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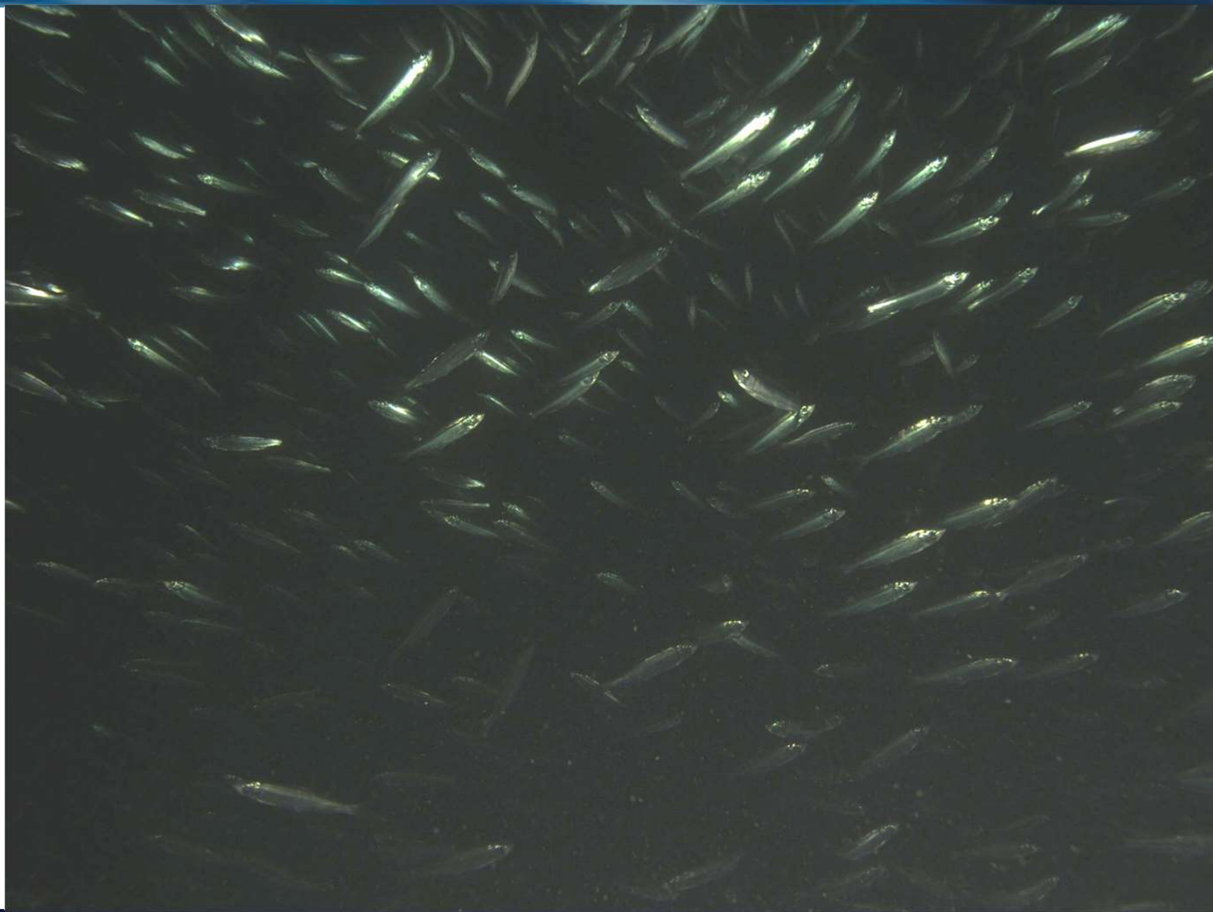


# PACIFIC Region Small Pelagic Fish Surveys


**Chris Rooper*, Jennifer Boldt, Stephane Gauthier, Autumn Wang, Kresimir Williams, Rick Towler, Jackie King, Jaclyn Cleary, Linnea Flostrand, Chrys Neville**


TESA Small Pelagic Fishes Workshop
Nov. 20, 2023

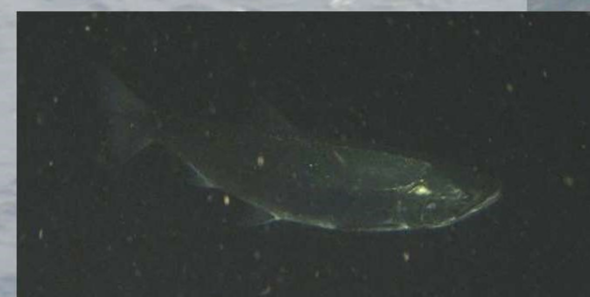
Canada

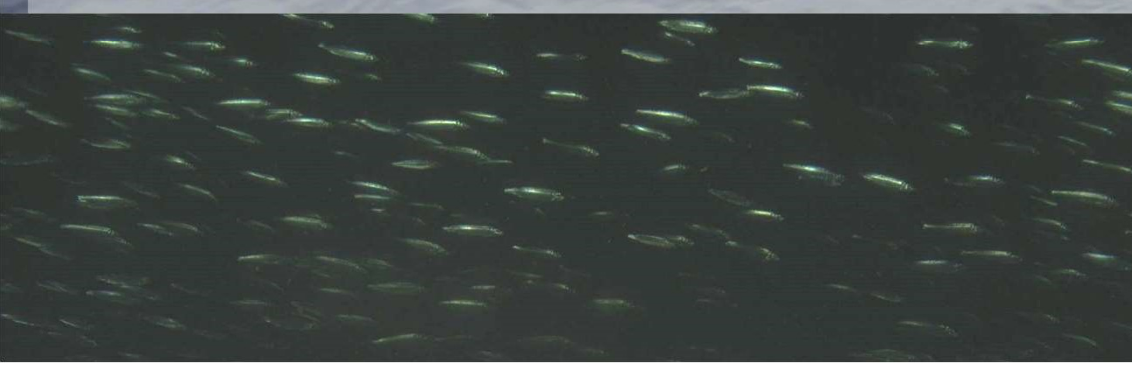
Pacific Region Surveys

- **Bottom trawl** (6, eulachon)
- Longline (2)
- Pot/trap (3)
- **Dive** (~4 – 6, herring)
- **Acoustic** (1+, multispecies pelagic)
- **Seine** (1, herring)
- **Surface trawl** (3, multispecies pelagic)
- **Plankton nets** (1, eulachon)
- Other (bivalves, birds, mammals, etc.)

Objectives

- Estimate abundance of small pelagic fish
  - SSB
  - Juveniles (pre-recruit index)
- Estimate size/age structure
- Estimate the distribution (and changes)

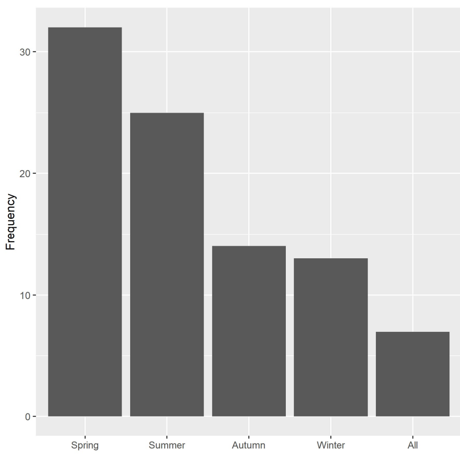


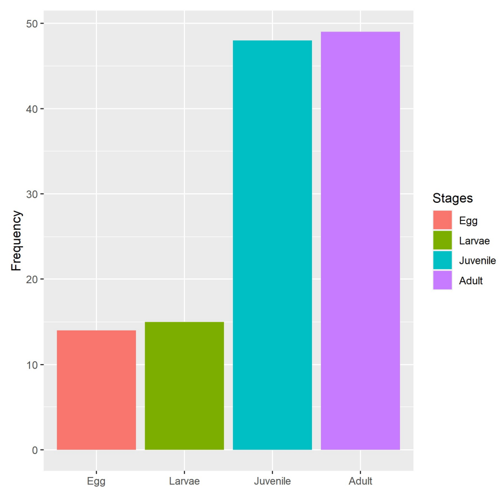


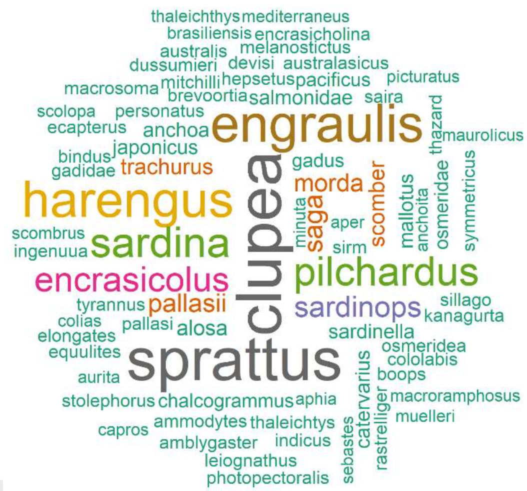
# Working Group on Small Pelagic Fishes

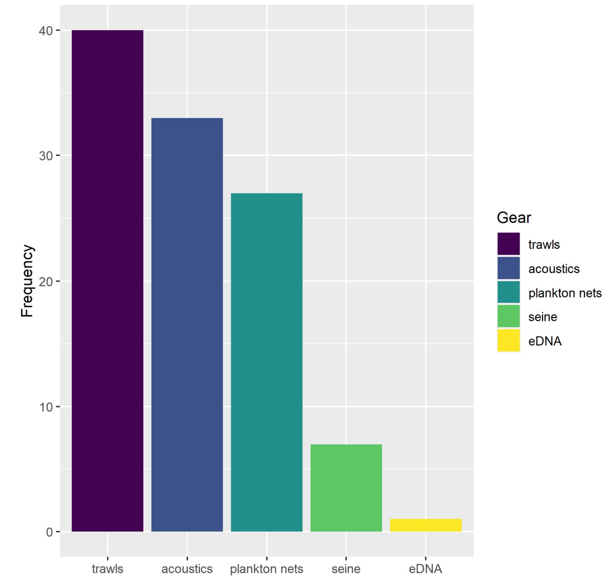
Worldwide SPF Survey Database

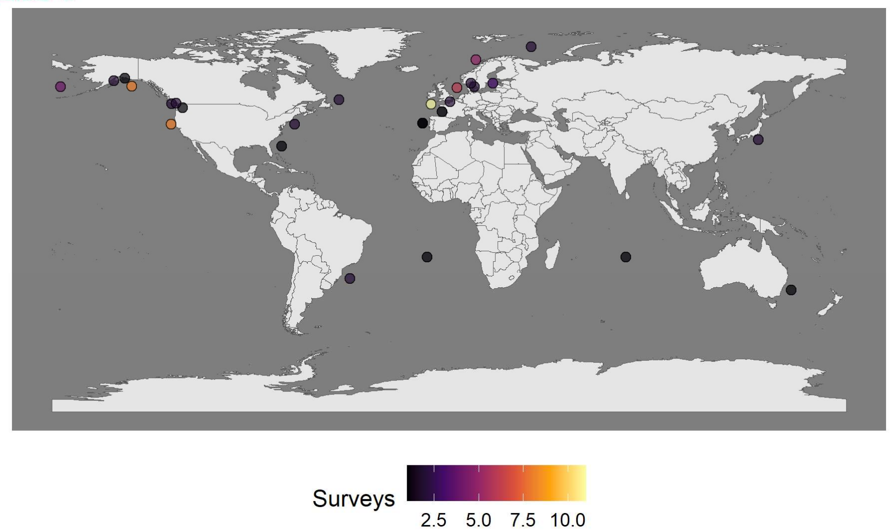
- 76 Surveys




https://github.com/rooperc4/ICES_PICES_WGSPF_SurveyDatabase

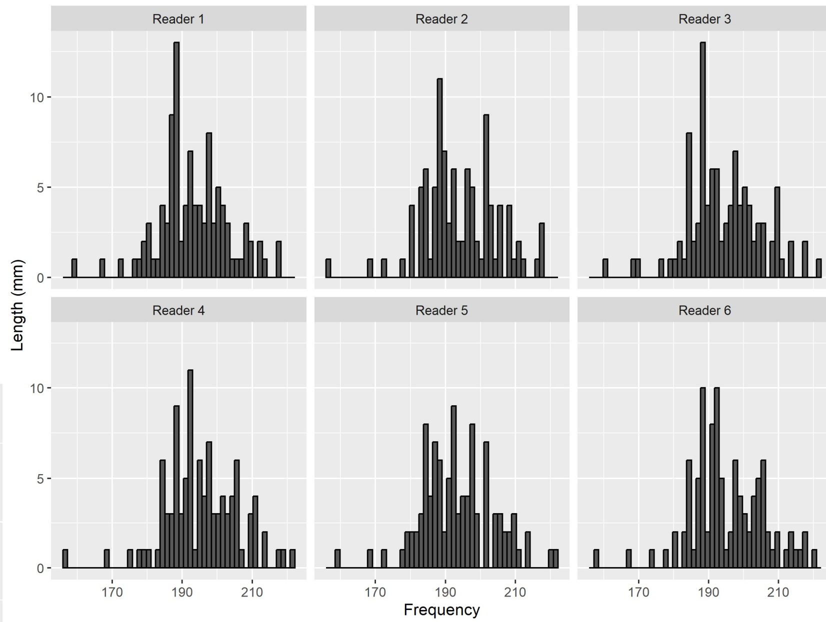
# A Survey of Potential Issues with SPF (and other surveys)

- Gear changes/Vessel changes/Net changes
- Technology creep

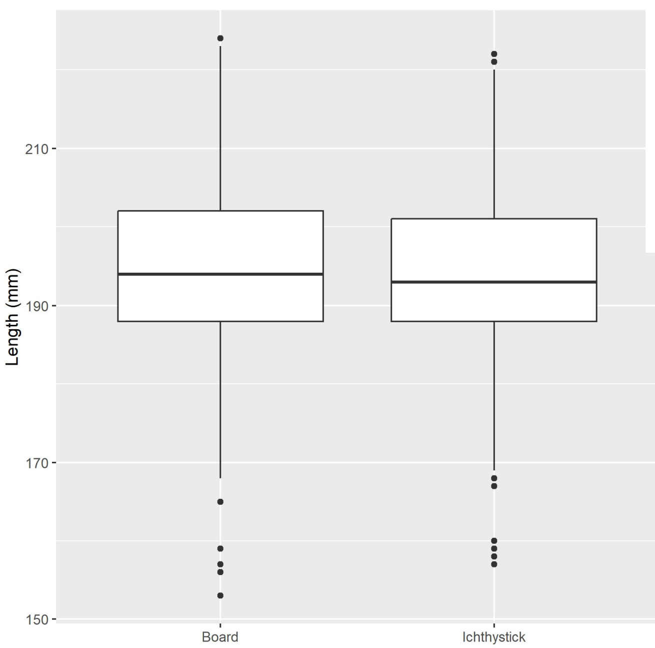
- Historical change in objectives/design considerations
- Inconsistency in methods over time
- Unforseen gaps in time series (funding/COVID)

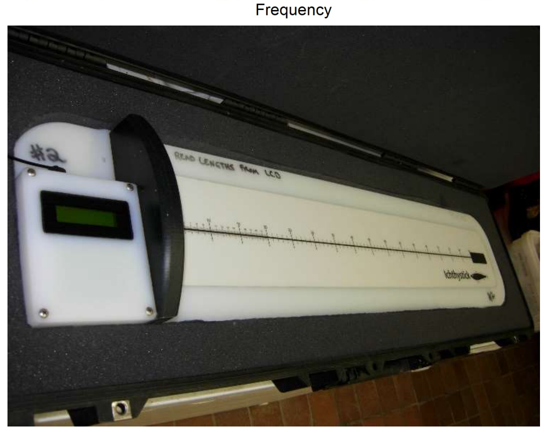
- Incomplete coverage of species distribution
- High variability!
- Underutilization of platform/data

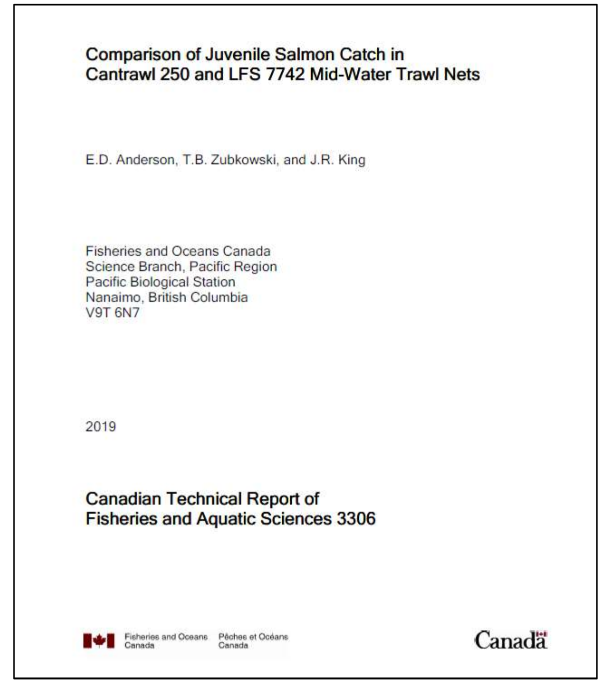
# Calibration of new gear/technology




< 1 mm difference in mean length





Comparison of Juvenile Salmon Catch in
Cantrawl 250 and LFS 7742 Mid-Water Trawl Nets

E.D. Anderson, T.B. Zubkowski, and J.R. King

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Science Branch, Pacific Region
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Nanaimo, British Columbia
V9T 6N7

2019

Canadian Technical Report of
Fisheries and Aquatic Sciences 3306

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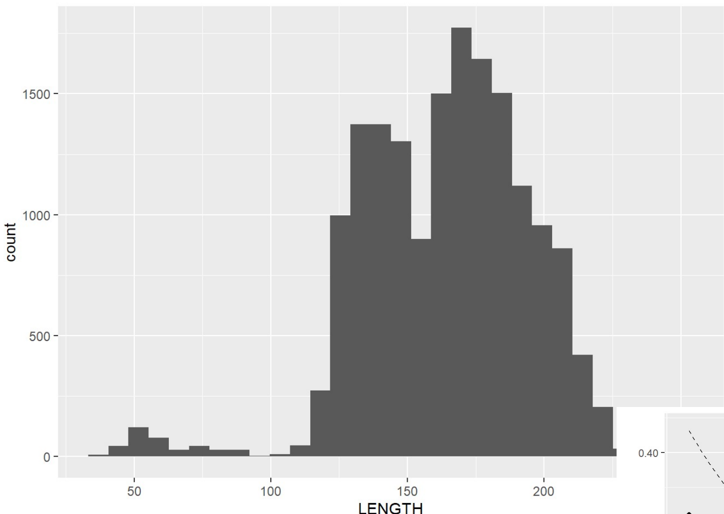
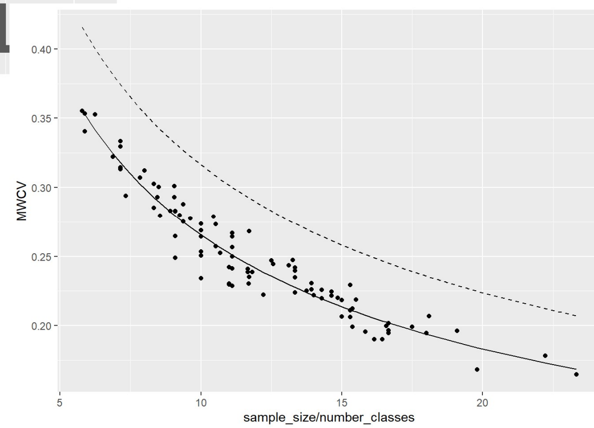
# Constant re-evaluation of methods

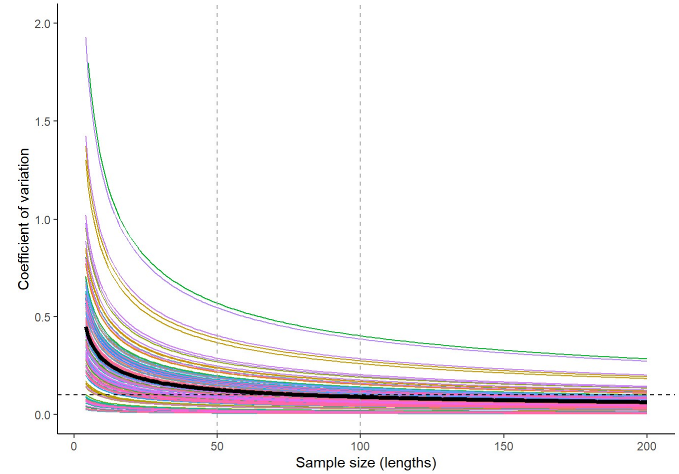
Example: Length, weight, age structure collections IPES herring in 2021




**<u>2022 Protocol</u>**

- Collect up to 150 lengths and weights
- 5 scales at random <=25 fish
- 10 scales <=50 fish
- 15 scales <150 fish
- 20 scales > 150 fish




## Evaluation of age collections

According to the Hulson et al. (2017) analyses, there were four optimal criterion to be met to produce data for good stock assessments:

1. Achieve a target CV of 15% for the most frequently caught age class
2. Achieve a target CV of 15% for the age class with the maximum within-length interval variance (e.g. the age class with the least information on age from the length data)
3. Achieve a target CV of 15% for the top 25% of age classes caught
4. Achieve the target CV of 15% for the age classes with proportions-at-age that were on average greater than the inverse of 1/2 of the maximum age. For herring, with a maximum age of 13 this would be a CV of 15% for all ages that were proportions > 1/6.5 or 15.4%.

CV's were calculated here according the method of Quinn and Deriso (2002). The rule of thumb from the Hulson et al. 2017 analysis was that about 10% of the total lengthed fish should be aged.

## Conclusions

In 2022 11% were aged, **slightly above** the Hulson et al. ((2017) criterion.

Table 4 shows the CV's by age for herring collected in 2022. Criterion 1 was **met** (the most frequently caught age class had a CV=0.05) Criterion 2 was **met** (the age class with the widest variation on length was age 2, with a CV of 0.05) Criterion 3 was **not met**, the abundance weighted CV for age 2 and 3 was Criterion 4 was **met**, as only age 2 herring had proportions > 15.4% and they had a CV of 5%.

# A Survey of Potential Issues with SPF (and other surveys)

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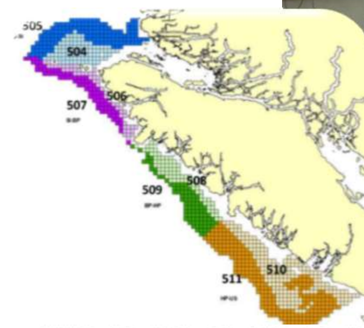
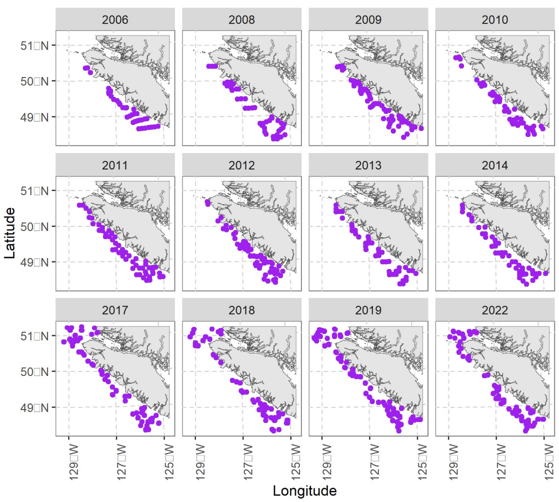
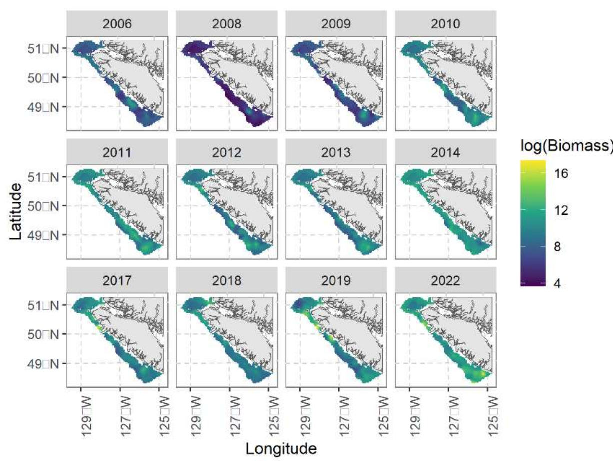
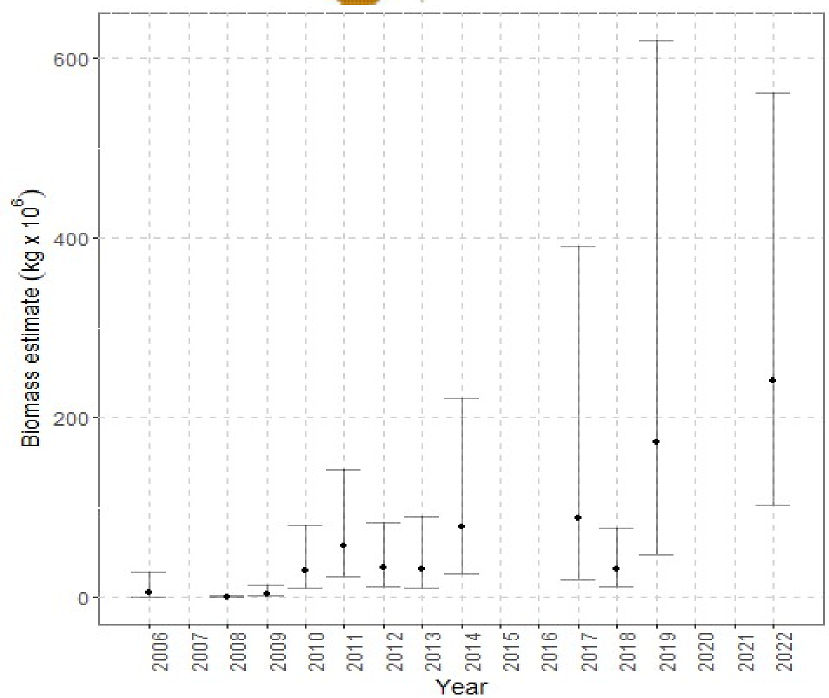
# Integrated Pelagics Ecosystem Survey

- Combining three historical surveys:
  - offshore summer juvenile salmon survey (1998-2015)
  - pelagic ecosystem nighttime trawl survey (2010-2014)
  - La Perouse acoustic-trawl survey (2011-2015)
- Pelagic (surface trawl)
- Random stratified (by depth, area) survey since 2017



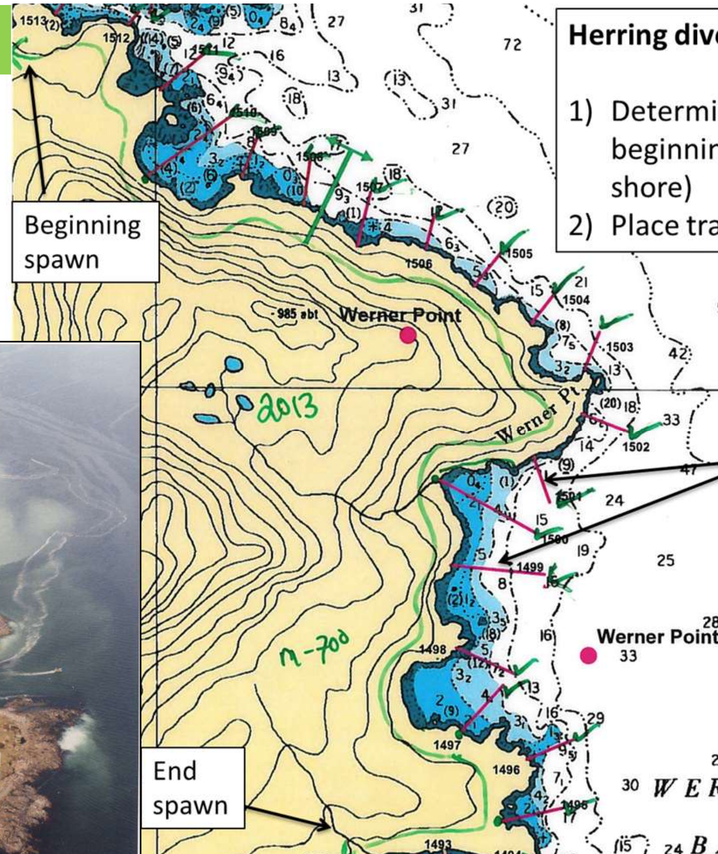



## Herring Spawn Deposition Surveys (Jaclyn Cleary)

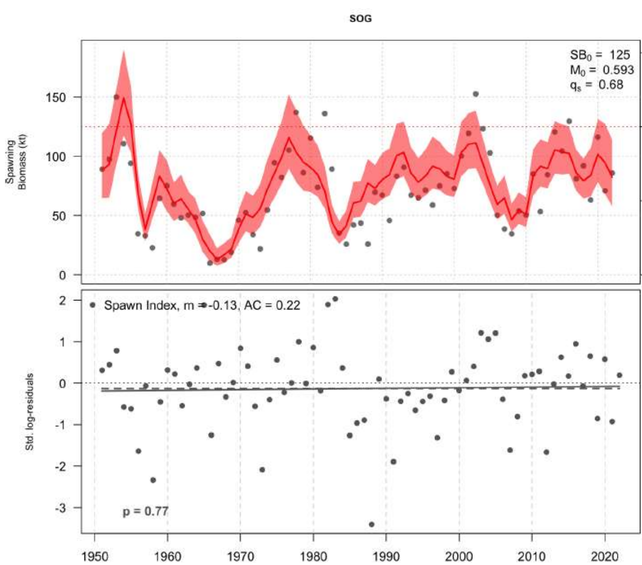
- Surface/overflight surveys (1951-present)
- Fixed systematic dive transects (1981-present*)
- Covers spawn extent

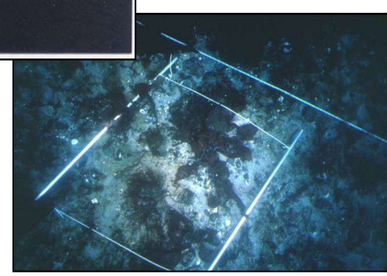



**Herring dive survey**

1) Determine spawn length (locate beginning and end of spawn parallel to shore)
2) Place transects every 350m

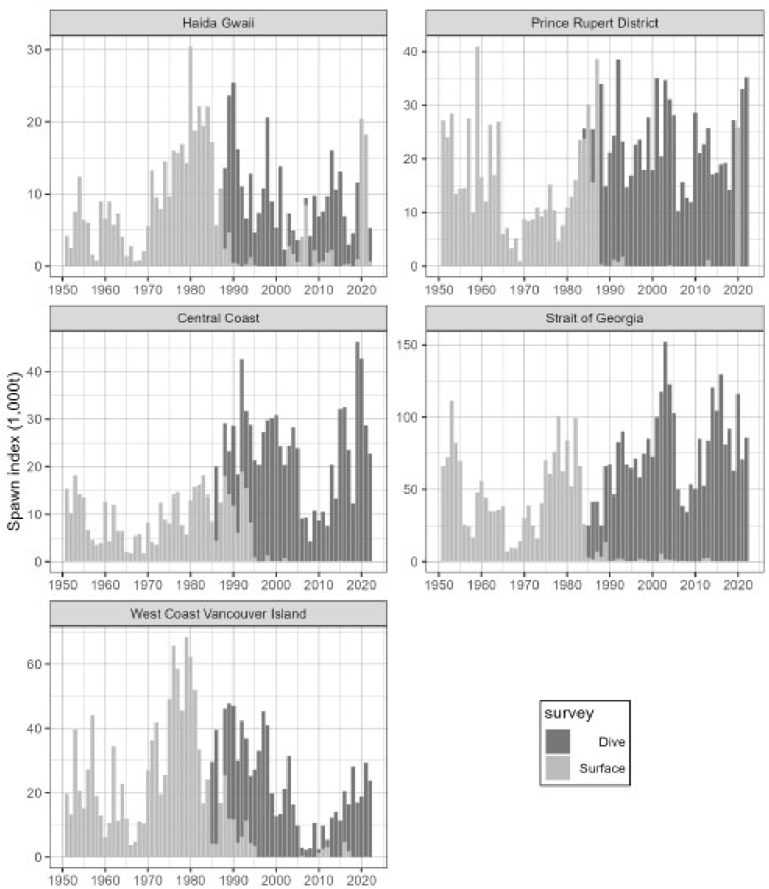
Area = Length x Width
Egg Density = Egg Layers By Vegetation Type and Coverage

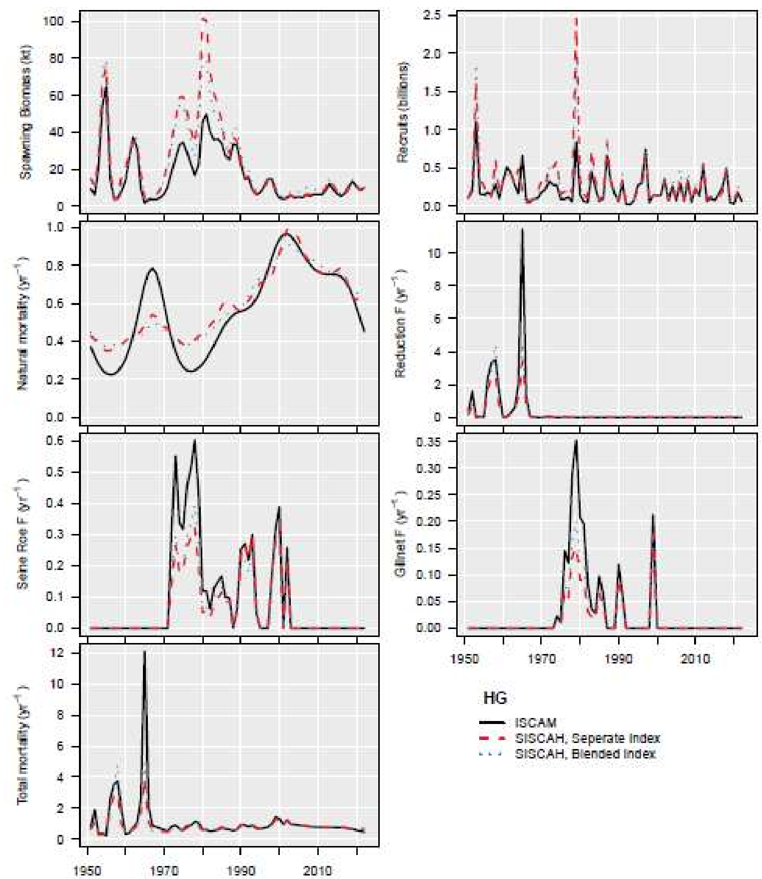


# Incorporating into stock assessment (q)

- Move from separate to blended index – Pacific herring



# Interruptions in time series – a common problem

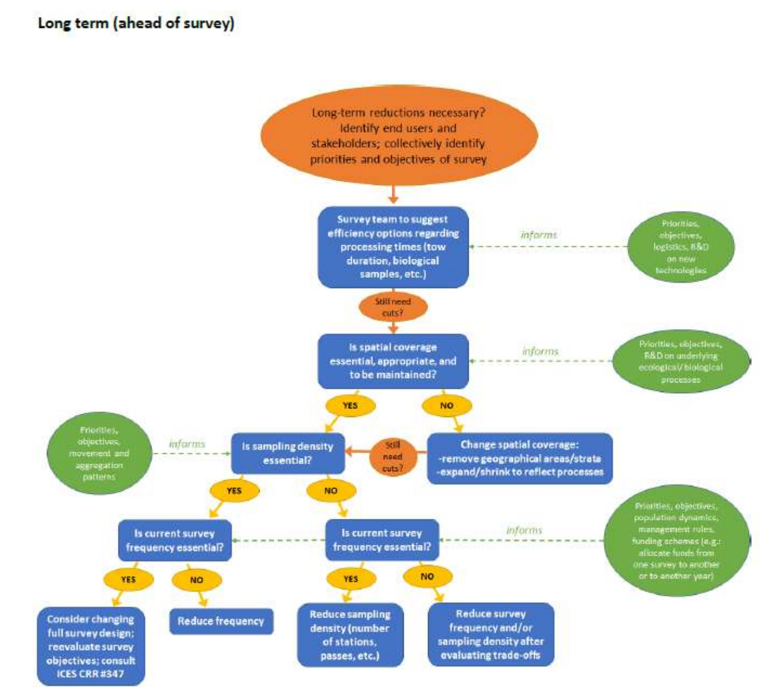



Figure 2.1.1. Decision tree for considering long term changes to survey effort and design.

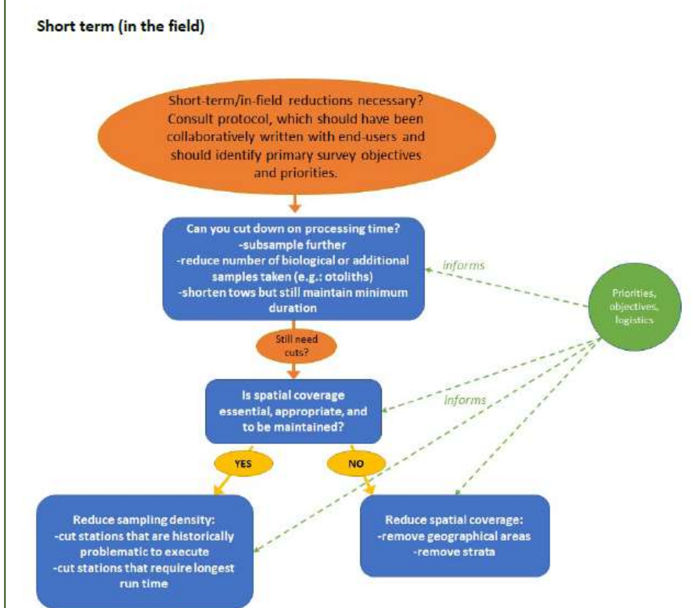
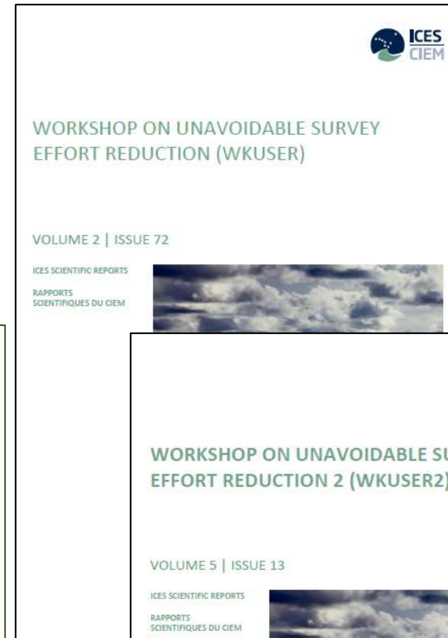
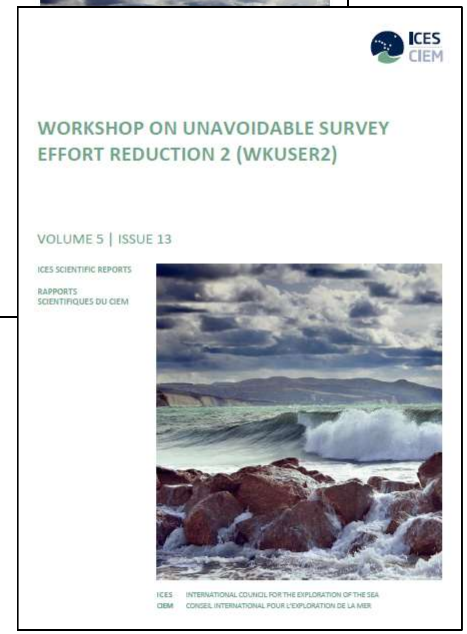



Figure 2.1.2. Decision tree for considering short-term changes to survey effort and design.



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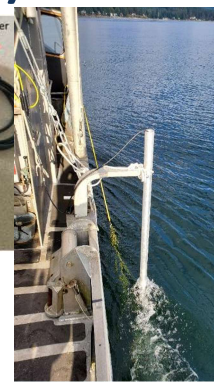
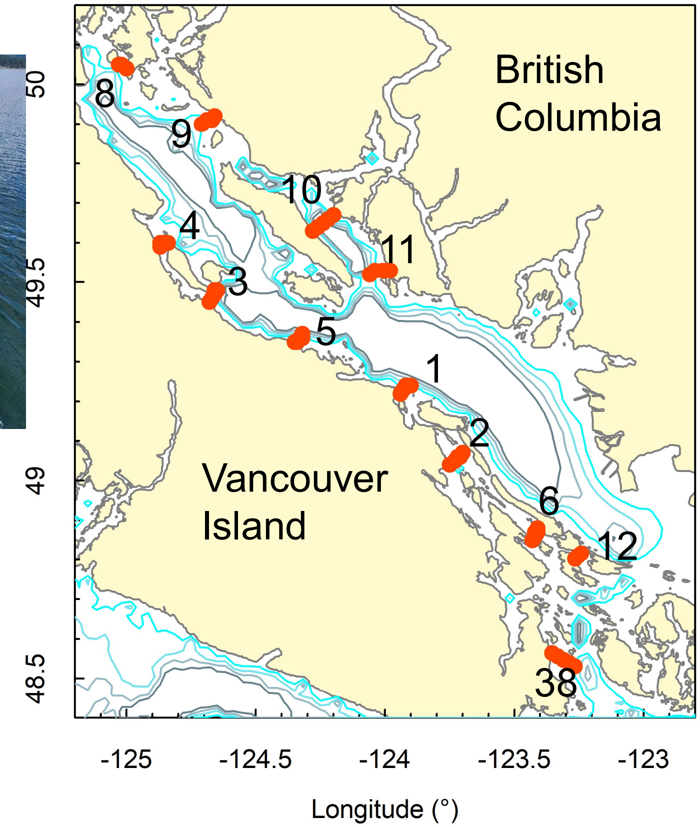
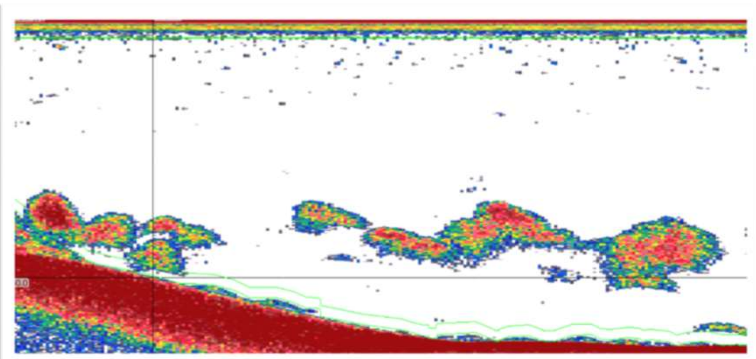
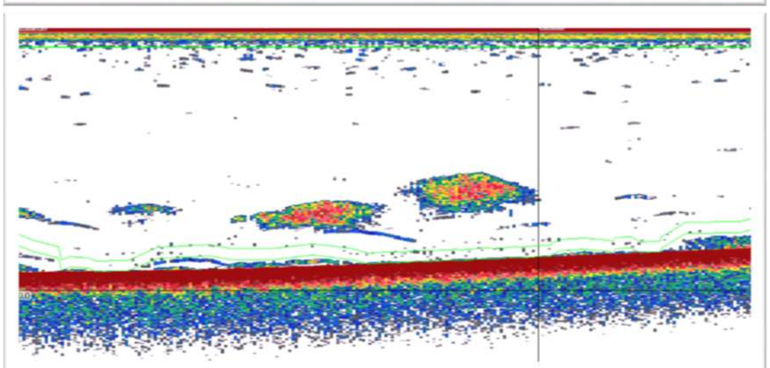
# Strait of Georgia Age-0 Herring (Jennifer Boldt)

- Annual 1992-2022 (except 1995, 2020)
- 10 “Core” Transects
    - 3 or 5 stations each
- Small purse seine (183 x 27 m)
- Acoustics data (2021-2023): 1-3 passes per transect
    - Pole mounted transducer (38 and 200 kHz)



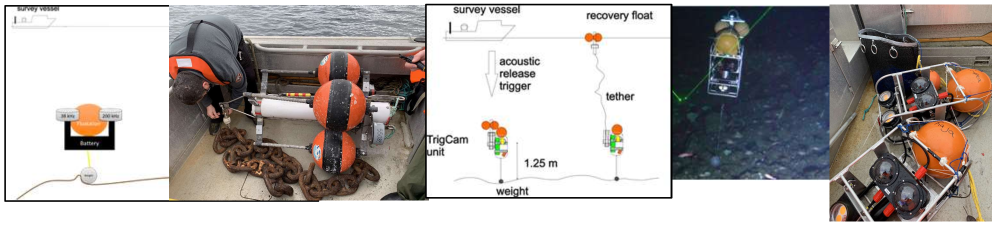



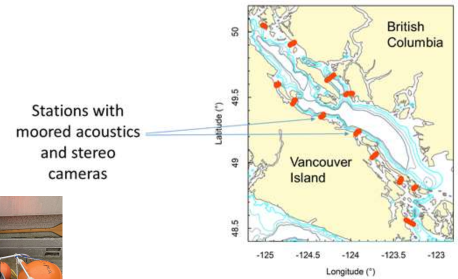


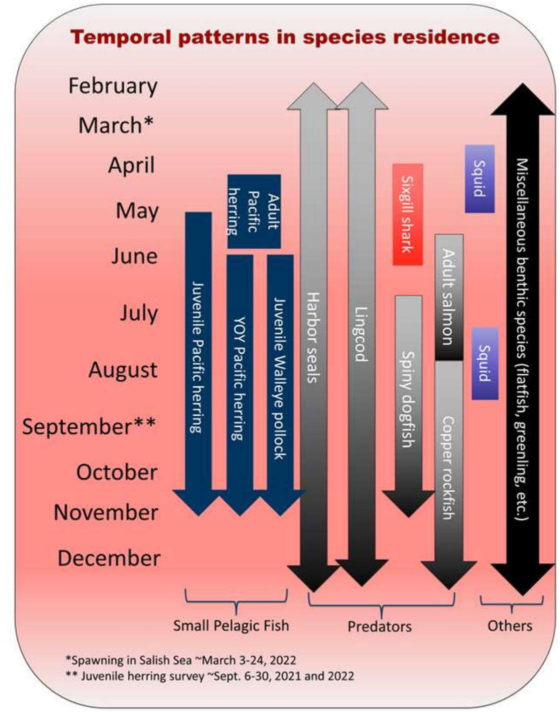
# Strait of Georgia Age-0 Herring

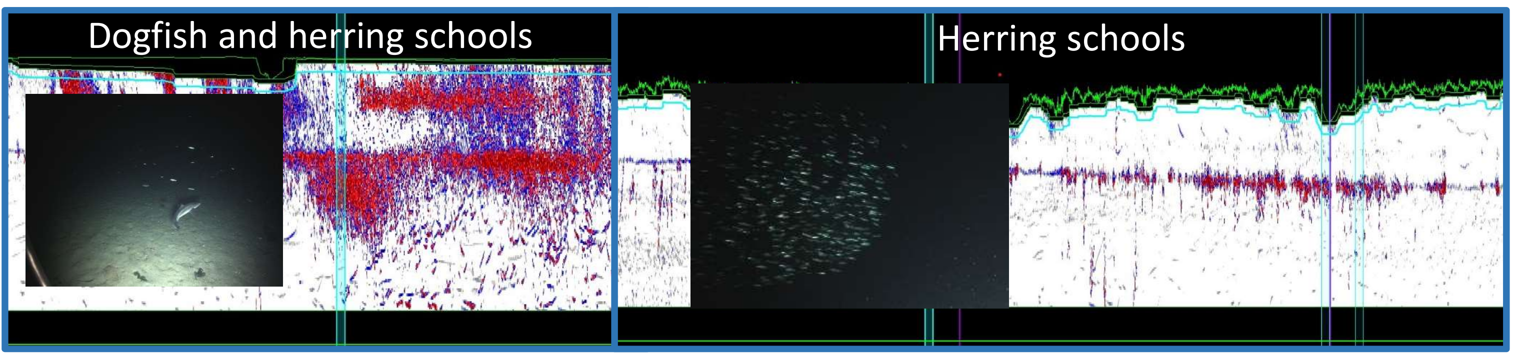
## Nearshore residence (2021-2023):

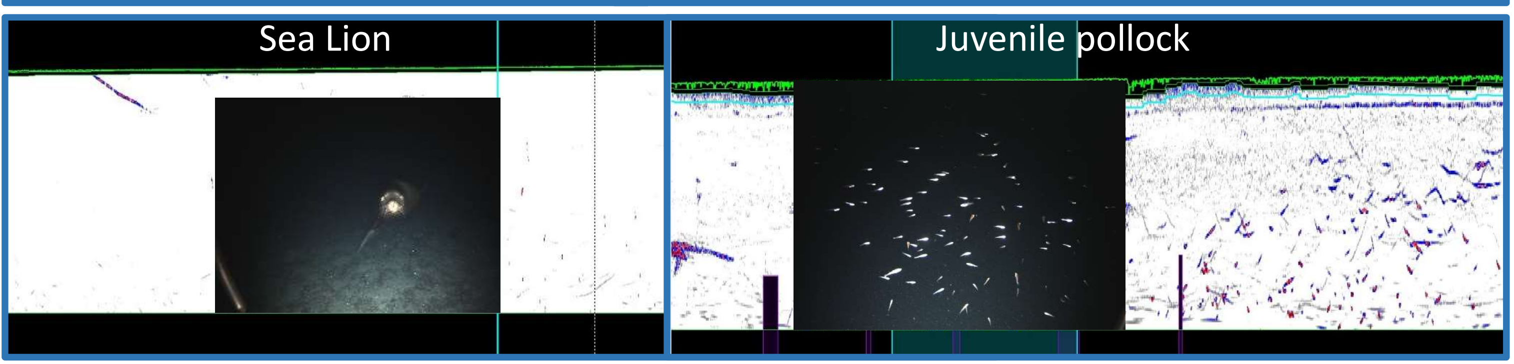
- Moored transducers (2) and stereo cameras (2)

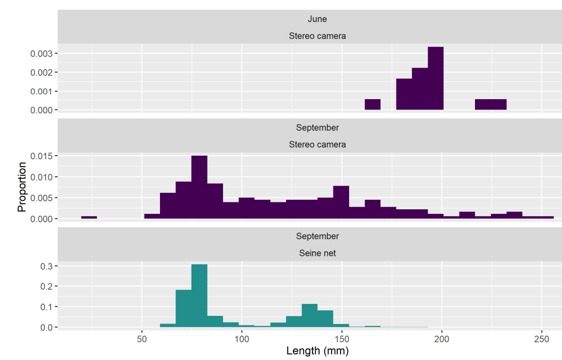


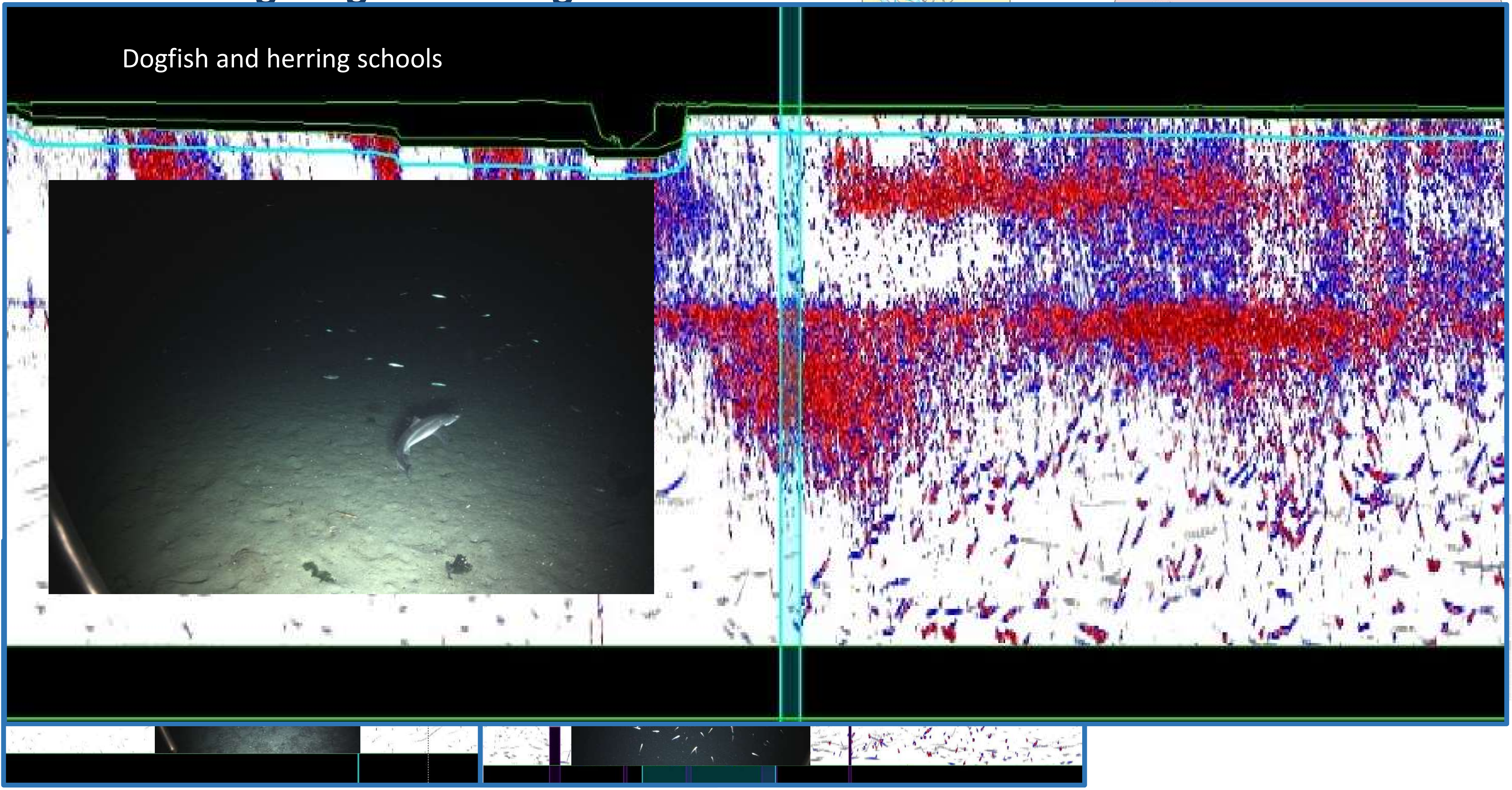



# Strait of Georgia Age-0 Herring

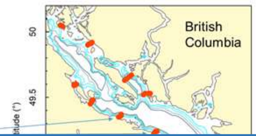

Temporal patterns in species residence



# Strait of Georgia Age-0 Herring

## Nearshore residence (2021-2023):

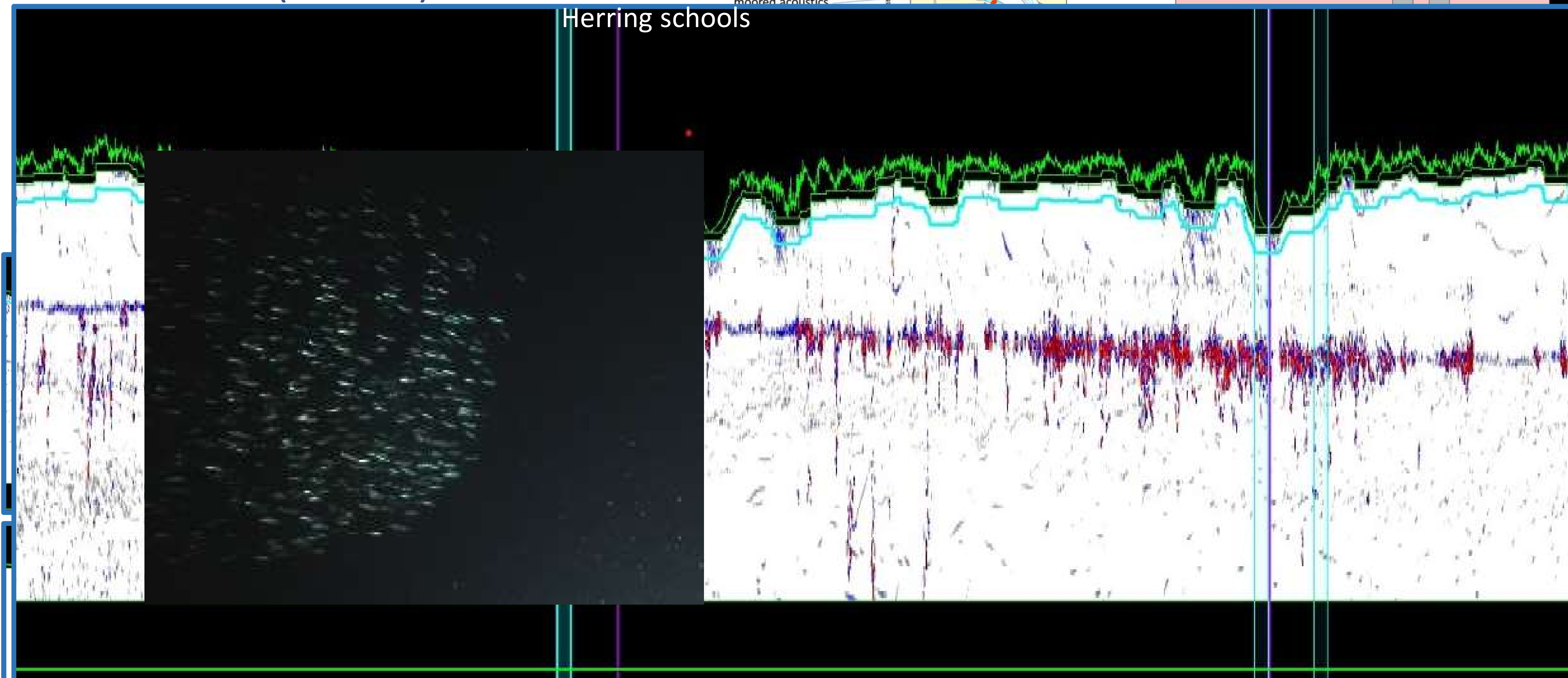
Stations with moored acoustics

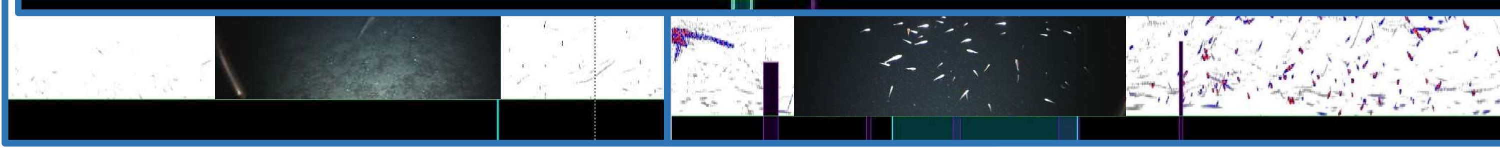



**Temporal patterns in species residence**

February

March*



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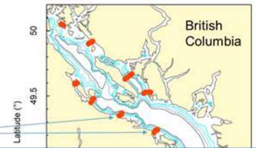
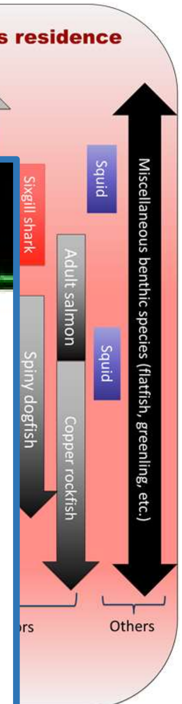
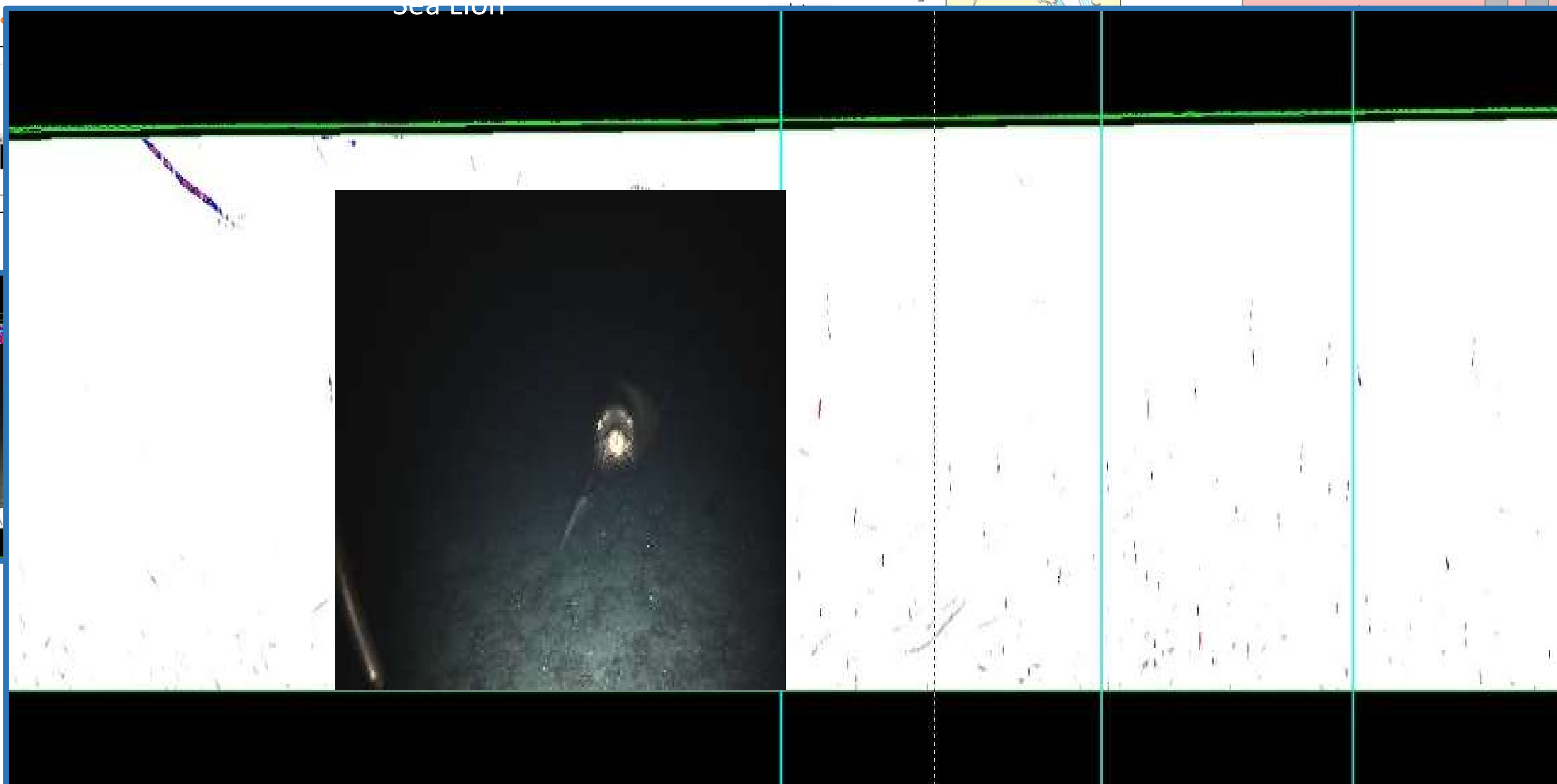
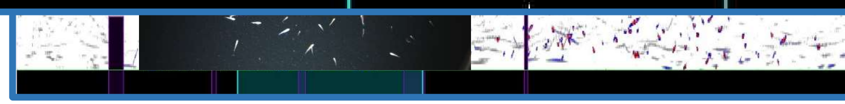



Sea Lion





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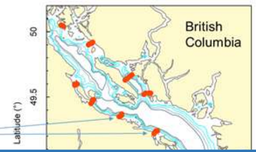
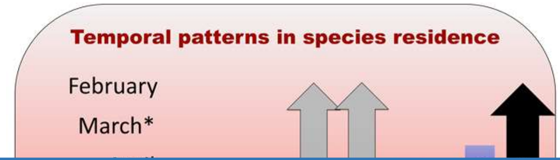
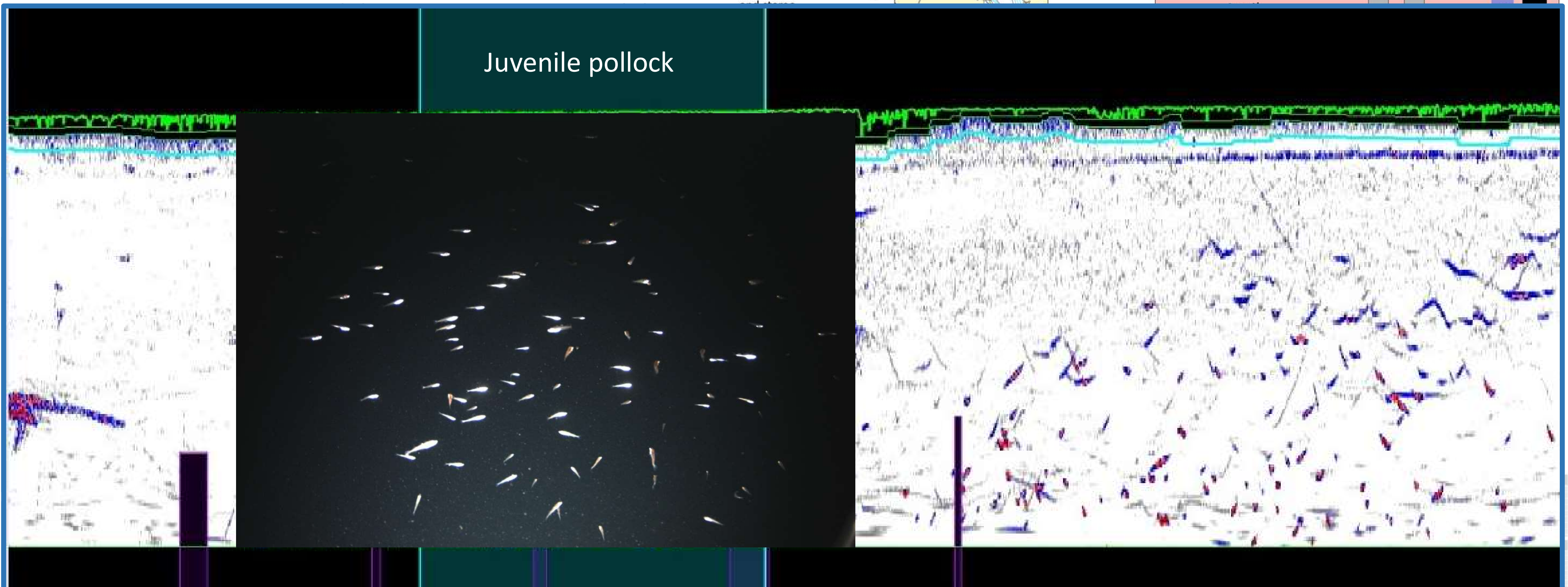
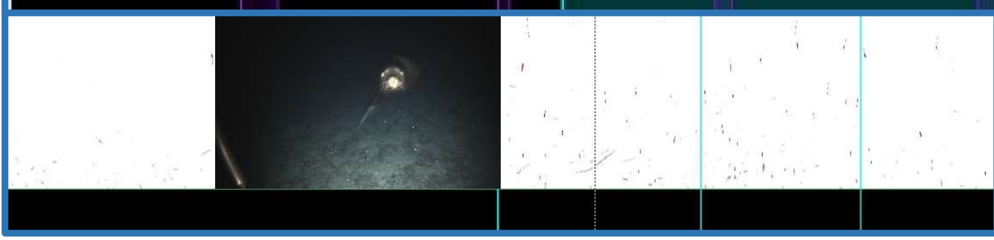
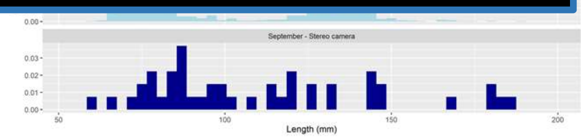


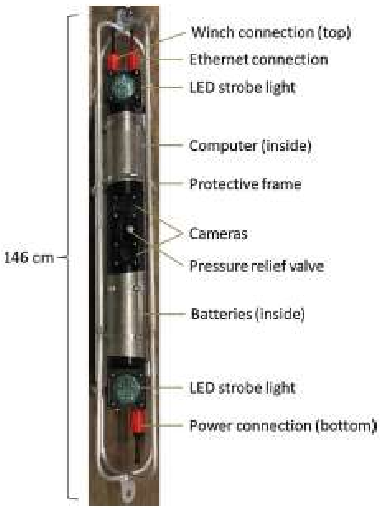



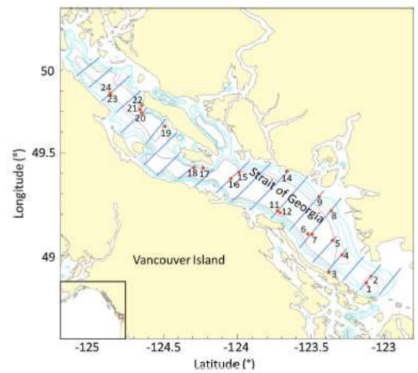





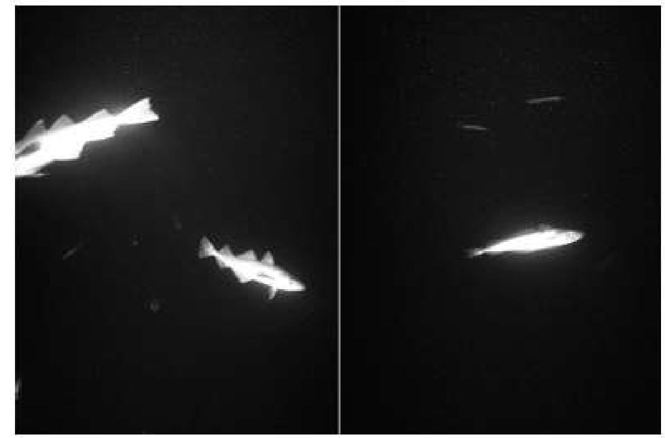
# Surveys – SLYCAM to increase sampling efficiency

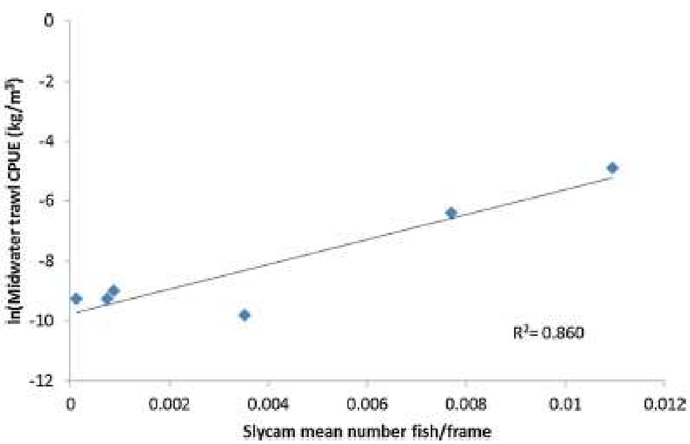


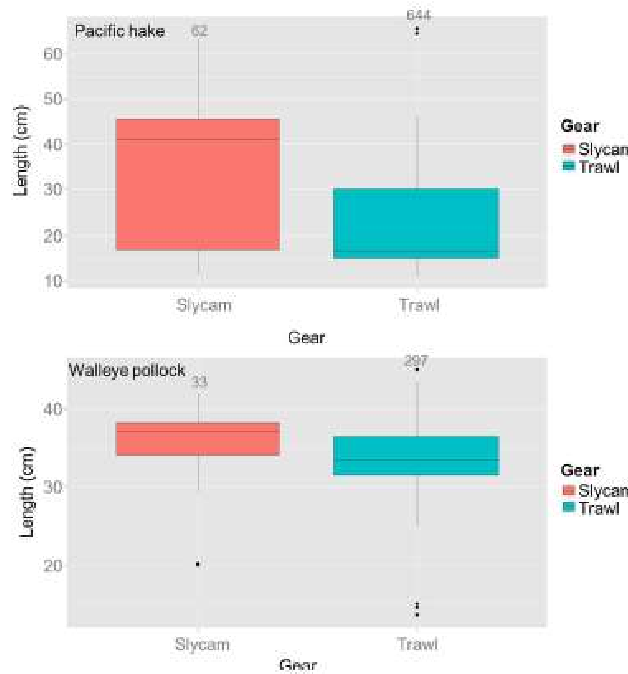



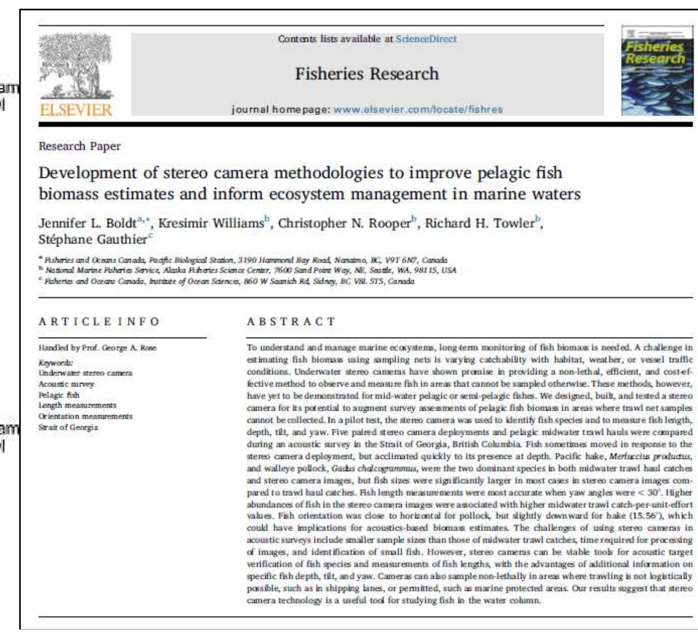

## Goals

- Verify acoustic targets
- Produce length-frequencies for biomass estimation



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Research Paper

## Development of stereo camera methodologies to improve pelagic fish biomass estimates and inform ecosystem management in marine waters


Jennifer L. Boldt[a,*], Kresimir Williams[b], Christopher N. Rooper[b], Richard H. Towler[b], Stéphane Gauthier[c]

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[b] National Marine Fisheries Service, Alaska Fisheries Science Center, 7600 Sand Point Way, NE, Seattle, WA, 98115, USA
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ARTICLE INFO

Handled by Prof. George A. Rose

*Keywords:*
Underwater stereo camera
Acoustic survey
Pelagic fish
Length measurements
Orientation measurements
Strait of Georgia

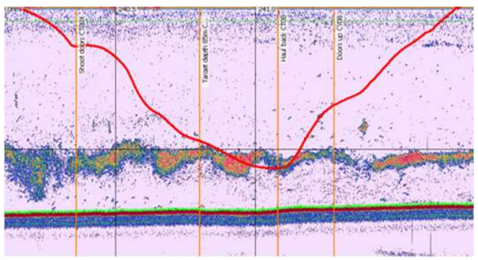


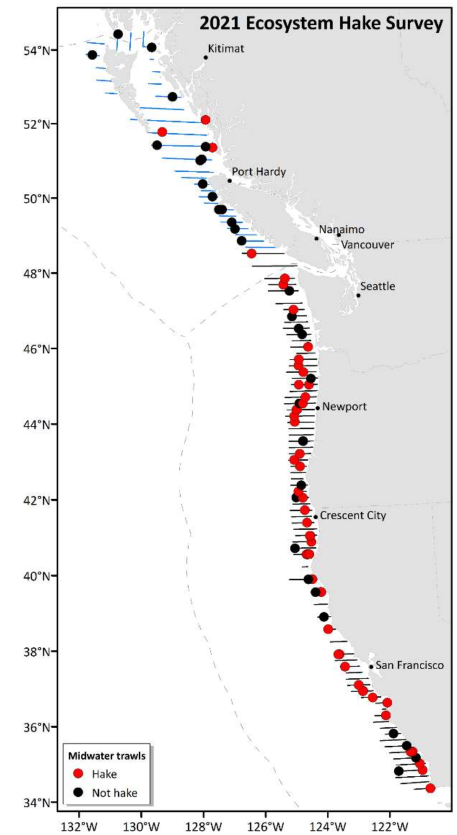
ABSTRACT

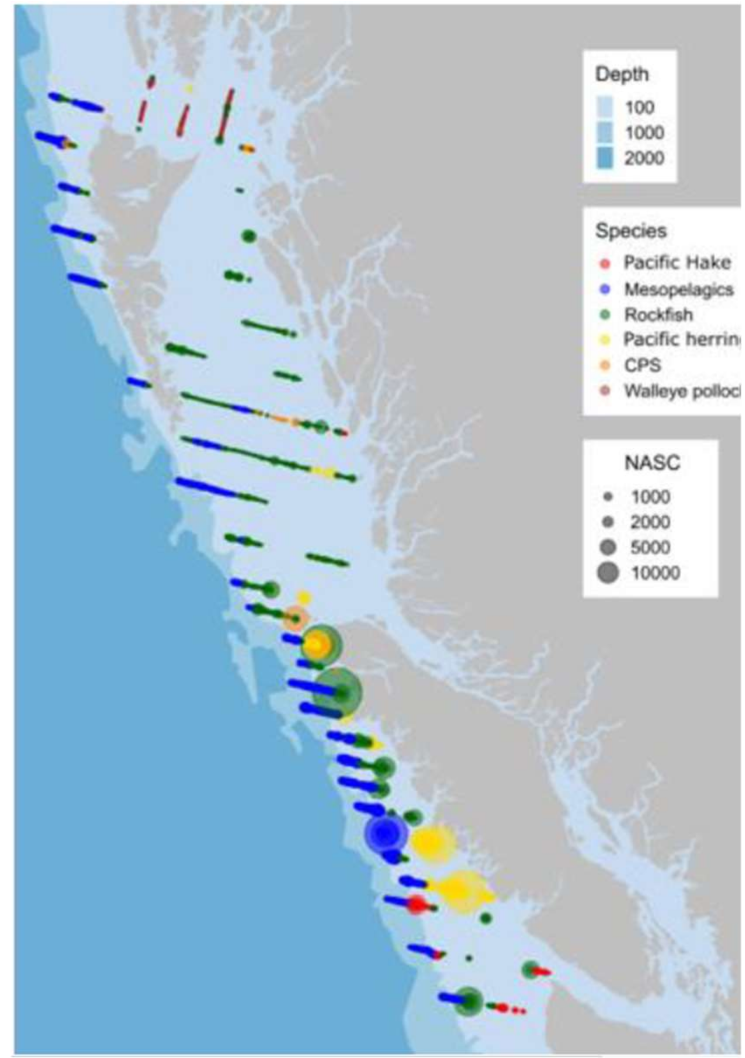
To understand and manage marine ecosystems, long-term monitoring of fish biomass is needed. A challenge in estimating fish biomass using sampling nets is varying catchability with habitat, weather, or vessel traffic conditions. Underwater stereo cameras have shown promise in providing a non-lethal, efficient, and cost-effective method to observe and measure fish in areas that cannot be sampled otherwise. These methods, however, have yet to be demonstrated for mid-water pelagic or semi-pelagic fishes. We designed, built, and tested a stereo camera for its potential to augment survey assessments of pelagic fish biomass in areas where trawl net samples cannot be collected. In a pilot test, the stereo camera was used to identify fish species and to measure fish length, depth, tilt, and yaw. Five paired stereo camera deployments and pelagic midwater trawl hauls were compared during an acoustic survey in the Strait of Georgia, British Columbia. Fish sometimes moved in response to the stereo camera deployment, but acclimated quickly to its presence at depth. Pacific hake, *Merluccius productus*, and walleye pollock, *Gadus chalcogrammus*, were the two dominant species in both midwater trawl haul catches and stereo camera images, but fish sizes were significantly larger in most cases in stereo camera images compared to trawl haul catches. Fish length measurements were most accurate when yaw angles were < 30°. Higher abundances of fish in the stereo camera images were associated with higher midwater trawl catch-per-unit-effort values. Fish orientation was close to horizontal for pollock, but slightly downward for hake (15.56°), which could have implications for acoustics-based biomass estimates. The challenges of using stereo cameras in acoustic surveys include smaller sample sizes than those of midwater trawl catches, time required for processing of images, and identification of small fish. However, stereo cameras can be viable tools for acoustic target verification of fish species and measurements of fish lengths, with the advantages of additional information on specific fish depth, tilt, and yaw. Cameras can also sample non-lethally in areas where trawling is not logistically possible, such as in shipping lanes, or permitted, such as marine protected areas. Our results suggest that stereo camera technology is a useful tool for studying fish in the water column.

**Pacific Hake acoustic-trawl survey**

- Systematic parallel transects with random start
- 10 or 20 nmi transect spacing
- Targeted midwater trawling based on acoustic backscatter
- Geostatistics for variance estimates

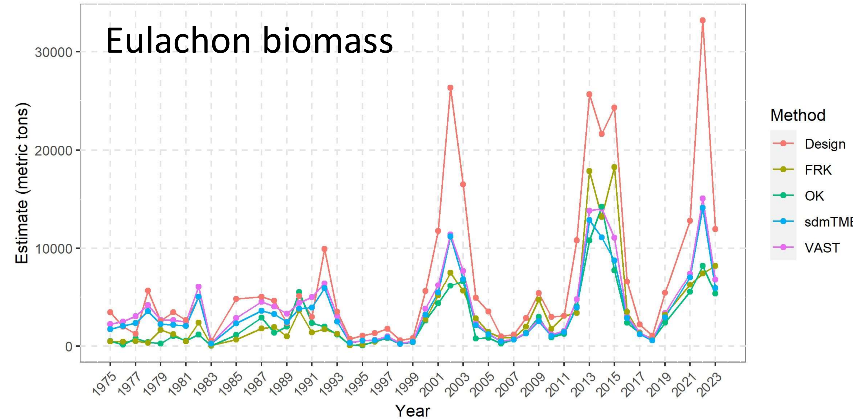





Target is Pacific Hake
indices of abundance for
forage species
(krill, CPS, Pacific herring)

# Summary & lessons learned




<u>Understand that its an index</u>

- Everything has a catchability
- Use a design that easily gets to biomass for the stock
- Consistency in sampling

<u>Modeling can address most issues to some degree</u>

- Will not solve everything (high variability & poor design)

<u>Consistent effort to pair research with monitoring</u>

- Selectivity experiments

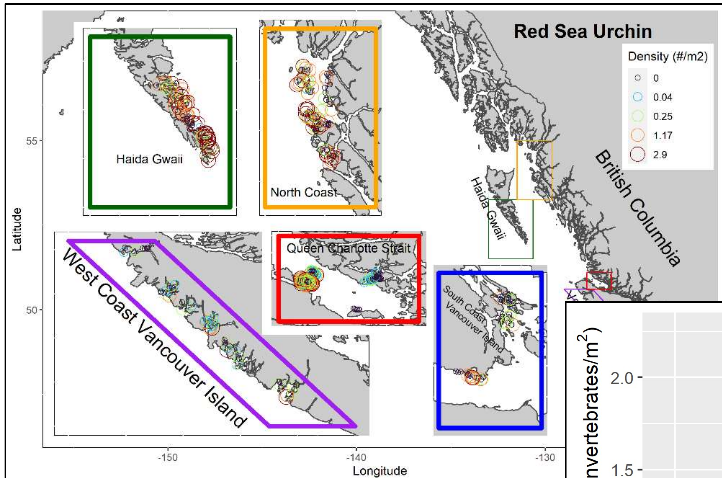
<u>Whole ecosystem monitoring surveys (e.g. IPES)</u>

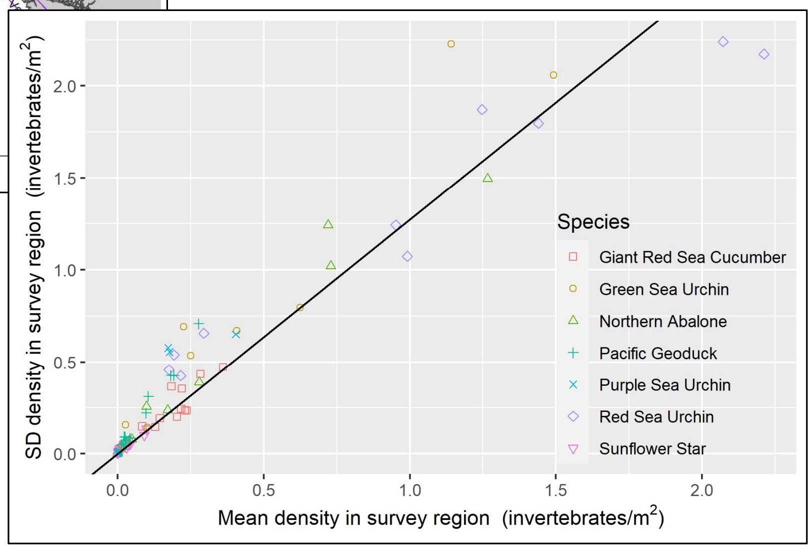
- Single species is over
- Diets, oceanography, zooplankton, mammals, birds

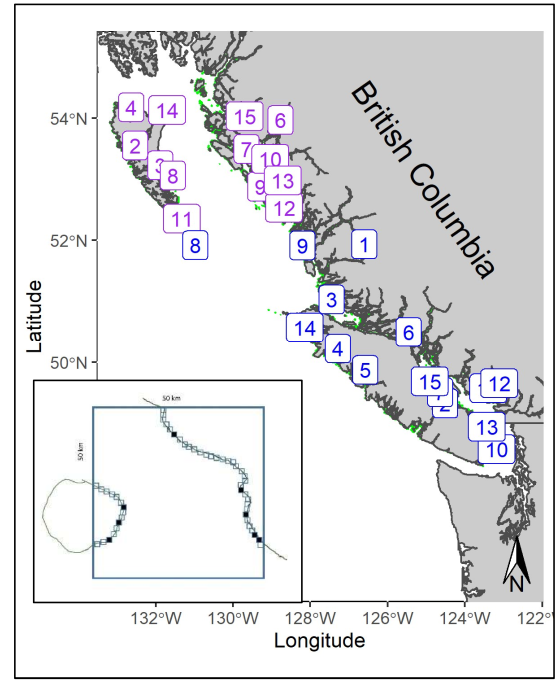
# EXTRA SLIDES

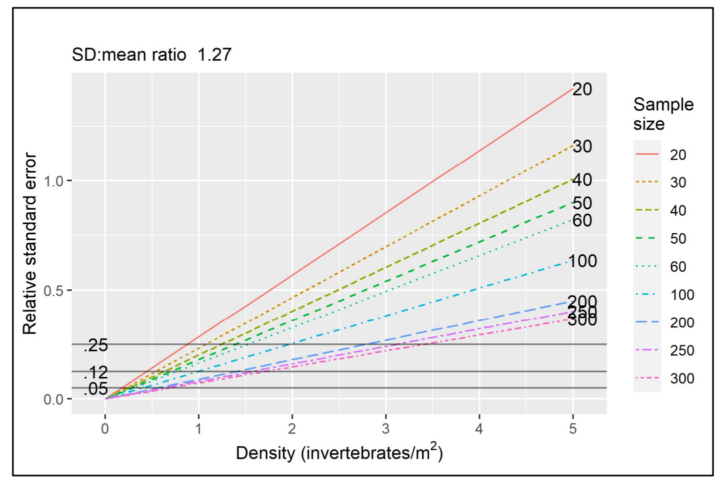
# Multispecies dive survey for invertebrates –(Lochead et al. 2020)

- piloted for 4 years
- used variance and standard design
- no model – reference points by density



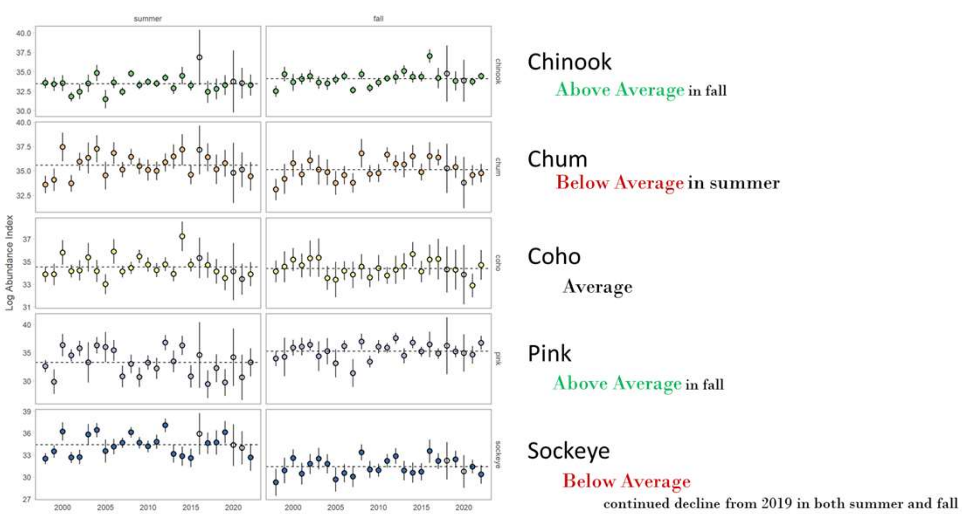



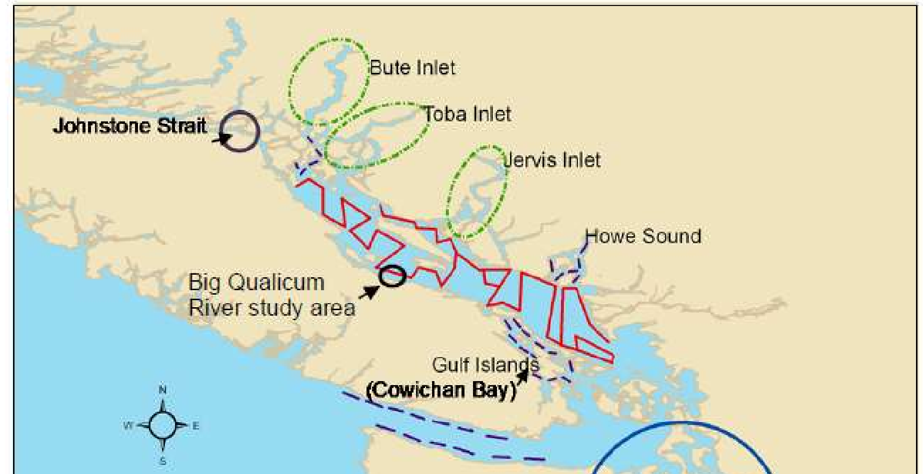



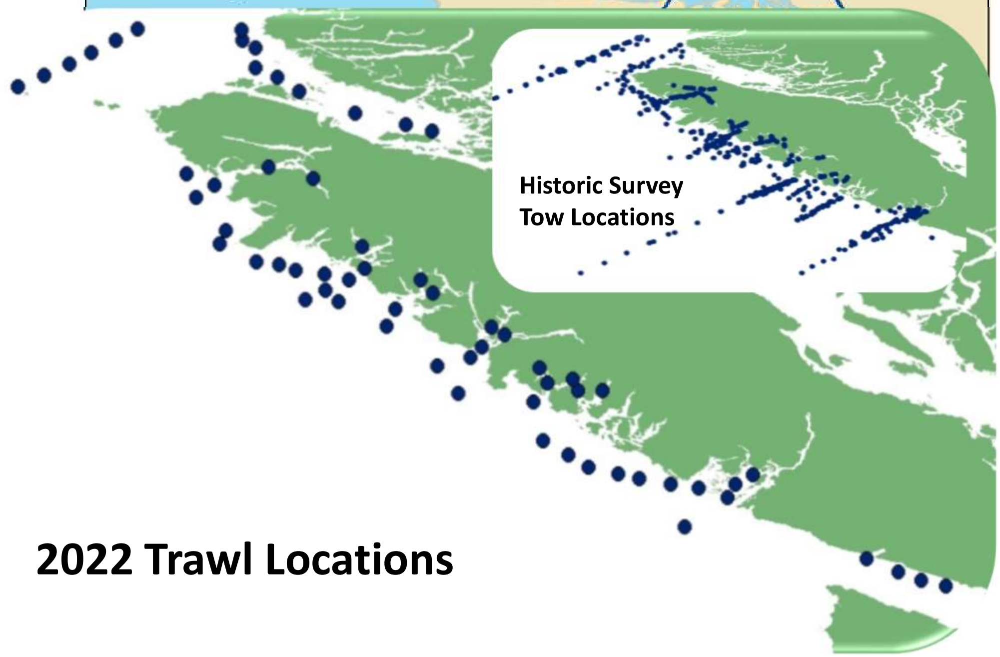
## Juvenile salmon surveys (J. King & C. Neville)

- Pelagic (surface) net
- Fixed tracklines, depth stratified
- Original design was to cover most areas of SoG
- Original design fixed locations on the west coast (offshore transects, coastal and sound fishing)
- Fall (offshore and SoG), Summer (SoG, IPES)
- 1998 - Present




C. Freshwater, S. Anderson and J. King. 2023. Model-based indices of juvenile Pacific salmon abundance on the British Columbia continental shelf. MEPS. *In review*.



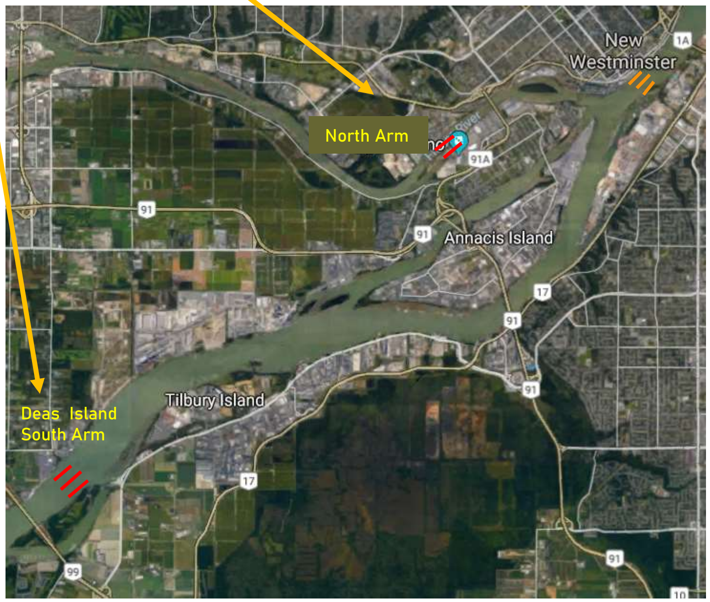



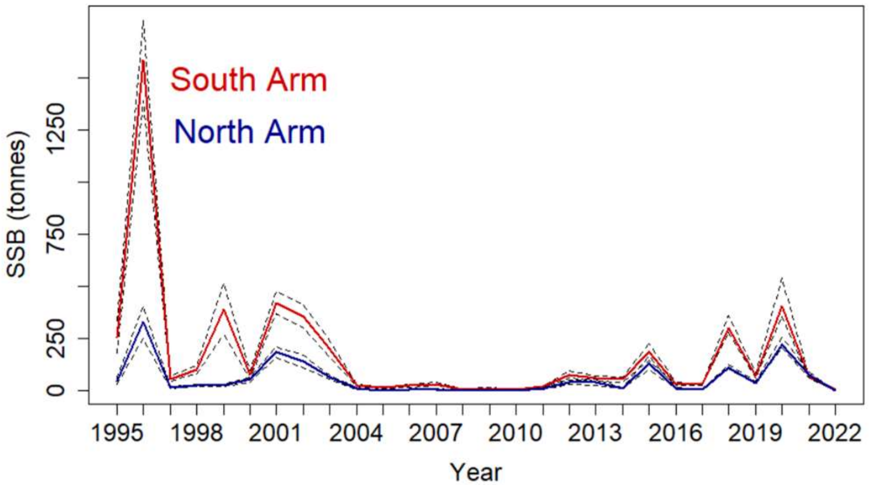

2022 Trawl Locations

# Fraser River Egg and Larval survey (Linnea Flostrand)

- Annually since 1995 (29 years to 2023)
- Index samples from South Arm (Deas Island) and North Arm transects –red on map (New West ancillary transects)
- Plankton nets with a flow meter to measure counts of eggs and larvae and water volume sampled
- Biweekly sampling late March/ early April – June,

2x19.5 cm diameter plankton nets



# Small – mesh bottom trawl survey (L. Flostrand)

- Estimate shrimp abundance
- Fixed station design
- 1975 – present (some missing years)
- Area determined by early commercial fishing