Puget sound habitat status and trends monitoring program: nearshore and large river delta geospatial data and habitat status and trends monitoring metrics

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Jason E. Hall, Alex Stefankiv, Britta Timpane-Padgham, Martin Liermann, T. J. (Tim J.) Beechie, and George R. Pess

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Puget Sound Habitat Status and Trends Monitoring Program: *Nearshore and Large River Delta Metrics*

Jason Hall*, Alex Stefankiv, Britta Timpane-Padgham, Martin Liermann, Tim Beechie, George Pess

*Work completed with NOAA NWFSC
Now with Cramer Fish Sciences
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PSHSTM Program Objectives

1. Provide consistent habitat metrics at threatened Chinook Salmon and steelhead MPG scales

2. Detect differences in habitat status AND trends

3. Relate metrics to Viable Salmon Population (VSP) parameters
1. **Sampling strata**
   - Large rivers & floodplains
   - **Large river deltas**
   - Nearshore

2. **Monitoring approach**
   - Complete census of habitat
   - Primarily rely on readily available and frequently updated aerial imagery
   - Metrics selected through expert panel reviews and evaluation
   - Repeat every 3-5 years?
Puget Sound’s Large River Deltas

Puget Sound’s 17 large river deltas

Selected Large River Delta Metrics

<table>
<thead>
<tr>
<th>Scale/Resolution</th>
<th>Delta Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satellite</td>
<td>% land cover by type</td>
</tr>
<tr>
<td>Aerial</td>
<td>Area, length, &amp; edge of tidally influenced channels</td>
</tr>
<tr>
<td>Field</td>
<td>Length of shoreline armoring, levees, &amp; dikes</td>
</tr>
</tbody>
</table>

Legend:
- Purple: Delta
- Blue: Floodplain
- Red: Nearshore
Digitized Large River Delta Features

- **Delta boundary**
  - Geomorphic tidal floodplain
  - Low & High Density veg edge

- **Digitized features**
  - Distributaries
  - Industrial Waterways
  - Large Tidal Channels (>2-5 m)
  - Small Tidal Channels (<2-5 m)
  - Tidal Channel Complexes
  - Interior Tidal Flats
  - Current & Potential wetlands
  - Tidal barriers
## Large River Delta Metrics Scorecard & Layers

### Example large river delta metric scorecard for the Snohomish River delta with updated protocol

<table>
<thead>
<tr>
<th>Land Cover by Type and Connectivity</th>
<th>May 2015 Aerial Image, CCAP 2011, and 50% Tidal Exceedence Model</th>
<th>Historic Tidal Wetland Area (ha)</th>
<th>Tidal Wetland Area (ha)</th>
<th>Potential Tidal Wetland Area (ha)</th>
<th>Disconnected Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergent</td>
<td>1103.29</td>
<td>486.31</td>
<td>1485.99</td>
<td>999.68</td>
<td></td>
</tr>
<tr>
<td>Scrub/Shrub</td>
<td>6550.94</td>
<td>110.55</td>
<td>508.41</td>
<td>397.86</td>
<td></td>
</tr>
<tr>
<td>Forested</td>
<td>6575.77</td>
<td>50.19</td>
<td>459.02</td>
<td>408.83</td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.00</td>
<td>18.32</td>
<td>2603.97</td>
<td>2585.65</td>
<td></td>
</tr>
<tr>
<td>Developed</td>
<td>0.00</td>
<td>32.48</td>
<td>295.31</td>
<td>262.83</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unvegetated Tidal Features</th>
<th>May 2015 Aerial Image</th>
<th>Area (ha)</th>
<th>Edge (km)</th>
<th>Length (km)</th>
<th>Nodes (within type)</th>
<th>Barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Distributary</td>
<td>1338.88</td>
<td>98.93</td>
<td>49.46</td>
<td>NA</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Distributary</td>
<td>1561.33</td>
<td>146.24</td>
<td>73.12</td>
<td>9</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Tidal Channel</td>
<td>91.24</td>
<td>124.49</td>
<td>62.25</td>
<td>188</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Tidal Channel Restored</td>
<td>38.90</td>
<td>63.78</td>
<td>31.89</td>
<td>127</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Small Tidal Channel</td>
<td>27.80</td>
<td>278.10</td>
<td>278.10</td>
<td>4651</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Small Tidal Channel</td>
<td>2.90</td>
<td>29.00</td>
<td>29.00</td>
<td>201</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

| Industrial | 77.10 | 6.98 | 3.49 | NA | 3 |

| Tidal Flat | 164.58 | 49.61 | 24.80 | NA | 0 |

<table>
<thead>
<tr>
<th>Modified Banks, Dikes, and Levees</th>
<th>2004 Field Surveys</th>
<th>Length (km)</th>
<th>Armored Length (km)</th>
<th>Length (km)</th>
<th>Armored Length (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dike/levee</td>
<td>50.66</td>
<td>16.65</td>
<td>Bulkhead</td>
<td>0.26</td>
<td>6.52</td>
</tr>
<tr>
<td>Graded</td>
<td>0.21</td>
<td>1.84</td>
<td>Revetment</td>
<td>0.64</td>
<td>8.64</td>
</tr>
<tr>
<td>Berm</td>
<td>1.87</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Large River Deltas
Channel edge habitat by feature & delta

- Example summary from 2011 image analysis
- To be updated with new boundaries and protocols
- Shows differences in habitat quantity & complexity
Puget Sound’s Nearshore Habitat

• Census of ≈4,000 km of shoreline

• Nearshore aerial image metrics
  – Length of forested shoreline
  – Embayment area
  – Connectivity of embayments
  – Overwater structure area

• Forested shoreline & embayment metrics underway

• Overwater structures completed
Overwater Structures

• Numerous potential OWS impacts
  – Migration, shading, noise, water quality

• No consistent/updated layers

• Started with 2006 DNR Layer...
  – Digitize new & update existing features
  – Improve accuracy/consistency
  – Consider docks/piers, boat rails, buoys/floats, bridges, aquaculture, & log booms
  – Not considering fill structures & boats

Dock features from 2006 DNR layer vs. Updated PSHSTM Layer
Single Docks/Piers vs. Marinas/Slips

Marinas: Minimum bounding slip area

Exclude boats on individual docks/piers

Green = DNR layer
Red = Updated PSM layer
Overwater Structure Results

Area of overwater structures by shoreline land cover type

- Forest/Wetland
- Mixed
- Agriculture
- Developed

Area of overwater structures by Chinook Major Population Group (MPG)

- Strait of Georgia
- Whidbey Basin
- Central/South Basin
- Hood Canal
- Strait of Juan de Fuca

*Initial field validation indicates omission error ≈30 structures per 100 km of shoreline
Future Directions

• Update and complete the following:
  – *Update deltas with new boundaries & protocols (2011 & 2015)*
  – *Complete forested shoreline and embayment components*

• Field validation:
  – *Swales vs. channels, forested cover omissions, barrier effects & presence, connectivity classifications, OWS types & presence…*

• Analyze trends:
  - *Natural, restoration, and degree of modification*

• Share GIS products and summary reports!
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• Lots of input from many agencies/groups...ODFW, CHaMP, CDFW, Univ of Montana, Univ of WA, PSP, USGS, WDFW, Numerous tribes throughout Puget Sound, County governments, consultants, various divisions throughout NOAA.

Questions? Contact me at jason.hall@fishsciences.net
Supplemental Slides
Large River Delta Boundaries

- **Landward** = Geomorphic 2-year tidal floodplain extent
- **Seaward** = Low/High density vegetation boundary

*Elwha example showing geomorphic 2-year tidal floodplain extent*

*Stillaguamish example showing Low/High density Veg Boundary and old dike footprint*
Tidal Complexes and Interior Tidal Flats

Example of unvegetated mud flats common in restoration sites

Dense channel networks common at marsh fringes
Tidal Wetland Classifications and Connectivity

- CCAP to classify cover
- Potential extent from 2-year tidal FRI
- Aerial photos inform connectivity from...
  - Tidal channels
  - Dikes/levees
  - Tide gates, culverts, causeways, etc...
  - Muted vs complete barriers?

2015 Tidal Wetlands in the Snohomish River delta