International Gulf of Alaska Expedition

February –March 2019

RV *Professor Kaganovskiy*

Expedition organized by Richard Beamish, DFO emeritus

With support from North Pacific Anadromous Fish Commission (NPAFC), Pacific Salmon Foundation, DFO Science Branch, Salmon Farmers Association of BC, Province of British Columbia, Pacific Salmon Commission, Harmac Canada, Port Authority of Nanaimo and private donors

Photo by Egor Glyzin, 3rd mate

INTERNATIONAL YEAR OF THE SALMON

Expedition Science Team

Photo by Egor Glyzin,
3rd mate

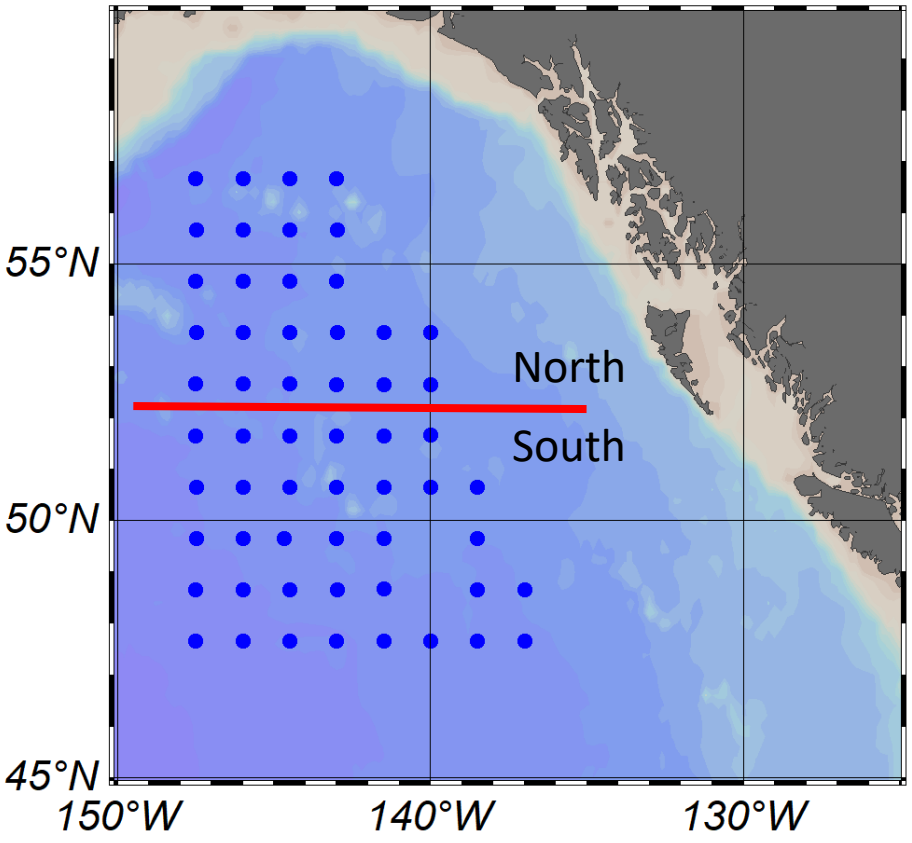
Canada: Christoph Deeg, Svetlana Esenkulova, Brian Hunt, Chrys Neville, Evgeny Pakhomov, Vishnu Perumthuruthil
Korea: Hae Kun Jung **Japan:** Hiko Urawa
Russia: Arkadii Ivanov, Gennady Kantakov, Albina Kanzeparova, Anton Khleborodov, Igor Shurpa, Aleksnadr Slabinskii, Aleksei Somov, Anna Vazhova, Mikhail Zuev
US: Gerard Foley, Charlie Waters, Laurie Weitkamp
NPAFC: Vladimir Radchenko

The making of the Expedition

1. This expedition is occurring due to the initiative of Richard Beamish.
    1. Recognized need to be in north Pacific in winter
    2. Attained agreement from Russian government to charter one of their research vessels for this expedition.
    3. Privately funded the expedition with support from many donors/groups/organizations/government departments.
    4. Selected science team based on abilities and ensuring international participation. Each participant “volunteered” to be on a Russian ship in GoA in winter.

2. Two major objectives from the start
    1. Test the hypothesis that the abundance of salmon is mostly determined by the end of the first ocean winter. Fish that grow faster and quicker in their first year survive better.
    2. See if an international team of researchers can work effectively together to make the discoveries we need to be responsible stewards in a future of rapidly changing ocean ecosystems.

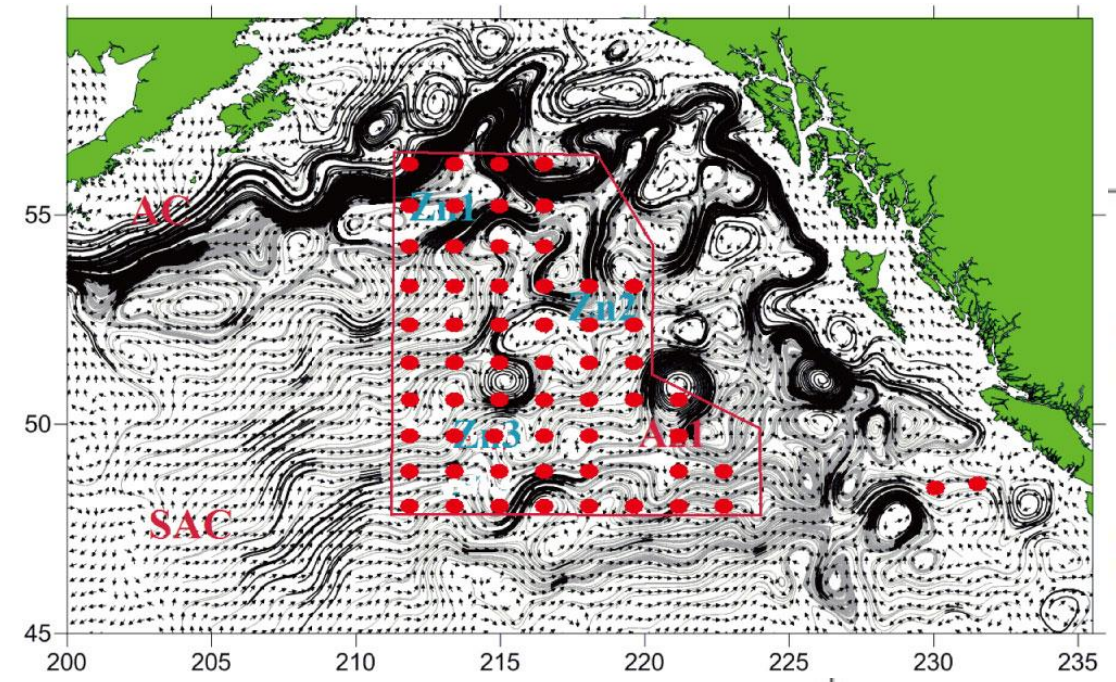
Study area and key objectives

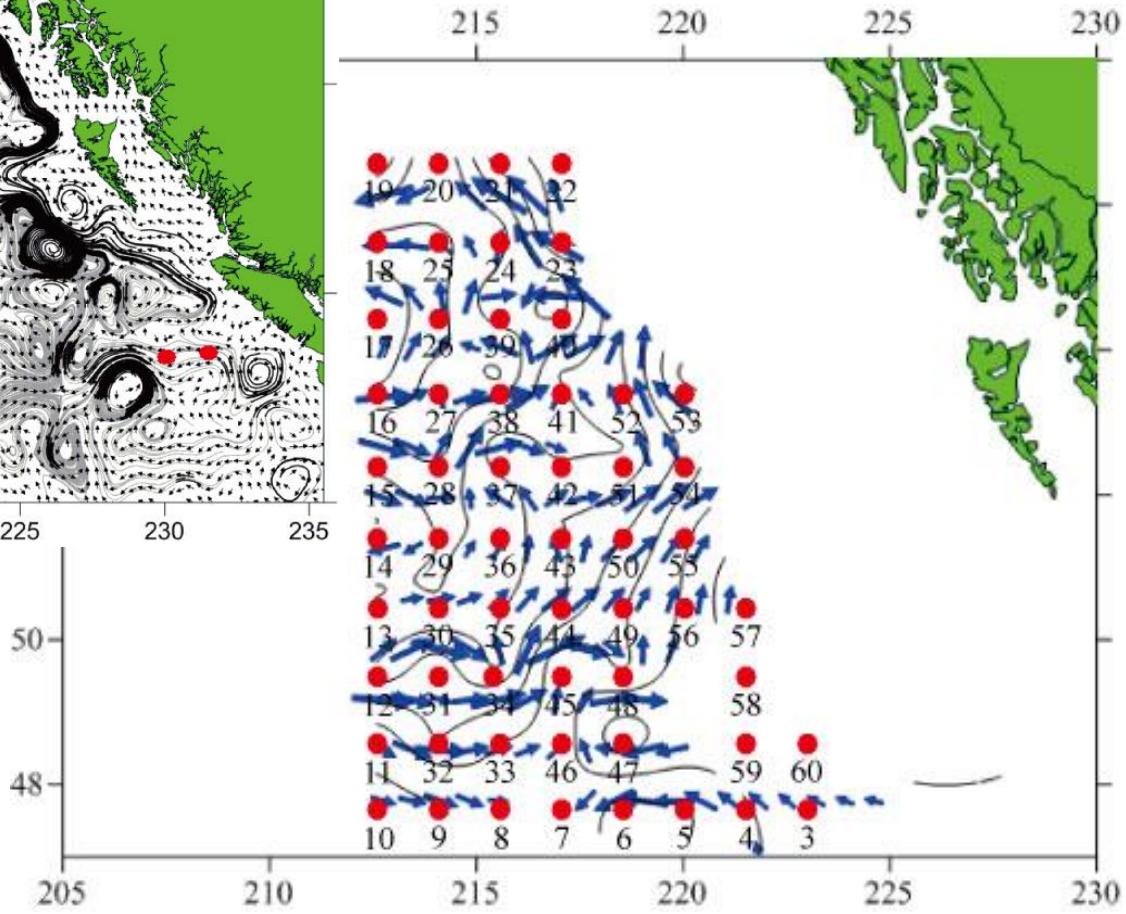


1. Identify the species and stock specific distribution of Pacific salmon in Gulf of Alaska in winter.
2. Conduct first abundance estimates of Pacific salmon in eastern Pacific in winter
3. Examine health and condition of salmon in relation to region caught, ocean conditions and stock overlap
4. Test key hypothesis regulating salmon production including
   a) Critical size and period
   b) Temperature based distributions
   c) Competition between species

Surface currents

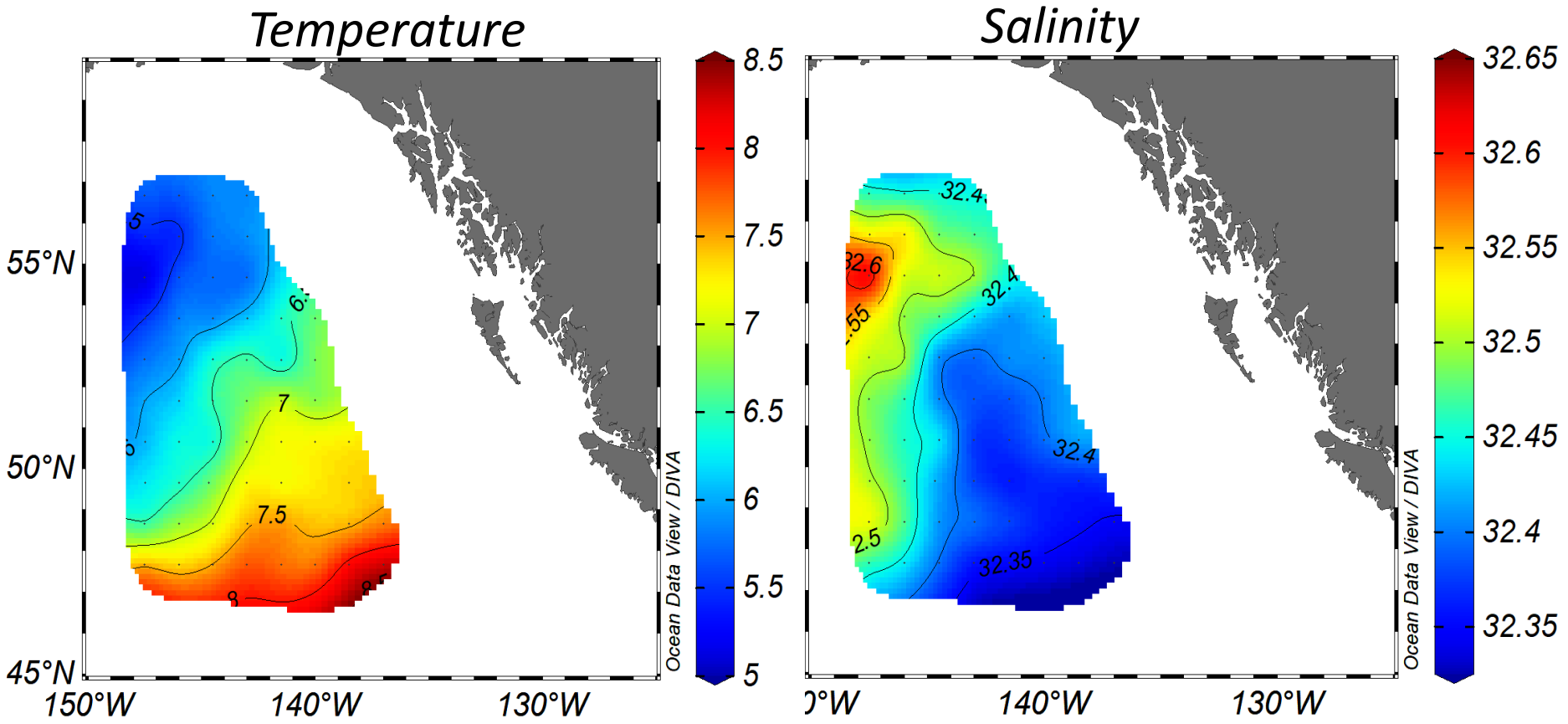
Arkadii Ivanov, Gennady Kantakov, Igor Shurpa –Russia
Hae Kun Jung – South Korea





Surface temperature and salinity

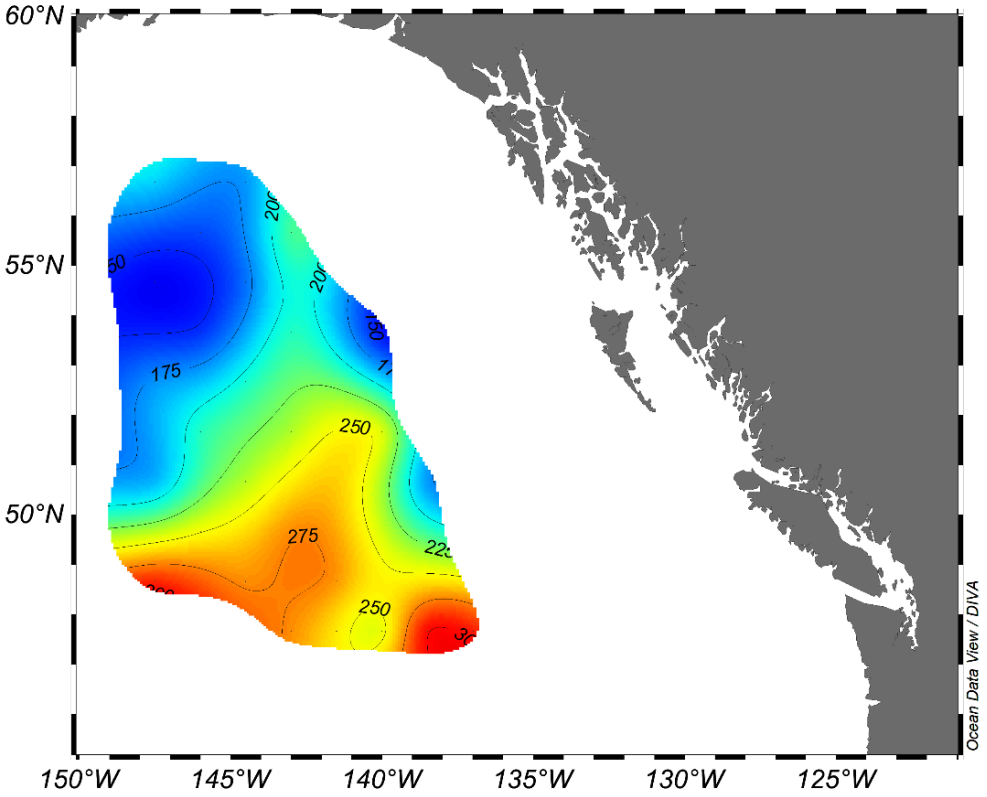
Anna Vazhova, Arkadii Ivanov, Gennady Kantakov, Igor Shurpa -Russia
Hae Kun Jung – South Korea



Critical oxygen depth (2.5 ml/l)

Anna Vazhova, Arkadii Ivanov, Gennady Kantakov, Igor Shurpa –Russia
Hae Kun Jung – South Korea

Depth of 2.5 ml/l oxygen



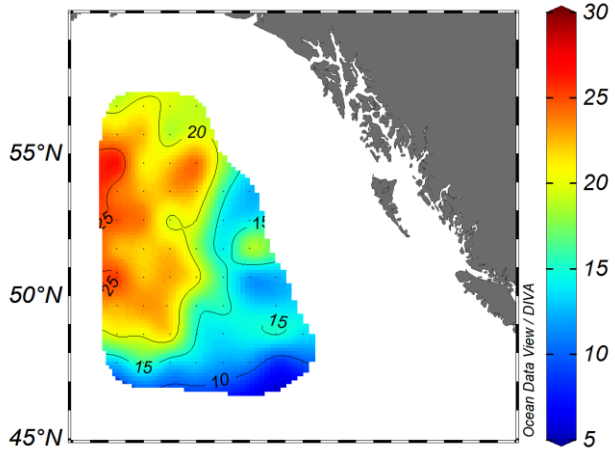
-2.5 ml/l is O_2 level that impairs animal health

-In the north this 0_2 level is much shallower (150m) than in the south (300m)

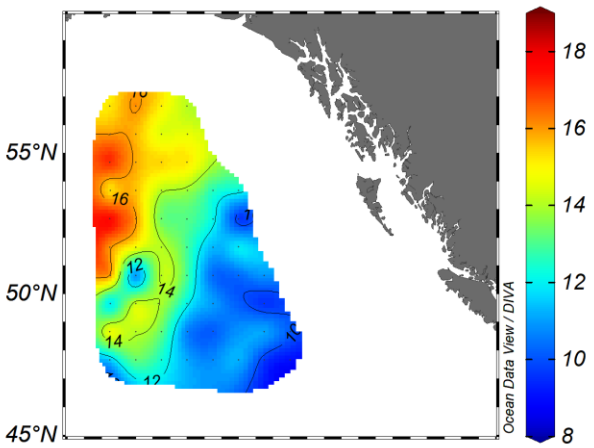
Chemical analysis of surface waters

Anna Vazhova,Arkadii Ivanov, Gennady Kantakov, Igor Shurpa –Russia
Hae Kun Jung – South Korea

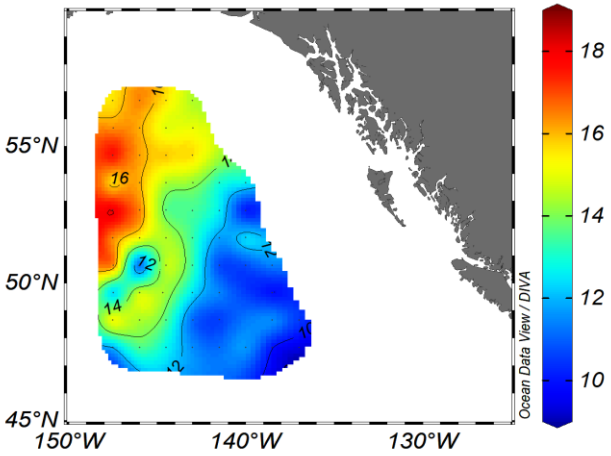
Silicate (mkM/l)



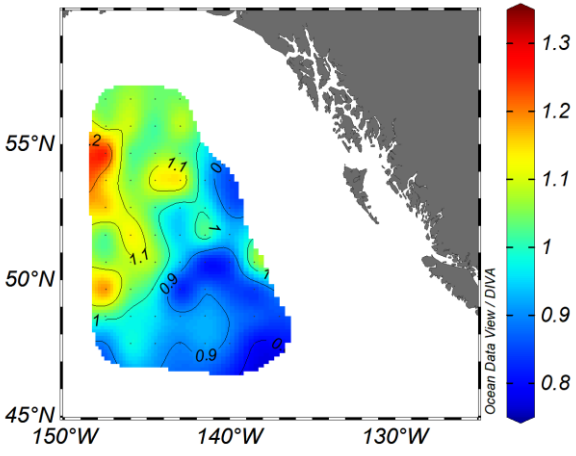
Ammonium (mkM/l)



Dis. In. nitrogen (mkM/l)



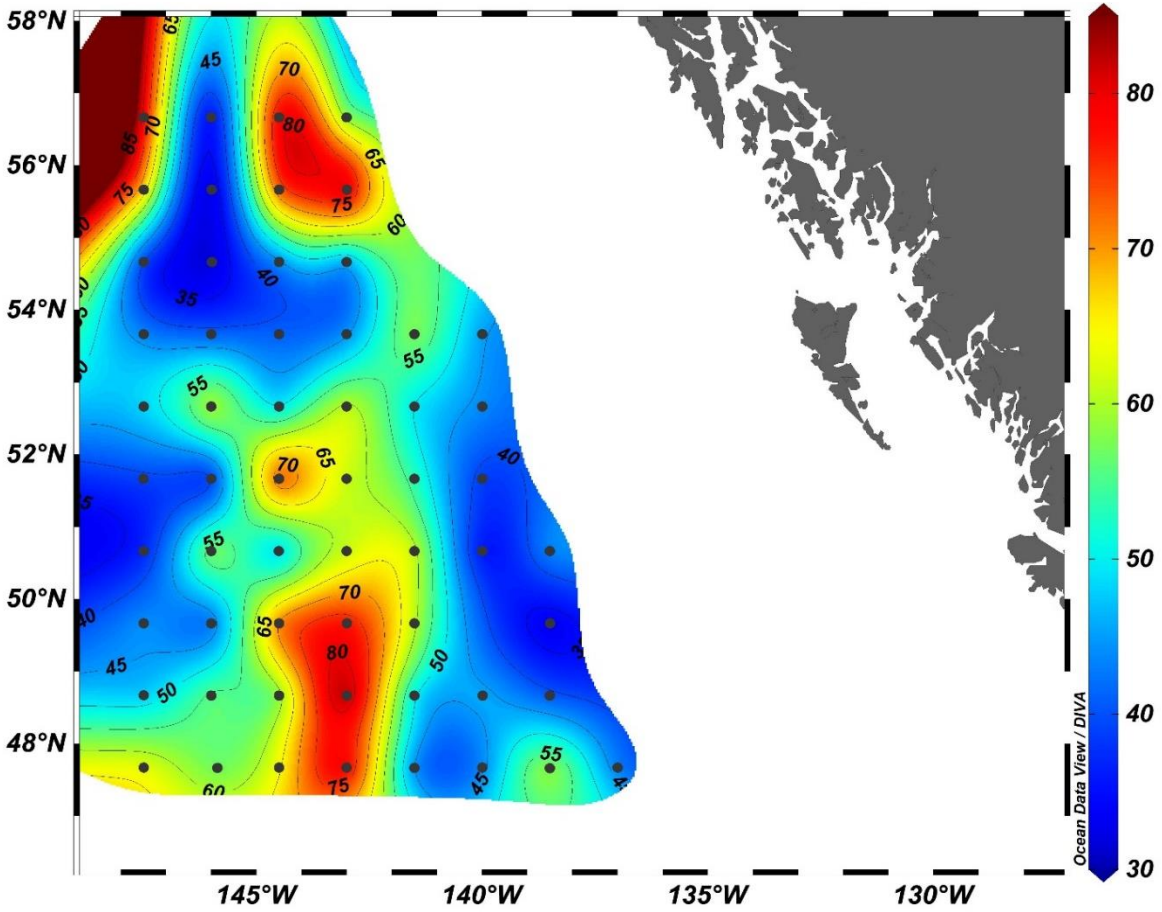
Dis. In. phosphate (mkM/l)



-clear north to south differences in chemical signatures of surface waters.

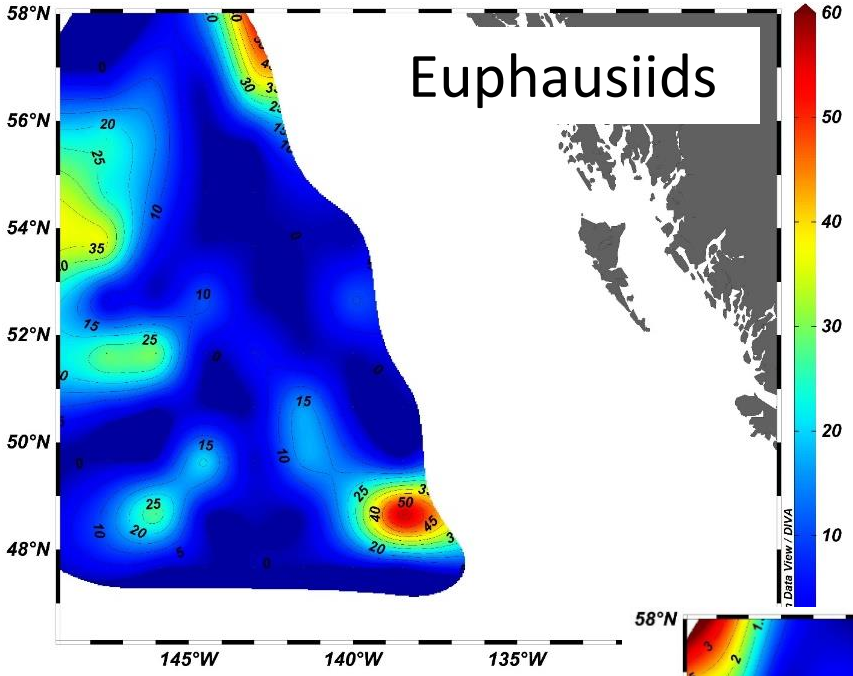
Phytoplankton biomass (mg Chl-a.m^{-2})

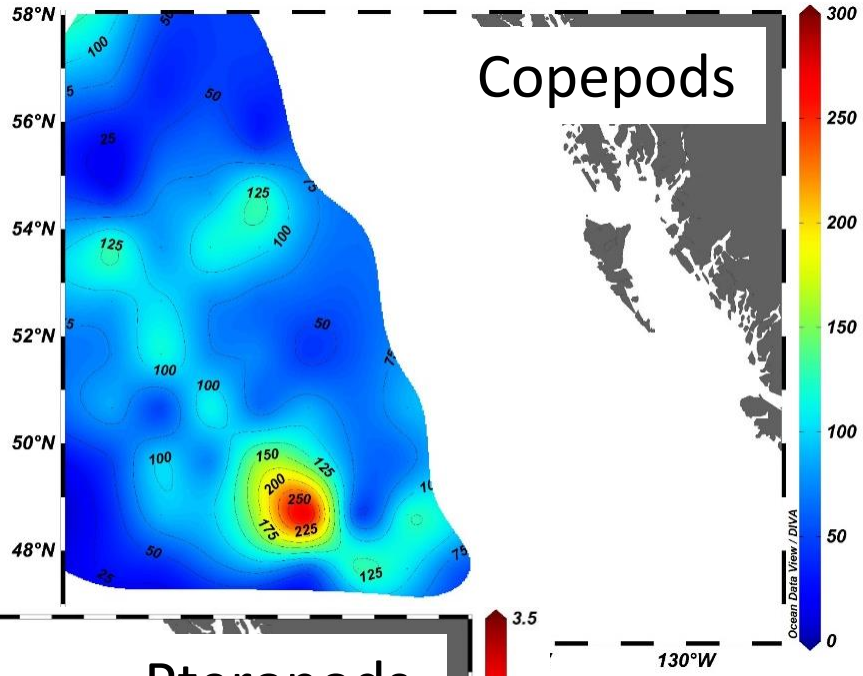
Brian Hunt and Evgeny Pakhomov – Canada
Alexander Slabinskii– Russia

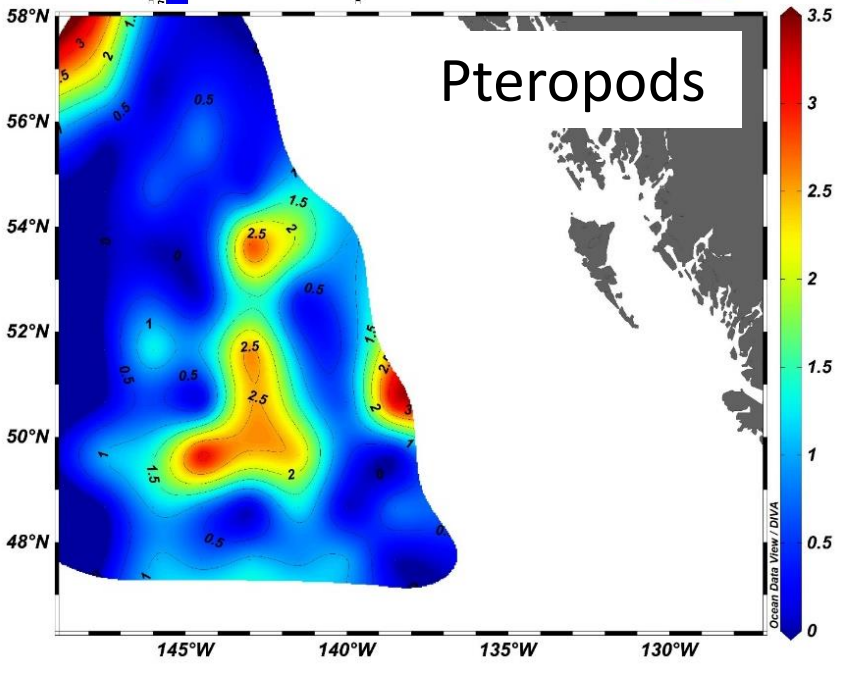


- Extracted chl-a from rosette samples 0-150m Integrated
- West to east increase reflected seasonal biomass increase
- High biomass associated with eddies sin the north

Zooplankton biomass (mg WW.m^{-3})



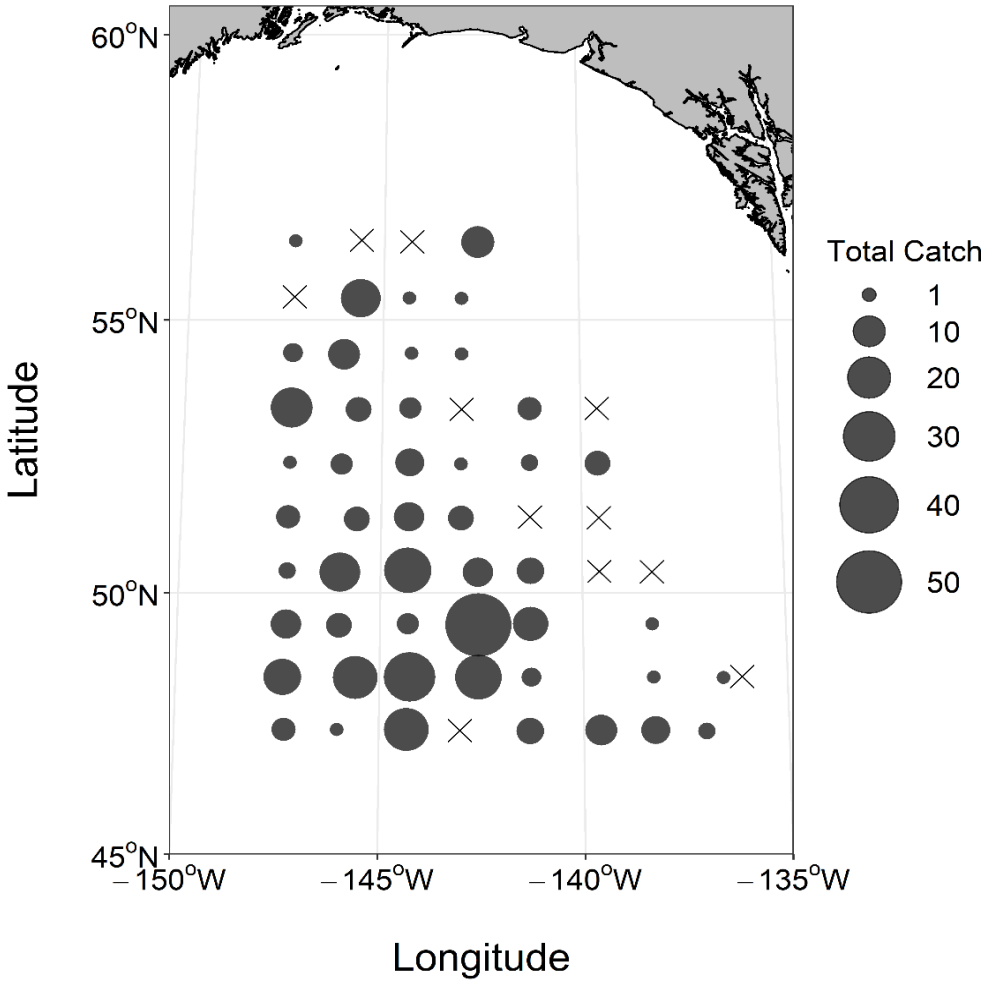




Brian Hunt and
Evgeny Pakhomov – Canada
Alexander Slabinskii– Russia

Total salmon catch (all species)

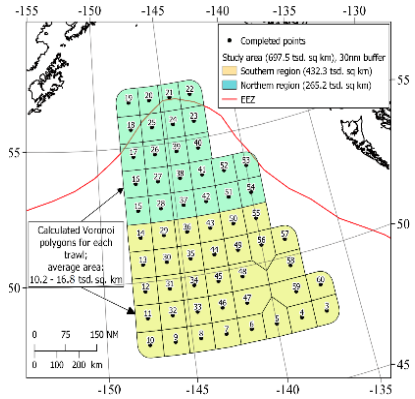
FISH TEAM: Chrys Neville – Canada; Charlie Waters, Laurie Weitkamp, Gerard Foley – US; Hiko Urawa – Japan; Aleksei Somov, Albina Kanseparova, - Russia; Vladimir Radchenko - NPAFC



- Salmon caught in 85% of sets although numbers lower than expected.
- Possible day/night signal in catch but may be species specific

Salmon Abundance Estimates

Vladimir Radchenko (NPAFC) and
Aleksei Somov (Russia)

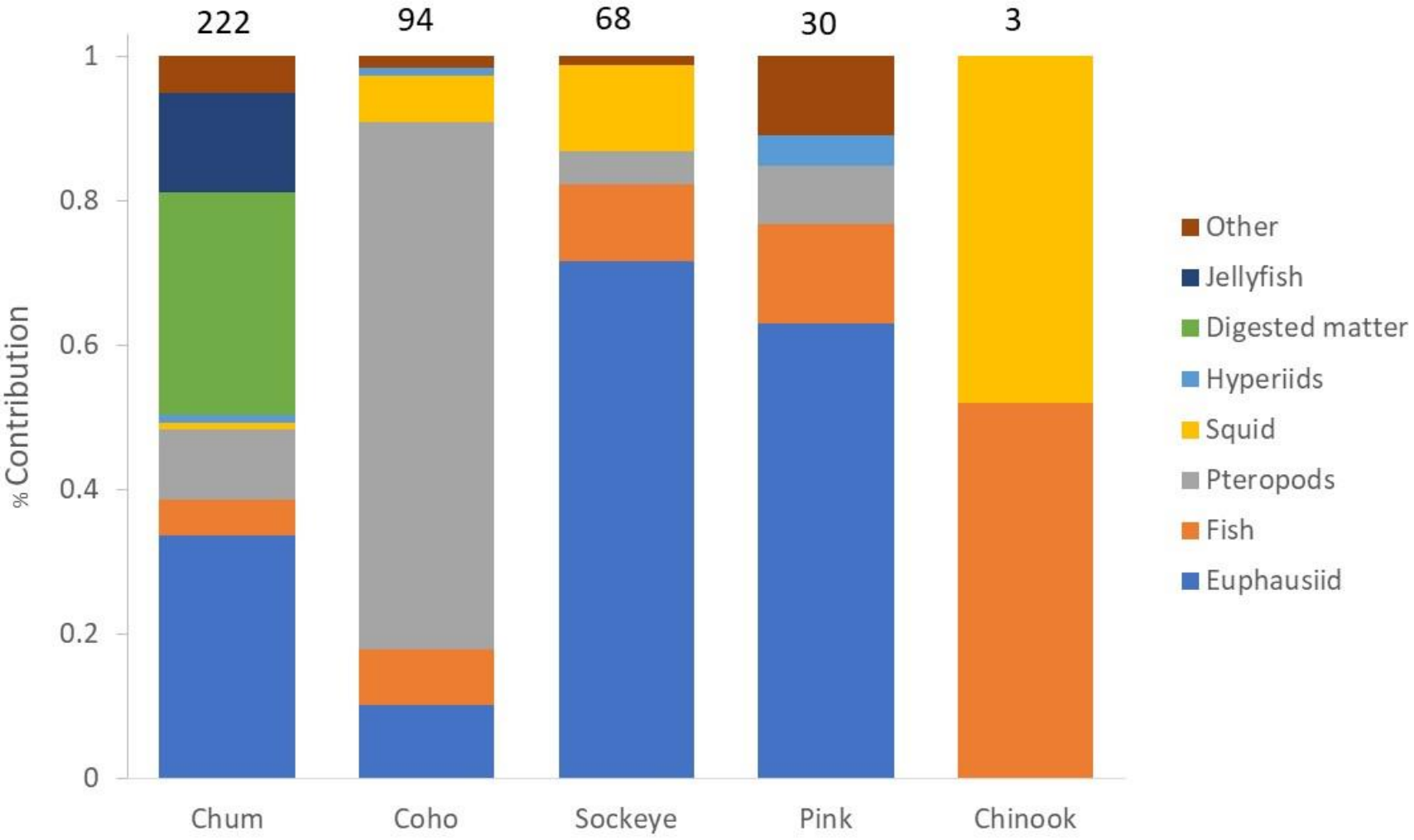


Salmon species	Frequency of occurrence (%)	Numbers (millions)	Biomass (1,000 tons)
Chum	63.8	27.73	27.70
Sockeye	31.0	9.04	10.30
Coho	37.9	13.59	10.37
Pink	17.2	4.21	1.63
Chinook	5.17	0.37	1.32
All species	82.8	54.95	51.33

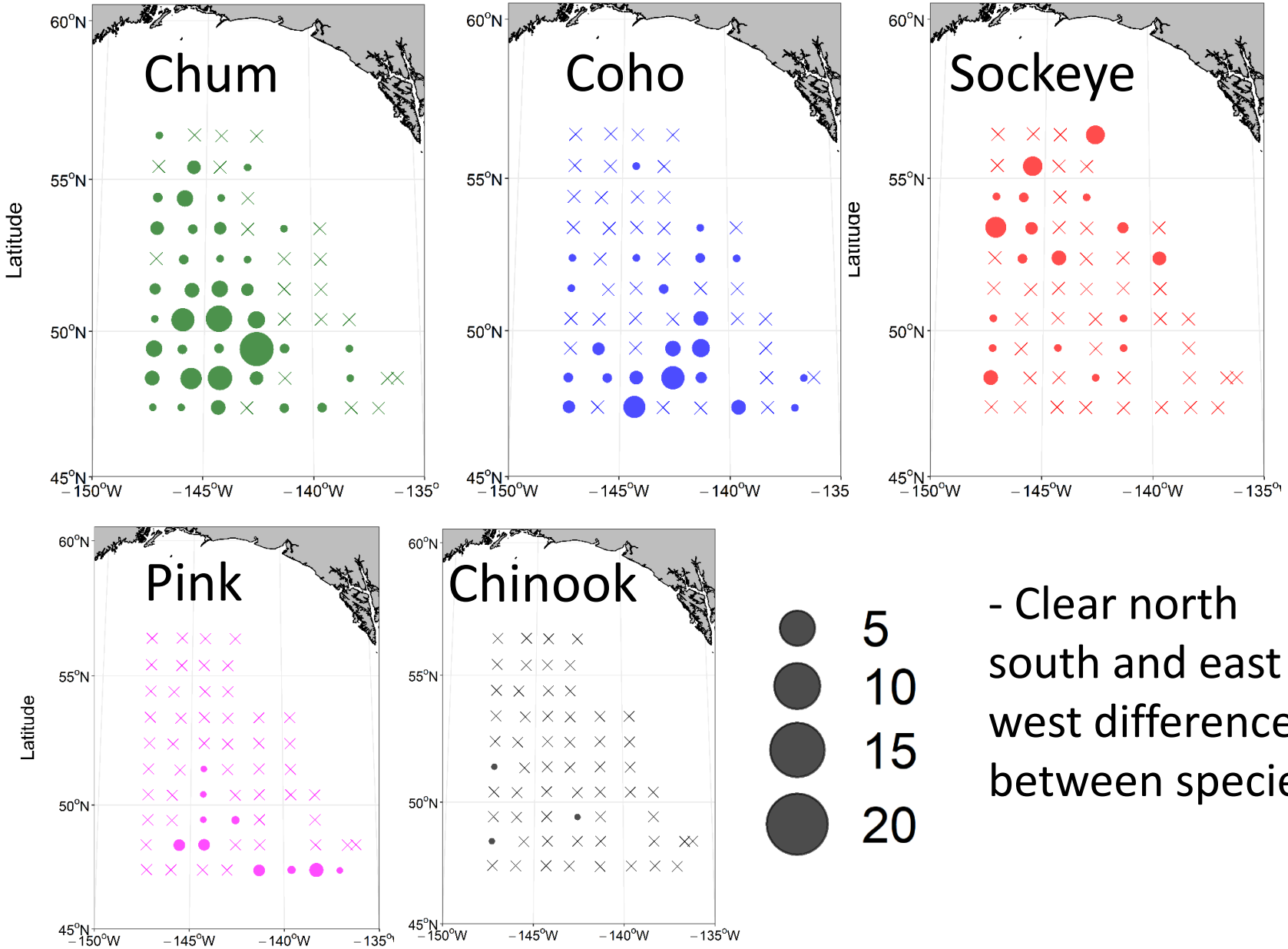
Major prey taxa by salmon species

Fish Team and prey ID's done by Anton Khleborodov, Russia

(number of stomachs above histogram)



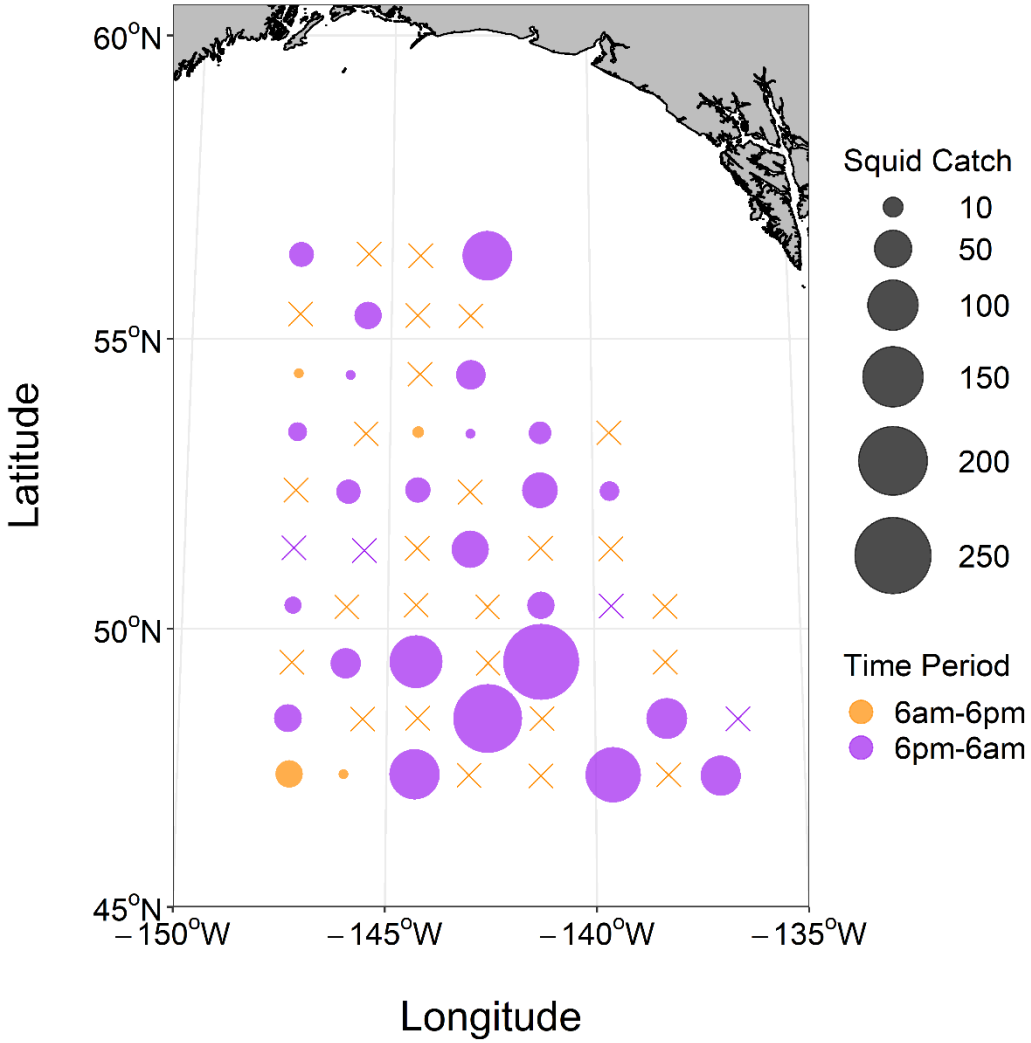
Fish team cont.



- Clear north south and east west differences between species

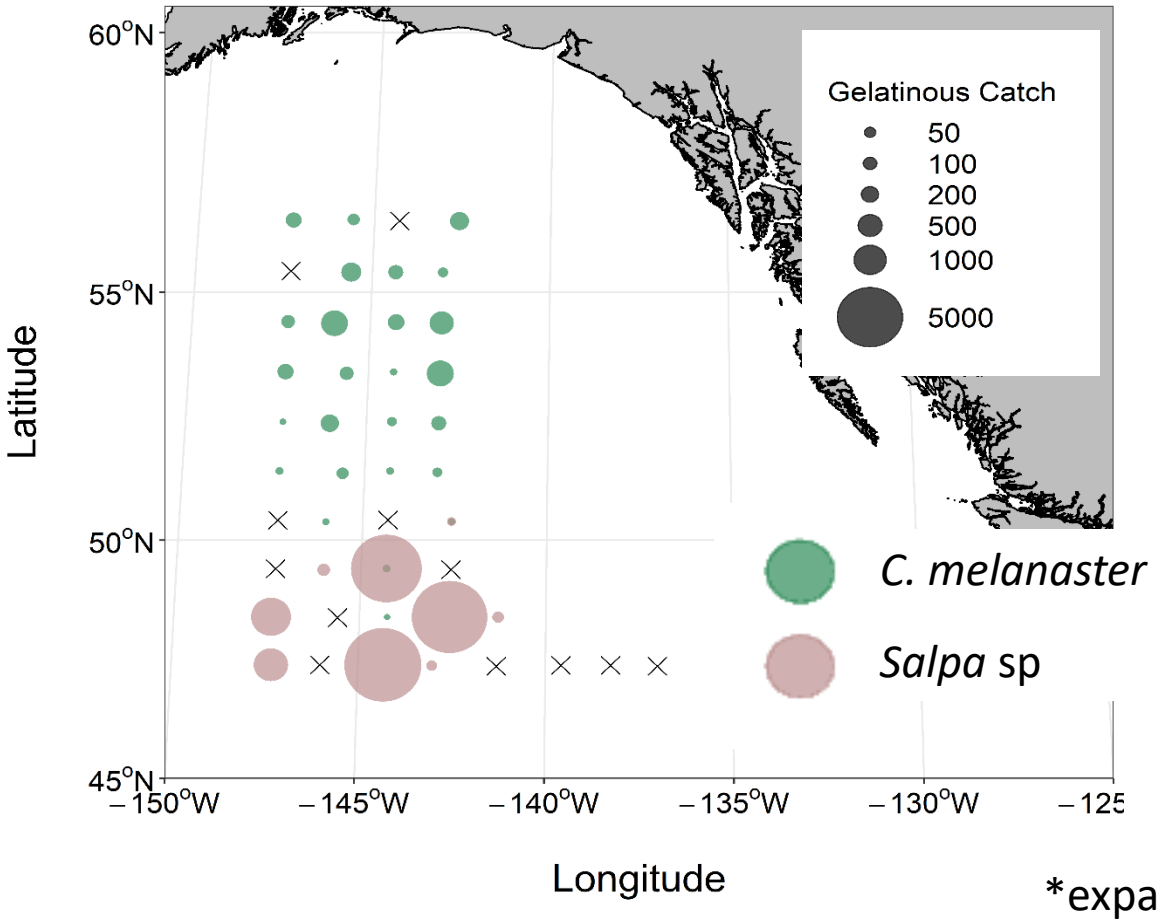
Total catch of squid by day/night

Mikhail Zuev (Russia), Svetlana Esenkulova (Canada)



- 95% caught at night
- 1 to 5 species in any set
- ~90% of catch one species (*Boreteothis borealis*)
- All species pelagic
- Possible spawning range extension for some species

Gelatinous species distributions: *Chrysaora melanaster* and *Salpa aspera*



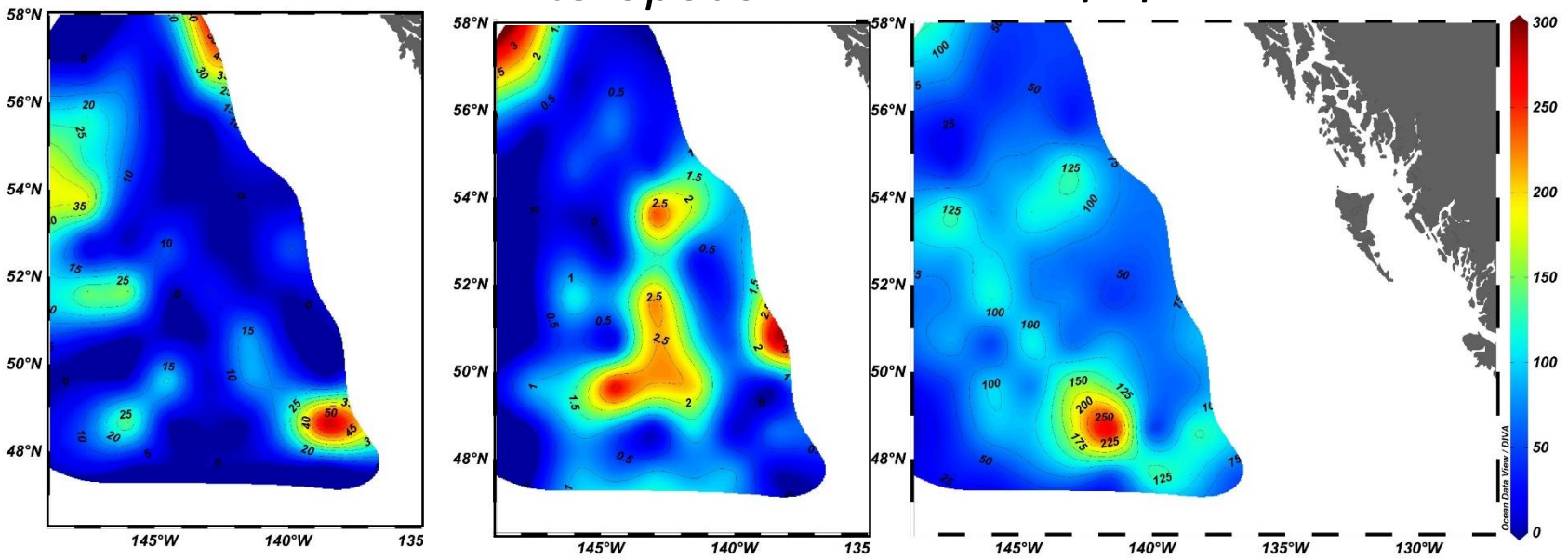
- Clear north/south segregation
- *C. melanaster* jellyfish visible in north at night in surface waters.
- Salps have low occurrence in chum salmon diet

*expanded counts by station

Zooplankton biomass (mg WW.m^{-3})

Brian Hunt and Evgeny Pakhomov – Canada
Alexander Slabinskii – Russia

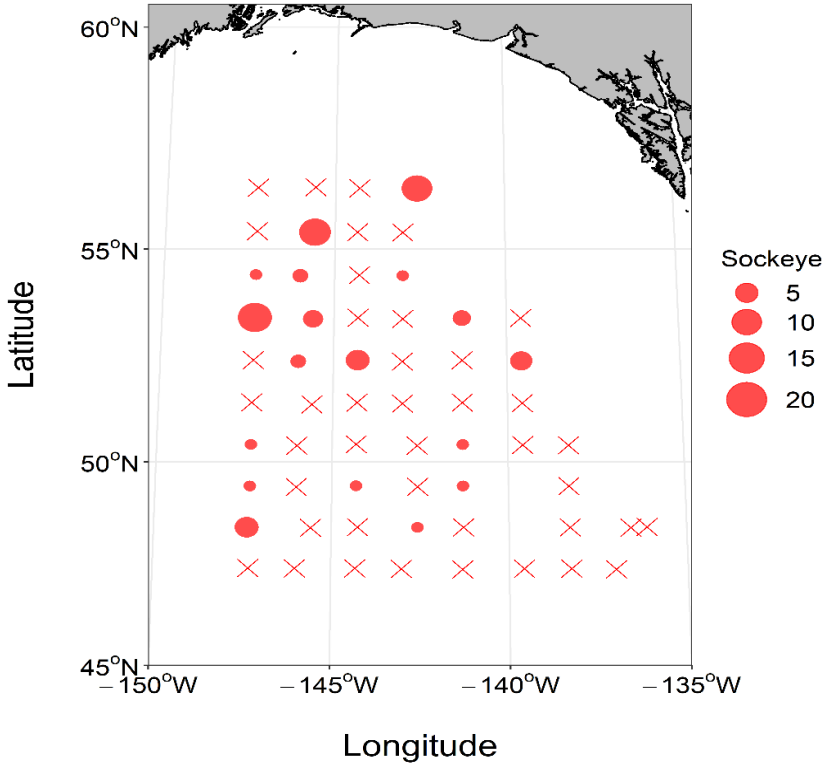
Euphausiids *Pteropods* *Copepods*

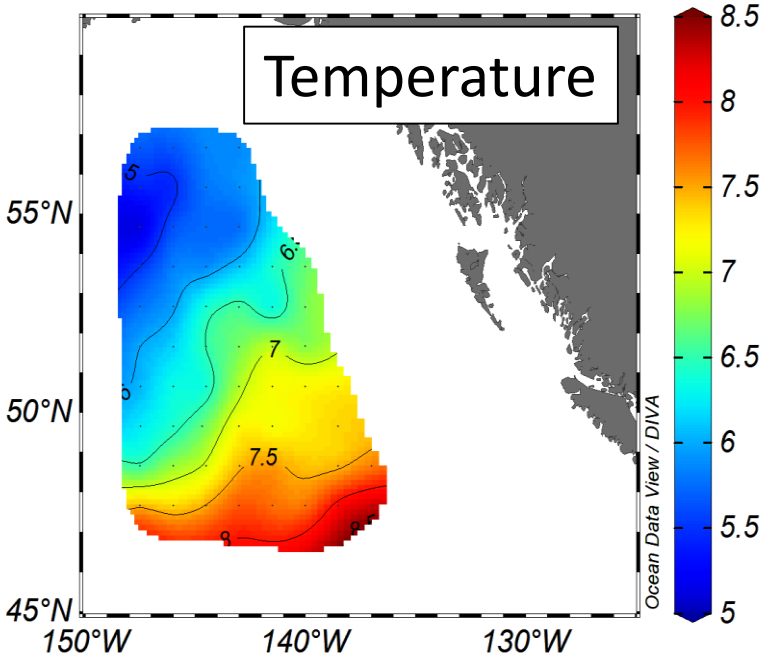


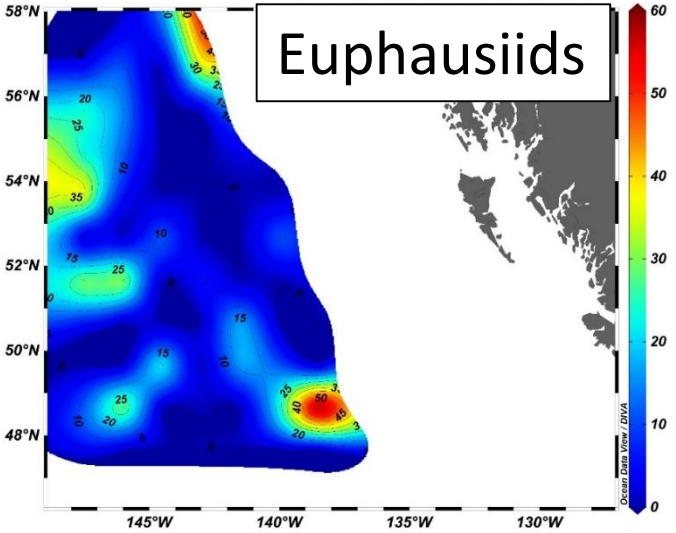
- Euphausiid biomass highest in the north and south east
- Copepod biomass highest in the south
- Pteropod biomass highest in the mid latitudes

Is there a relationship with salmon?

Sockeye salmon



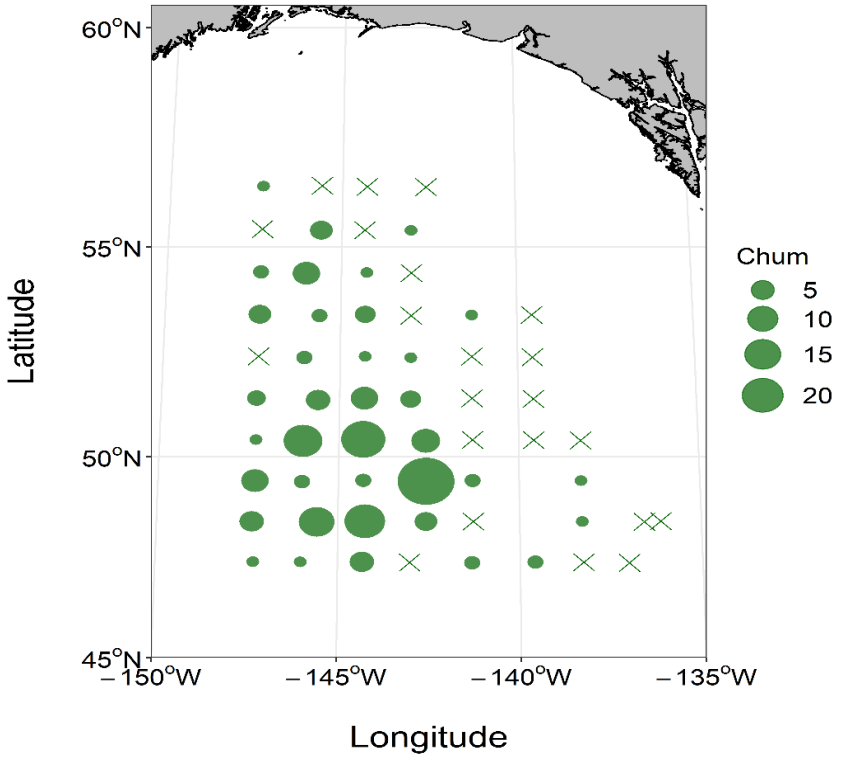


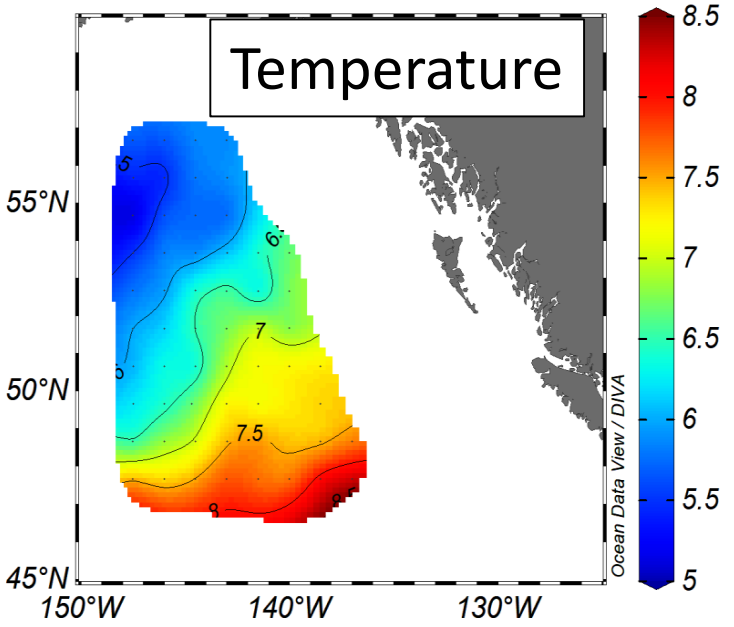


-Distribution primarily in cooler waters of northern portion of study area.

- Distribution overlap with localized concentrations of euphausiids in the north and south. This prey group represented over 70% of diet by volume in this northern portion of study region

Chum salmon

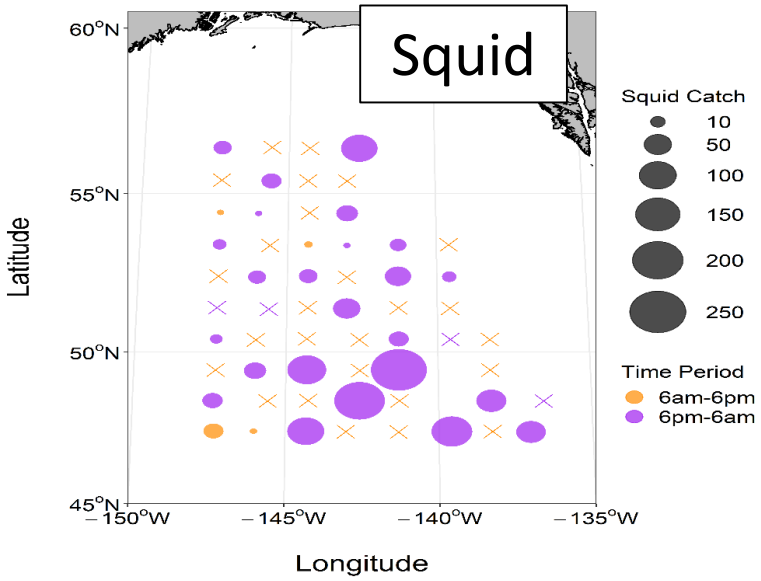




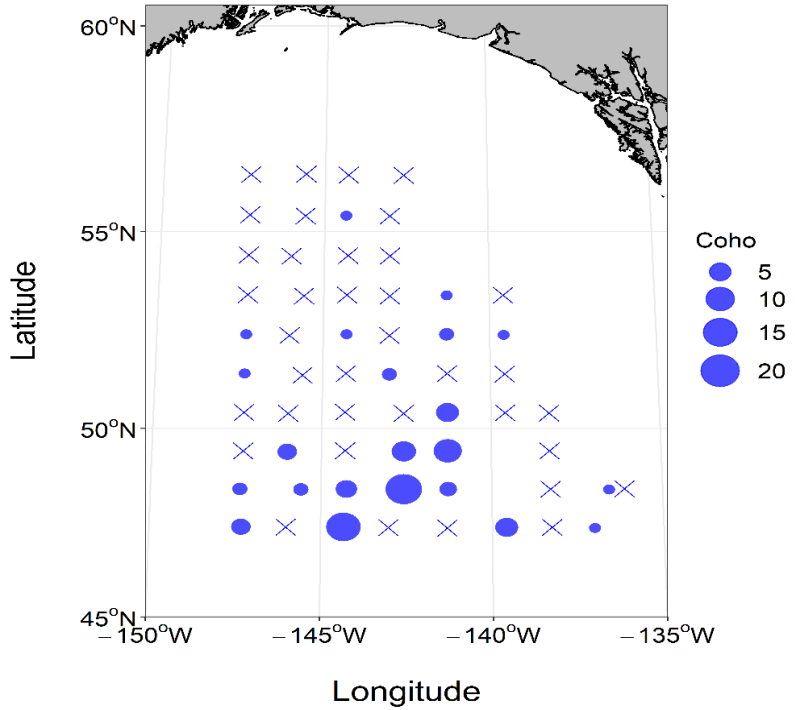
-Highest catches in southern portion of study area but found in both warm and cool waters.

- Lowest condition and one of highest empty stomachs observed for salmon

- Possible overlap with squid distribution but not eating squid

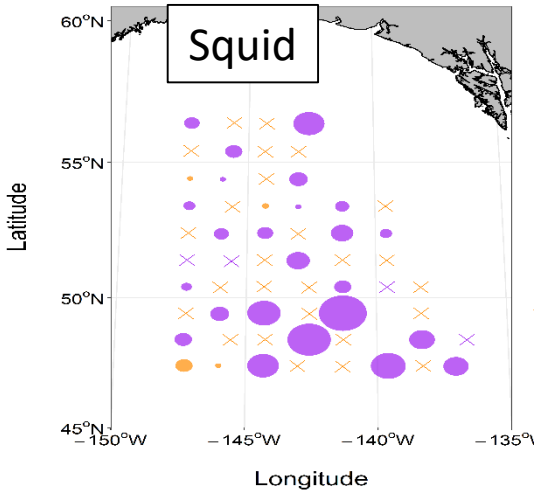


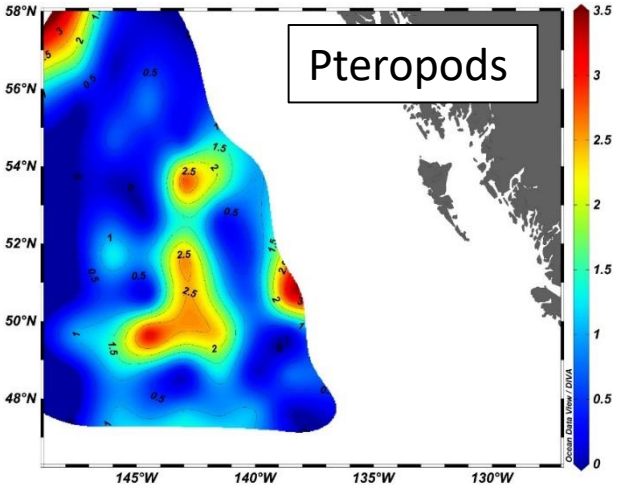
Coho salmon

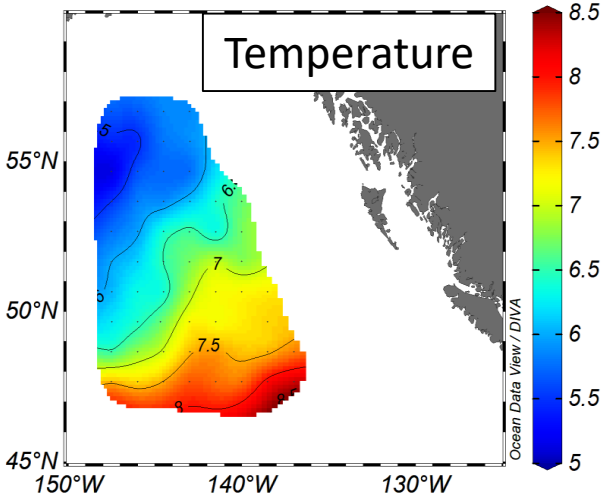


- Distribution in warmer waters of the SE quadrant of survey area.

- Distribution overlap with Pteropods. This prey group represented over 50% of diet by volume in the southern portion of study region

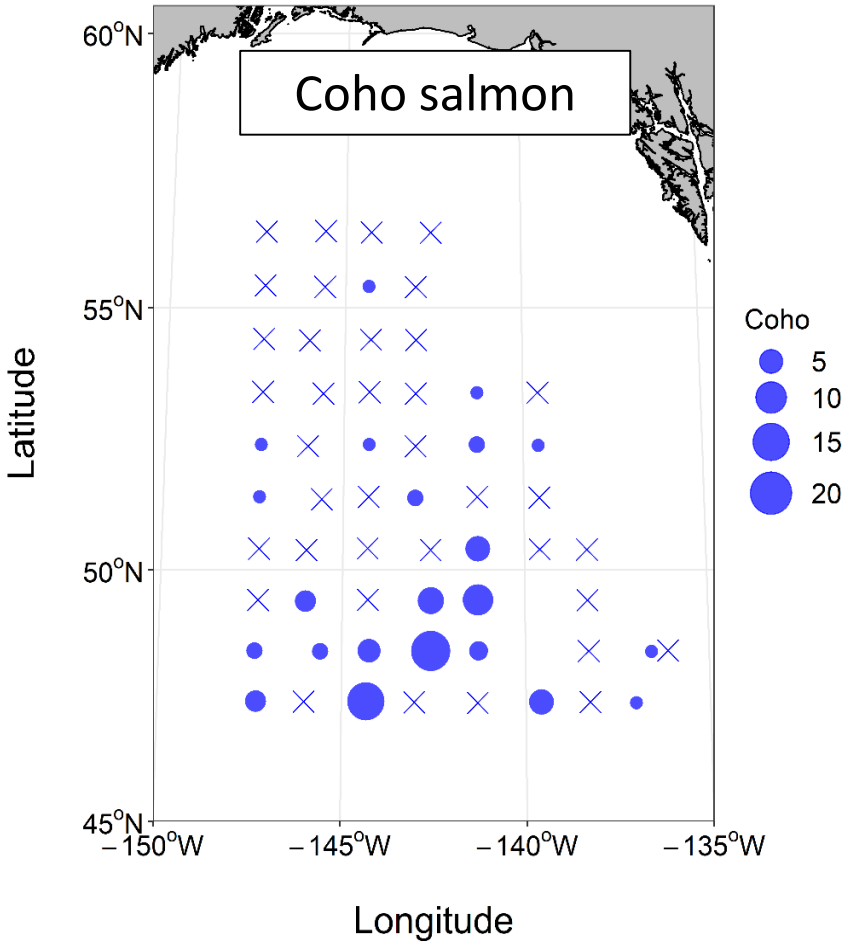




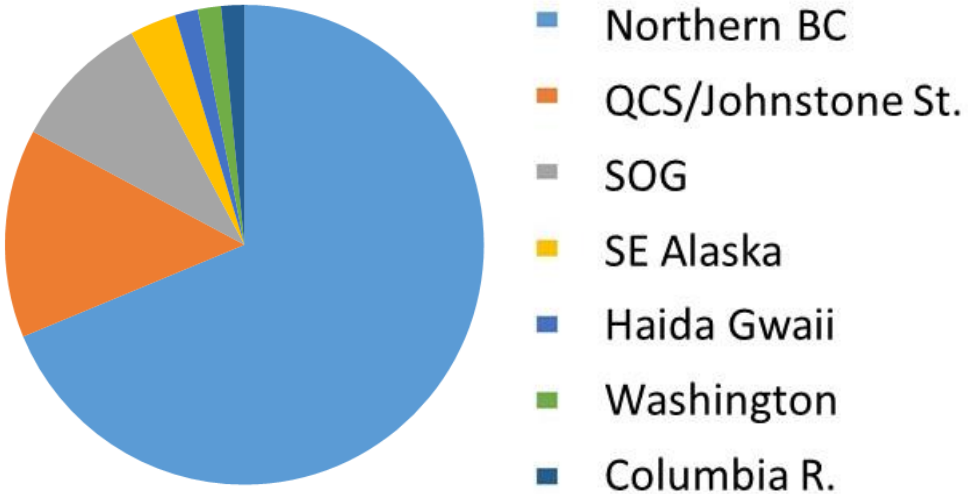


At sea genetic stock identification

Christoph Deeg, Canada



- Proof of concept testing of field based DNA analysis
  - DFO lead development
- Originate from Alaska to Columbia River with no spatial separation by stock



Initial impressions

- Winter surveys in the Gulf of Alaska are possible.
- International collaboration works
- Catches of salmon show spatial variation across study area. Species differences may be the strongest signal.
- Some salmon species have stronger distribution patterns associated with ocean climate
  - Sockeye and cool water
  - Pink and Coho warmer water
- North-south differences in species composition
  - Jellyfish (*Chrysaora melanaster*) vs salps
- Some species have overlap but no apparent major preditor/prey relationship
  - Coho and chum salmon with squid
- Many more results to come…….

More to be done when samples reach shore….

- Genetic stock ID's of all salmon and confirmation of on-vessel analysis (proof of concept)
- Stock specific abundance estimates
- Fish health assessments
- Bioenergetics (energy density)
- Otolith analysis for early marine growth dynamics
- Otolith analysis for thermal marks
- Stable isotope and fatty acid analysis of salmon, by-catch and zooplankton
- eDNA analysis
- Integration of data and information
- Spectral analysis for primary production
- and still more…….

Deepest gratitude to the sponsors!

Big THANK YOU to the Prof. Kaganovsky crew, officers, mechanics and Captain Alexander Pakker !!!