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Establishing a baseline for Northern Anchovy populations by ichthyoplankton sampling in Puget Sound, WA.

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Introduction

Northern Anchovy are a short-lived pelagic forage fish that are important to the northeast Pacific food web. During the summer, Northern Anchovy spawn as frequently as every 10 days in open water where their eggs remain near the surface for 2-4 days until hatching. The range of the northern subpopulation of Northern Anchovy is from northern California through British Columbia, including the inland waters of the Salish Sea. Most investigations of anchovy abundance, distribution, and life history have focused on coastal areas where they are targeted as bait for tuna, salmon, and rockfish fisheries. Northern Anchovy are subject to sporadic boom and bust cycles of abundance thought to be driven by factors influencing young of the year survival, with adult distribution influenced by factors such as sea surface temperature and salinity. Though we have no estimates of abundance for anchovy in Puget Sound (PS), in 2015, during a marine heat wave in which anchovy were scarce in offshore waters, we observed a potential boom of anchovy in the inshore waters of PS after nearly a decade of apparently low abundance. Continued observations and incidental encounters of anchovy during subsequent years' surveys indicate that anchovy abundance has remained elevated in the PS since 2015. This increase has drawn the attention of both marine and terrestrial predators, including commercial fishermen who in recent years have struggled to find anchovy in the usual coastal areas. Faced with many questions and limited resources, we have looked to a 2006 WDFW study by Perry and Penttila as a model for a pilot study to use ichthyoplankton surveys to assess where and when anchovy are spawning in PS, and lay the groundwork to develop an index of abundance to assess the trends of Northern Anchovy abundance in years to come.

Figure 1. Juvenile Northern Anchovy

Methods

- Sampling occurred biweekly in August and September 2020 and from May through September 2021 at various locations through Puget Sound (Figure 5)
- Ichthyoplankton samples were obtained from a 5.8m boat using a plankton net with a 0.5-meter diameter opening and 500-micron mesh and cod end and fitted with a flow meter
- Temperature and salinity were measured with a YSI at each sample site
- Typical plankton tows were
  - 5 minutes in duration, towed under engine power at about 2.5 knots
  - Horizontally towed within 1 meter of the surface
  - Sampled 200m^3 to 300m^3 volume surface water
- Plankton samples were examined using a 10X dissecting scope. Northern anchovy eggs, which are easily identifiable by their oval shape, were separated and enumerated
  - A Fulsom plankton splitter was used to divide samples containing more than 100 anchovy eggs

Results

- Out of 384 samples taken, 179 had at least one anchovy egg (46.6% of samples)
- Maximum number of eggs encountered in a single sample was estimated to be 4864, off Herron Island in Case Inlet
- Within the range of salinity and temperature sampled, there was not a significant relationship between anchovy egg abundance and temperature and salinity (Poisson regression, p=0.33 and p=0.571 respectively)
- Density of anchovy eggs was significantly different between basins (PERMANOVA, p=0.007), indicating that anchovy spawning is not evenly distributed throughout Puget Sound

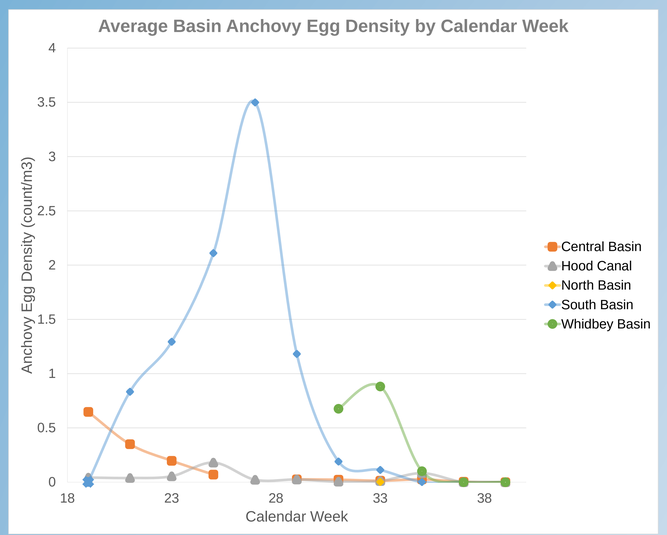

Figure 2. Average density of anchovy eggs by basin and calendar week, with week 18 beginning in early May, and week 40 the end of September. The egg densities by basin were significantly different according to a PERMANOVA, with a p value of 0.007.

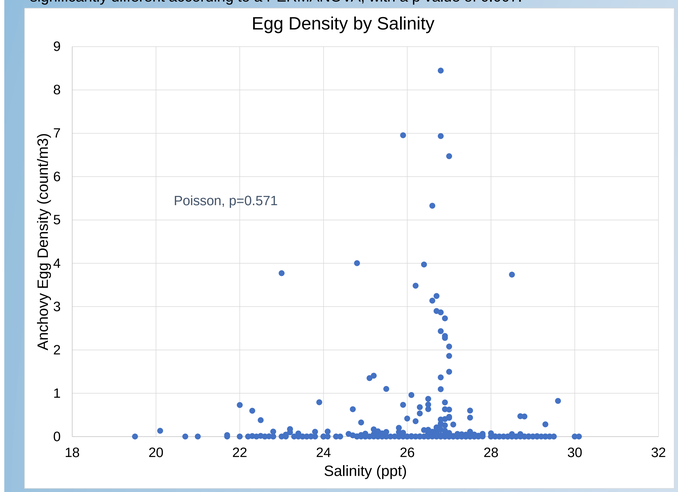

Figure 3. Anchovy egg density is not affected by salinity of the sites sampled within Puget Sound (Poisson, p=0.571). Salinity sampled ranged from 19ppt to 31ppt.

Figure 4.The oblong shape of anchovy eggs make them distinctive

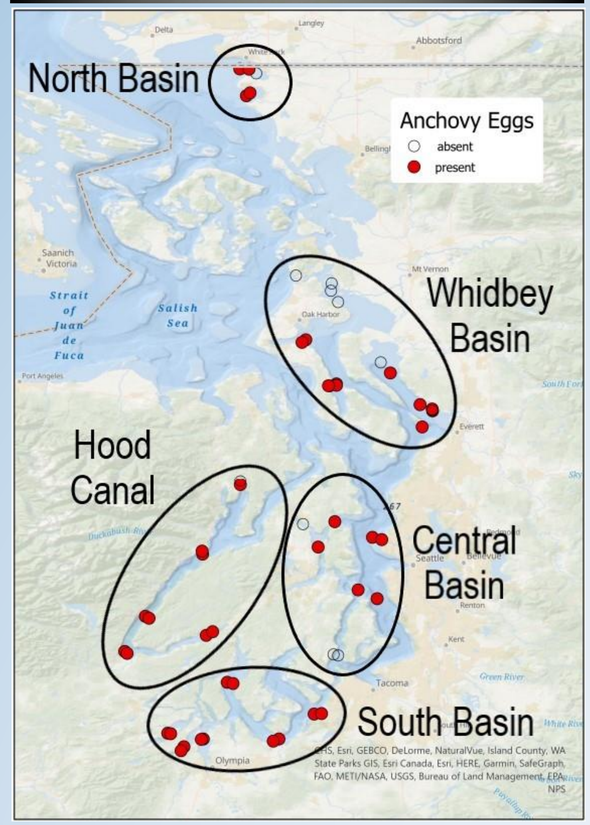

Figure 5. Locations sampled throughout Puget Sound according to anchovy presence or absence.

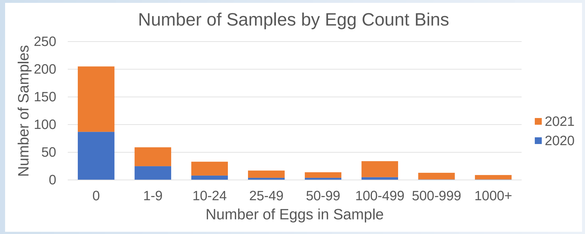

Figure 6. Number of samples with associated counts of eggs.

Conclusions

Anchovy spawn throughout Puget Sound, with the greatest egg abundance observed in the South Basin. The difference in eggs density across basins suggests that anchovy are not evenly distributed throughout Puget Sound. Eggs were observed from May through August, but since eggs were present in some of the first samples taken the first week of May in 2021, it is likely that spawning occurred in April. In the South Basin, where eggs were most abundant, peak spawning appeared to occur in late June.

While neither temperature nor salinity were shown to be significant factors in predicting where anchovy eggs were found, the narrow ranges of temperature and salinity observed across sites limits our ability to determine what localized factors may influence egg abundance between samples.

Future Work

Ichthyoplankton surveys are scheduled to resume in April 2022 with the intent to sample during the full extent of the spawning season.

Circulation models may be used in the future to better estimate locations where drifting anchovy eggs are most likely to collect.

While anchovy egg identification is relatively easy, the volume of non-egg material has proven to be a challenge that limits processing efficiency. We will explore methods to reduce sample processing time in hopes of increasing our sample capacity.

As more data is gathered, further analysis may explore the influence of tidal and lunar cycles on spawning and investigate the effects of low dissolved oxygen on egg abundance and anchovy populations.

Figure 7: Retrieving plankton net.

Acknowledgements

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