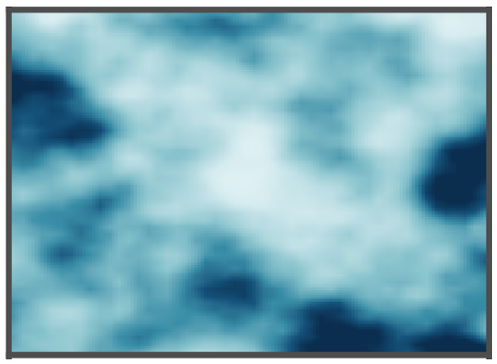
Integrating transboundary survey data using spatiotemporal models

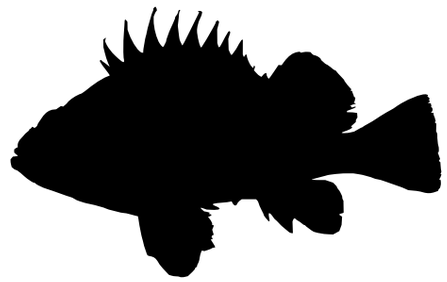
Lessons from the Northeast Pacific

Sean C. Anderson
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PICES, October 2026

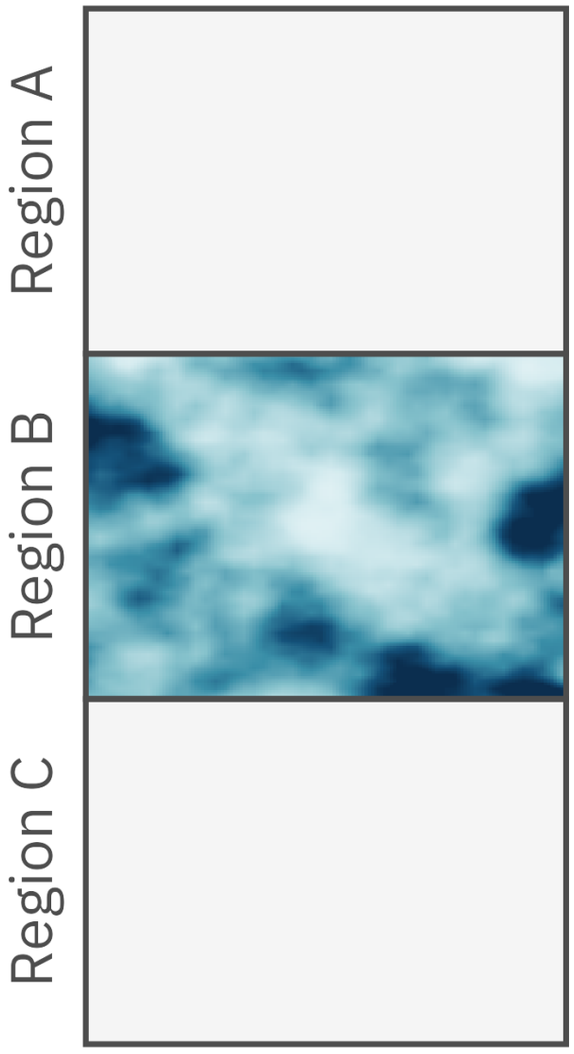
A story of one survey and one fish species



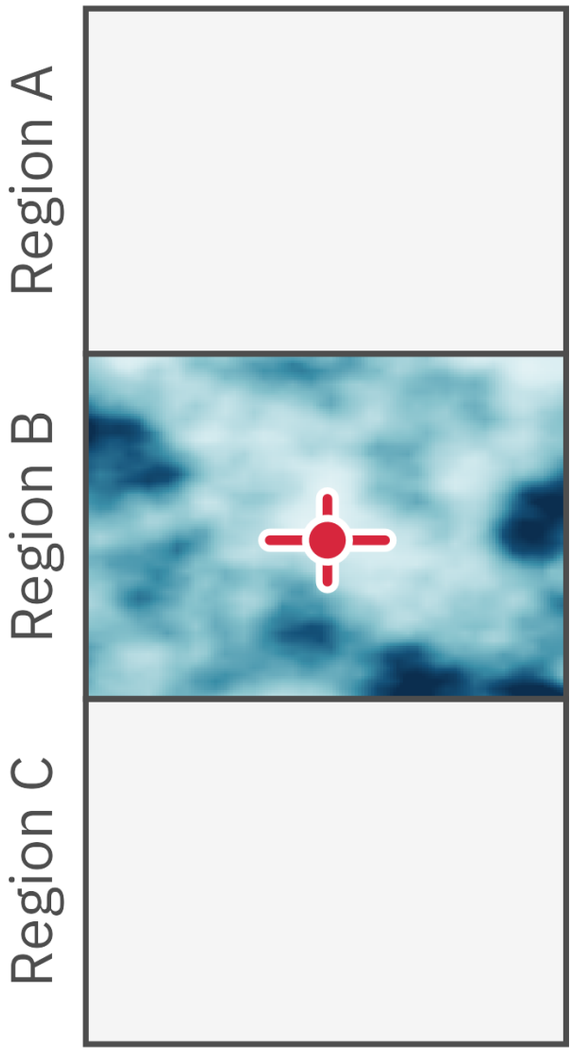


Distribution from one survey region

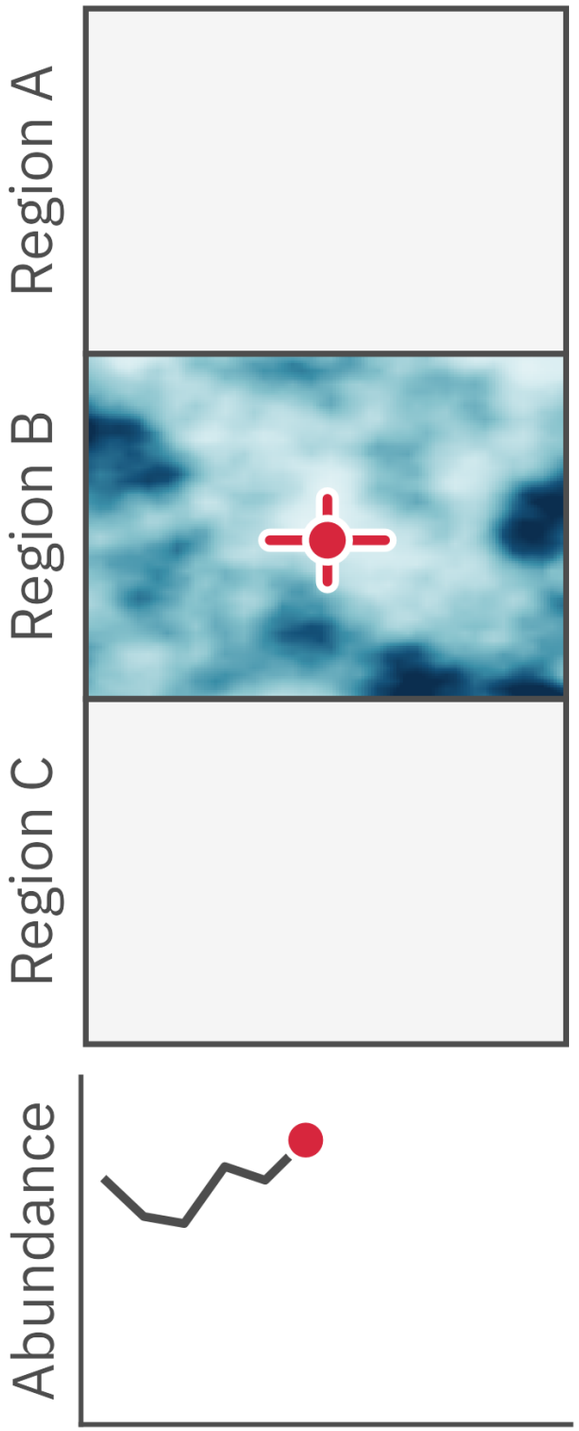
What does our survey see?



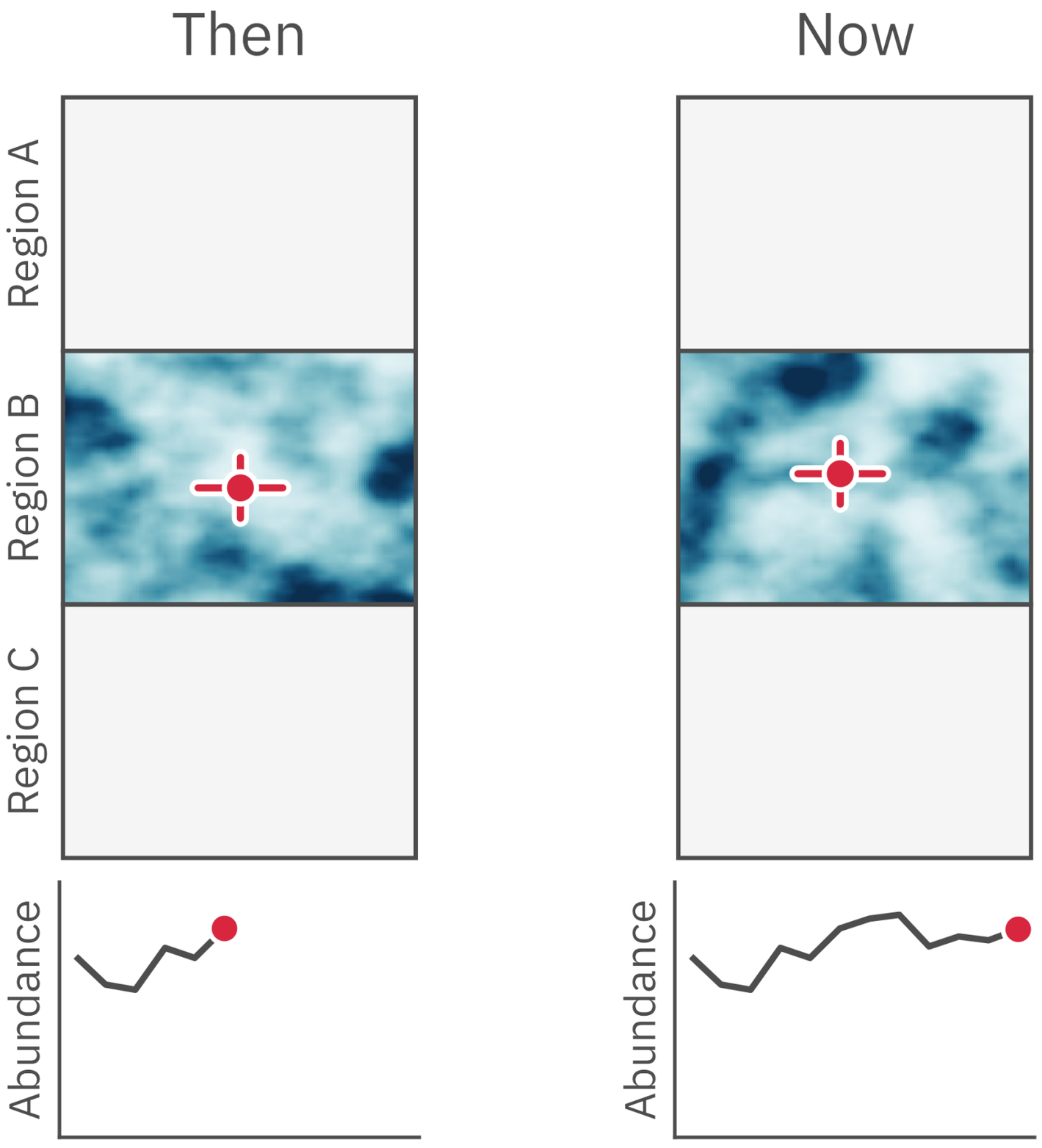
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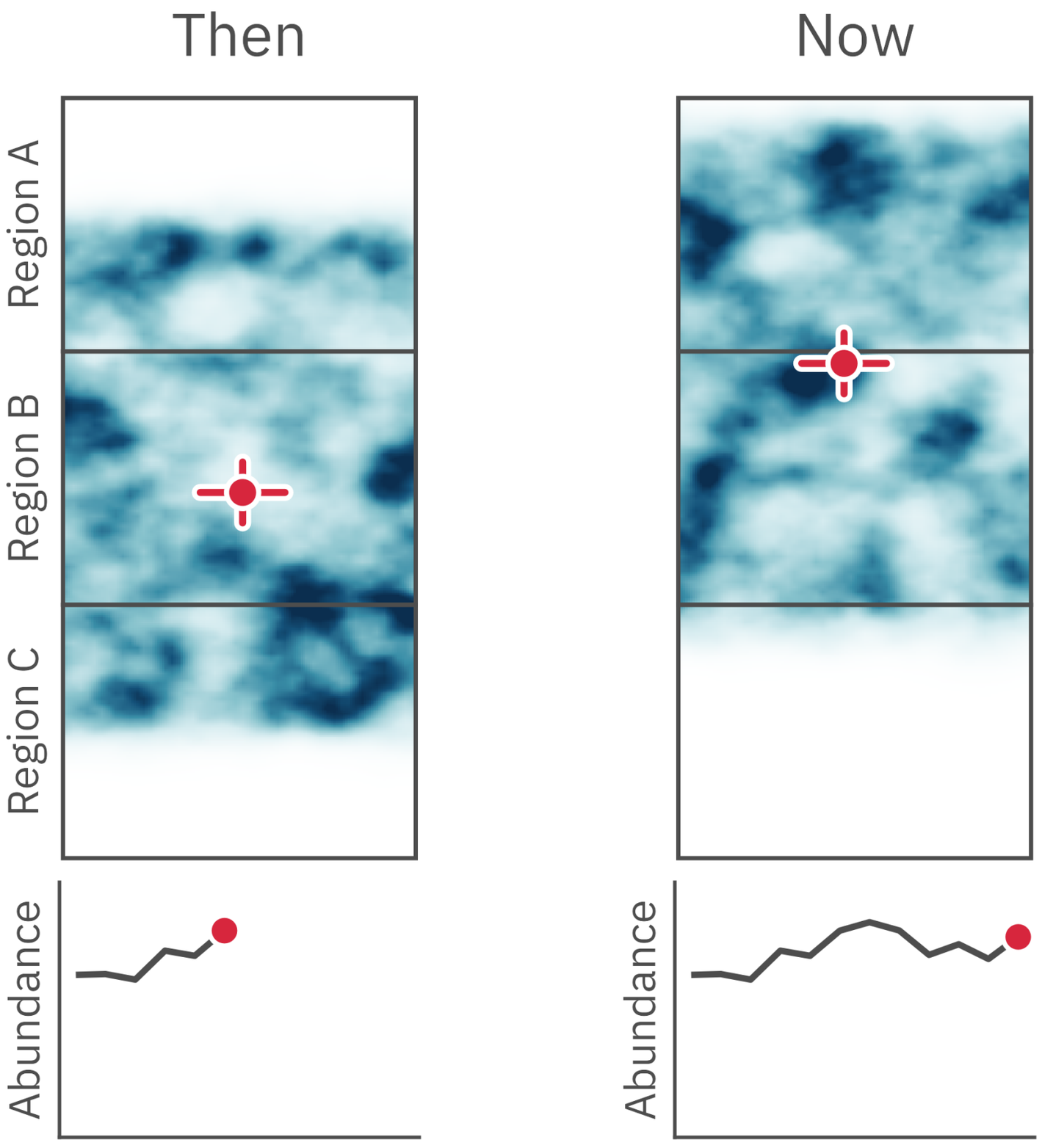
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What does our survey see?



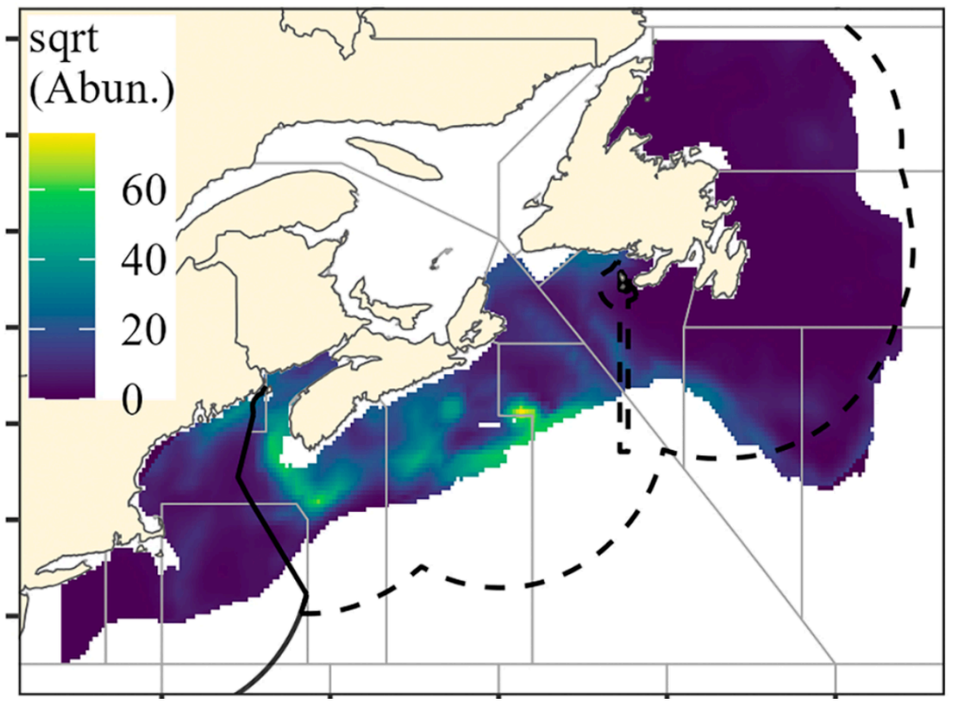
One survey alone can miss a distribution shift

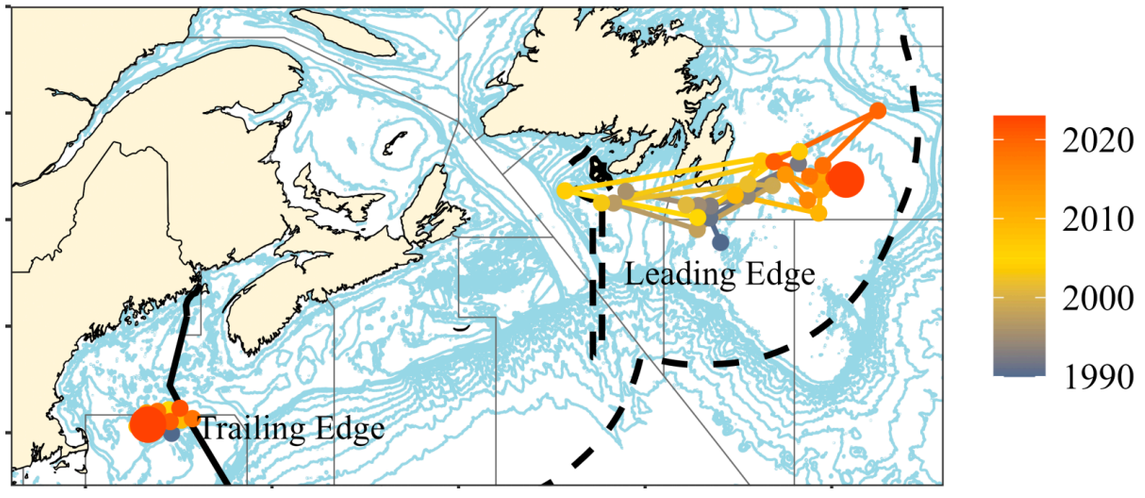


Atlantic halibut expanded north

A single survey view off Nova Scotia would have missed this

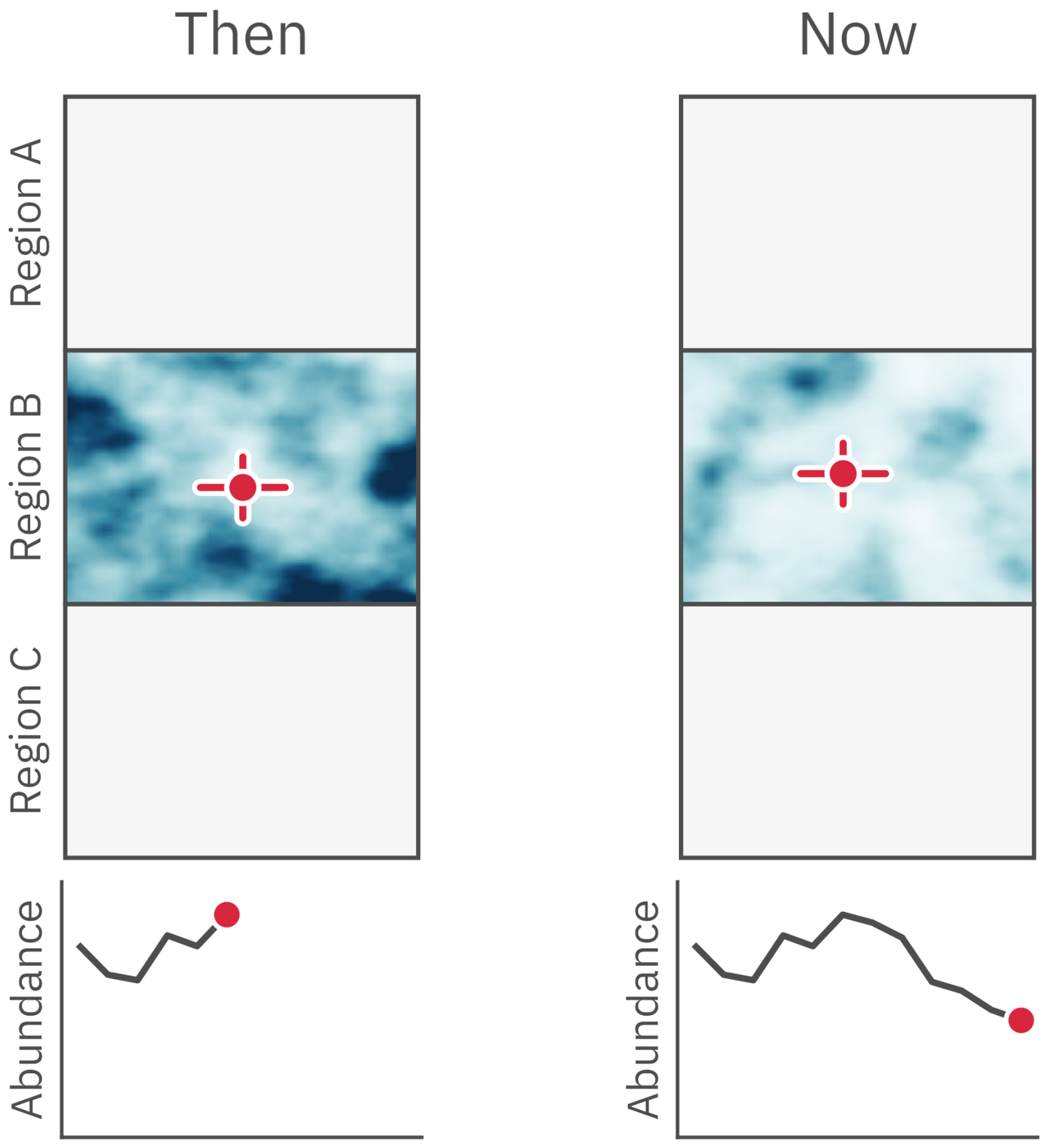




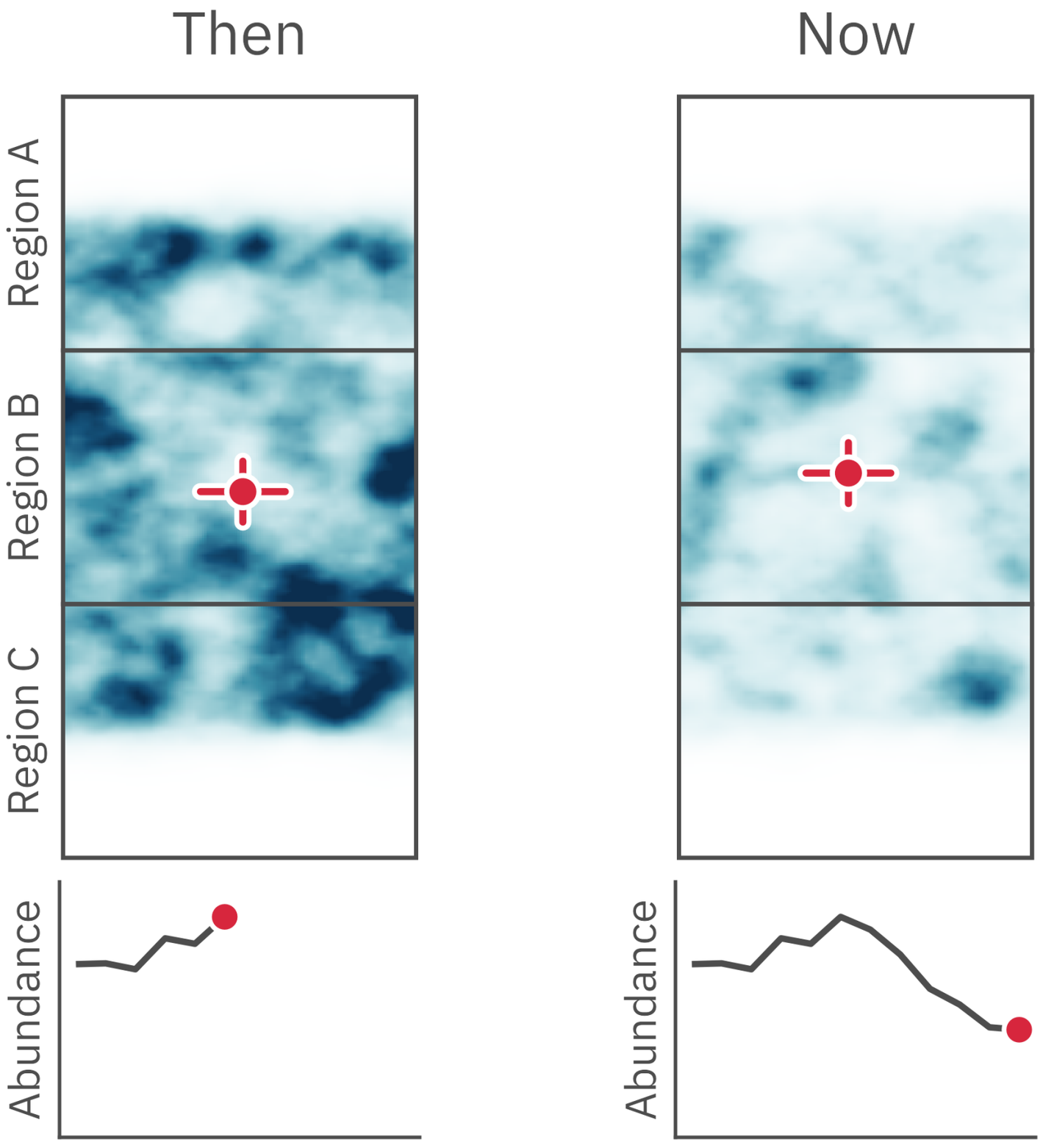


Shackell et al. (2026) Ecol. Appl. https://doi.org/10.1002/eap.70311

Survey B sees a decline. Did the fish move north?

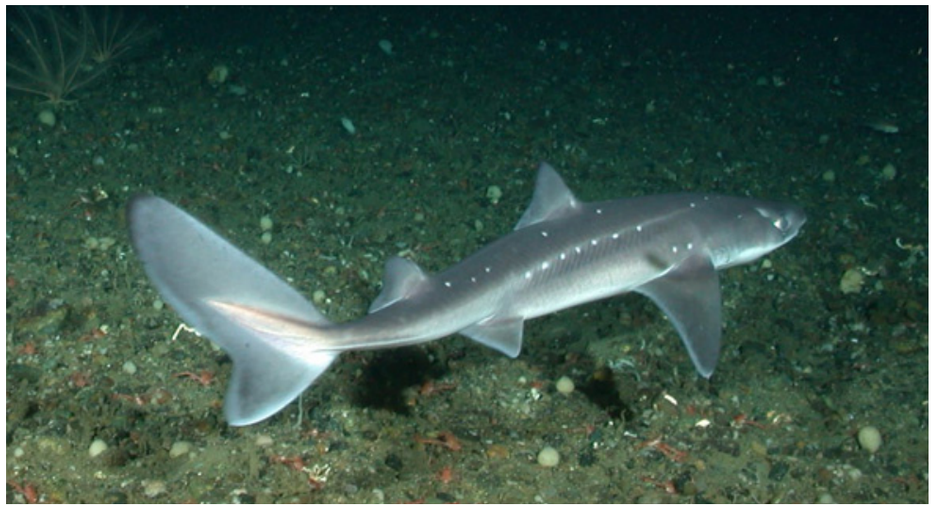


One survey can't tell a shift from a decline

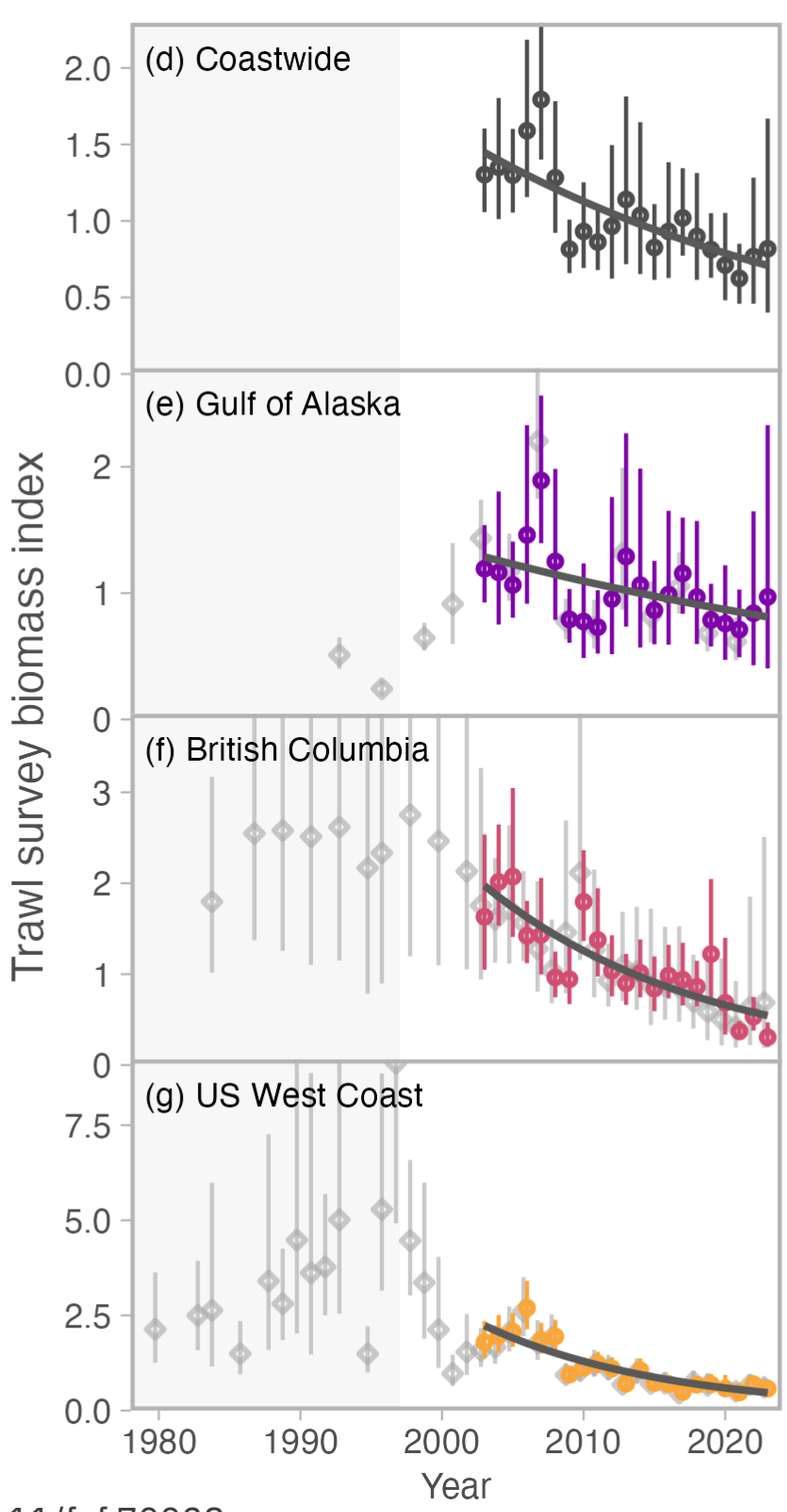


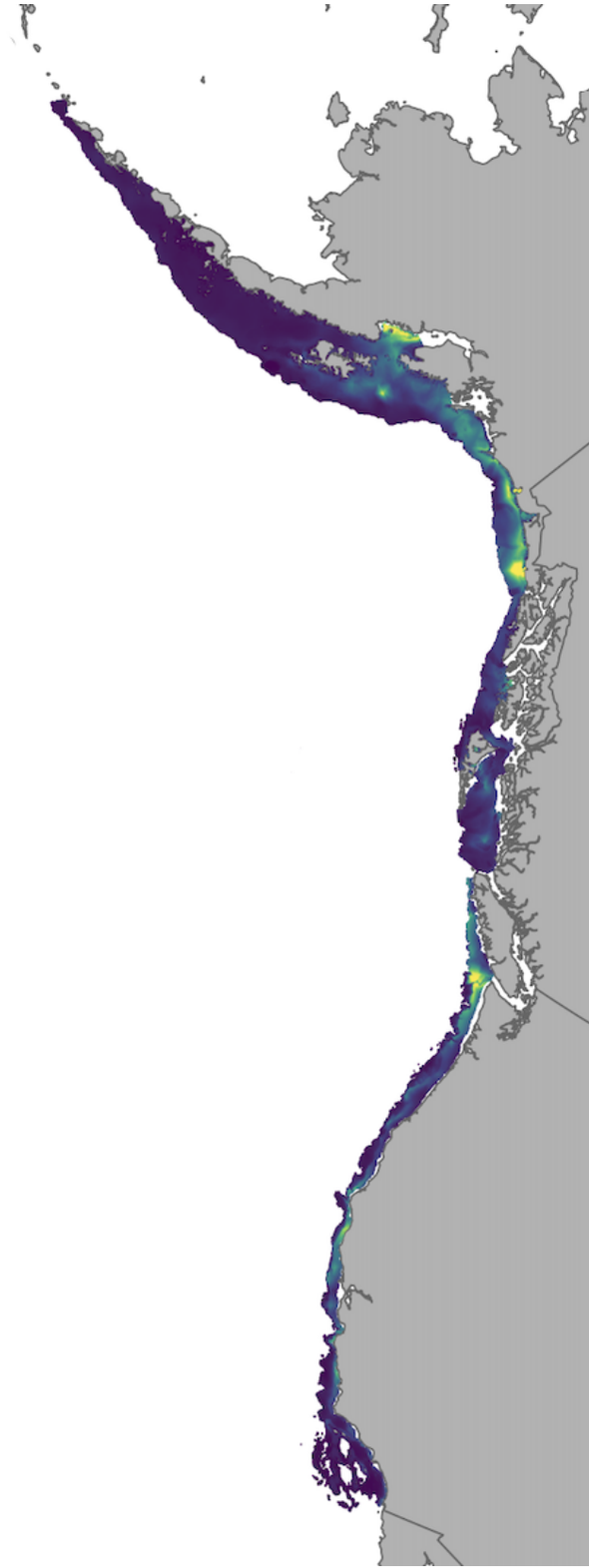
Dogfish declined everywhere rather than moving north

Without a whole-stock view we may incorrectly blame range shifts



NOAA's National Ocean Service





Coastwide decline: ~51%

13-54% in Alaska

58-82% in Canada

71-85% on US West Coast

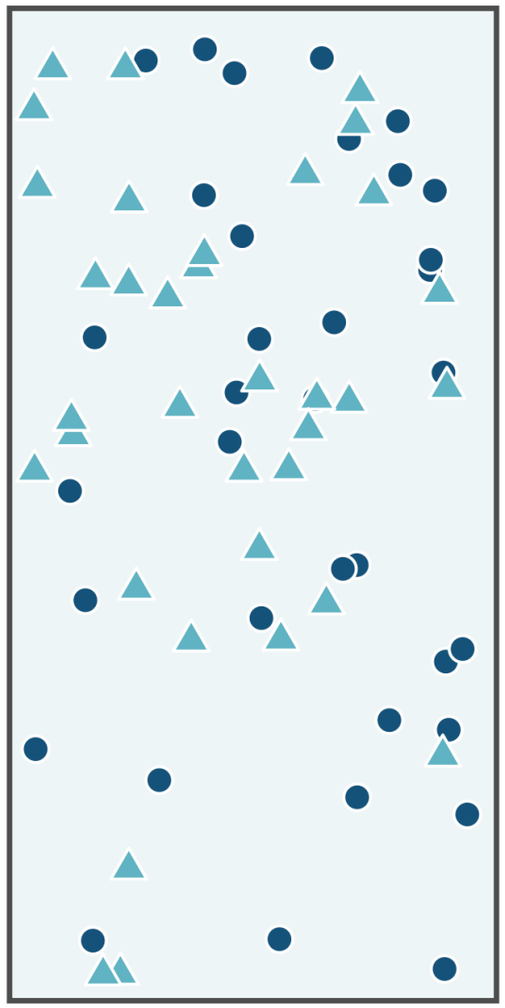
Davidson et al. (2026) Fish and Fisheries https://doi.org/10.1111/faf.70028

We need a whole-stock view, so we need to combine surveys across borders

We have the statistical tools to do this

Data integration = combining multiple data sources in one model

Same domain

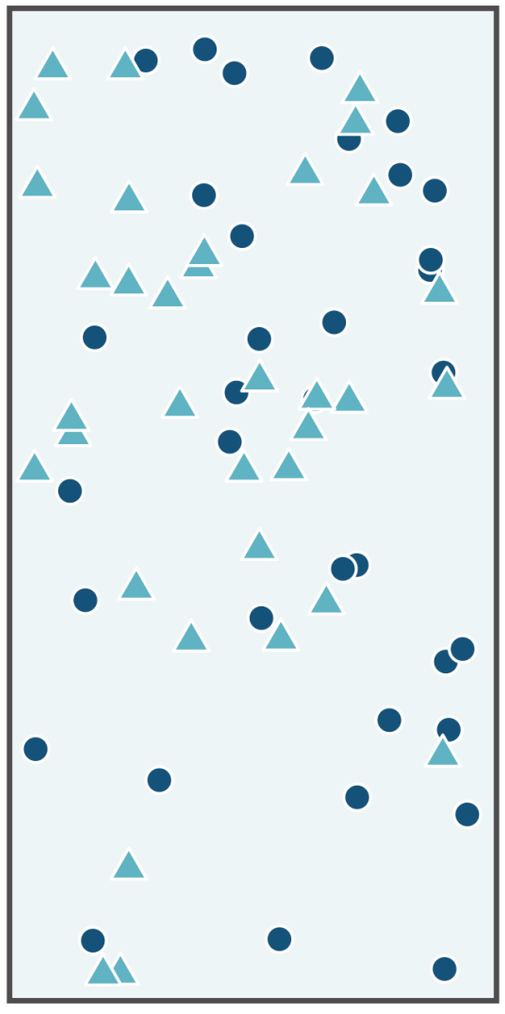


e.g., trawl and longline surveys in one area

Survey 1 Survey 2

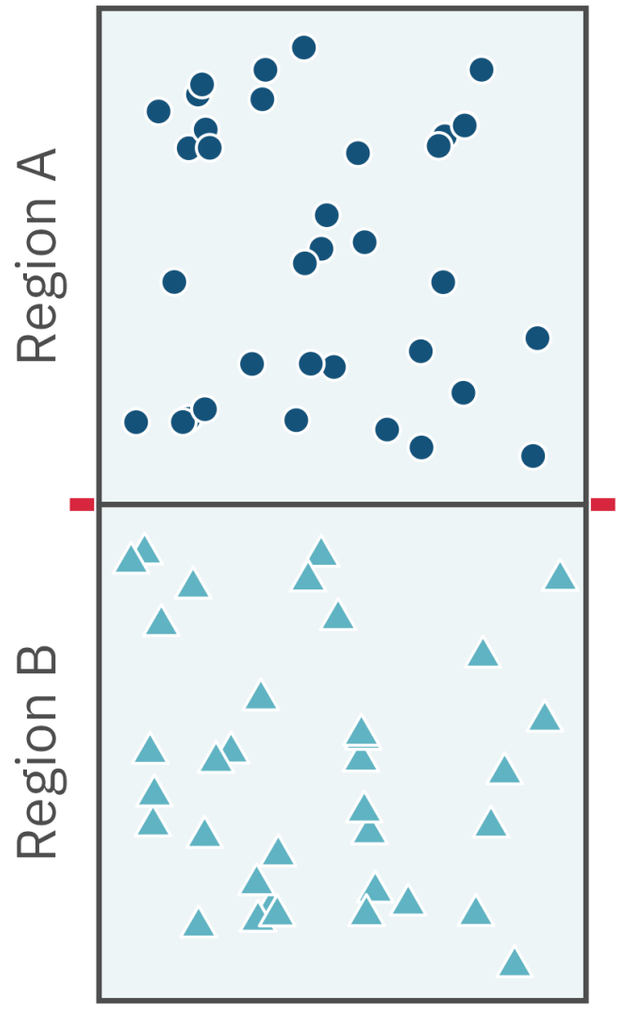
Data integration = combining multiple data sources in one model

Same domain



e.g., trawl and longline surveys in one area

Expanded domain



e.g., neighbouring national surveys

Survey 1 Survey 2

"Expanded domain" term: Grüss et al. (2025) Fisheries Research https://doi.org/10.1016/j.fishres.2025.107321

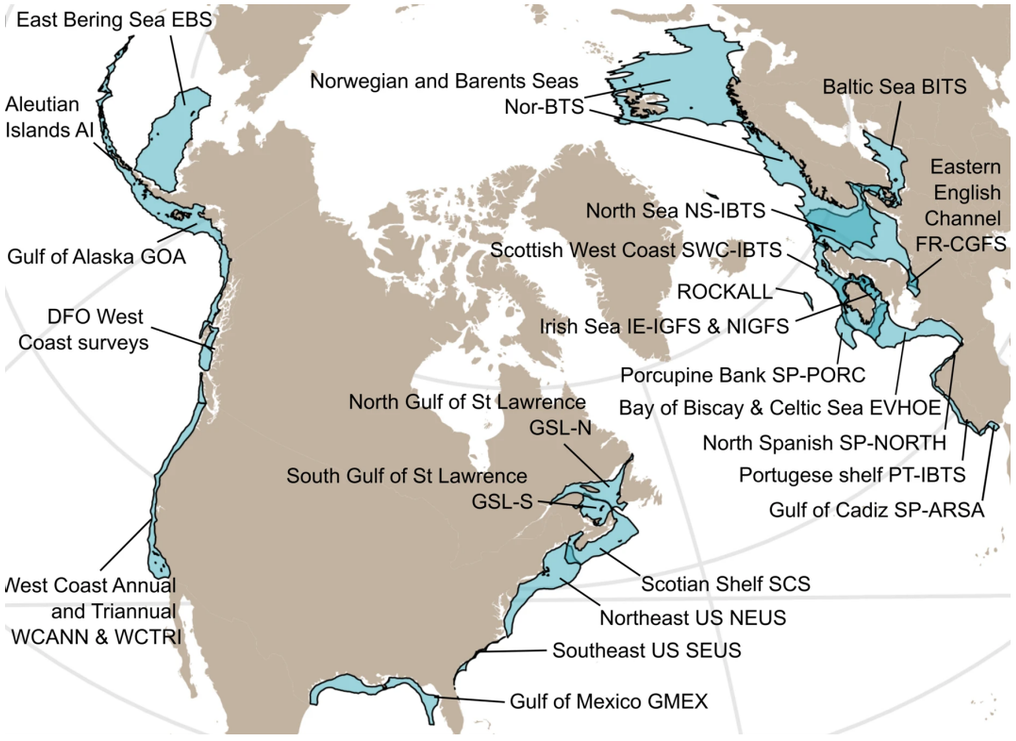
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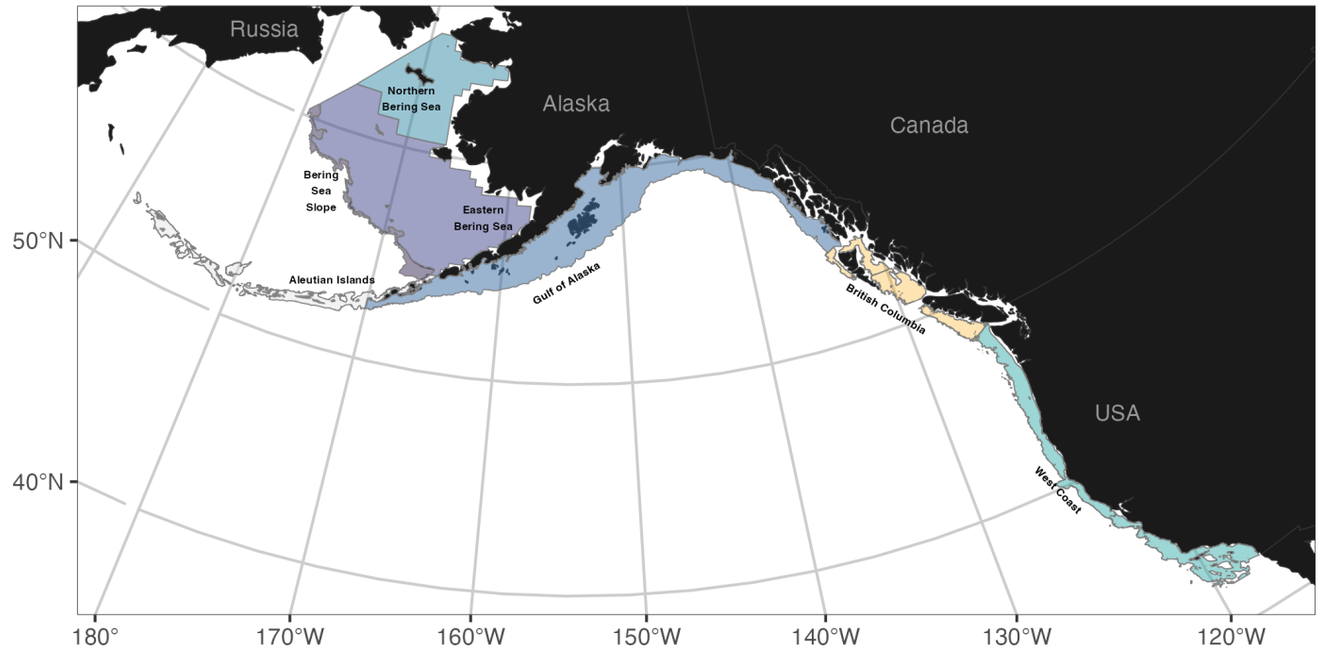


"Expanded domain" term: Grüss et al. (2025) Fisheries Research https://doi.org/10.1016/j.fishres.2025.107321

Getting the data

Multi-region databases take the pain out of obtaining the data from neighbouring countries





fish glob
Fish Biodiversity facing Global change

https://fishglob.sites.ucsc.edu/

Maureaud et al. (2024) Scientific Data. https://doi.org/10.1038/s41597-023-02866-w

surveyjoin

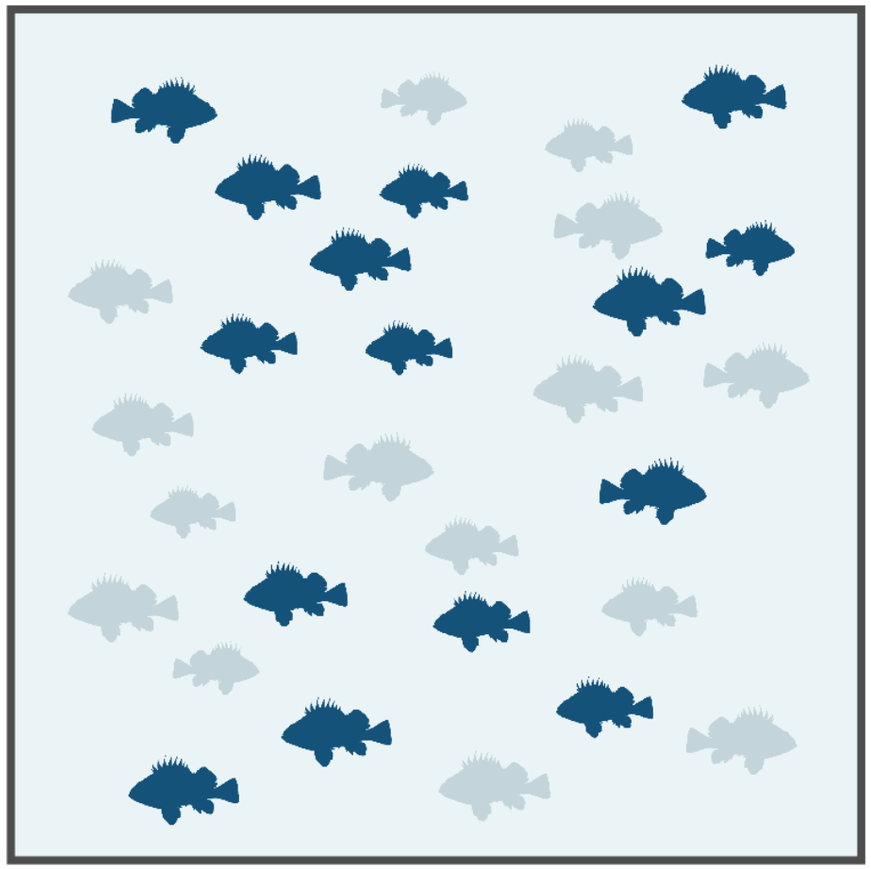
https://github.com/DFO-NOAA-Pacific/surveyjoin

Ward et al. (2025) PeerJ. https://doi.org/10.7717/peerj.19964

Modelling differences in catchability

Survey gear sees a fraction of the fish, and the fraction differs by survey

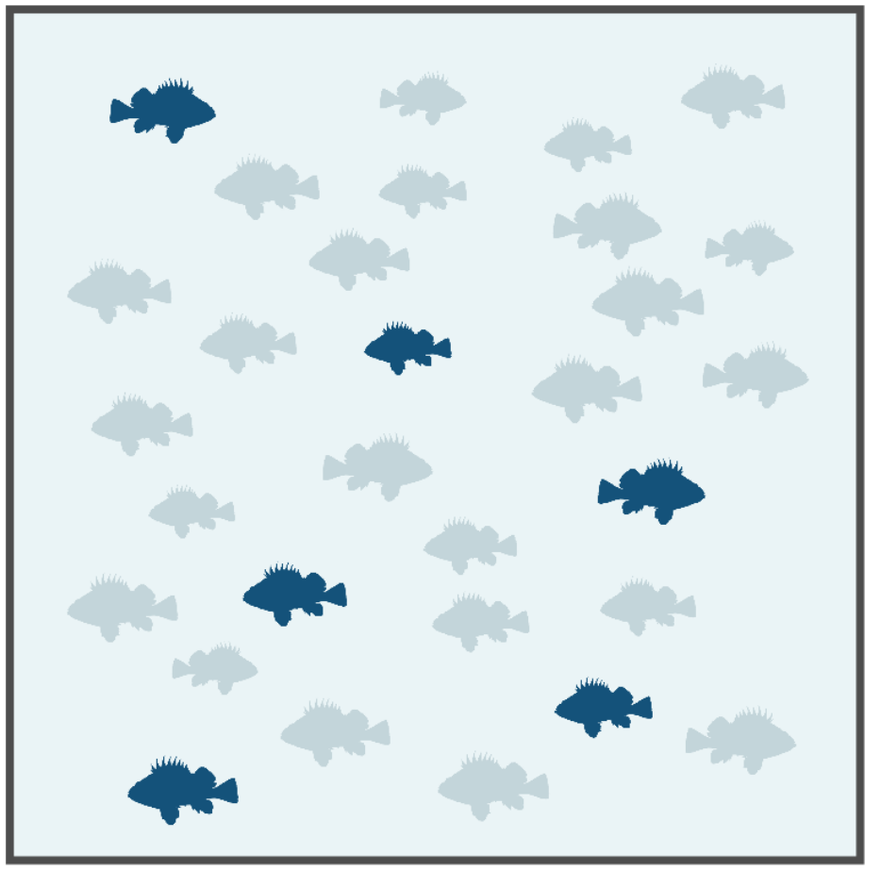
Survey A



Catches 15 of 30 fish

Catchability = 0.5

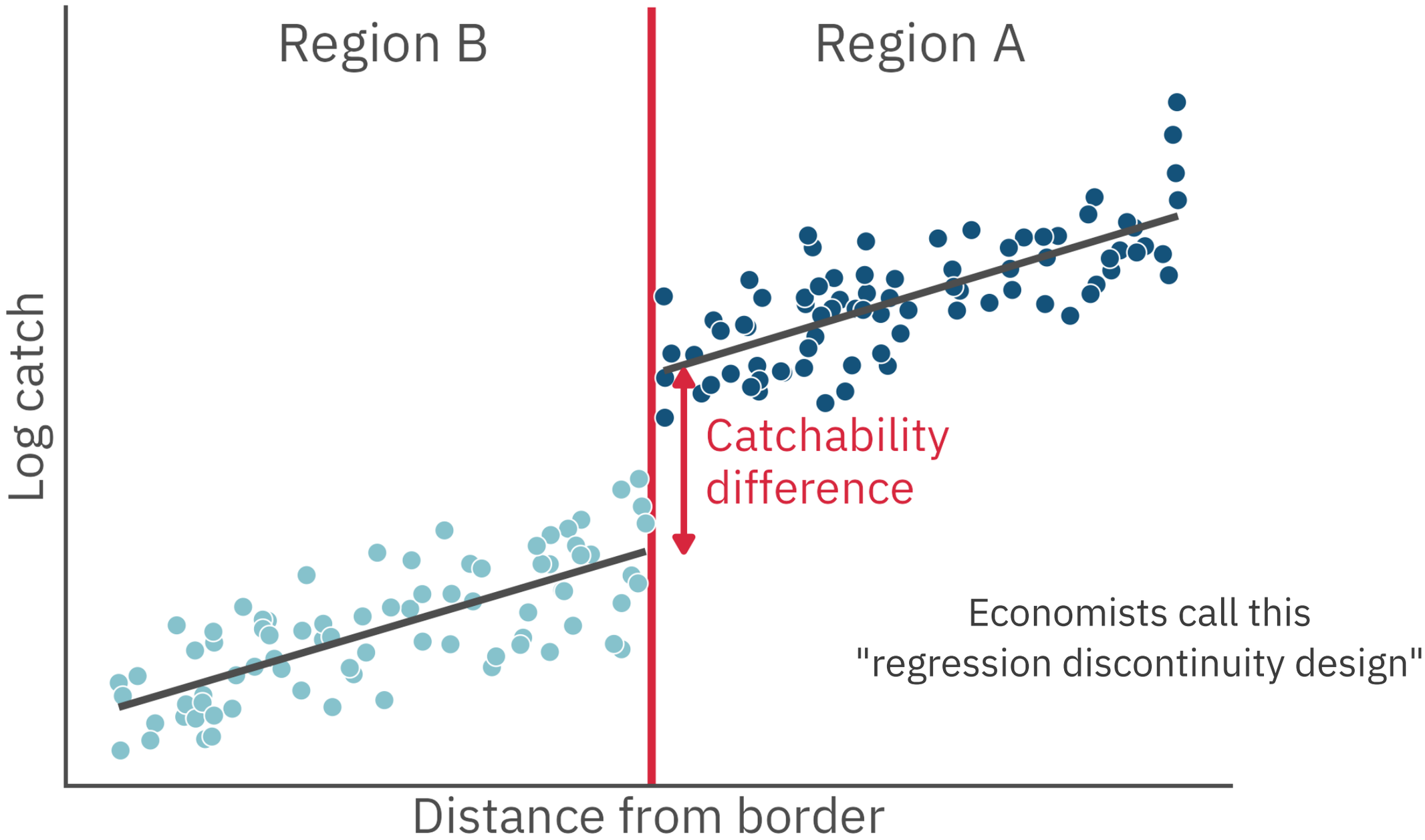
Survey B



Catches 6 of 30 fish

Catchability = 0.2

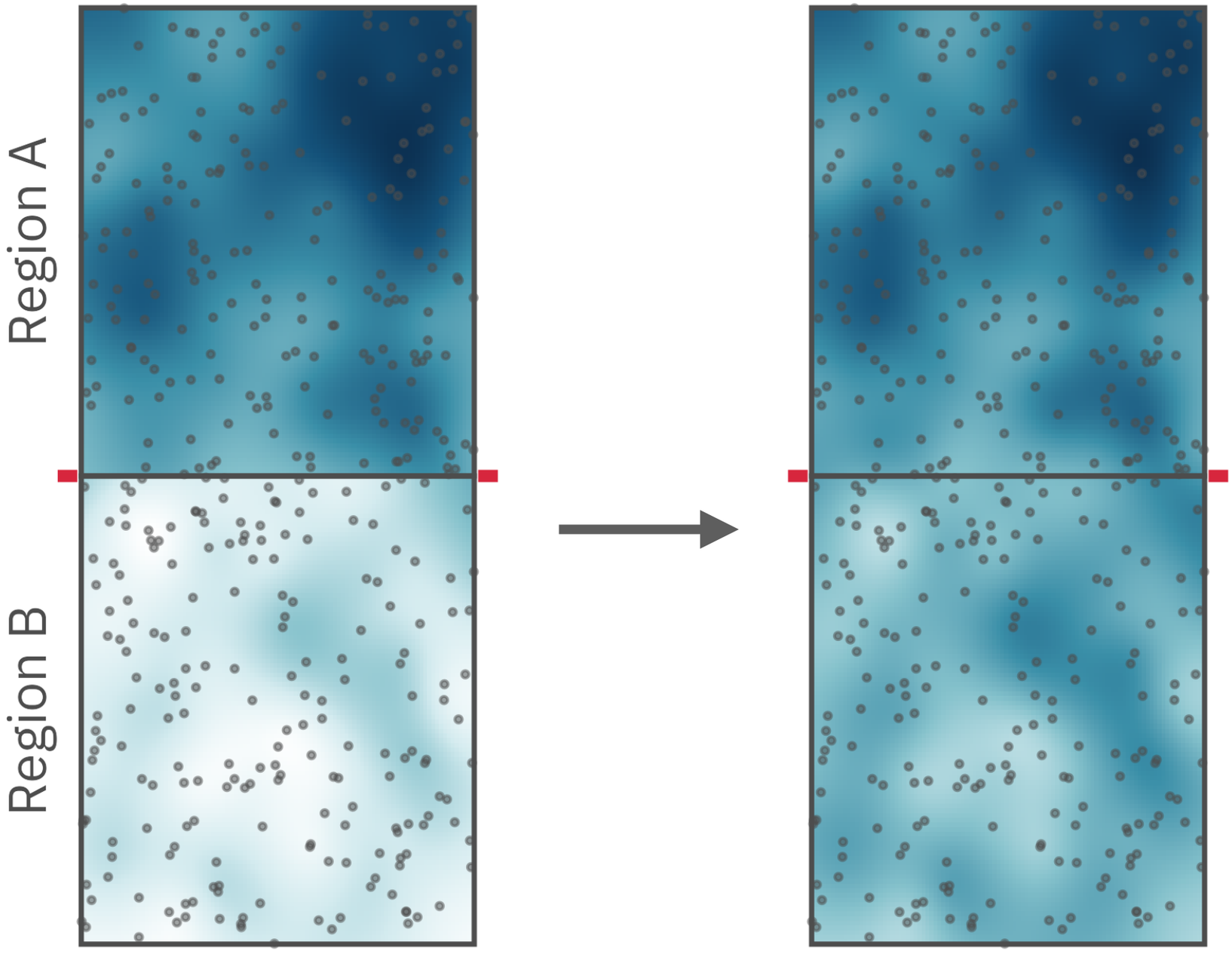
Fish don't stop at borders, so true density should be smooth across them



Calibrating removes the artificial jump at the border

Not accounting for catchability differences

Standardizing to a single catchability



Spatiotemporal models can separate the survey from the fish

catch = catchability × effort × density × noise

the survey

the fish

depth, temperature, location, year

Can be fit with sdmTMB, an R package for large spatiotemporal datasets



https://github.com/sdmTMB/sdmTMB

The code doesn't have to be hard

although the judgement calls might be!

```
fit ← sdmTMB(
  catch ~ s(depth) + factor(year) + factor(survey),
  data = dat,
  time = "year",
  family = tweedie(),
  offset = log(dat$effort),
  spatial = "on",
  spatiotemporal = "ar1"
)

grid$survey ← "A"
predictions ← predict(fit, newdata = grid)

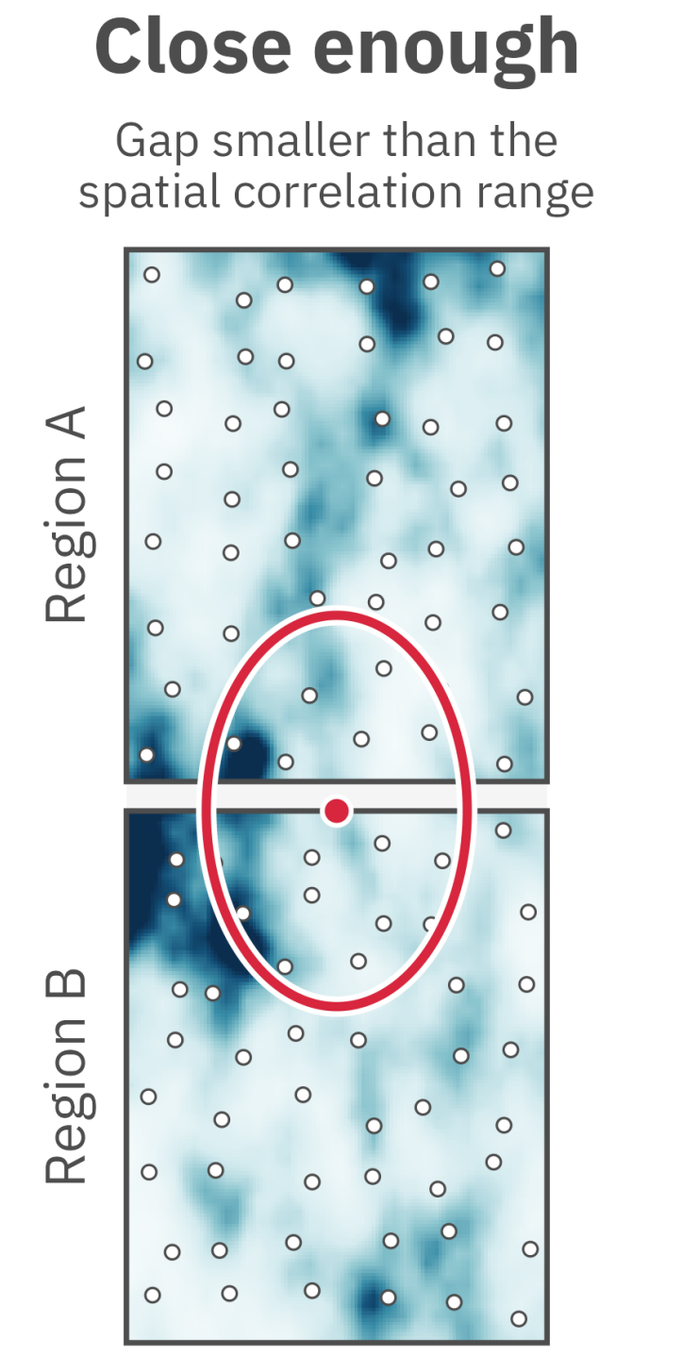
index ← get_index(fit, newdata = grid)
distribution_centre ← get_cog(fit, newdata = grid)
 ...
```



https://github.com/sdmTMB/sdmTMB

Deciding when expanded domain data integration is reasonable

Expanded domain integration depends on spatial proximity with help from environmental covariates



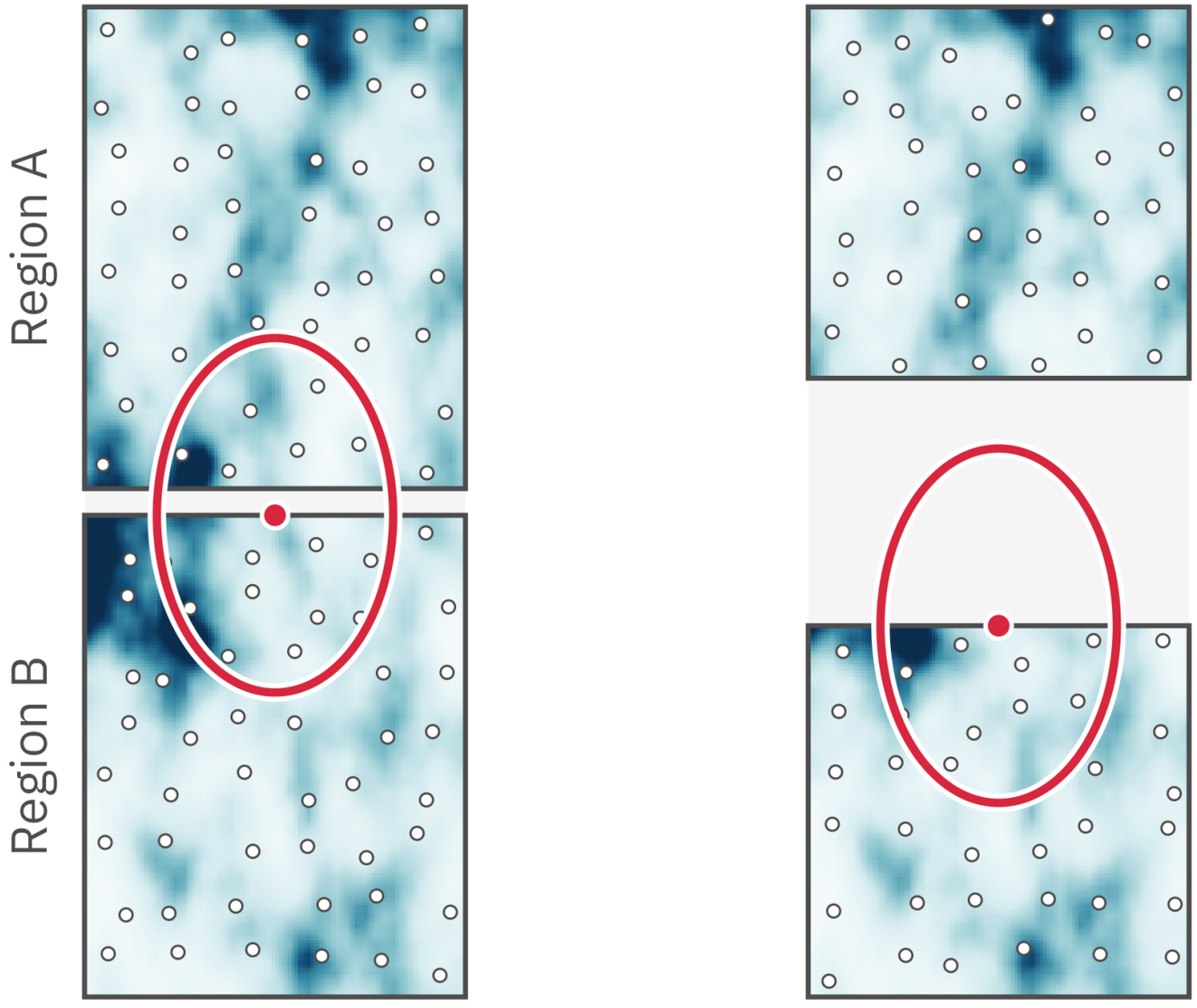
Expanded domain integration depends on spatial proximity with help from environmental covariates

Close enough

Gap smaller than the spatial correlation range

Too far

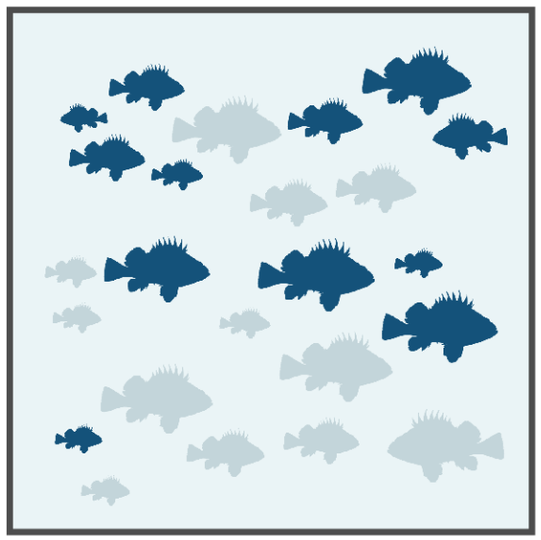
Gap larger than the spatial correlation range



Oval = spatial correlation range

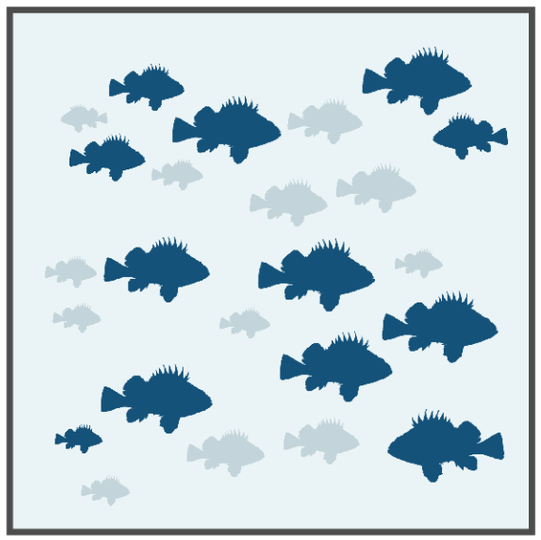
Catchability for different fish lengths ("selectivity") can vary by survey too

Survey A



Catches 12 of 24 fish
All sizes

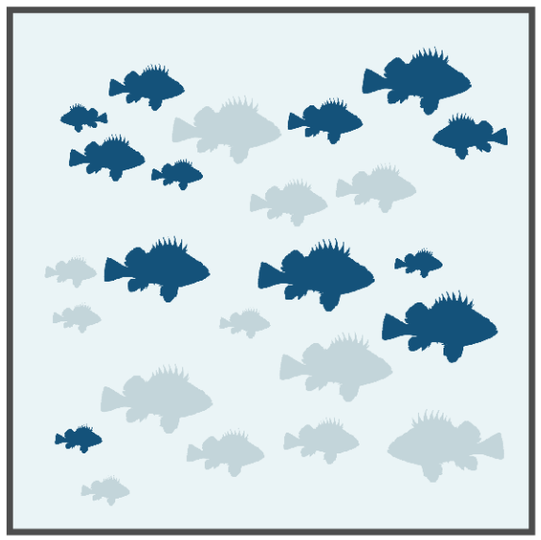
Survey B



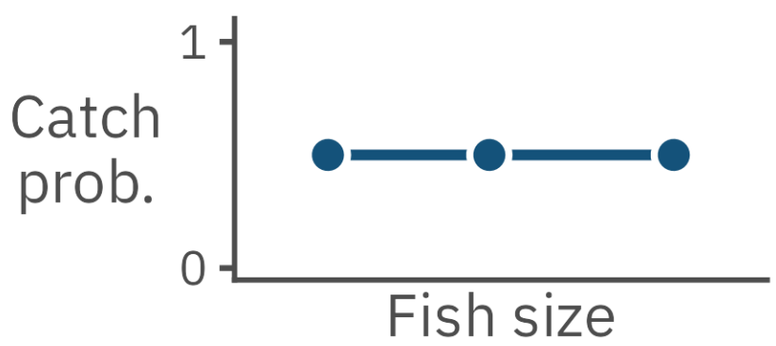
Catches 12 of 24 fish
Mostly large fish

Catchability for different fish lengths ("selectivity") can vary by survey too

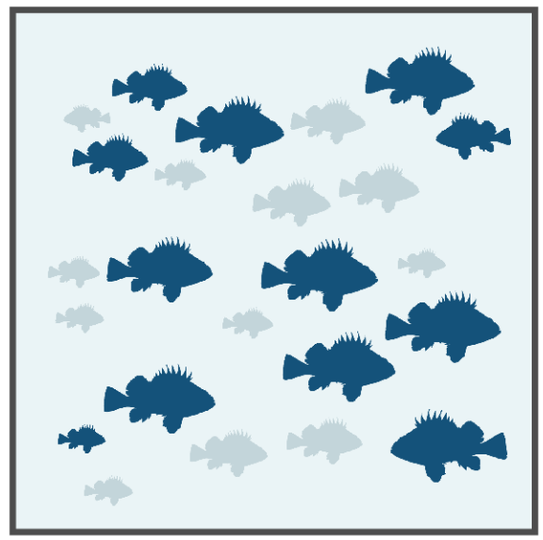
Survey A



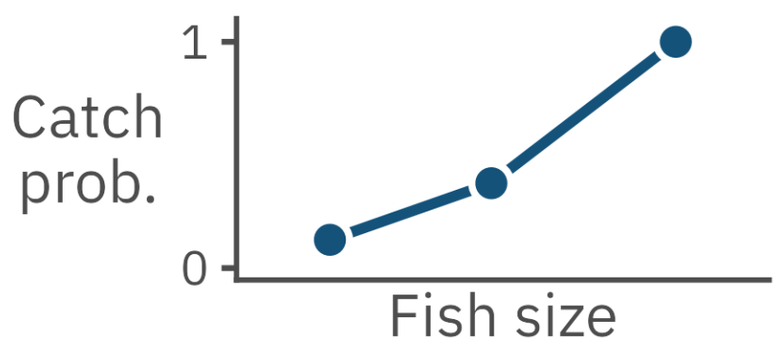
Catches 12 of 24 fish
All sizes



Survey B



Catches 12 of 24 fish
Mostly large fish



Should I integrate survey data?

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1. Same population?

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2. Close enough in time and space?

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3. Similar size selectivity? If not, model it.

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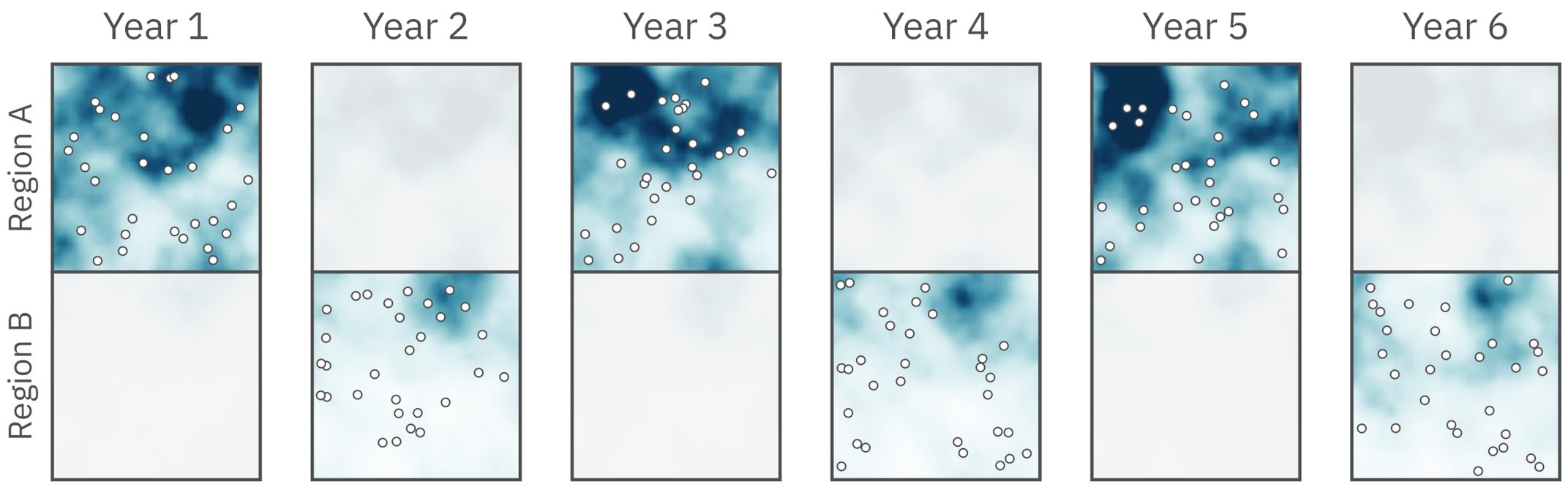
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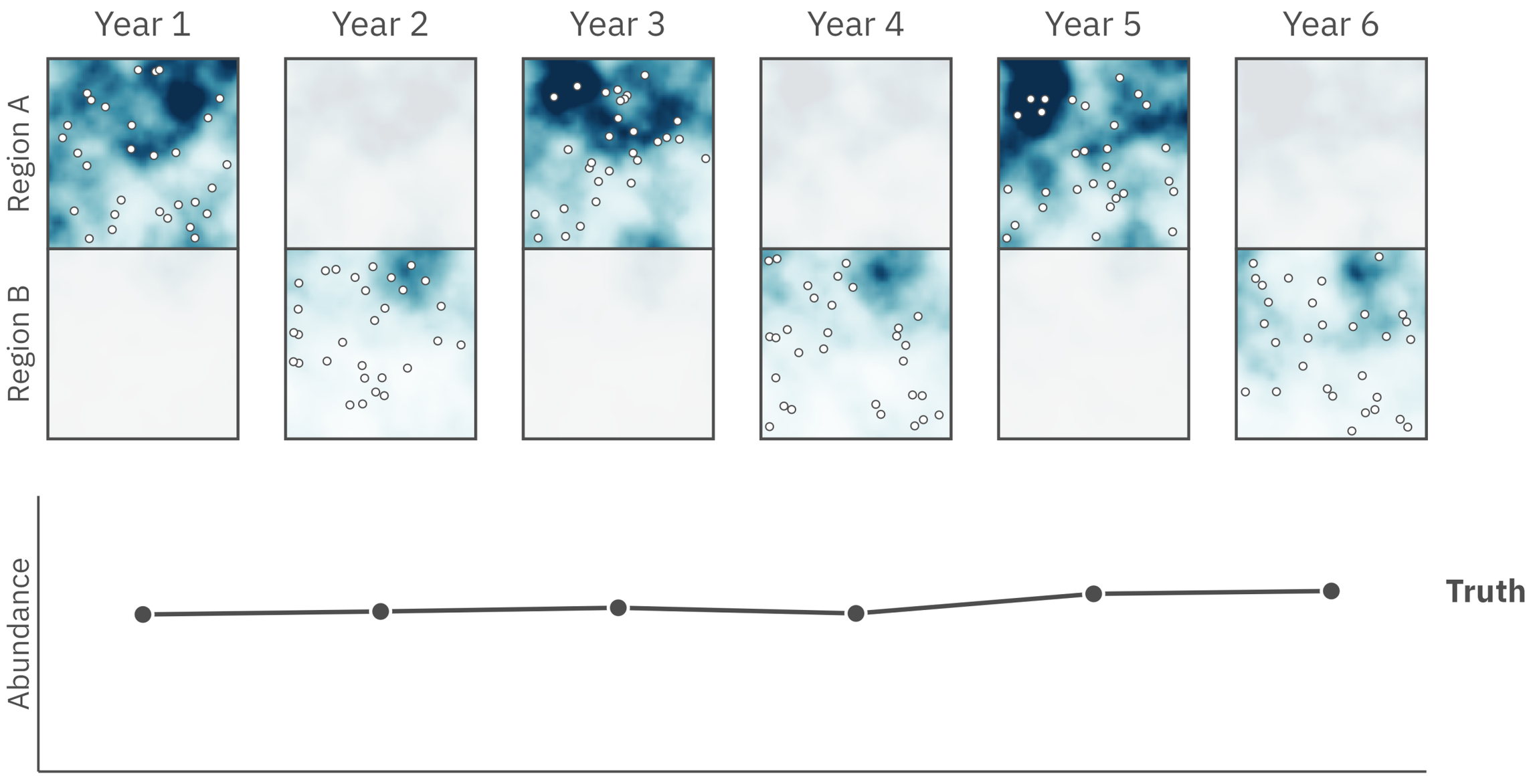
4. Consistent story?

Avoiding modelling artefacts

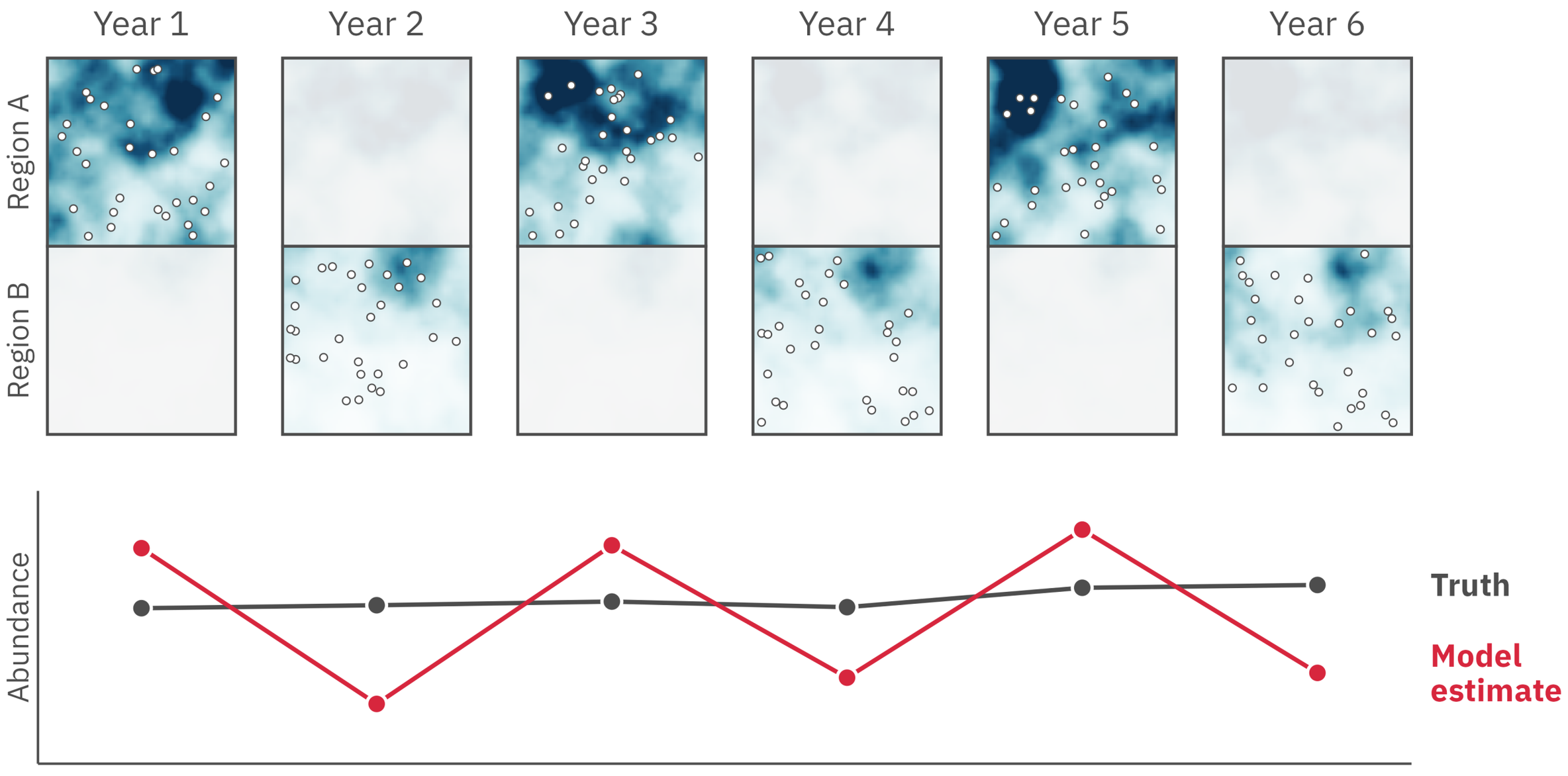
Alternating surveys can make the index seesaw



Alternating surveys can make the index seesaw



Alternating surveys can make the index seesaw



Alternating surveys can make the index seesaw



A seesaw

CC: @swhsu Flickr

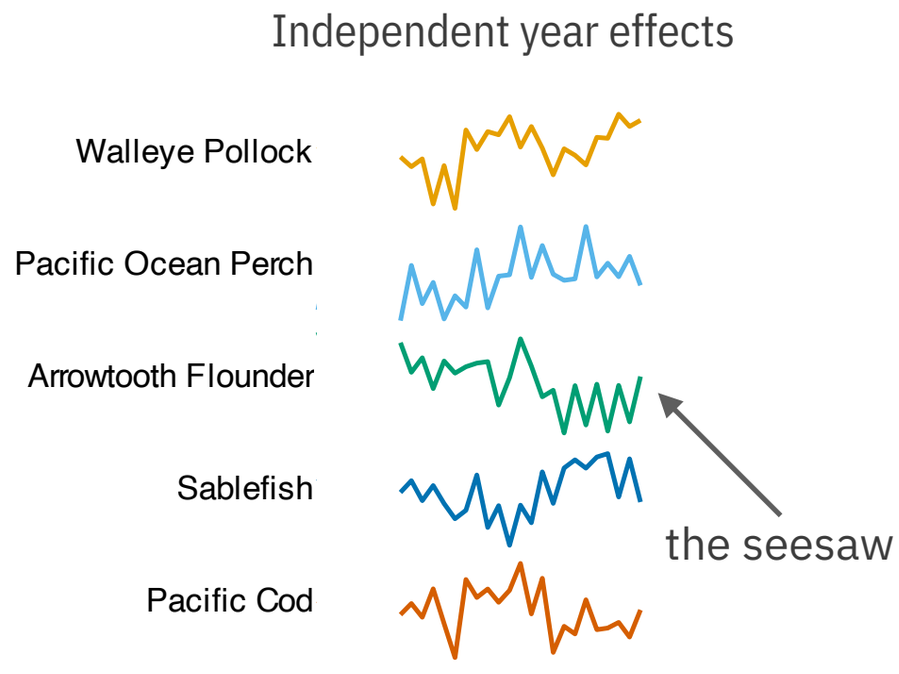
Alternating surveys by year can cause "seesaw" effects

Anderson et al. In prep.

Alternating surveys by year can cause "seesaw" effects



CC: @swhsu Flickr

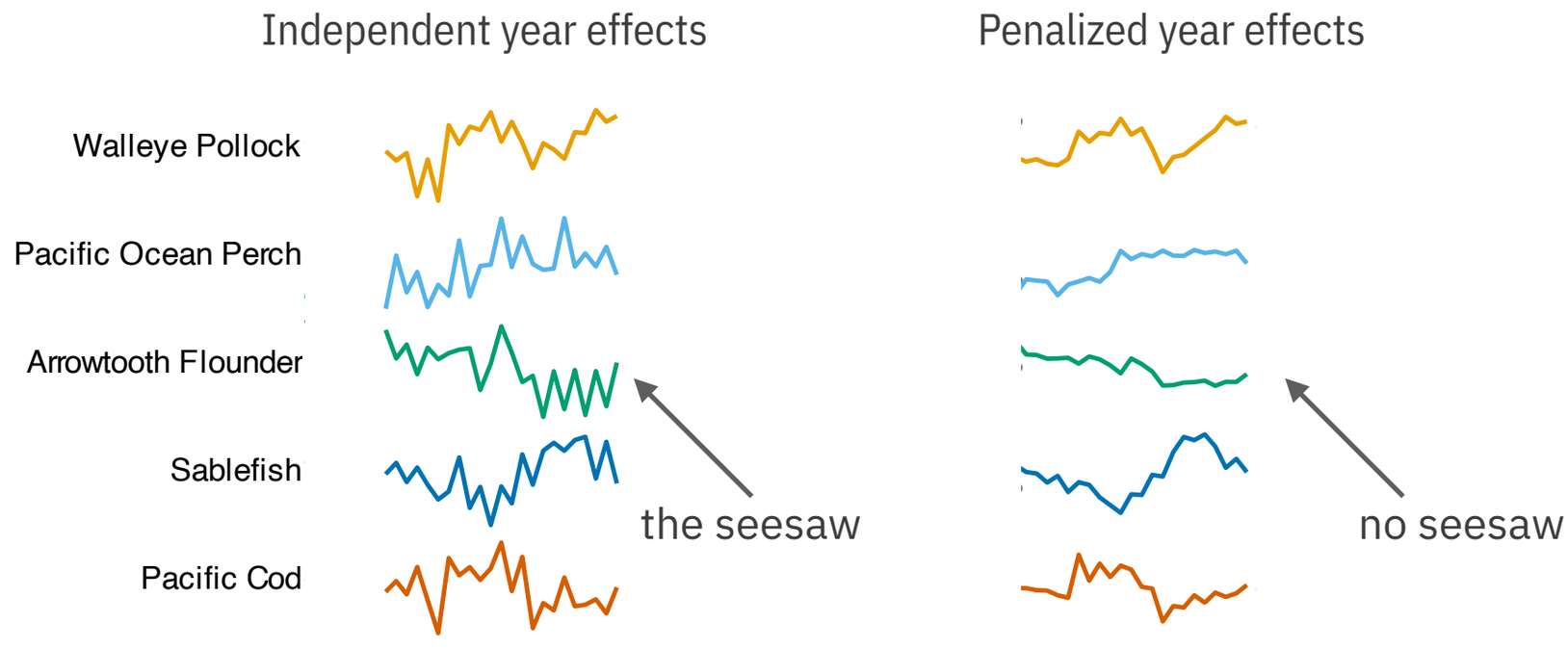


Anderson et al. In prep.

Alternating surveys by year can cause "seesaw" effects



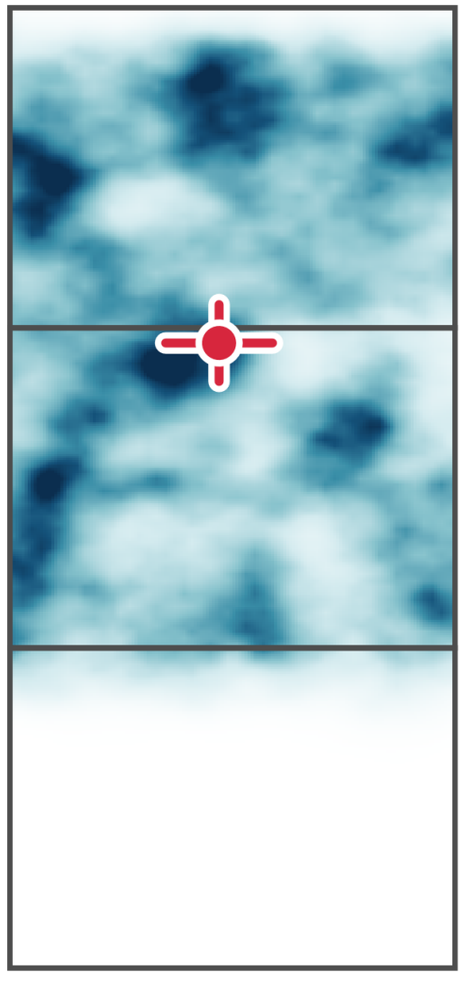
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Anderson et al. In prep.

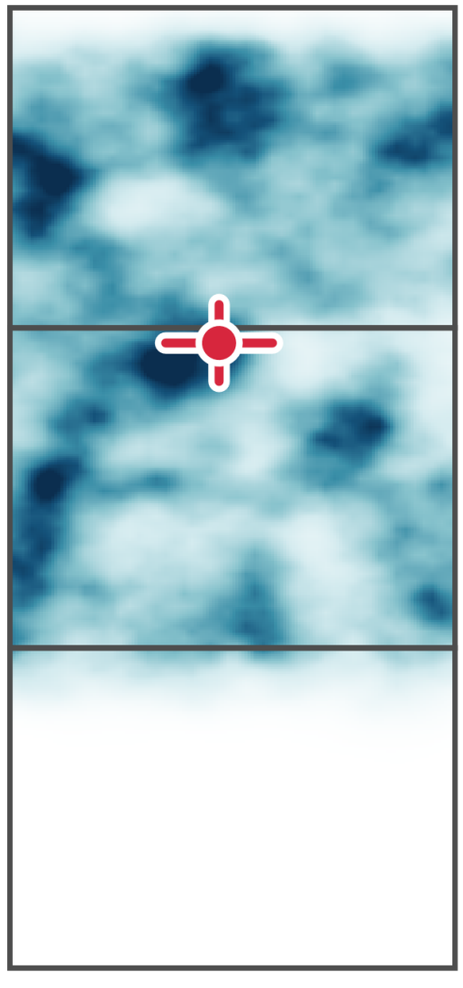
Conclusions

Four lessons



Four lessons

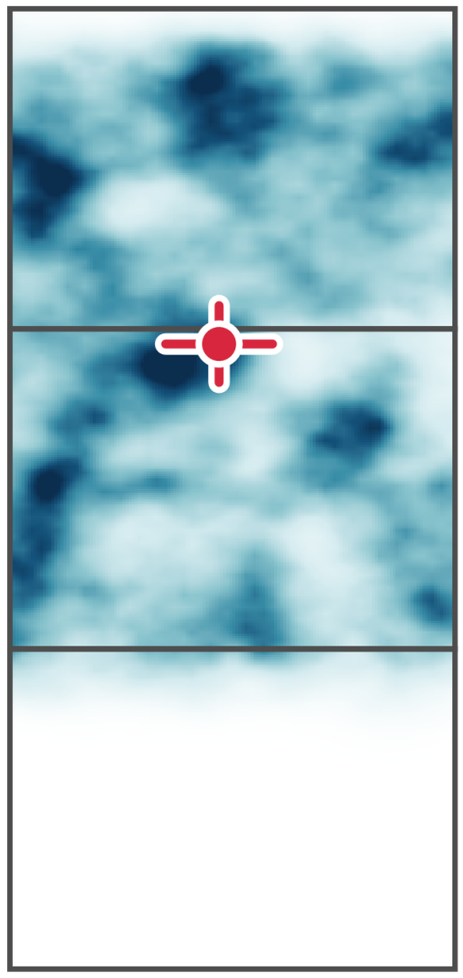
1. **International databases** make data integration easier



Four lessons

1. **International databases** make data integration easier

2. Surveys need to be **close enough** in space and time and sample the same population

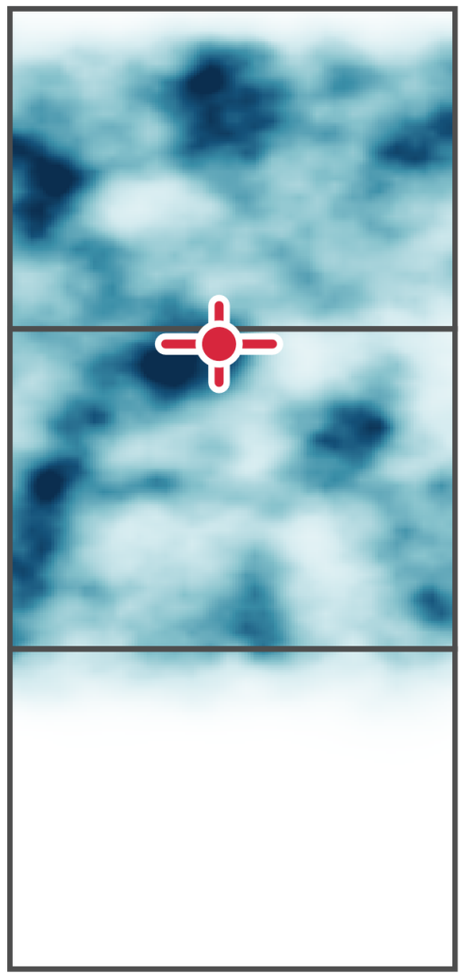


Four lessons

1. **International databases** make data integration easier

2. Surveys need to be **close enough** in space and time and sample the same population

3. **Let catchability vary** by survey and check selectivity



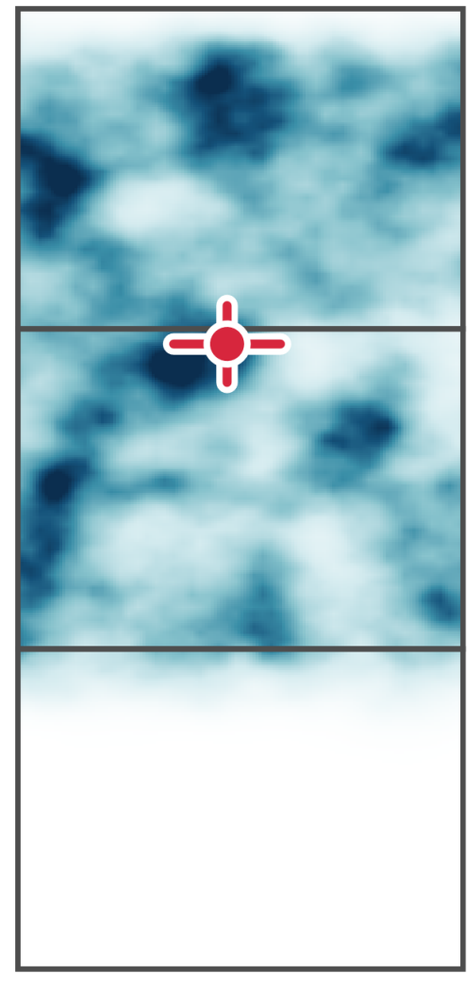
Four lessons

1. **International databases** make data integration easier

2. Surveys need to be **close enough** in space and time and sample the same population

3. **Let catchability vary** by survey and check selectivity

4. **Watch for artefacts** when every region isn't sampled every year; model fitting is easy, model validation is hard



Fish don't stop at borders.

Our surveys do,

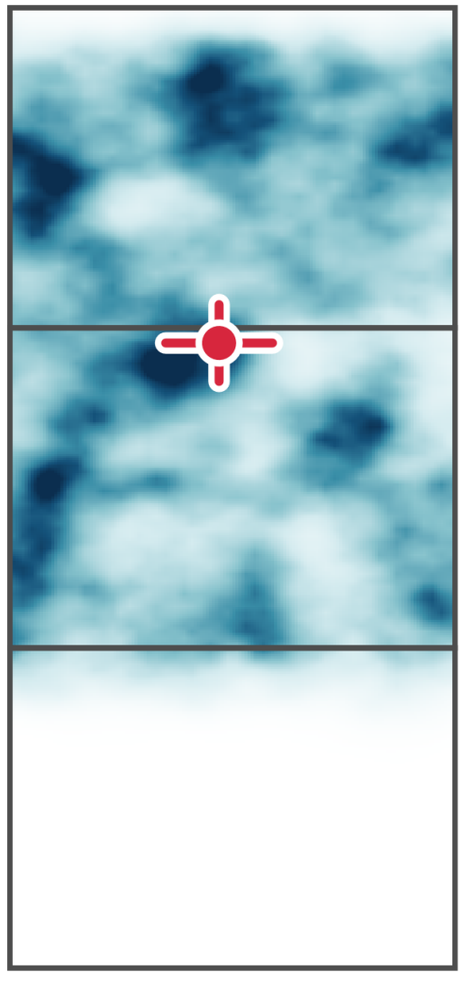
but our models don't have to.



Sean C. Anderson, Fisheries and Oceans Canada
sean.anderson@dfo-mpo.gc.ca
https://seananderson.ca
https://github.com/sdmTMB/sdmTMB

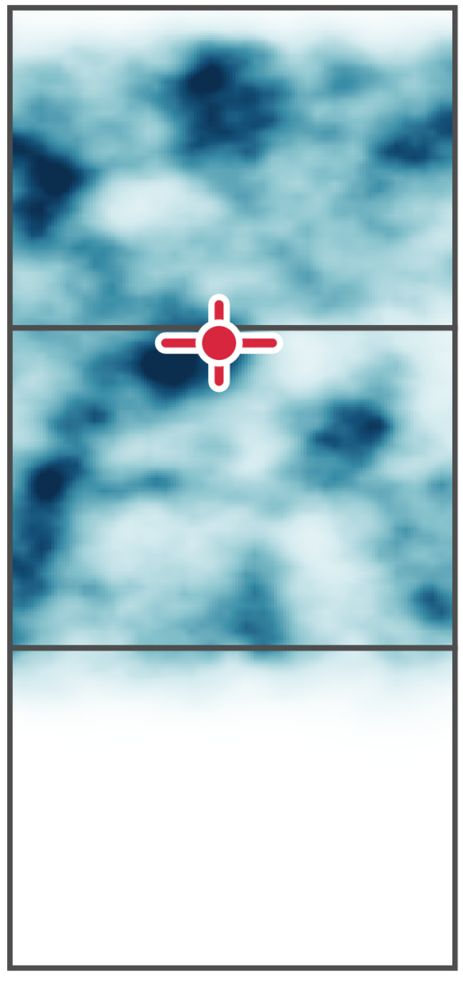
Thanks to Lindsay Davidson, Jillian Dunic, Philina English, Quang Huynh, Jackie King, Brian Stock, Jim Thorson, Eric Ward
Illustrative figures created with assistance from Claude Opus 5.5

We still don't know



We still don't know

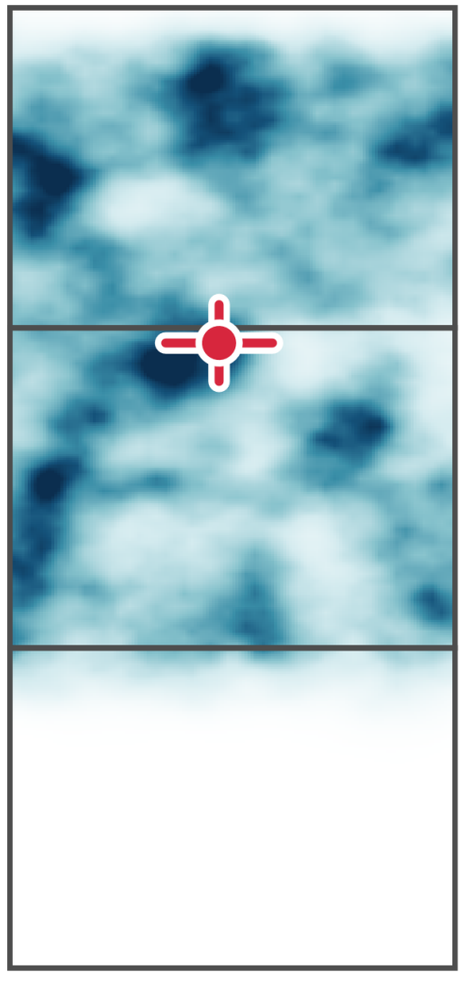
1. How many **researcher degrees of freedom** are there in these models?



We still don't know

1. How many **researcher degrees of freedom** are there in these models?

2. What **model diagnostics** help analysts avoid "bad" models?

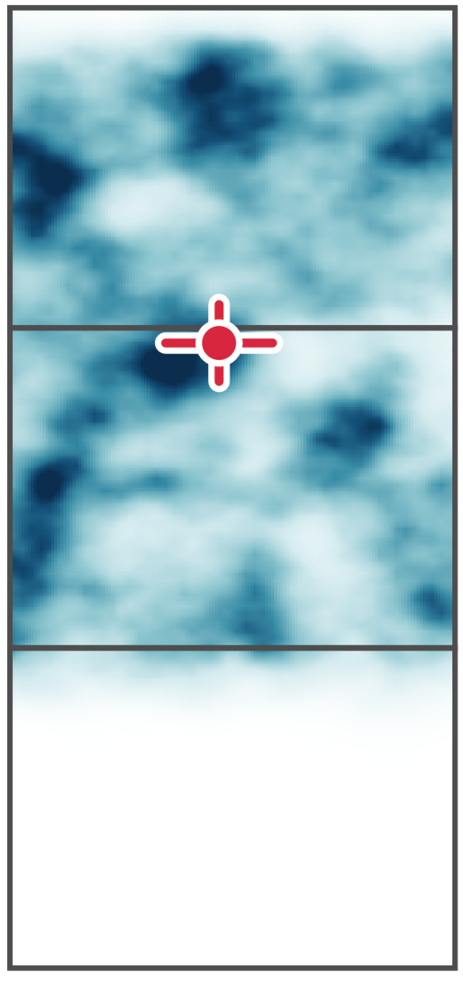


We still don't know

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3. When is it important to let **catchability vary spatially**?



We still don't know

1. How many **researcher degrees of freedom** are there in these models?

2. What **model diagnostics** help analysts avoid "bad" models?

3. When is it important to let **catchability vary spatially**?

4. How much could we gain through **targeted calibration** experiments?

