May 1st, 3:30 PM - 5:00 PM

Changes in Kelp and Other Seaweeds Following Elwha Dam Removal

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*Washington (State). Department of Natural Resources*

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Speaker
Stephen P. Rubin, Helen Berry, Nancy Elder, Ian Miller, Jeff Duda, Melissa M. Foley, Jonathan A. Warrick, Matt Beirne, Mike McHenry, and Rob Pedersen

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Changes in Kelp and Other Seaweeds Following Elwha Dam Removal

Steve Rubin\textsuperscript{1}, Helen Berry\textsuperscript{2}, Nancy Elder\textsuperscript{3}, Ian Miller\textsuperscript{4}, Jeff Duda\textsuperscript{1}, Melissa Foley\textsuperscript{5}, Jon Warrick\textsuperscript{5}, Matt Beirne\textsuperscript{6}, Mike McHenry\textsuperscript{6}, Rob Pedersen\textsuperscript{7}

\textsuperscript{1}USGS Western Fisheries Research Center \hspace{2cm} \textsuperscript{2}WA Department of Natural Resources
\textsuperscript{3}USGS WFRC Marrowstone Marine Station \hspace{2cm} \textsuperscript{4}WA Sea Grant, Port Angeles WA
\textsuperscript{5}USGS Pacific Coastal and Marine Science Center \hspace{2cm} \textsuperscript{6}Lower Elwha Klallam Tribe
\textsuperscript{7}USEPA Region 10 Environmental Cleanup Office
Nearshore Vegetation

• Diverse algae and seagrasses
• 3-D structure
• Important food source to local and distant ecosystems
Expected Changes

- **Long-term**
  - Shift toward soft sediment species

- **Short-term**
  - Turbidity
  - Scour
  - Burial
Floating Kelp Monitoring Methods (Since 1989)

Near-vertical aerial photography collected from small plane during a late summer low tide (7500’ MSL) with Nikon D200 digital 35mm DSLR camera. Hand delineated onto 1:12K basemaps.
Floating Kelp Canopy Area Changes Following Elwha Dam Removal

-53% (2011-2013)

- Crescent Bay -54%
- Tongue Pt – Observatory Pt -42%
- Freshwater Bay -74%
- Angeles Point – Elwha Bluffs -100%
- Ediz Hook +14%
- Dungeness Bluffs -7%
- Dungeness Spit -42%
- Angeles Point – Elwha Bluffs -100%
- Freshwater Bay -74%
- Tongue Pt – Observatory Pt -42%
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Underwater Transects Surveyed in 2010*, 2012 & 2013 from shallow to -15 m

* Thanks to Clallam County (Cathy Lear) and MRC (Jim Norris) for 2010 imagery.
Underwater Video Classification

- **Vegetation Types**
  - All macrovegetation
    - All kelp
      - Stipitate kelp
      - Prostrate kelp
      - Floating kelp
    - Non-kelp red/brown algae
    - Green algae
    - Seagrass

- **Cover classes**
  - Really Low <15%
  - Low 15-33%
  - Medium 33-66%
  - High 66-85%
  - Really High >85%

Mapping Unit ~ 1 m²
Directly east of the Elwha River mouth, -8 m (MLLW).
Major Decrease in Area with Vegetation Present, 2010-2013

- **p < 0.2**
- **p < 0.05**
Dive surveys

• Identify and count plants in 30 m x 1 m swaths
• Transect endpoint markers on seafloor:
  - End pyramid
  - Center post

• Two transects per site
• Seasonal window: Late July-early September
• Surveys conducted annually at 17 sites:
  1 site: 2009-2013
  4 sites: 2010-2013
  9 sites: 2011-2013
  3 sites: 2009 (GPS only, no endpoint markers), 2012-2013
All kelp

- Density before dam removal
All kelp

- Percent change in density after dam removal

Before

Before-2012

Before-2013

Percent change

-100.0 -99.9
-99.8 -90.0
-89.9 -80.0
-79.9 -70.0
-69.9 -60.0
-59.9 -50.0
-49.9 -0.0
0.1 - 80.0

Percent change

-100.0
-99.9 -90.0
-89.9 -80.0
-79.9 -70.0
-69.9 -60.0
-59.9 -50.0
-49.9 -0.0
0.1 - 10.0
Kelp species

- Density before dam removal and in 2012 and 2013
Kelp species

- Density before dam removal and in 2012 and 2013

<table>
<thead>
<tr>
<th>Species</th>
<th>Before</th>
<th>2012</th>
<th>2013</th>
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</thead>
<tbody>
<tr>
<td>Agarum fimbriatum</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
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<tr>
<td>Alaria marginata</td>
<td>0.0</td>
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<tr>
<td>Costaria costata</td>
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<td>0.0</td>
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<tr>
<td>Cymathere triplicata</td>
<td>0.0</td>
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<tr>
<td>Laminaria setchellii</td>
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<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Nereocystis luetkeana (bull kelp)</td>
<td>2.5</td>
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<td>0.0</td>
</tr>
<tr>
<td>Pleurophyca gardneri</td>
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<td>0.0</td>
</tr>
<tr>
<td>Pterygophora californica</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Saccharina spp</td>
<td>0.0</td>
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Kelp species

- Density before dam removal and in 2012 and 2013

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<tr>
<td>Cymathere triplicata</td>
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<tr>
<td>Agarum fimbriatum</td>
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<td>0.0</td>
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<td>0.1</td>
<td>0.0</td>
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Other seaweeds

- Also decreased after dam removal
- Acid kelp (*Desmarestia* spp):

- Red algae (*Rhodophyta*):

- Kelp + acid kelp + red algae = total vegetation
Unseasonal recruitment

- Juveniles appeared in late August 2013

← Not present August 16

Present August 30 →
Unseasonal recruitment

• Species that typically recruit in spring:

  - *Alaria marginata*
  - *Cymathere triplicata*
  - *Nereocystis luetkeana*
  - *Laminaria ephemera*
  - *Desmarestia “bushy”*
  - *Desmarestia “flat-bladdled”*

• Present at three sites:

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Unseasonal recruitment

- Present
- Not present
- Unknown
Physical drivers

• Not “permanent” burial

Not buried

2012: 15 sites
2013: 11 sites

Buried

2012: 0 sites
2013: 4 sites
Physical drivers

- Not “permanent” burial

Gelfenbaum et al. in prep.
Physical drivers

- Ephemeral deposition
- Scour ("sandblasting")
- Light reduction

Photos from Jonathon Warrick
Chance to learn

- How does sedimentation affect kelp and other seaweeds?