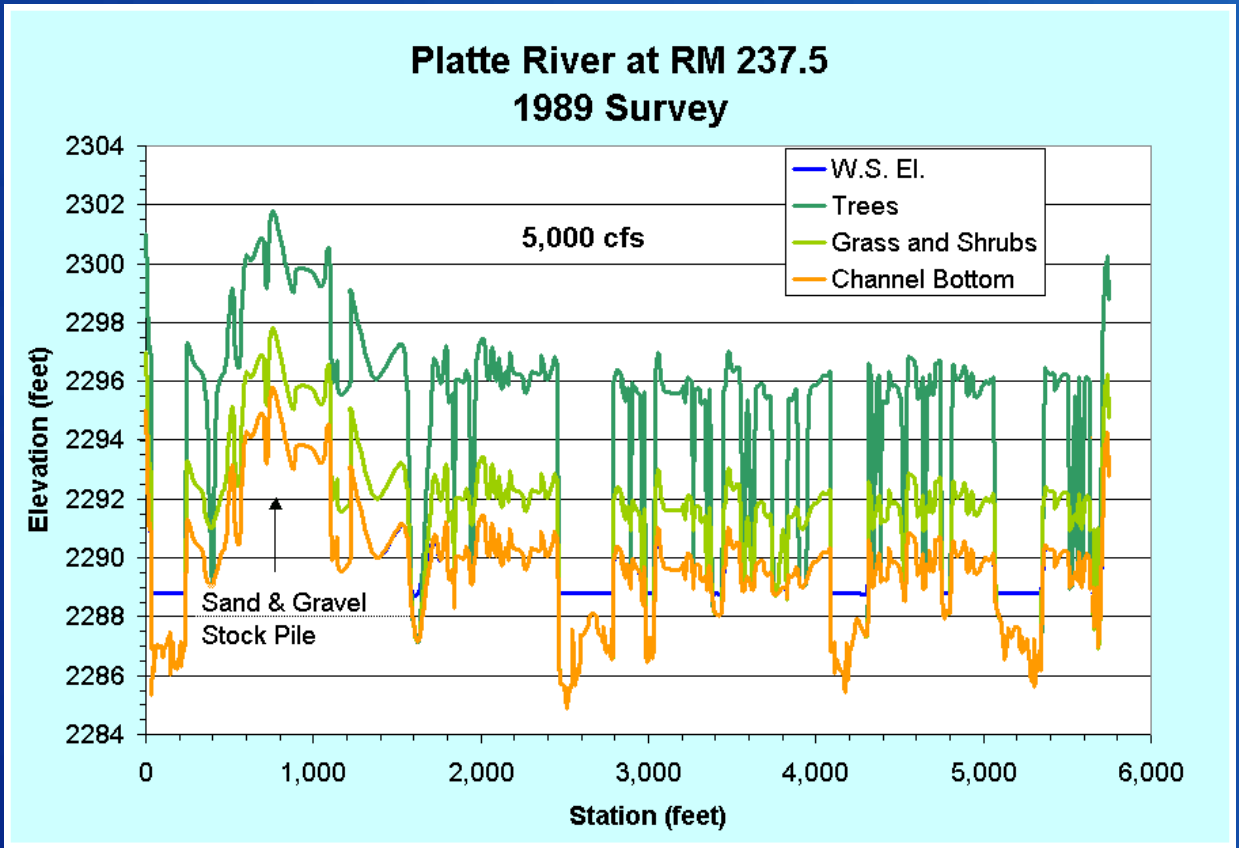
Science Prediction Challenges

- Species response to restoration actions.



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Science Prediction Challenges

- Impact of invasive species.

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More Research is Needed

- Improved understanding of physical and biological processes.
- Improved numerical modeling tools.
- Improved measurement techniques.
- Development of guidelines

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Elwha River Restoration

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Olympic Mountains

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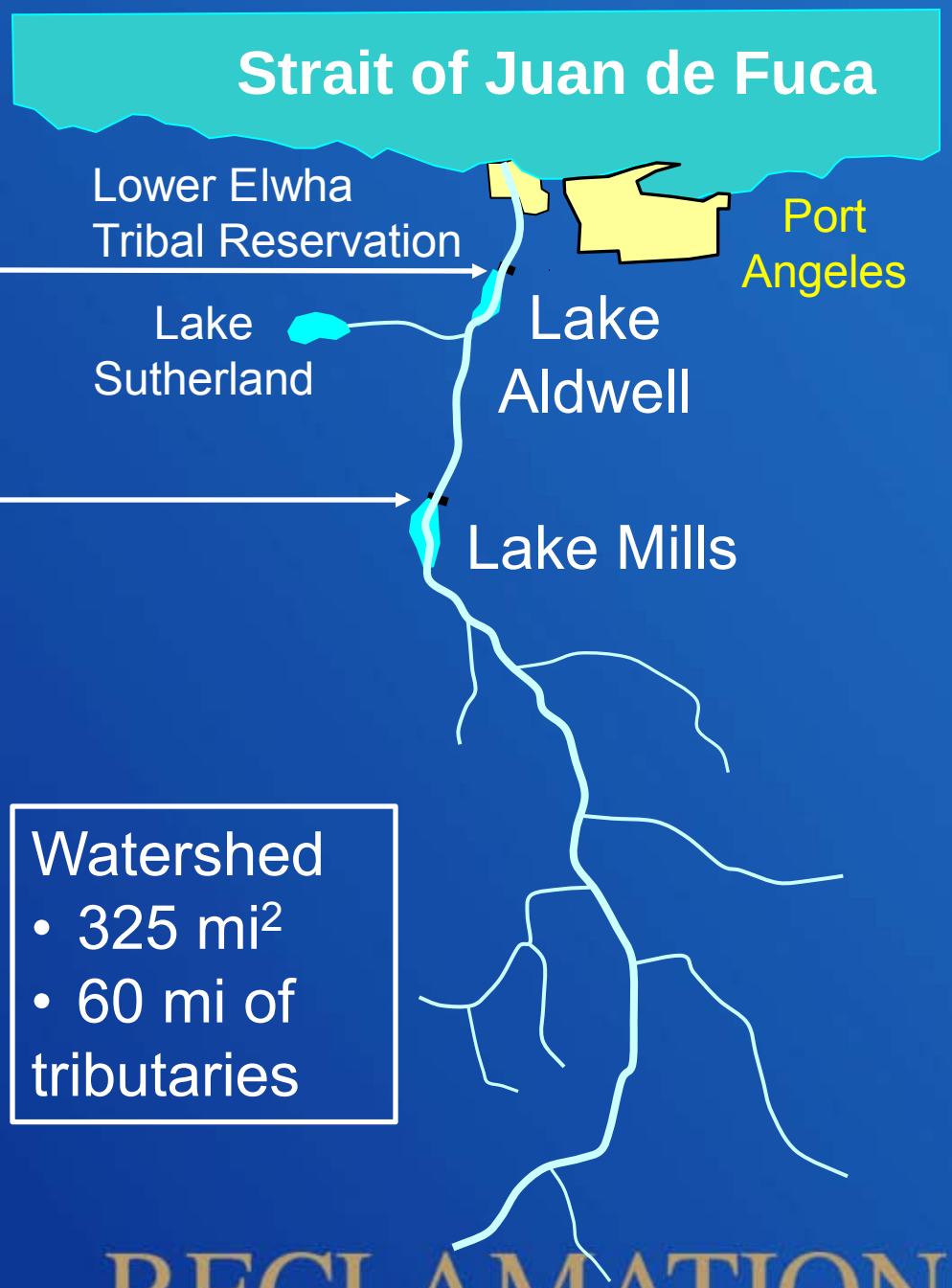
Elwha Dam (5 mi)

Glines Canyon Dam (13 mi)



Watershed
- 325 mi^2
- 60 mi of tributaries

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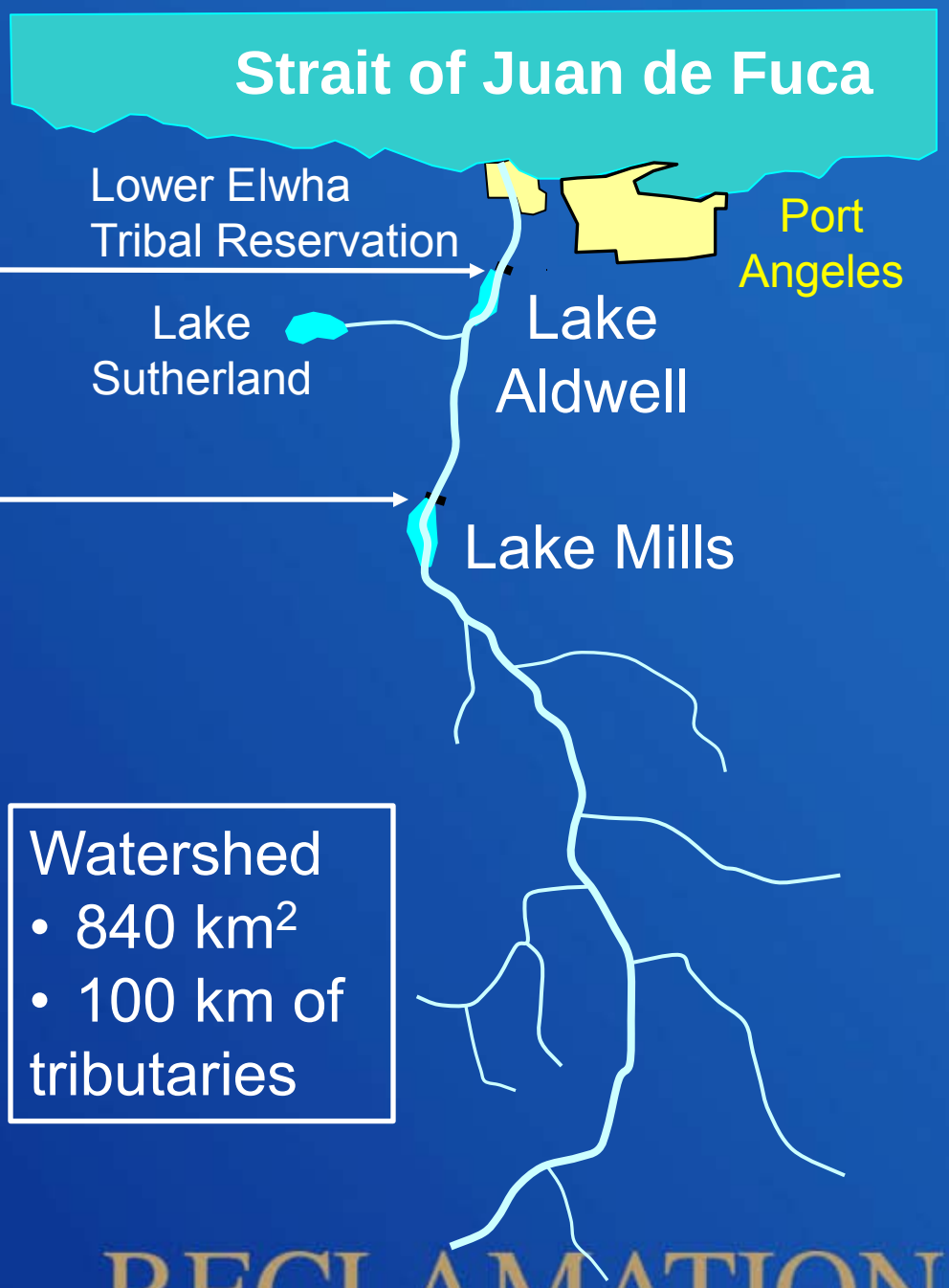
Elwha Dam (8 km)

Glines Canyon Dam (22 km)



Watershed
- 840 km^2
- 100 km of tributaries

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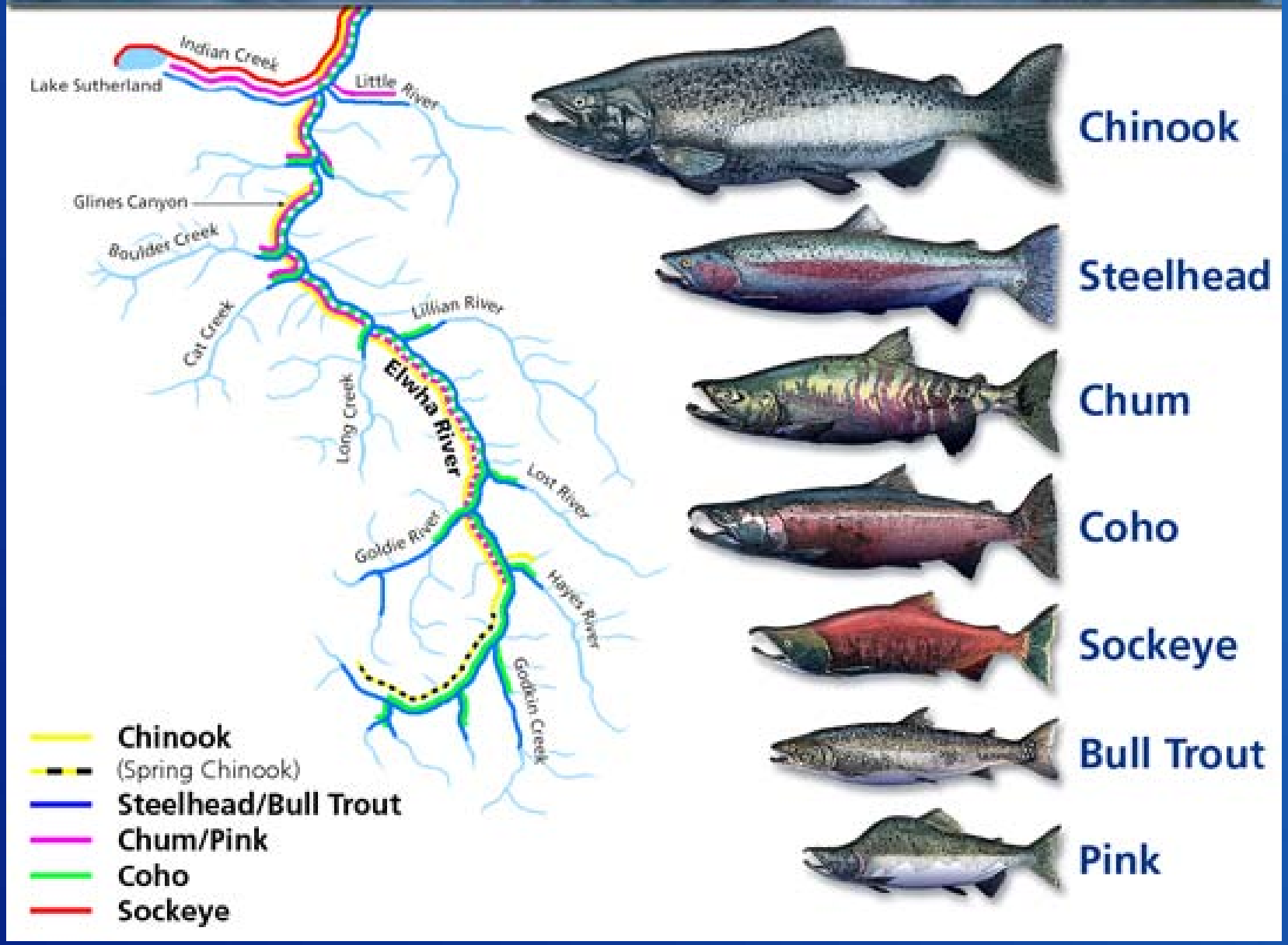
Potential Range Map for the Seven Elwha Salmonids



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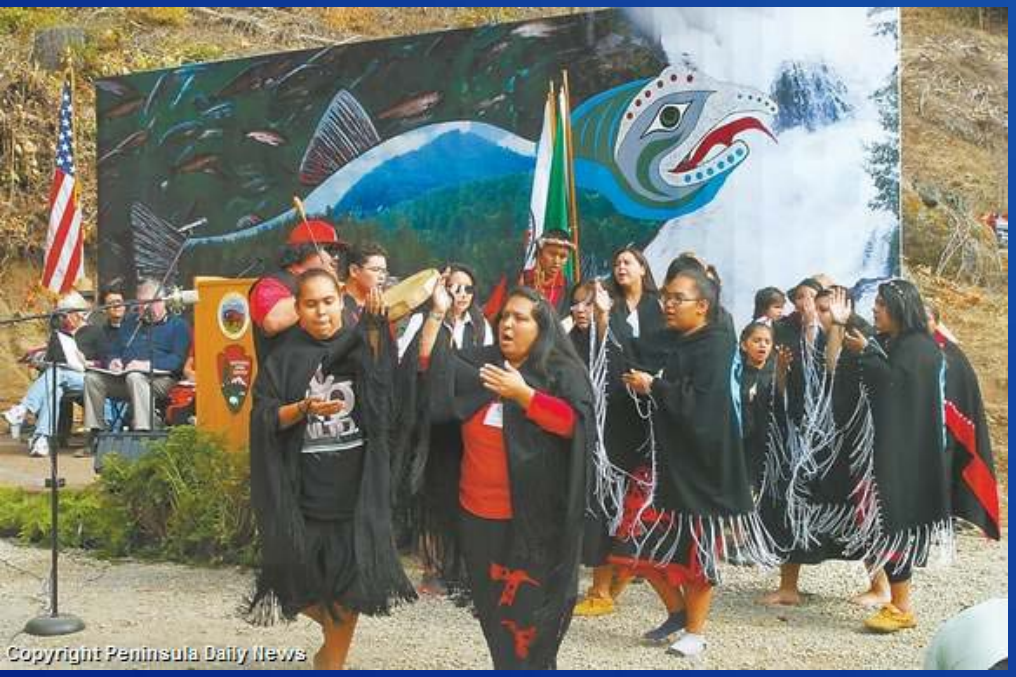
Importance to Elwha S'Klallam Tribe



- The culture and way of life of the Elwha people centered around the river and fish.
- Elwha Dam and Lake Aldwell inundate the sacred creation site of the Elwha people.
- Local Tribes have treaty rights to half the fish harvest.

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Reservoir Sedimentation

Lake Aldwell

Lake Mills

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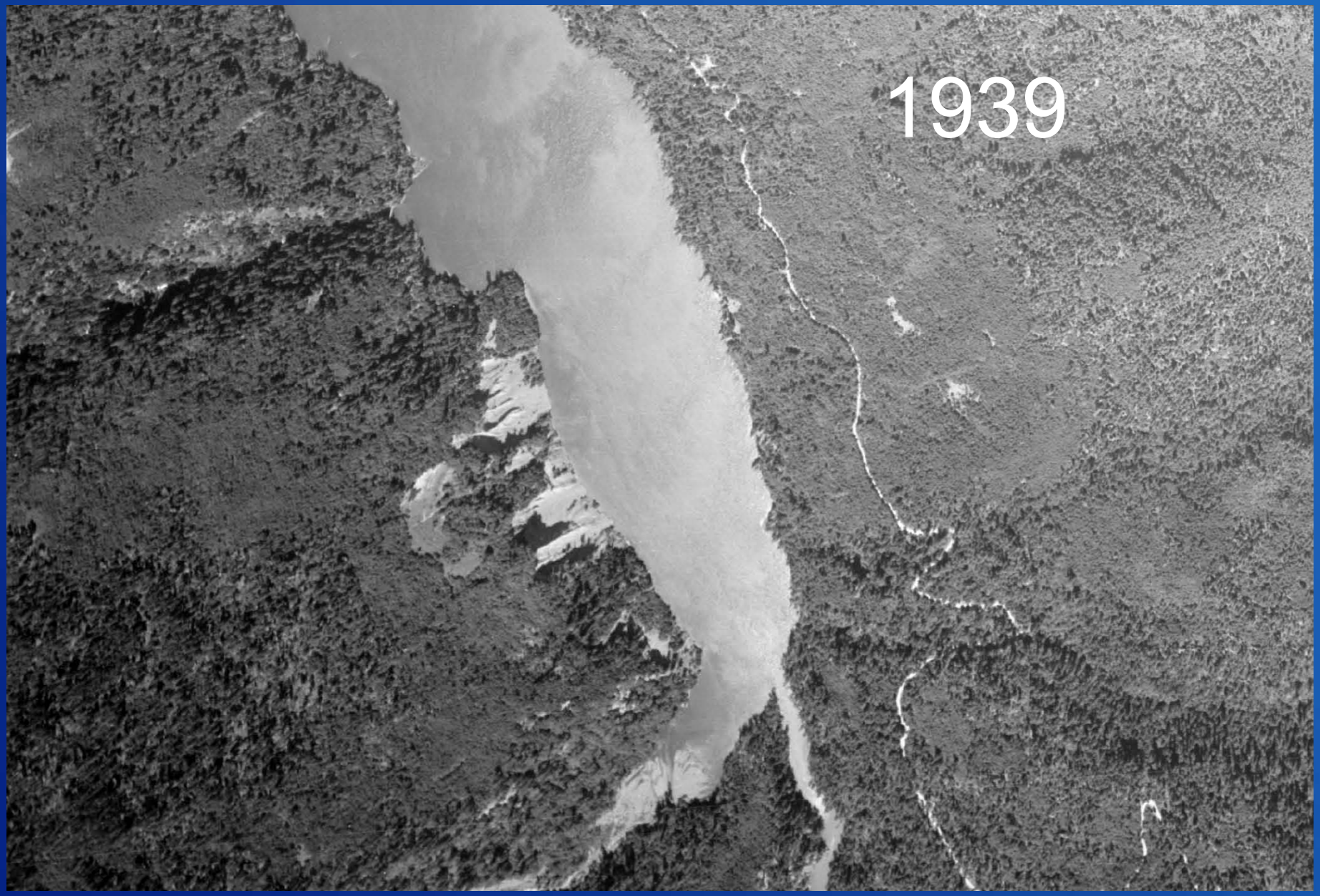

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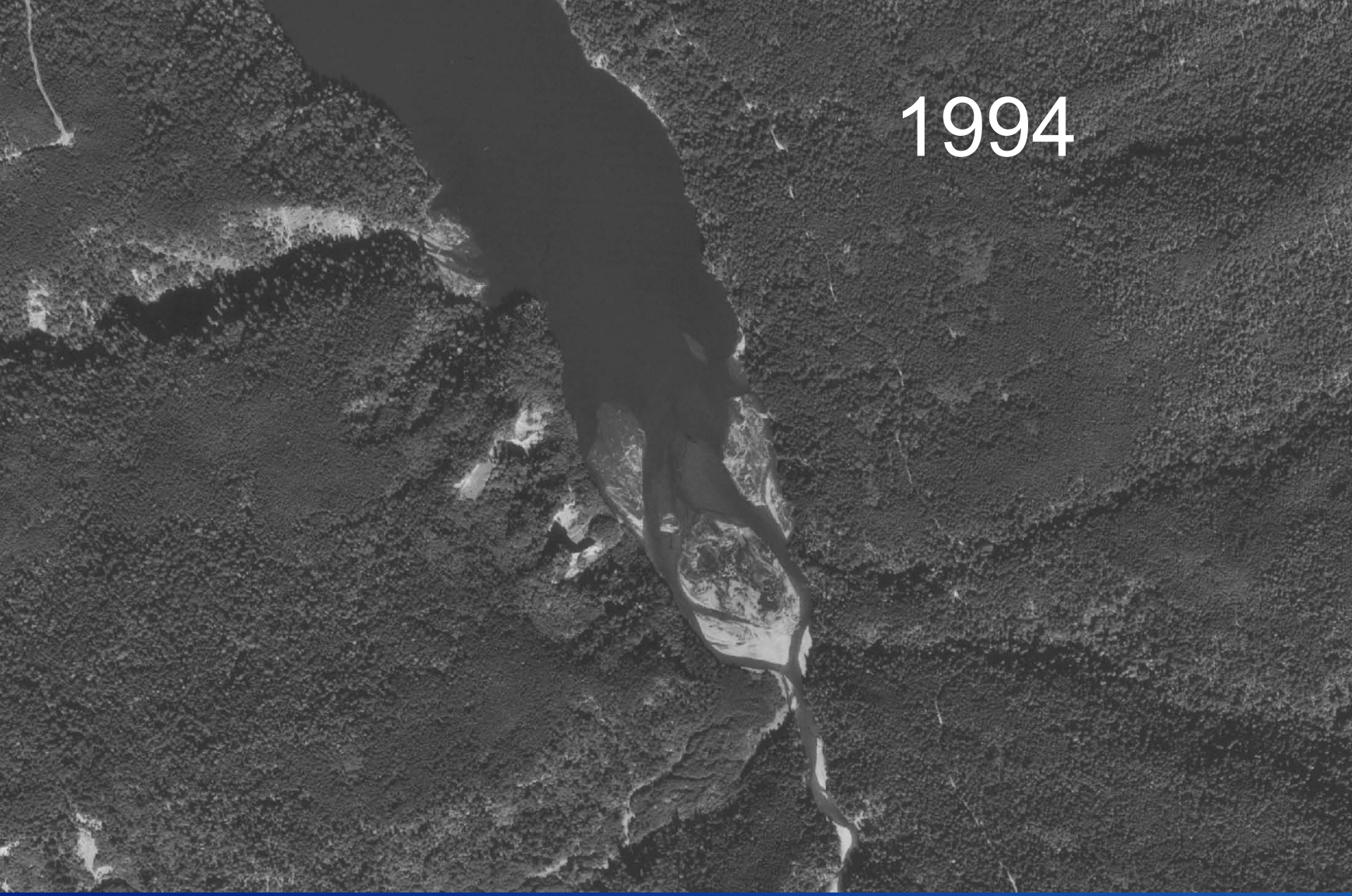

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2010 Reservoir Sedimentation: 24 million yd^3 ± 4 million yd^3

Lake Mills Sediment Volume:

- 20 million yd^3
- ½ clay and silt
- ½ sand and gravel

Lake Aldwell Sediment Volume:

- 4 million yd^3
- 2/3 clay and silt
- 1/3 sand and gravel

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2010 Reservoir Sedimentation: 19 million m^3 ± 3 million m^3

Lake Mills Sediment Volume:

- 16 million m^3
- ½ clay and silt
- ½ sand and gravel

Lake Aldwell Sediment Volume:

- 3 million m^3
- 2/3 clay and silt
- 1/3 sand and gravel

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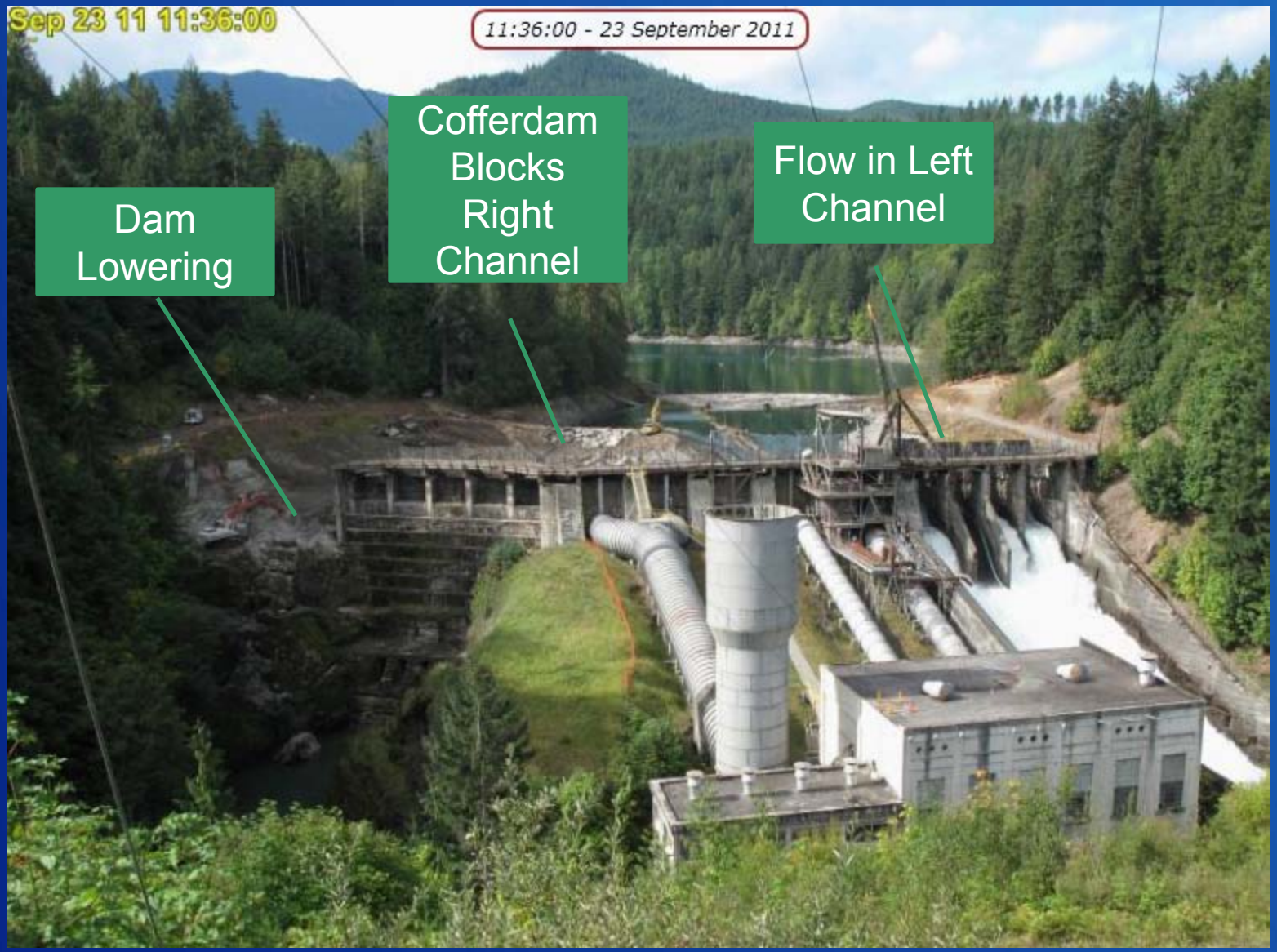

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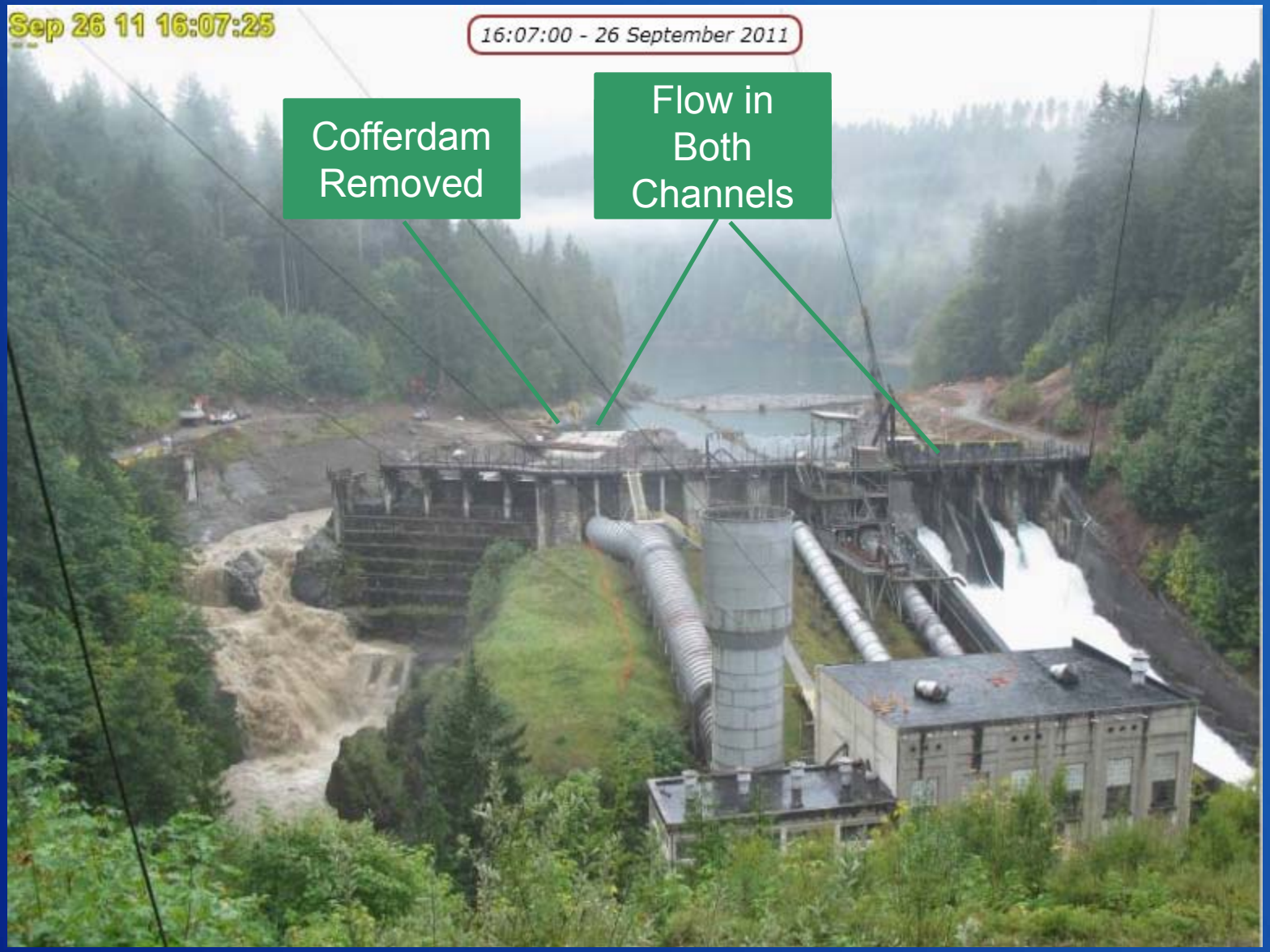

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Lake Mills Physical Model Experiment

Chris Bromley
University of Nottingham / Oregon State University

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700
740

RECLAMATION

620
660
700
740

700
740

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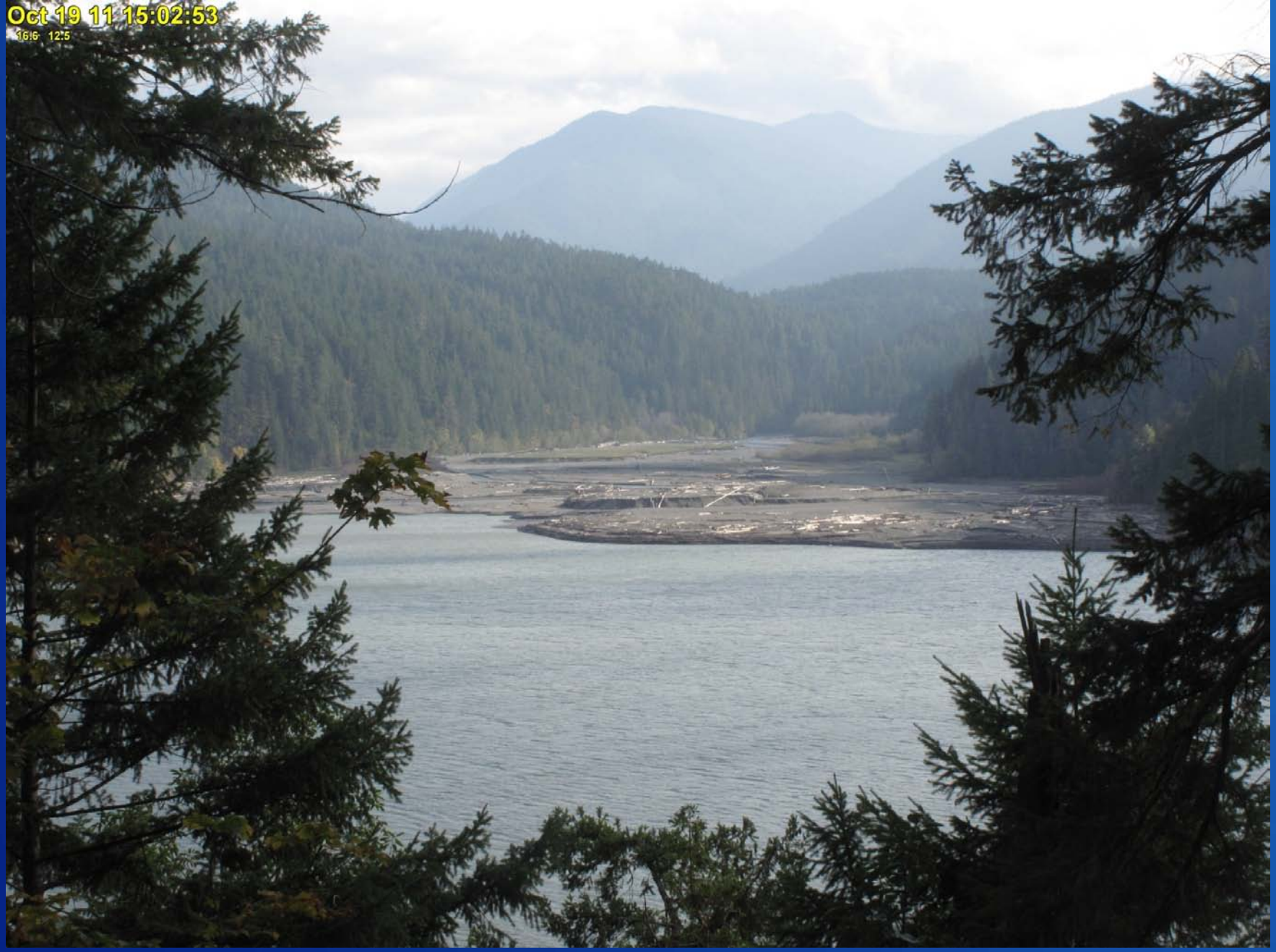

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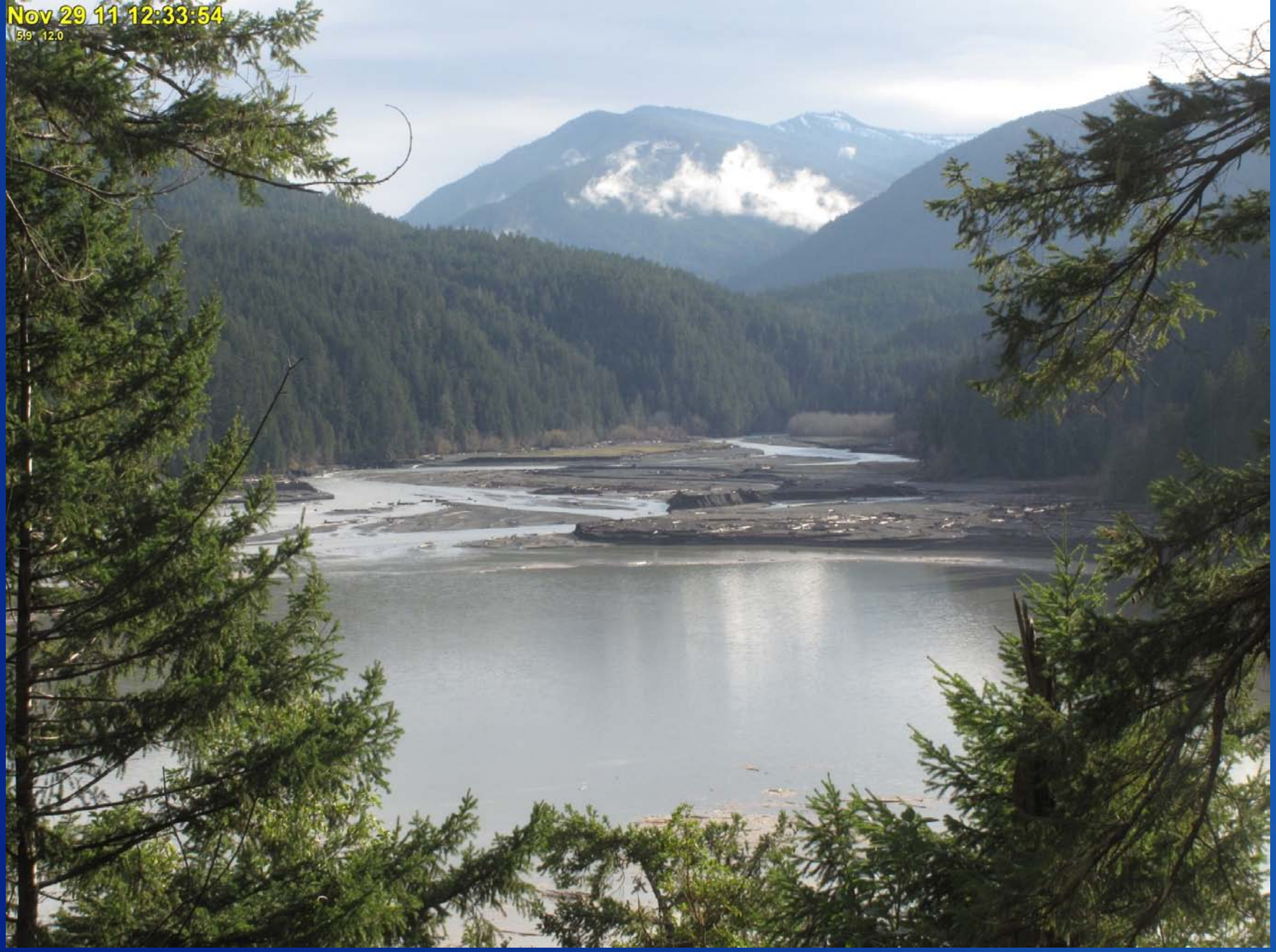

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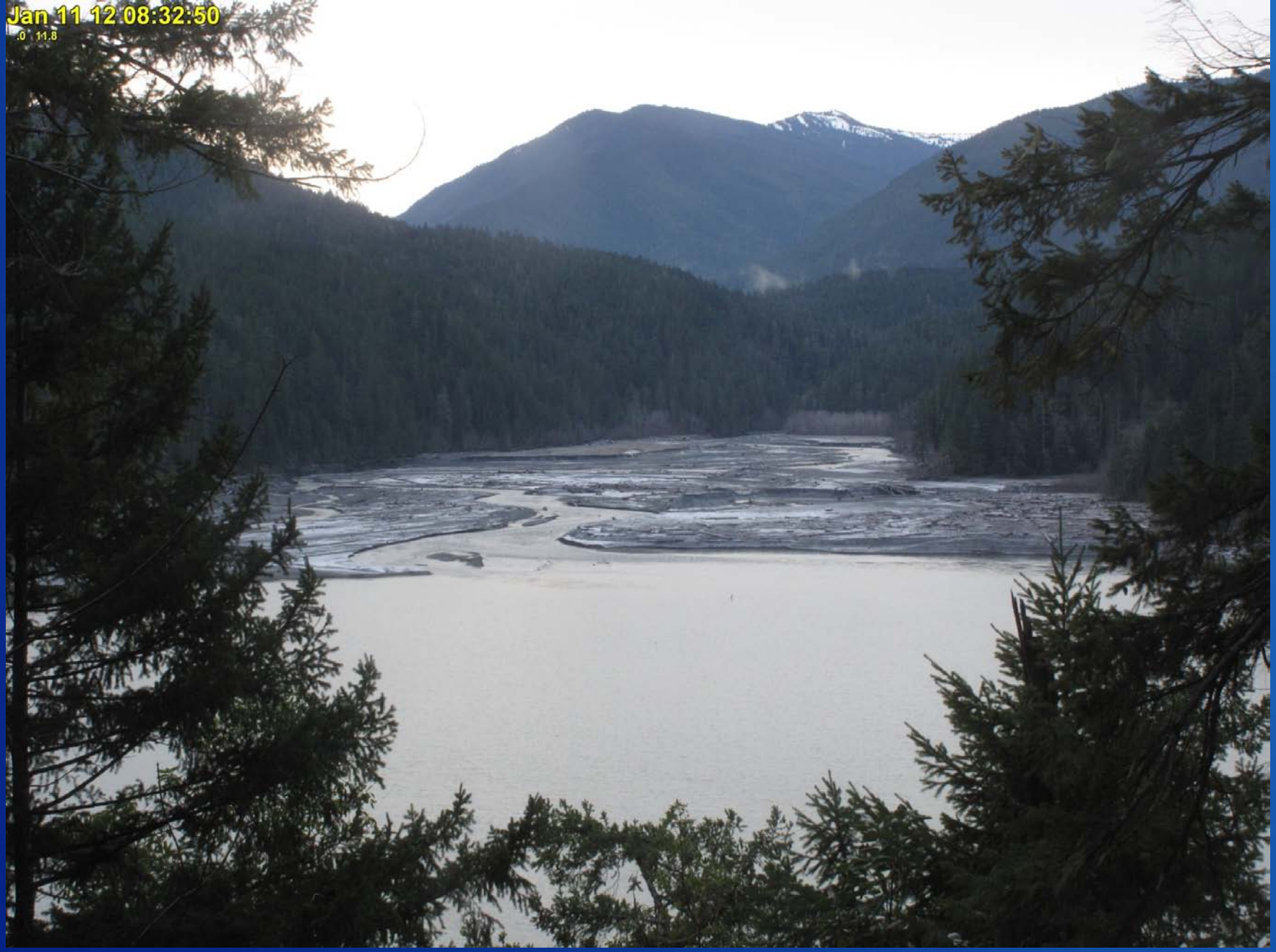

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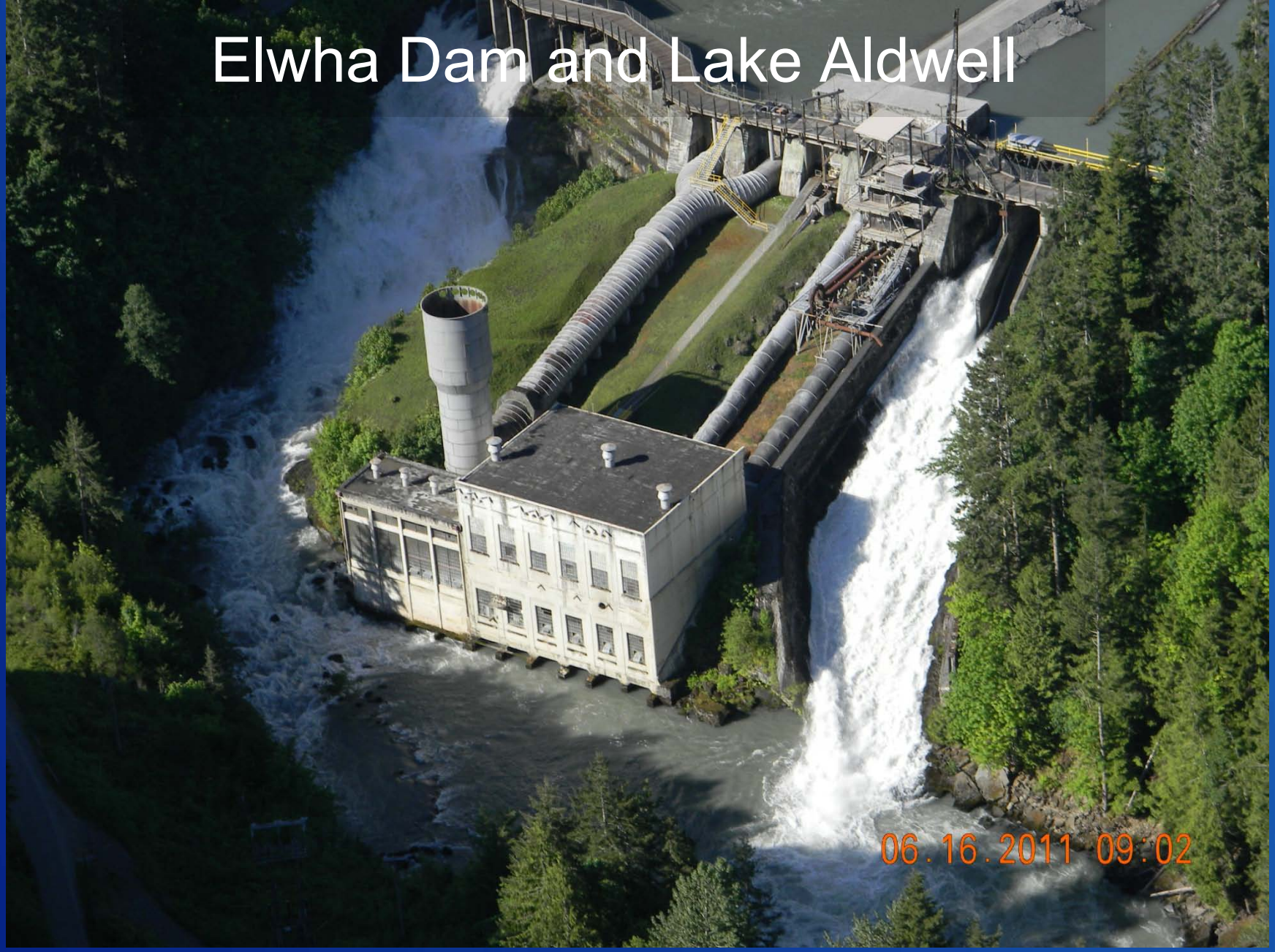
Elwha Dam and Lake Aldwell



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Lake Aldwell Delta June 16, 2011

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Lake Aldwell Delta August 18, 2011

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Q ~ 10,200 cfs (USGS McDonald Gage)
Reservoir = 178.4 (1929 NGVD)

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Q ~ 4,280 cfs (USGS McDonald Gage)
Reservoir = 171.5 (1929 NGVD)

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Q ~ 3,050 cfs (USGS McDonald Gage)
Reservoir = 172.1 (1929 NGVD)

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Q ~ 3,050 cfs (USGS McDonald Gage)
Reservoir = 172.1 (1929 NGVD)

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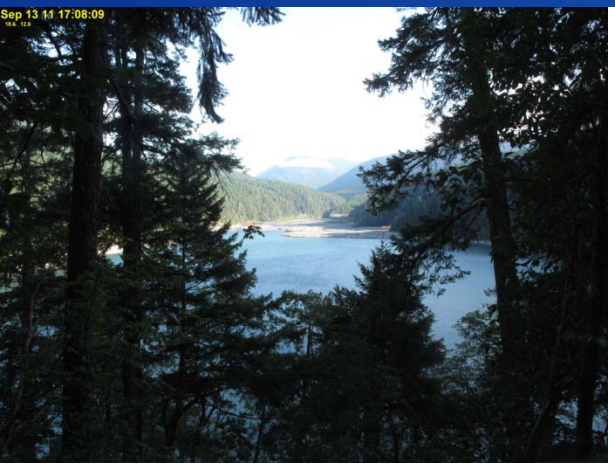
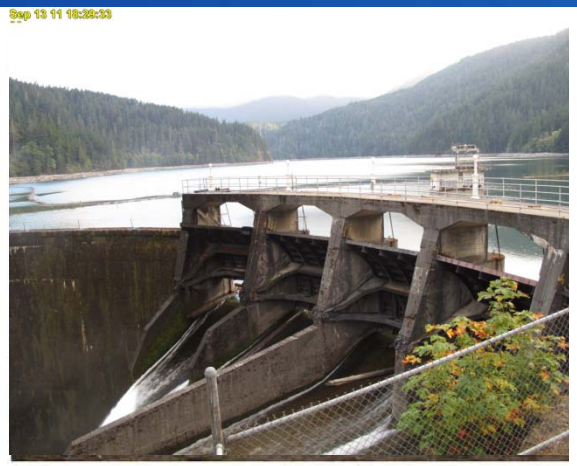
WEB Camera Views



Lake Mills Delta



Lower Lake Mills

Glines Canyon Dam

Lake Aldwell Delta

Lower Lake Aldwell

Elwha Dam

http://www.video-monitoring.com/construction/olympic/js.htm

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Elwha River Floodplain Restoration

Lower Elwha Klallam Tribe

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The End

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Questions?

http://www.nps.gov/olym/naturescience/elwha-ecosystem-restoration.htm

ELWHA RIVER
RESTORATION
Natural Wonders Never Cease

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