

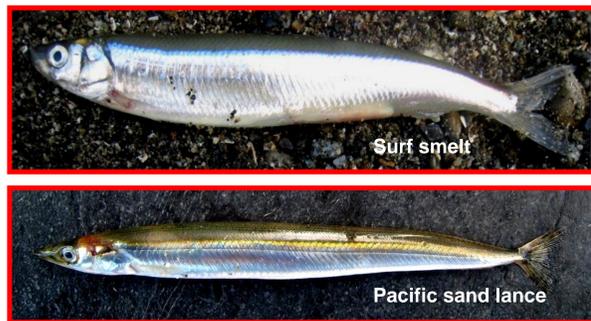
Spatiotemporal Detection of Forage Fish Eggs Derived from Long-term Spawning Surveys

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Introduction

Surf smelt (*Hypomesus pretiosus*) and Pacific sand lance (*Ammodytes hexapterus*) are vital parts of the Salish Sea ecosystem – providing an important energetic link between primary and secondary producers and many marine mammals, sea birds, and other fish species. Unfortunately, we know little about the status or trends of their populations and no monitoring strategy has been developed or implemented. We also have little information describing the life history or geographic distribution of these species that are prerequisites for developing an efficient monitoring strategy.

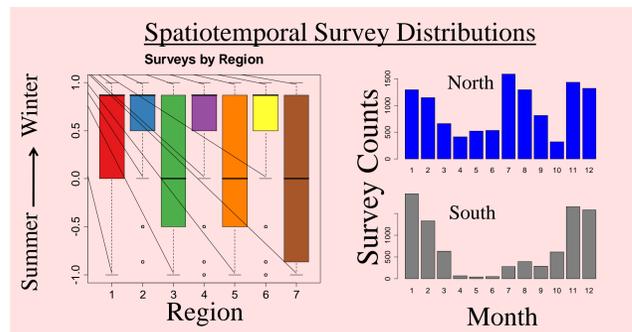


WDFW has been conducting surveys in Puget Sound for more than thirty years to identify beaches where surf smelt and Pacific sand lance spawn. We constructed a geodatabase to house these data and initiated analyses to discern spatial and temporal patterns within Puget Sound.

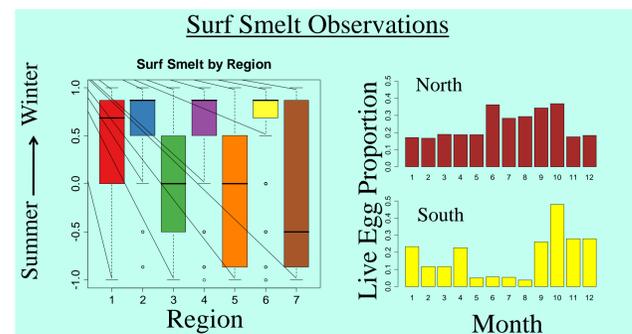
Methods

We analyzed forage fish spawning surveys conducted throughout Puget Sound since 1972 to assess egg presence and live egg proportion as a measure of reproductive success over regional spatial scales and seasonal temporal scales. The sampling was conducted for the purpose of documenting spawning locations and consists of greater than 20,000 observations. Surf Smelt eggs were found in 6,574 surveys and Sand Lance in 1,540. We aggregated individual sampling locations to beaches delineated by the Dept. of Ecology shoreline data and to seven regional groups to gain insight into spatial patterns. Over the sampling period 3,689 of the 6,956 shorezone beaches were visited. Spawning by one or both species was observed on 37% of those beaches. We examined the months and locations of the observations, and the live egg proportions to initially assess the spatiotemporal distribution of these two important ecosystem components.

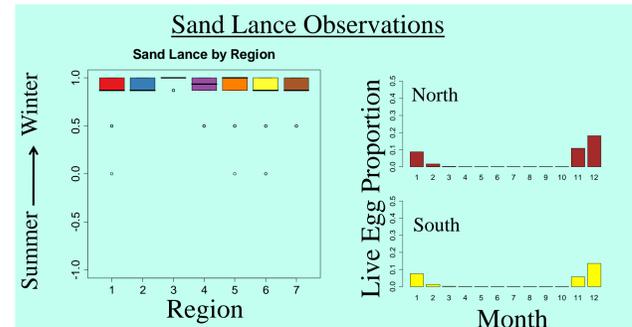
Results



Surveys were haphazardly located and were intended to identify beaches where spawning was present. Surveys were proportionally more frequent in northern Puget Sound and during fall and winter months.



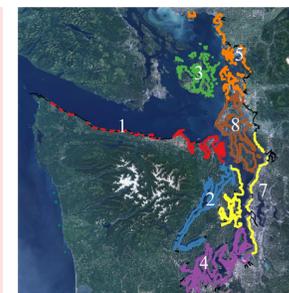
Surf smelt observations were temporally distributed similarly to the overall distribution of surveys, suggesting Sound-wide, year-round spawning. However, the timing of optimal live-egg proportions appears to differ by seasons between the northern and southern regions of Puget Sound.



Observations of sand lance eggs are temporally consistent across the seven regions - most frequently in the Nov.-Jan. period. Live-egg proportions are also remarkably temporally consistent across Puget Sound.

Seasonal patterns of spawning were investigated by transforming the survey month of each observation along an axis from December (1) to June (-1).

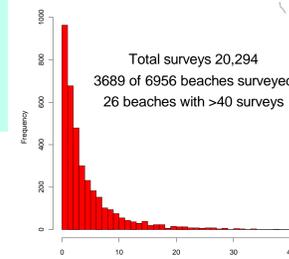
Seasonal spawning success was investigated by examining live egg percentage among collected eggs by month.



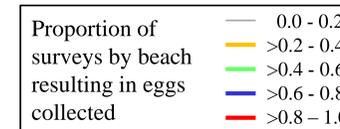
Puget Sound Regions

Locations of Surveys and Egg Observations on Puget Sound Beaches

Surveys were aggregated to the Dept. of Ecology's shorezone beaches to create spatial units along the shoreline. Frequency of detection was calculated as the proportion of surveys on a beach where one or both species' eggs were collected.



964 of the 3,689 surveyed beaches were only visited once.



Conclusions

We constructed a geodatabase with 30 years of surf smelt and Pacific sand lance spawning surveys in Puget Sound. Patterns of spawning timing and relative success differed between surf smelt and Pacific sand lance. Surf smelt reproductive success differed temporally between the Northern and Southern Sound but Sand Lance timing and success appeared uniform region wide.

- 1) Observations of surf smelt eggs on beaches were proportional to survey effort among regions and seasons suggesting year-round spawning.
- 2) Sand lance egg observations were restricted to winter months (Nov. - Jan.)
- 3) Reproductive success (as measured by proportion live eggs) was lowest for surf smelt in the three southern regions May-August, while highest in the four northern regions June-October.

At least three explanations could account for the spatiotemporal patterns we observed for surf smelt.

- There is one population that migrates throughout Puget Sound, spawning in different areas in different seasons.
- There is one population whose spawning timing is influenced by environmental factors that differ in north and south Puget Sound.
- There are at least 2 populations whose spawning timing has diverged.

The difference between the spatial and temporal patterns of spawning between surf smelt and sand lance might be due to differences in their population geographic distribution or habitat requirements.

Our dataset raises these and other hypotheses but cannot answer them robustly. A systematic monitoring study and genetic analyses would greatly enhance our understanding of these populations and provide insight into their contribution to the Puget Sound food web.

Forage Fish observations can be accessed at:

<http://wdfw.wa.gov/mapping/salmonscape/index.html>

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