Spatio-temporal models provide new insights on the biotic and abiotic drivers shaping Pacific Herring (*Clupea pallasii*) distribution

**Strongest drivers** of Pacific Herring summer distribution & density:

- **Pacific Hake**, predator
- **Pacific Sardine**, potential competitor
- **Zooplankton** prey

**INTRODUCTION**

- Determining how fish respond to variation in biotic and abiotic conditions is a prerequisite to forecasting changes in productivity and spatial distribution of fish stocks.
- We investigated physical and biological drivers of spatio-temporal dynamics of Pacific Herring, a forage fish species important for commercial fisheries and First Nations in the NE Pacific.

**METHODS**

- **Spatio-temporal vector autoregressive (VAST) models** used to describe & quantify:
  - spatio-temporal fluctuations
  - abundance dynamics through time,
  - effects of abiotic and biotic factors,
  - spatio-temporal covariation with prey, predators, and competitors.
- Three fishery independent DFO surveys:
  - pelagic fish, nightime near-surface trawl
  - multispecies, daytime bottom trawl
  - Pacific Hake, daytime acoustic.
- Zooplankton (total biomass & Herring prey)
- Environment (temperature, chla, salinity, oxygen, fluorescence, & transmissivity)
- Timing differed among surveys; however, expect data collected during spring and summer reflects abundance.

**RESULTS**

- Increased relative abundance Herring, 2006-2014
- Herring abundance quadratically correlated with May sea surface temperature
- Herring on continental shelf (<185 m)
- Euphausiids, Pacific Hake, Sablefish and Arrowtooth Flounder near shelf break (>185 m)
- Positive covariation between Herring and its zooplankton prey
- Negative covariation in spatio-temporal densities between Herring and both Hake & Sardine
- Positive covariation in spatio-temporal densities between Herring and several groundfish species (Arrowtooth Flounder, Sablefish, Halibut, Cod)

**CONCLUSION**

Results suggest that strongest drivers of Pacific Herring summer distribution and biomass are: i) zooplankton prey availability; ii) predator avoidance, particularly Pacific Hake; and iii) competition with sardines.