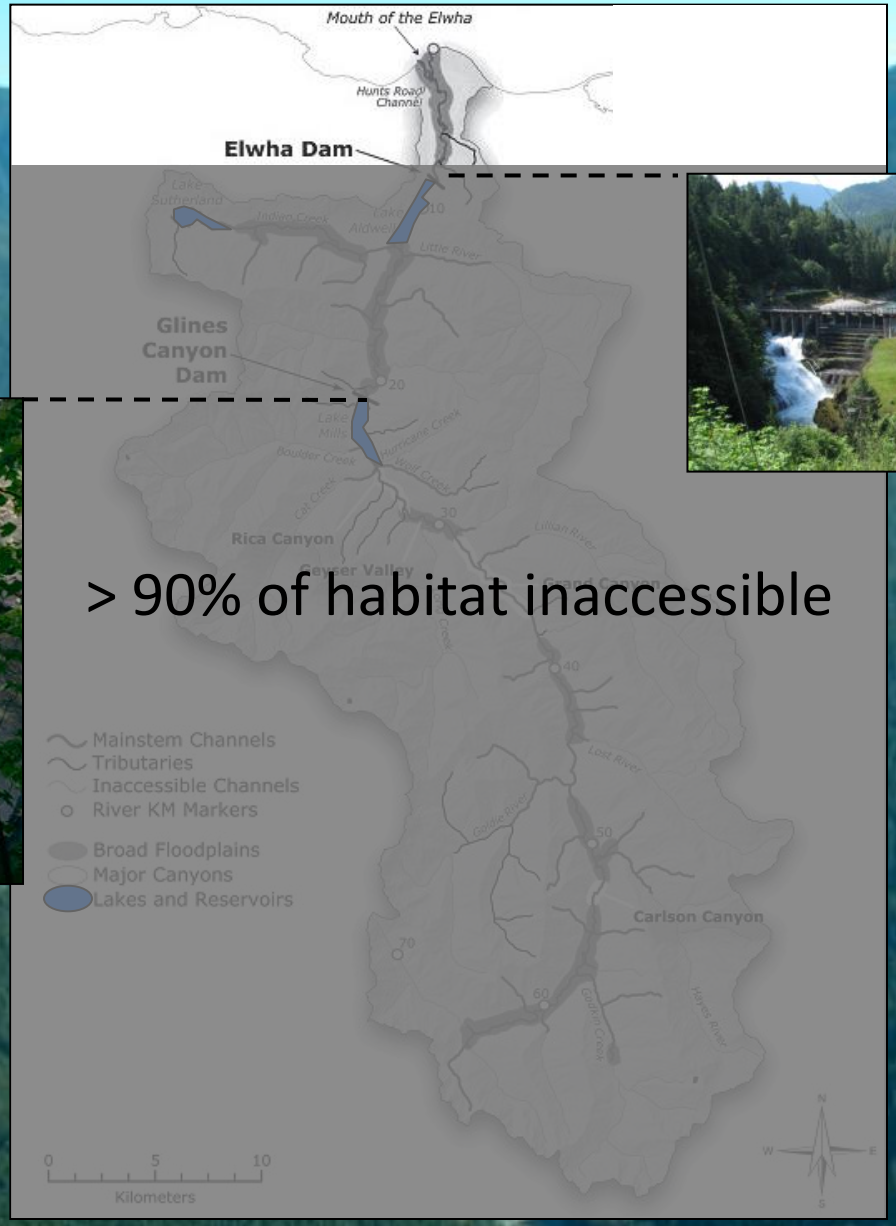
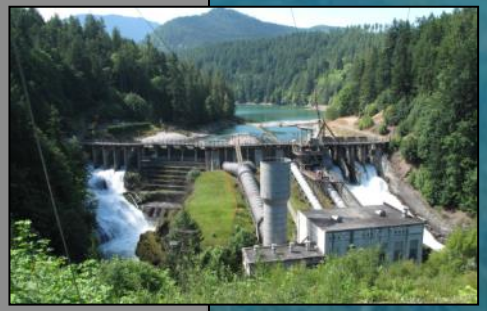
Ecosystem response during the removal of the Elwha River Dams

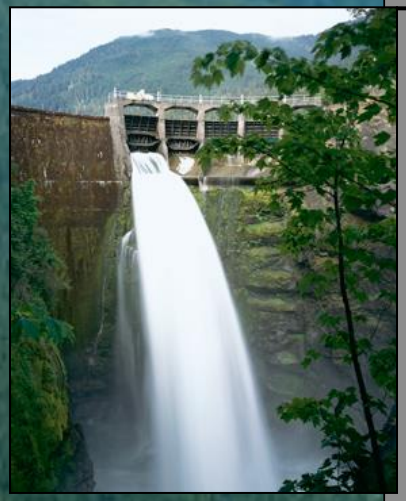
Presentation Prepared by George Pess - NOAA

December 2015

The Elwha River Basin

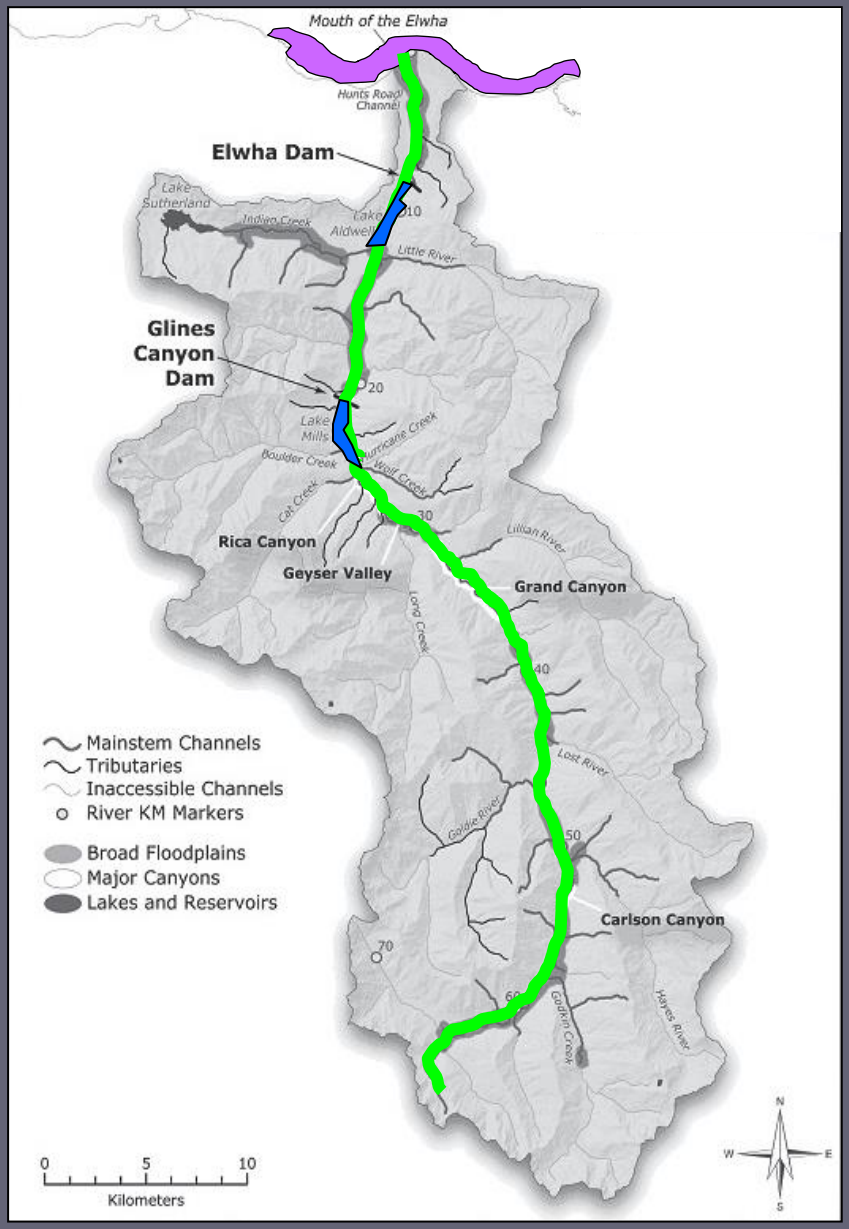






> 90% of habitat inaccessible

Elwha River ecosystem – place & processes



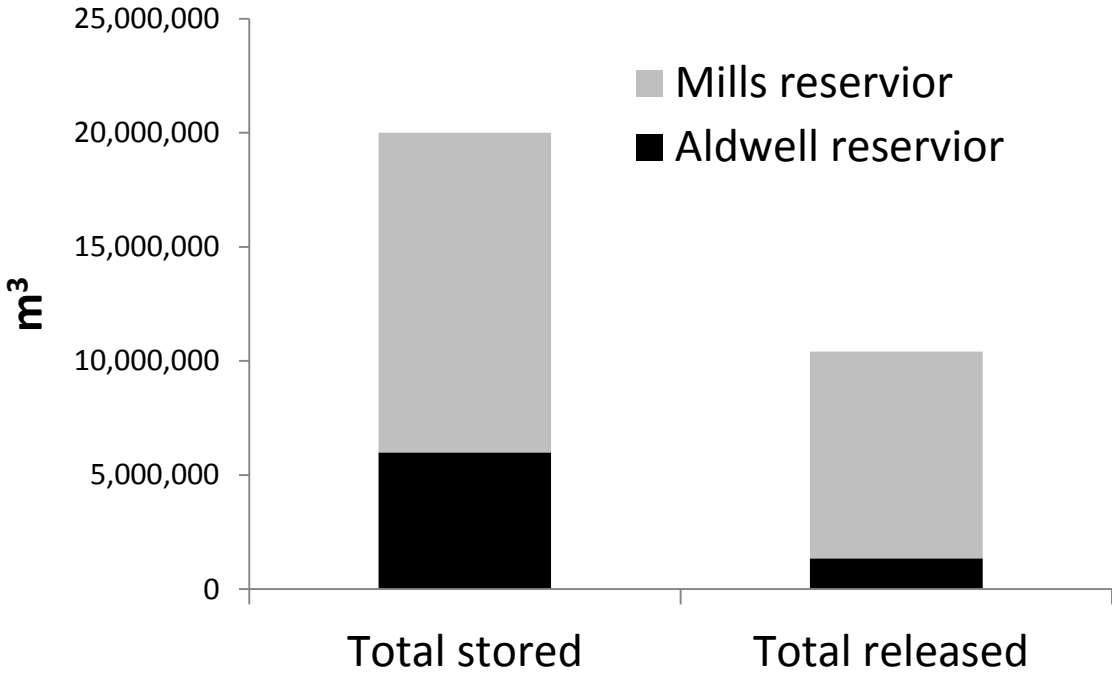
- Former reservoirs
- Nearshore
- River ecosystem
  - Sediment dynamics
  - Geomorphic change
  - Fish recolonization
  - Riverine foodwebs
  - Vegetation change

Sediment Dynamics

- ~ 58% of total stored sediment released as of October 2015
- Mainstem & floodplain downstream of dams aggraded 1-2m
- Majority of sediment transported to Strait of Juan de Fuca

Sediment dynamics

Between 40% to 60% of the total stored sediment was estimated to be released during & post dam removal.



~ 58% of the total stored released as of October 2015

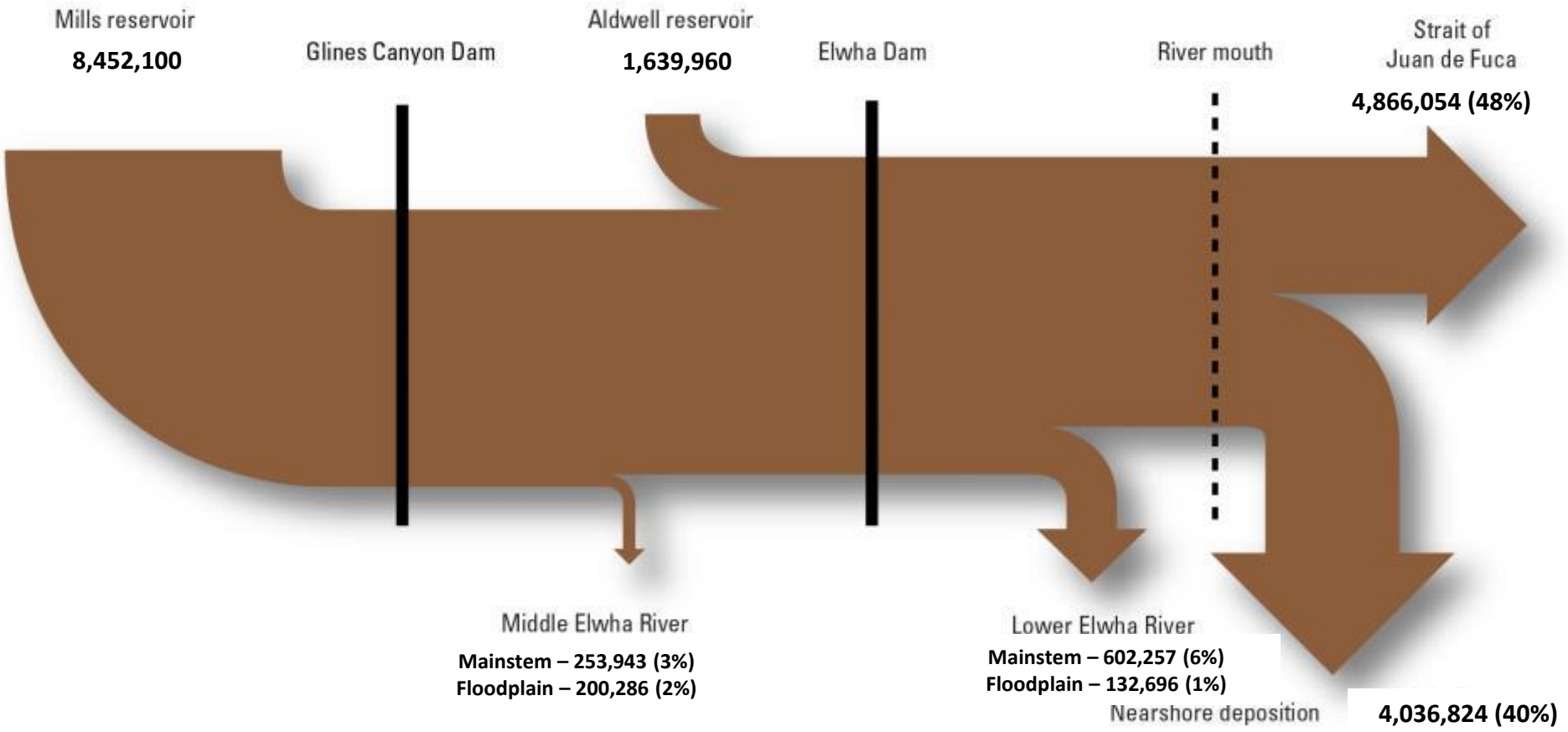
Mills reservoir

Pre dam removal 2015

Randle, T.J., et al., 2015. Large-scale dam removal on the Elwha River, Washington, USA: Erosion of reservoir sediment. Geomorphology.

Sediment dynamics

The majority of sediment would be transported out of the system and into the Strait of Juan de Fuca

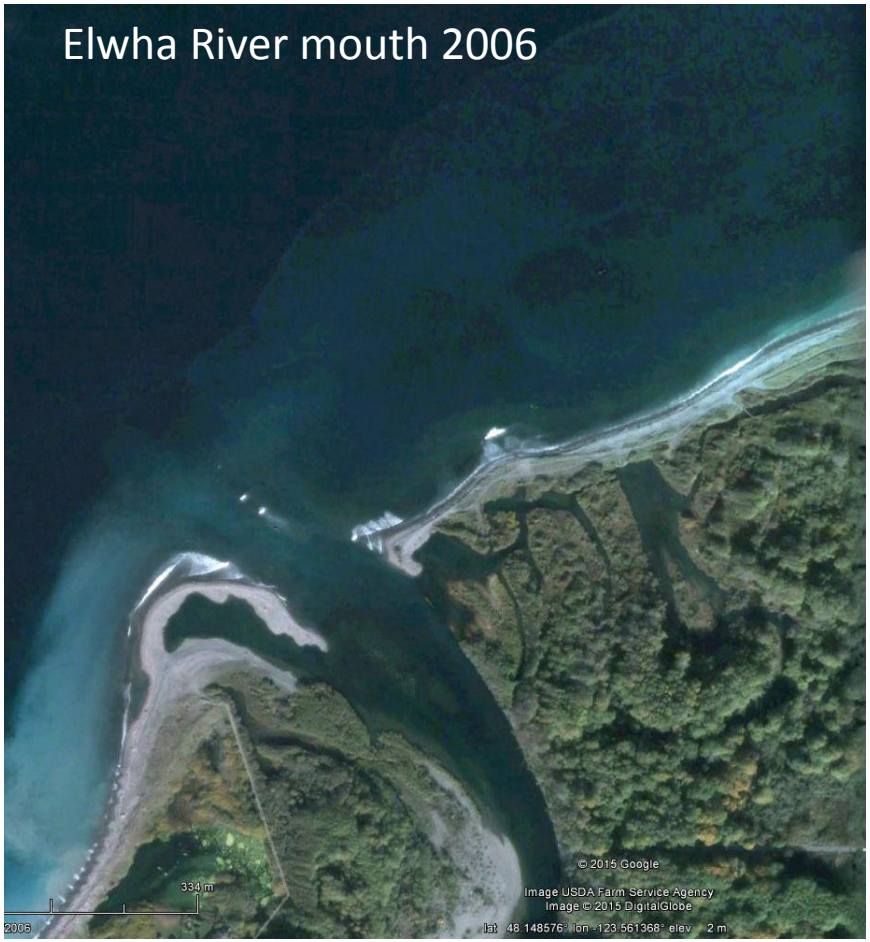


~90% of the sediment transported is in the Strait of Juan de Fuca

Warrick, T.J., et al. 2015. Large-scale dam removal on the Elwha River, WA, USA: source-to-sink sediment budget & synthesis. Geomorphology.

Geomorphic change

The majority of sediment deposited in the nearshore would be eastward or radial and not westward

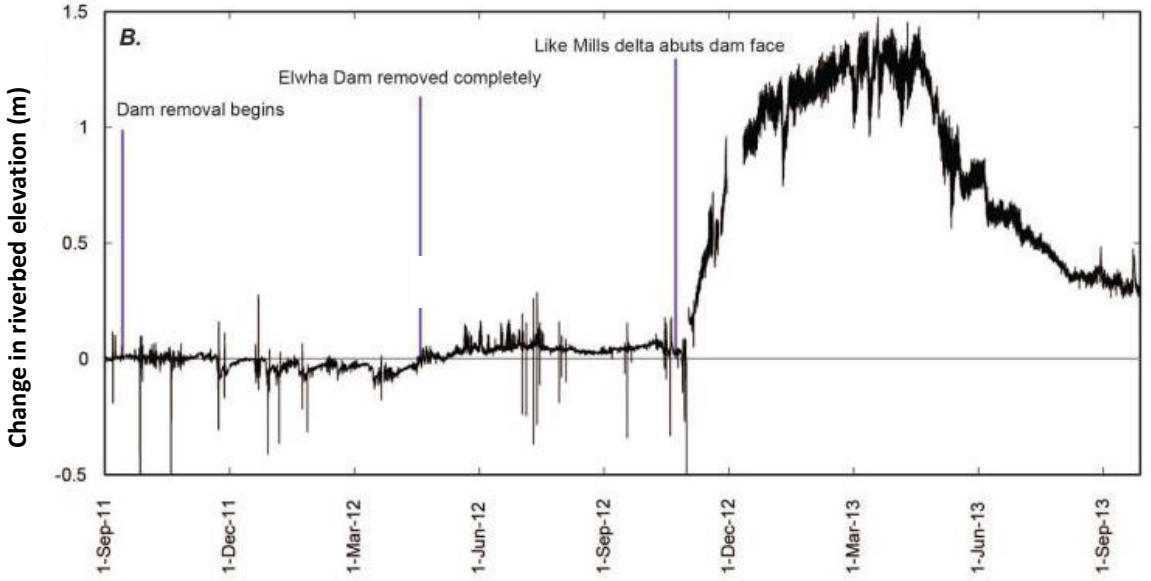


The majority of Elwha River delta is eastward and radial

-Warrick & Stevens, 2011

Geomorphic change

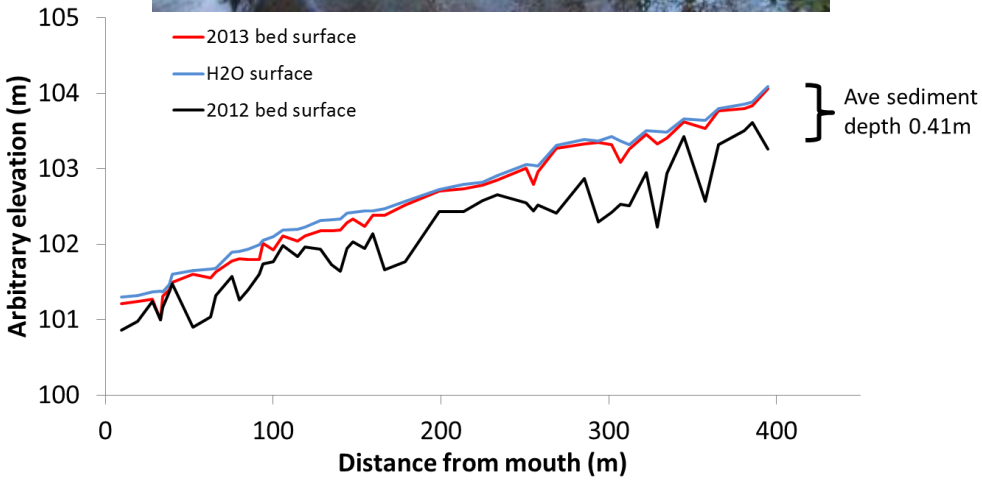
- Main stem river aggradation of 1 to 2 meters, temporary deposition of sediment in pools, greater channel braiding.
- Eventual widespread bed aggradation of 0.6 to 1 m, greater where pools filled.
- The development of new gravel bars which prompted channel avulsion that increased channel braiding by 50%.
- Pools coming back.

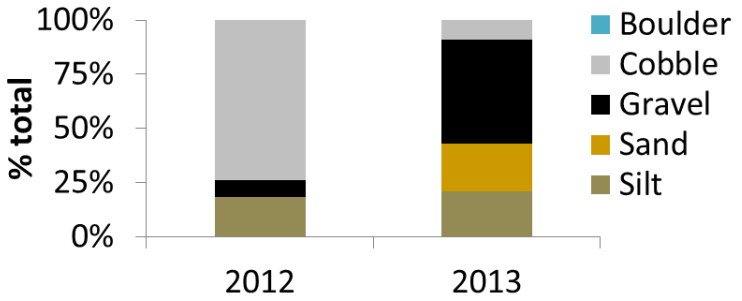


- Konrad, 2009 , Ecological Engineering
- East, A. E., et al 2015. Geomorphology
- Magirl, et al. 2015. Geomorphology.

Geomorphic change

Floodplain channels fish refuge or development of sediment plugs in side channels?





Sediment plugs, ~3% of all sediment stored in Elwha is in floodplain channels. Pools not coming back.

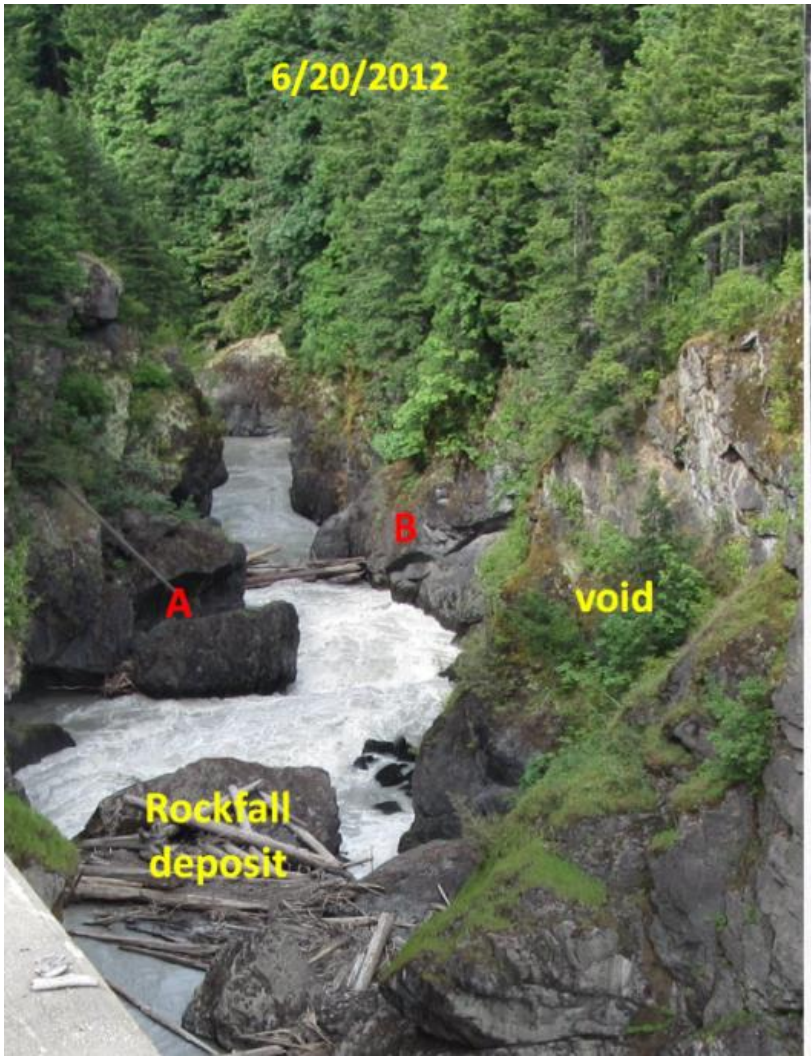
- Pess et al. 2008; Konrad 2009; East et al 2015; Warrick et al. 2015

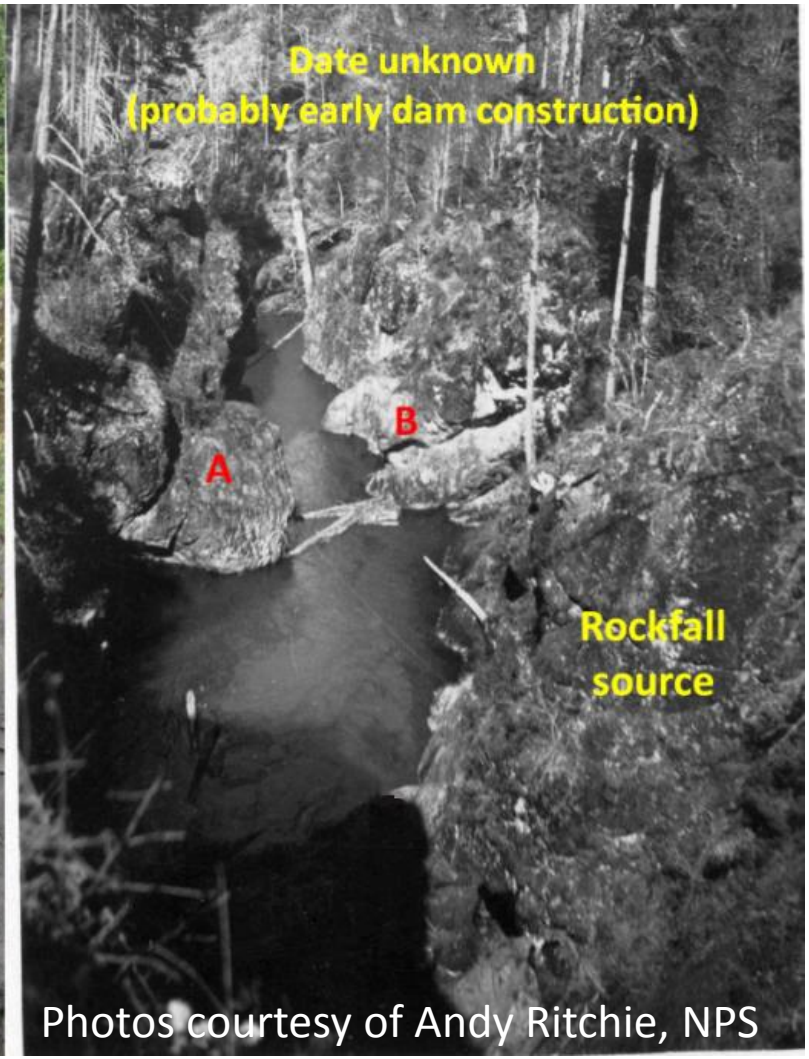
Fish Recolonization

- Salmonids making it above former Elwha Dam
- There has been an increasing number of adult salmonids each year above former Elwha Dam
- New species are being seen & salmonids are adapting to the local environmental conditions resulting in an increase in life history strategies

Fish recolonization

Salmon would reoccupy habitats immediately following dam removal





Photos courtesy of Andy Ritchie, NPS

Fish are getting past former Elwha dam but passage beyond former Glines Canyon dam has been limited due to rockfall

Fish recolonization

Salmon would reoccupy habitats immediately following dam removal

Photos courtesy fo Andy Ritchie , NPS

Former Glines Canyon dam rockfall blasting Sept/Oct 2015

Fish recolonization

Salmon would reoccupy habitats immediately following dam removal

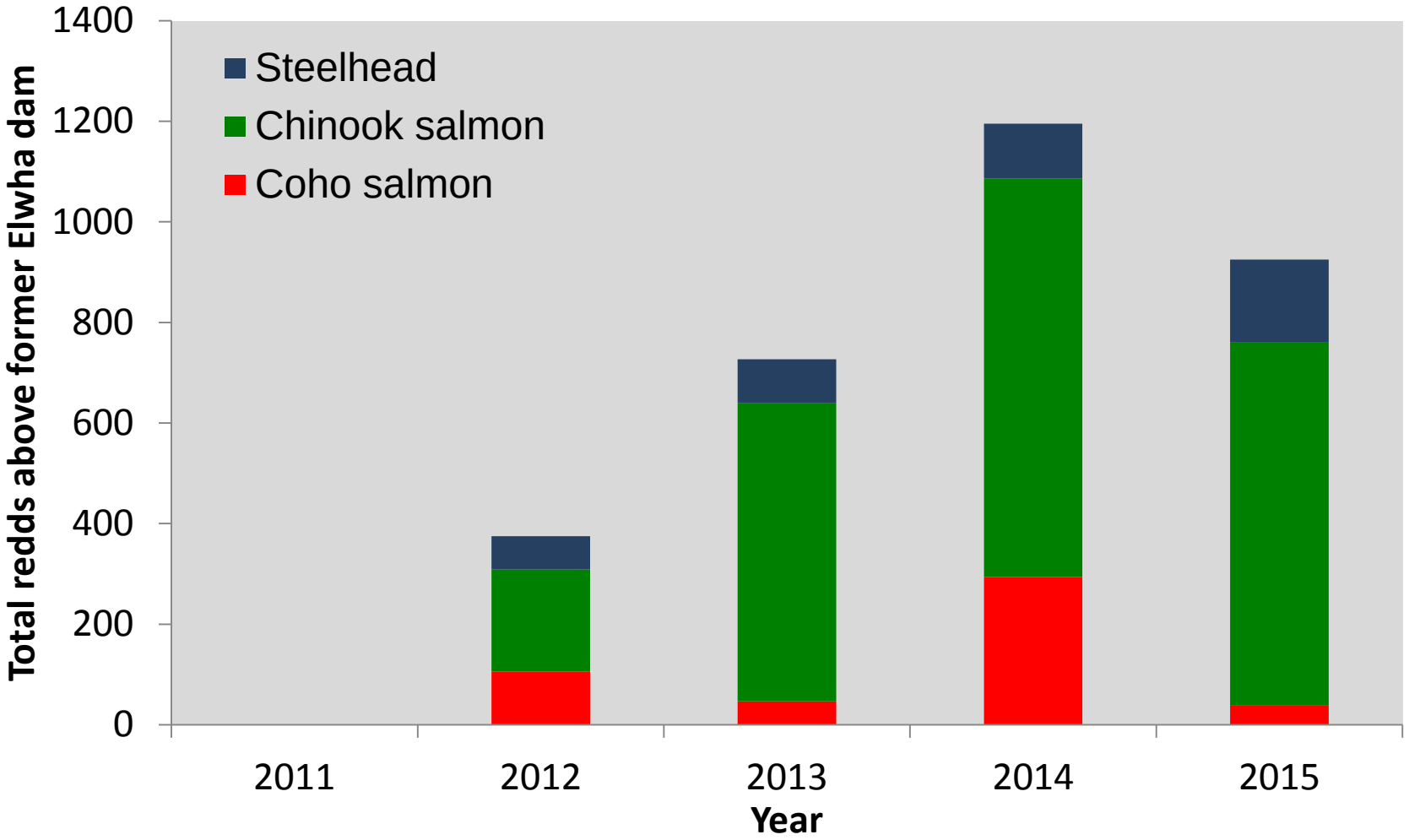
- Assisted Relocation
  - Hatchery & wild adult coho salmon
  - Wild steelhead

- Natural colonization
  - Steelhead, Chinook salmon, Coho salmon, Pink salmon, Sockeye salmon, & Pacific Lamprey

Recolonization is a combination of relocation & natural colonization by adult salmonids & other species

Fish recolonization

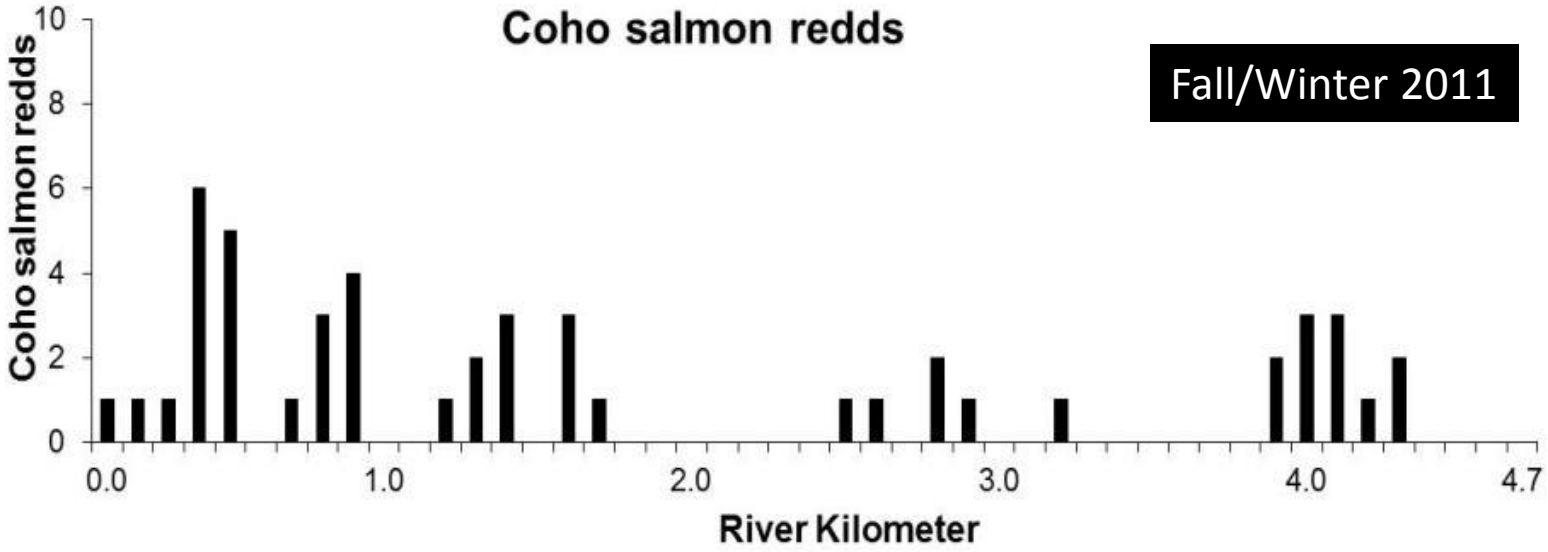
The rate & magnitude of salmonid recolonization would be similar to previous recolonization events in watersheds across the Pacific Rim (Pess et al. 2008).

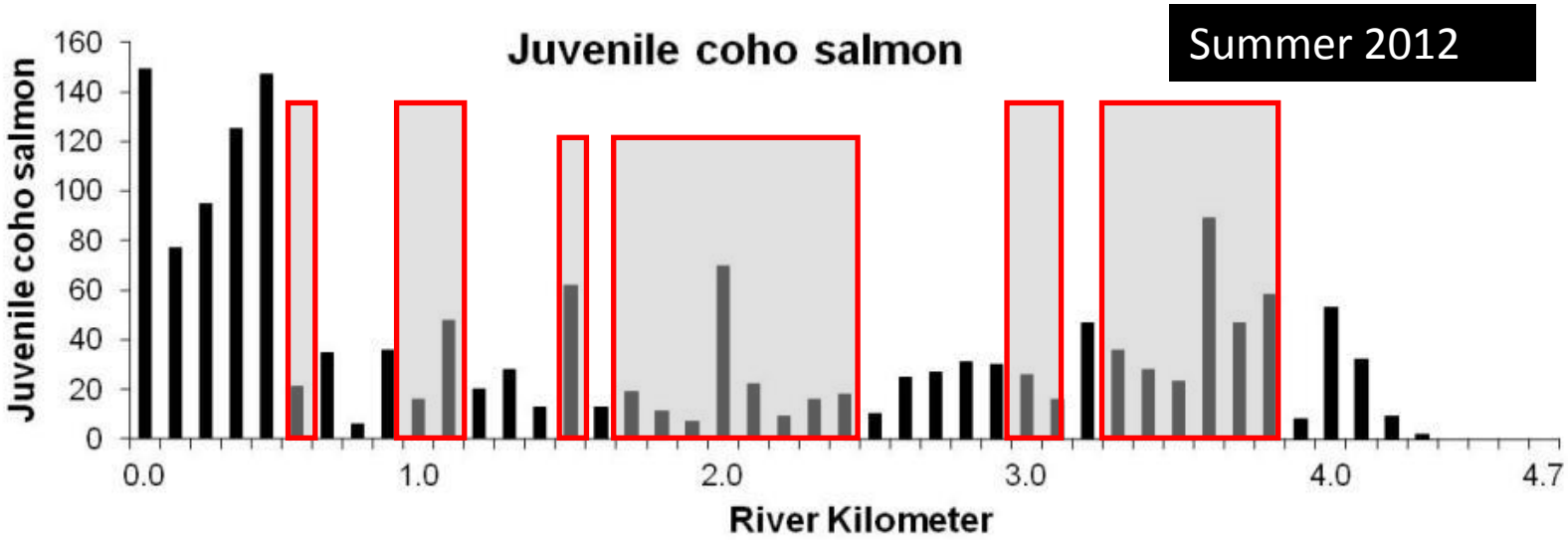


Recolonization rates for Chinook salmon & steelhead are similar to previous recolonization events (1.95 & 1.61/year) (Pess et al. 2014)

Fish recolonization

Juvenile anadromous salmonids can also disperse & colonize new areas of a reconnected watershed (Anderson et al. 2008)





- Juveniles have dispersed in new habitats between the dams in areas where adults have not spawned

Fish recolonization

Life history strategies of juvenile salmonids will emerge as a function of local environmental conditions such as stream temperature (Pess et al. 2008)

Length ~ 70mm

Length ~ 150mm

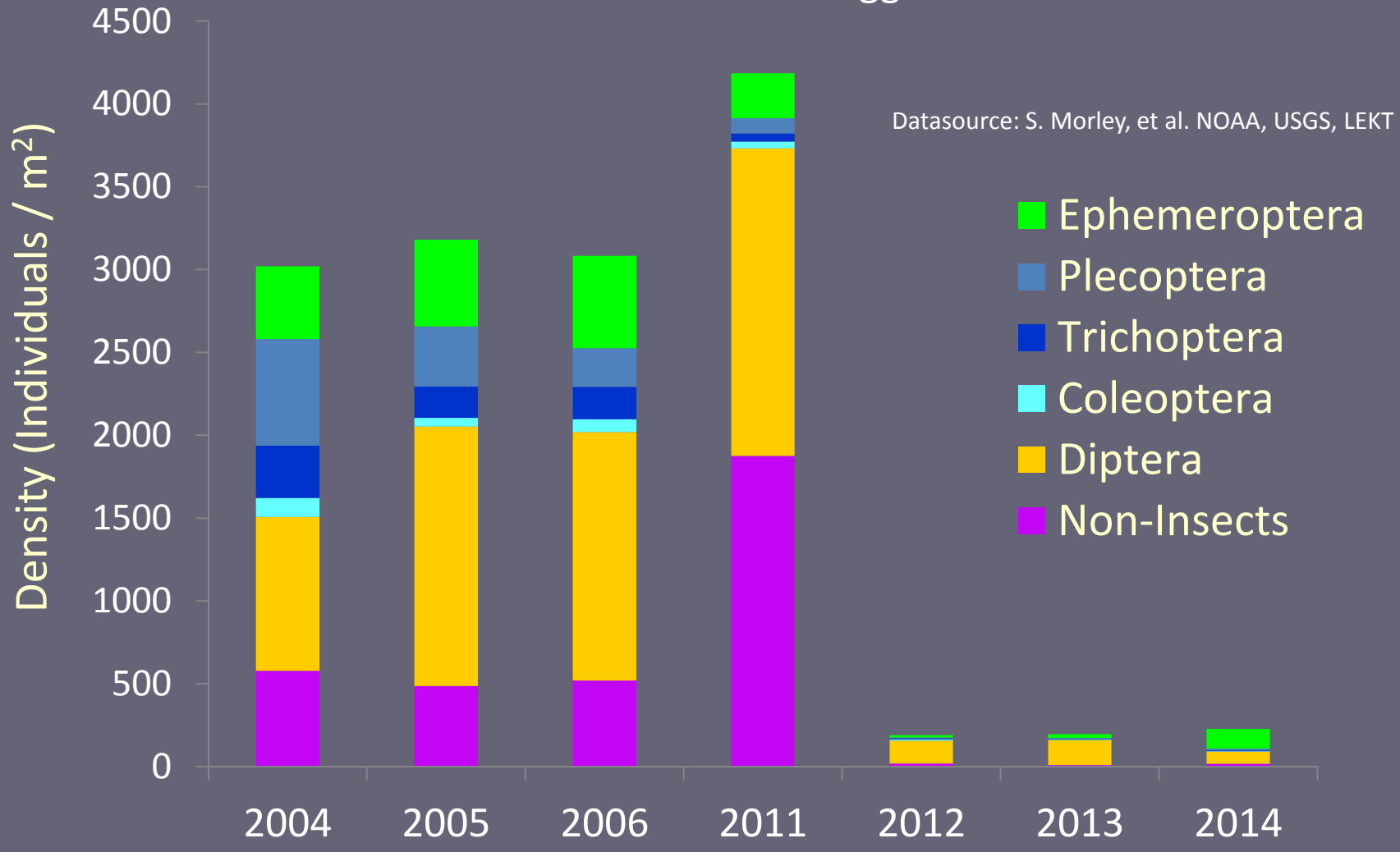
- The progeny of the first generation of anadromous salmonids has resulted in the documentation of different life history strategies of individuals with the same genetic composition. (Not predicted)

Riverine Foodwebs

- Benthic invertebrates reduced over 95% in lower Elwha
- Juvenile salmon relying more on terrestrial food sources
- American dippers benefiting from return of salmon & altering their migratory behavior

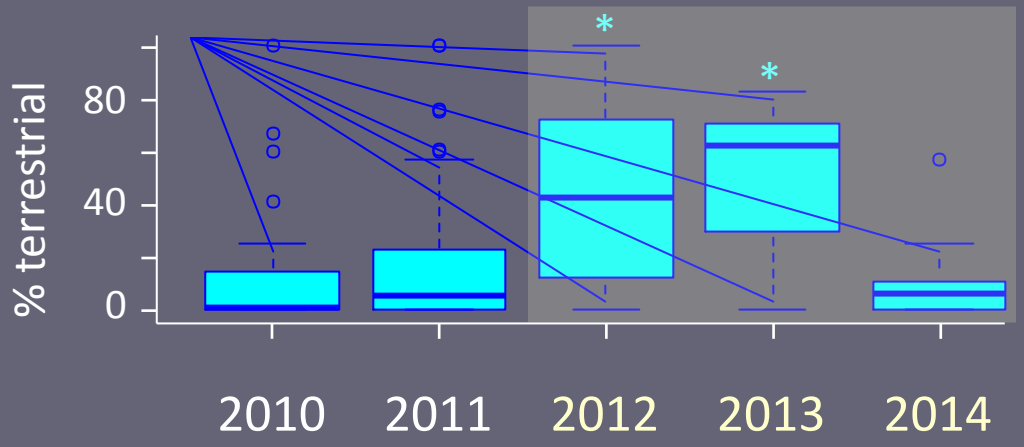
Benthic Foodweb

Initial decrease in aquatic invertebrate density due to increased suspended sediment levels and streambed aggradation.



There has been a 95% decrease in benthic invertebrate density below former Elwha dam and a shift in the benthic taxonomic composition

Benthic Foodweb



Below former Elwha Dam

* $P < 0.05$

There was a shift in the diet of *O. mykiss* due to the reduced benthic invetebrate density towards terrestrial resources (not predicted)

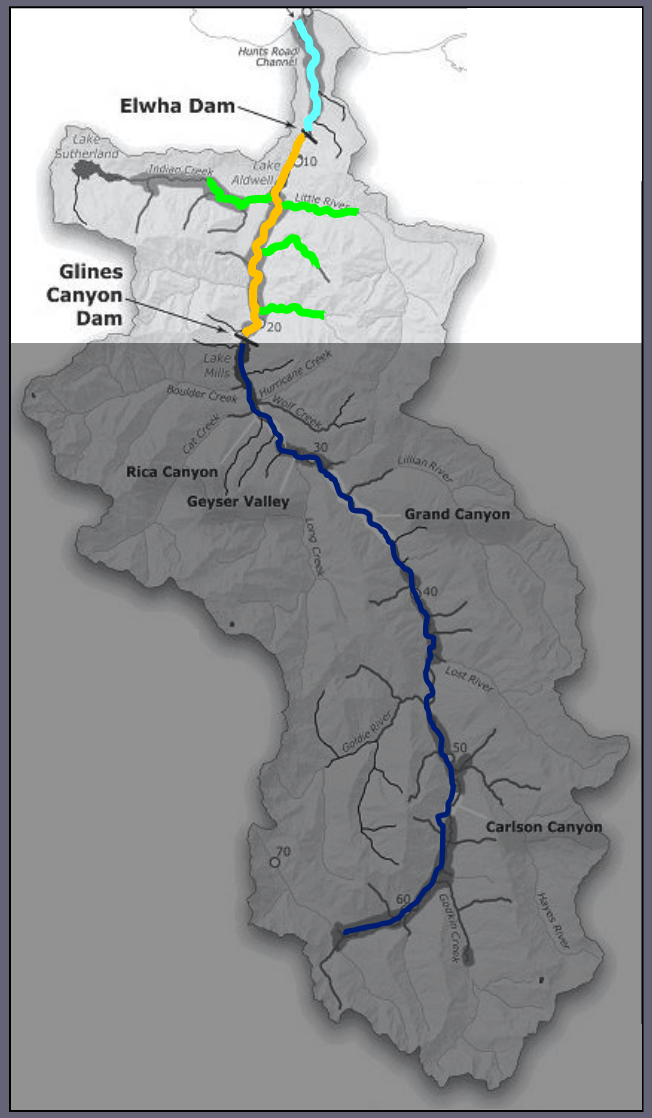
Marine-Derived Nutrients in the Freshwater Foodweb

The case of the American dipper (*Cinclus mexicanus*)

Photo by Chris Tonra

Photo by John McMillan

Elwha River dam removal benthic foodweb study design



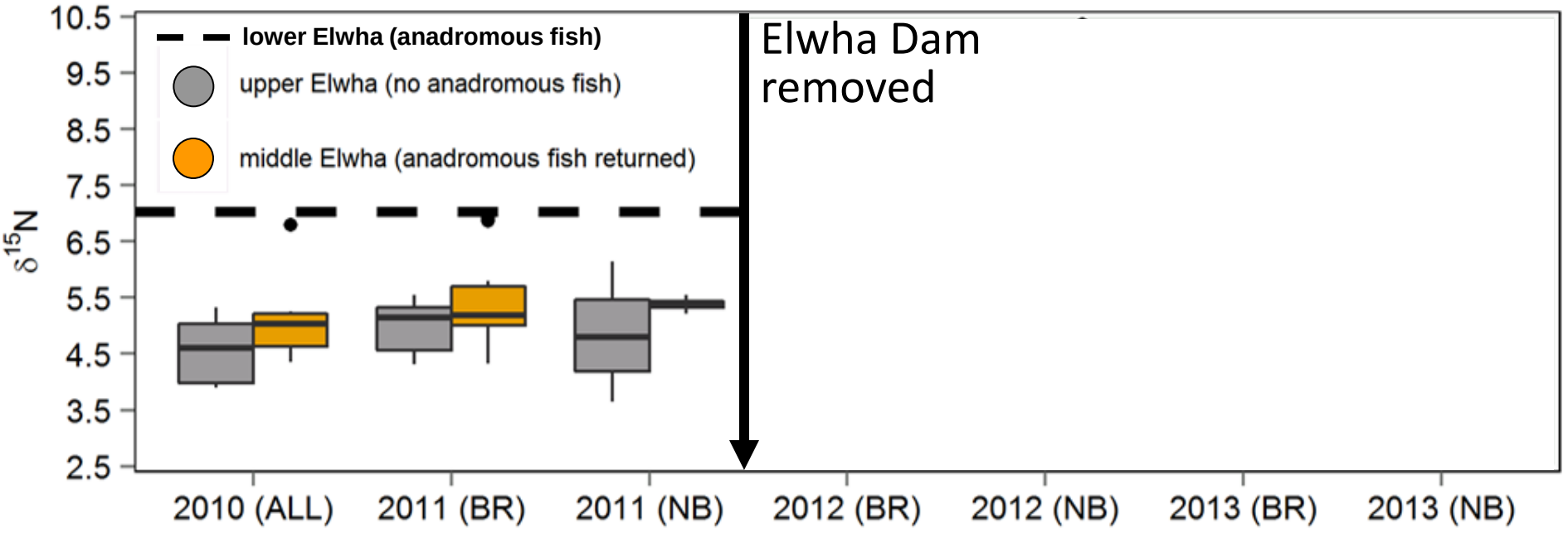
River sections: Below
Between
Above

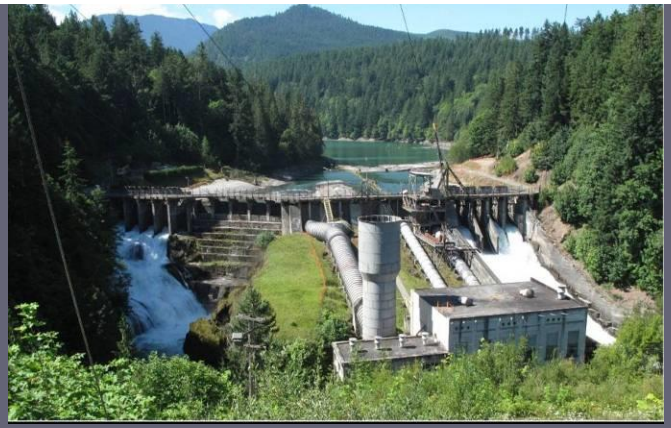
Habitat types: Mainstem
Side channels
Tributaries

Pre-removal: 2004-2011

During-removal: 2012-2014

Return of Marine-derived Nutrients to Elwha Foodweb





Modified from: Tonra, C. M., et al. 2015. The rapid return of marine-derived nutrients to a freshwater food web following dam removal. Biological Conservation

Terrestrial linkages – Marine dervied nutrients & river otter in the Elwha River

Kim Sager-Fradkin, Lower Elwha Klallam Tribe

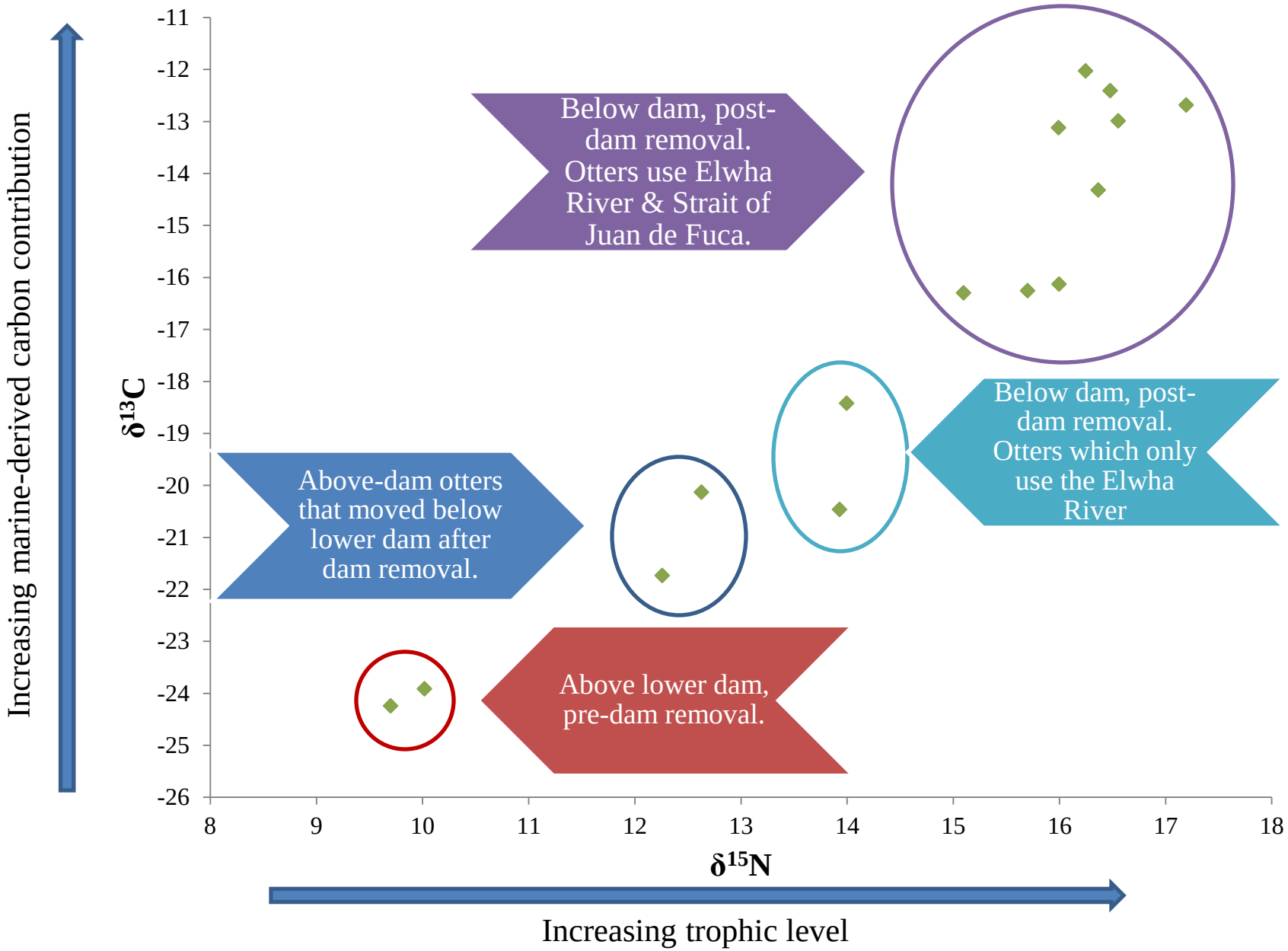
Former Glines Canyon Dam

Former Elwha Dam

18 miles west

9 miles east

Elwha River MDN in river otter diets 2011-2013



Revegetation - Reservoir revegetation plan

- 7 year plan
- Plant 400,000 native plants
- Sow 5,000 pounds of locally harvested seed

Slide courtesy Josh Chenoweth

Revegetation – Josh Chenoweth, NPS

2012

2014

Fine sediments

Coarse sediments

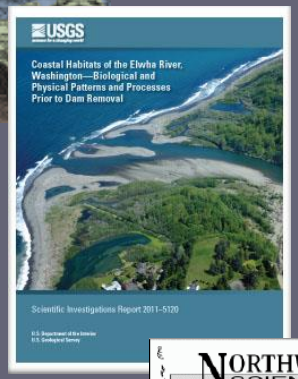
Revegetation

- Reservoirs being re-vegetated both naturally and with restoration efforts.
- Natural regeneration and plantings readily establish and thrive on fine sediments
- Coarse sediments proving to be a difficult substrate for most plants

Photo courtesy of Josh Chenoweth, NPS

Where to Find Additional Information

Geomorphology 2014-2015. Large-scale dam removal on the Elwha River, Washington USA. Series of five papers.



USGS Scientific Investigations Report, 2011. Coastal Habitats of the Elwha River, Washington: Biological and Physical Patterns and Processes Prior to Dam Removal.

Northwest Science Special Issue, 2008, Vol. 82: Dam Removal and Ecosystem Restoration in the Elwha River Watershed, Washington State.

www.elwharesearchconsortium.wildapricot.org/
www.nps.gov/olym/naturescience/elwha-ecosystem-restoration.htm