Historical fluctuations and recent observations of Northern Anchovy in the Salish Sea

Photo: Dianne Sandford

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Additional data and input provided by: Cheryl Morgan, Kym Jacobson, Anna Kagley, Correigh Greene, Dianne Sandford, Duane Fagergren, Jason Assonitis, and Josh Chamberlain
The Salish Sea

- Estuarine circulation
- Complex physical oceanography
- Epipelagic forage fish community dominated by Pacific Herring
Impetus

• Anchovy are present but generally not considered ecologically significant in Salish Sea

• But then came 2016....

• How has Northern Anchovy abundance fluctuated in the Salish Sea and what may drive fluctuations?

Photo: Jay Assonitis

Anchovy schools are back in session, with 'phenomenal numbers' spawning in Howe Sound
From: Smith and Lasker 1978

Northern Anchovy (*Engraulis mordax*)

- Three subpopulations
- High abundance linked to cool ocean
- Salish Sea at north end of distribution of less-studied northern subpopulation
- Richardson (1981) suggested northern subpopulation spawned off-shelf in Columbia Plume in summer; Fraser Plume could be another spawning habitat
- More recent work has suggests spawning may also occur much earlier in the year
Approach

- Review paleoarchaeological, fishery catch, and fishery research literature
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  - **DFO YOY Pacific Herring surveys 1992-2016**
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  - Fraser Plume pair trawl survey 1966-69 and 1973; DFO Trawl 2014-16
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  - WDFW year-round midwater trawl survey 2016
  - Snohomish and Elwha beach seine surveys; Skagit Bay tow net surveys
  - Various other published records of surveys likely to catch anchovy based on gear, location and period.
Is low abundance the norm?

Paleosedimentary, Paleoarchaeological and early historical accounts

Pierson (2011) – Anchovy 3rd most abundant fish in First Nations middens up to 3000 years old

Mckenchie and Moss (2016) – Anchovy present in 37% of 94 First Nations Archaeological sites from the Salish Sea

O’Connell (1998) – Anchovy scales present in majority of laminated strata in Saanich Inlet from 1861-1900; very scarce in 20th century
Is low abundance the norm?

Paleosedimentary, Paleoarchaeological and early historical accounts

“Anchovy:— This fish is only second to the oulachan or houlican in its abundance. During the autumn it abounds in the harbours and inlets, and may be taken with great ease in any quantity.” — 1872 - Annual report of the Department of Marine and Fisheries - The Honorable H.L. Langevin

“The anchovy come to Puget Sound in enormous quantities, and during their season, from May to November, every bay and inlet is crowded with them….. I have known them to be in such masses ... that they could be dipped up with a common water bucket” — 1893 US Fish Commission Report
Timeline of available data, **abundant**, **present**, **absent** or very scarce

*Generally based on frequency of presence in catch*

- DFO Zooplankton
- Juvenile Herring Surveys
- BC Commercial Catch Records
- Annual Reports of Pacific Biological Station
- Puget Sound Commercial Catch Records
- Snohomish Beach Seine
- Elwha Beach Seine
- Neocaligus Roberts Bank and Howe Sound Trawl
- Strait of Georgia Pair Trawl
- Skagit Bay Tow Net
- Beamish and Neville Plume Surveys
- Beamish et al. 1976
- Groot et al. 1985
Proportion of sets with Anchovy

Timeline of available data, abundant, present, absent or very scarce

*Generally based on frequency of presence in catch*

Strait of Georgia YOY Herring Surveys

Proportion of sets with Anchovy

Diagram showing the proportion of sets with Anchovy from 1992 to 2016.
Timeline of available data, abundant, present, absent or very scarce

*Generally based on frequency of presence in catch*
Green boxes indicate inferred periods of high abundance in Salish Sea – other periods may or may not have occurred
Standardized central subpopulation biomass based on egg and larval surveys (Thayer et al. 2016)

Standardized log (density+1) for anchovy in June Columbia River plume surface trawls (courtesy Cheryl Morgan)
Standardized annual average surface temperature at Pacific Biological Station in the Strait of Georgia
Where is Abundance Controlled?

• Spawning and Recruitment within Salish Sea Basins
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- Spawning occurs offshore (Columbia Plume) larval advection or juvenile migration to rearing habitat in Salish Sea
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- Combination of resident and migratory populations or population components
Does Successful Reproduction occur in the Salish Sea?

**DFO Zooplankton Tows 2006 and 2012-16**

- Proportion Tows with Anchovy Eggs
- Proportion Tows with Anchovy Larvae or Juveniles
- Number of Tows

![Graph showing the proportion of tows with anchovy eggs, larvae or juveniles, and the number of tows by month from February to November.](image)
What About Migration? Puget Sound Midwater Trawl Survey 2016

February-April

June-August

October-December
What About Migration? Puget Sound Midwater Trawl Survey 2016

Maps showing the distribution of fish in Puget Sound for different months:
- **February-April**
- **June-August**
- **October-December**

Below each map are histograms showing the distribution of fork length for each time period.
<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2016</th>
</tr>
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<tbody>
<tr>
<td><strong>Planktonic eggs/larvae detected in current/recent years?</strong></td>
<td>No</td>
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<td>Yes</td>
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![Wind stress graphs for 2005 and 2016](Pierce and Barth, Oregon State University)
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<td>Juvenile size in SOG in Fall</td>
<td>Larger</td>
<td>Smaller</td>
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Pierce and Barth, Oregon State University
Outstanding Research Questions

- Population Genetics?
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• Mechanism limiting persistence in Strait of Georgia
  • Summer reproductive phenology and growth?
  • Winter temperature limitation?
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• Implications of persistent future presence in Salish Sea?
QUESTIONS?