Eco-FOCI recruitment research

Dan Cooper and Matt Wilson
Eco-FOCI Program
AFSC

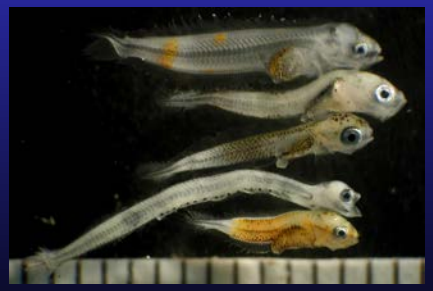
Outline

- What is eco-FOCI?
- Where do early career researchers fit into the program?
- Examples of recruitment research
  - Gulf of Alaska pollock
  - Eastern Bering Sea northern rock sole

What is Eco-FOCI?

- Joint program between biologists (NOAA/AFSC) and oceanographers (NOAA/PMEL)
- Collaboration to study the relationships between marine environment and survival of fish
- Focus on ELH stages
- 30+ years of zoo- and ichthyoplankton sampling
- Now part of Recruitment Processes Alliance



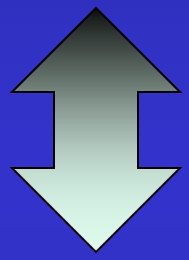



Where do early career researchers fit in?

BS Lab/At sea technician tasks

MS

PhD Conducting/leading studies



Laboratory chlorophyll measurements

Stomach content analysis

Larval fish ID

Error checking data

Otolith age reading

Study design

Statistical analyses

Manuscript writing

Supervising technicians

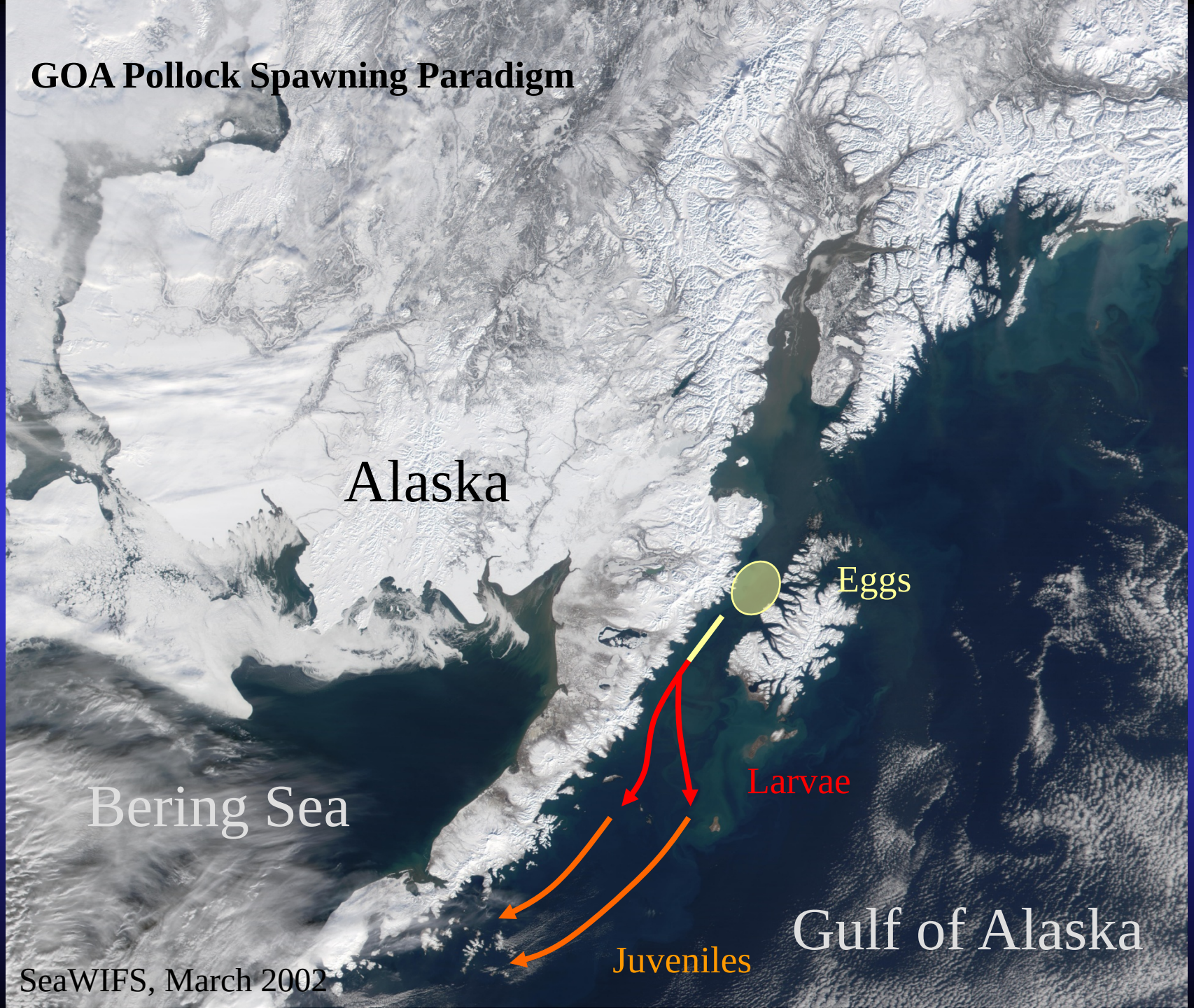
Opportunities for Students

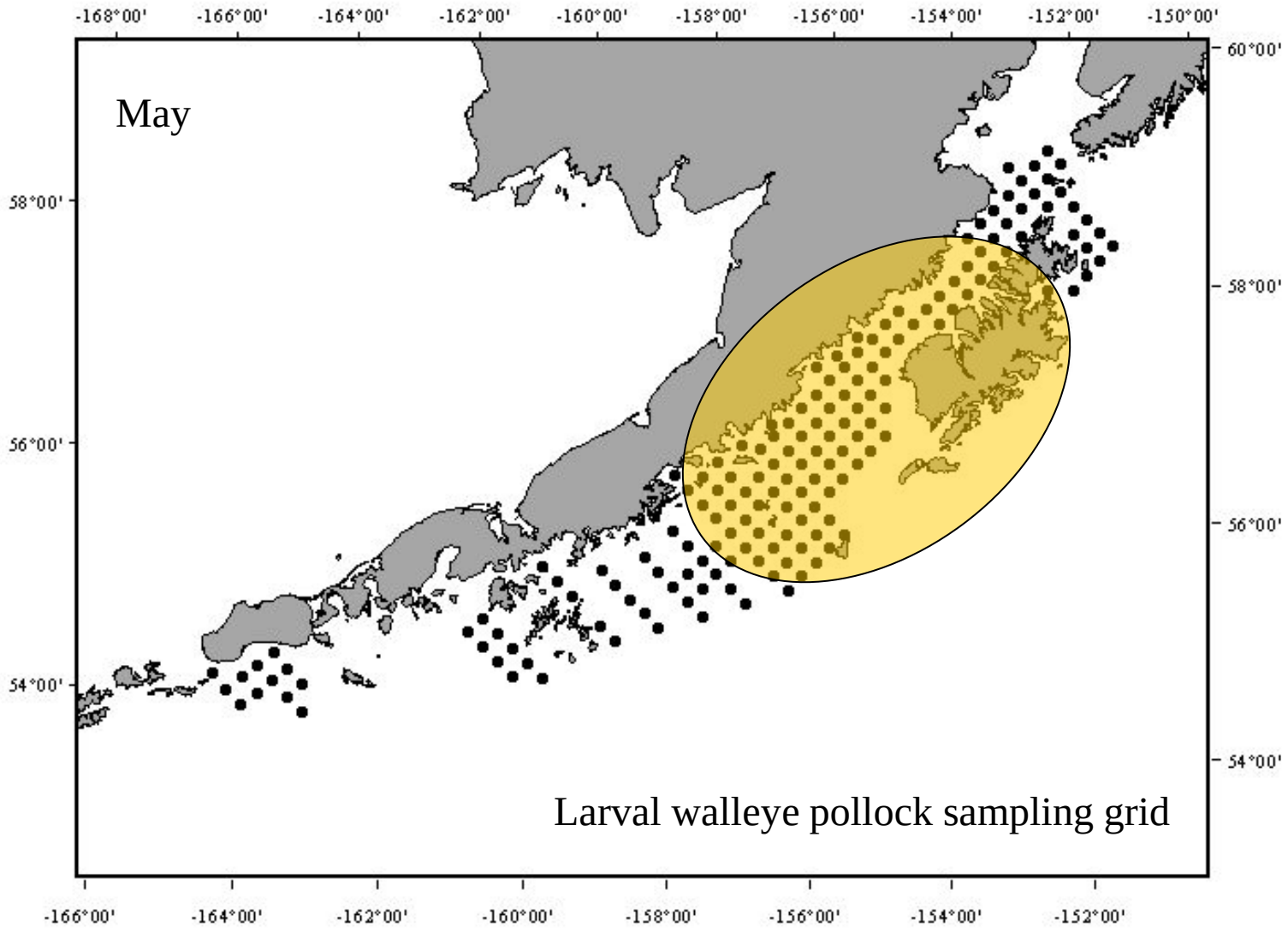
- Internships
  - Hollings scholarships (opens in September)
  - JISAO internships (applications just closed)
- Student volunteers
- Undergraduate capstone projects
- Graduate student projects

Gulf of Alaska Pollock

Walleye pollock recruitment in the Gulf of Alaska

What a riability?

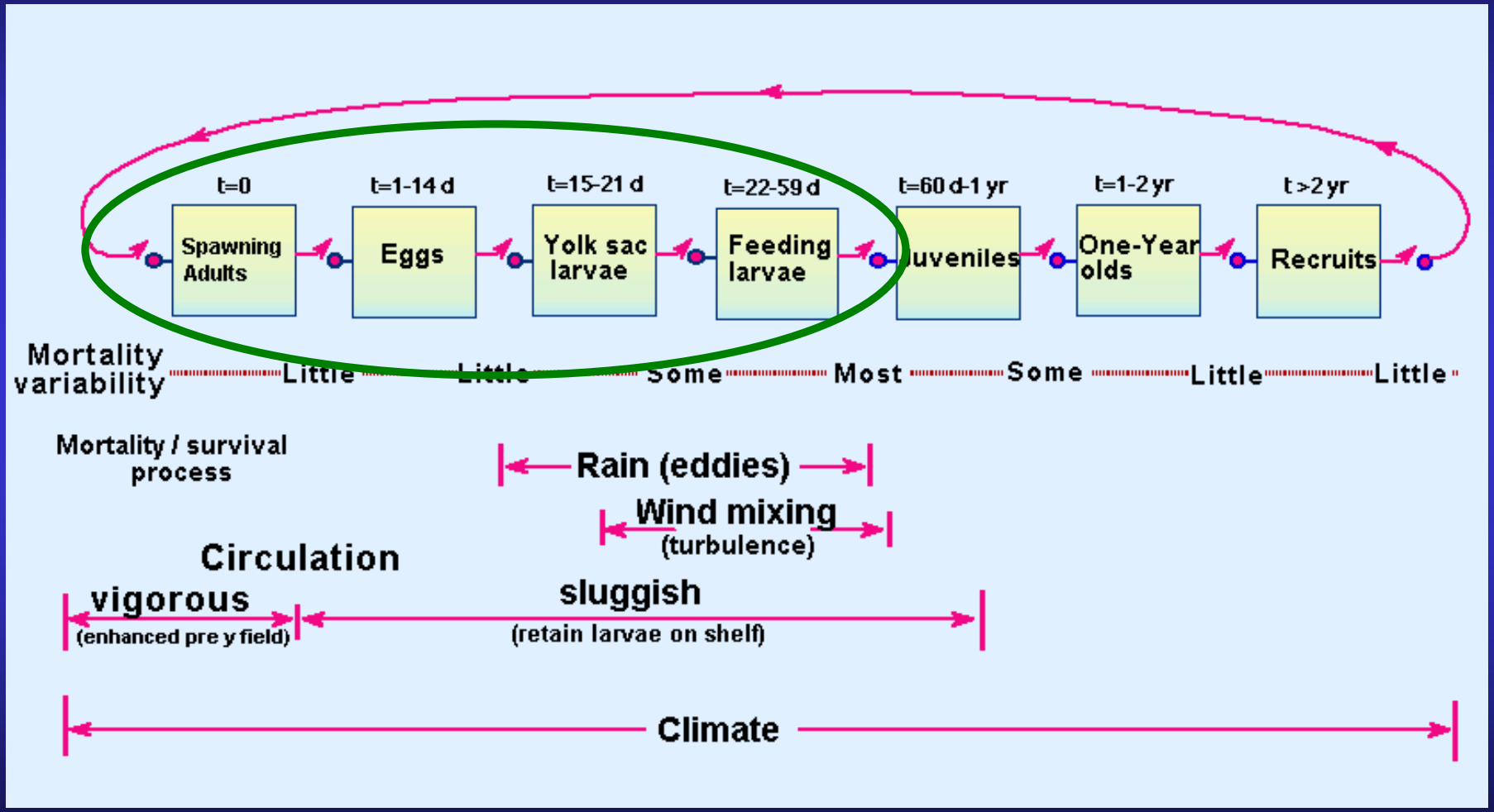

GOA Pollock Spawning Paradigm
Alaska
Eggs
Larvae
Bering Sea
Gulf of Alaska
Juveniles
SeaWIFS, March 2002


May
-168°00'
-166°00'
-164°00'
-162°00'
-160°00'
-158°00'
-156°00'
-154°00'
-152°00'
-150°00'
60°00'
58°00'
56°00'
54°00'
Larval walleye pollock sampling grid

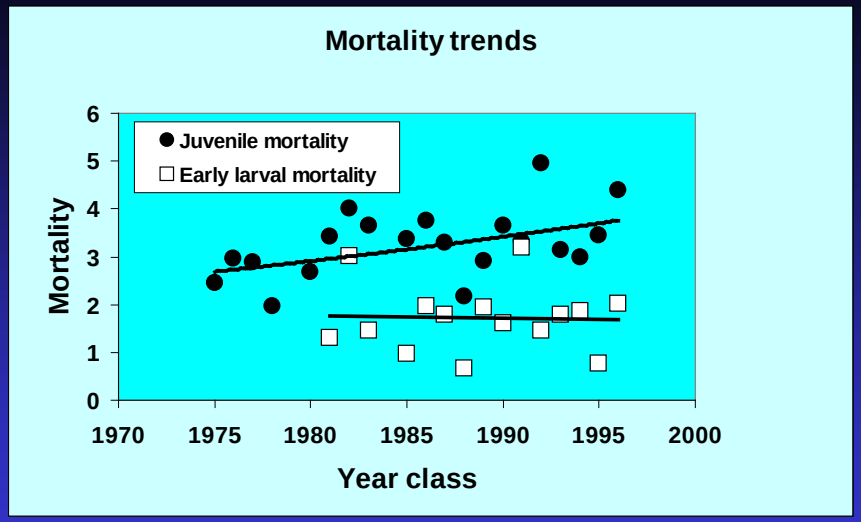
Mortality Process Studies Hypotheses

- Turbulence High mortality
- Flow in Shelikof (drifter studies)
  - Prior to spawning Low mortality
  - After spawning High mortality
- Eddies (larvae, prey concentrations) Low mortality
- Low Temperature High mortality

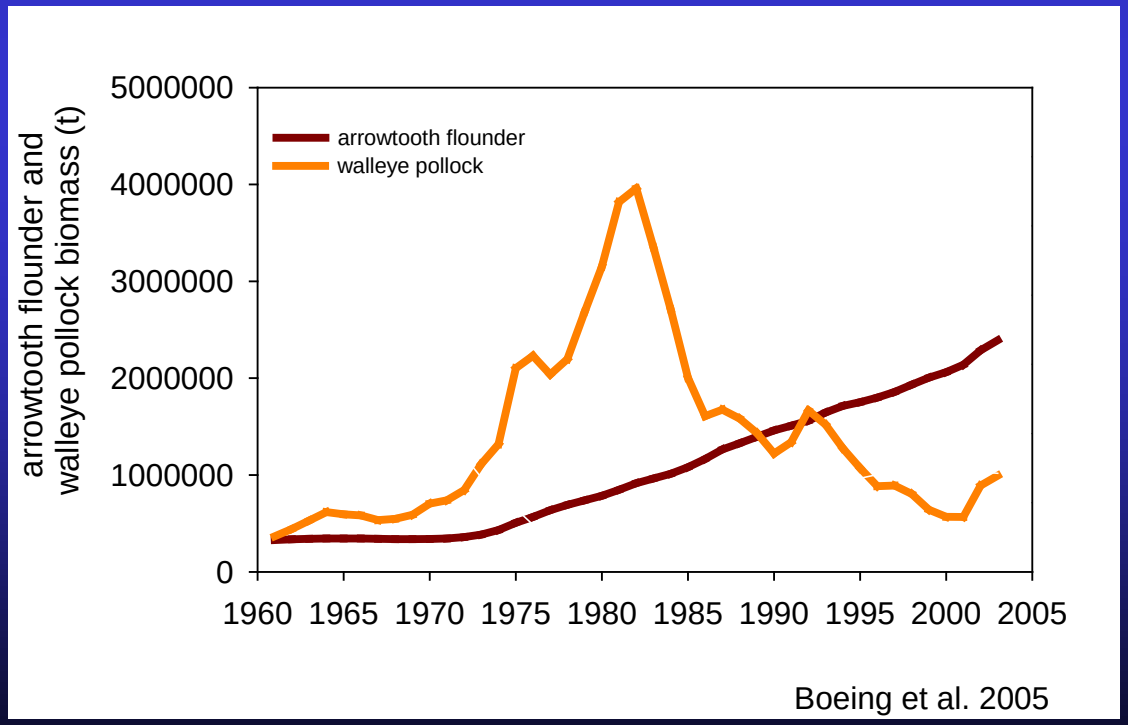
Switch model



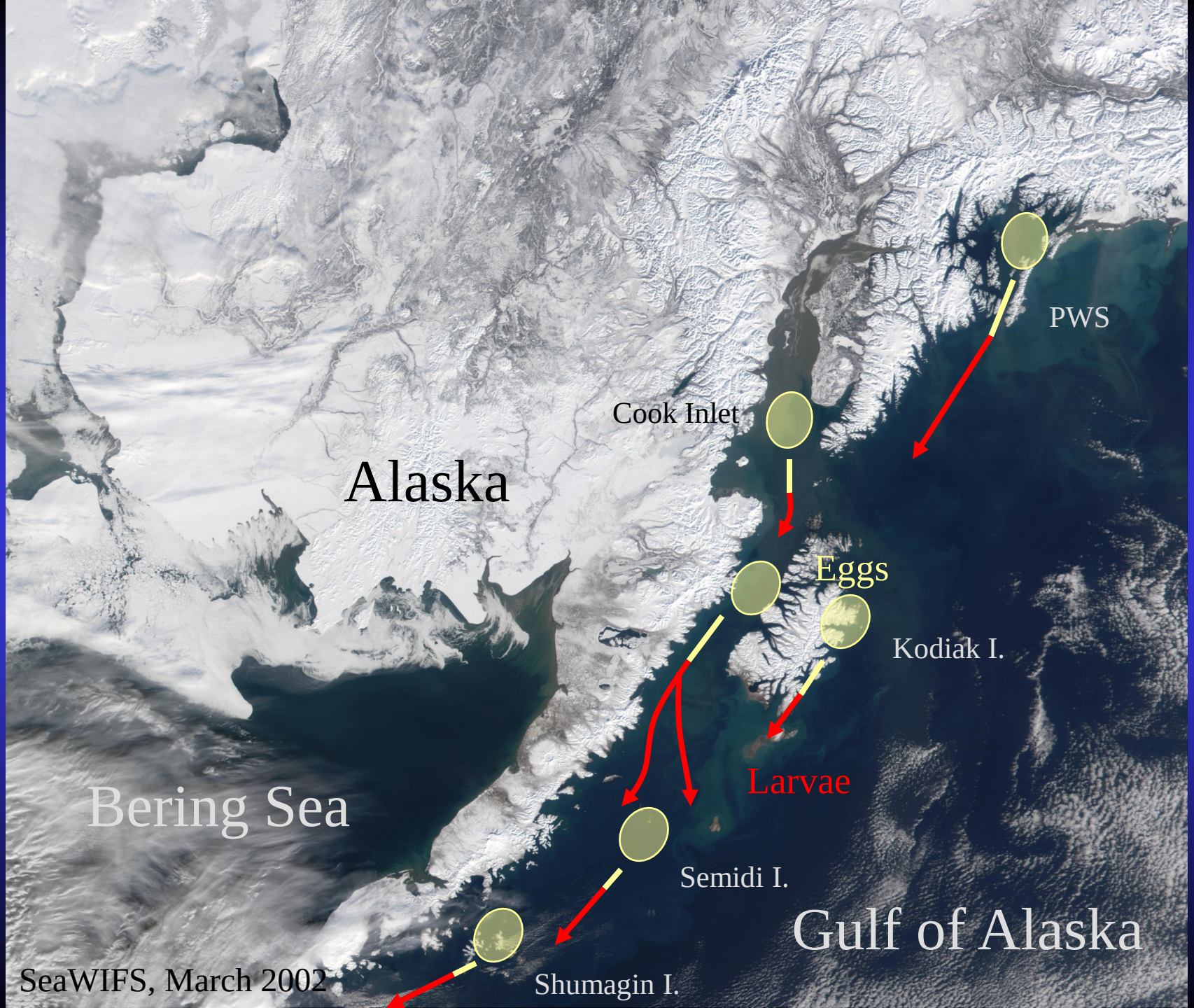
Megrey and Macklin, 2007



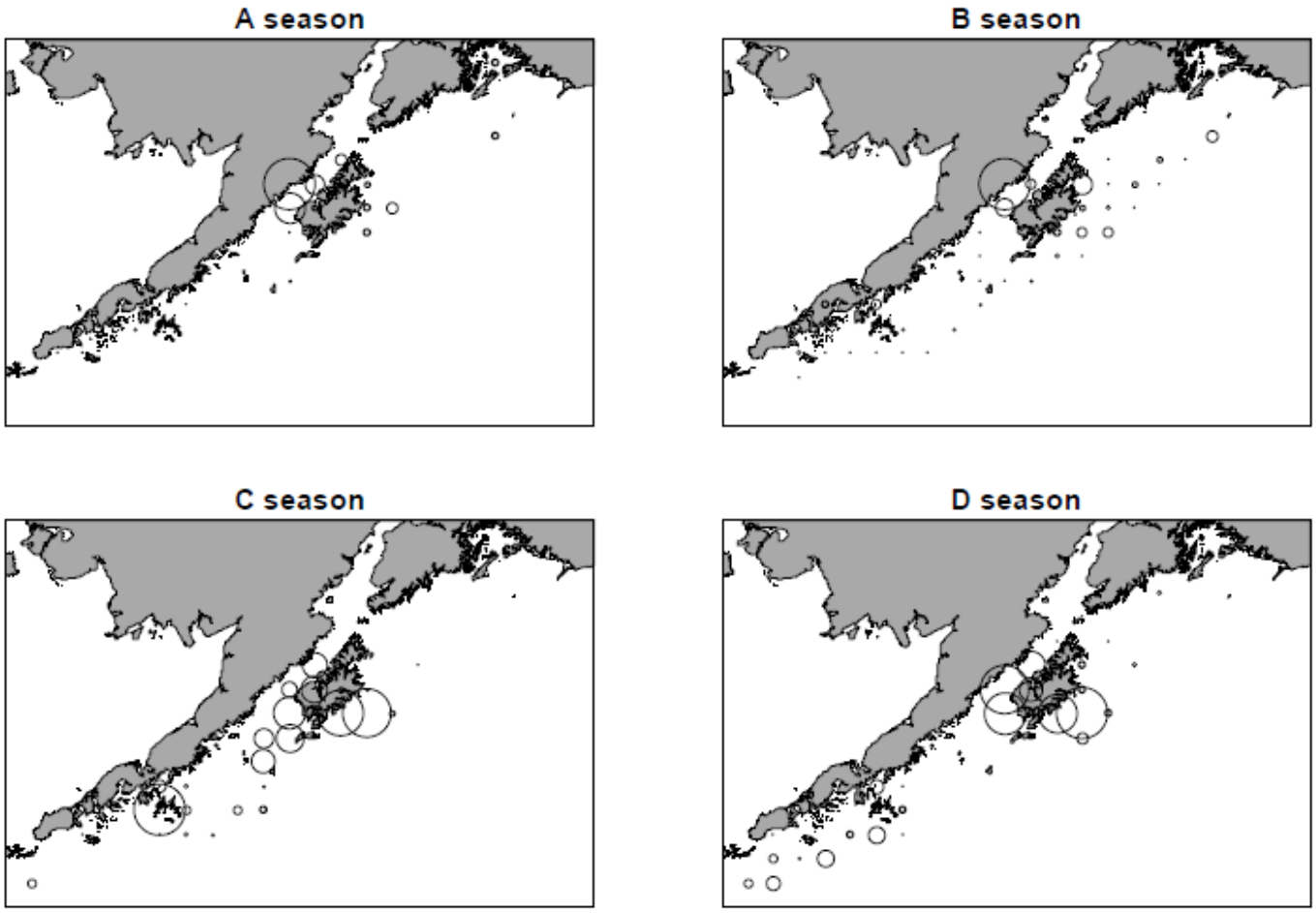
Bailey 2000



Boeing et al. 2005


PWS
Cook Inlet
Alaska
Eggs
Kodiak I.
Larvae
Bering Sea
Semidi I.
Gulf of Alaska
SeaWIFS, March 2002
Shumagin I.

Are adult aggregations supported locally?

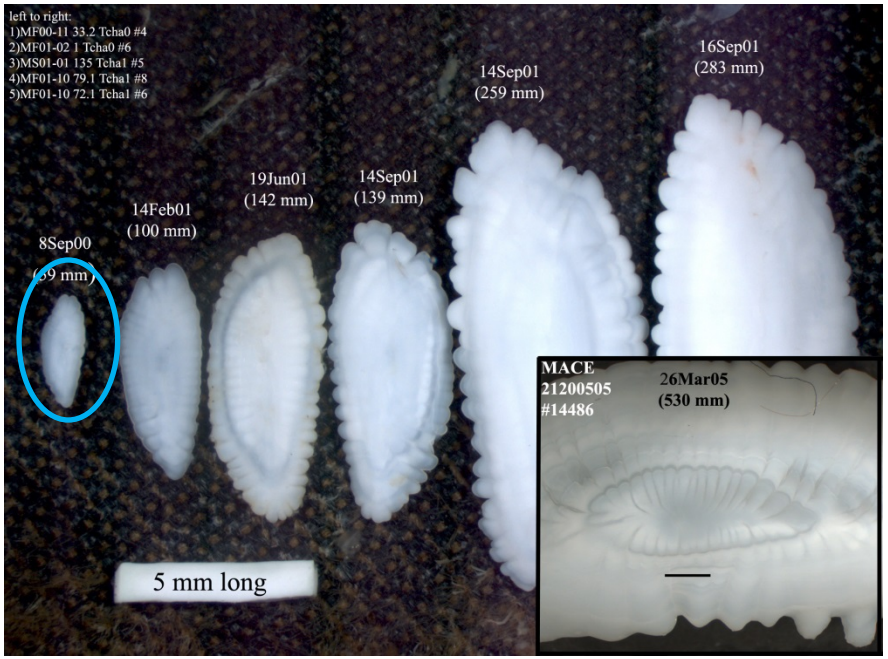


Dorn et al. 2015

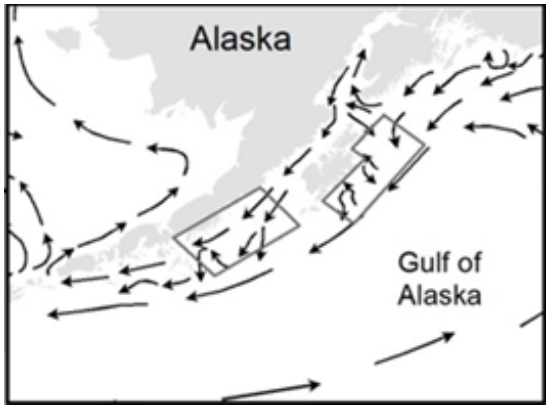
Figure 1.1. Pollock catch in 2014 for 1/2 degree latitude by 1 degree longitude blocks by season in the Gulf of Alaska as determined by fishery observer-recorded haul retrieval locations. Blocks with less than 1.0 t of pollock catch are not shown. The area of the circle is proportional to the catch.

Age-0 juvenile walleye pollock

Otoliths



Background



"A new perspective"
Water masses & otoliths

Our objectives

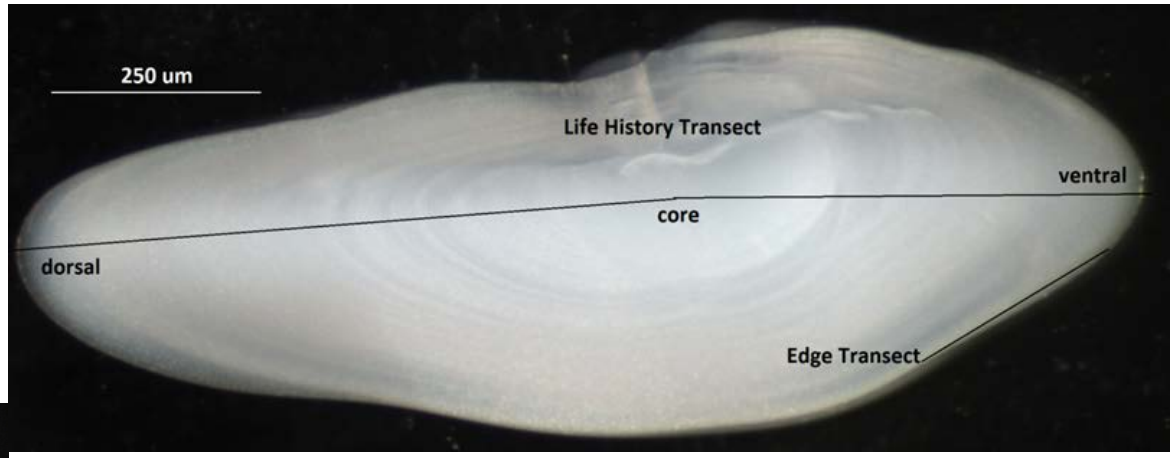
- Does element composition vary regionally?
- If so, how well does it discriminate region?
- What elements are most responsible?
- Is the life history of element composition relevant?

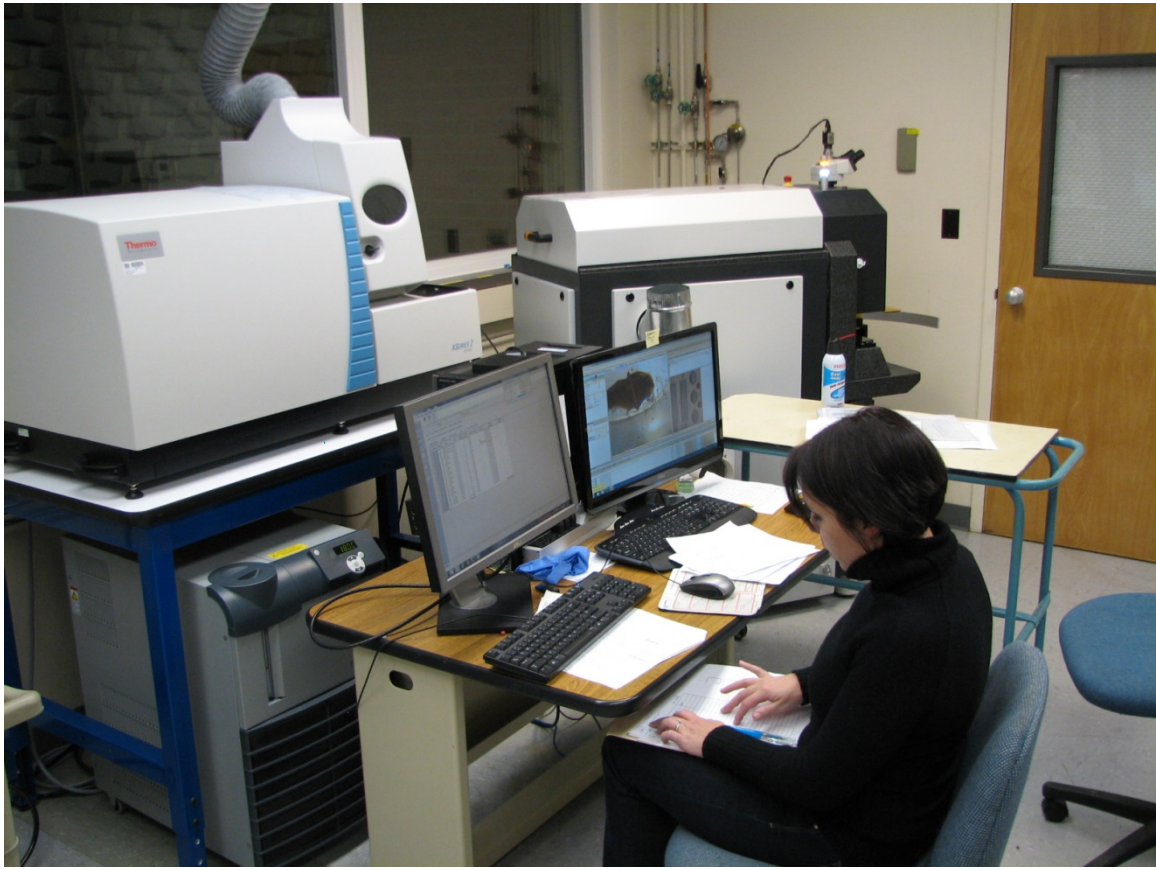
Element data

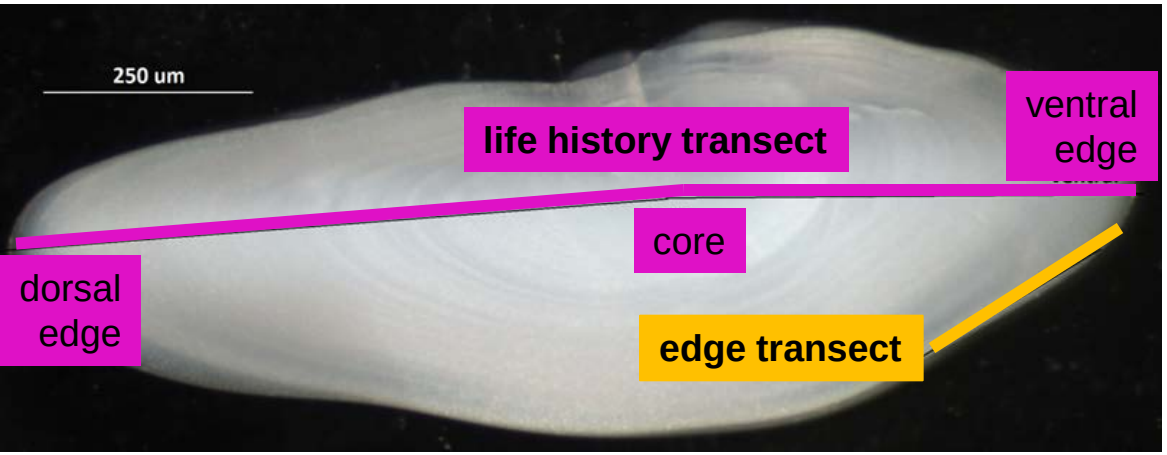
LA-ICPMS

WM Keck Collaboratory,

OSU, Corvallis, OR



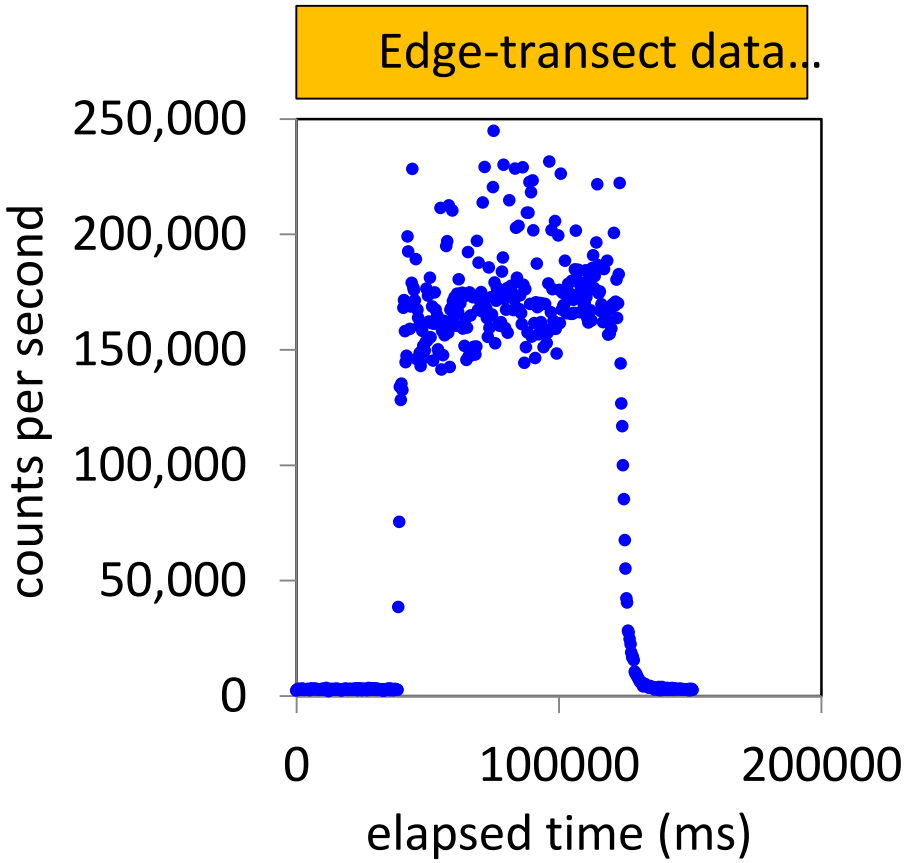


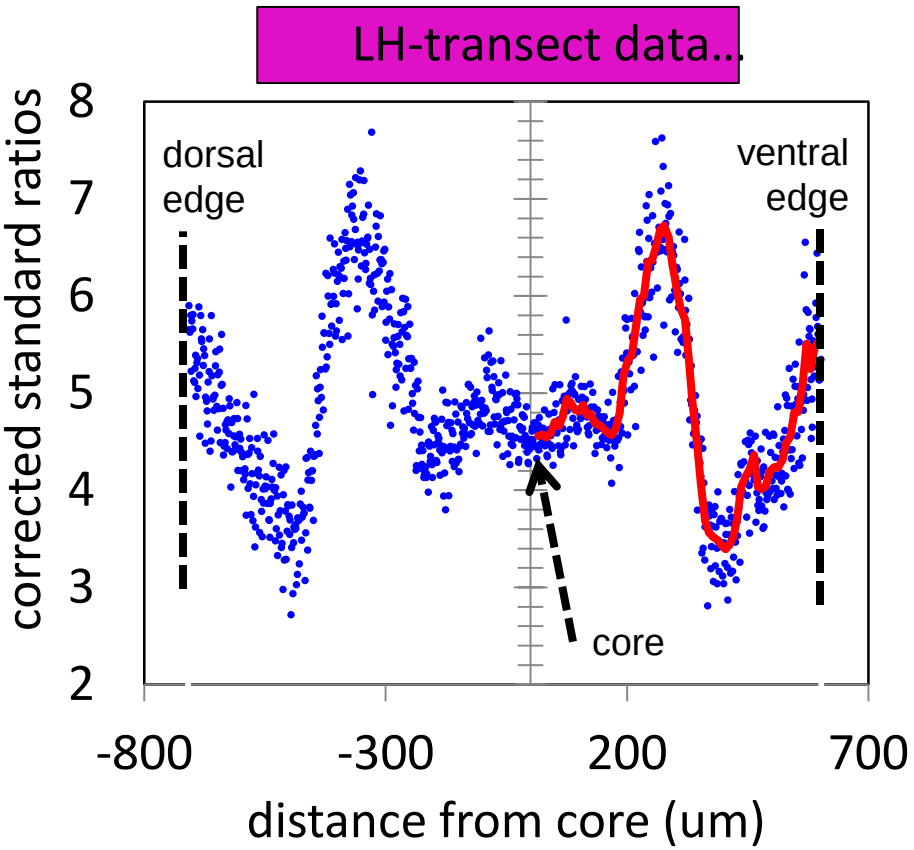


Element data

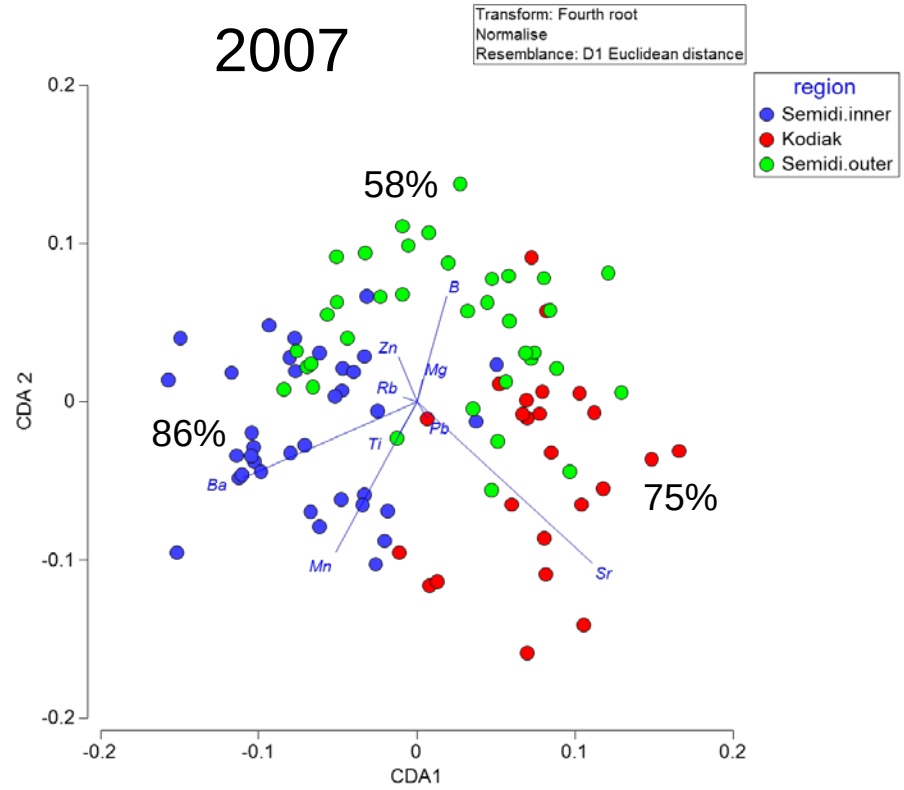
1)edge transect

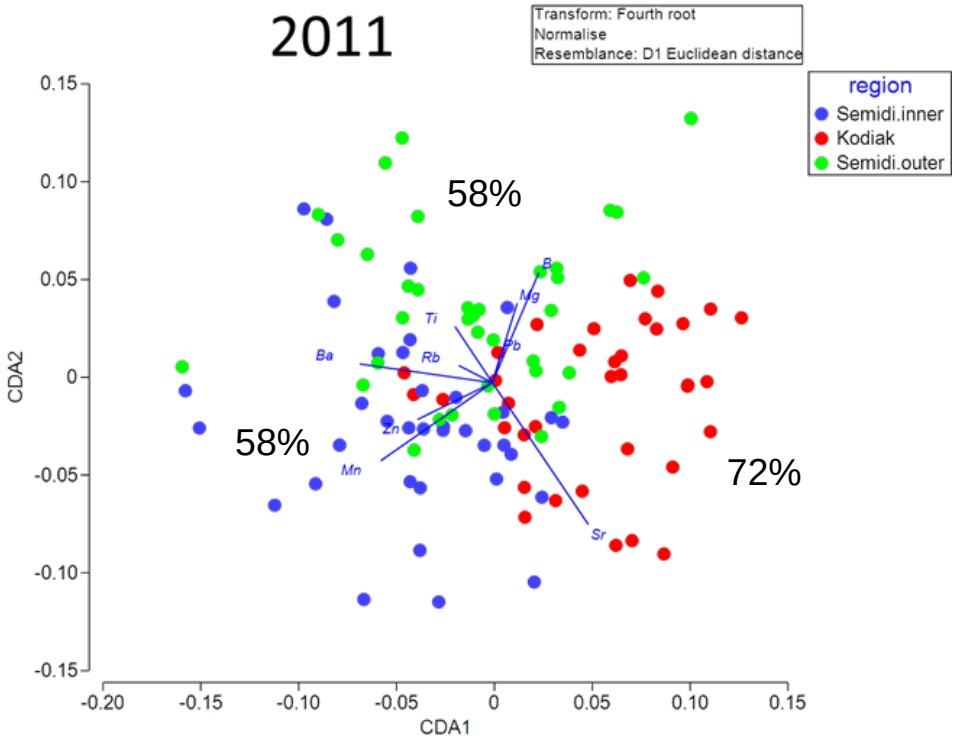
2)life history transect





Discriminant analysis

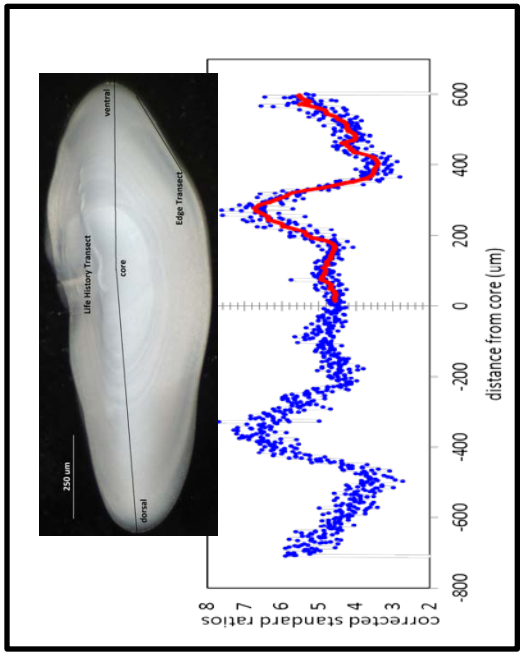


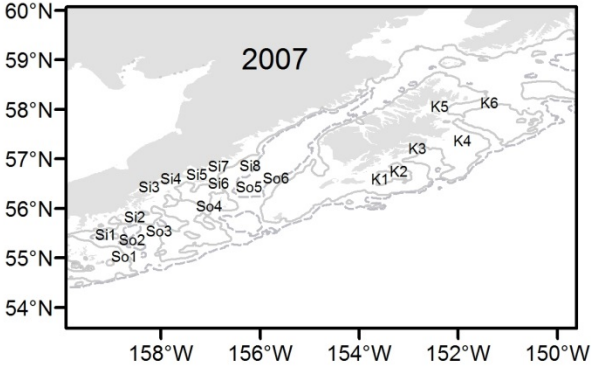


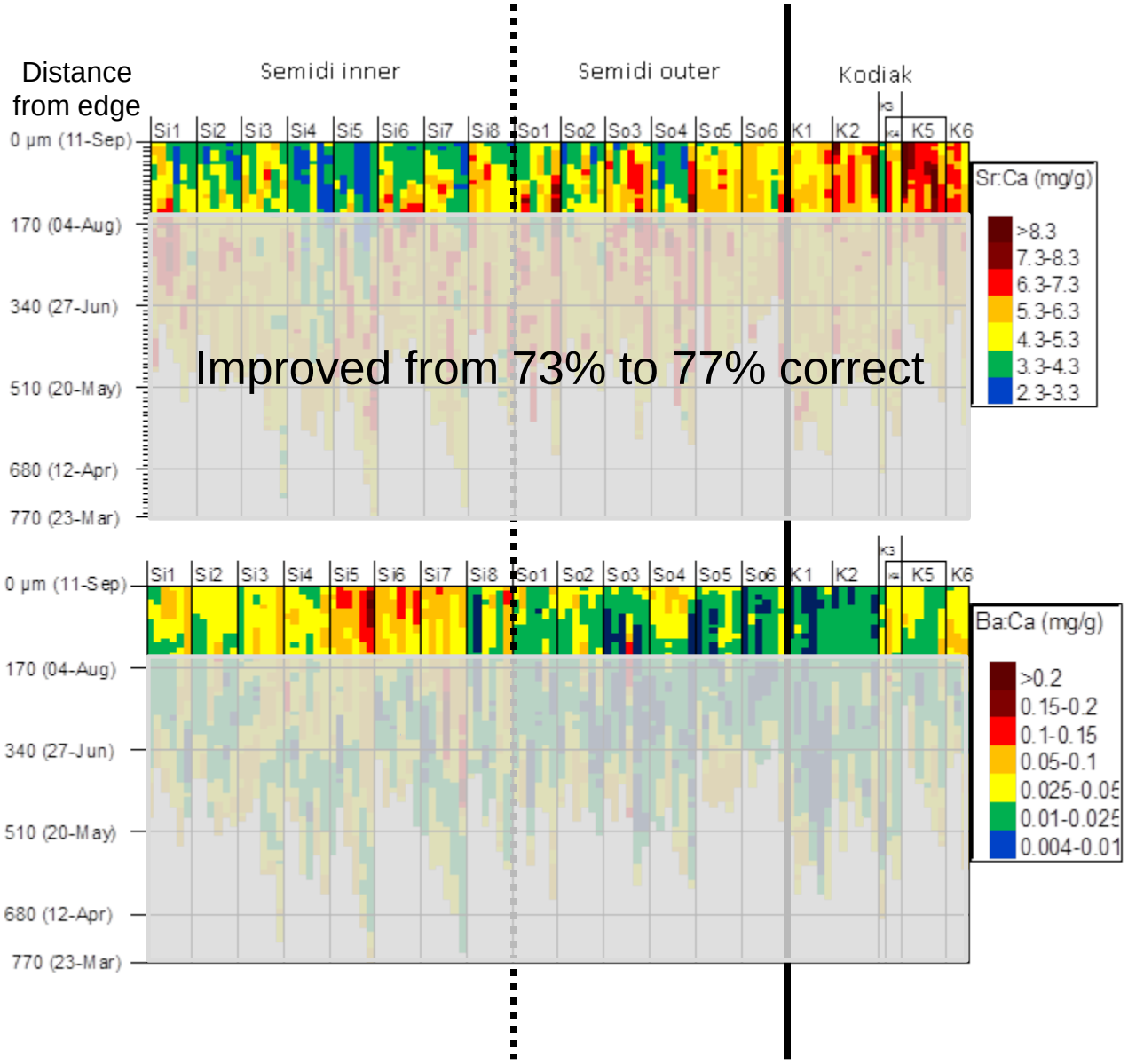
OVERALL
73% correct
assignment

OVERALL
63% correct
assignment

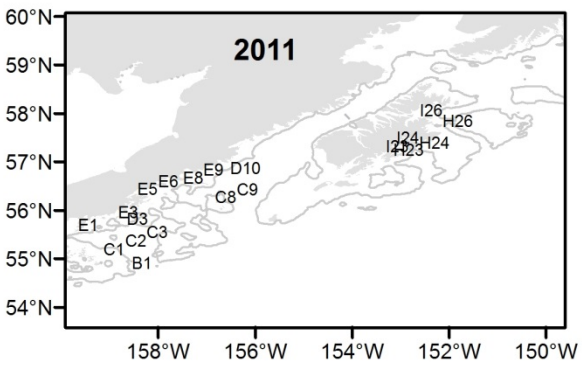
Life history transects **Sept 2007**

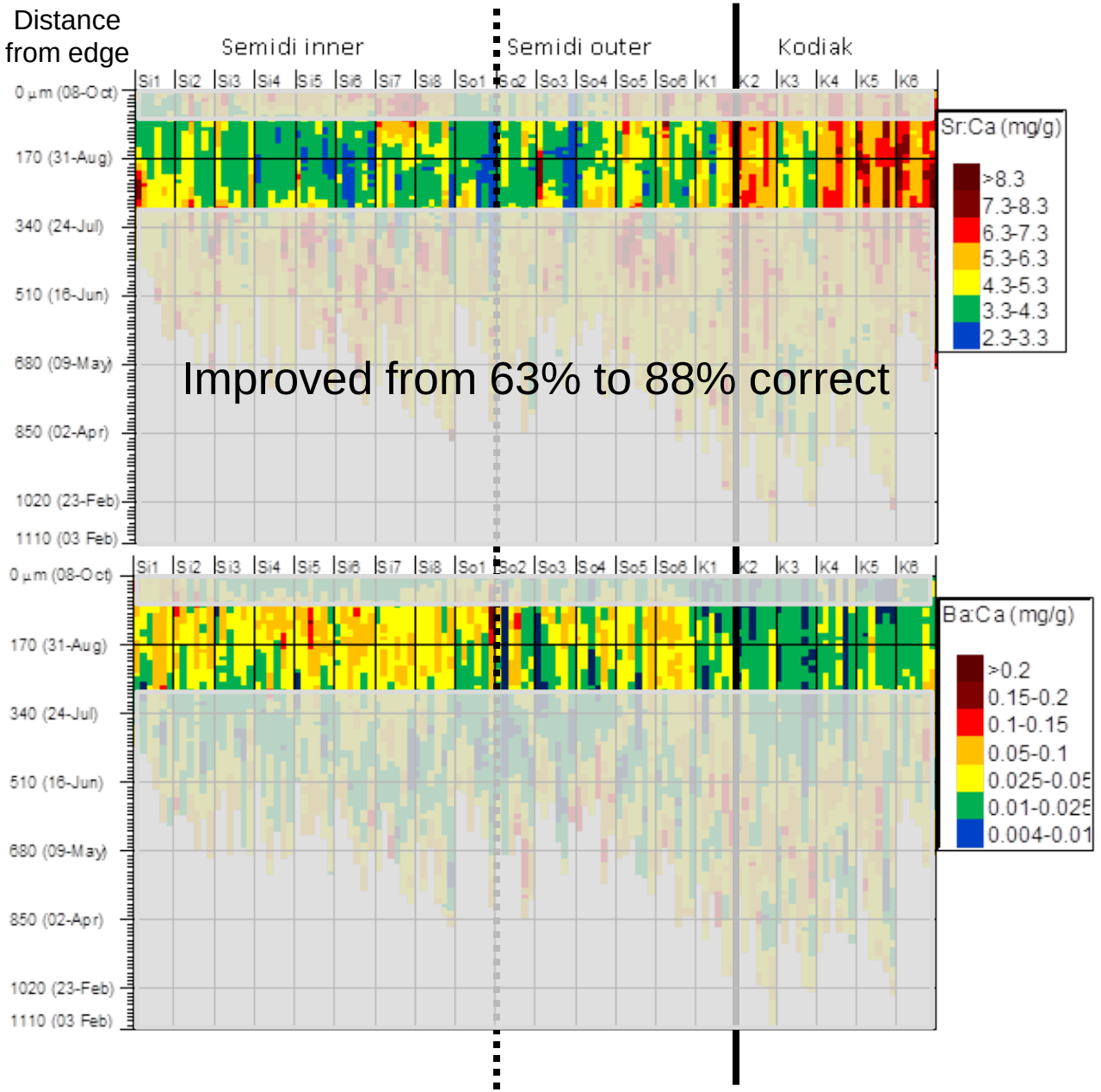






Oct 2011


2011
60°N
59°N
58°N
57°N
56°N
55°N
54°N
158°W
156°W
154°W
152°W
150°W
E1
E3
D3
C3
C1
C2
B1
E5
E6
E8
E9
D10
C8
C9
I26
H26
I24
H24
I23

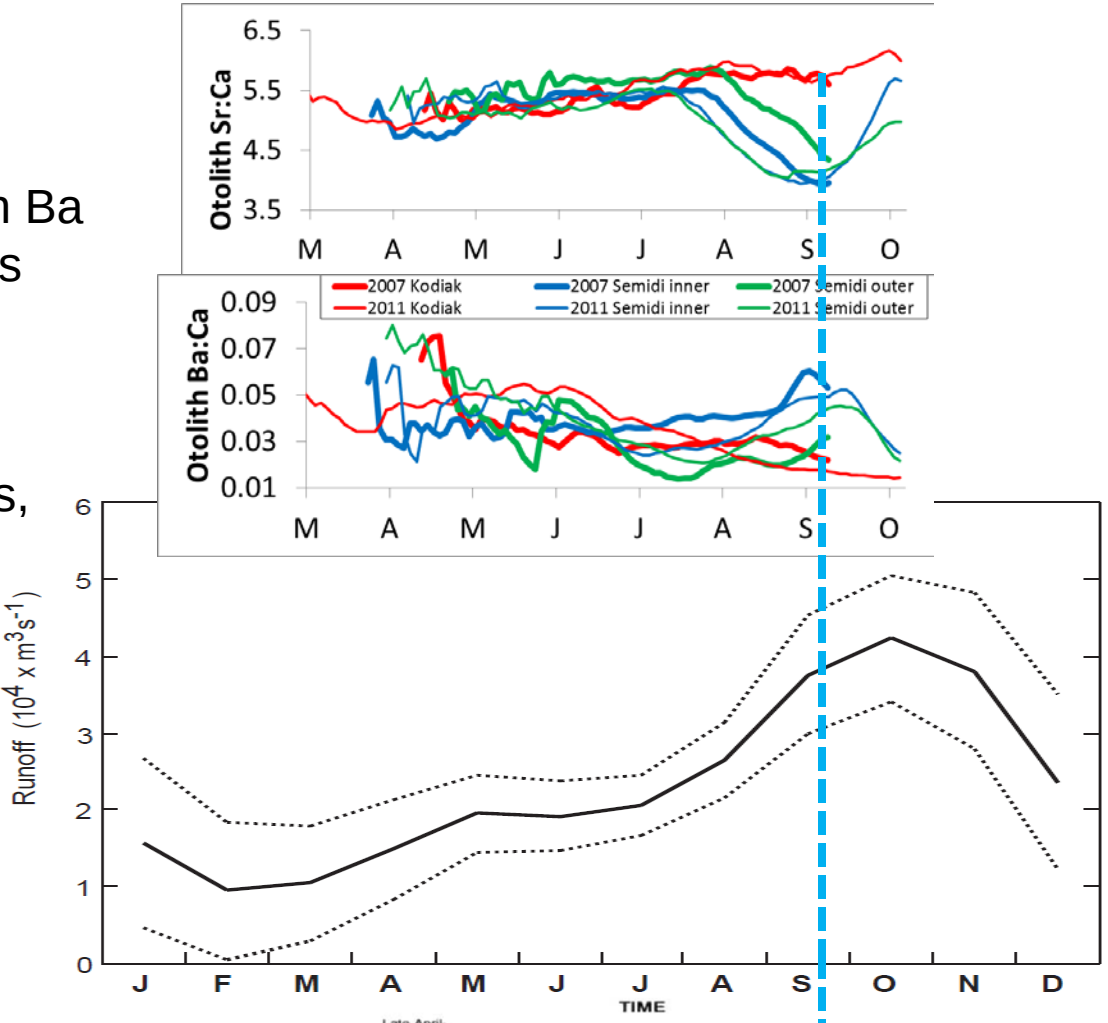

Distance from edge
Semidi inner
Semidi outer
Kodiak
Si1 Si2 Si3 Si4 Si5 Si6 Si7 Si8 So1 So2 So3 So4 So5 So6 K1 K2 K3 K4 K5 K6
0 µm (08-Oct)
170 (31-Aug)
340 (24-Jul)
510 (16-Jun)
680 (09-May)
850 (02-Apr)
1020 (23-Feb)
1110 (03 Feb)
Sr:Ca (mg/g)
>8.3
7.3-8.3
6.3-7.3
5.3-6.3
4.3-5.3
3.3-4.3
2.3-3.3
Improved from 63% to 88% correct
Ba:Ca (mg/g)
>0.2
0.15-0.2
0.1-0.15
0.05-0.1
0.025-0.05
0.01-0.025
0.004-0.01

Discussion

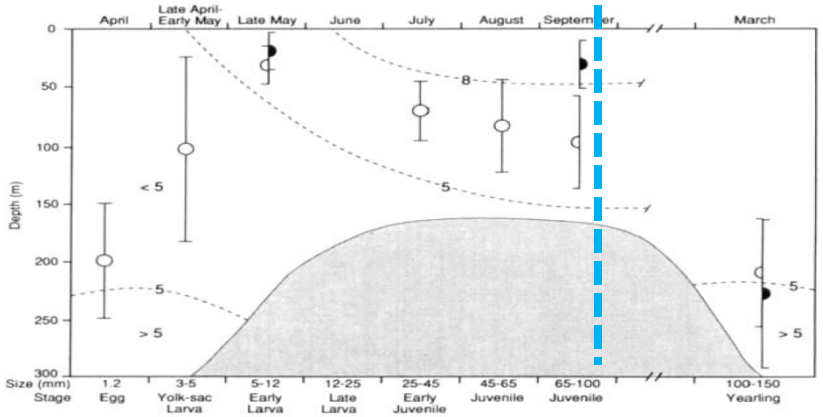
The seasonal pattern in Semidi otolith Ba and Sr likely reflects a change in fish's ambient environment due to:

1) water masses moving over fish,
2) fish moving among water masses,
3) or both.

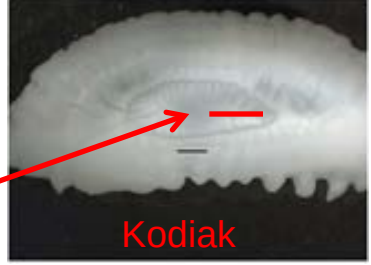
Stabeno et al. 2004
(after Royer 1982)

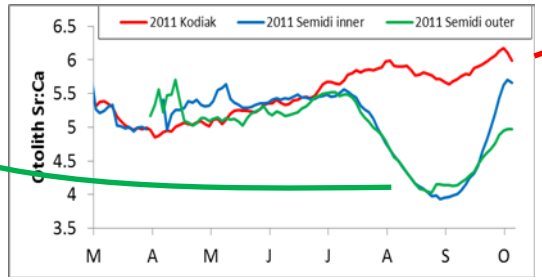


Brodeur & Wilson 1996



Future directions

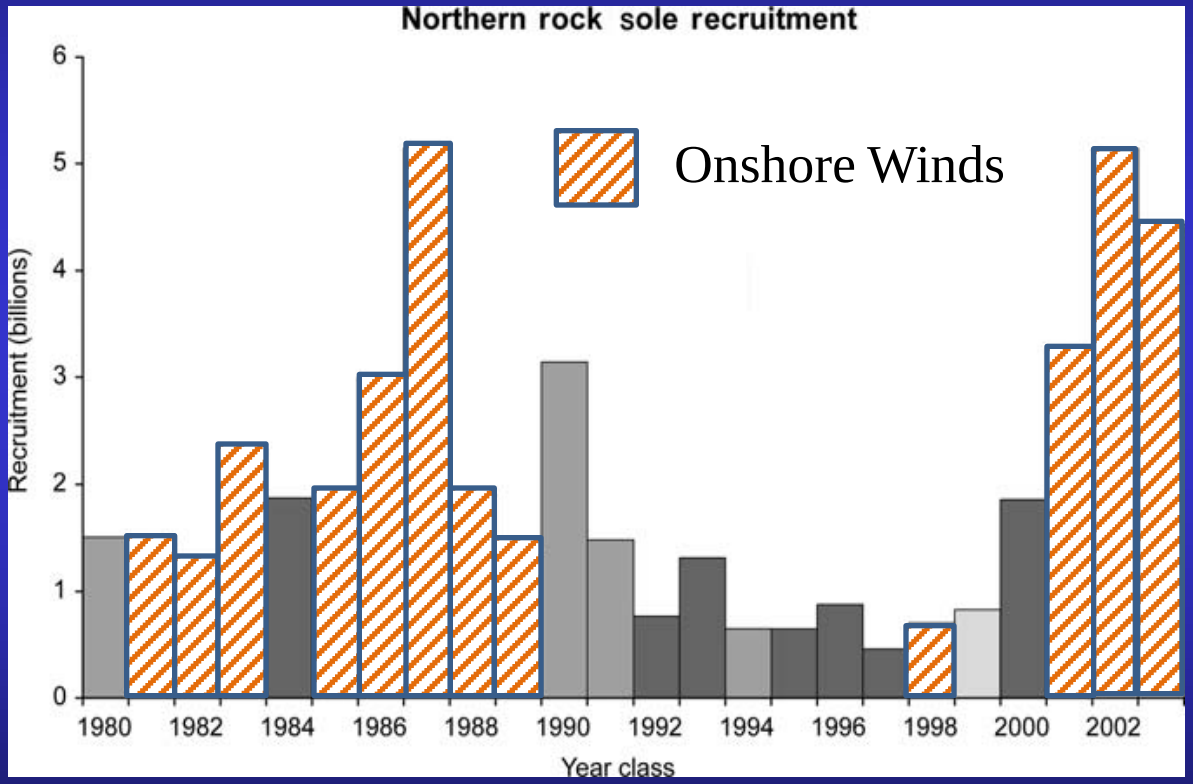


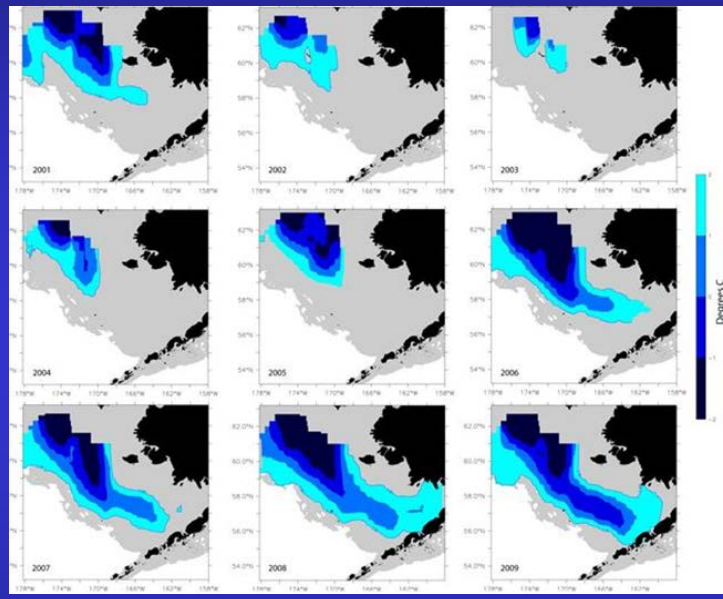


- Compare chemistry of age-0 portion of adult otoliths between Shelikof and Kodiak adult aggregations, and to our results here for evidence of separate, local nurseries.
- Investigate the “ACC” signature: Does it reflect water chemistry; Is it unique to the Semidi vicinity (i.e., local Shelikof nursery)?
- Determine if the otolith chemistry of other species (e.g., sablefish) reflects ACC exposure.

Eastern Bering Sea
Northern Rock Sole

Background





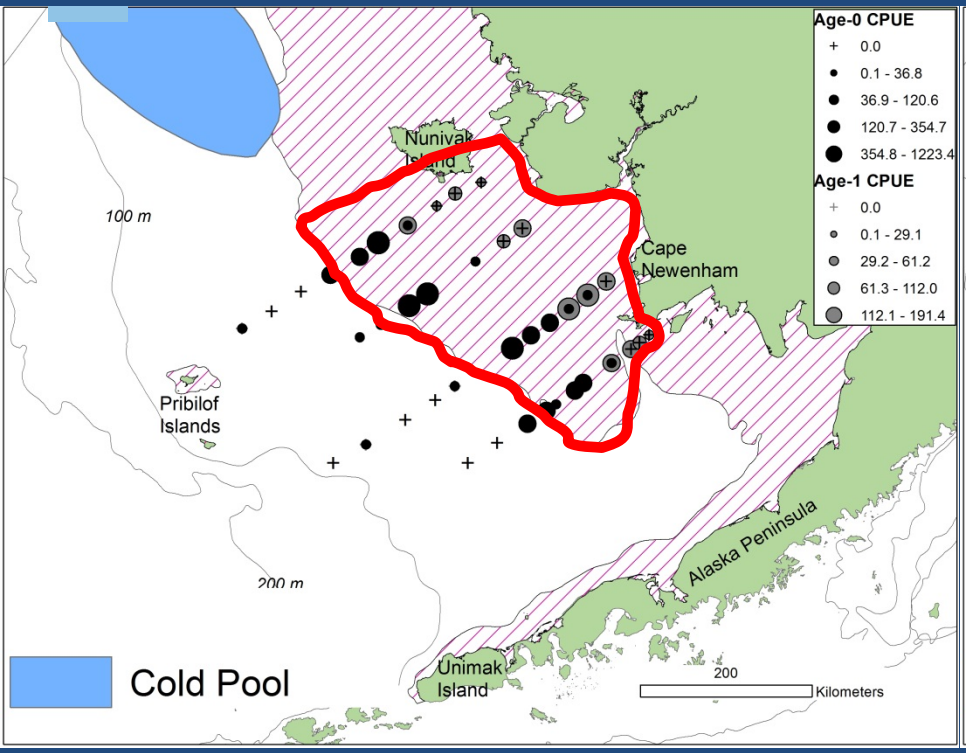
Wilderbuer et al. (2002 and 2013)
From Hollowed et al. (2009)

Age-0 and age-1 northern rock sole beam trawl studies

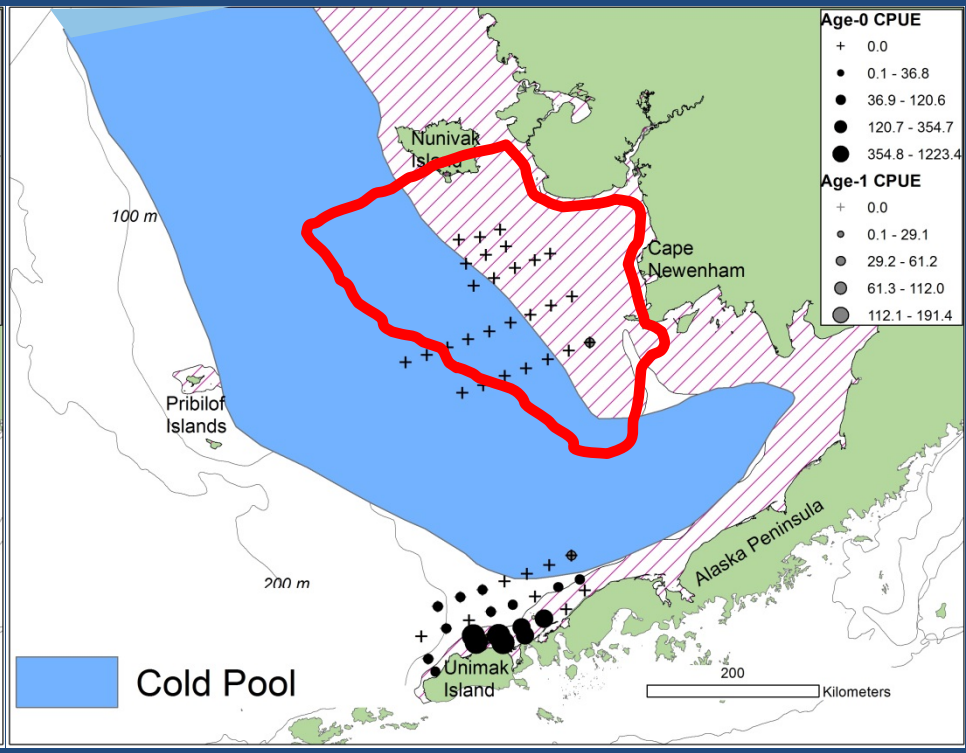
Photos by Morgan Busby

Beam trawl studies: Age-0 and Age-1 fish abundance variable in northern nursery area

2003

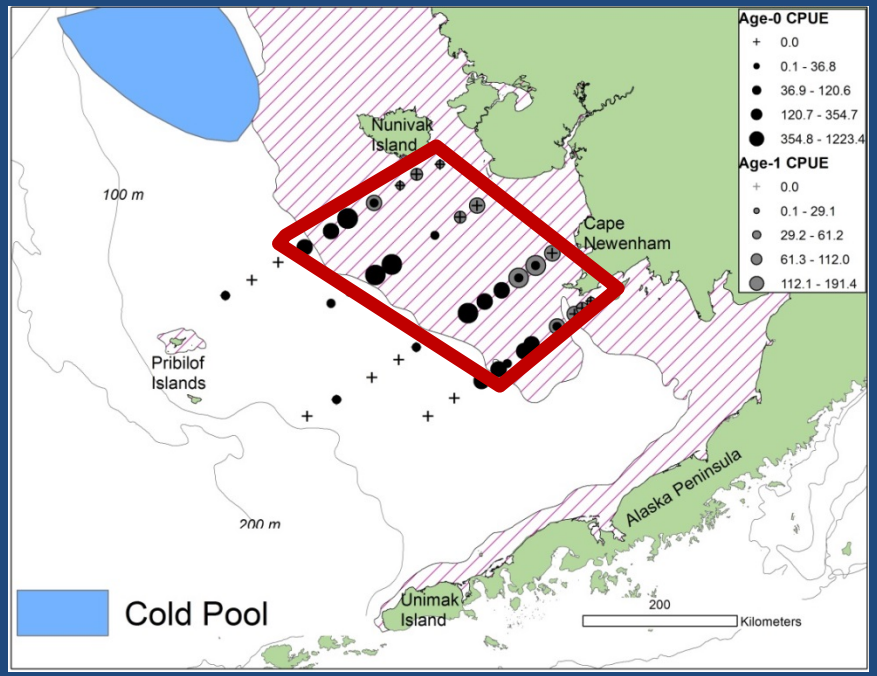


2010



Hypothesis: Northern nursery area not used in cold age-0 years

Production

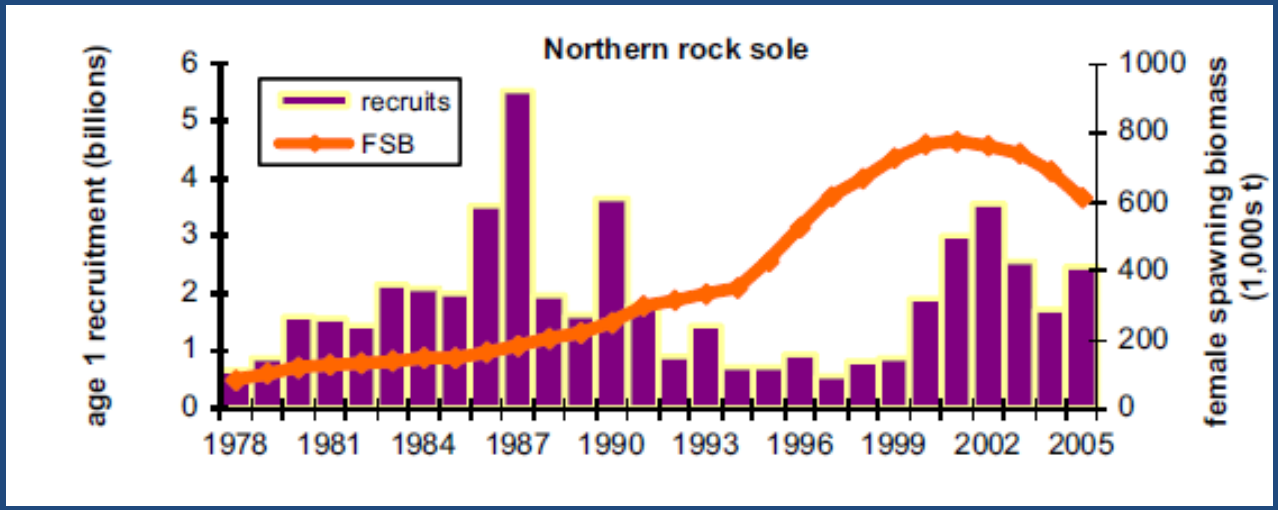


Rough estimate

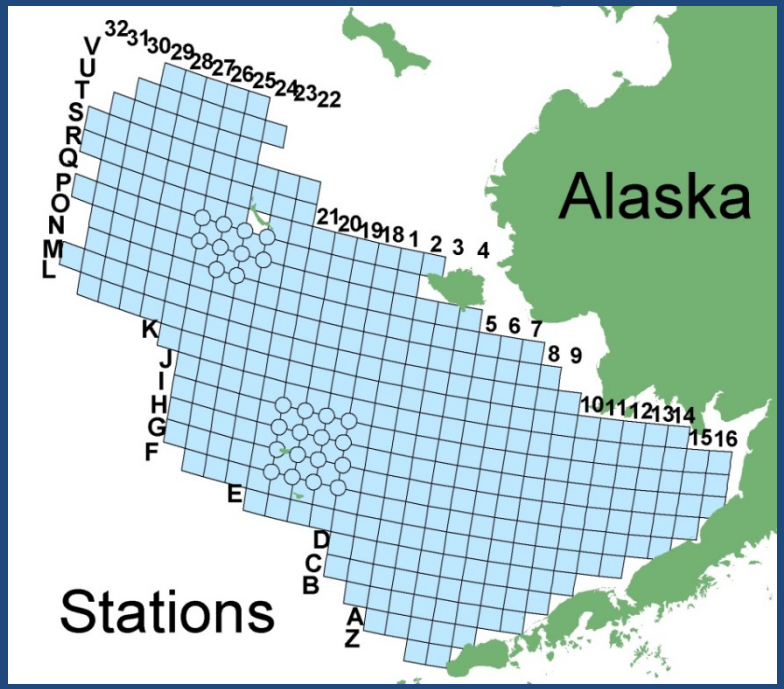
- 7 billion age-0
- 3 billion age-1

Cooper et al. (2014)

Hypothesis: Large year classes are produced when northern nursery area is occupied



AFSC EBS shelf Trawl Survey



Source:
http://www.afsc.noaa.gov/RACE/groundfish/survey_data/ebswater.htm

Photo by Dan Nichol

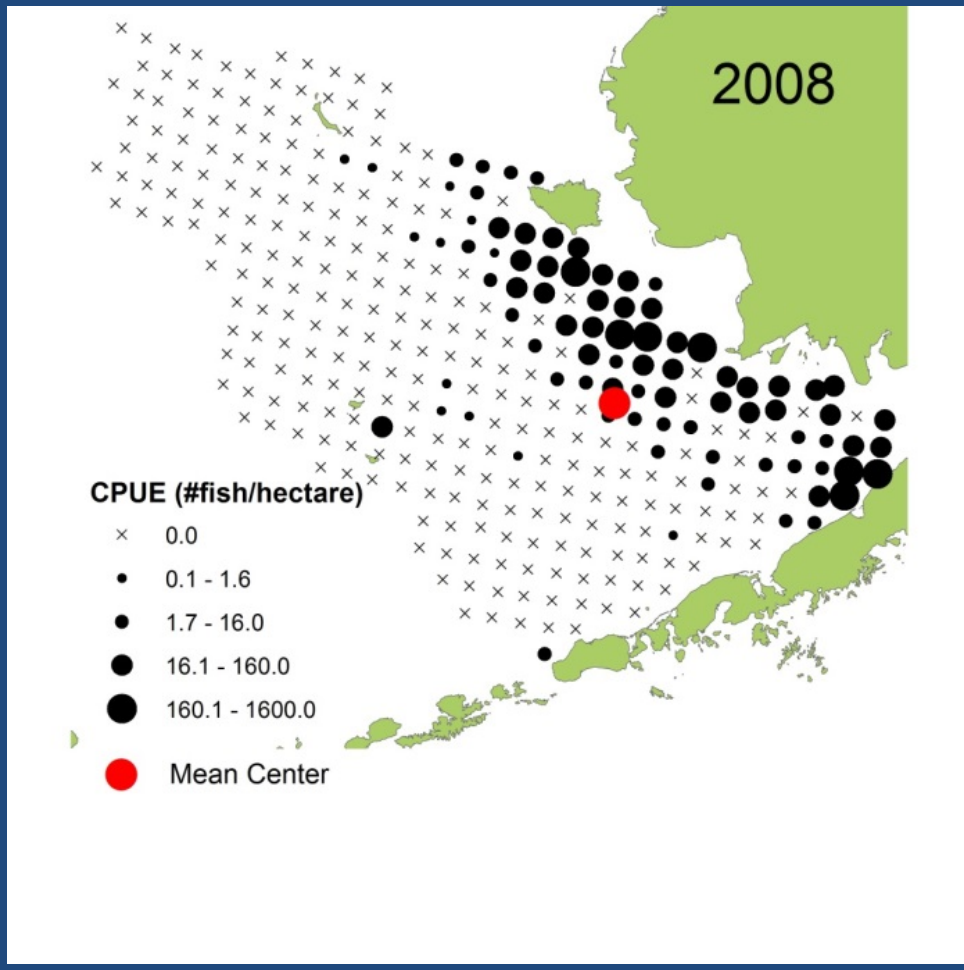
- 1982 – 2012
- Does not catch ages-0&1 northern rock sole
- Low selectivity for ages-2&3, but selectivity assumed constant over time series

Northern nursery area not used in cold years?

Methods

- For each year, we calculated:
  - Center of distribution
  - Mean summer bottom temperature (Lauth and Nichol 2013)

Trawl Survey
Example year



Objective 2: Does temperature in the age-0 year affect later age-2 and age-3 spatial distribution?

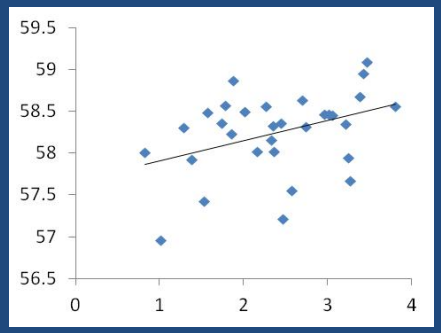
survey year

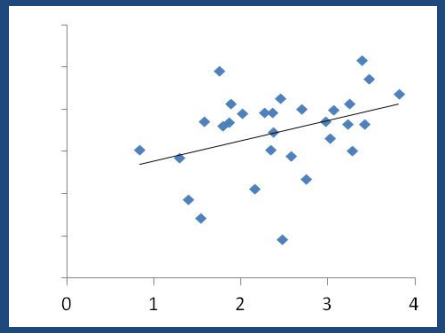
1 year prior

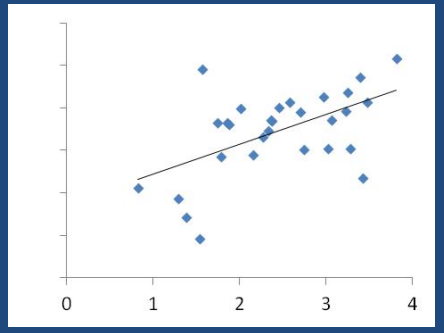
2 years prior

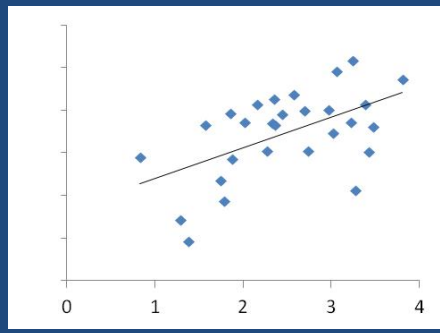
3 years prior

Latitude of Center of Distribution







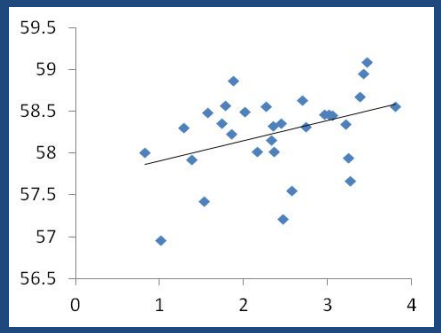


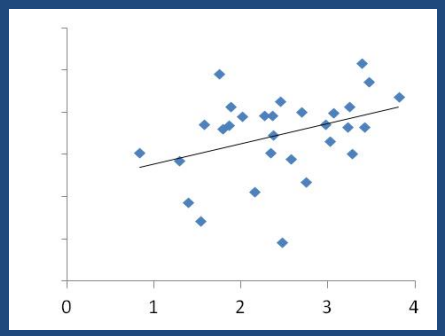
Mean EBS summer bottom temperature (°C)

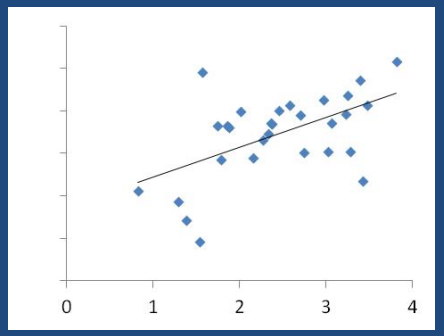
Objective 2: Does temperature in the age-0 year affect later age-2 and age-3 spatial distribution?

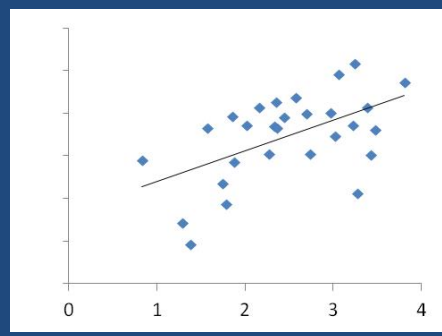
survey year | 1 year prior | 2 years prior | 3 years prior

Latitude of Center of Distribution



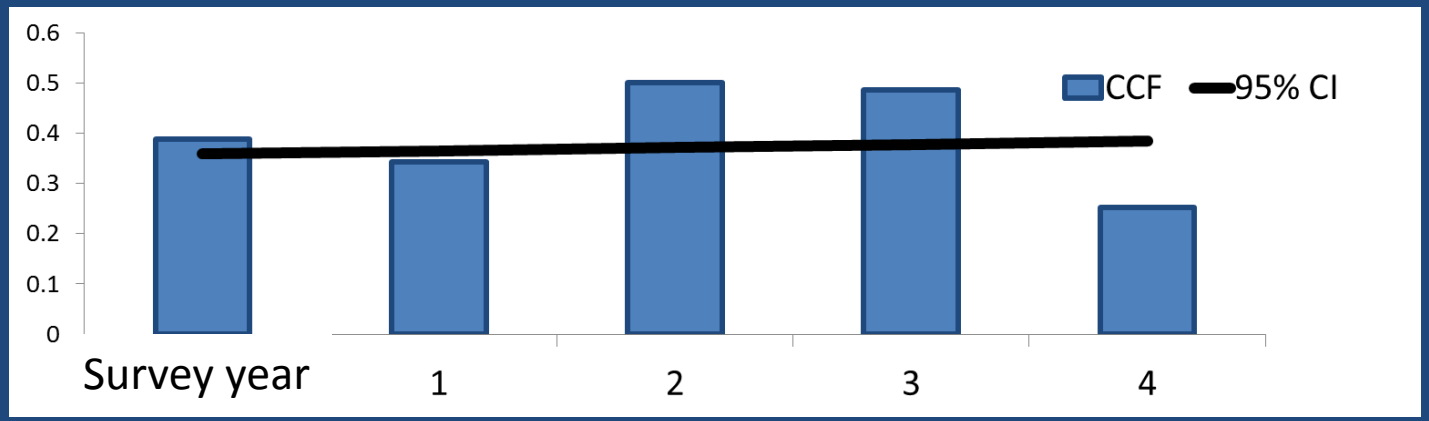






Mean EBS summer bottom temperature (°C)

CCF



Years temperature leads distribution

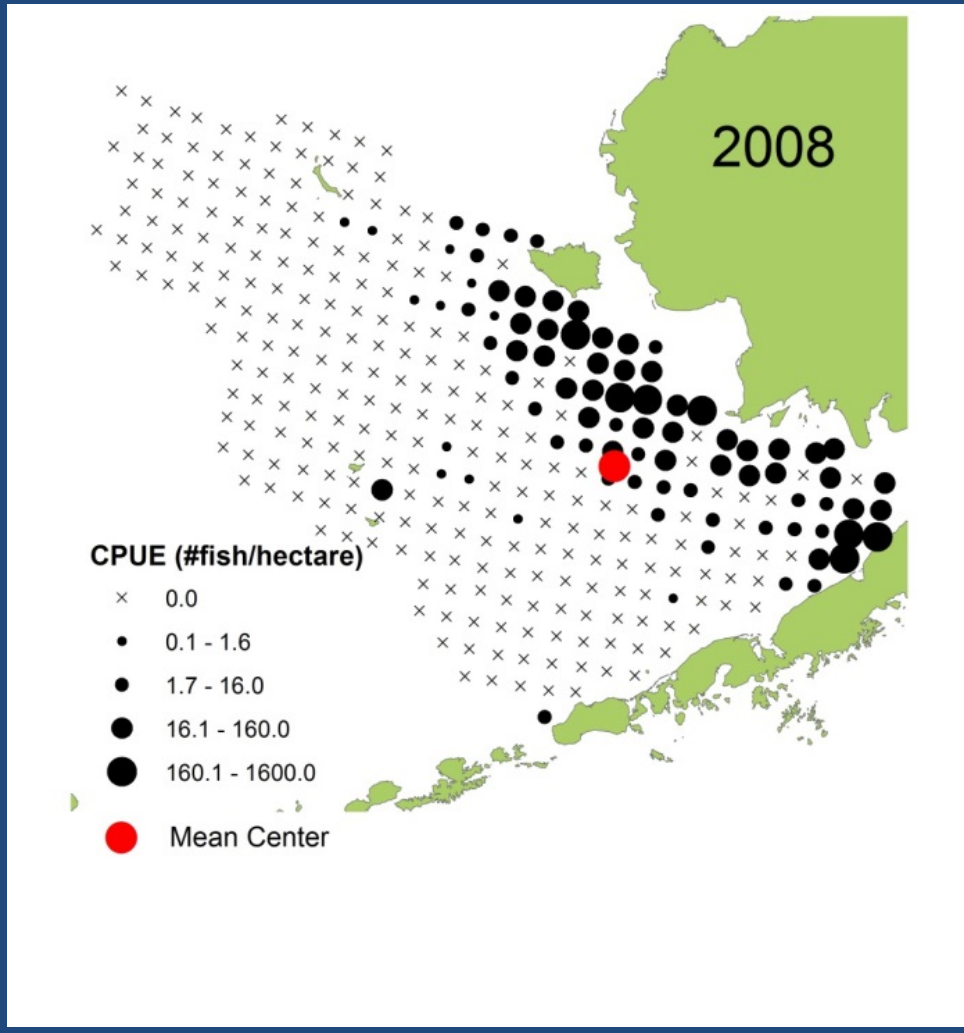
Cooper and Nichol 2016

Does the northern nursery area produce high abundances of ages-2&3 fish?

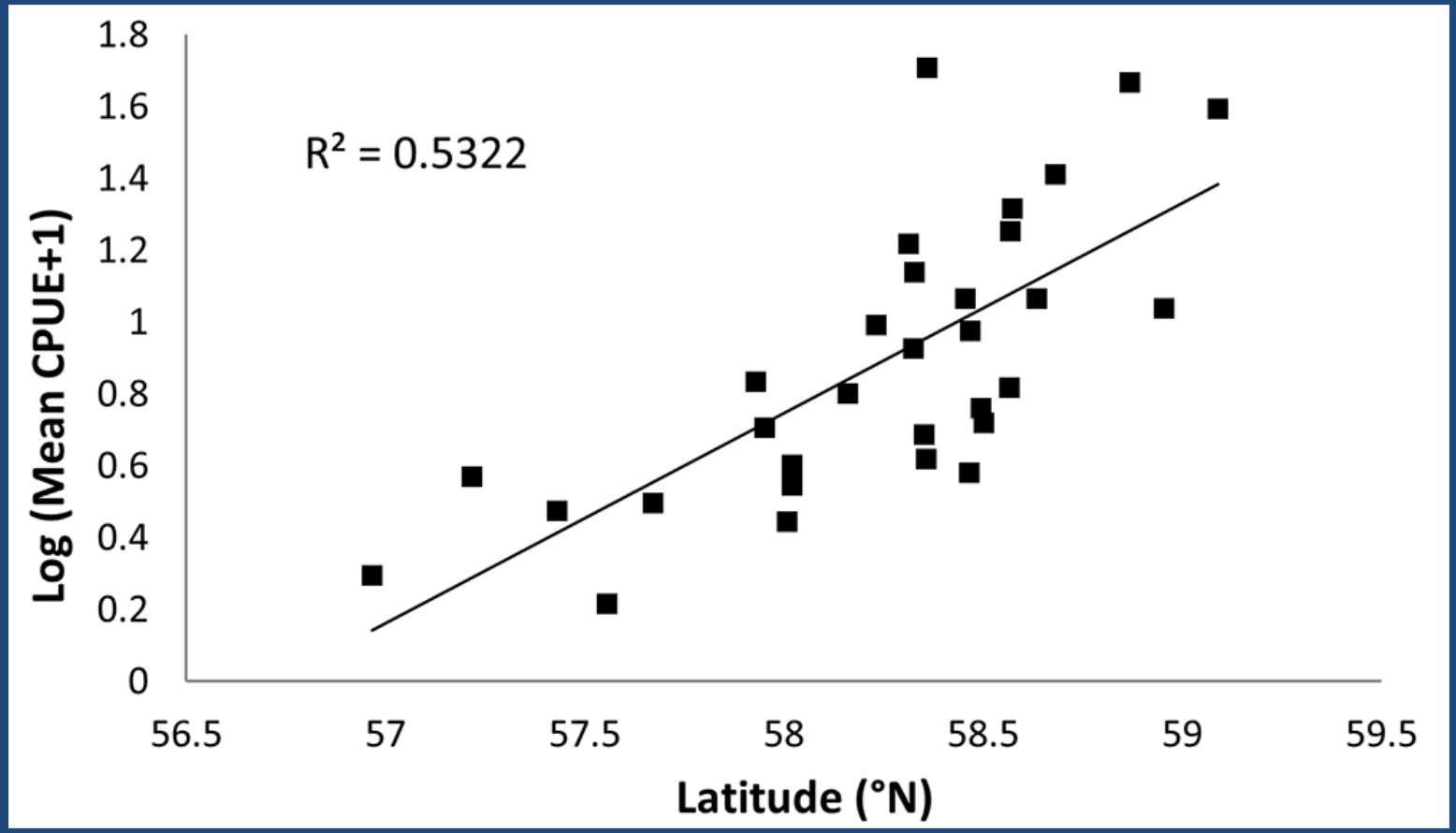
Methods

- Ages-2&3 CPUE by station
- For each year, we calculated:
  - Center of distribution
  - Index of abundance = Mean CPUE

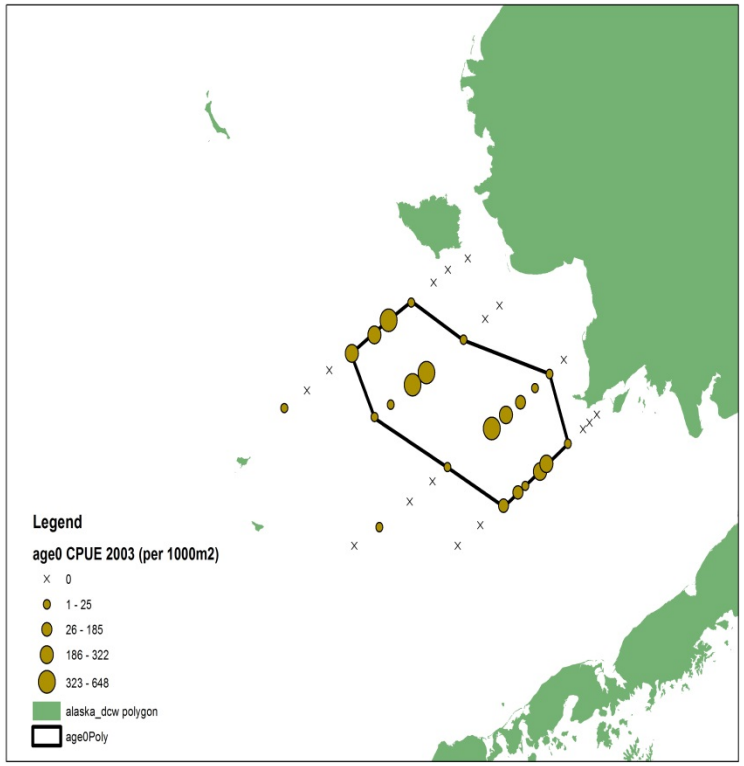
Example year

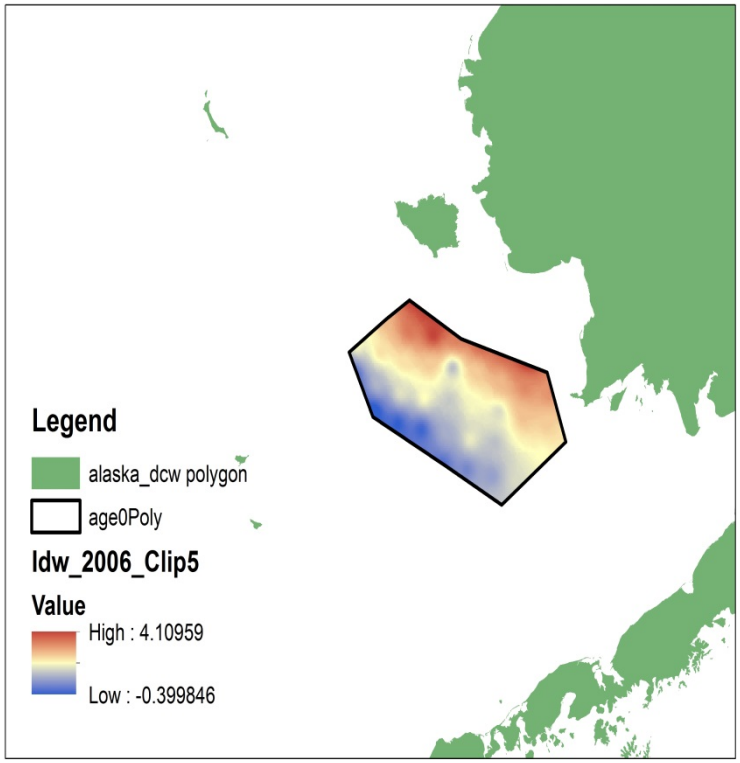


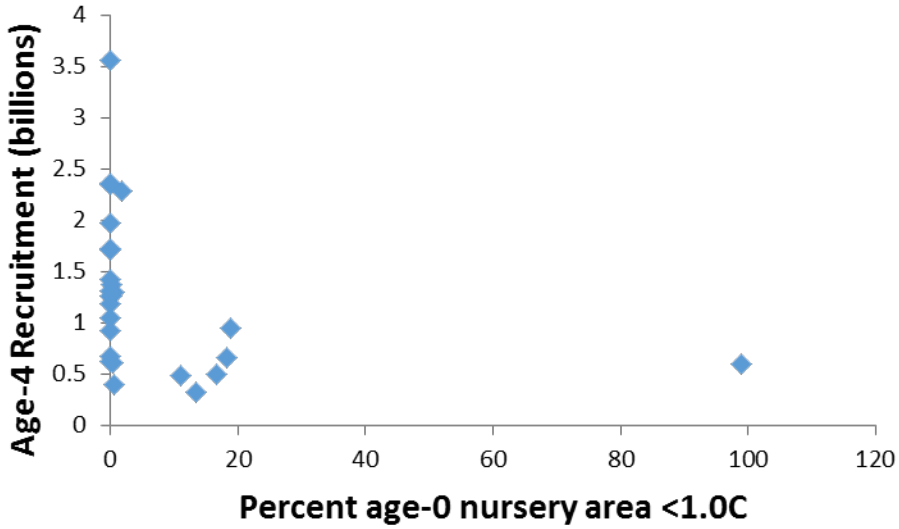
Objective 3: Does the northern nursery area produce high abundances of ages-2&3 fish?



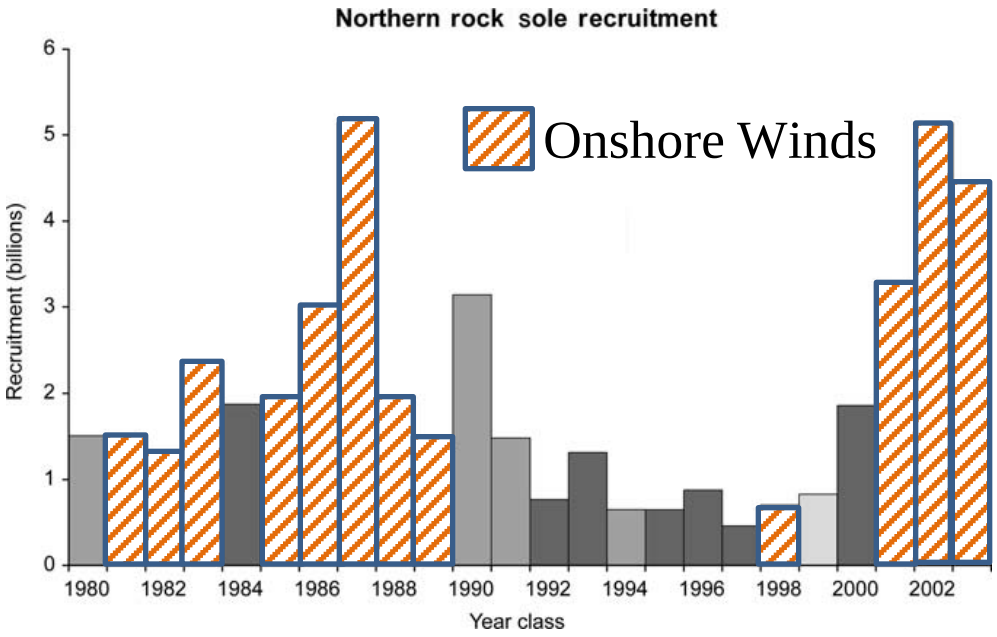
(Cooper and Nichol 2016)

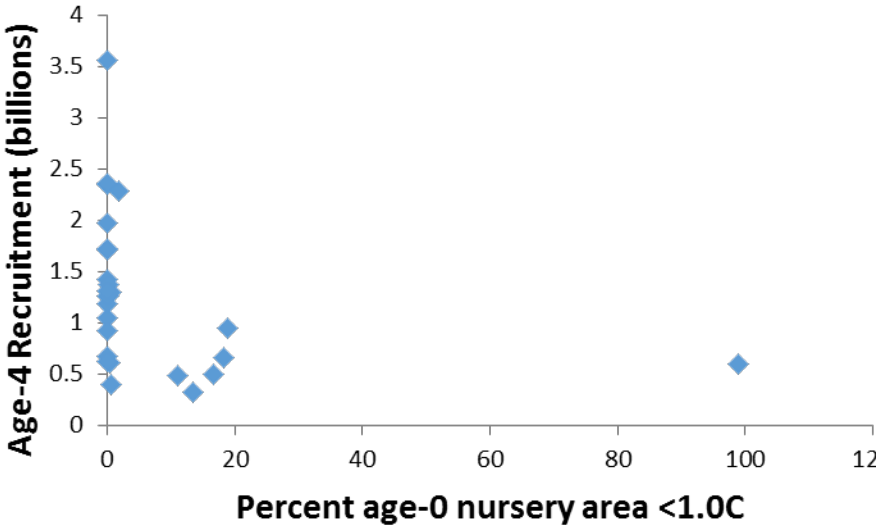

Legend
age0 CPUE 2003 (per 1000m2)
0
1 - 25
26 - 185
186 - 322
323 - 648
alaska_dcw polygon
age0Poly


Legend
alaska_dcw polygon
age0Poly
Idw_2006_Clip5
Value
High : 4.10959
Low : -0.399846


Age-4 Recruitment (billions)
0
0.5
1
1.5
2
2.5
3
3.5
4
0
20
40
60
80
100
120
Percent age-0 nursery area <1.0C

Model with winds and nursery cold pool index





Appendix

Estimating Northern Rock Sole recruitment in the last (most recent) 6 years of the assessment using environmental covariates

Dan Cooper, Lauren Rodgers and Tom Wilderbuer