



**PACIFIC SALMON
FOUNDATION**



**INTERNATIONAL
YEAR OF THE SALMON**



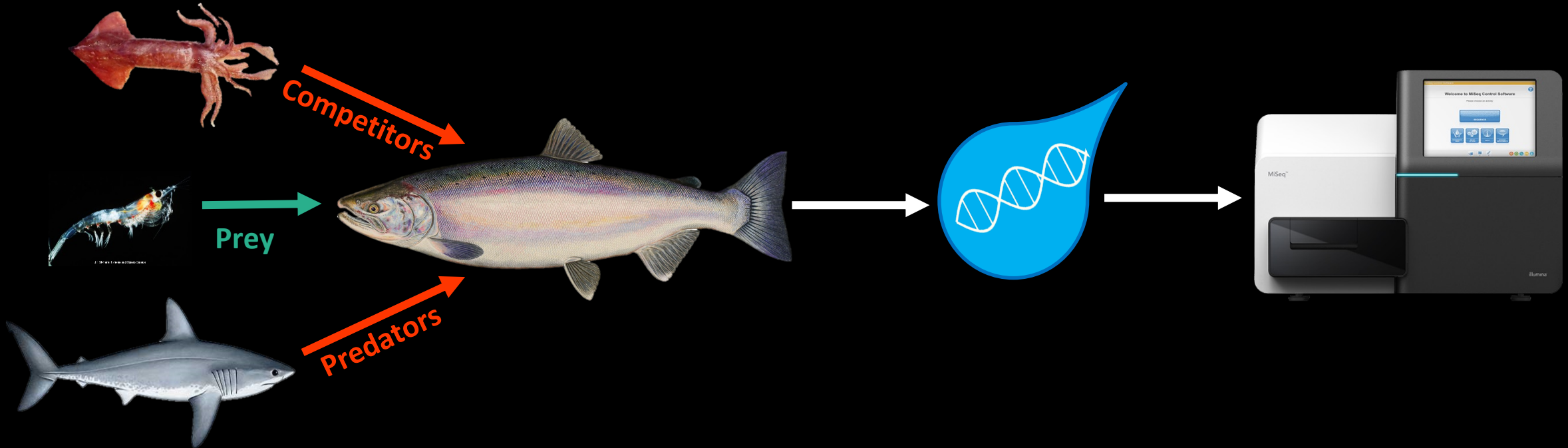
Entering the next dimension: Combining continuous eDNA, hydroacoustic, and oceanographic sampling to deciphering open ocean ecosystem structure



2022 IYS Synthesis Symposium

Christoph Deeg, Brandon Chasco, Jarrod Santora, Brian Wells, Abigail Wells, Robert Saunders, Brian Dykeman, Andrew Bateman, and Kristina Miller

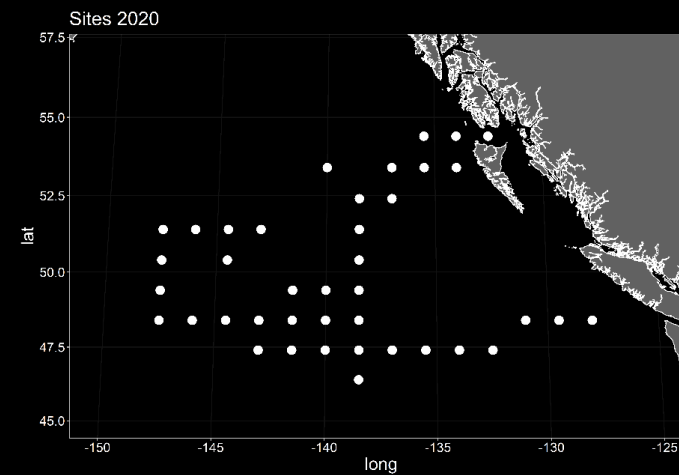
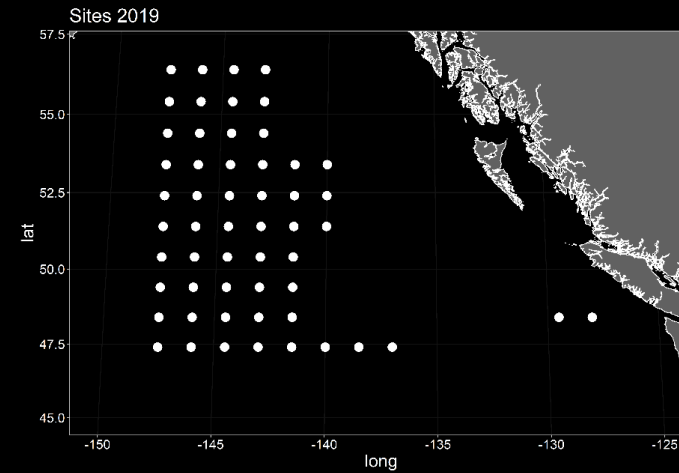
Illuminating the black box with Environmental (e)DNA



What is the **environment** like for salmon?
eDNA survey of the winter salmonosphere

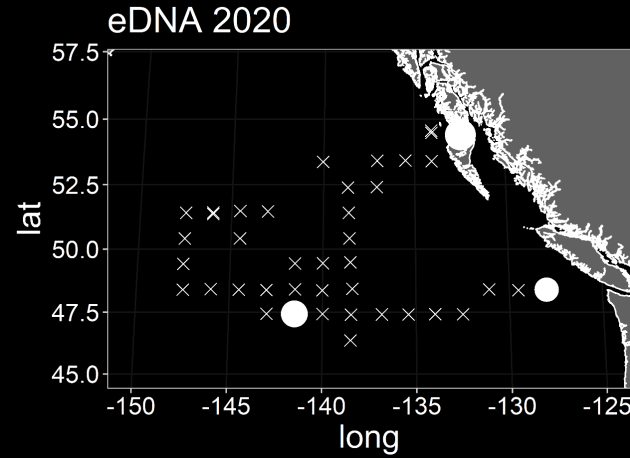
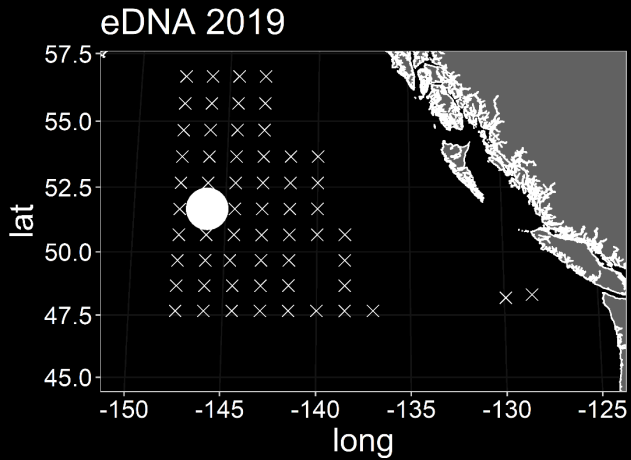
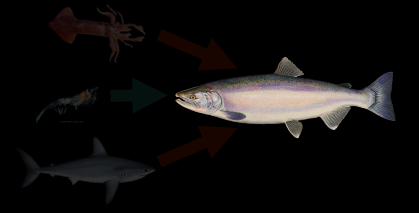


2019-2020 IYS GoA expeditions

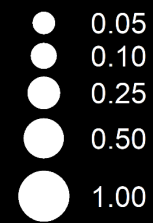




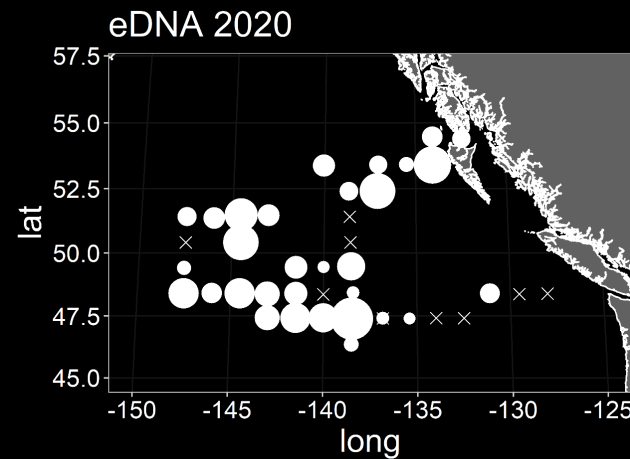
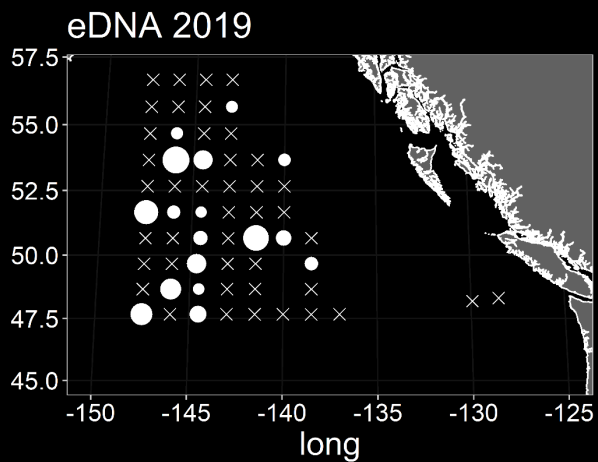
Gulf of Alaska eDNA: Salmon



eDNA Index



Chinook salmon
(Oncorhynchus tshawytscha)

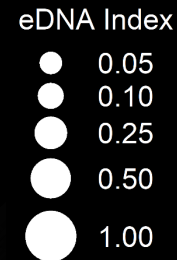
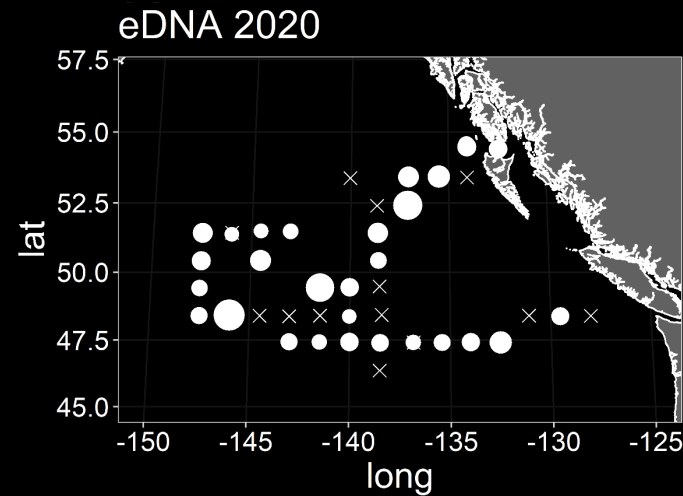
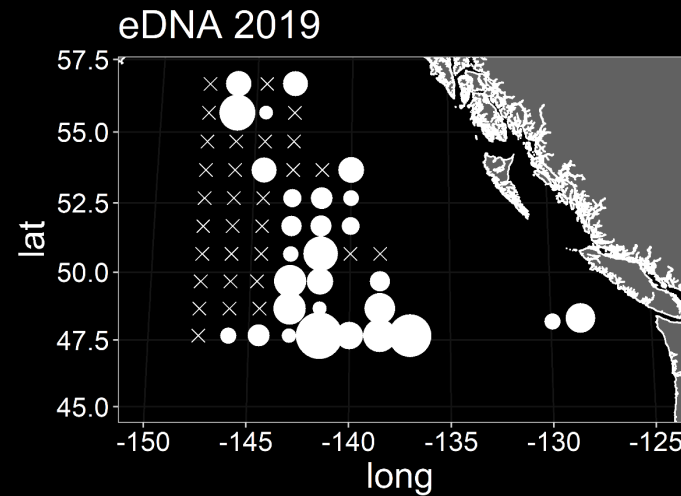
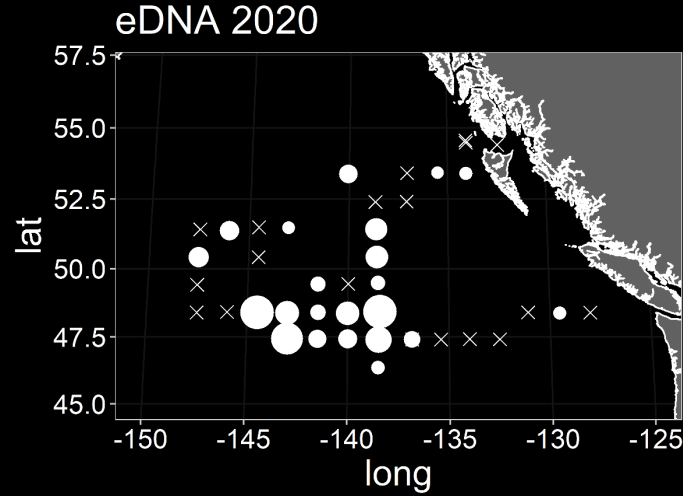
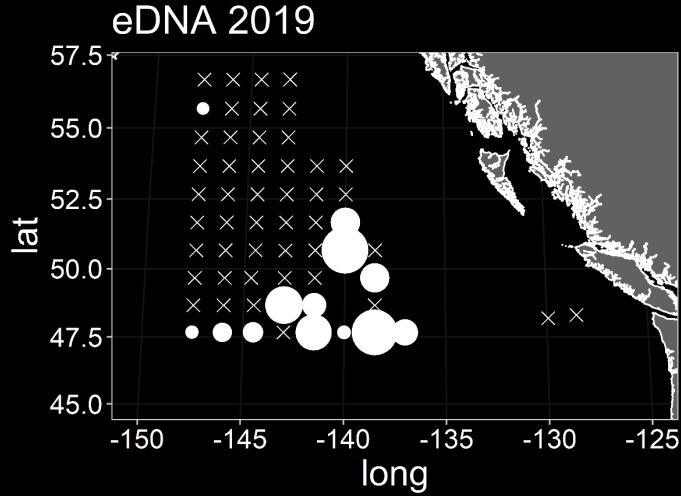
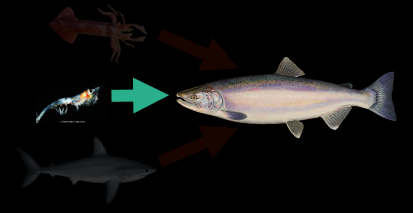


Pink salmon (*Oncorhynchus keta*)

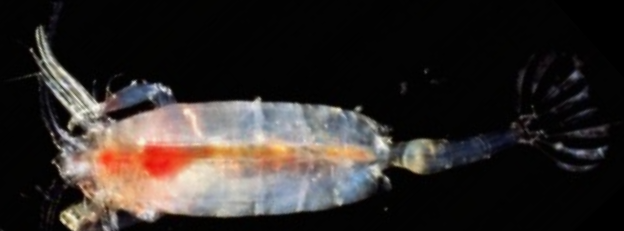




Gulf of Alaska eDNA: Prey



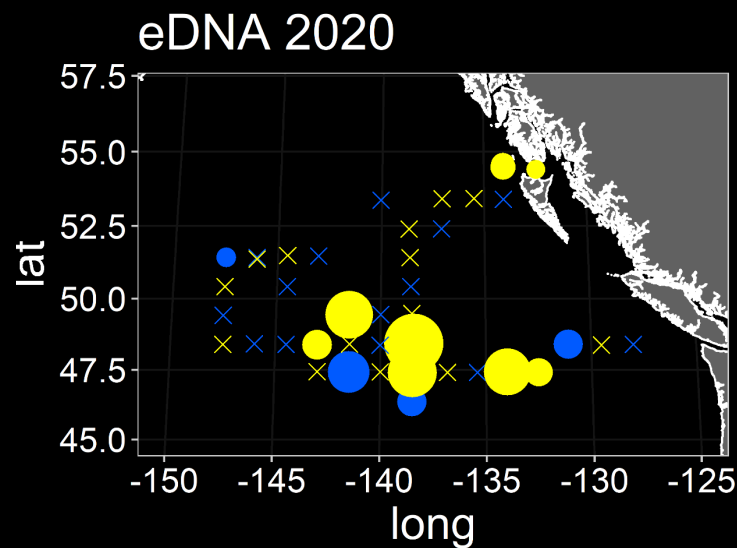
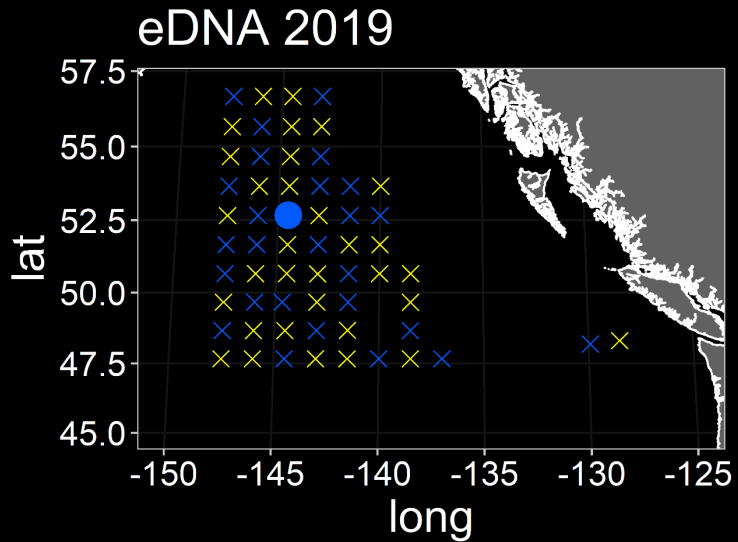
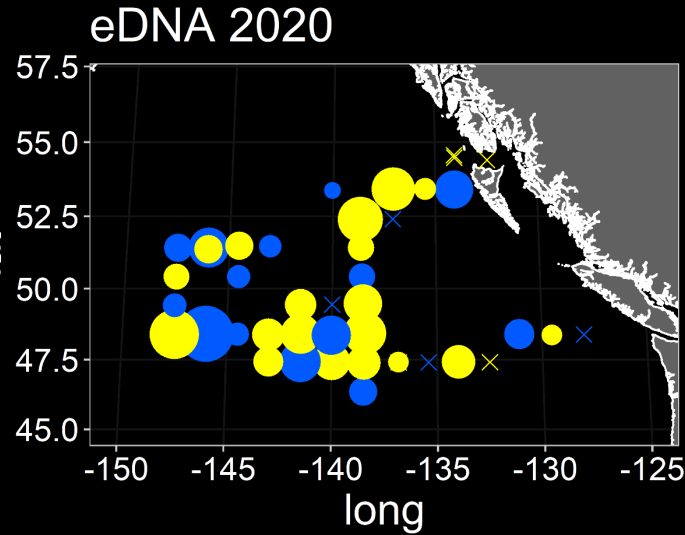
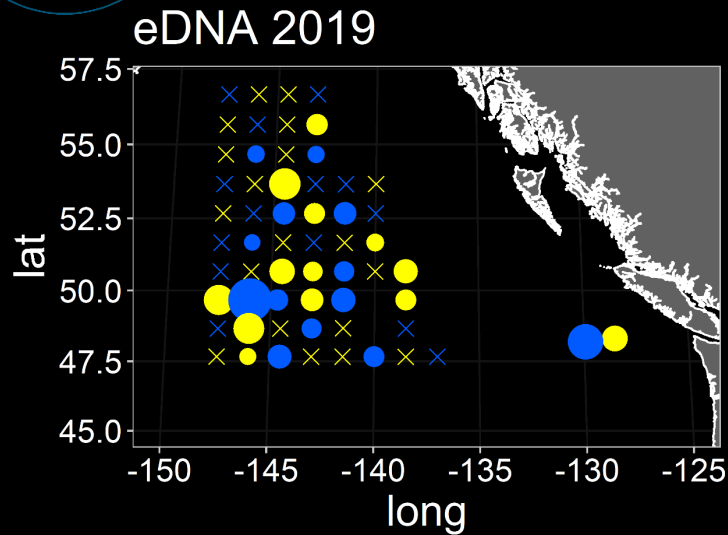
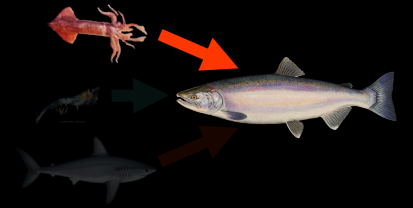
Mesocalanus tenuicornis



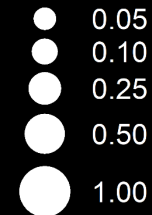
Paraeuchaeta spp.



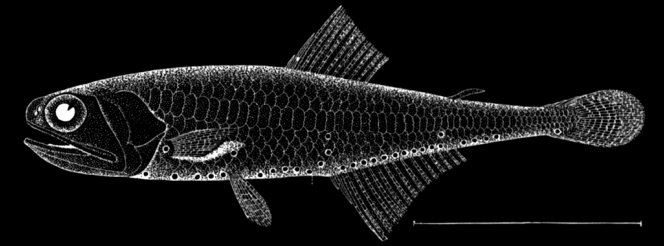
Gulf of Alaska eDNA: Competitors



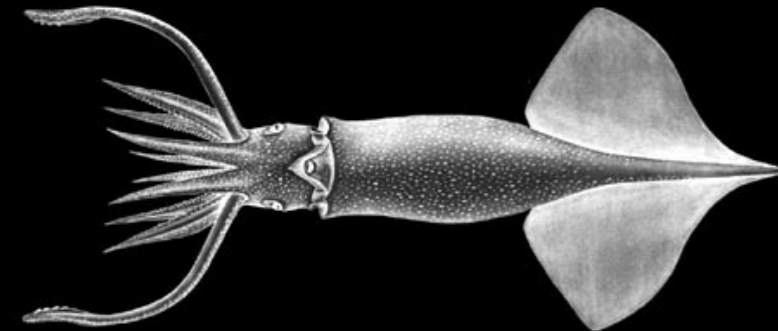
eDNA Index



Time



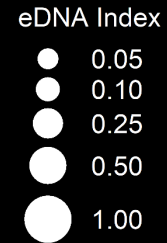
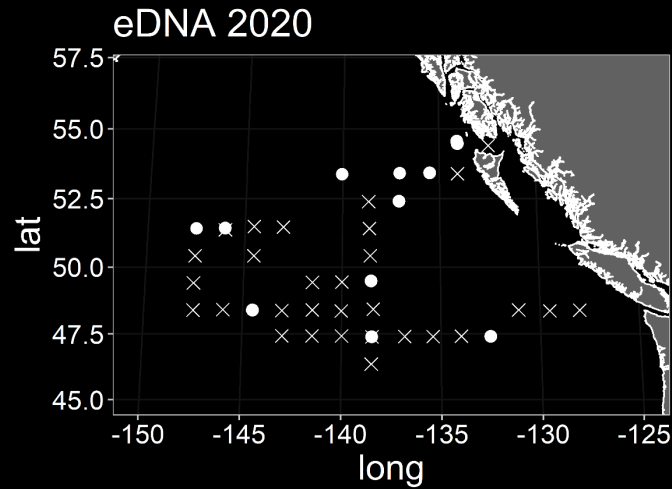
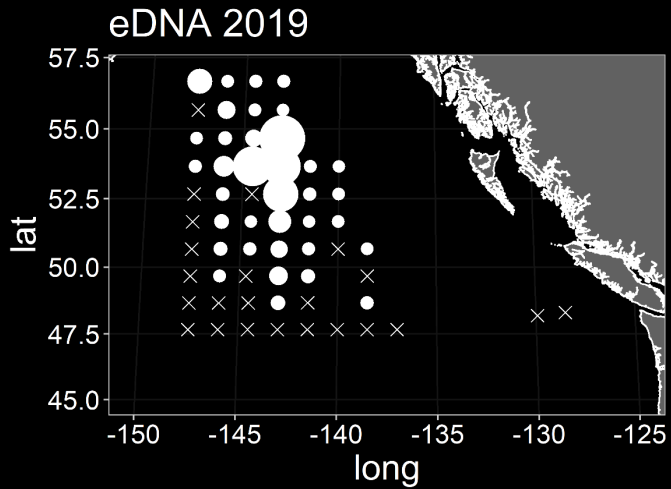
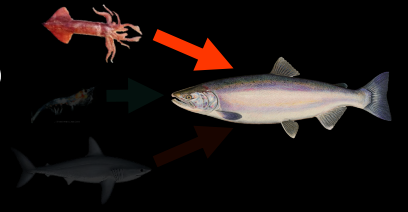
Blue lanternfish
(Tarletonbeania crenularis)



Boreal clubhook squid
(Onychoteuthis borealijaponica)



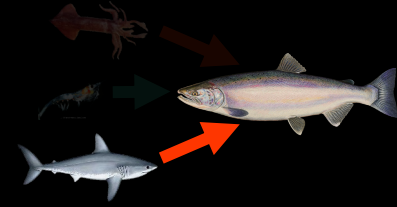
Gulf of Alaska eDNA: Competitors?



Chrysaora melanaster



Gulf of Alaska eDNA: Predators



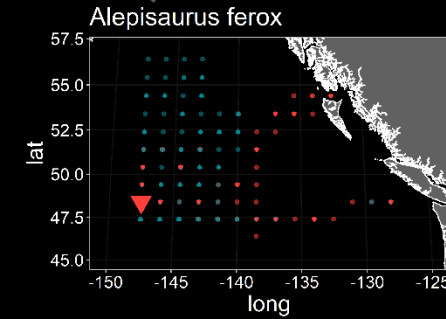
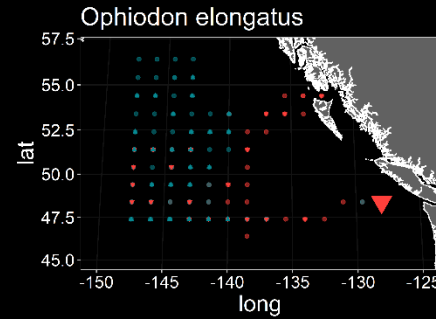
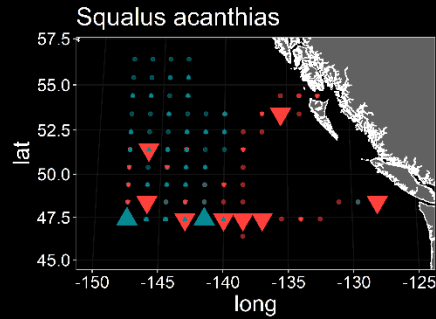
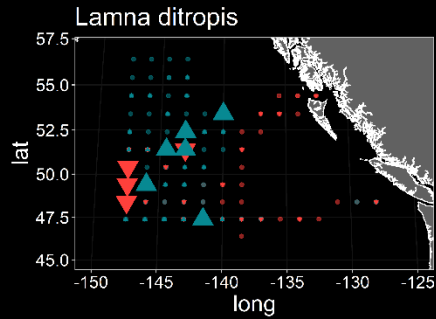
Dietmar Weber / Shark Foundation



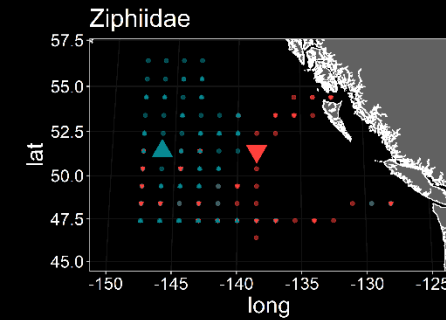
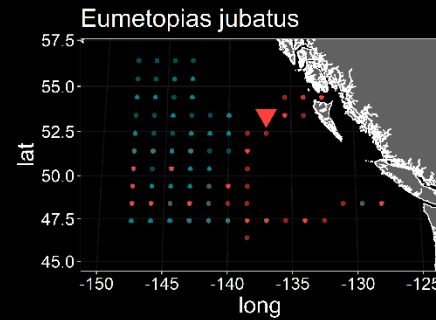
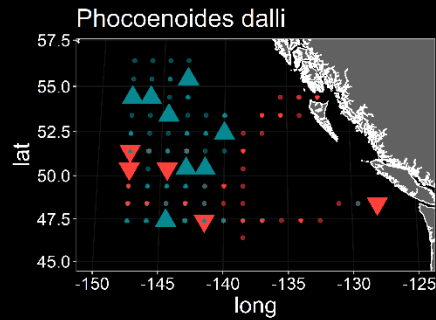
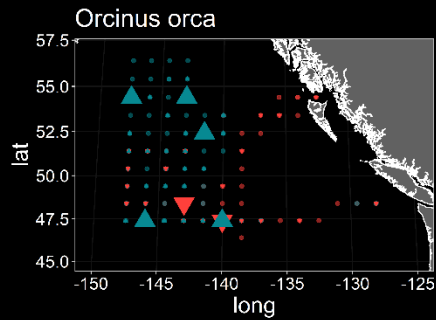
fishwatch.govpphido



efishalbum.com



2019
2020



Uko Gorter



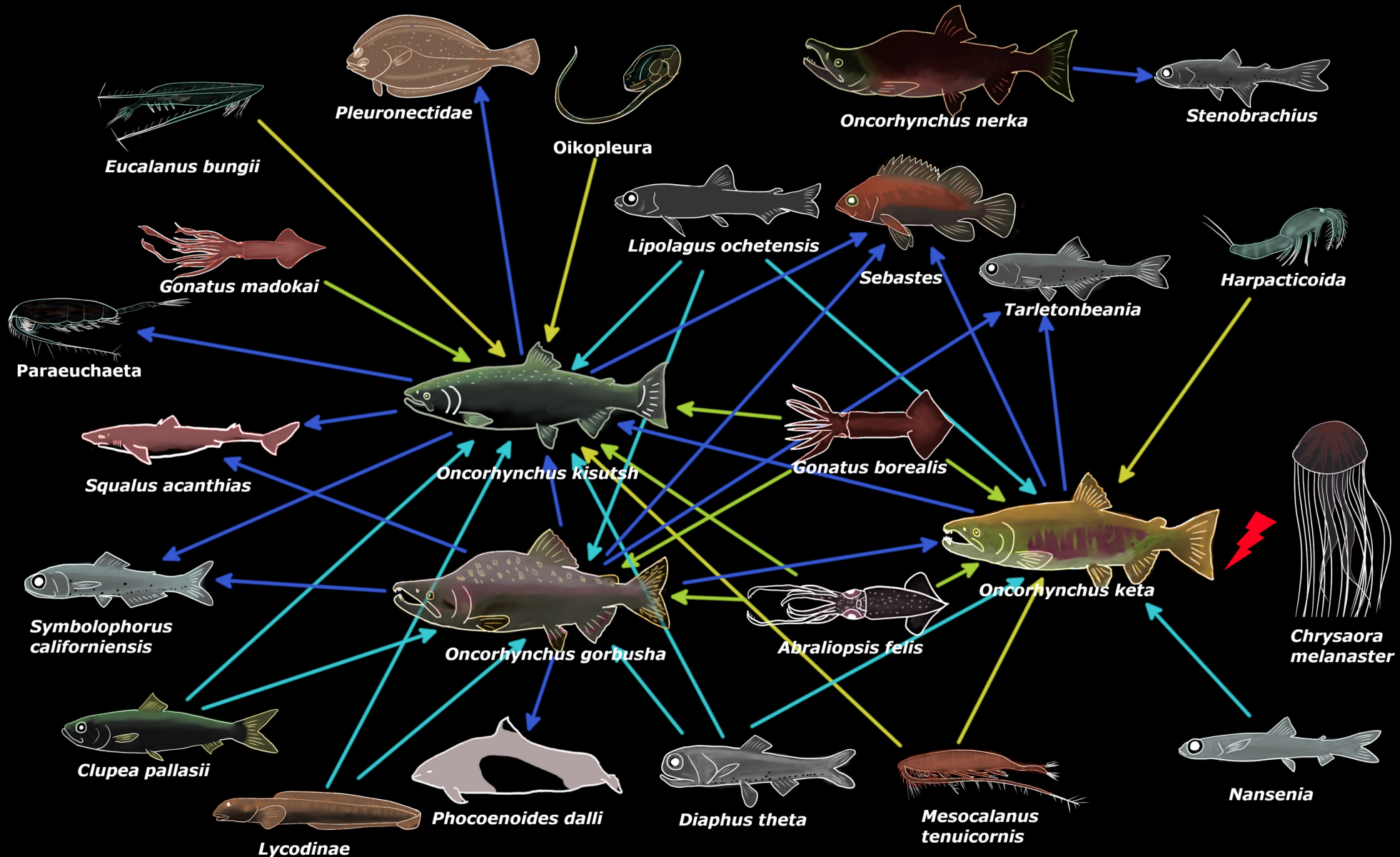
<http://cetus.ucsd.edu/>



NOAA



GoA eDNA Co-occurrence Network

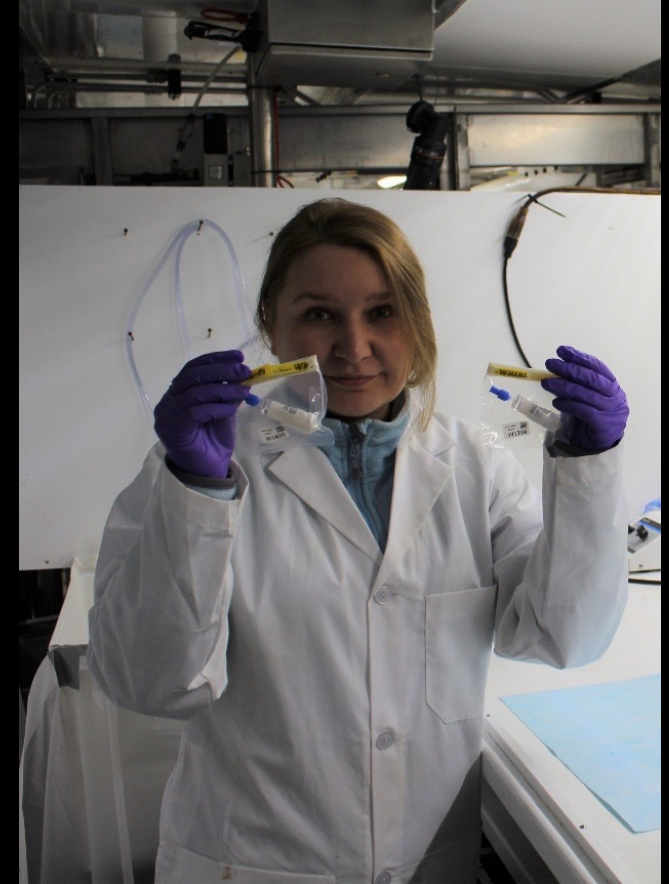




2019-2020 IYS GoA expeditions



- Subsurface 2L grab sample
 - Niskin -> Whirlpak
 - 0.22µm Sterivex
- ➔ Spatiotemporal snapshot

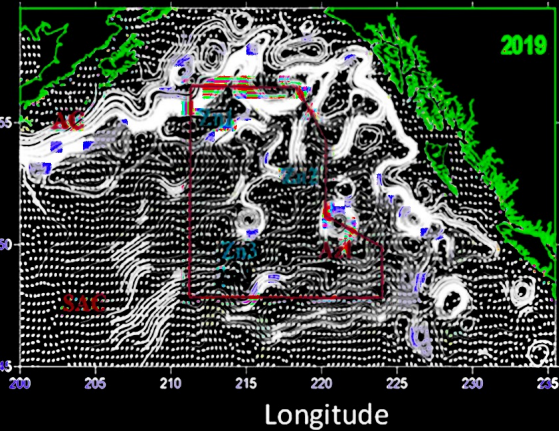




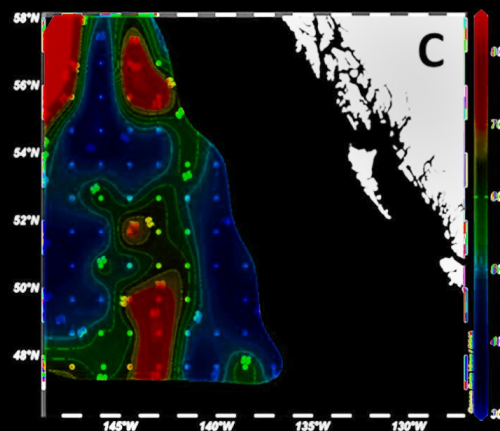
Spatiotemporal snapshot -> Patchy data

2019

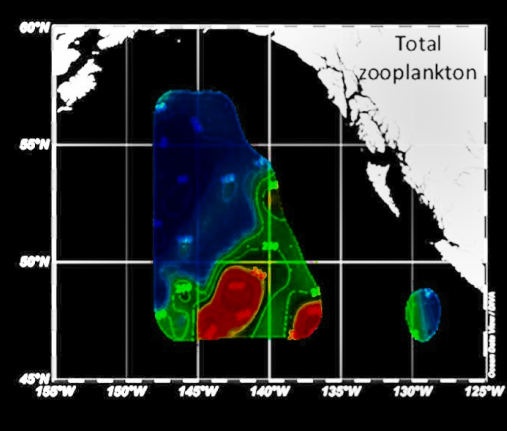
Surface currents



Chlorophyll



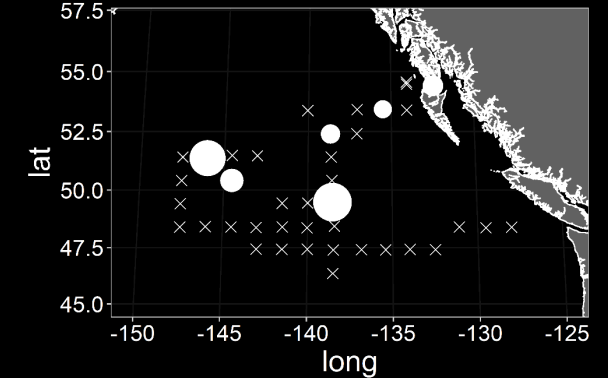
Zooplankton



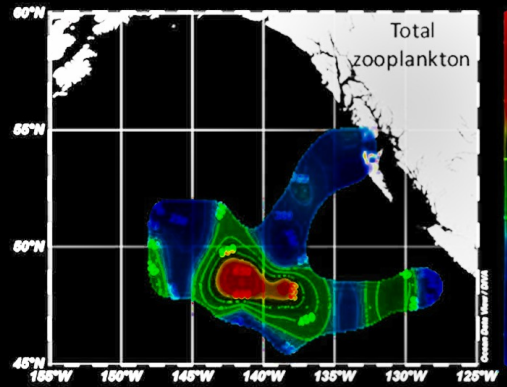
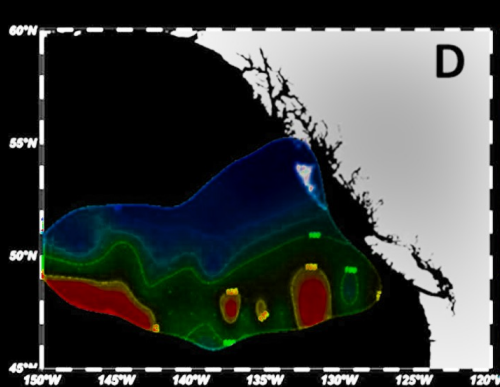
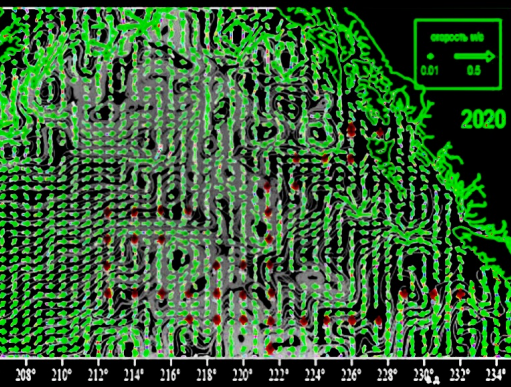
Sockeye



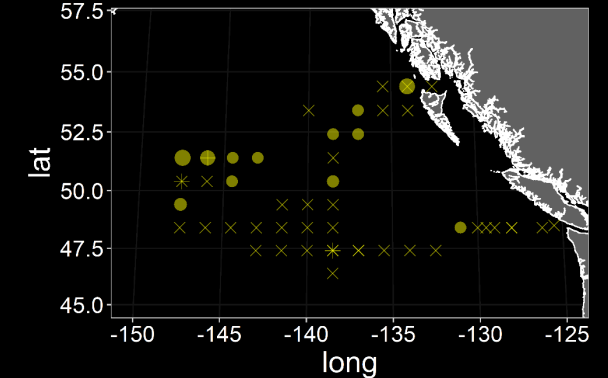
eDNA 2020



2020

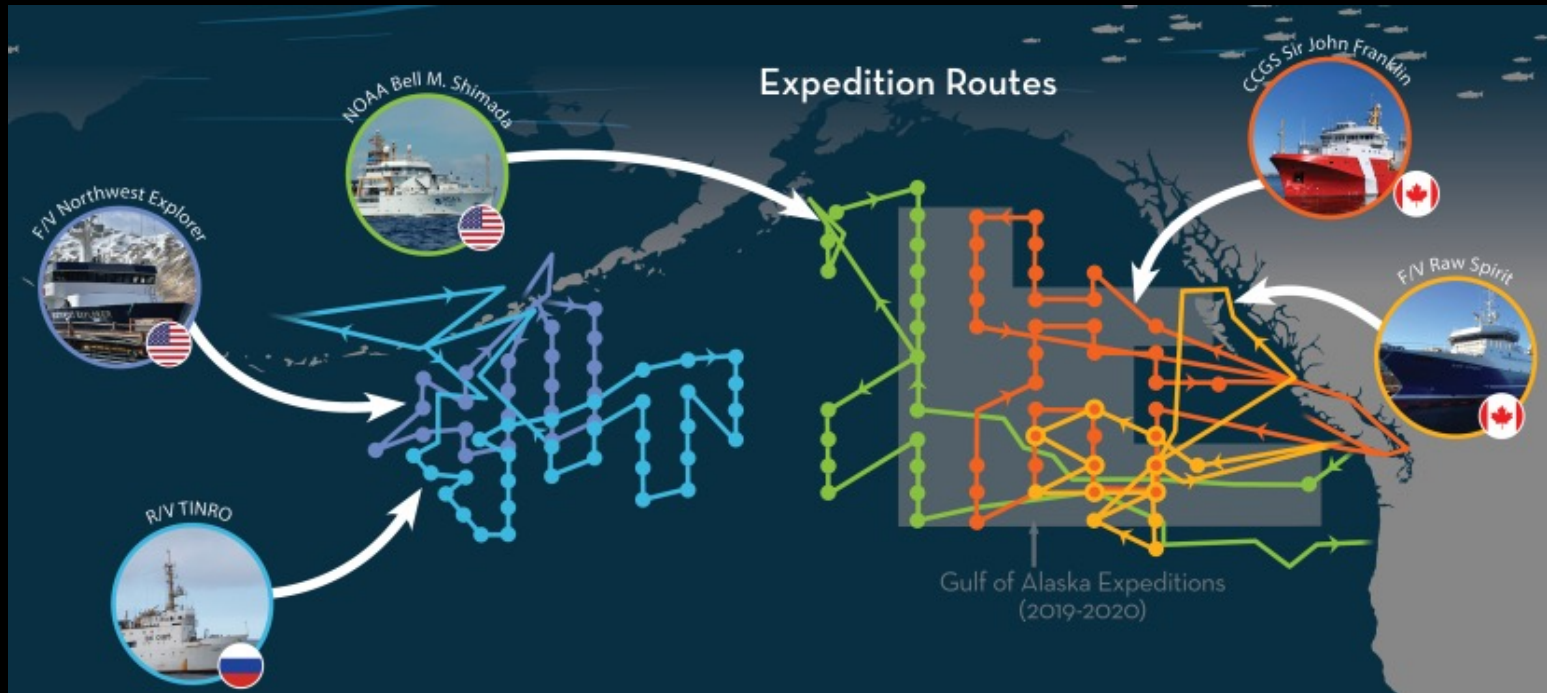


CPUE 2020





2022 IYS Pan Pacific expedition

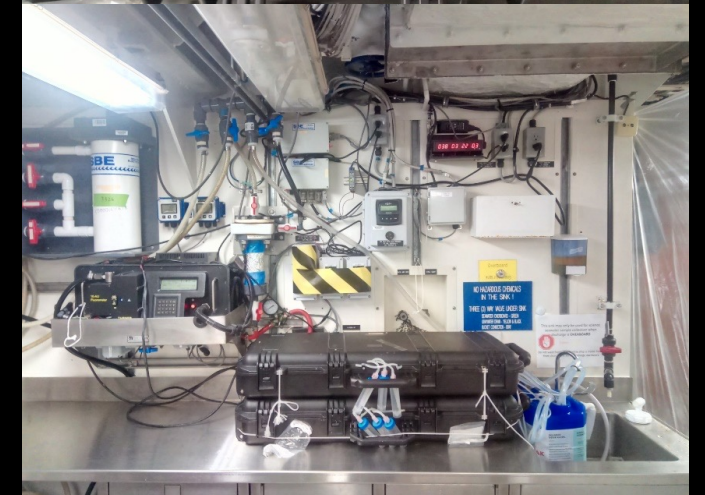
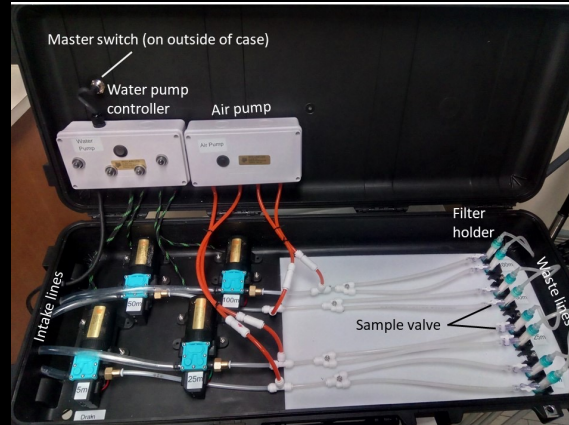


Goal: Increase spatiotemporal resolution to reveal seascape structure



2022 IYS: eDNA sampling

- Hollow membrane filters -> 5L
- Simultaneous on-site Niskin sampling
 - 5m, 25m, 50m, 100m
- Automatic continuous flowthrough transect sampling





2022 IYS: Continuous flowthrough eDNA sampling

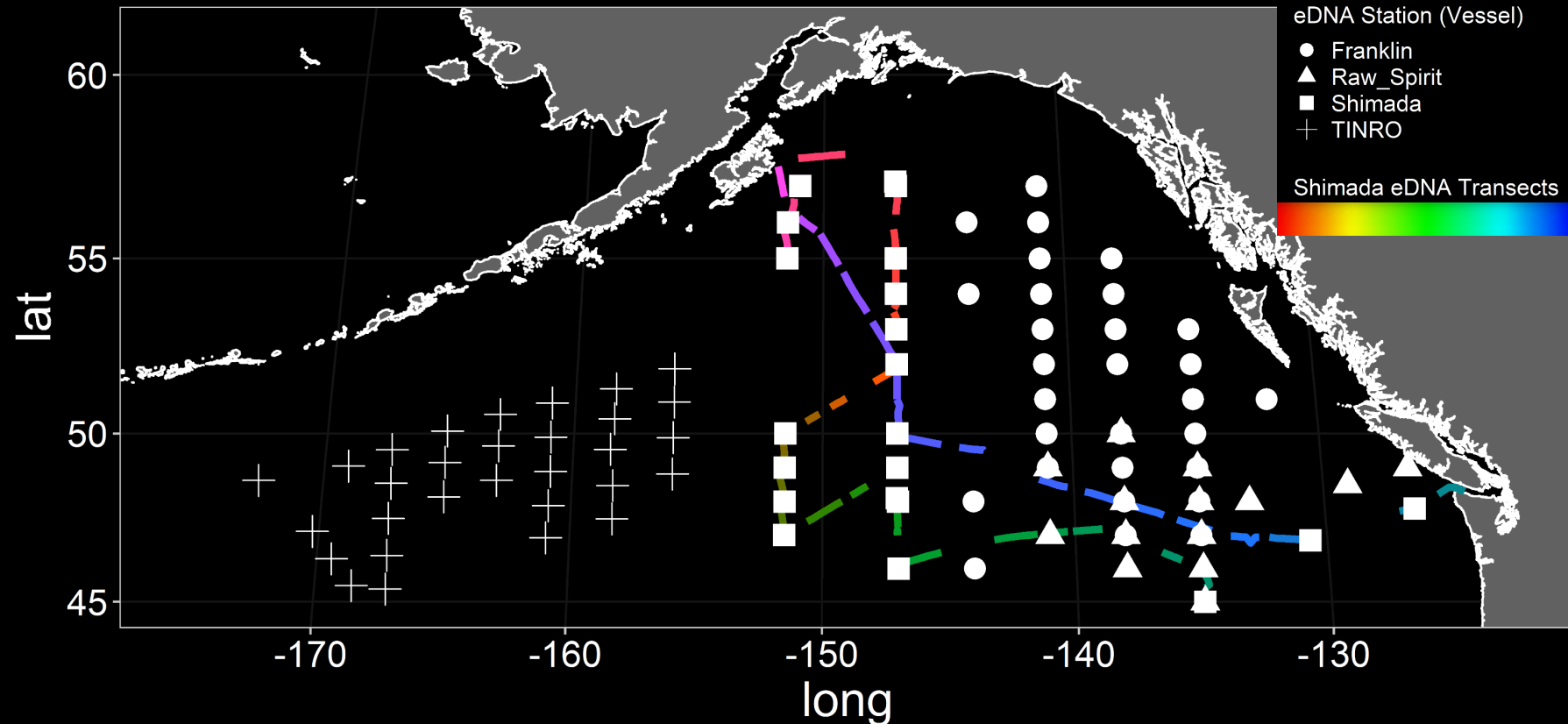


- Automatic transect eDNA sampling
 - 6x1h
 - 5-10L/h
 - **5-18 km resolution!**
- Synoptically collected
 - Flowthrough
 - Thermosalinograph
 - Chla
 - Hydroacoustics
 - 18, 38, 70, 120, 200 kHz





IYS 2022: eDNA sampling



101 stations -> ~2.2 million km² @ 4 depths

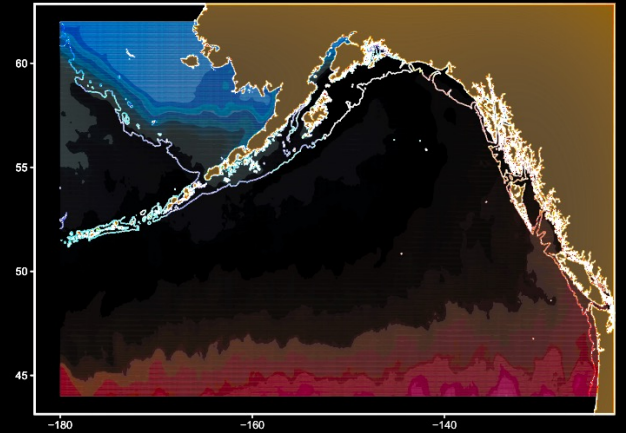
260 transect samples -> 6000 km @ 10km resolution



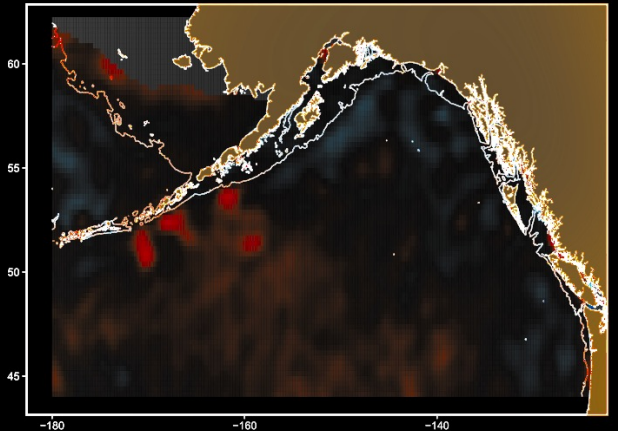
Better together: eDNA and Hydroacoustics

- eDNA: Species ID
- Hydroacoustics: Quantification
- High resolution oceanographic data: Environment
- Hypothesis: **Species abundance and community composition are associated with mesoscale oceanographic features**
 - Eddies
 - Gyres
 - Currents

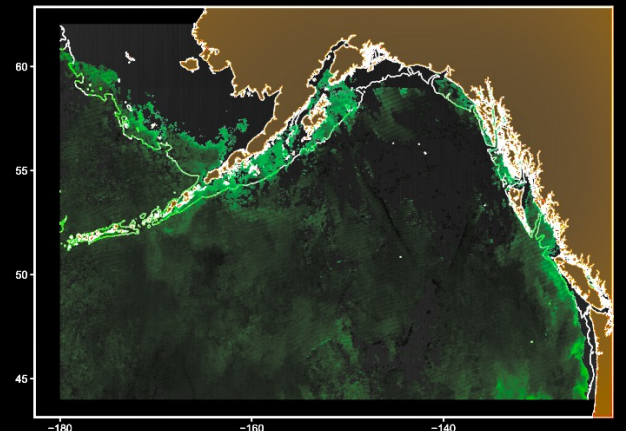
SST



SLA

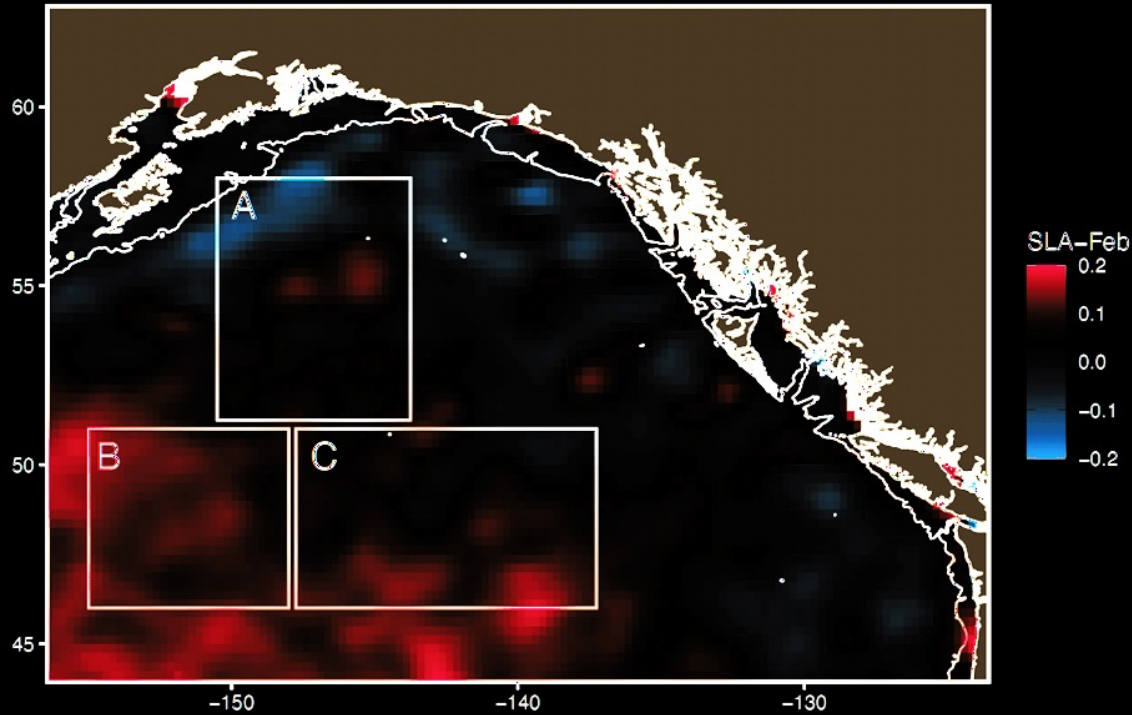


Chla



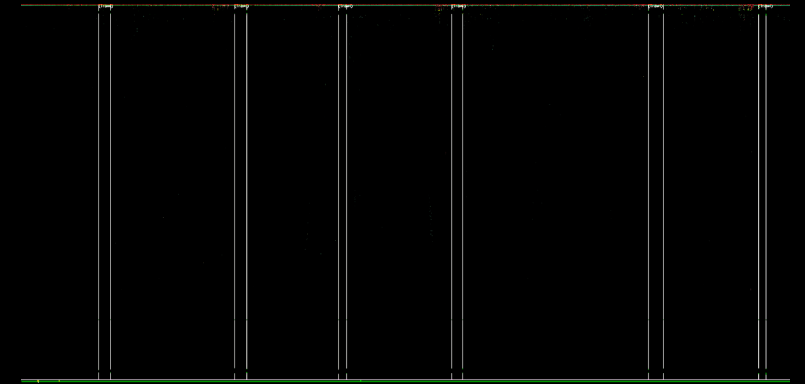


2022 Transect Hydroacoustics

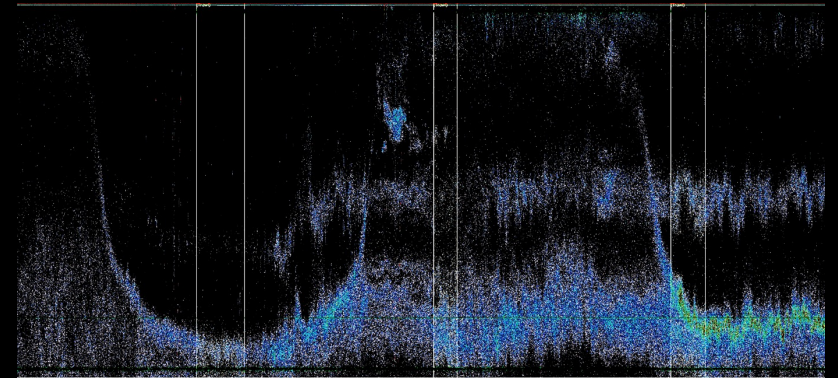


Brandon Chasco, Jarrod Santora, Brian Wells

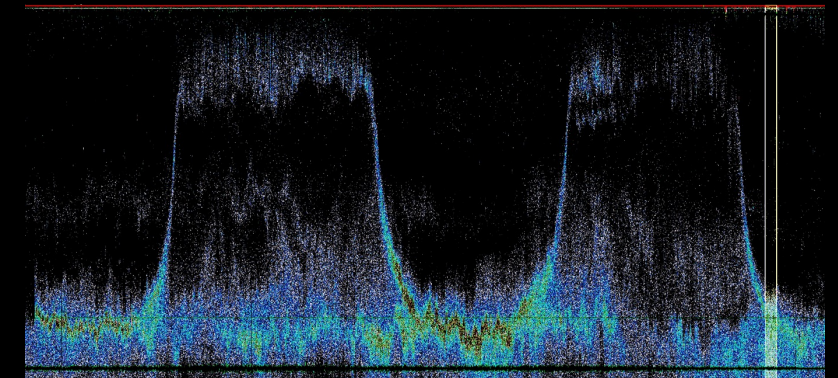
A



B



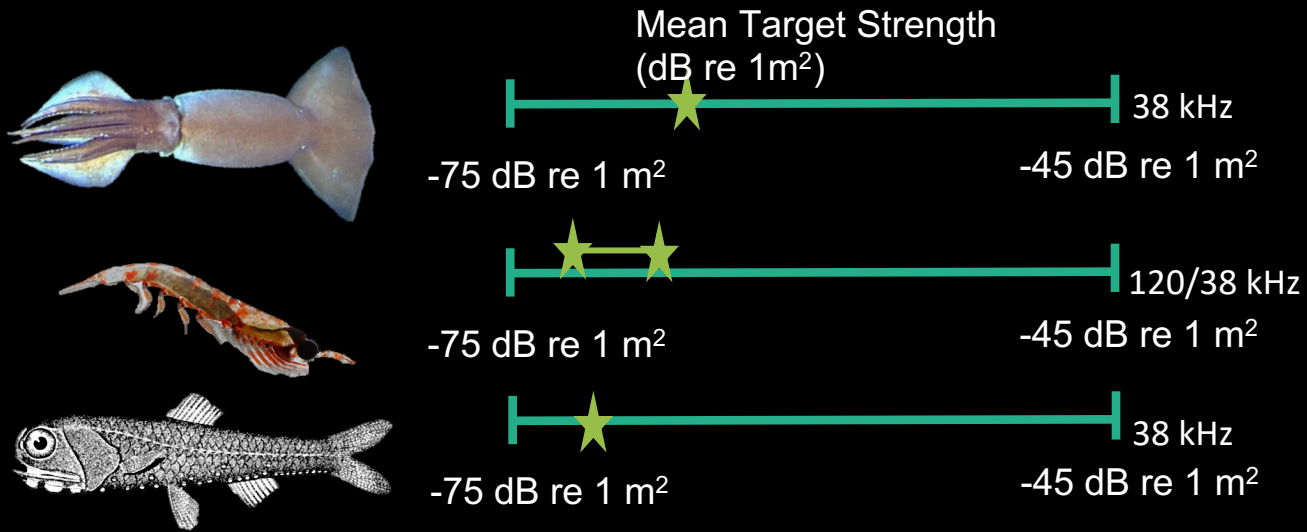
C



-75 dB to -35 dB @38 kHz



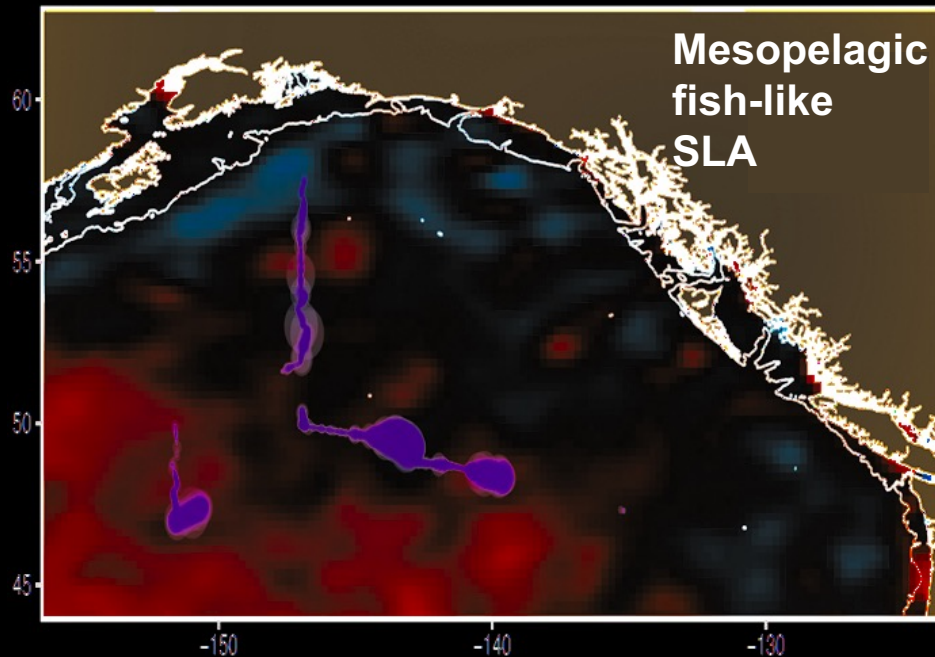
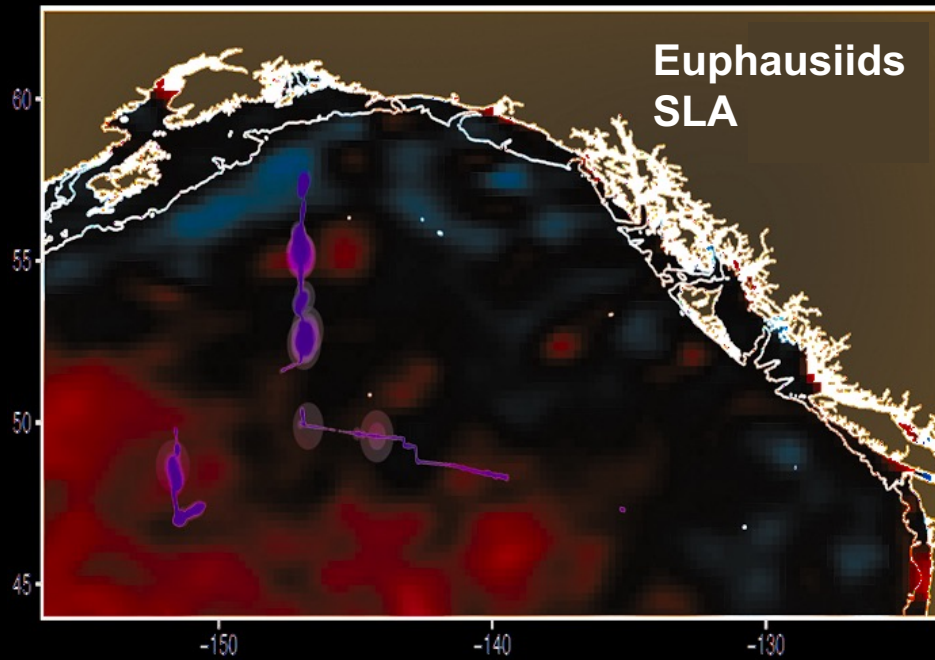
2022 Transect Hydroacoustics



9m to 350m vertical bin






0.5nm horizontal bin

Brandon Chasco, Jarrod Santora, Brian Wells





Next steps towards hypothesis testing

- Sequence eDNA samples for species ID
 - Zooplankton (12S/COI/16S) 
 - Teleosts(12S) 
 - Chordates (16S) 
 - Cephalopods (16S) 
 - Salmonids (COI) 
- Refine Hydroacoustics
- Combine with physical and biological Oceanographic data

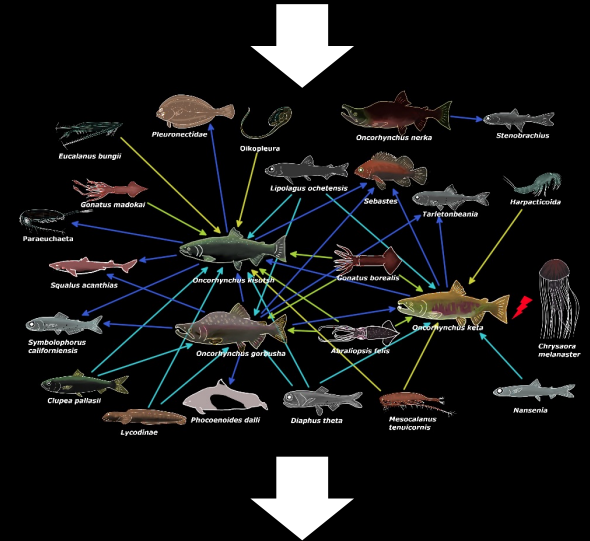
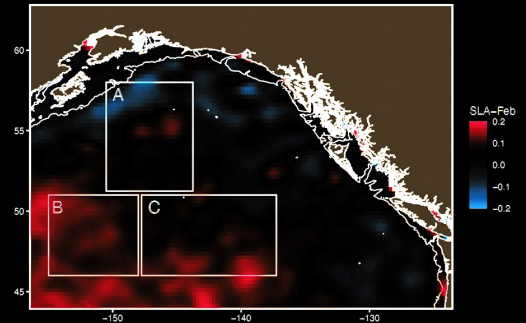


eDNA extraction system



Goals

- Describe meso- and macro-scale ecosystem structure and function
- Identify biophysical features associated with hotspots of biological activity
 - Impacts on salmon ocean survival?
 - Targets for remote sensing?



Thank you!



PACIFIC SALMON
FOUNDATION



- Shaorong Li
- Svetlana Esenkulova
- Brian Hunt
- Mark Saunders
- Aiden Schubert
- Caroline Graham
- Richard Beamish
- Brian Riddell
- Laurie Weitkamp
- Angela Schulze
- Chelsea Stanley
- Cynthia Wright
- Valeria Soshnina
- Nick Ens
- Christopher Tam