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The Cumulative Impacts of Shoreline Armoring on Forage Fish Spawning Habitat in San Juan County, Washington

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The impacts of shoreline armoring on forage fish spawning habitat in San Juan County, Washington

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UW, SJC, USGS, NOAA, DNR, Ecology, SSRC, PSP, Samish Indian Nation, Tulalip Tribes, BC Shore Spawner’s Alliance.
Forage Fish Spawning Habitat Research:

1. Armor and forage fish spawn habitat GIS analysis
2. Tidal distribution of surf smelt spawn field study
3. Sea level rise vulnerability assessment
4. Research needs & management implications

“Healthy beaches for people and fish project: protecting shorelines from the impacts of armor today and rising seas tomorrow”
Armor & Forage Fish Spawn Methods

- ARC GIS analysis.
- Field based beach slope characterization.
Armor & Forage Fish Spawn Results

Developed parcels w/ armor and primary structure setback distance
15% (1.5 miles) of documented spawn beaches in the county are armored.

90% of armor covers a portion of the spawning habitat zone, burying approximately 11 acres.

88% of drift cells with documented spawn have a total of 1.4 miles of armored feeder bluffs up-drift of spawning beaches.

Overhanging vegetation is significantly reduced at armored spawn beaches:

- Feeder bluffs = 76-100% to 0.1-25%,
- Pocket beaches = 76-100% to none,
- Rocky shores = 76-100% to none.
Site Selection:
- Documented spawning beaches in SJC

Field Surveys:
- At sites with visible eggs present, perpendicular transects established and substrate samples collected at 6 vertical elevations determined from NOAA predicted tides and laser level.

Lab:
- Egg count and density,
- Embryological stage distribution, and
- In situ mortality.

Analysis of Results:
- Gamma distributions fit to egg density data.
Exploratory surveys of 39 known spawning beaches on 49 dates.

Incubating eggs found and 26 transects collected from 15 surf smelt spawning beaches on 9 dates.

20% of known spawning beaches in the county included in project results.
**Tidal Elevation of Spawn Study Results**

- Surf smelt eggs from 3.7 ft. to 9.2 ft. MLLW
- 80% eggs at or above 6.2 ft. MLLW
- 30% eggs at or above MHHW (7.6 ft. MLLW for Friday Harbor)

<table>
<thead>
<tr>
<th>Beach Elevation (feet MLLW)</th>
<th>Smelt Egg (count)</th>
<th>Smelt Egg (percent)</th>
<th>Samples with eggs (count)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 3 (n=1)</td>
<td>0</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>3.0-3.9 (n=11)</td>
<td>1</td>
<td>&lt; 1%</td>
<td>1</td>
</tr>
<tr>
<td>4.0-4.9 (n=24)</td>
<td>2</td>
<td>&lt; 1%</td>
<td>1</td>
</tr>
<tr>
<td>5.0-5.9 (n=27)</td>
<td>187</td>
<td>3%</td>
<td>9</td>
</tr>
<tr>
<td>6.0-6.9 (n=29)</td>
<td>2116</td>
<td>35%</td>
<td>24</td>
</tr>
<tr>
<td>7.0-7.9 (n=31)</td>
<td>2458</td>
<td>40%</td>
<td>22</td>
</tr>
<tr>
<td>8.0-8.9 (n=25)</td>
<td>1241</td>
<td>20%</td>
<td>15</td>
</tr>
<tr>
<td>9.0-9.9 (n=15)</td>
<td>110</td>
<td>2%</td>
<td>1</td>
</tr>
<tr>
<td>Above 9.9 (n=2)</td>
<td>0</td>
<td>0%</td>
<td>0</td>
</tr>
</tbody>
</table>
Tidal Elevation of Spawn Study Results

Spatial Distribution of Surf Smelt eggs in Relation to Beach Elevation

- **x-axis**: approximate elevation in feet relative to the MLLW.
- **y-axis**: likelihood of encountering eggs at a given elevation.
- **Area under curve**: range of elevations eggs found for that transect.
Sea level rise projections for 2030, 2050 and low, moderate and high for 2100 were applied as +0.2 feet, +0.5 feet, +1.1 feet, +2.0 feet, and +3.0 feet above current sea level, respectively (NRC 2012).

Proportions of eggs that would be inundated under the different sea level rise scenarios were estimated, assuming that armor is present at MHHW +1.5 feet and that beach morphology does not change over time.
10-20% of incubating surf smelt eggs could be inundated by 2050
35% to 99% of eggs likely to be inundated by 2100

<table>
<thead>
<tr>
<th>Scenario (NRC 2012)</th>
<th>Sea Level Rise</th>
<th>% of incubating surf smelt eggs inundated</th>
</tr>
</thead>
<tbody>
<tr>
<td>2030</td>
<td>+ 0.2 ft.</td>
<td>10%</td>
</tr>
<tr>
<td>2050</td>
<td>+ 0.5 ft.</td>
<td>19%</td>
</tr>
<tr>
<td>2100 (-1 SD)</td>
<td>+ 1.1 ft.</td>
<td>35%</td>
</tr>
<tr>
<td>2100</td>
<td>+ 2.0 ft.</td>
<td>80%</td>
</tr>
<tr>
<td>2100 (+1 SD)</td>
<td>+ 3.0 ft.</td>
<td>99%</td>
</tr>
</tbody>
</table>
Research Needs

- Vertical distribution of surf smelt eggs in areas with different tidal-amplitude ranges.
- Monitoring of forage fish spawning habitat utilization.
- Improved understanding of the relationship between spawning sites and armor-related impacts:
  - Biologic response to reduction of overhanging vegetation, reduction in spawn area, increased inundation;
  - Geologic response (beach substrate) to changes in sediment supply or transport at both the drift cell and pocket beach scale.
Management Implications

- Current shoreline management does not adequately address cumulative impacts or the impacts of rising sea levels.
- Expanded building setbacks will be an effective tool to reduce future demand for armoring.
- Beach spawning forage fish habitat is vulnerable to the impacts of rising sea levels, especially at armored sites.
- Natural beach substrates at elevations significantly higher than MHHW play an important role as spawning habitat.
- Opportunities exist to preserve habitat, coastal processes and human access through re-alignments of public roads.
Thanks! Questions?

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Final reports at:
www.sanjuans.org/NearshoreStudies.htm
or contact: tina@sanjuans.org