Monitoring nearshore, delta, and freshwater habitats in Puget Sound

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*Speaking on behalf of project

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Why are we doing this?


Objectives, scale, metrics, methods, & cost

- **Objective:** Quantify status & trends of 4 salmon habitats in Puget Sound:
  - Marine – nearshore and delta
  - Freshwater – mainstem rivers and floodplains
- **Temporal scale:** 15-20 years (~5 salmon generations)
- **Metrics:** 3-5 metrics per habitat area
- **Method:** Hierarchical monitoring design
- **Annual cost:** Targeted cost ~$350,000/yr
- **Current funding:** 1 year ($300,000)
What have we accomplished in 8 months?

- Developed an overall strategy to select, sample, & measure metrics
- Incorporated input from Puget Sound partners on all metrics
- Selected metrics for all habitats
- Developed mainstem, floodplain, & delta protocols
- Selected sites for mainstem & floodplain monitoring
- Sampled 21 field main stem sites to test monitoring protocols
- Sampled 124 main stem & floodplain sites using remote sensing
- Sampled all deltas using remote sensing
- Completed first year status and error analysis
- Write up almost completed
Four main habitat ‘types’

- Delta
- Nearshore
- Floodplain
- Mainstem
Hierarchical monitoring strategy

LIDAR/Satellite – Coarse scale
Assess status & trend in land use
% disconnected floodplain

Aerial photography - moderate
Assess reach-scale condition
Side-channel/mainstem ratio

Field measures - fine
Quantify habitat quantity/quality
Habitat composition
Sample design

• Stratify streams, rivers, floodplains, deltas, & nearshore by;
  – geomorphic type (i.e. shore, delta, or valley)
  – land cover
  – Chinook salmon & steelhead major population groups (MPG)

• Selects sample sites using a Generalized Random Tessellation Stratified (GRTS) design
What is the status of main stems & floodplains by MPG in Puget Sound?
## Selection of Metrics

**Expert panel lists of potential main stem metrics**

<table>
<thead>
<tr>
<th>Data Resolution</th>
<th>Pressure/process</th>
<th>Metrics (by indicator type)</th>
<th>Habitat quantity</th>
<th>Habitat quality</th>
</tr>
</thead>
</table>
| Satellite        | • Percent riparian land cover class  
                  • Percent of large river disconnected | • Stream type at network scale | • Hydrologic condition index (flashiness) |
| Aerial photography/LIDAR | • Riparian buffer width and type  
                              • Channel migration rate  
                              • Percent of mainstem disconnected from floodplain  
                              • Levee length  
                              • Bank armoring  
                              • Rating cross-section analysis from USGS sites | • Channel or water surface area  
                              • Pool spacing  
                              • Edge habitat area by type (shallow shore)  
                              • Flow metrics (monthly mean stream flows, peak flows, etc.)  
                              • Passable river miles | • Riparian forest providing direct shade  
                              • Sinuosity |
| Field            | • Length of human modified bank  
                  • Riparian buffer width and type  
                  • Entrenchment ratio  
                  • Percent of mainstem disconnected from floodplain | • Edge habitat area by type (shallow shore)  
                              • Wood abundance  
                              • Functional logjam frequency  
                              • Hydraulic complexity using tracer dye method  
                              • Pool spacing  
                              • CV of thalweg depth | • B-IBI  
                              • Invertebrate drift  
                              • Temperature  
                              • Turbidity  
                              • Fish-IBI  
                              • Conductivity |
Selection of Metrics
Evaluation criteria for all habitat types

1. Is the metric related to at least one of the Viable Salmon Population (VSP) parameters?
2. Is it sensitive to land management or restoration actions?
3. Is it related to coarser/finer resolution metrics?
4. Is it cost-effective?
5. Does it have a high signal-to-noise ratio?
<table>
<thead>
<tr>
<th>Scale/resolution</th>
<th>Type</th>
<th>Metric</th>
<th>Link to salmon VSP</th>
<th>Sens. to land use</th>
<th>Link across scales</th>
<th>Cost-effective</th>
<th>Signal/noise ratio</th>
<th>Total</th>
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The questions

1. What is the status of each habitat type by MPG in Puget Sound?

2. What is the status of each habitat type by land cover in Puget Sound?

3. What is the status of riparian habitat by MPG and land cover in Puget Sound?

4. What is the accuracy of satellite and aerial photography land cover classification?

5. What is the observer variability in measuring aerial photograph habitat metrics?
What is the status of deltas by MPG in Puget Sound?
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• Area
  – The Northern Cascades MPG has the most tidally influenced channel area. Majority of area are distributary channels.
  – The South Central MPG tidally influenced channel area is a combination of distributary, tidal channels, and land use influence.
  – The Olympic MPG has the least amount of tidally influenced channel area.

• Perimeter (surrogate for edge habitat)
  – The Northern Cascades MPG has the most tidally influenced channel perimeter
  – The Olympic MPG has almost as much tidally influenced channel perimeter as South Central.
What is the status of mainstem and floodplains by MPG in Puget Sound?
What is the status of main stems by MPG in Puget Sound?

N = natural
B = bar
M = modified

Mean proportion of habitat edge type and 95% confidence interval by Steelhead MPG
What is the status of floodplains by MPG in Puget Sound?

Mean proportion of habitat edge type and 95% confidence interval by Steelhead MPG

% disconnected floodplain data courtesy of USGS
What is the status of main stems & floodplains by MPG in Puget Sound?

• **Main stem – edge habitat type**
  – The Olympic MPG contains the greatest amount of natural habitat edge type.
  – The South Central MPG contains the greatest amount of modified habitat edge type.

• **Floodplains - % disconnected**
  – The Olympic MPG contains the least amount of disconnected floodplain, followed by the Northern Cascades MPG.

• **Anthropogenic effects**
  – The South Central MPG had the least amount of natural habitat edge type and the highest proportion of disconnected floodplain.
What is the status of deltas by land cover in Puget Sound?

**Chinook MPGs**

- Georgia Strait: 50%
- North Sound: 75%
- Hood Canal: 100%
- Juan De Fuca: 50%
- South Sound: 25%

**Steelhead MPGs**

- North Cascades: 25%
- Olympic: 50%
- South Central Cascades: 75%

*Green = Forested, Red = Agriculture, Black = Urban*
Proportion of delta that is forested land cover v. the log ratio of tidal channel to distributary length

\[ y = 4.2209x - 2.2973 \]
\[ R^2 = 0.799 \]

Less than 0 = more distributary than tidal channel
Greater than 0 = more tidal channel than distributary
What is the status of deltas by land cover in Puget Sound?

- **Urban areas**
  - Central Sound Chinook & Steelhead MPGs
  - Deltas have over 50% to 90% urban

- **Agricultural areas**
  - North Cascade Steelhead MPG, Georgia Strait & North Sound Chinook MPGs

- **Forested areas**
  - All other Chinook & Steelhead MPGs have ~75% forest

- **% forest v. ratio tidal channel to distributary length**
  - The Olympic MPG has the highest ratio of tidal channel length to distributary length relative to the other MPGs
What is the status of mainstem habitats by land cover in Puget Sound?

N = natural
B = bar
M = modified

95% confidence interval within agriculture, forest, mixed, and urban land cover class.
What is the status of floodplains by land cover in Puget Sound?

95% confidence interval within agriculture, forest, mixed, and urban land cover class.

% disconnected floodplain data courtesy of USGS
What is the status of floodplains by land cover in Puget Sound?

- Unconfined streams produce a greater amount of side channels due to the lateral movement of the main channel that results in more and better habitat.
What is the status of floodplains by land cover in Puget Sound?

- In confined streams main channel lateral movement is suppressed creating braids in gravel bars that results in lower habitat quality.
What is the status of floodplains by land cover in Puget Sound?

95% confidence interval within agriculture, forest, mixed, and urban land cover class.
What is the status of main stems & floodplains by land cover in Puget Sound?

- Land cover patterns in habitat status by land cover consistent with our expectations

- **Forest areas**
  - most natural habitat edge,
  - least disconnected floodplain,
  - highest side channel node density,
  - and highest wood jam density

- **Urban areas**
  - least natural habitat edge,
  - most disconnected floodplain,
  - highest braid node density, and
  - lowest wood jam density
What is the status of riparian habitat along main stems by MPG & land cover in Puget Sound?

Mean forested buffer width along Puget Sound mainstem rivers by Steelhead (*Oncorhynchus mykiss*) MPGs. The 95% confidence intervals are depicted by the bars.

Box plots indicating median (line), upper (75%) and lower (25%) quartiles (box edges), and upper and lower limits (whiskers) of mean forested buffer width along mainstem rivers in Puget Sound by land cover class.
What is the status of riparian habitat along main stems by MPG & land cover in Puget Sound?

• MPG
  – Olympic MPG – 85m
  – Northern Cascades - 72m
  – South Central – 50m

• Land Cover
  – Largest mean buffer widths in forest - ~73 m
  – Smallest mean buffer widths in urban - ~15 m
  – Median buffer widths at forested sites are 25 meters longer than at agriculture and mixed sites (~38 m).
Next steps

- Focus on nearshore protocols, data collection, & analysis
- Revise existing protocols for mainstem, floodplain, & delta
- Develop fish-habitat relationships for all habitat types
- Develop pilot programs with local watershed groups
- Retrospective analysis of metrics to determine sensitivity to land use
- Develop ground truth protocols for aerial photo metrics
- Create new floodplain reach map
Thanks!

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• Thanks to all those who have given us input!

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