Larval distribution patterns of offshore spawning flatfish in relation to topographic features, and the potential impact of climate events

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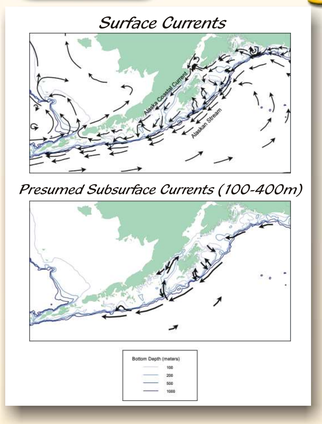
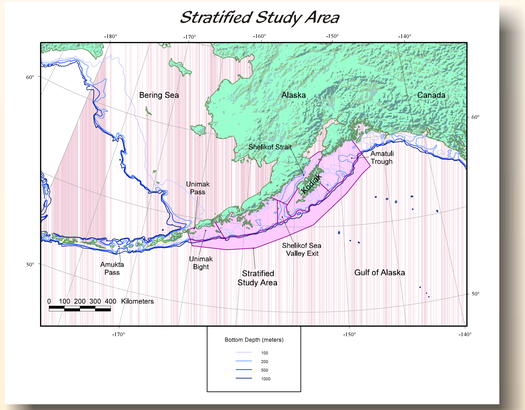
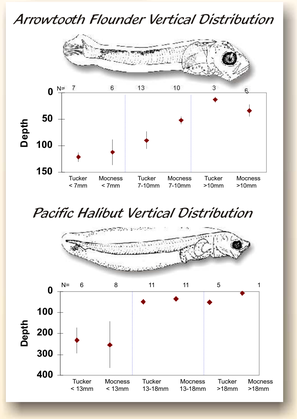
the Setting



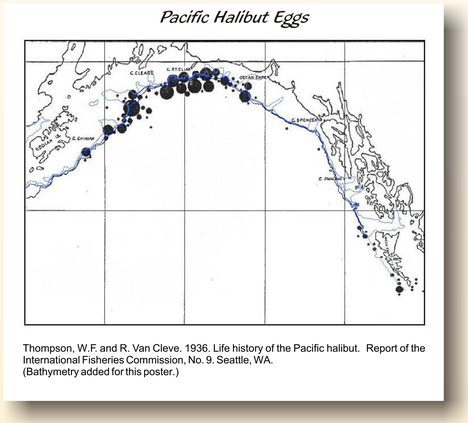
- Surface currents are dominated by the Alaska Coastal Current and the Alaskan Stream.
- Deep water currents are less well known but literature indicates that bottom water flows up the sea valleys, although this may be influenced by tides, Kelvin waves, sea level and upwelling.
- The study area is divided into strata based on bathymetry and longitude.



the Characters



- Offshore spawning flatfish species in the Gulf of Alaska, such as arrowtooth flounder, *Atheresthes stomias*, and Pacific halibut, *Hippoglossus stenolepis*, have juvenile nurseries that are inshore, in bays, or at the mouths of bays (Norcross et al. 1999, Fish. Oceanogr. 8:1, 50-67).
- Pacific halibut eggs are spawned in deep water offshore. Arrowtooth flounder also spawn in deep water.
- Young arrowtooth flounder and Pacific halibut larvae are deep in the water column and rise toward the surface as they grow larger. Larvae must emigrate from their spawning areas along the continental slope towards inshore bays, in a direction perpendicular to the prevailing Alaskan Stream.
- Juvenile arrowtooth flounder prefer colder nursery habitats, and the northern Gulf of Alaska is at the southern end of their preferred habitat. Conversely, juvenile Pacific halibut prefer warmer nursery habitats and the northern Gulf of Alaska is at the cold end of their preferred habitat.



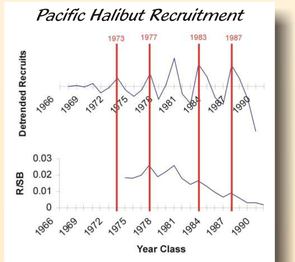
Thompson, W.F. and R. Van Cleve. 1936. Life history of the Pacific halibut. Report of the International Fisheries Commission, No. 9. Seattle, WA. (Bathymetry added for this poster.)

the Data

- Data on horizontal distribution are from a twenty-year time series of ichthyoplankton surveys using bongo tows in the Gulf of Alaska. Cruises are aggregated into El Niño and non-El Niño years.
- Data on vertical distribution are from MOCNESS and Tucker trawls.
- Pacific halibut recruitment time series was provided by the International Pacific Halibut Commission.
- The distribution of Pacific halibut eggs is from surveys conducted by the International Pacific Halibut Commission in 1926-34. No Pacific halibut eggs were collected in our surveys, as they are located farther offshore and deeper than our usual tows; arrowtooth flounder egg identification is uncertain.
- As with the eggs of both species, most young larvae are probably farther offshore than our usual survey region. They may also be prevalent in the water column earlier in the year than our usual surveys.

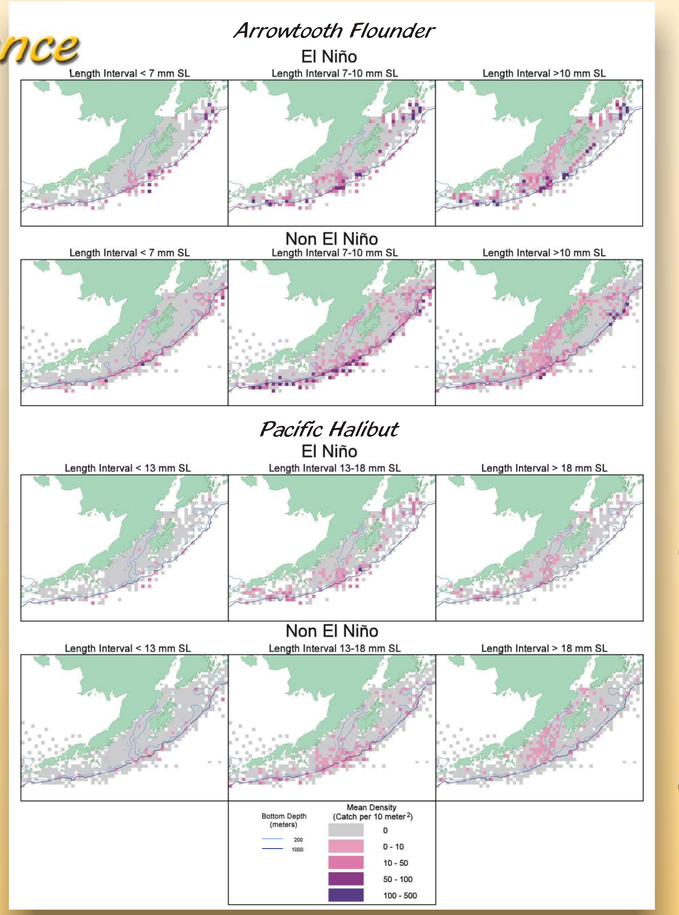
the Premise

- ENSO-conditions and warm year anomalies are linked to year class strength for Pacific halibut. (In our opinion, the recruitment time series of arrowtooth flounder may be unreliable). We examine patterns of variability in larval Pacific halibut and arrowtooth flounder distributions that may reflect processes resulting in successful recruitment to nursery areas.



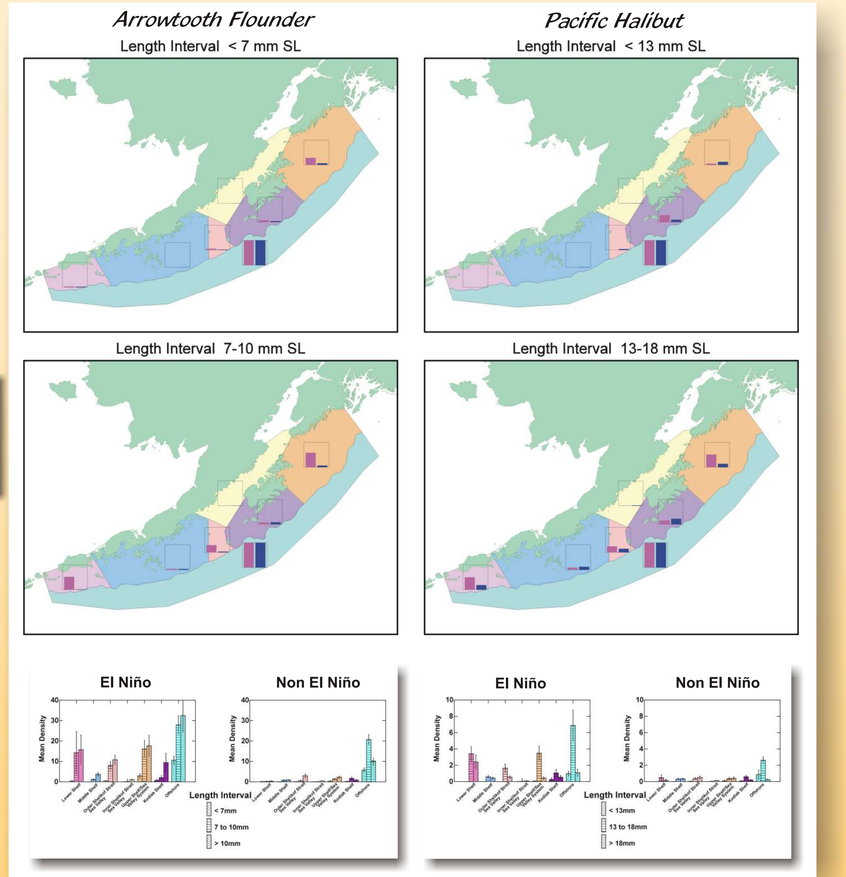
the Evidence

- This series of maps shows the mean density in 20 x 20 km grid cells. Means were calculated separately for three length ranges and for El Niño years and non-El Niño years.
- The larval distributions of both species are quite similar.
- For both species, the smallest sized larvae are located along the outer shelf and slope. Larger larvae tend to be located farther inshore over the continental shelf. As mentioned previously, our surveys may not sample the small larvae adequately due to their offshore distribution.
- For both species, larger larvae are also associated with deep-sea valleys and troughs that penetrate the shelf, especially the Amatuli Trough and the exit region of Shelikof Strait. These topographic features may serve as transport pathways to juvenile nursery grounds. This is consistent with the limited information indicating that the bottom water flows up the sea valleys.



- To further examine changes in larval distribution associated with El Niño conditions, the mean densities of larvae per tow in several different topographically-determined strata were calculated. The density of larvae in each stratum for each size category and species was standardized to the number of larvae found in the offshore strata. This standardization reflects the relative success of larvae moving onshore.

- For the smallest larvae, the distributions are similar in El Niño and non-El Niño years. However, in El Niño years, larger larvae are much more abundant in the Amatuli Trough, Shelikof sea valley exit, and Unimak Bight regions. This pattern is consistent for both species.
- The graphs at the bottom show that for both species, the mean larval abundances in our surveys were higher in El Niño years compared with non-El Niño years.



the Conclusions

- Sea valleys and troughs appear to serve as transport pathways for Pacific halibut and arrowtooth flounder larvae from their offshore spawning locations to inshore nurseries.
- During El Niño years, the abundance of Pacific halibut and arrowtooth flounder larvae over the shelf and outer slope region of our surveys is enhanced, perhaps indicating more onshore transport.
- During El Niño years, larvae are especially more abundant in the Amatuli Trough, Shelikof Strait sea valley exit, and Unimak Bight regions, indicating enhanced transport onshore in those areas.
- Enhanced transport of larvae onshore may contribute to the tendency for relatively strong year classes of Pacific halibut during El Niño years. This may not be the case for arrowtooth flounder because juvenile arrowtooth flounder prefer colder water, thus the benefit of enhanced transport may be offset by less desirable temperatures.

Poster designed by Wendy L. Carlson AFSC Graphics Unit, 2000
flatfish artwork provided by Henry Boyar
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