Session B3- Getting scientifically ready for the removal of the Elwha River dams- last call for baseline data

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Pess, George; McHenry, Mike; Morley, Sarah; Liermann, Martin; Beechie, Tim; McMillan, John; Denton, Keith; Peters, Roger; Duda, Jeff; Brenkman, Sam; Mayer, Kent; and Zimmerman, Mara, “Session B3- Getting scientifically ready for the removal of the Elwha River dams- last call for baseline data” (2011). International Conference on Engineering and Ecohydrology for Fish Passage. 42.
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Presenter Information
George Pess, Mike McHenry, Sarah Morley, Martin Liermann, Tim Beechie, John McMillan, Keith Denton, Roger Peters, Jeff Duda, Sam Brenkman, Kent Mayer, and Mara Zimmerman

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The removal of the Elwha River dams: last call for baseline data

Photo by John McMillan

George Pess, NOAA-NWFSC; Mike McHenry, Lower Elwha Tribe, Sarah Morley, Martin Liermann, Tim Beechie, John McMillan, Keith Denton: NOAA-NWFSC; Roger Peters, USFWS; Jeff Duda, USGS; Sam Brenkman, NPS; Kent Mayer, Mara Zimmerman: WDFW
Re-opening of fish passage at Embrey Dam on the Rappahannock River in Fredericksburg, VA. (Heinz Center 2002)
A context for dam removal in the Pacific Northwest

- Elwha River
- White Salmon River
- Sandy River
- Little Sandy River
- Calapooia (Umpqua) River
- Rogue River
- Klamath River

[Map showing locations of rivers with labels for dams: Removed, To be removed]
A Recent History of the Elwha River Basin

<1800’s

Large salmon runs

1910’s

1920’s

Dam construction

2000’s

Loss of salmon

2011

Dam removal

The Elwha River

- Large salmon runs
- Dam construction
- Loss of salmon
- Dam removal
The Action – removal of two dams

approx. 18-24 million m³ behind dams

dams to be removed 2011
Goals & questions

• Goals
  – Quantify the ecological “signal” following dam removal in the Elwha River basin.
  – Share critical findings with other dam removal projects.

• Questions
  • How will habitat condition and ecosystem processes change with the removal of the Elwha River dams?
  • How will salmon populations change with the removal of the Elwha River dams?
Study design

- Post dam removal
  - **Natural** downstream transport of sediment & wood
  - **Allowance of** upstream salmon migration

<table>
<thead>
<tr>
<th>Reach</th>
<th>Sediment</th>
<th>Fish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quinault</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Upper Elwha</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Middle Elwha</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Lower Elwha</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

○ Yes  ● No
How will habitat conditions & ecosystem processes change with the removal of the Elwha River dams?

- Increase in sediment & wood supply
- Mainstem channel
  - Channel widening & “aggradation”
  - Increased channel migration rate
- Decrease in riparian stand age
- **Floodplain channels**
  - Biological refuge?
  - Sediment repository?
  - Both?
Floodplains - bounded alluvial valley bottoms
Why are floodplain channels important to the Elwha dam removal?

Large amount of floodplain channels

<table>
<thead>
<tr>
<th>Location</th>
<th>Floodplain channels (km)</th>
<th>Main stem (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Elwha</td>
<td>17.50</td>
<td>14.11</td>
</tr>
<tr>
<td>Middle Elwha</td>
<td>12.60</td>
<td>8.89</td>
</tr>
<tr>
<td>Lower Elwha</td>
<td>7.76</td>
<td>8.05</td>
</tr>
</tbody>
</table>

Pess et al. 2008
Why are floodplain channels important to the Elwha dam removal?

Repository of wood, sediment, water, & nutrients

Lower Elwha River floodplain

Hunts road channel

Mainstem

Pess et al. 2008
Why are floodplain channels important to the Elwha dam removal?

Repository of wood, sediment, water, & nutrients

Upper Elwha River floodplain
Why are floodplain channels important to the Elwha dam removal?

Greater habitat use by salmonids

Clear = main stem  Black filled = floodplain

Pess et al. 2008
Why are floodplain channels important to the Elwha dam removal?

Better condition factor for outmigrating salmonids

Jeffres et al. 2008
Enclosed experiment, same age Chinook
Longitudinal response – Food web indices

- 52 study sites
- Periphyton
- Invertebrates
- Stable isotopes
Longitudinal response
Indices of primary productivity

- Initial reduction due to sediment
- Long-term increase due to marine derived nutrients?

organic matter density (AFDM)

mg/cm$^2$

Lower Middle Upper
0.05 0.10 0.20 0.50 1.00

p < 0.001, 1-way ANOVA log transformed, Tukey’s HSD
Longitudinal response
Habitat condition

- Pebble counts
- Residual pool depth
- Fine sediment sampling

Photo by John McMillan
Glines Canyon Dam

17 pools and riffle crests
8 fine sediment sites
(3 per site)

Elwha Dam

19 pools and riffle crests
9 fine sediment sites
(3 per site)

Flow

Strait of Juan De Fuca

Longitudinal response
Habitat condition
Longitudinal response

Residual pool depth

Residual depth = maximum depth – tail depth

---

= new stream bed post dam removal
How does residual pool depth vary by spatial location pre dam removal?

Lower & Middle Elwha

Residual pool depth

River Kilometer (rkm) vs. Residual pool depth (m)
How does residual pool depth vary by year pre dam removal?


Residual pool depth

- 2009
- 2000

n = 20, p = 0.15
How will salmon populations change with the removal of the Elwha River dams?

- How long will it take salmon to colonize?
- What habitats and locations will different salmon species colonize?
- How many more salmon will there be?
- Barriers
- Source population size
- Distance from source
- Source stray rate
- Colonizing productivity
- Habitat area & type
- Ocean conditions
- Resident species interaction
- Life history adaptations
Barriers

○ = dams
○ = canyons

The map shows the location of barriers such as dams and canyons along the river system, with markers indicating key locations like Elwha Dam, Glines Canyon Dam, Rica Canyon, and Grand Canyon.
<table>
<thead>
<tr>
<th>Species</th>
<th>Population size below dams</th>
<th>% Hatchery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Chinook</td>
<td>Unknown</td>
<td>Unknown</td>
</tr>
<tr>
<td>Summer/Fall Chinook</td>
<td>~1,500</td>
<td>~75 (?)</td>
</tr>
<tr>
<td>Coho</td>
<td>~2,000</td>
<td>~76 (?)</td>
</tr>
<tr>
<td>Chum</td>
<td>~100</td>
<td>0</td>
</tr>
<tr>
<td>Pink</td>
<td>~100</td>
<td>0</td>
</tr>
<tr>
<td>Sockeye</td>
<td>~25</td>
<td>0</td>
</tr>
<tr>
<td>Winter steelhead</td>
<td>~500</td>
<td>?</td>
</tr>
<tr>
<td>Summer steelhead</td>
<td>~50</td>
<td>?</td>
</tr>
<tr>
<td>Sea-run cutthroat</td>
<td>Unknown</td>
<td>0</td>
</tr>
<tr>
<td>Char</td>
<td>~500</td>
<td>0</td>
</tr>
</tbody>
</table>
Distance from source population

- Chinook & coho
- Pink & chum
- Sockeye, Steelhead/rainbow, char, & cutthroat
Source population size & stray rate

Population size – 10,000
Stray rate – 1%
# strays - 100

Population size – 1,000
Stray rate – 10%
# strays - 100
Source stray rate will be a large driver in determining the number of colonists.

Fraser river adult pink salmon colonists

Estimated straying rate into newly opened habitats

- 1%
- 2.5%
- 5%

Habitat opened

Year

Straying away from sediment source

• High sediment load in a short time period
  – Deleterious effects on salmon

• Straying away from Elwha

• Mt. St. Helens
  – Stray rates increased from 16% to 45%
Turbidity & the buffering effects of floodplains
Turbidity & the buffering effects of floodplain channels

- Groundwater channel
- Surfacewater channel
- Main stem
## Colonizing productivity

<table>
<thead>
<tr>
<th>Species</th>
<th>Location</th>
<th>Population growth rate (r)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pink salmon</td>
<td>Fraser River (Above Hell's Gate), British Columbia, Canada</td>
<td>1.18</td>
</tr>
<tr>
<td>Pink salmon</td>
<td>Glacier Bay, Southeast Alaska</td>
<td>2.01</td>
</tr>
<tr>
<td>Pink salmon</td>
<td>South Fork Skykomish, Puget Sound, Washington State</td>
<td>1.18</td>
</tr>
<tr>
<td>Coho salmon</td>
<td>Cedar River, Puget Sound, Washington State</td>
<td>2.08</td>
</tr>
<tr>
<td>Chinook salmon</td>
<td>Cedar River, Puget Sound, Washington State</td>
<td>1.95</td>
</tr>
<tr>
<td>Chinook salmon</td>
<td>South Fork Skykomish, Puget Sound, Washington State</td>
<td>1.28</td>
</tr>
</tbody>
</table>
Colonizing productivity & successful colonization

% increase in population abundance vs. Number of years since colonization

- Cedar River: ~300
- Glacier Bay: ~11,500
- Fraser River: ~1,800,000
- S.F. Skykomish: ~22,000
Colonizing productivity & modeled Chinook salmon response in the Elwha River

Habitat opened
Elwha habitat area and type
Elwha River salmon redistribution
Elwha adult & juvenile enumeration

- Redd surveys
- SONAR
- Fish weir
- Snorkel surveys
- Smolt trap
- Various juvenile sampling
  - Snorkel
  - Seine
  - E-fishing

Photos by John McMillan
Elwha Adult Residence

- **Bull trout**
- **Steelhead**
- **Chinook**
- **Coho**
- **Chum**
- **Pink**
- **Spawner surveys, weir, SONAR**

- **Spring**
- **Summer**
- **Fall**
- **Winter**
Chinook SONAR v. redd count

![Histogram showing the comparison between Chinook SONAR and redd count surveys. The x-axis represents Total Chinook with intervals from 2400 to 3000, and the y-axis represents Frequency with intervals from 0 to 1000. There is a red oval highlighting a specific data point related to Spawner surveys. The diagram illustrates that the sonar data points are higher than the redd count surveys.]
Elwha Juvenile Residence

- Bull trout
- Steelhead
- Chum
- Coho
- Pink
- Chinook

Seasons:
- Spring
- Summer
- Fall
- Winter
Elwha Juvenile Residence

- **Bull trout**: Smolt trap, end of summer population estimate
- **Steelhead**: Smolt trap
- **Chum**: Smolt trap
- **Coho**: Smolt trap, end of summer population estimate
- **Pink**: Smolt trap
- **Chinook**: Smolt trap, end of summer population estimate

**Seasons:**
- Spring
- Summer
- Fall
- Winter
How many years until we can detect change due to dam removal?

The number of years

Effect size (the magnitude of change)

- Adult Chinook
- Smolts
- Juvenile salmonid density
- Invertebrate density
- Residual pool depth

The graph shows the time it takes to detect changes in various metrics (effect size) after dam removal.
Elwha River hypotheses summary

- Side channels will act as either;
  - biological refuge
  - sediment repository.

- Primary & secondary productivity
  - Initial decrease – sediment
  - Long term increase – marine derived nutrients & detrital input

- Salmonids will establish self sustaining populations in the middle & upper Elwha
If you forget everything else...

- We don't need to teach an ecosystem what to do. We just need to give it the opportunity to do it.
Acknowledgements

Collaborators
NWFSC – Todd Bennett, Holly Coe, Kurt Fresh, Daniel Hernandez, Kris Kloehn, Gary Winans, Kinsey Frick, Brian Burke

NOAA’s Restoration Center – Polly Hicks, Tisa Shostik

Lower Elwha Tribe - Mel Elofson, Sonny Sampson, Raymond Moses, Doug Morrill, Larry Ward

NPS – Brian Winter, Pat Crain, Jerry Frelich

Bureau of Reclamation – Tim Randle, Jennifer Bountry

U.S. Fish & Wildlife Service - Brad Thompson

U.S. Geological Survey - Jason Dunham, Joe Peterson, Pat Shafroth, Chris Konrad

WDFW – Mike Gross, Dan Rawding

Support
NOAA Fisheries – NWFS C

NOAA Fisheries – Restoration Center, Open Rivers Initiative

Lower Elwha Tribe, USFWS, USGS, NPS

For today’s talk - National Conference on Engineering and Ecohydrology for Fish Passage