Update on EBS Pollock assessment plans for 2022

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Today

- No model changes
  - Added features to accommodate ACLIM projections (courtesy Paul Spencer)
    - Includes posterior predictive distributions
  - Continue to test alternatives for comparison (e.g., WHAM, SAM, SS, AMAK)
    - Key features (e.g., covariance spec on BTS survey time series)

- Survey weight-at-age estimation
  - Affects conversion of model N-at-age to predicted survey biomass (and hence fits)
  - Adds to the estimate of current-year fishery weight-at-age and projections

Survey body-mass-at-age

- 2021 Method (old)

For i^{th} year, j^{th} age:

$$w_{i,j} = \frac{\sum^{k} N_{ijk} a_k L_a^{b_k}}{\sum^{k} N_{ijk}}$$

Where *k* indexes sex (unid, male, female)

- Problem is it only captures inter-annual variation due to length
- Subsequently less missing years of L-W data from survey

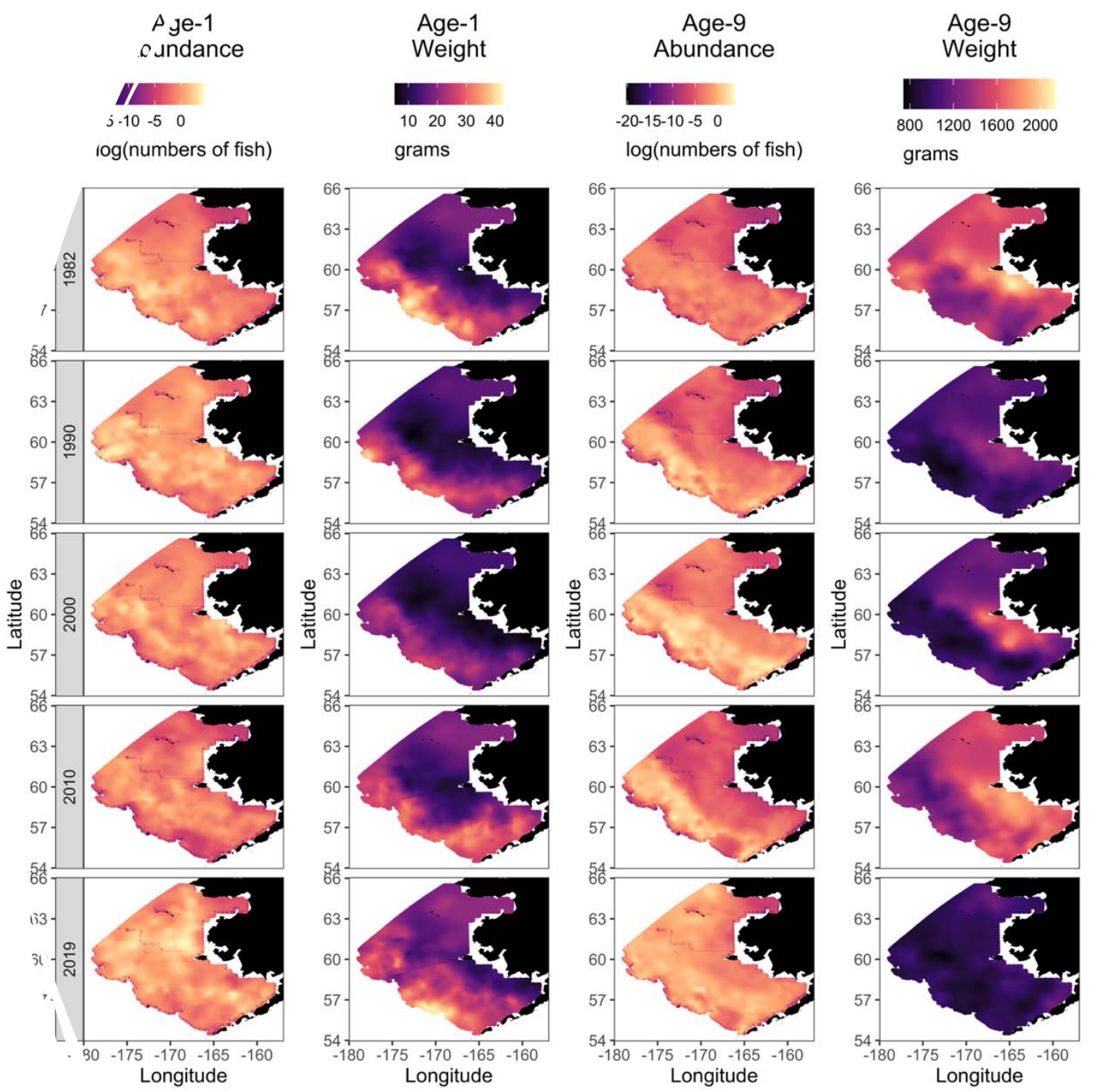
```
# These the LW coefficients from RACE (CA 1999)
b_m <-  3.038;  a_m <-  0.000004919
b_f <-  2.986;  a_f <-  0.000006681
b_u <-  2.9954; a_u <-  6.3611E-06
```

YEAR	SEX	AGE	POPULATION	MEAN_LENGTH	SD_LENGTH
<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
1982	1	0	6441.	100	0
1982	1	1	188468524.	174.	15.8
1982	1	2	1423470506	231.	24.7
1982	1	3	1649836830	302.	28.9
1982	1	4	2347681861	380.	40.7
1982	1	5	725886718	408.	53.5
1982	1	6	101883300.	461.	81.0
1982	1	7	54104725.	527.	47.1
1982	1	8	27379440.	568.	49.0
1982	1	9	19137331.	573.	58.3

Survey body-mass at age re-evaluation

- Study by Julia Indivero
- Goal to make survey wt-at-age consistent w/ other SDM estimates

$$\log(w_{g_i,a_i,y_i}) = \underbrace{\beta_{a_i,y_i}}_{Temporal\ variation} + \underbrace{\omega_{a_i,g_i}}_{Spatial\ variation} + \underbrace{\varepsilon_{g_i,a_i,y_i}}_{Spatio-temporal\ variation}$$

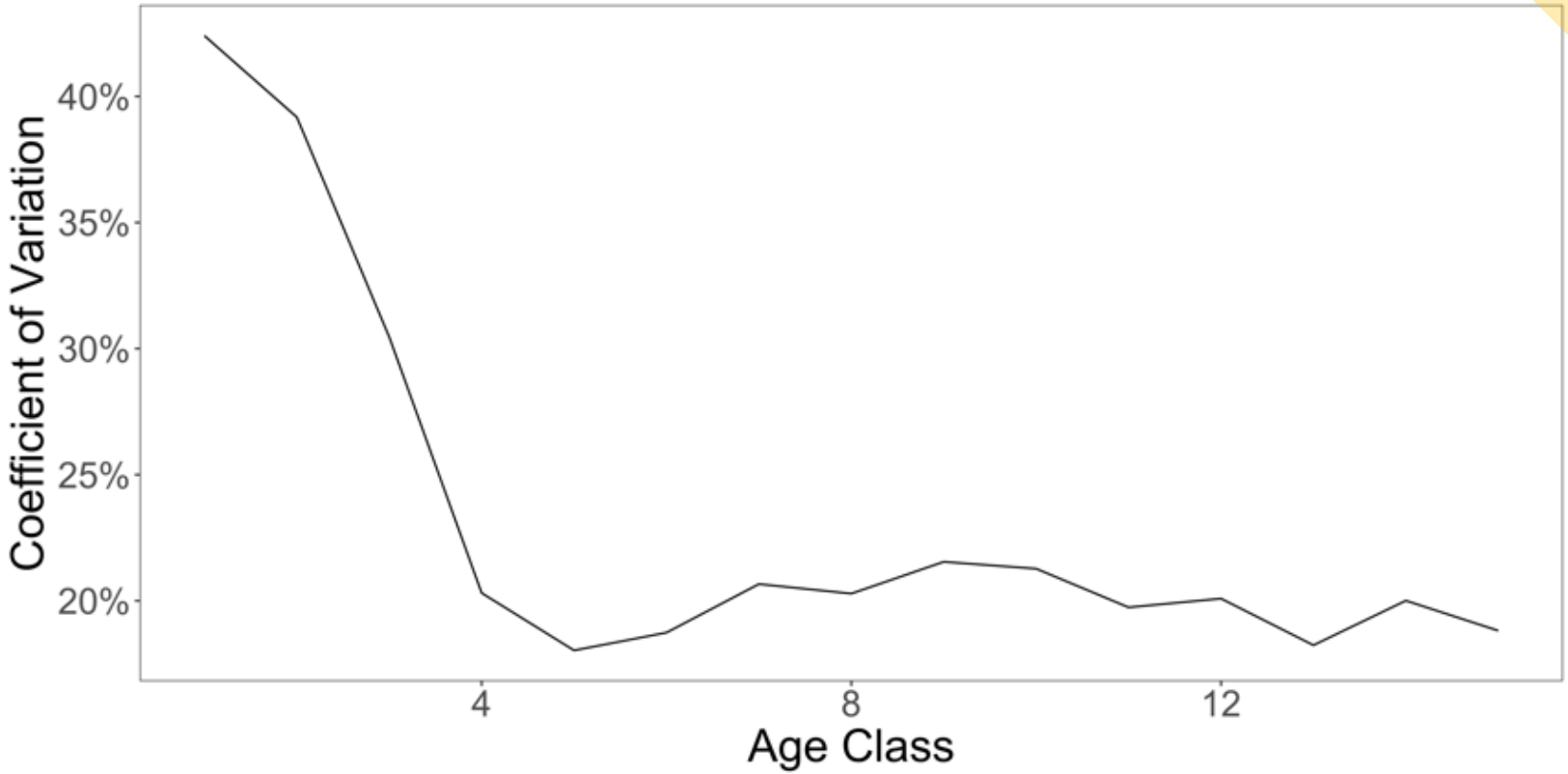


Indivero study objectives

1. What is the spatial and temporal pattern of size at fine-scale (i.e. local) and population-scale (i.e. index)?
2. Do local spatial and spatio-temporal variation impact index size-at-age?
3. Does local variation in size matter more than abundance for index size-at-age?
4. How does our model of population size-at-age affect the stock assessment estimate of population biomass compared to a non-spatial naïve estimate?

Bonus feature of new method—estimates of uncertainty in wt-at-age

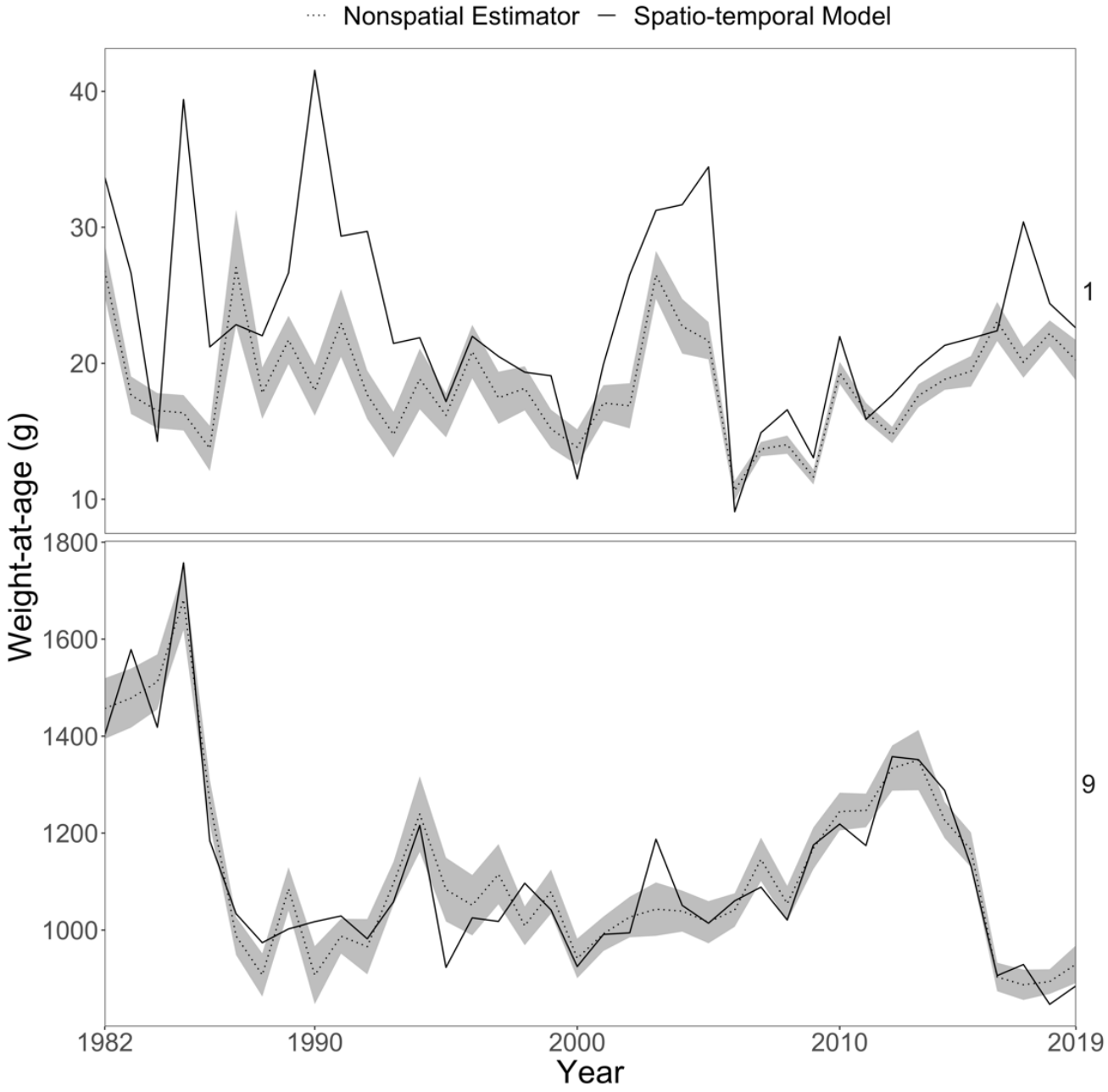
- Useful in supplementing fishery mean-wt-at-age projections
  - Year and cohort effects



Julia Indivero et al. , In Review

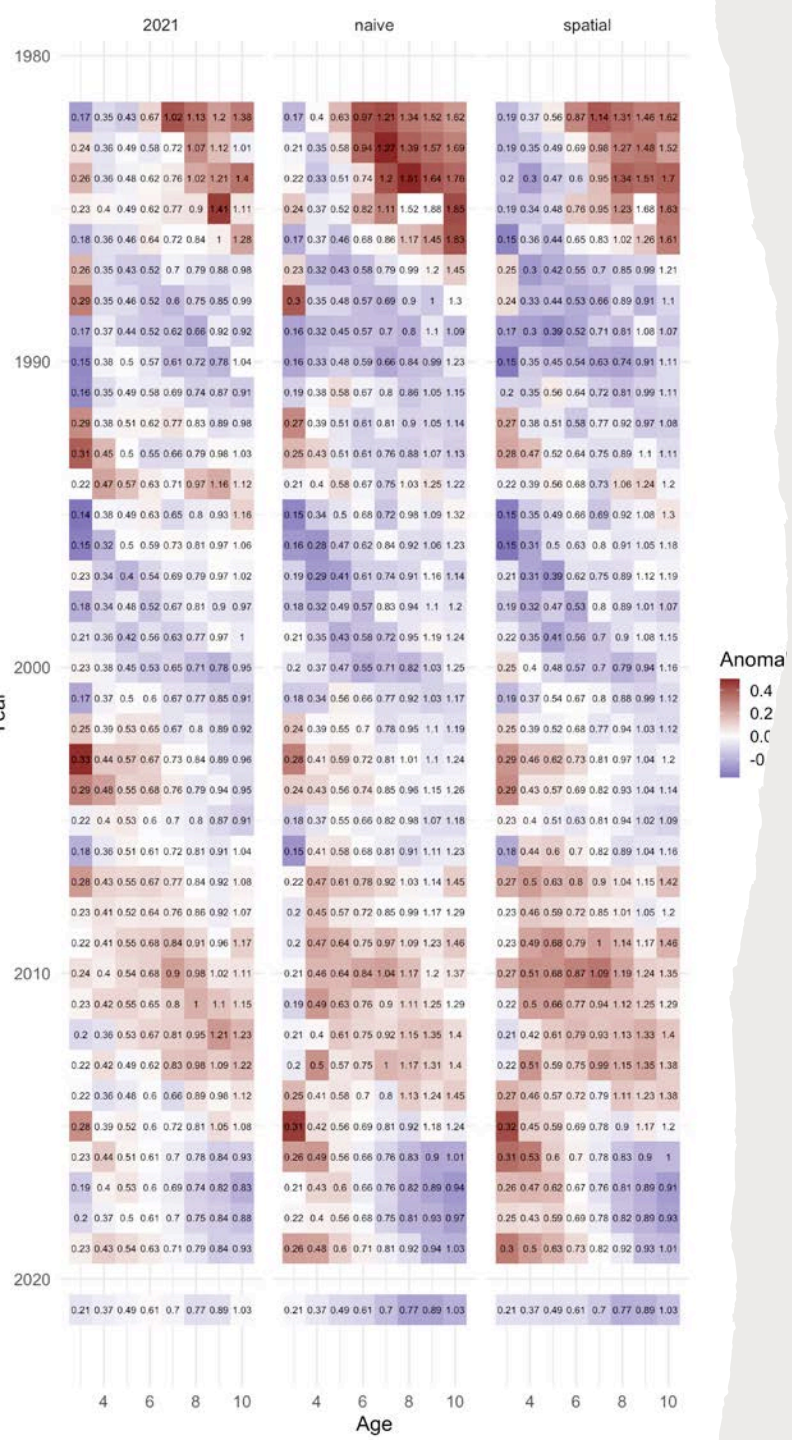
Added feature

- Useful for aiding the fishery mean-wt-at-age projections
  - Year and cohort effects



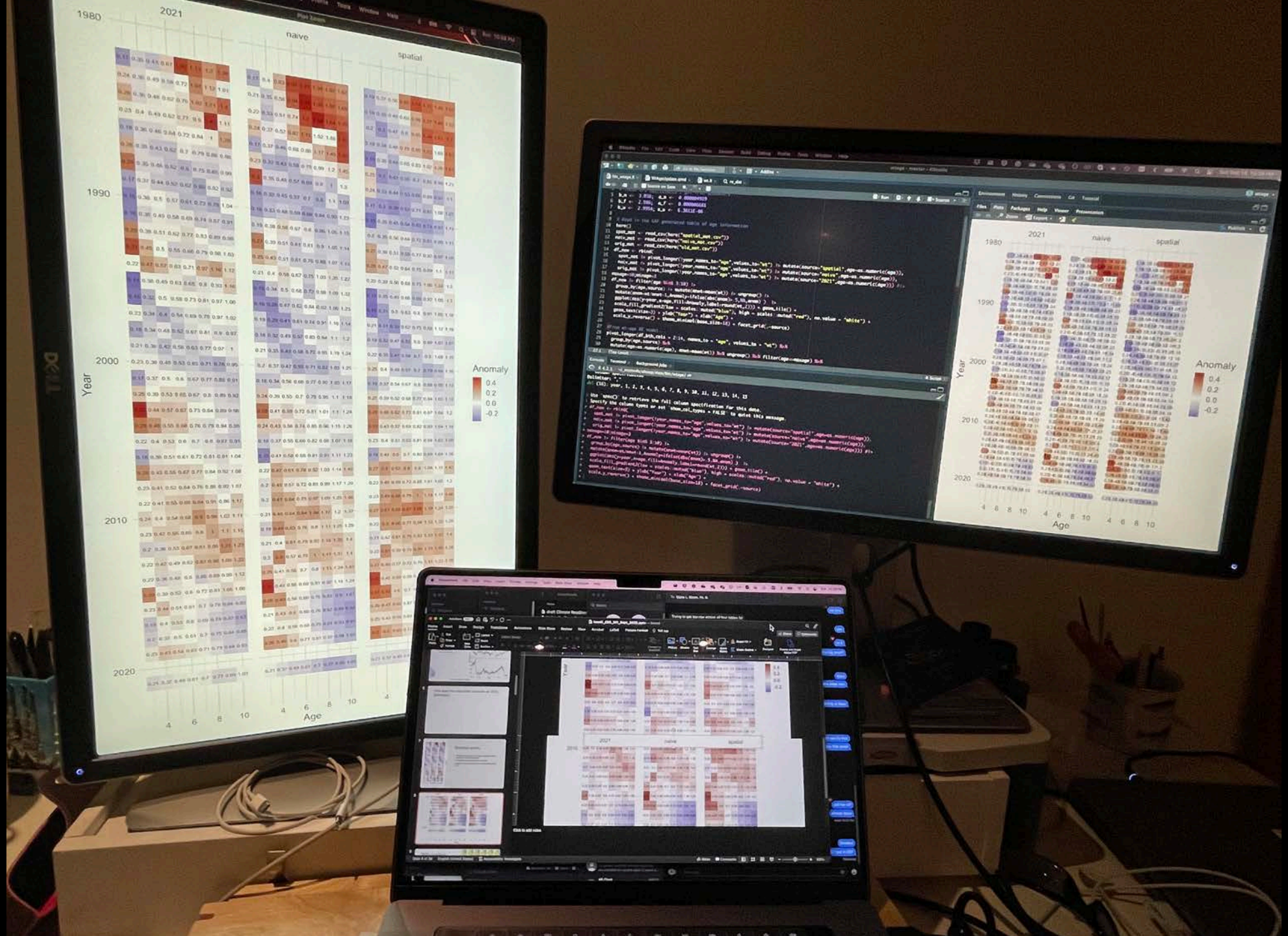
Courtesy Julia Indivero, In Review

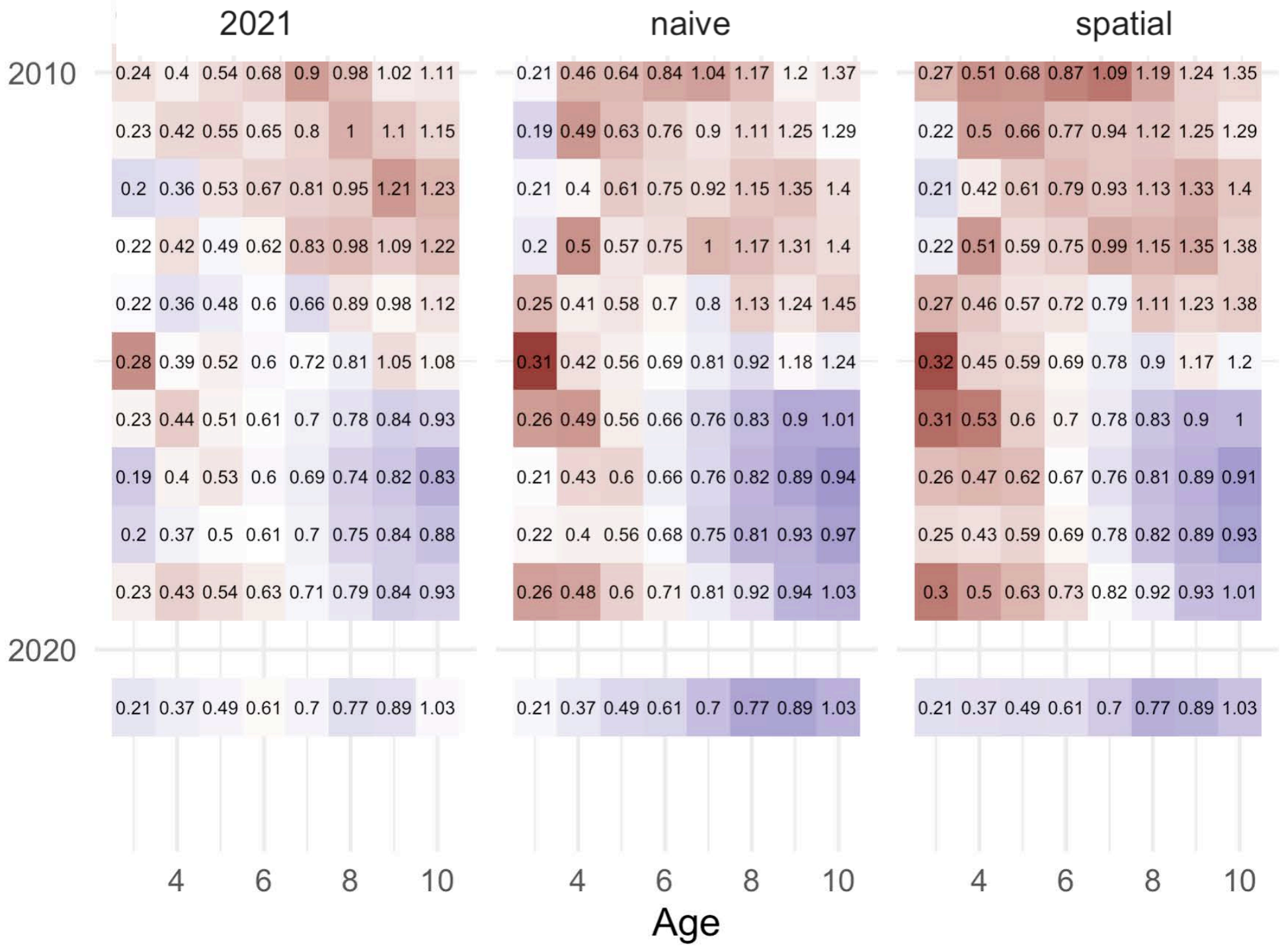
How does the evaluation compare w/ 2021 Estimates?



Relatively poorly…

- Traditional method went from length to weight with fixed, sex-specific wt-length parameters
- This affected the predicted biomass estimates within the model
- In general, old way tended to have anomalies closer to the mean…

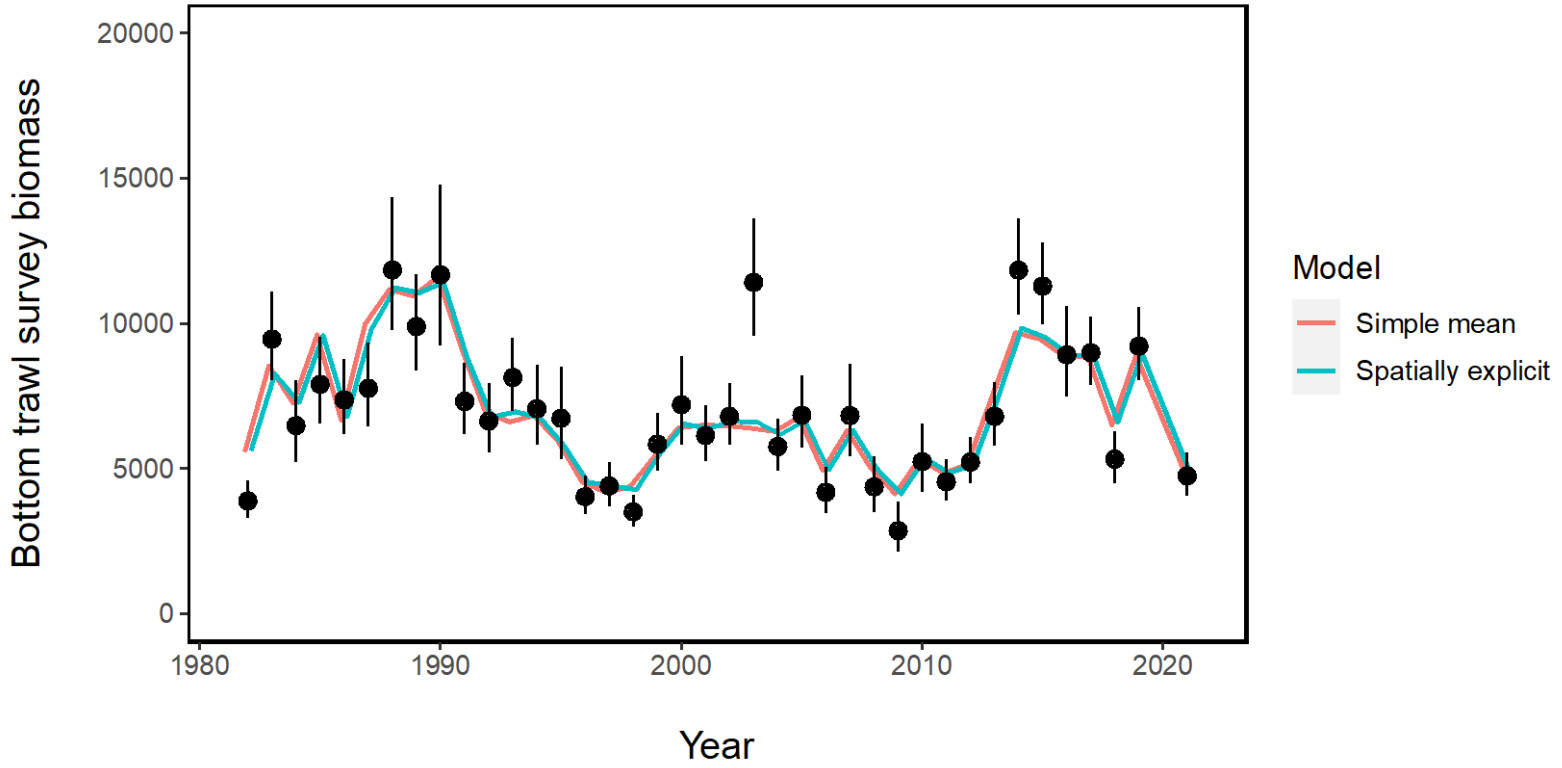

1980
2021
naive
spatial
1990
2000
2010
2020
Year
Anomaly
0.4
0.2
0.0
-0.2
4
6
8
10
Age

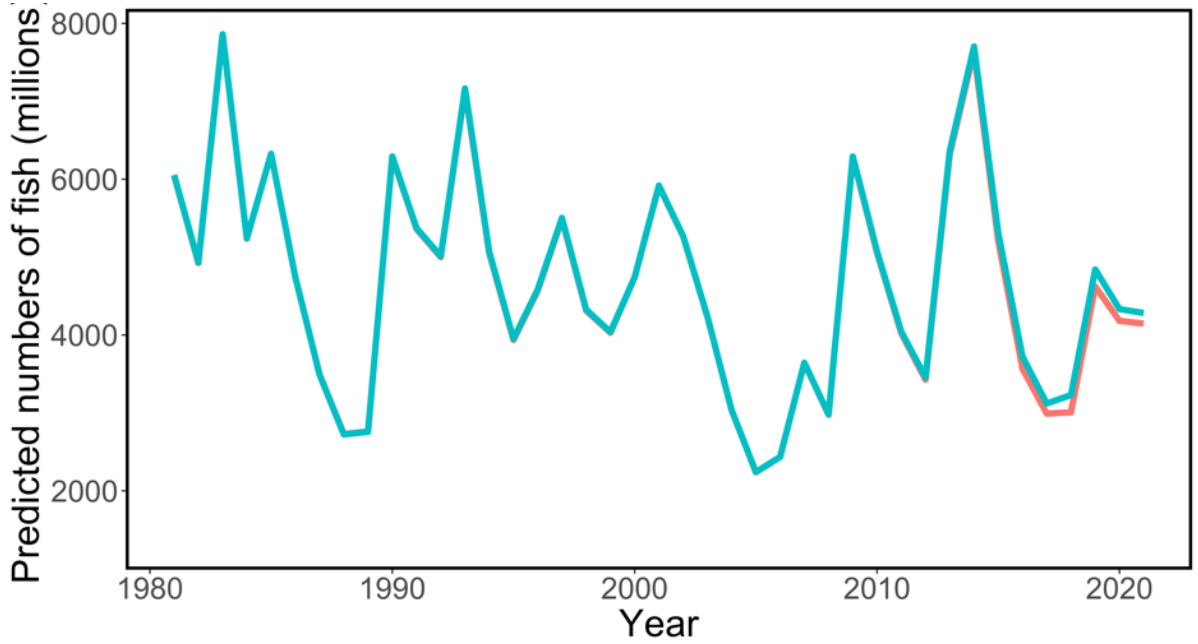

2021
naive
spatial
2010
2020
0.24 0.4 0.54 0.68 0.9 0.98 1.02 1.11
0.23 0.42 0.55 0.65 0.8 1 1.1 1.15
0.2 0.36 0.53 0.67 0.81 0.95 1.21 1.23
0.22 0.42 0.49 0.62 0.83 0.98 1.09 1.22
0.22 0.36 0.48 0.6 0.66 0.89 0.98 1.12
0.28 0.39 0.52 0.6 0.72 0.81 1.05 1.08
0.23 0.44 0.51 0.61 0.7 0.78 0.84 0.93
0.19 0.4 0.53 0.6 0.69 0.74 0.82 0.83
0.2 0.37 0.5 0.61 0.7 0.75 0.84 0.88
0.23 0.43 0.54 0.63 0.71 0.79 0.84 0.93
0.21 0.37 0.49 0.61 0.7 0.77 0.89 1.03
0.21 0.46 0.64 0.84 1.04 1.17 1.2 1.37
0.19 0.49 0.63 0.76 0.9 1.11 1.25 1.29
0.21 0.4 0.61 0.75 0.92 1.15 1.35 1.4
0.2 0.5 0.57 0.75 1 1.17 1.31 1.4
0.25 0.41 0.58 0.7 0.8 1.13 1.24 1.45
0.31 0.42 0.56 0.69 0.81 0.92 1.18 1.24
0.26 0.49 0.56 0.66 0.76 0.83 0.9 1.01
0.21 0.43 0.6 0.66 0.76 0.82 0.89 0.94
0.22 0.4 0.56 0.68 0.75 0.81 0.93 0.97
0.26 0.48 0.6 0.71 0.81 0.92 0.94 1.03
0.21 0.37 0.49 0.61 0.7 0.77 0.89 1.03
0.27 0.51 0.68 0.87 1.09 1.19 1.24 1.35
0.22 0.5 0.66 0.77 0.94 1.12 1.25 1.29
0.21 0.42 0.61 0.79 0.93 1.13 1.33 1.4
0.22 0.51 0.59 0.75 0.99 1.15 1.35 1.38
0.27 0.46 0.57 0.72 0.79 1.11 1.23 1.38
0.32 0.45 0.59 0.69 0.78 0.9 1.17 1.2
0.31 0.53 0.6 0.7 0.78 0.83 0.9 1
0.26 0.47 0.62 0.67 0.76 0.81 0.89 0.91
0.25 0.43 0.59 0.69 0.78 0.82 0.89 0.93
0.3 0.5 0.63 0.73 0.82 0.92 0.93 1.01
0.21 0.37 0.49 0.61 0.7 0.77 0.89 1.03
4 6 8 10
4 6 8 10
4 6 8 10
Age

Indivero et al.

- Effect of spatial vs simple mean estimates on assessment results

Last year's 2021 assessment fits and abundance estimates





From Indivero et al. (submitted)

"Results from our case study suggests that accounting for spatially unbalanced sampling improved stock assessment consistency. Additionally, it improved our understanding on the dynamics of how local and population-level demographic processes interact. As climate change affects fish distribution and growth, integrating spatiotemporally explicit size-at-age processes with anticipated environmental conditions may improve management advice."

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Summary

I recommend

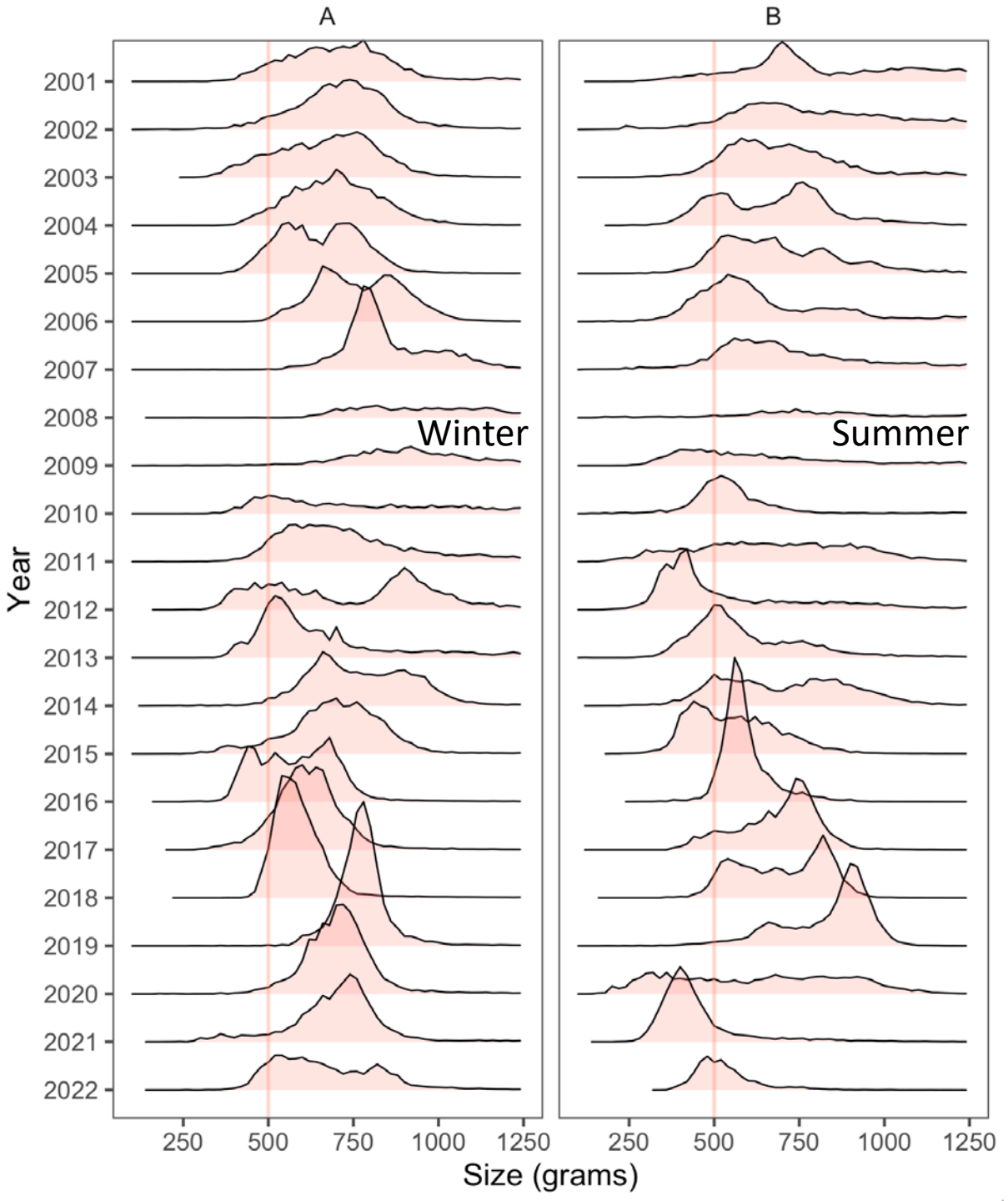
- Abandoning the old L-W relationship and mean length way of computing mean body-weight-at-age to fuller spatial data extent

- Adopting new approach that is most consistent with the VAST data

- For design-based tests (and alternative model runs), use the spatially naïve estimates (in place of old LW approach)

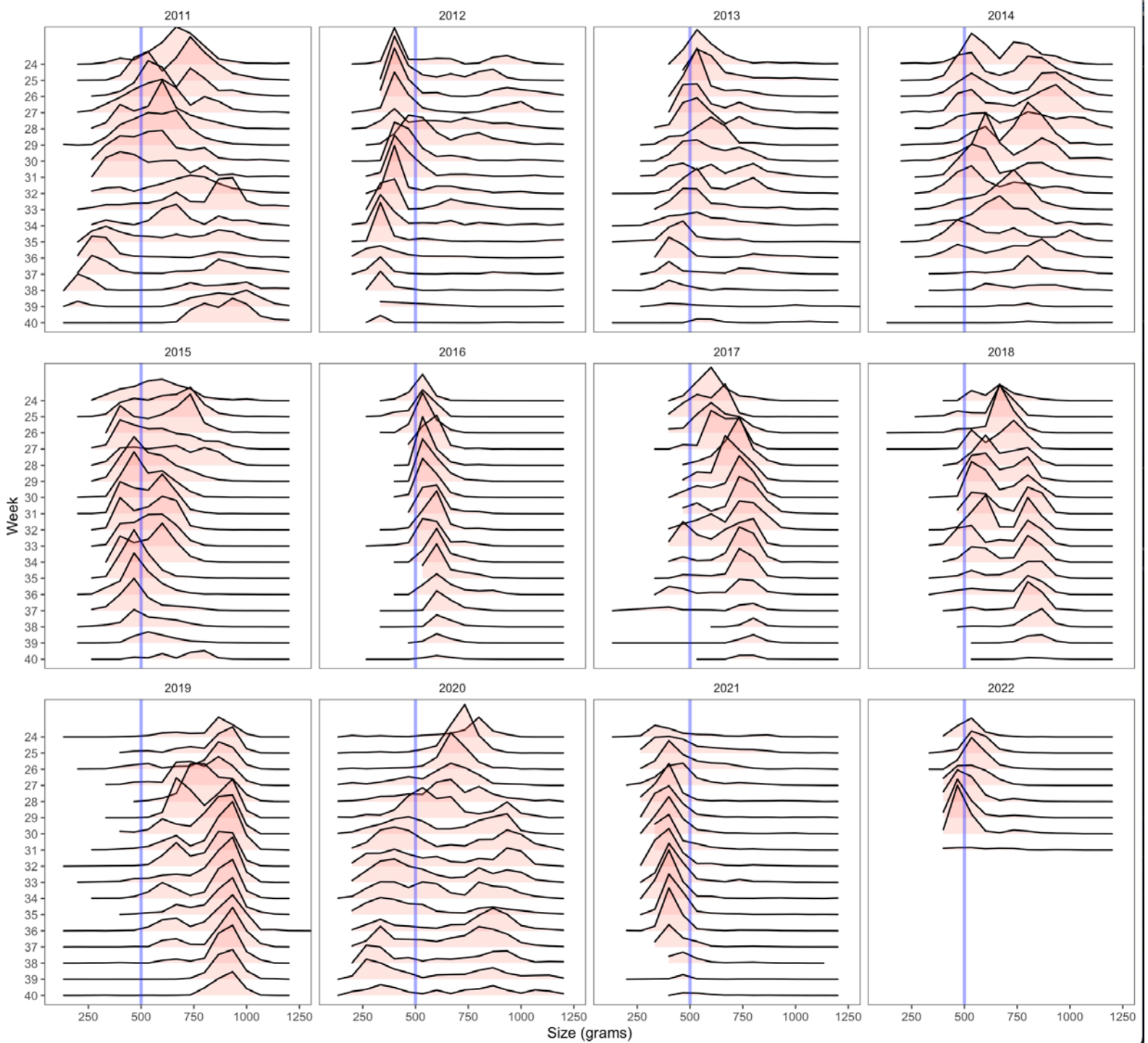
Bering Sea Pollock Fishing conditions

Trends in weight frequency of catch

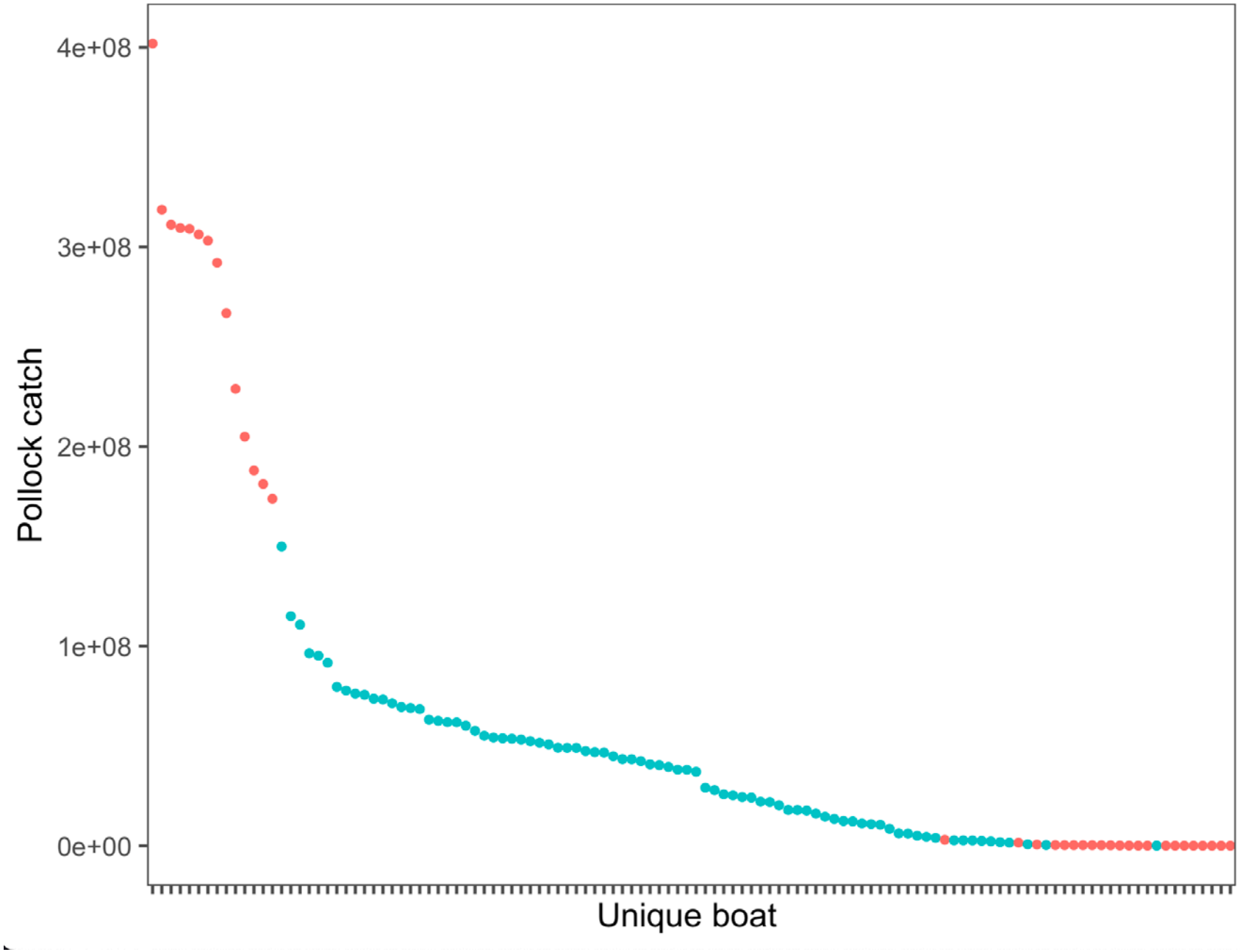


B-season

Tow-by-tow mean weight frequency by week

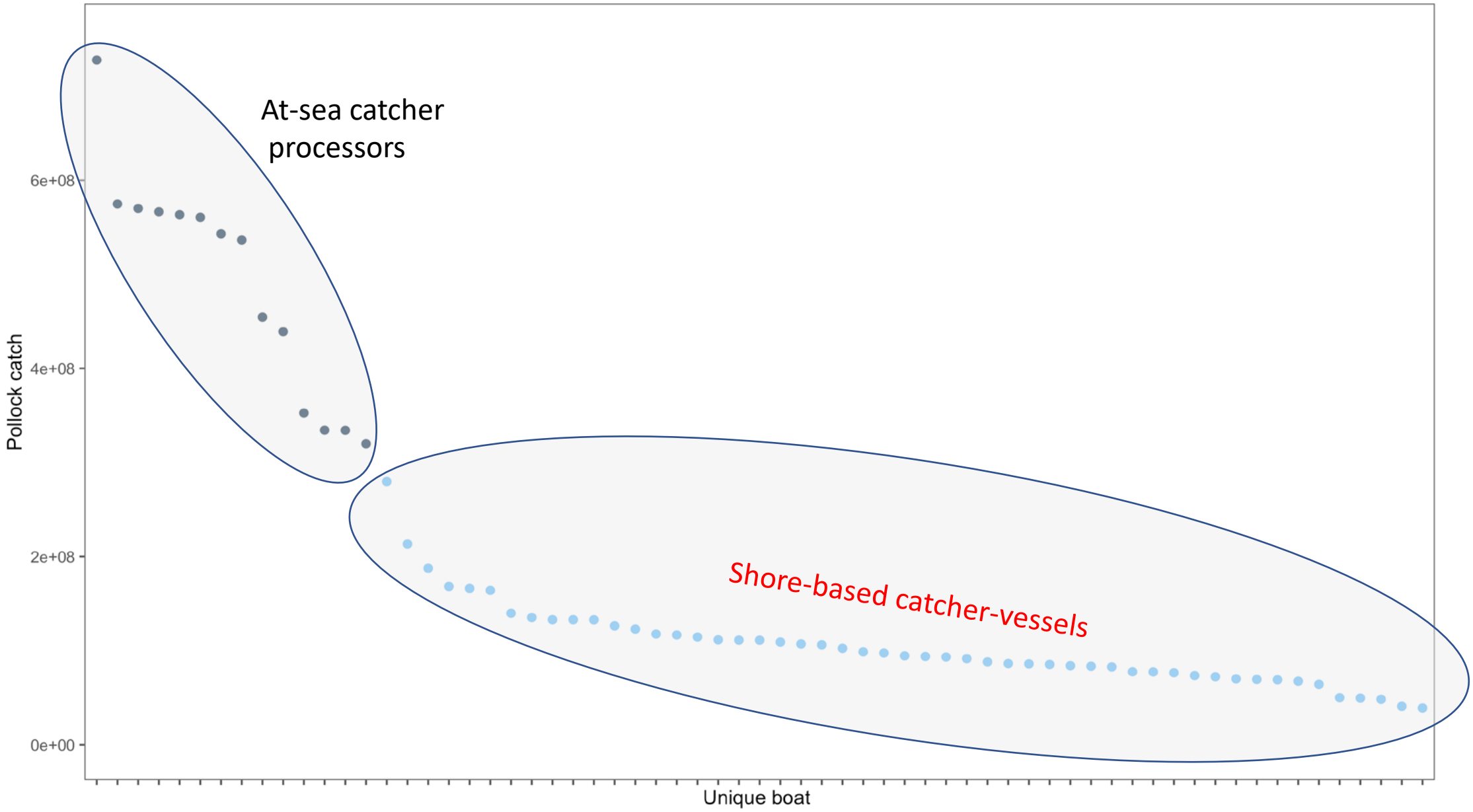


B-season catch patterns



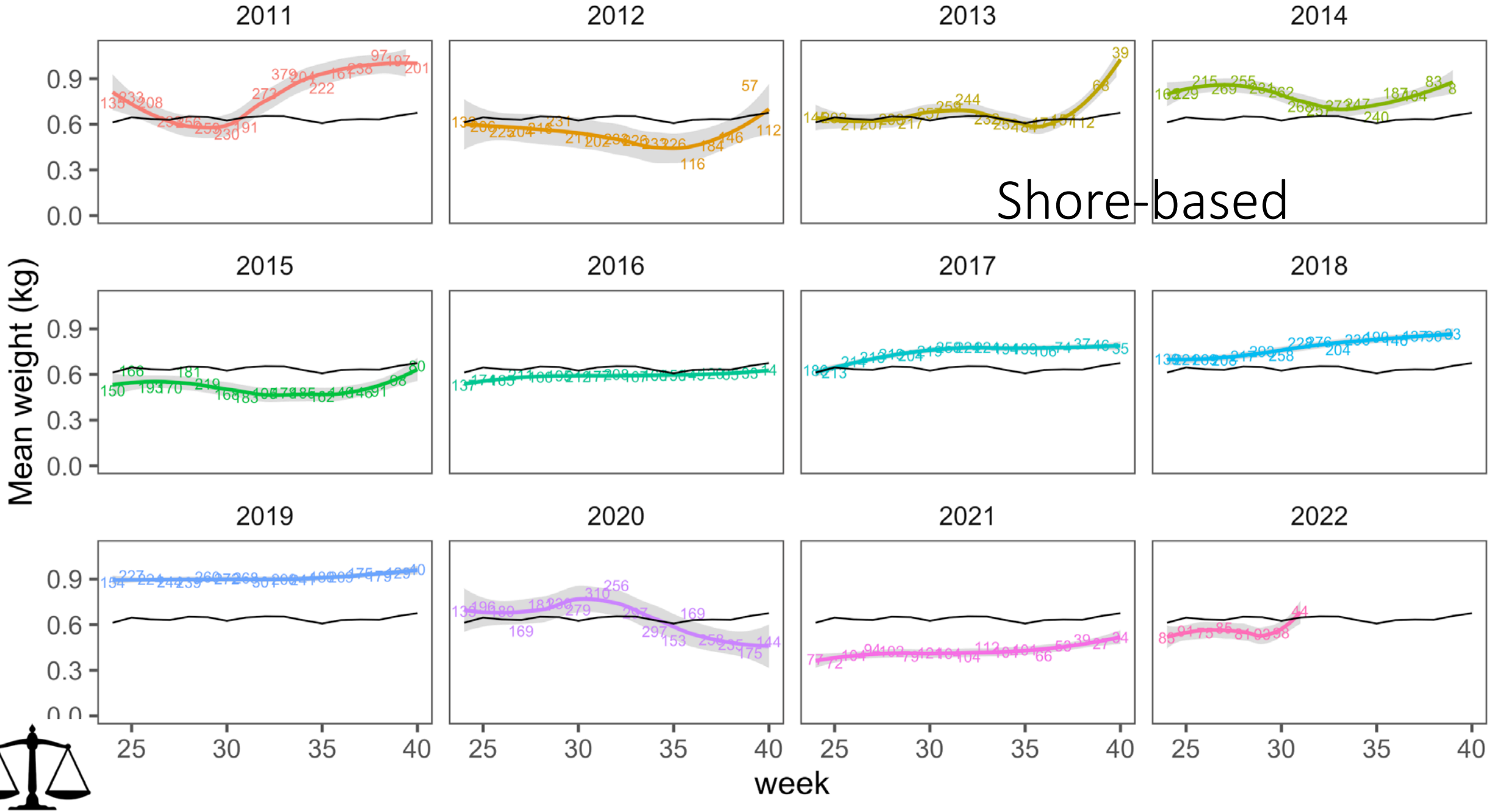
Deeper dive into observer data

B-season catch patterns



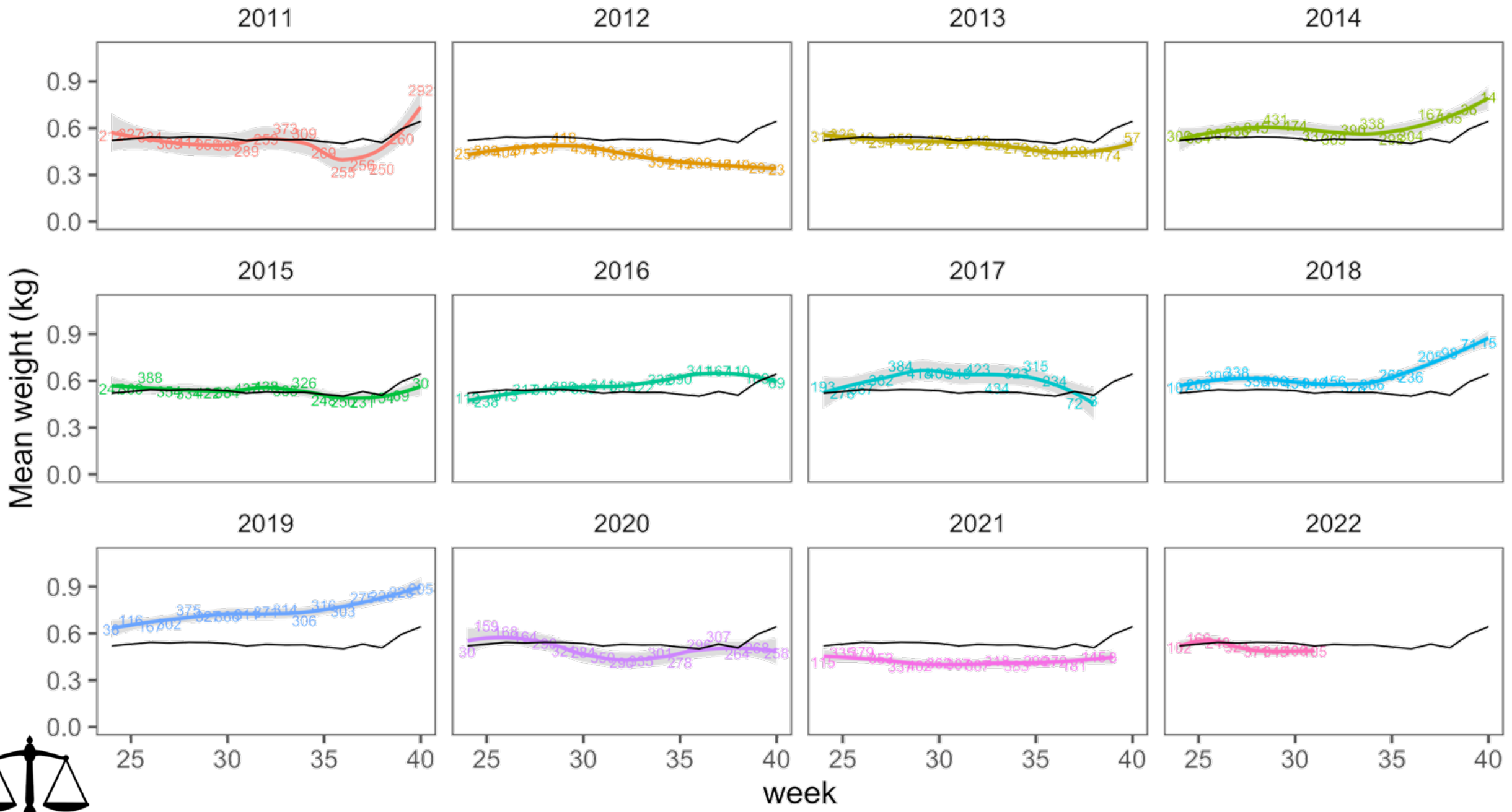
Catcher-vessels

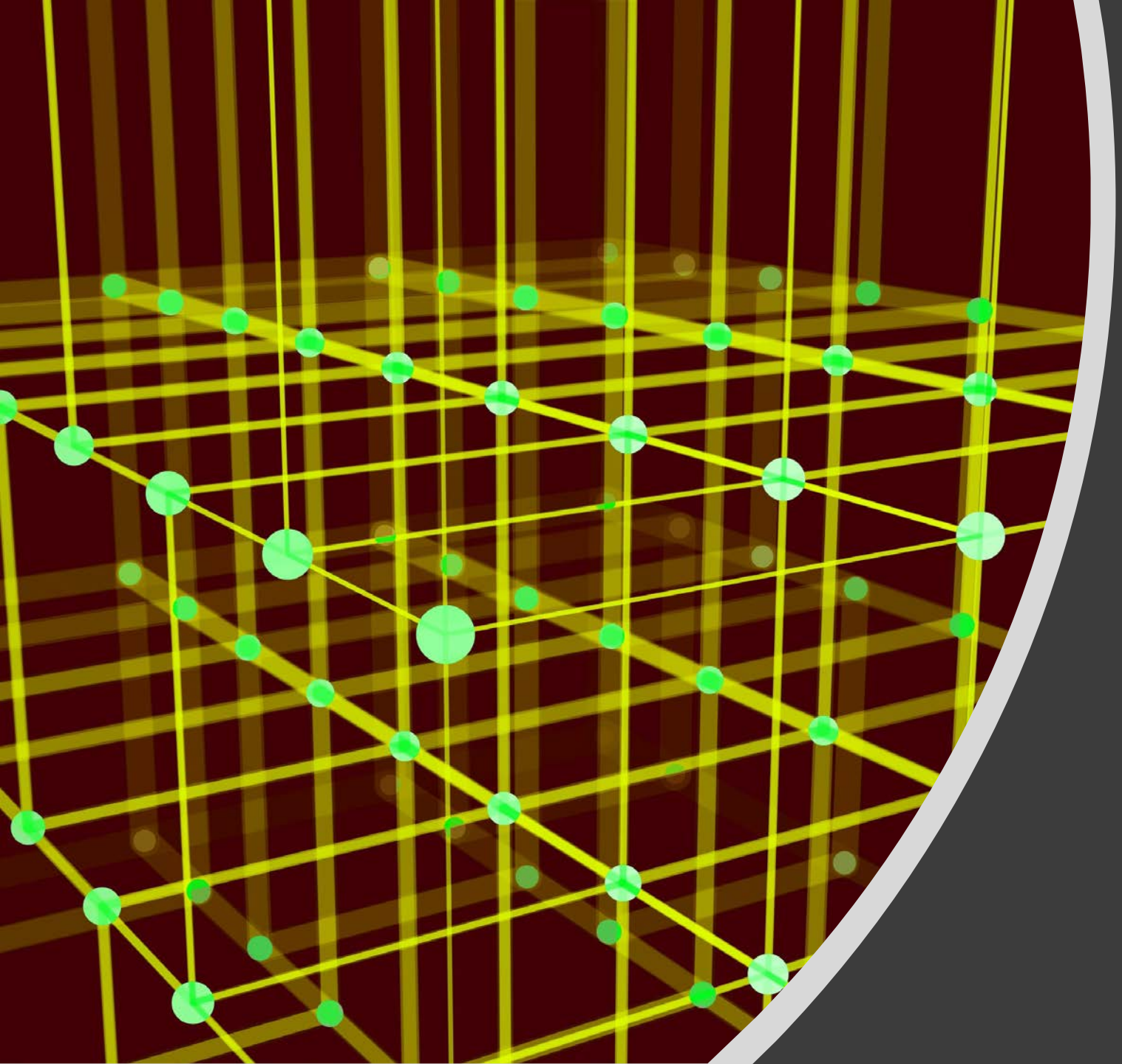
B-season catch patterns



Catcher-processors

B-season catch patterns

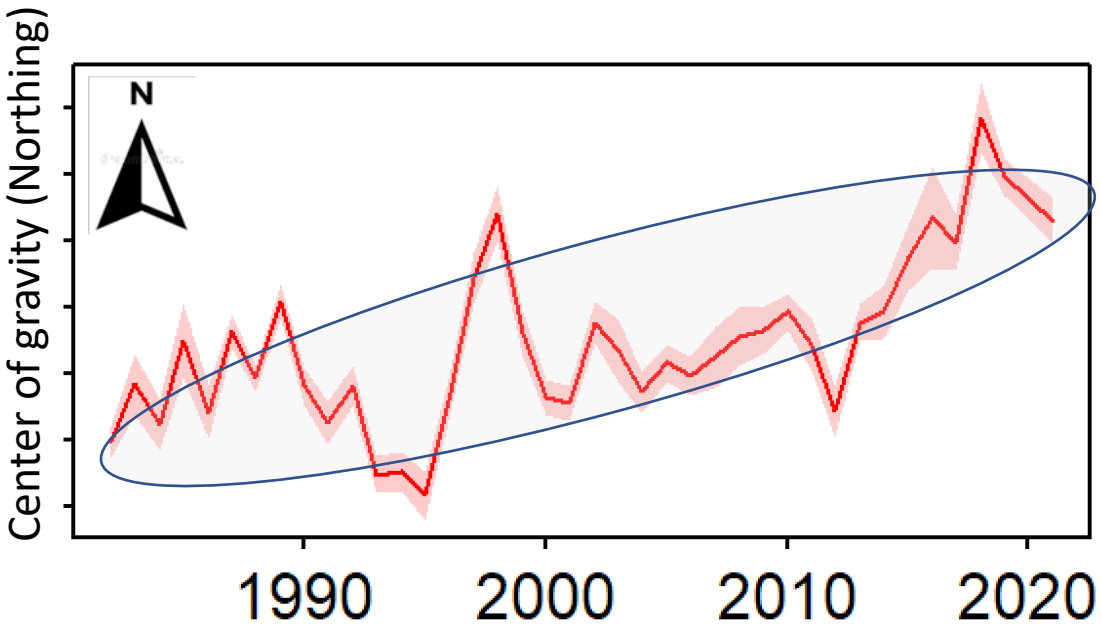


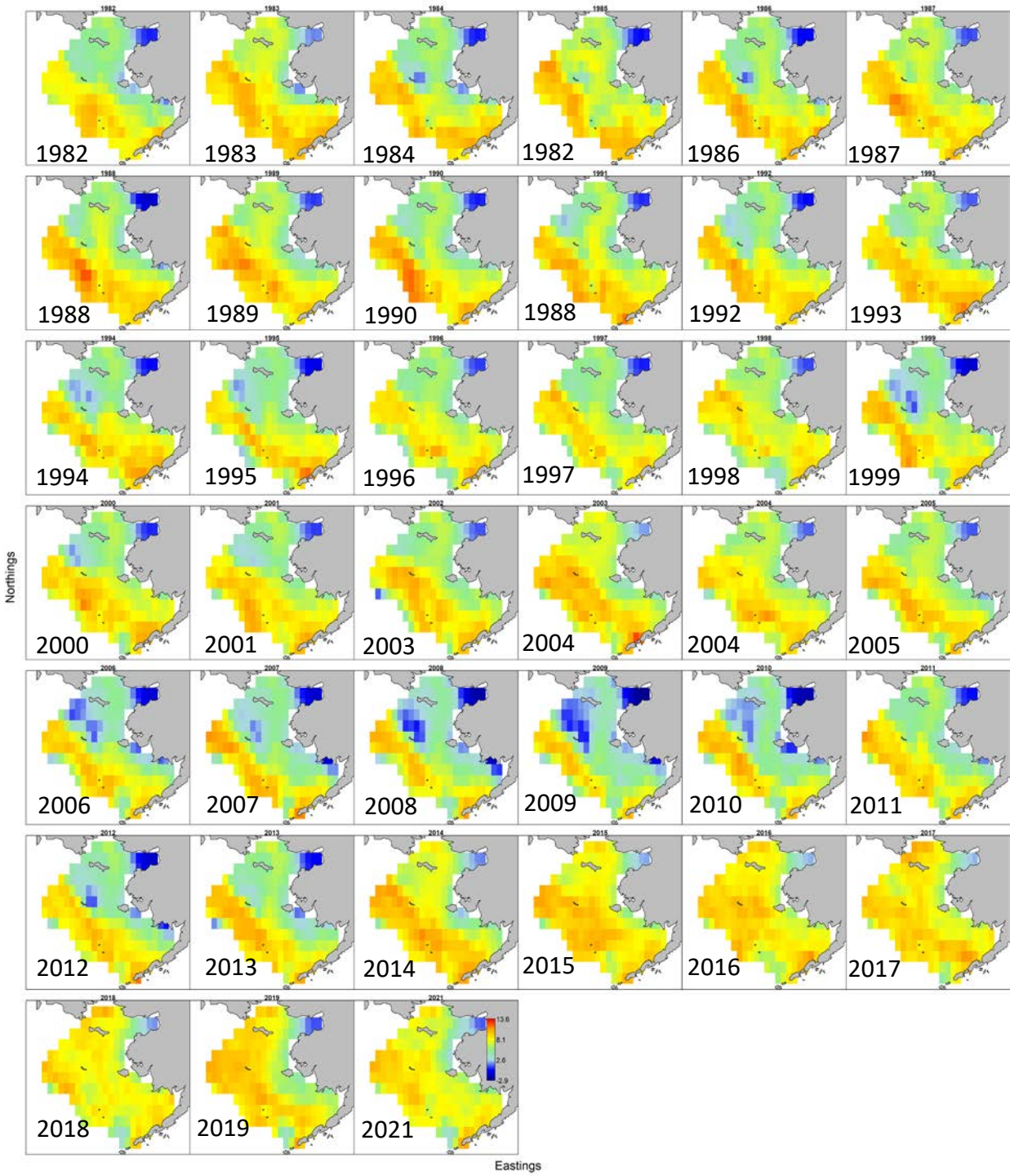


Explorations of spatial patterns and assessment impacts

Shifts in pollock distribution

- NMFS summer bottom trawl survey
- Fishery INDEPENDENT
- VAST model estimates





Shifts in pollock distribution

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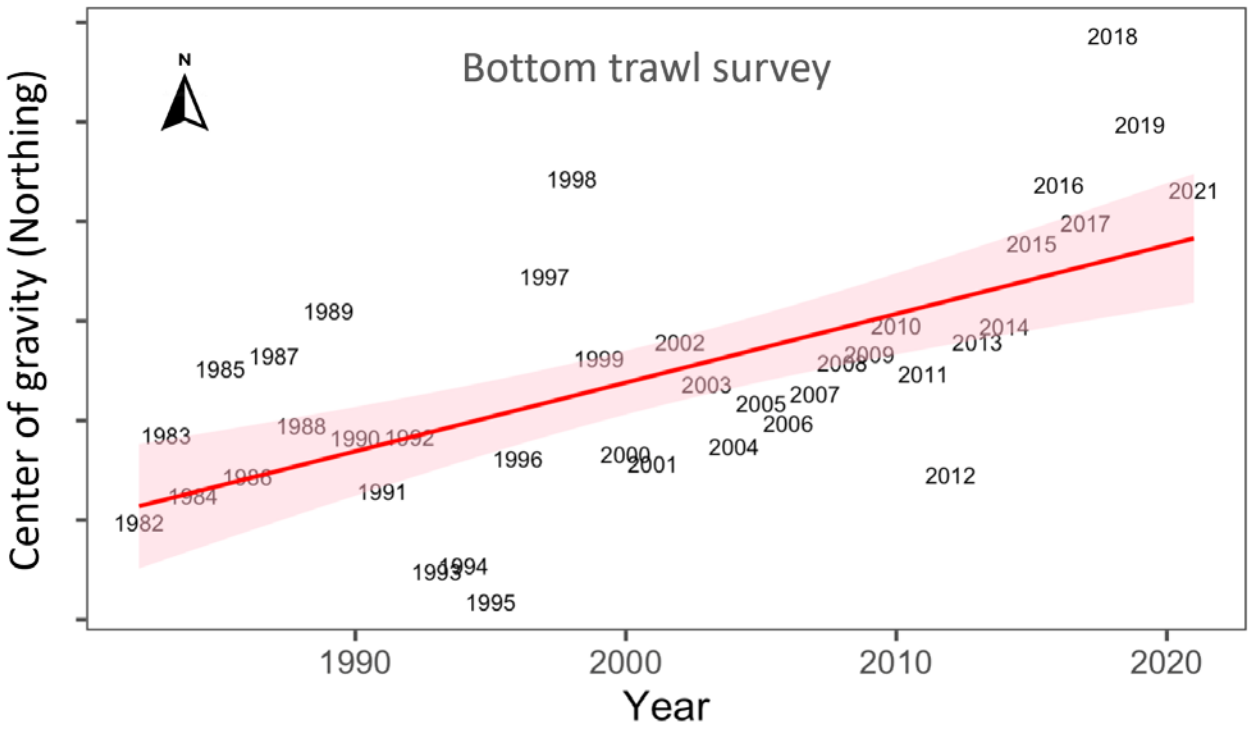

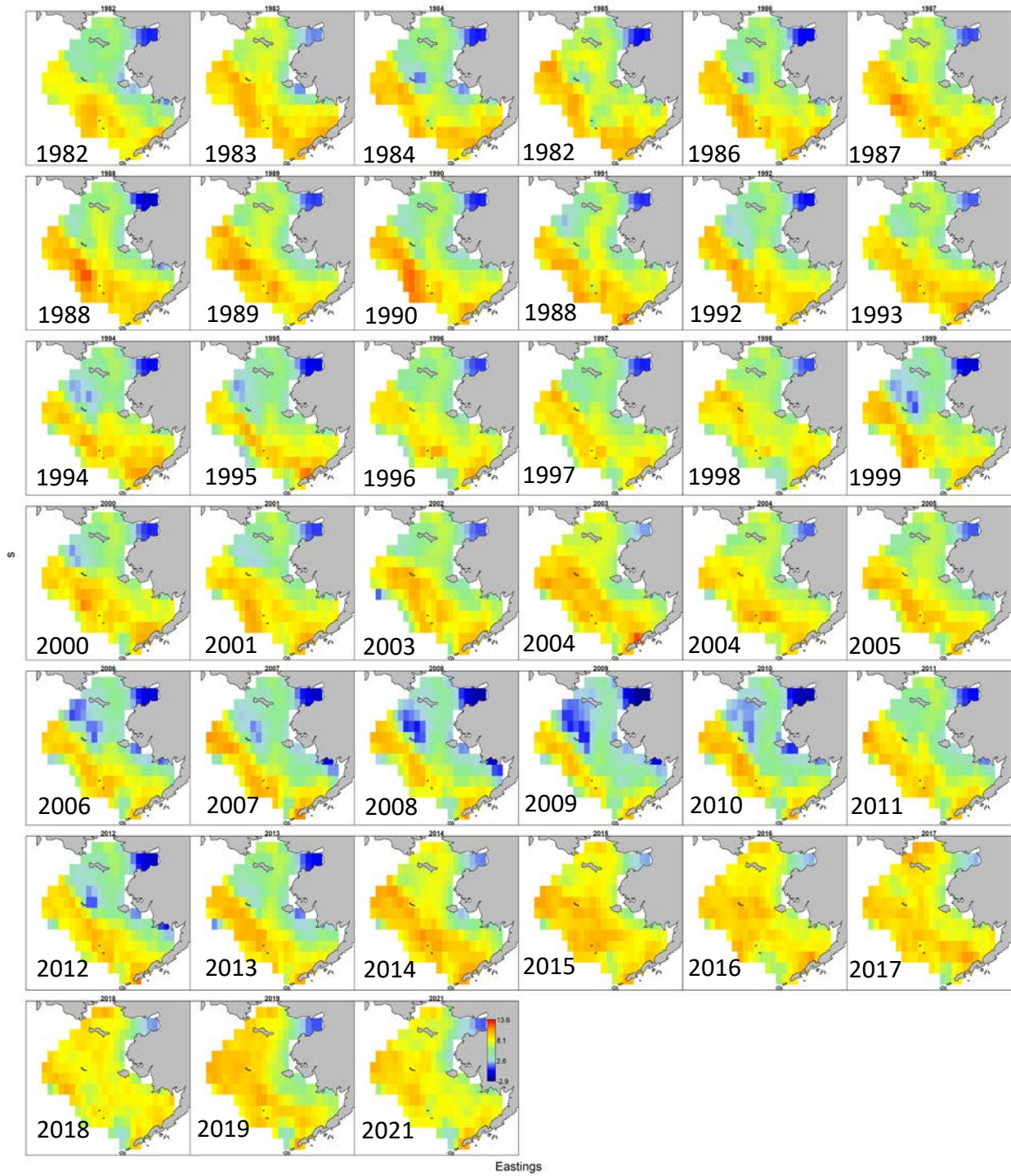

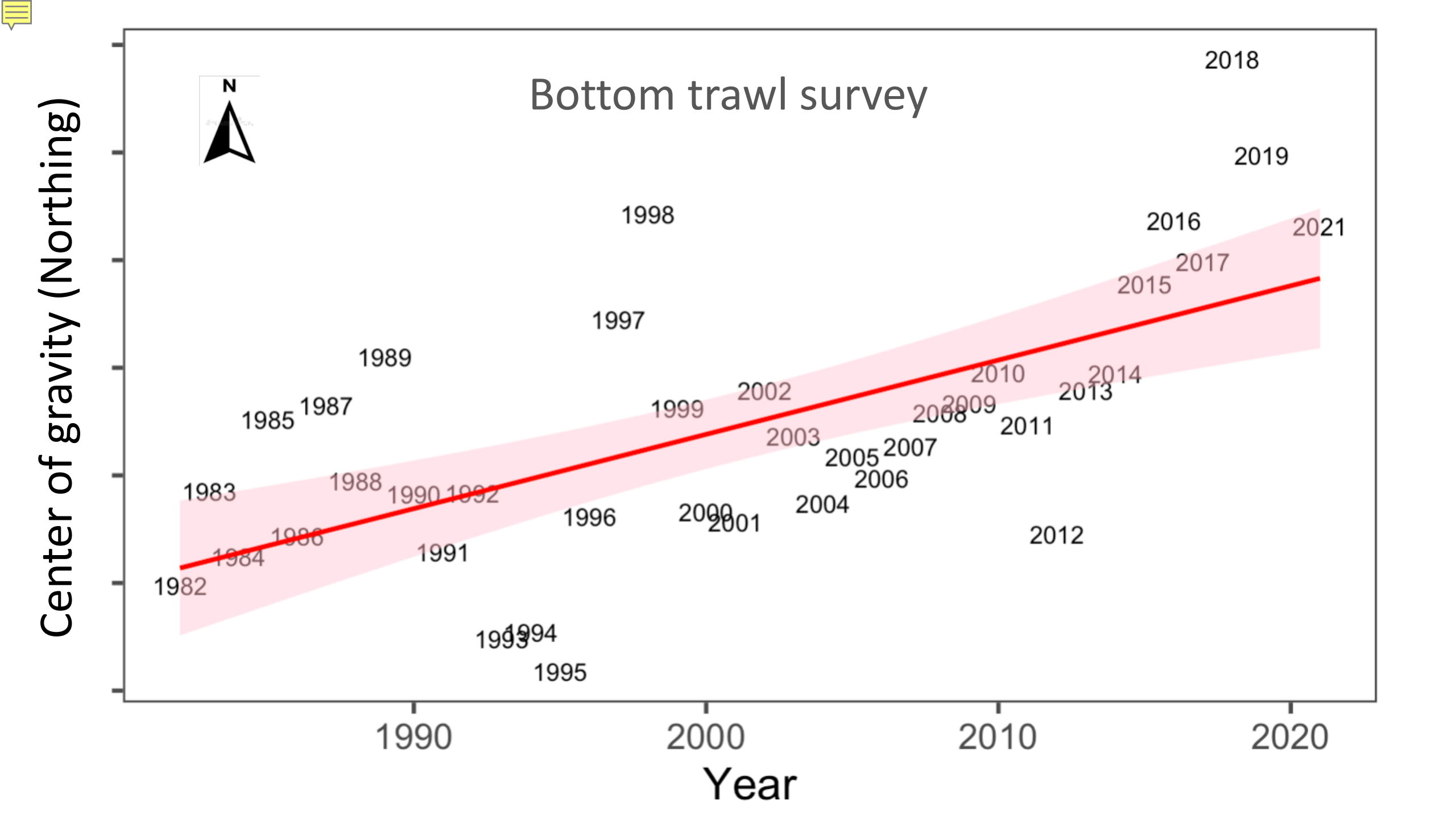
Bottom trawl survey
N
Center of gravity (Northing)
Year
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2010
2020
1982
1983
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1991
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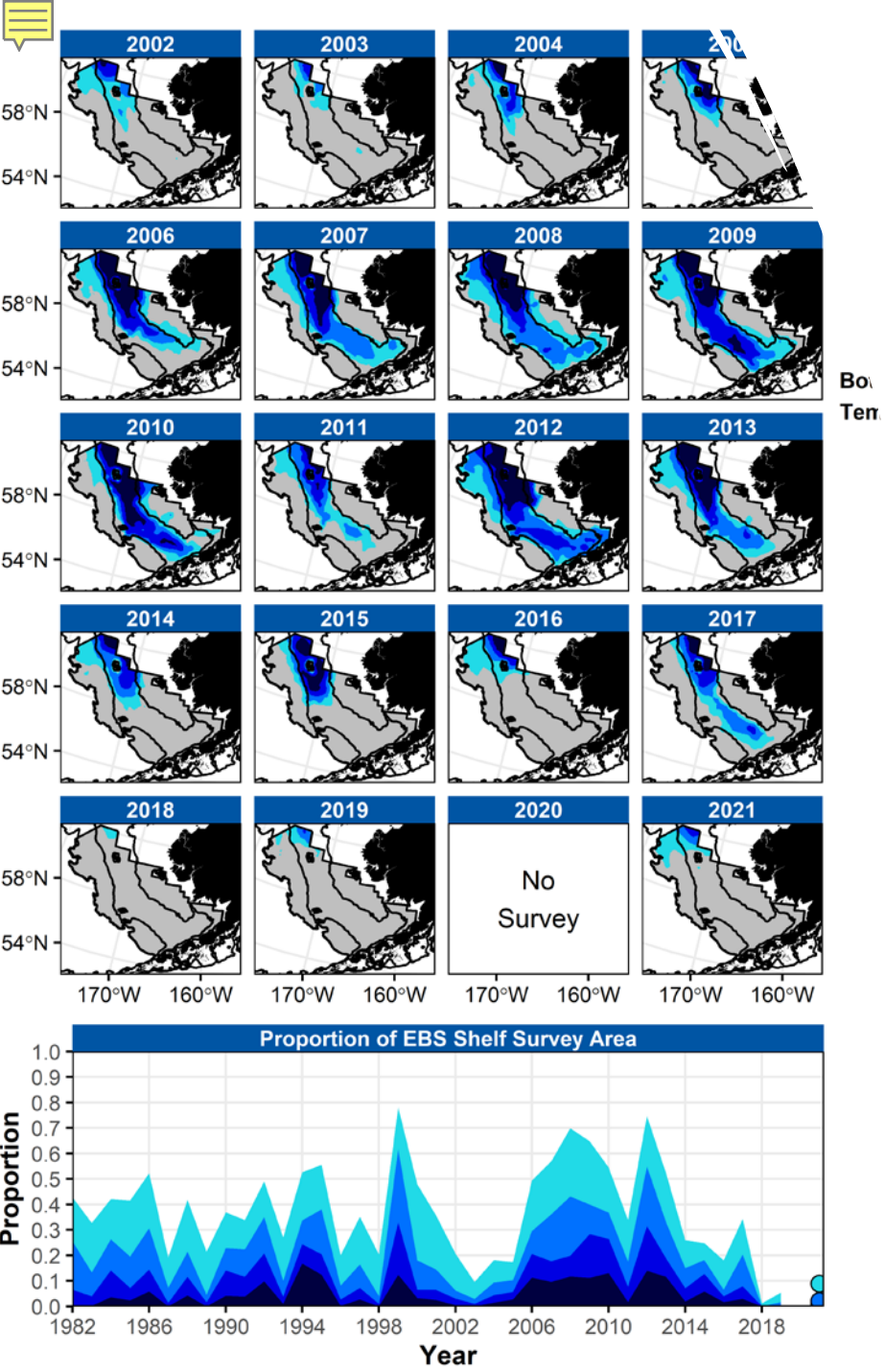
2019
2021

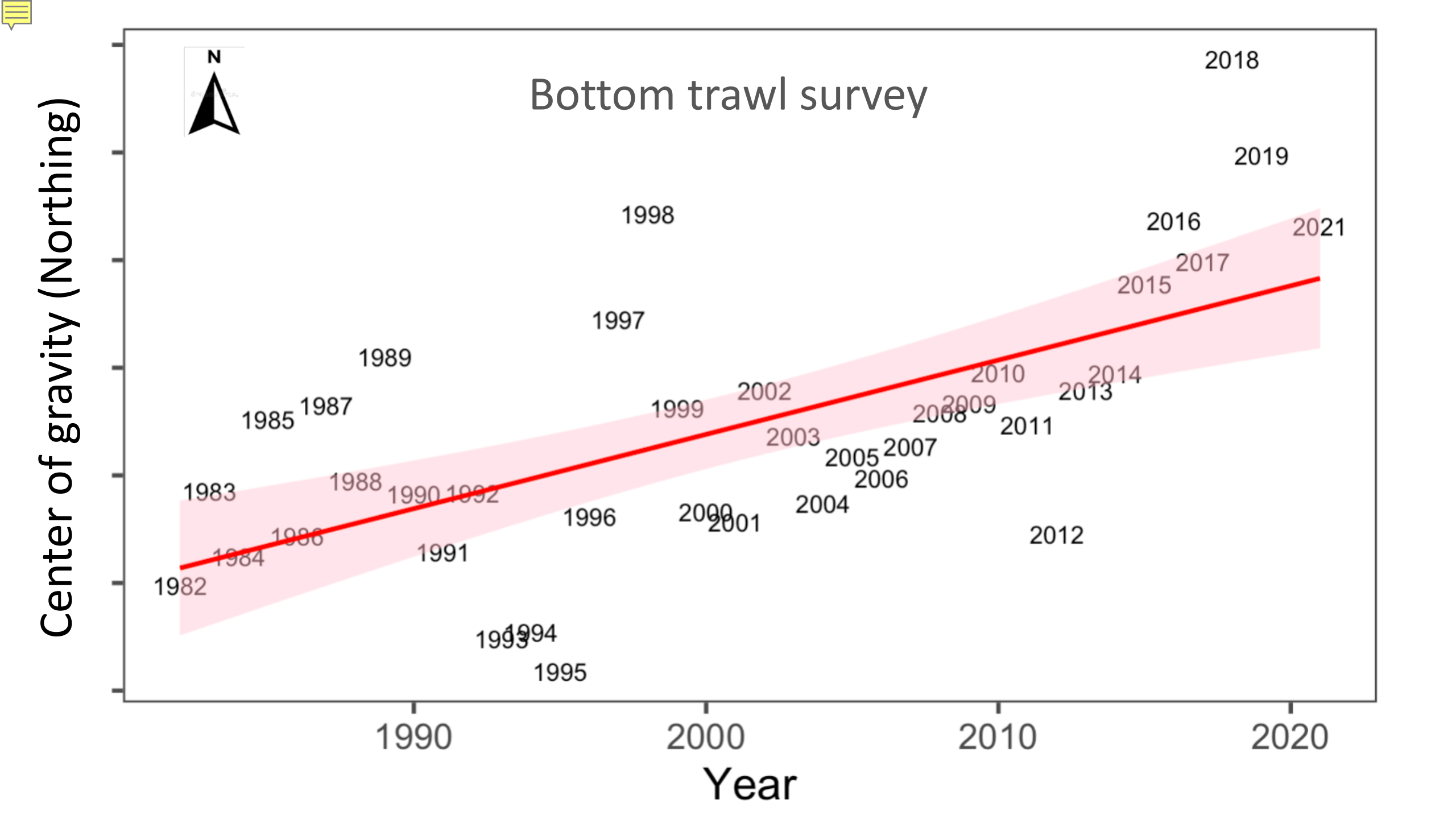


A great survey product: Bottom Temperature

```
df_cpe <- coldpool:::cold_pool_index |>
          dplyr::select(year=YEAR,CPE=AREA_LTE2_KM2)
```

Sean Rohan and Lewis Barnett R package

https://github.com/afsc-gap-products/coldpool


Bottom trawl survey
N
Center of gravity (Northing)
Year
1990
2000
2010
2020
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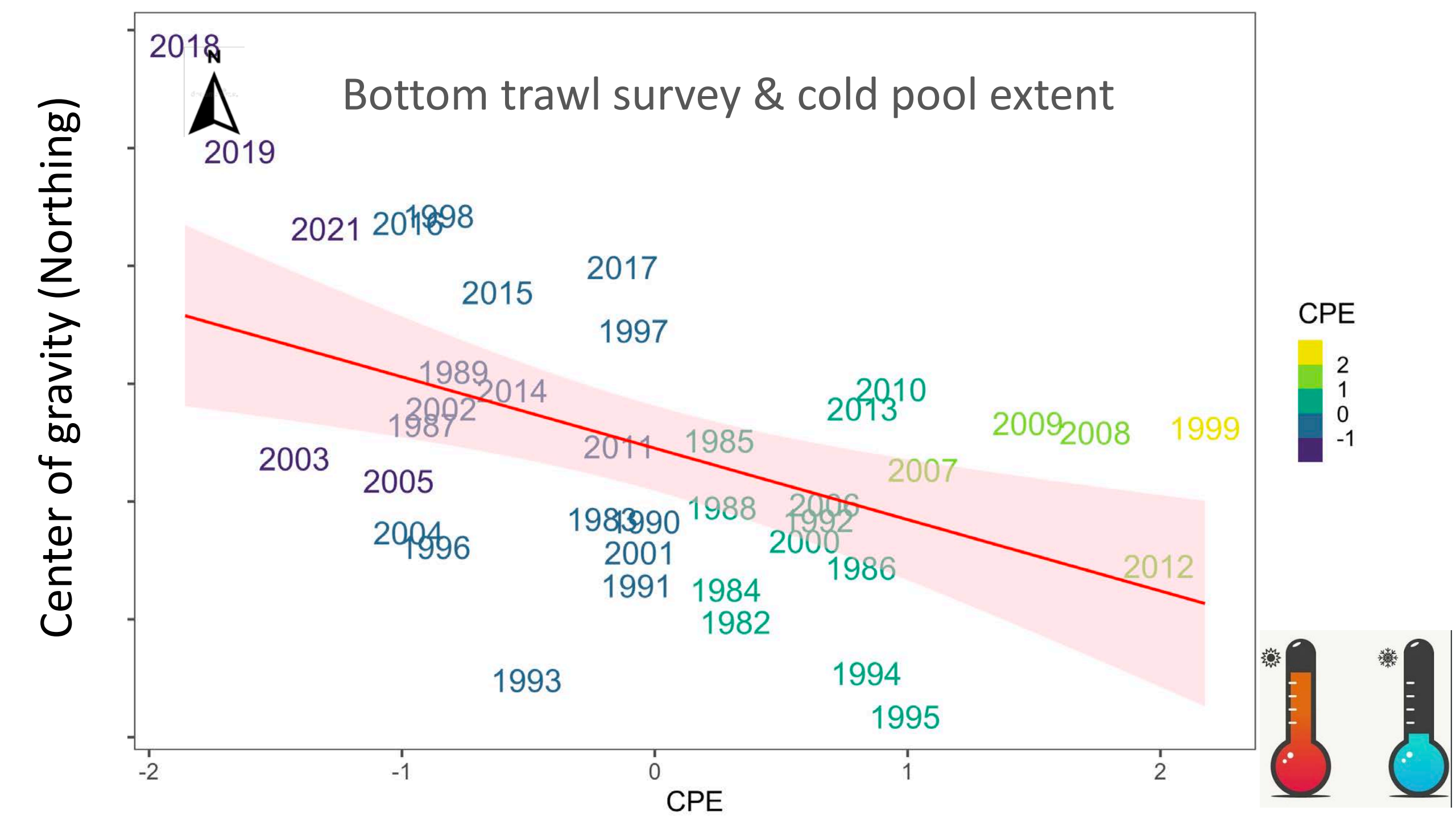
2019
2021

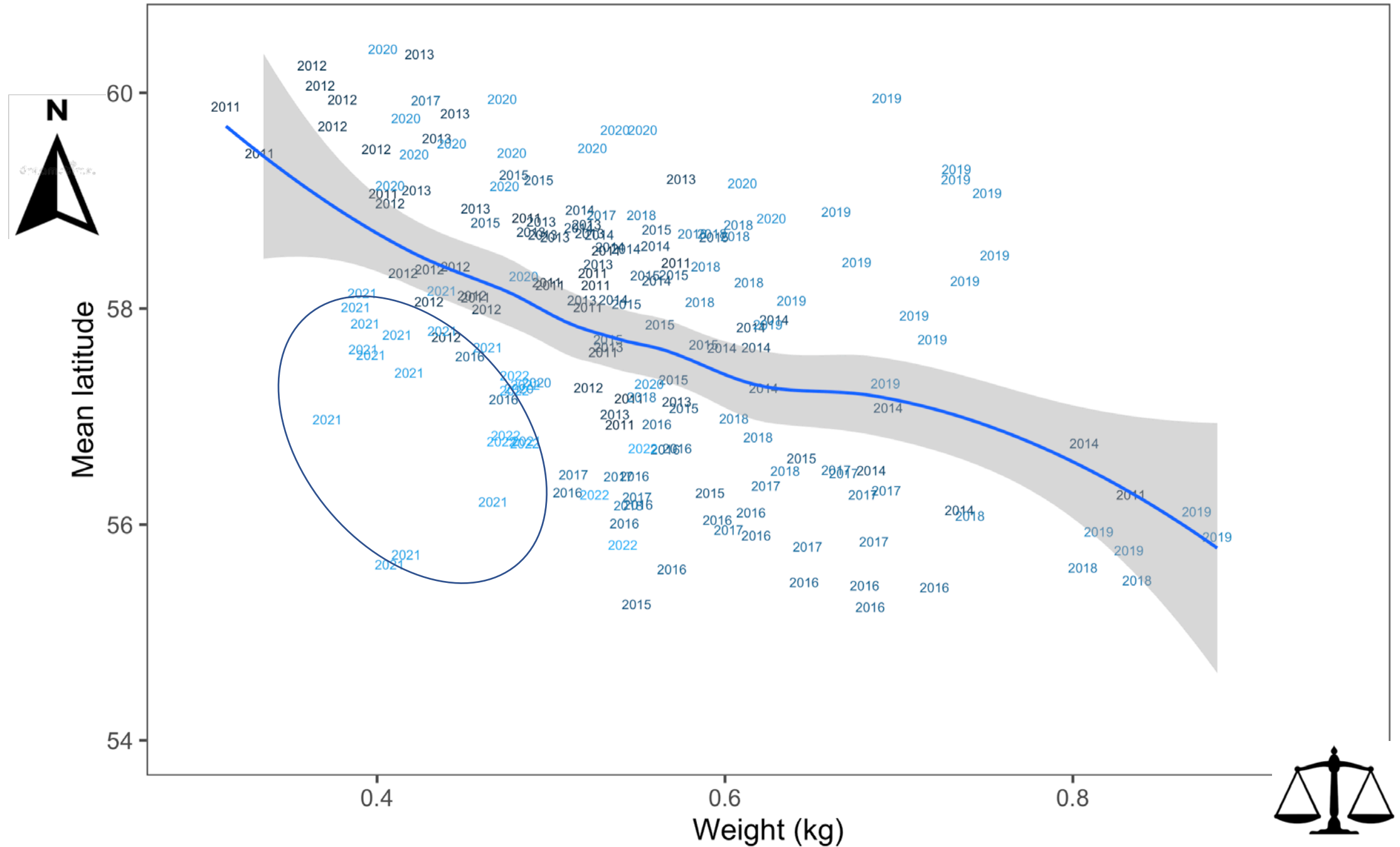
Bottom trawl survey & cold pool extent



How much is due to shifted pattern of fishing?

Catcher-processors

B-season catch patterns



Catcher-vessels

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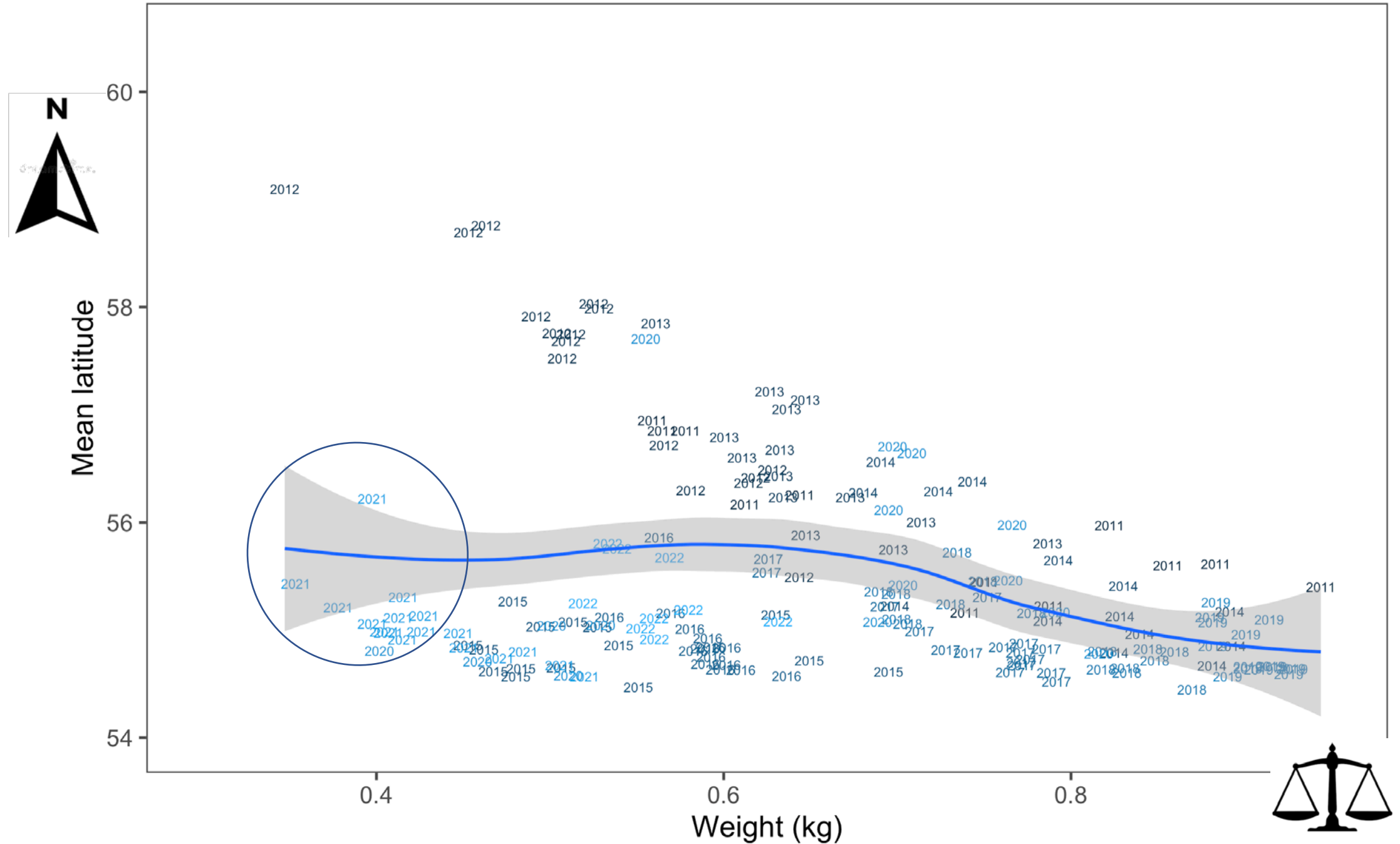

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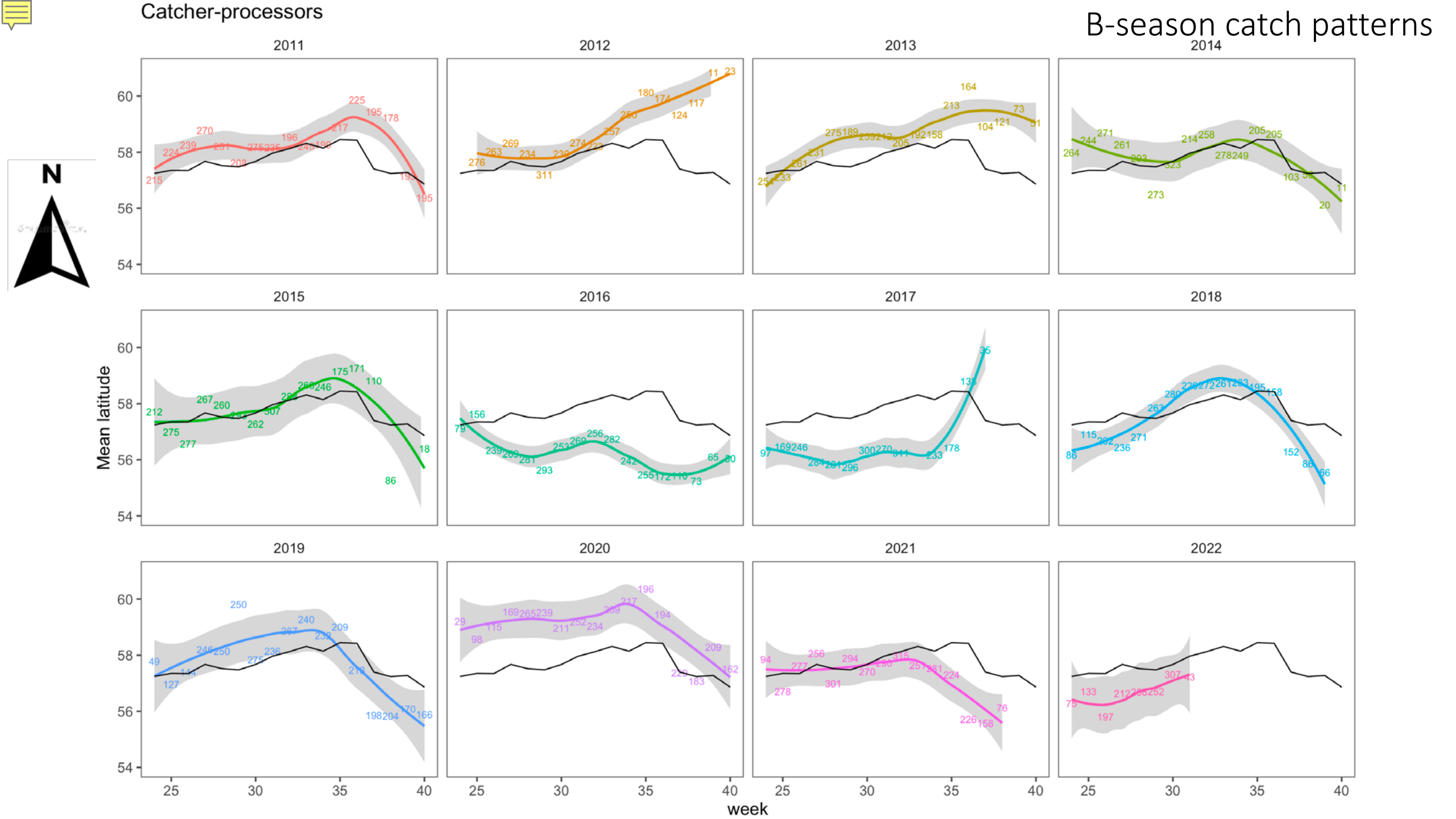
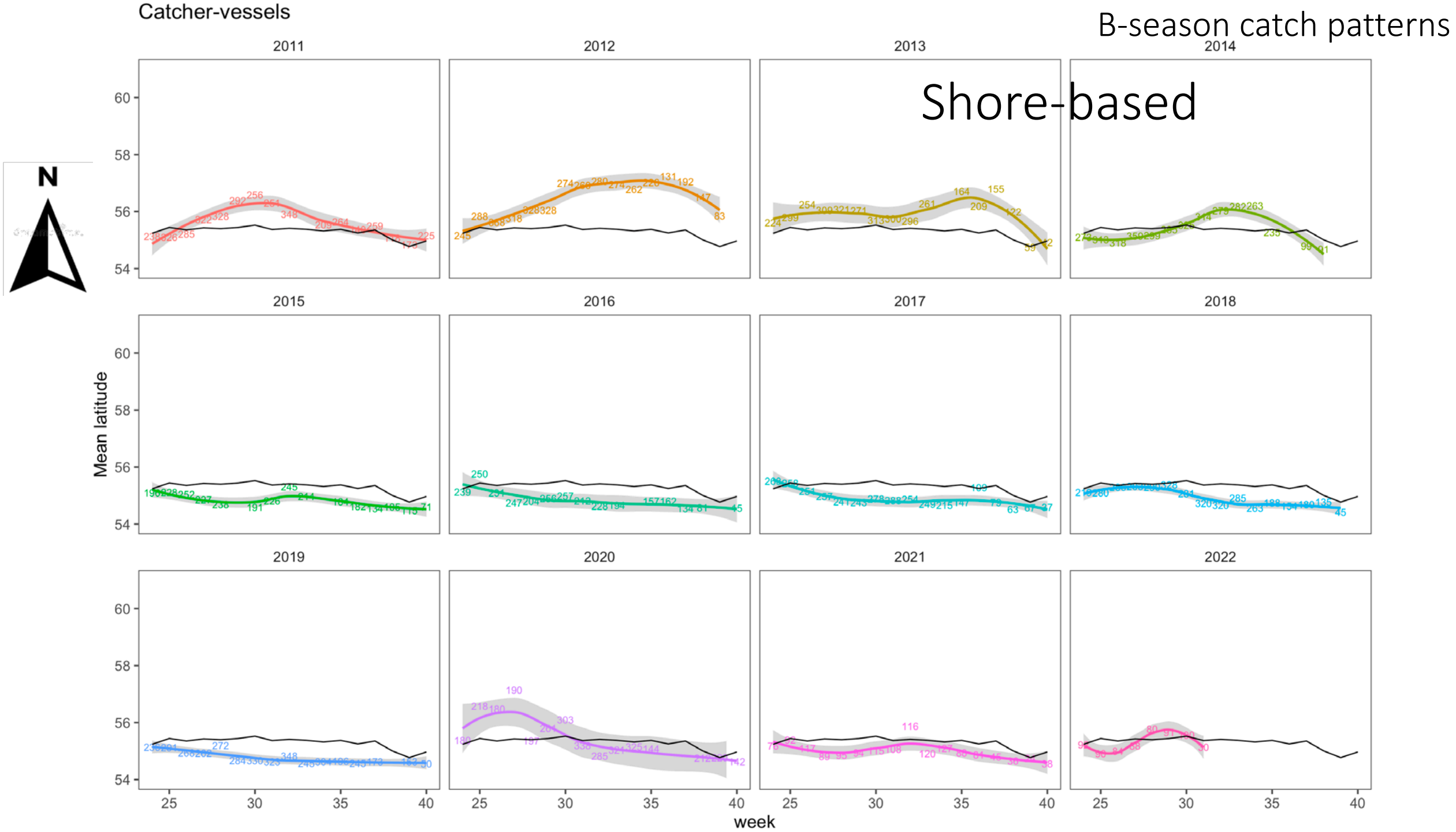
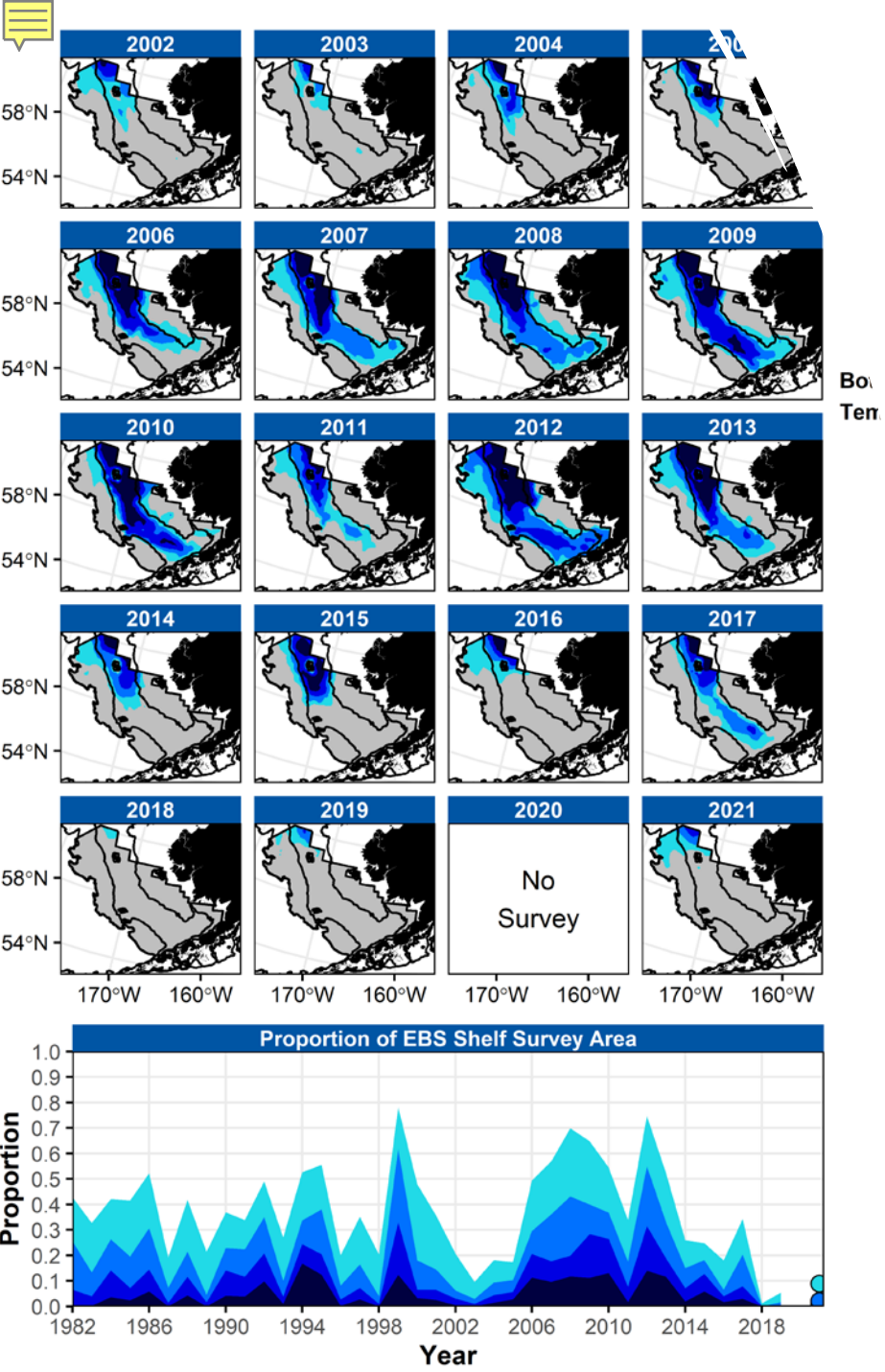


B-season catch patterns





How does it compare to fishery data?

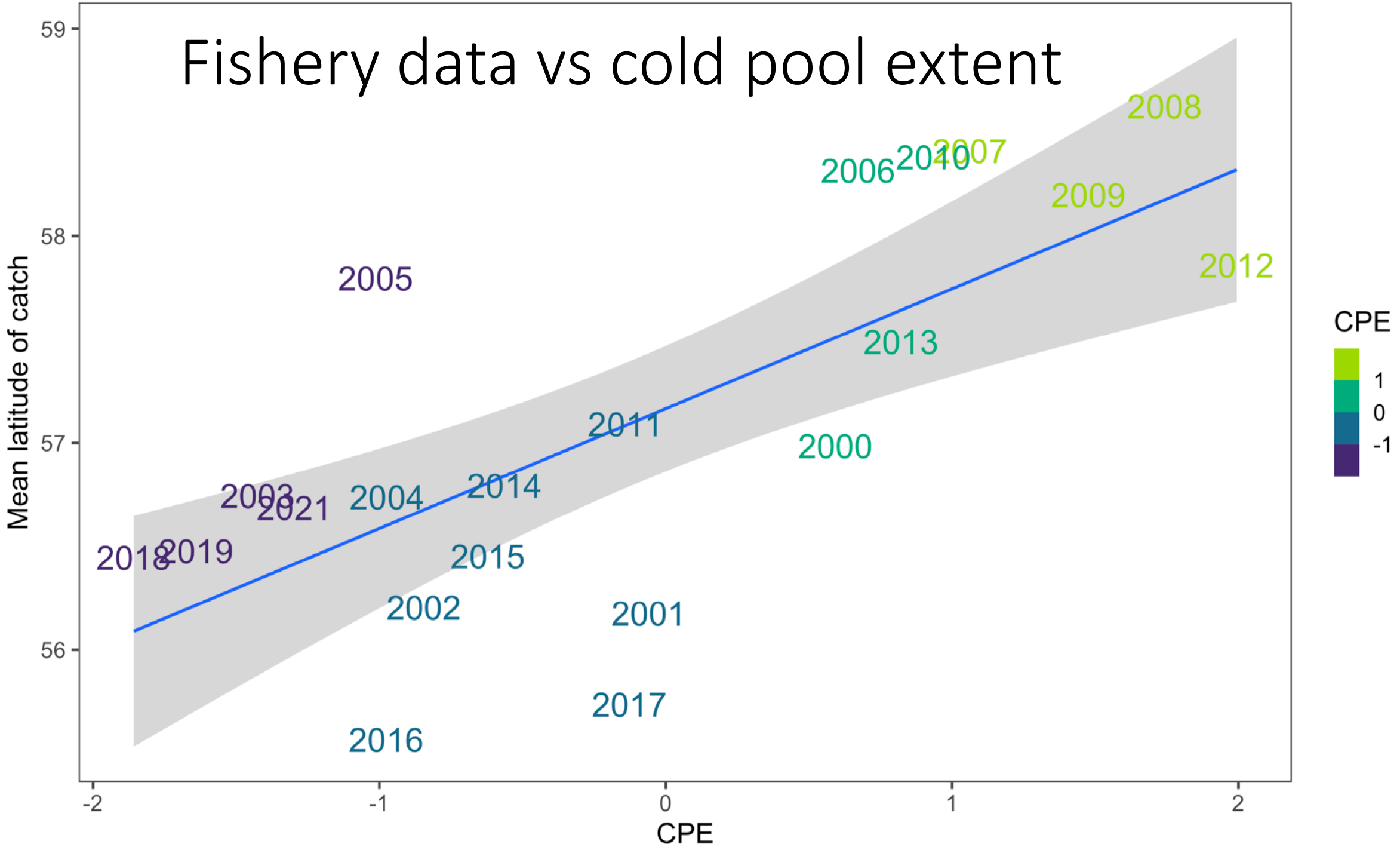
A great survey product: Bottom Temperature

```
df_cpe <- coldpool:::cold_pool_index |>
          dplyr::select(year=YEAR,CPE=AREA_LTE2_KM2)
```

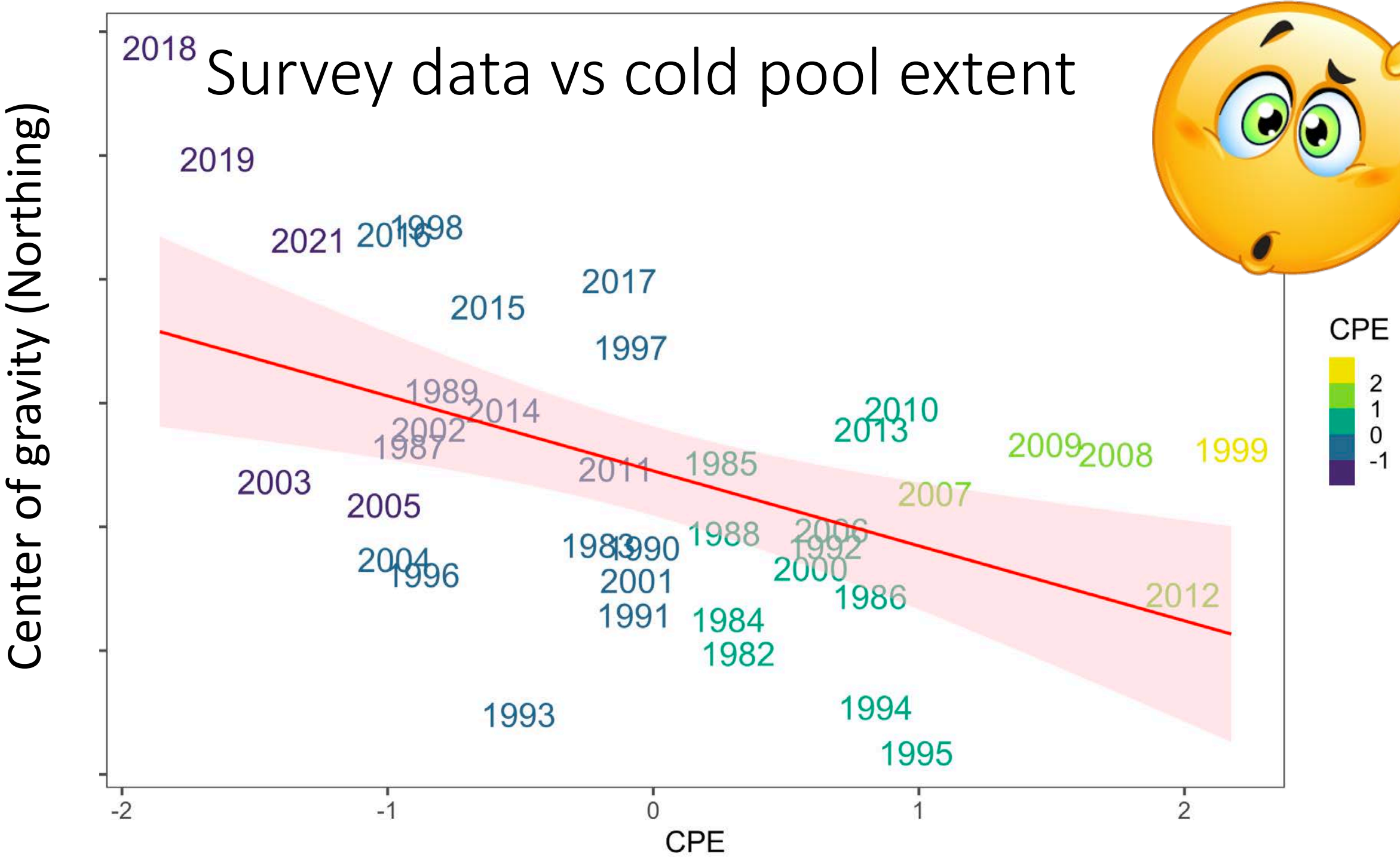
Sean Rohan and Lewis Barnett R package

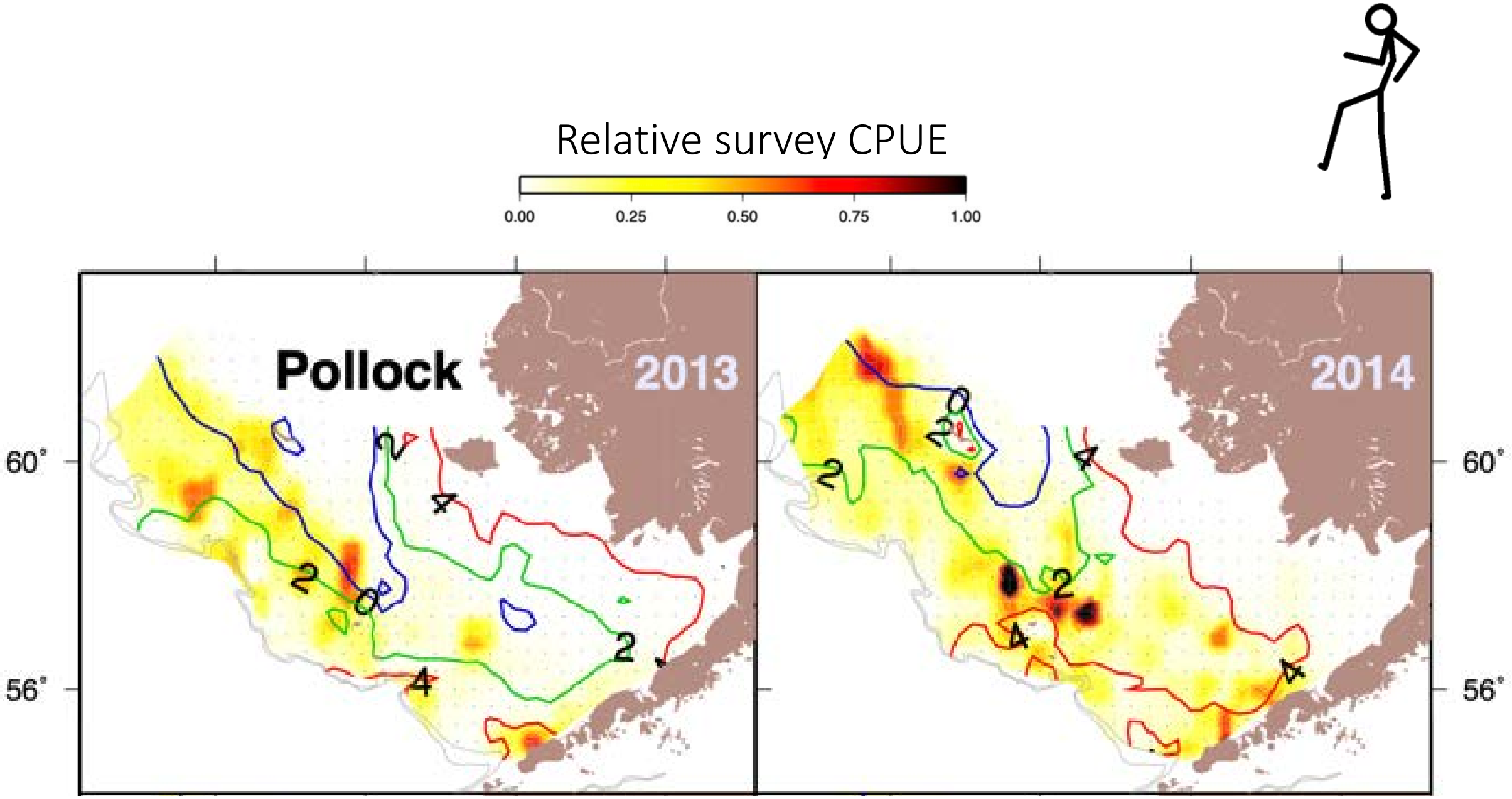
https://github.com/afsc-gap-products/coldpool

Fishery data vs cold pool extent



Survey data vs cold pool extent



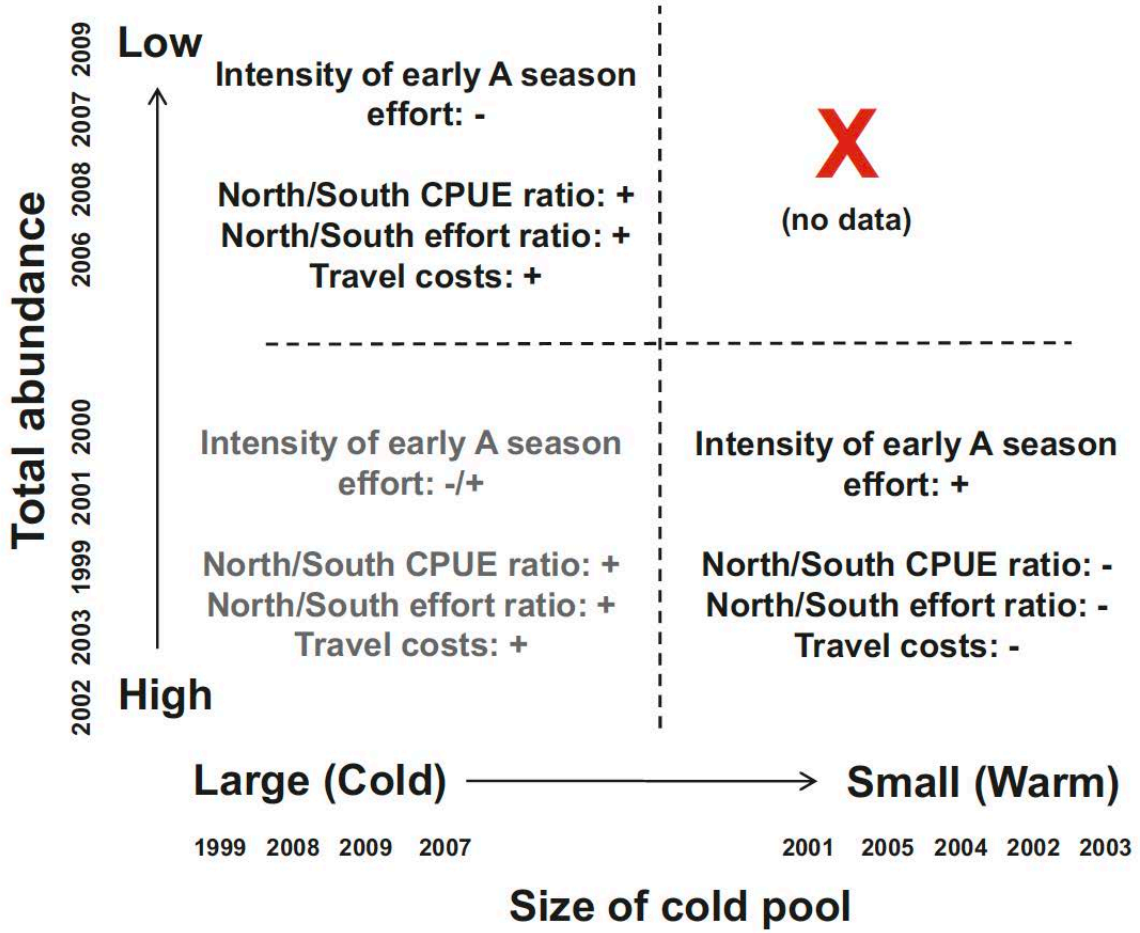

Relative survey CPUE
0.00
0.25
0.50
0.75
1.00
Pollock
2013
2014
60˚
56˚
60˚
56˚

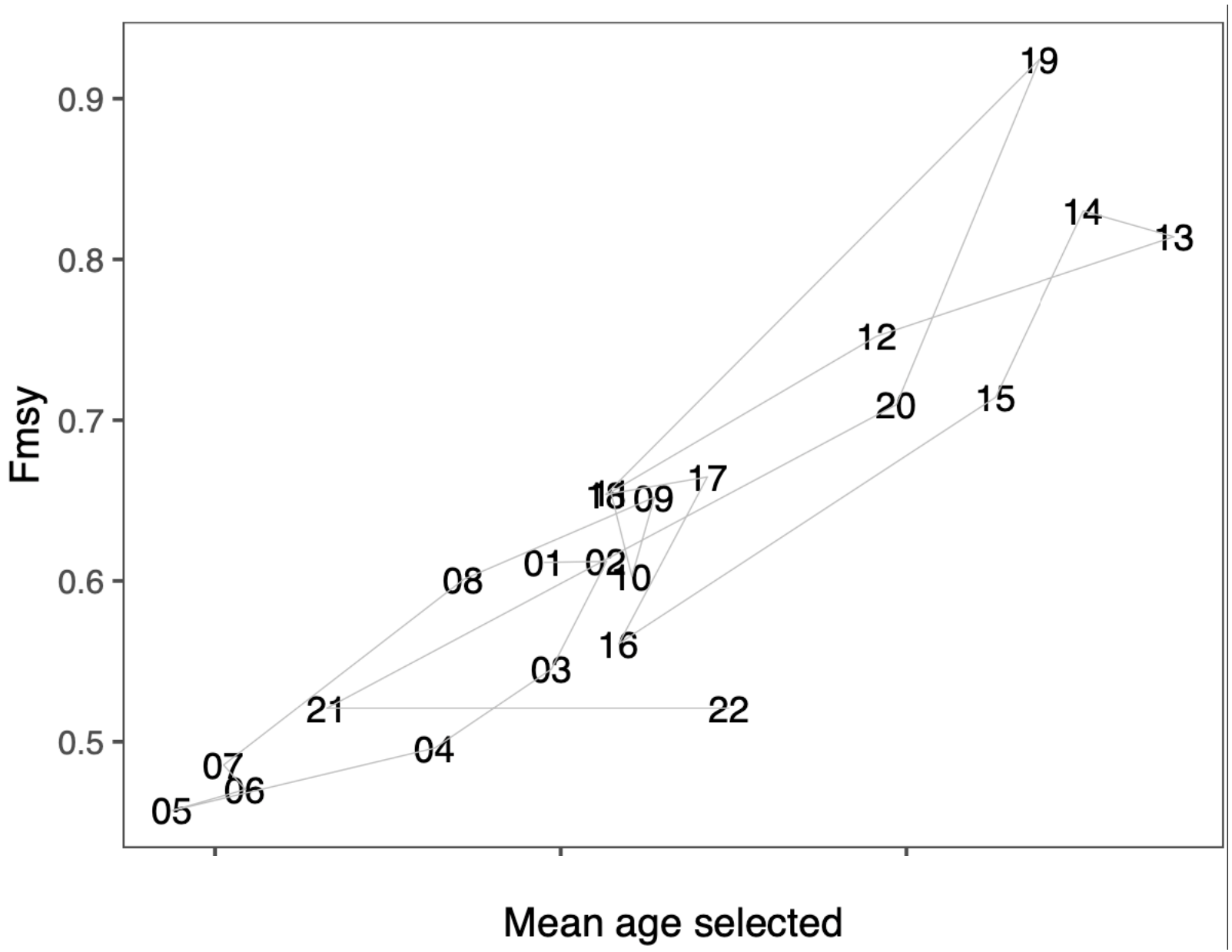
Included CPUE

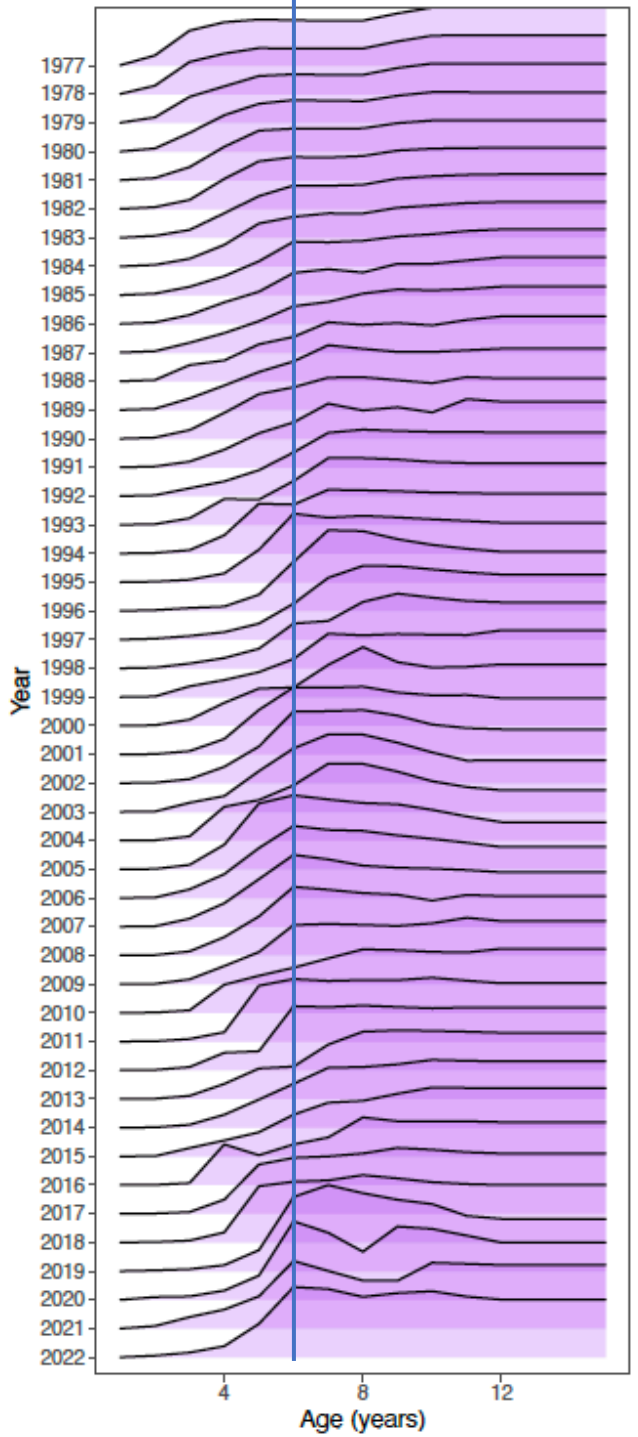
- Updated some
- Ratio from survey data

Haynie and Pfeiffer

Fig. 7. Summary of the effects of the size of the cold pool and total walleye pollock abundance on the intensity of early A-season (winter season) effort, B-season (summer season) CPUE, B-season effort, and B-season travel costs. Years in the sample characterized by varying abundance and cold pool levels are listed on the horizontal and vertical axes.




Fmsy
0.9
0.8
0.7
0.6
0.5
19
14
13
12
20
15
17
09
01
02
10
08
16
03
21
22
04
07
06
05
Mean age selected


Year
1977
1978
1979
1980
1981
1982
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1995
1996
1997
1998
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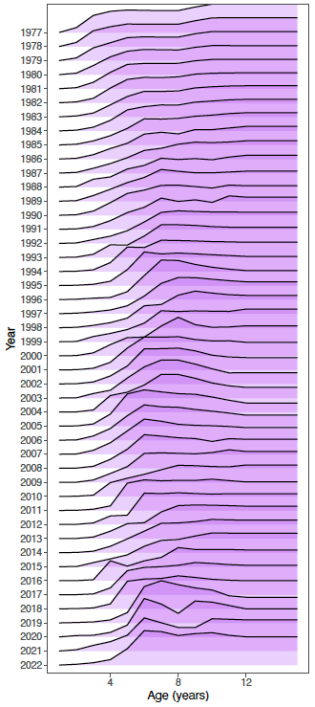
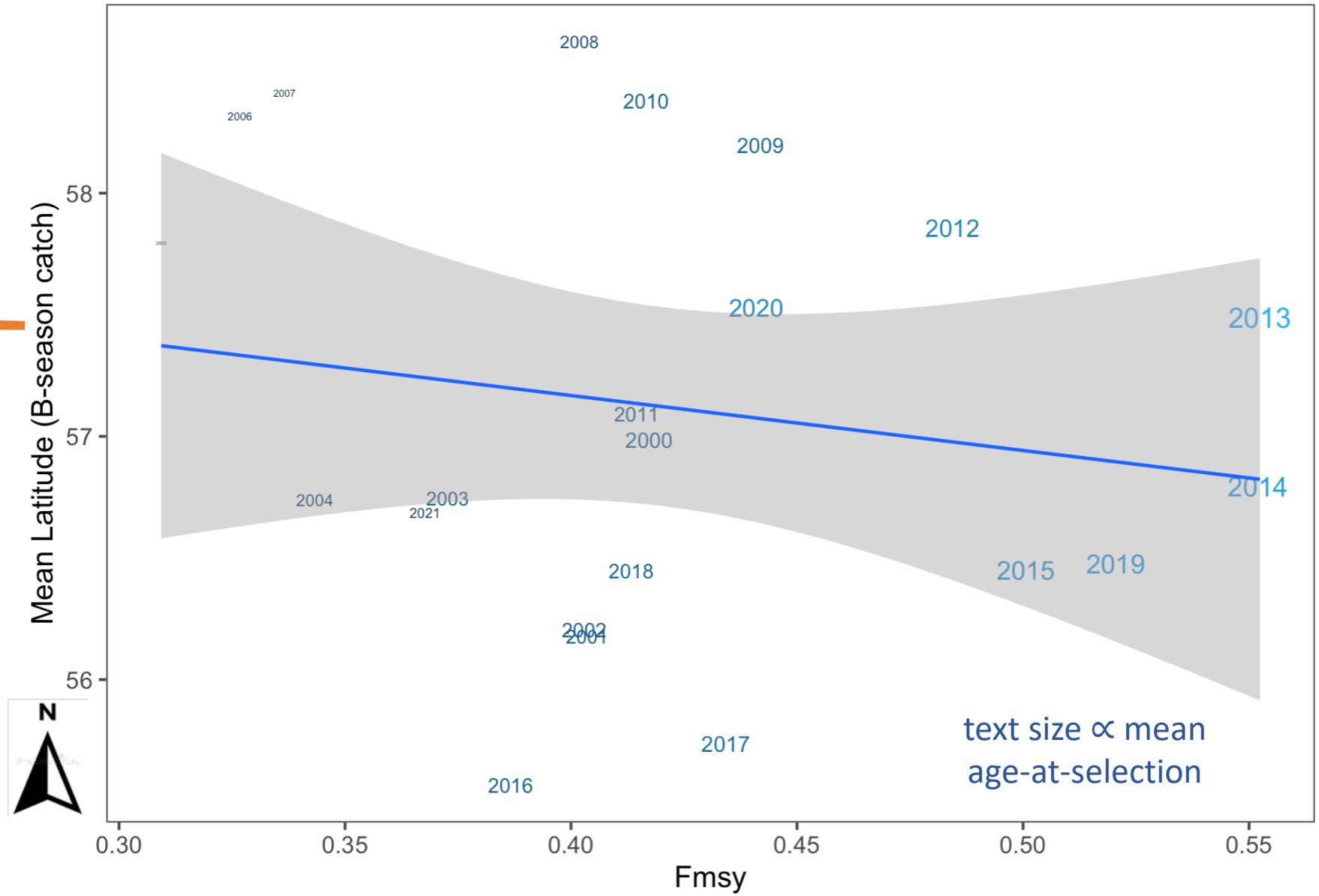
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
4
8
12
Age (years)

F_{MSY}

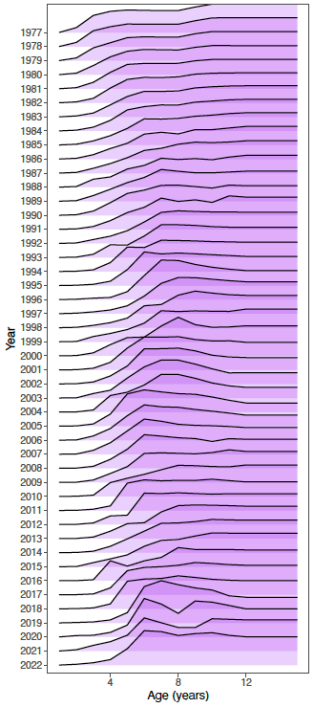
- By year and latitude (and F_{MSY})

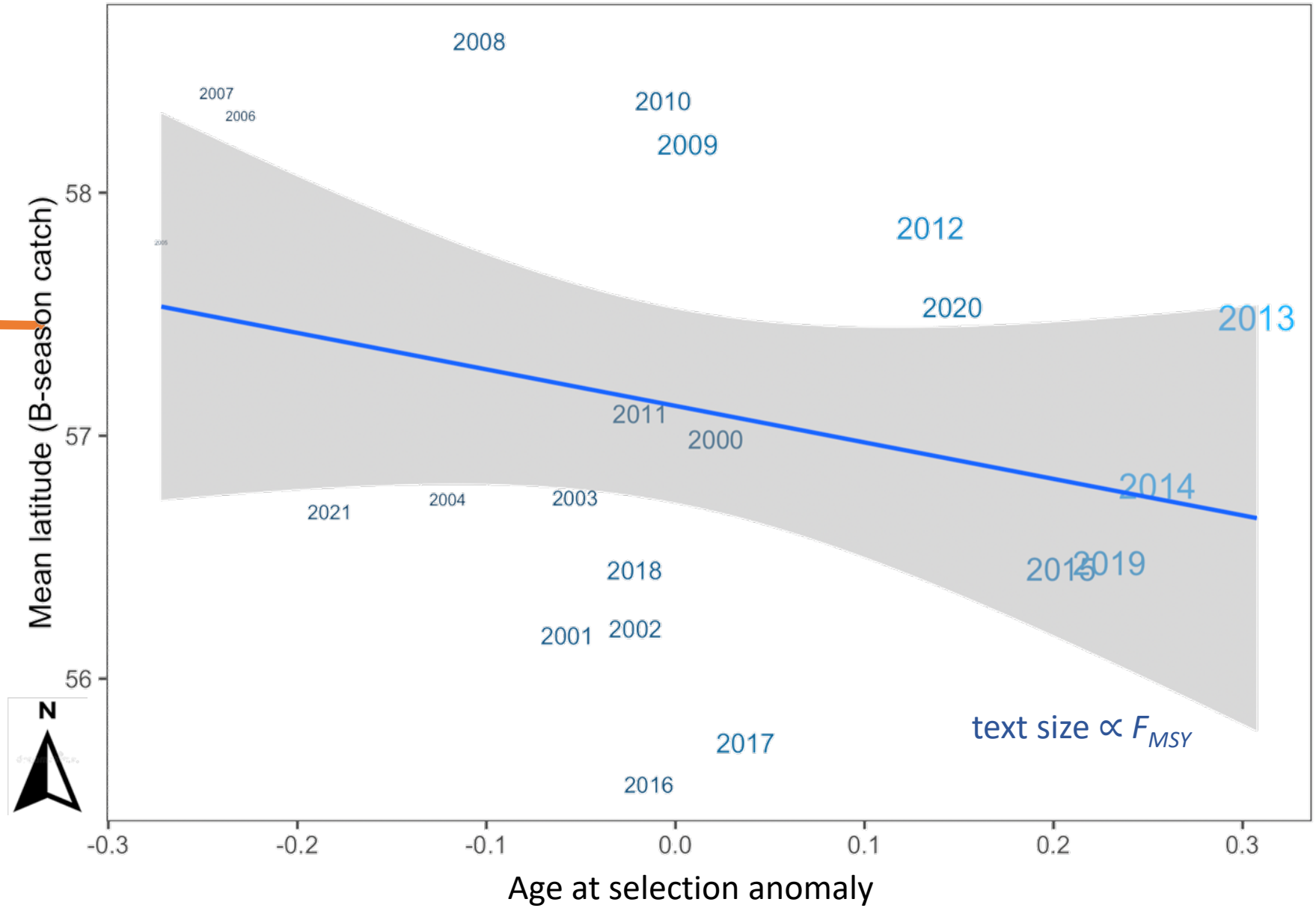


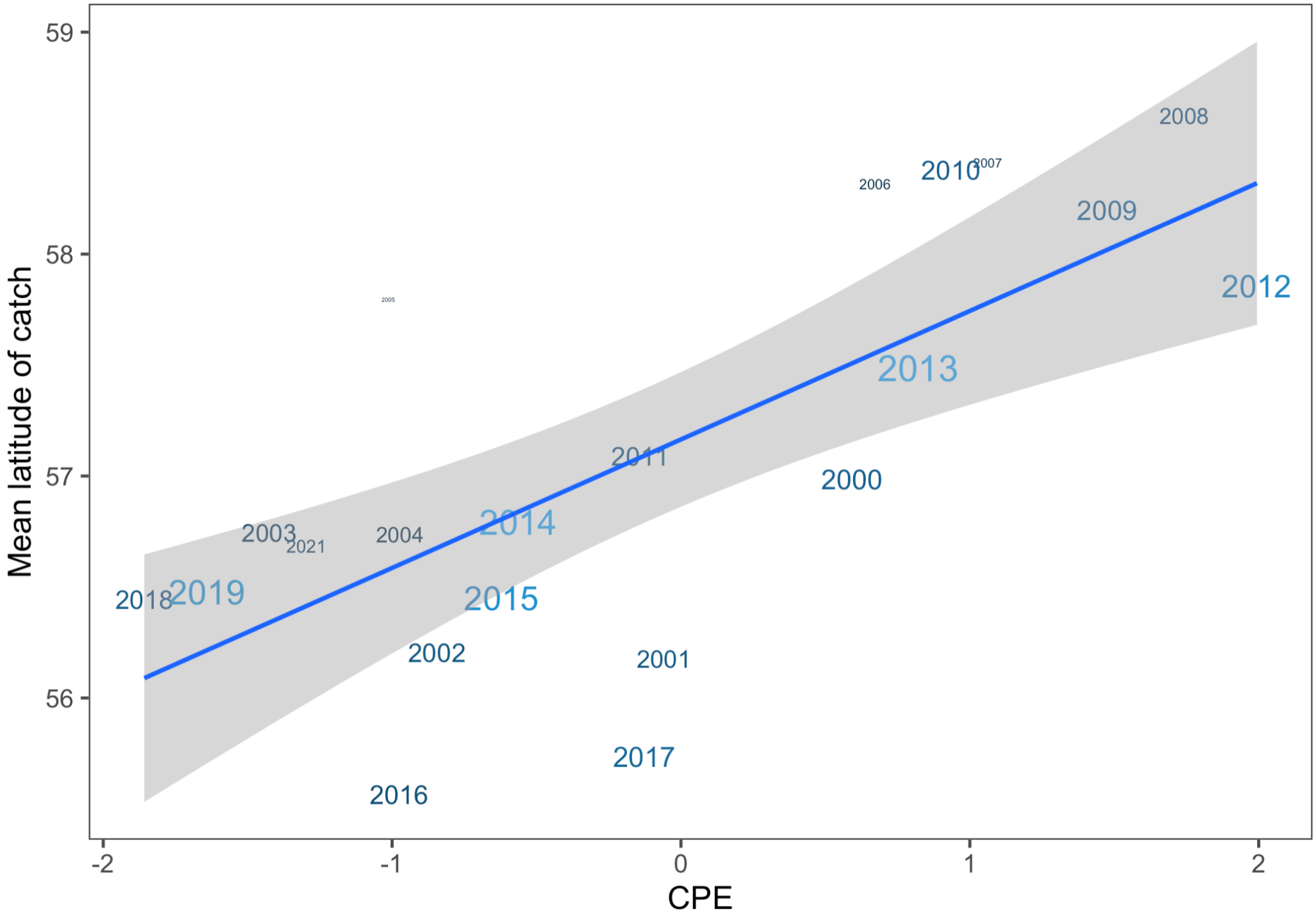


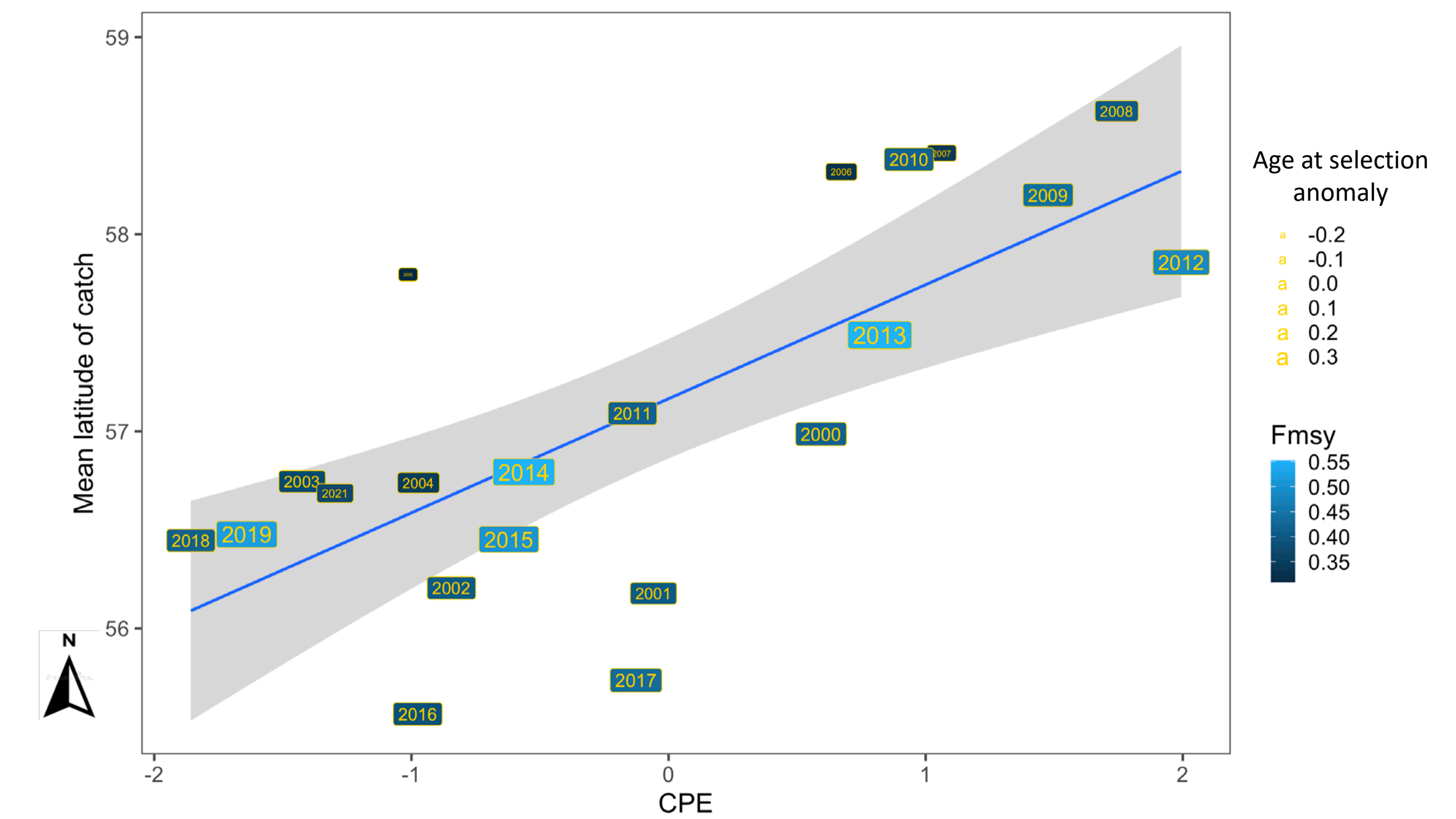
F_{MSY}

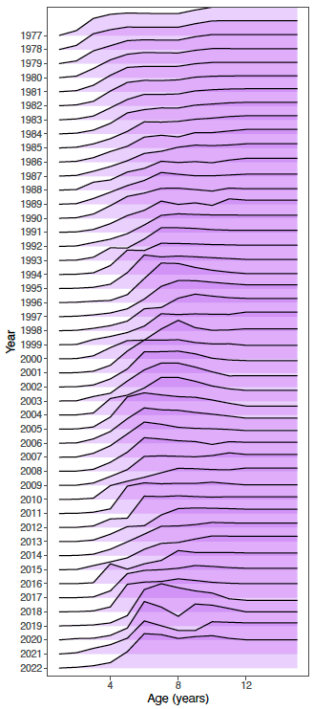
- By year and latitude
  (and mean selected age)

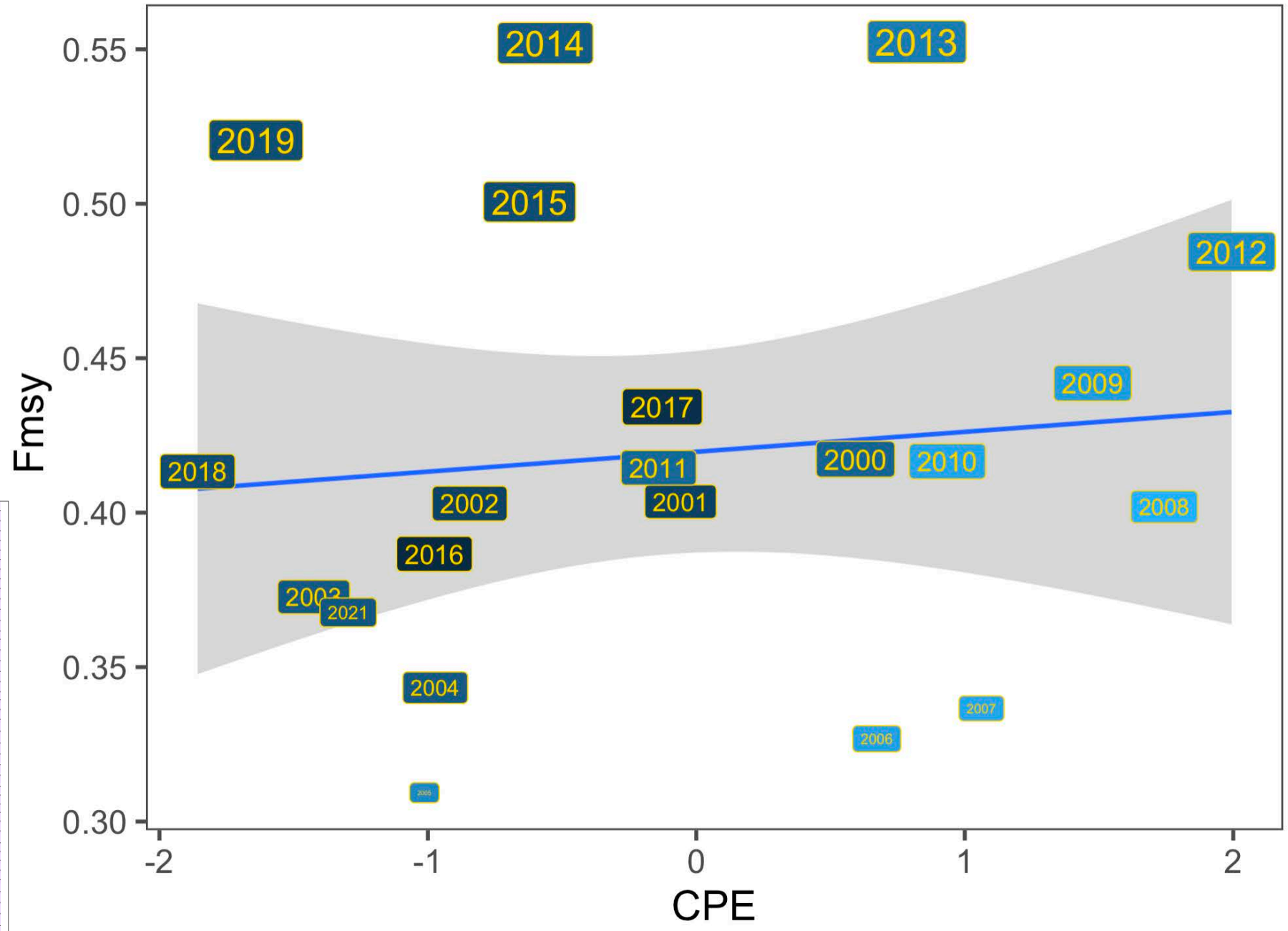





Mean latitude of catch
59
58
57
56
-2
-1
0
1
2
CPE
2008
2010
2007
2006
2009
2012
2005
2013
2011
2000
2003
2021
2004
2014
2018
2019
2015
2002
2001
2017
2016


Mean latitude of catch
59
58
57
56
-2
-1
0
1
2
CPE
2008
2010
2007
2006
2009
2012
2013
2011
2000
2014
2003
2021
2004
2018
2019
2015
2002
2001
2017
2016
N
Age at selection anomaly
a -0.2
a -0.1
a 0.0
a 0.1
a 0.2
a 0.3
Fmsy
0.55
0.50
0.45
0.40
0.35





Age at selection anomaly

a -0.2
a -0.1
a 0.0
a 0.1
a 0.2
a 0.3

MeanLat

58.5
58.0
57.5
57.0
56.5
56.0

N

Summary on spatial distributions

I recommend

- Continue to evaluate the interaction of spatial distribution of the fishery and the relative selectivity
  - Particularly as it pertains to F_{MSY} estimates and uncertainty

Other initiatives coming in November 🤞

Make the calculations of Tiers 1, 2, and 3 more transparent

- SSC and others (including me!) had difficulty tracking down calcs

AVO, ATS, and BTS (EBS + NBS) survey data should all be available

- Age data from 2021 fishery + 2022 BTS data as well

2011 assessment MEY calculation to be revisited?

Closer look at EM data (for spatial analyses)