Regional and temporal variability in Puget Sound zooplankton: bottom-up links to juvenile salmon

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Speaker
Julie Keister, Julia Bos, Bethel Reu Hermann, Mya Keyers, Christopher Krembs, John Mickett, Jan Newton, Wendi Reuf, and Amanda Winans

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Regional and temporal variability in Puget Sound zooplankton

Julie Keister, Julia Bos, BethElLee Herrmann, Christopher Krembs, Mya Keyzers, John Mickett, Jan Newton, Wendi Reuf, Amanda Winans, and numerous partners.
Puget Sound Zooplankton Monitoring Program
Initiated in 2014 to address hypotheses of bottom-up controls on salmon survival.

**Provides data on:**

1) Response of zooplankton community to environmental change.

2) Patterns in prey availability for salmon and other fish and seabirds.

Fills long-standing data gap for fishery and ecosystem modelers and managers.
Sampling Methods:

At most locations:
Bi-weekly sampling March-October, 2014-2017
+ Year-round sampling in Central Basin by King County

- **Vertical net tows**
  
  Full water column tows
  60-cm dia., 200-µm mesh

  Targets smaller, diverse taxa
  Used as indictors of environmental changes

- **Oblique bongo net tows**
  
  Upper 30 m
  60-cm dia., 335-µm mesh

  Targets larger taxa
  Used as indictors of salmon prey fields
Late 2014 = Intrusion of “The Blob” into the Salish Sea
Water column heat content

- **Region**
  - Strait of Juan de Fuca
  - Central Sound
  - South Sound
  - North Sound
  - Whidbey Basin
  - Hood Canal

- **Month**
  - 1 2 3 4 5 6 7 8 9 10 11 12

- **Year**

Legend:
- Dark red = higher than expected (> *IQR*)
- Red = higher than previous measurements
- Black = expected (= *IQR*)
- Green = lower than expected (< *IQR*)
- Light gray = lower than previous measurements
- No data

*IQR = Interquartile Range (25th – 75th percentiles); n = 17*
Juvenile Chinook salmon growth and size: Tended to be lower and more variable in 2014 than 2015

**IGF-1 index of growth by region**

- Bellingham Bay: Nooksack, San Juan: SJL, N. Whidbey: Skagit

**N. Whidbey juvenile salmon size**

Chamberlain et al. 2017

Courtesy of C. Greene et al., NOAA
How was this big variability in years reflected in the zooplankton?
Total zooplankton biomass (vertical net tows): 2015-16 biomass was high. Big differences among regions.
Copepod biomass:
Comprises most of the total biomass.
Juvenile Salmon Prey Field Index

(Subtle) increase during warm years overall, but mixed.
Crab larvae biomass (vertical net tows):

- **San Juan Islands**
  - Cumulative Biomass (mg C m$^{-3}$)
  - 2014, 2015, 2016, 2017

- **Admiralty Inlet**
  - Cumulative Biomass (mg C m$^{-3}$)
  - 2014, 2015, 2016, 2017

- **Central Basin**
  - Cumulative Biomass (mg C m$^{-3}$)
  - 2014, 2015, 2016, 2017

- **South Sound**
  - Cumulative Biomass (mg C m$^{-3}$)
  - 2014, 2015, 2016, 2017
Siphonophore Biomass

Large decreases during warm years
Noctiluca Abundances

Decreased during warm years
Conclusions

- Puget Sound zooplankton monitoring began just prior to the warmest years on record.

- Total zooplankton and biomass of important fish prey were higher in 2015-16 than 2014.

- Biomass of some “unfavorable” taxa declined during the warm years.

- Large regional variability observed.

- Funding beyond 2019 has not been secured!
### Many rare taxa observed in 2015-2017

<table>
<thead>
<tr>
<th>Genus Species</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Copepod</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Candacia bipinnata</em></td>
<td>x</td>
<td></td>
<td>x</td>
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<td>Bellingham, Central Basin, South Sound</td>
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<tr>
<td><em>Clausocalanus</em></td>
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<tr>
<td><em>Clytemnestra rostrata</em></td>
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<td>Bellingham</td>
</tr>
<tr>
<td><em>Eucalanus californicus</em></td>
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<tr>
<td><em>Euchirella pulchra</em></td>
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<tr>
<td><em>Mesocalanus tenuicornis</em></td>
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<tr>
<td><em>Pleuromamma abdominalis</em></td>
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<td></td>
<td>x</td>
<td>South PS</td>
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<tr>
<td><em>Scaphocalanus brevicornis</em></td>
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<td>x</td>
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</tr>
<tr>
<td><em>Scolechitricella ovata</em></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>N Hood Canal</td>
</tr>
<tr>
<td><em>Tharybis fultoni</em></td>
<td>x</td>
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<td>x</td>
<td></td>
<td>Bellingham, Whidbey, Central Basin, N&amp;S Hood Canal</td>
</tr>
<tr>
<td><em>Tricionia conifera</em></td>
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<td>Throughout</td>
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<tr>
<td><em>Emerita analoga</em></td>
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<td></td>
<td>x</td>
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<td>Main PS</td>
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<tr>
<td><strong>Crabs</strong></td>
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<tr>
<td><em>Emerita analoga</em></td>
<td>x</td>
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<td>Main PS</td>
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<td><strong>Kril</strong></td>
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<td><em>Nematoscelis difficilis</em></td>
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<td><strong>Shrimp</strong></td>
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<tr>
<td><em>Sergestes similis</em></td>
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<td>San Juan, Admiralty</td>
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<td><strong>Tunicate</strong></td>
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<tr>
<td><em>Thaliacean</em></td>
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<td></td>
<td></td>
<td>x</td>
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</tr>
</tbody>
</table>

* = species seen only once; x= not present; **Bold** = species observed off Oregon during the warming years of 2014-2016.