Steelhead response to the removal of the Elwha River Dams

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Acknowledgements

Lower Elwha Klallam Tribe
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Elwha River

833 km² watershed

Elwha Dam
- built 1913
- 32 m tall
- River km 8

Glines Canyon Dam
- Built 1927
- 64 m tall
- River km 21

115 km of habitat upstream of Elwha Dam site

Pess et al. 2008
NW Science
Photo montage compiled by George Pess
Photos from NPS time lapse camera
Photo montage compiled by George Pess
Photos from NPS time lapse camera
Sediment release

• 21 million m$^3$ of sediment stored in former reservoirs
  • 16 million m$^3$ in Lake Mills (upstream of Glines)
  • 5 million m$^3$ in Lake Aldwell (upstream of Elwha)

• Approximately two-thirds evacuated from former reservoirs
  • 90% delivered to coastal habitats
  • Pools filled, 1.0 – 1.5 m increase in river channel height downstream of dams during peak of sediment wave

• At this point, erosion from reservoirs mostly complete

• Greatest remaining impact to salmon habitat in floodplain channels, not mainstem
Turbidity

- Dam removal begins
- Elwha Dam removed
- Glines Canyon Dam removed
- Glines rockfall blasting

Formazin Backscatter Units (FBU)
Formazin Nephelometric Units (FNU)

Approximate lethal threshold

Data from USGS
Elwha River mouth, estuary & nearshore

Slide courtesy of George Pess, NOAA
1. **Preservation**  
Prevent extinction when river conditions at times are lethal to fish

2. **Recolonization**  
Ensure continual access to habitat above former dam sites with some successful spawning

3. **Local Adaptation**  
Promote evolution of traits advantageous for natural river, increase life history diversity

4. **Viable Natural Population**  
Self-sustaining natural population productive enough to withstand harvest without hatchery supplementation
Triggers dictate movement between phases

- **Species:** Steelhead, *Oncorhynchus mykiss*

<table>
<thead>
<tr>
<th>GOALS</th>
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<tbody>
<tr>
<td>Preservation</td>
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<tr>
<td>Recolonization</td>
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<td>Viable Natural Population</td>
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</table>

<table>
<thead>
<tr>
<th>PHASE</th>
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<th>Recolonization</th>
<th>Local Adaptation</th>
<th>Viable Natural Population</th>
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<tbody>
<tr>
<td><strong>Abundance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural Spawners</td>
<td>&lt;196</td>
<td>&gt;196 or &lt;969</td>
<td>&gt;969 or &lt;2,619</td>
<td>&gt;2,619</td>
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<tr>
<td>Spawner Escapement duration</td>
<td>4 yrs</td>
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<td>Managing for pHOS</td>
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<tr>
<td>pHOS (natural-origin spawner)</td>
<td>*</td>
<td>0.90</td>
<td>1.0</td>
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<td>pHOS (proportion hatchery-origin spawner)</td>
<td>*</td>
<td>0.10</td>
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<td><strong>Productivity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#Juvenile migrants/female</td>
<td>75</td>
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<tr>
<td>#Pre-fishing recruits/spawner (h+n)</td>
<td>&gt;1.0</td>
<td>&gt;1.0</td>
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<td>&gt;1.0</td>
<td>&gt;1.0</td>
<td>&gt;1.0</td>
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<tr>
<td>Productivity trend</td>
<td>4 yrs</td>
<td>4 yrs</td>
<td>4 yrs</td>
<td>4 yrs</td>
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<tr>
<td><strong>Spatial Distribution</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Extent</td>
<td>Above Elwha Dam: 9% intrinsic potential</td>
<td>Above Elwha Dam: 37% of Intrinsic Potential</td>
<td>Above Glines Canyon Dam: 74% of Intrinsic Potential</td>
<td>100% of Intrinsic Potential</td>
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<tr>
<td>Barriers</td>
<td>No migration barriers exist below Elwha Dam</td>
<td>No ‘artificial’ migration barriers exist in Aldwell reach</td>
<td>No ‘artificial’ migration barriers exist in Mills reach</td>
<td>No ‘artificial’ barriers exist within Intrinsic Potential</td>
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<tr>
<td><strong>Diversity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entry timing variance</td>
<td>n/a - data collection</td>
<td>0.5 days/yr</td>
<td>0.5 days/yr</td>
<td>0.5 days/yr</td>
</tr>
<tr>
<td>Entry timing</td>
<td>Fish returning in February</td>
<td>Fish returning in January</td>
<td>Fish returning in December</td>
<td>No change from previous</td>
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</table>
Elwha hatchery steelhead program

- **Goal:** conservation of Elwha native steelhead population
- Current program is integrated broodstock management
- Eggs and fry collected 2005 – 2011, raised to reproductive maturity and spawned in captivity
- Currently switching from captive broodstock to adult returns to river
- Production goal = 175,000 age-2 smolts
  - Average release 2011 – 2016 = 141,935 smolts
  - Release site located at river km 3

Sources:
Lower Elwha Klallam Tribe 2012
Steelhead Hatchery Genetic Management Plan (HGMP)
Lower Elwha Klallam Tribe HGMP Annual reports
Abundance

Estimate abundance using SONAR
Information for hatchery and natural origin steelhead was taken during species composition collections. The intent of species composition was not designed to estimate such proportions but is more of an indicator.
Productivity

Elwha River screw trap locations

- Glines Canyon Dam
- Little River
- Indian Creek
- Elwha Dam
- Mainstem Elwha

Flow

RKM 22
RKM 12
RKM 0

Straits of Juan De Fuca

2005
2012
2013

= screw traps
Smolt Productivity

Elwha River, Indian Creek, & Little River Steelhead smolts

![Graph showing estimated steelhead smolts outmigrants for Elwha River, Little River, and Indian Creek from 2013 to 2017. The data includes a significant increase in esthesis in 2017.]
Spatial distribution

Lower Elwha (below Elwha Dam site)
Middle Elwha (between dams)
Upper Elwha (above Glines Canyon)

Elwha dam removed
Glines Canyon dam removed

Year

Steelhead Redds
0 50 100 150 200 250 300
## Natural and Assisted Recolonization

![Fish Image](image)

### Data source: McMillan et al. 2018

Summary of 2017 winter steelhead surveys in the Elwha River

<table>
<thead>
<tr>
<th>Year</th>
<th>Indian Creek</th>
<th></th>
<th>Little River</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Fish relocated</td>
<td>Redds</td>
<td>Fish relocated</td>
<td>Redds</td>
</tr>
<tr>
<td>2012</td>
<td>11</td>
<td>9</td>
<td>35</td>
<td>43</td>
</tr>
<tr>
<td>2013</td>
<td>0</td>
<td>24</td>
<td>88</td>
<td>47</td>
</tr>
<tr>
<td>2014</td>
<td>0</td>
<td>36</td>
<td>59</td>
<td>73</td>
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<tr>
<td>2015</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>36</td>
</tr>
<tr>
<td>2016</td>
<td>34</td>
<td>7</td>
<td>0</td>
<td>28</td>
</tr>
<tr>
<td>2017</td>
<td>0</td>
<td>16</td>
<td>0</td>
<td>37</td>
</tr>
</tbody>
</table>

Note – 25% of Indian Creek and 98% of Little River are surveyed for spawners. Number of reds is not representative of the total number of spawners in each creek
Spatial distribution

Steelhead spawning distribution 2016

Mouth to Elwha Dam

Elwha Dam to Glines Canyon

Upstream of Glines Canyon

Source: McMillan et al 2017
### Spatial distribution of hatchery mark rates

<table>
<thead>
<tr>
<th>Year</th>
<th>River km</th>
<th>Hatchery-origin</th>
<th>Natural-origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Elwha below hatchery</td>
<td>0 - 3</td>
<td>202</td>
<td>28</td>
</tr>
<tr>
<td>Lower Elwha above hatchery</td>
<td>3 - 8</td>
<td>33</td>
<td>14</td>
</tr>
<tr>
<td>Middle Elwha</td>
<td>8 - 21</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Upper Elwha</td>
<td>21 +</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

- Netting from SONAR and radio telemetry projects
- Data represent all encounters 2014 – 2017
- Information for hatchery and natural origin steelhead was taken during species composition collections. The intent of species composition was not designed to estimate such proportions but is more of an indicator.
Former Glines Canyon Dam rockfall blast
September/October 2015

Photos courtesy of Andy Ritchie, NPS
Diversity

Summer run steelhead observations
• Summer steelhead first observed in newly accessible habitat Oct 2013
• N = 72 counted during backcountry snorkel survey in September 2017 covering approximately 20 river km
Diversity

Age structure determined from N = 207 adult steelhead

N = 9 distinct anadromous life history forms, accounting for repeat spawners
Diversity

Winter-run entry timing

Source: Denton et al. 2018
2017 SONAR Annual Report
How long will recovery take?

- **Turbidity**
  - Suspended sediment concentration

- **Site**
  - (10^0km)

- **Reach**
  - (10^1km)
  - Streambed particle size
  - Juvenile fish density
  - Invertebrate density & species composition

- **Watershed**
  - (10^2-10^3km^2)
  - Salmon populations
  - Vegetation
  - Wood recruitment

- **Hours/days**
- **Months/Years**
- **Decades**
Outlook for the future

• **Encouraging signs:** fish accessing areas upstream of dams, massive physical disturbance tapering off

• Steelhead populations far short of long term recovery goals

• First step is to ensure colonists reach newly accessible spawning and rearing habitats

• Interagency collaborative monitoring effort intended to adaptively manage Elwha fish populations

• Unique opportunity for salmon recovery
Thank you

Photo by John McMillan