



NOAA
FISHERIES

The performance of model-based indices given alternative sampling strategies in a climate-adaptive survey design

Meaghan Bryan

Status of Stock and Multispecies Assessments Program

Resource Ecology and Fisheries Management Division

James Thorson

Habitat and Ecological Processes Research Program

Context

- From Joint Crab and Groundfish Plan Team (September, 2019)

“A suggestion was made to investigate the ability of VAST to predict large unobserved areas by omitting some data from the EBS Bering Sea trawl survey in a cross-validation type exercise. This would provide some indication of the prediction ability for the northern Bering Sea.”

- From Joint Groundfish Plan Team (September, 2020)

“The Teams recommend simulation testing to evaluate the performance of VAST under spatially unbalanced designs, such as with the EBS and NBS trawl surveys”

- Additionally there has been the question of how frequently the NBS and at what intensity to obtain unbiased density estimates



Context

We conducted an empirical analysis and a simulation experiment to address the following questions:

How well can spatio-temporal index standardization estimate the proportion of abundance in a new “climate-adaptive” spatial stratum?

Does annual sampling at reduced density or biennial sampling result in better model-based abundance indices?



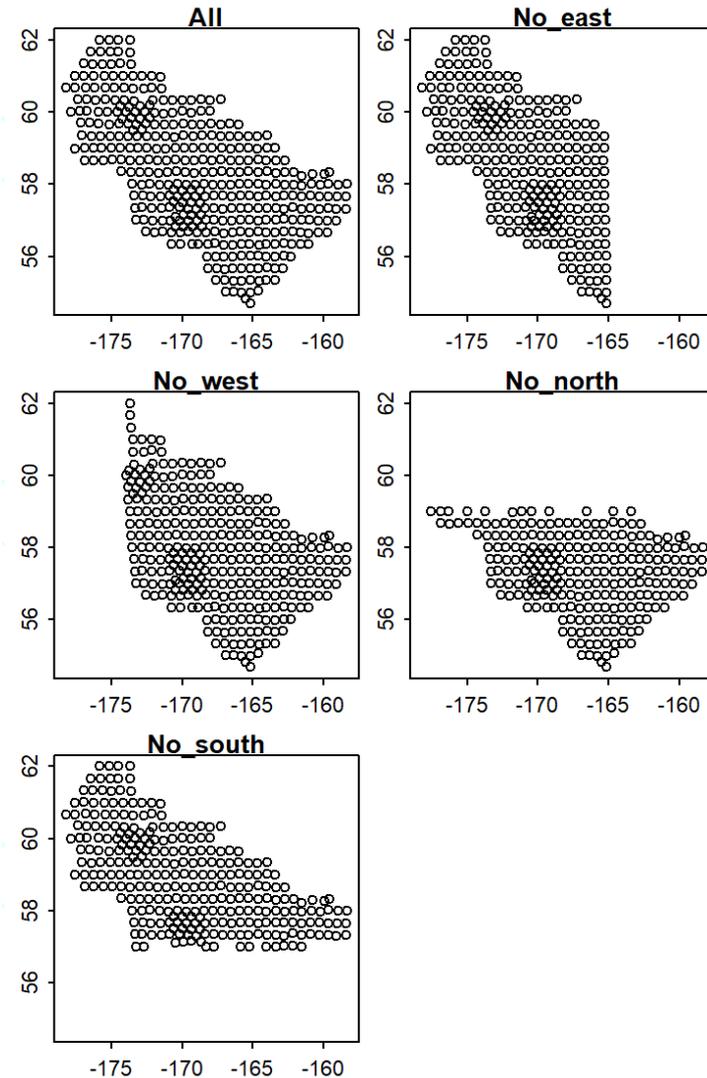
Empirical analysis

Drop stations from arbitrarily chosen areas in the EBS

Stations dropped in all years except years when the NBS survey has been conducted to mimic unbalanced survey design

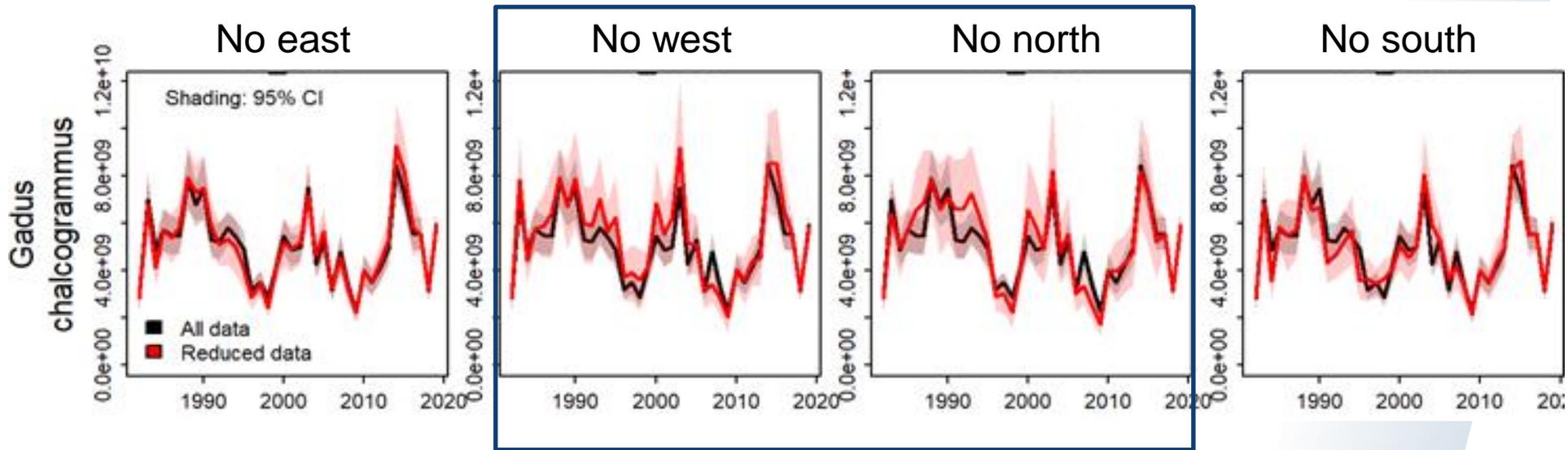
Four species: walleye pollock, Pacific cod, yellowfin sole, and snow crab

Data fit to VAST model used in the pollock and Pacific cod assessments



NOAA
FISHERIES

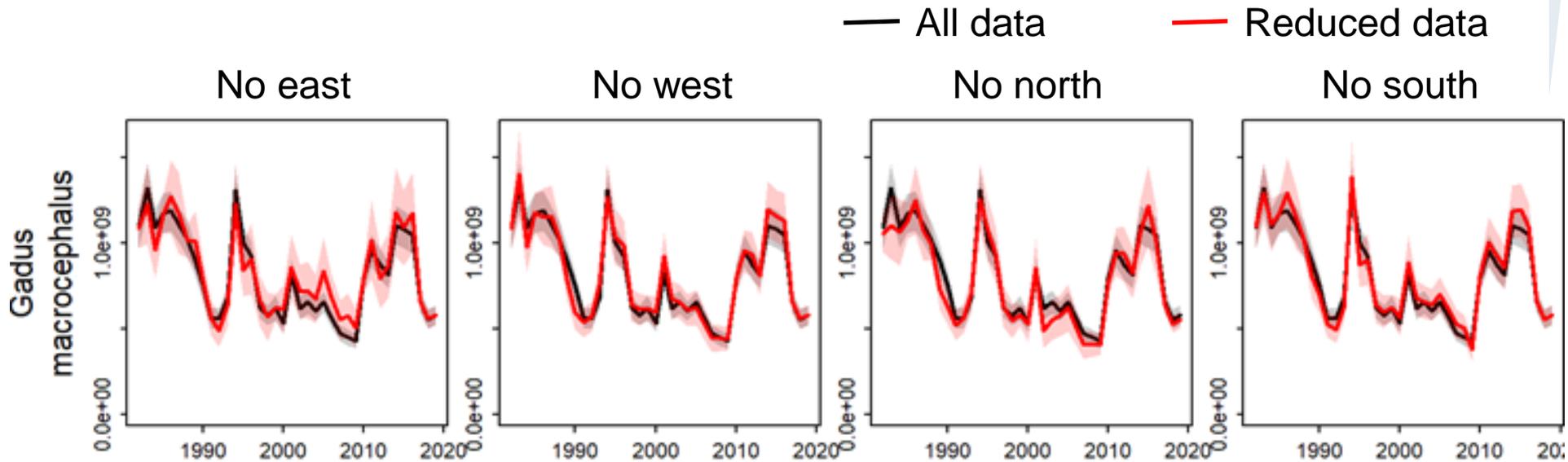
Pollock



Scale and trends generally similar

Larger standard errors when data were missing, especially in west and north

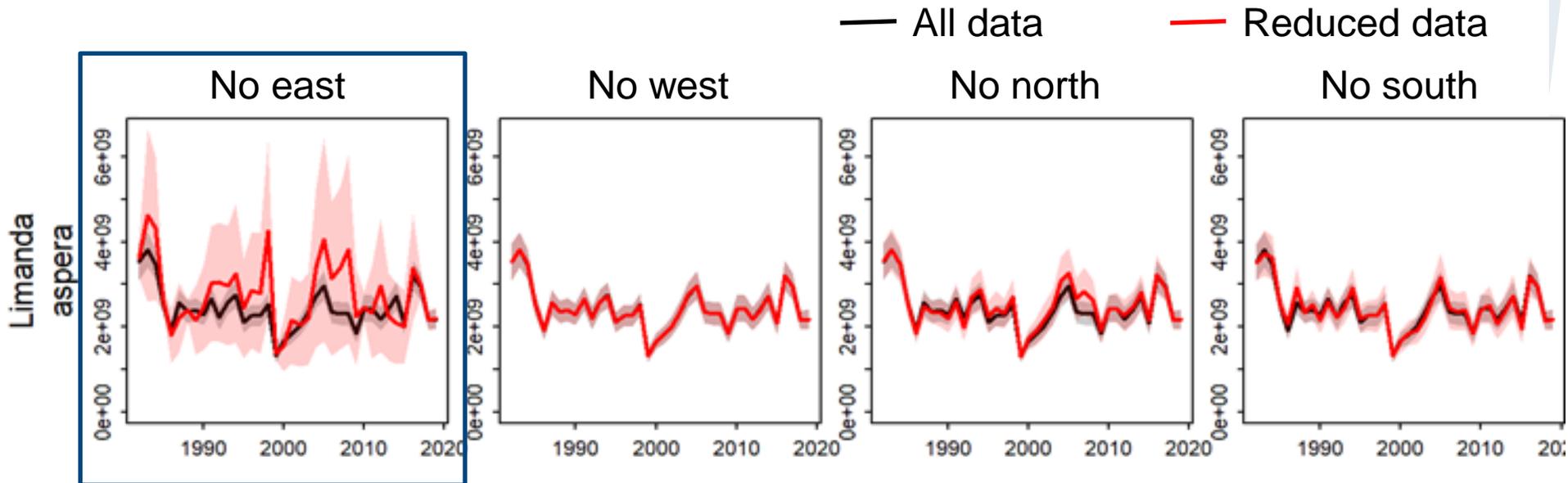
Pacific cod



Scale and trends similar

Larger standard errors when data were reduced and similar across scenarios

Yellowfin sole



Larger standard error when data were reduced, especially when data were removed from the eastern EBS

Snow crab

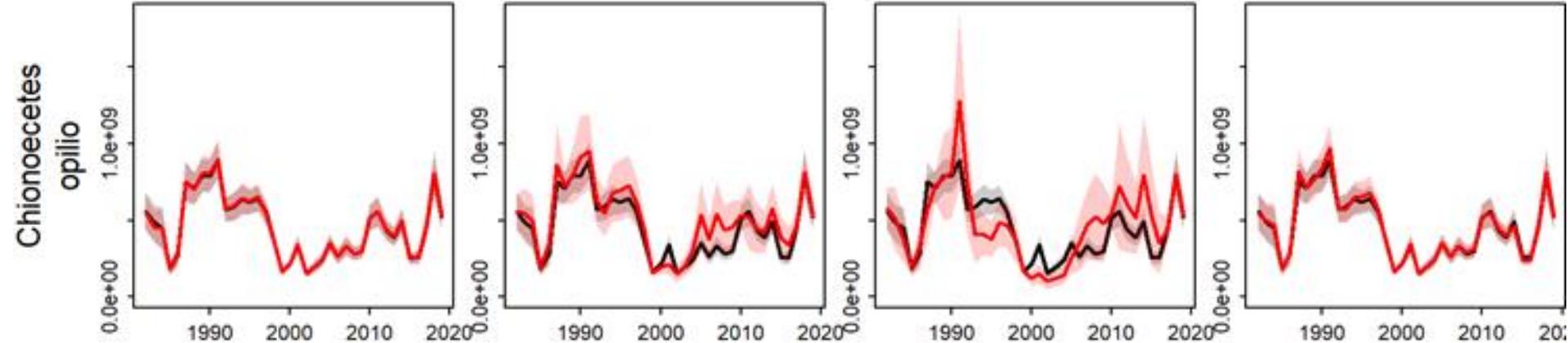
— All data — Reduced data

No east

No west

No north

No south

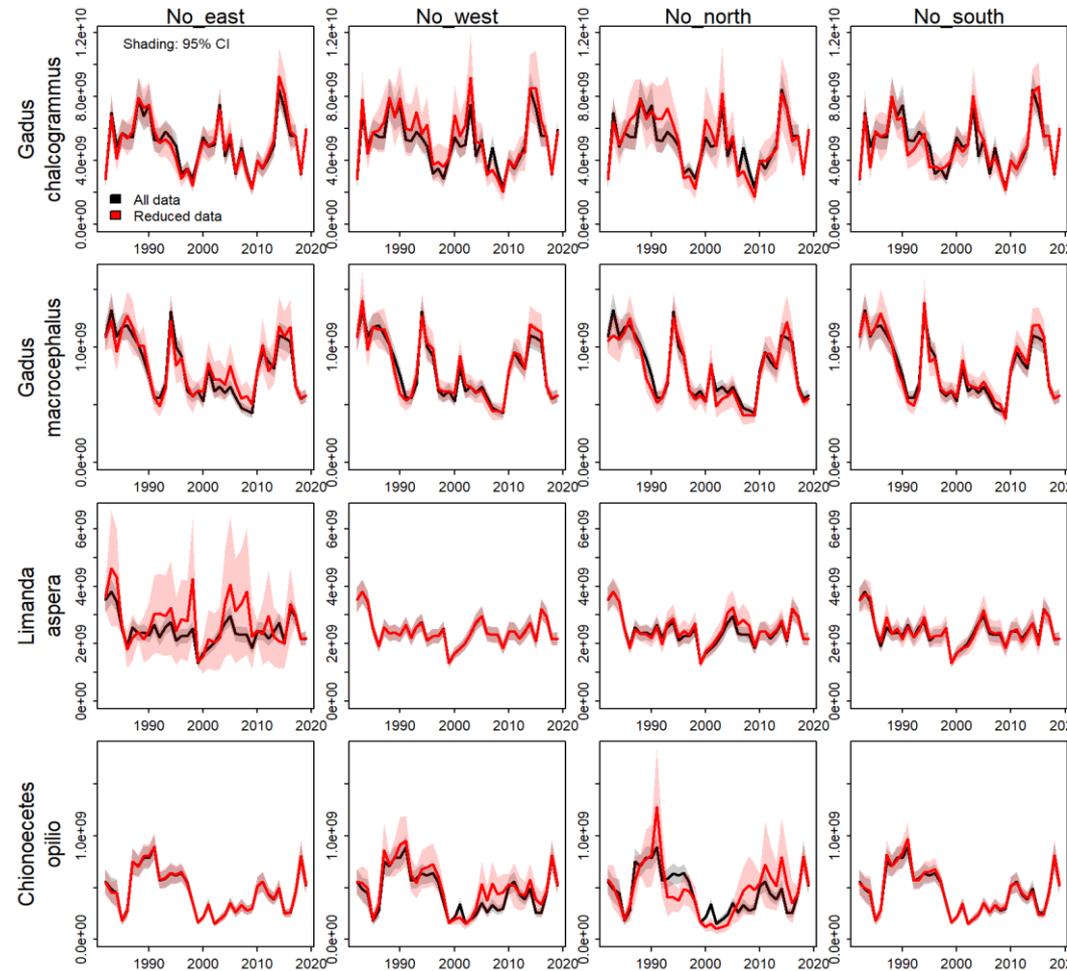


Larger standard errors, especially in the north, when data were missing

Summary of empirical analysis

Scale and trends are generally similar between the reduced and all data scenarios

Reducing the survey footprint leads to greater uncertainty in density estimates especially in areas central to the distribution of a species



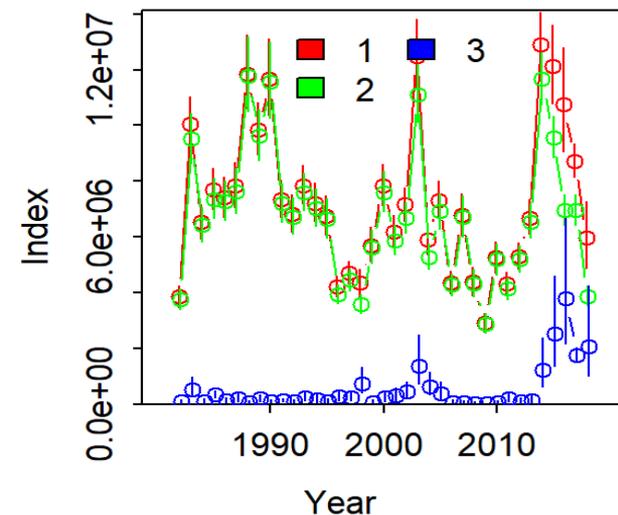
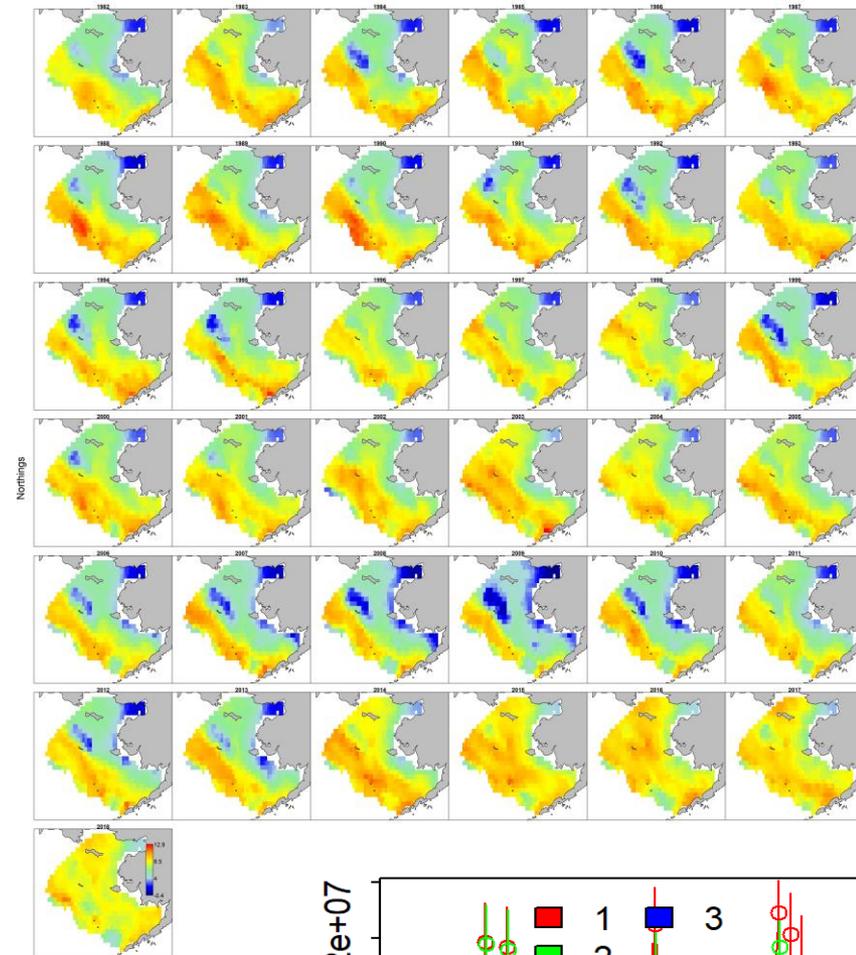
Simulation

Operating model generated observations from VAST model

Same configuration as that used for EBS pollock and Pacific cod assessments

Model is fit to data to obtain density estimates for EBS, NBS, and combined

Then we used different data scenarios to sample the simulated densities

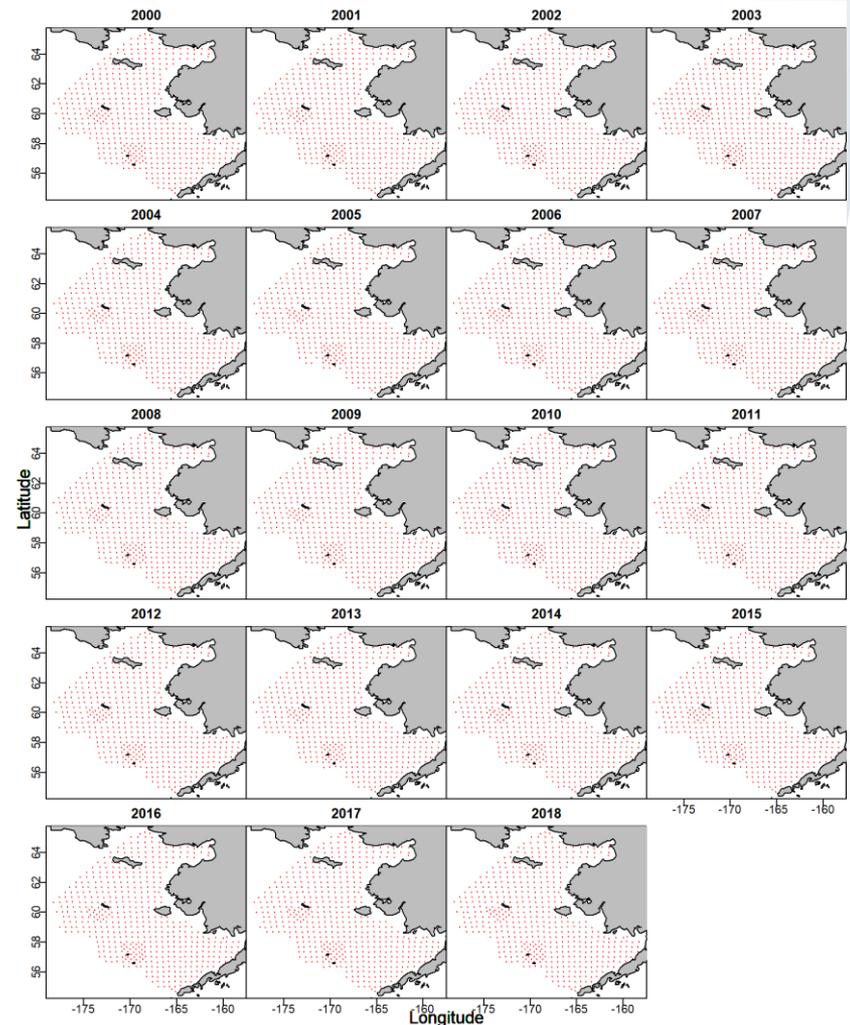


Simulation

Used EBS sampling grid
and the 2017 NBS
sampling grid

Data scenarios:

1. Annual full sampling
2. Annual reduced
sampling in NBS
50% reduction
Random sampling
3. Biennial sampling in
the NBS (sampled odd
years)

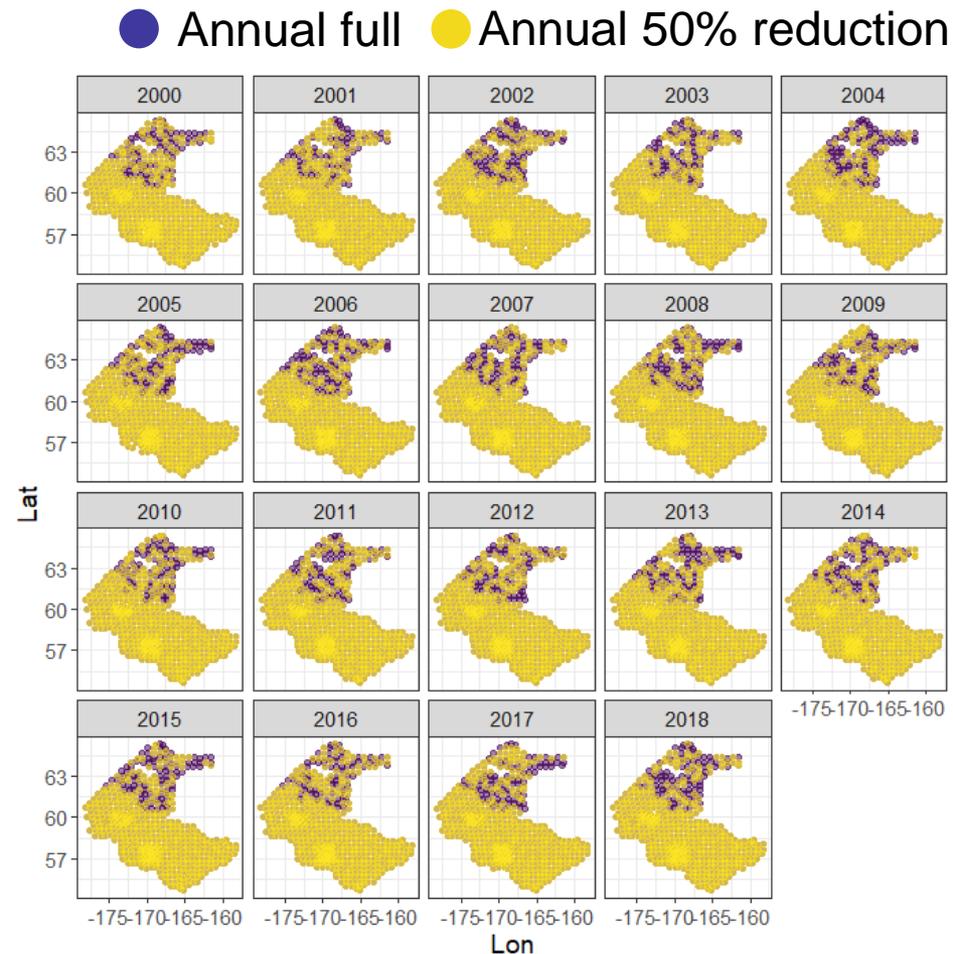


Simulation

Used EBS sampling grid
and the 2017 NBS
sampling grid

Data scenarios:

1. Annual full sampling
2. Annual reduced sampling in NBS
50% reduction
Random sampling
3. Biennial sampling in
the NBS (sampled odd
years)

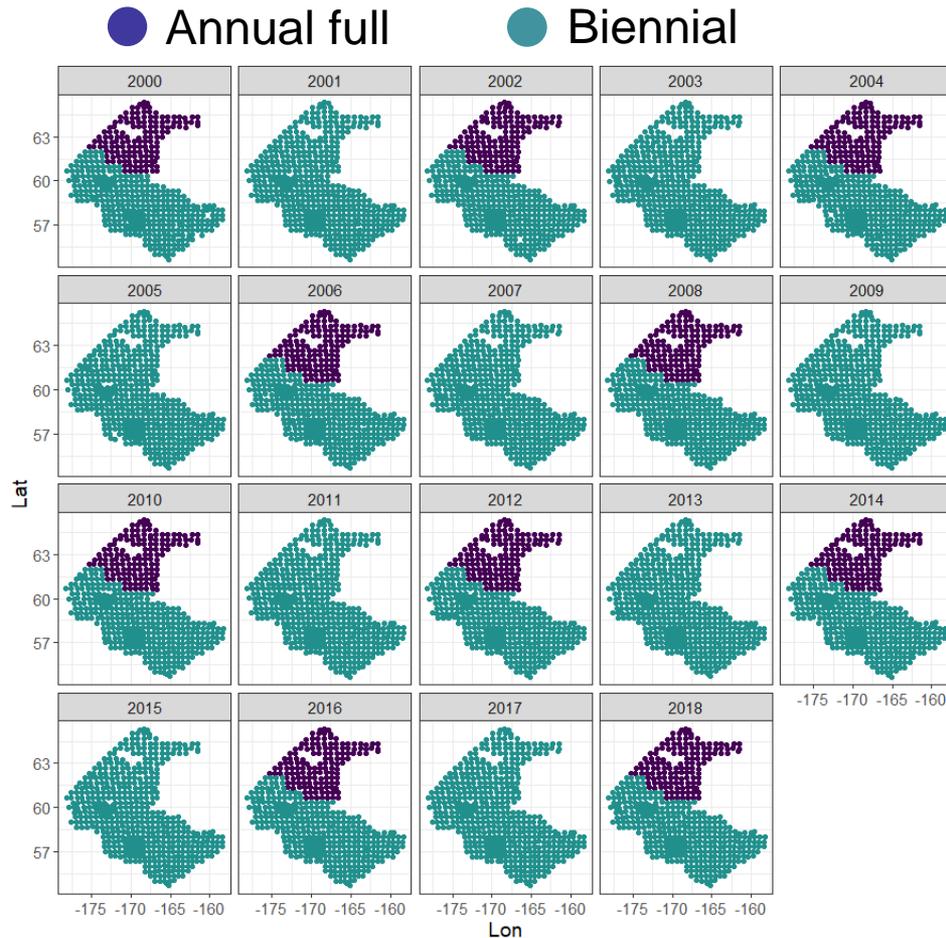


Simulation

Used EBS sampling grid
and the 2017 NBS
sampling grid

Data scenarios:

1. Annual full sampling
2. Annual reduced sampling in NBS
50% reduction
Random sampling
3. Biennial sampling in
the NBS (sampled odd
years)



Simulation-estimation

Estimation model had same structure as the operating model, except:

- Reduced number of knots (50 from 250)

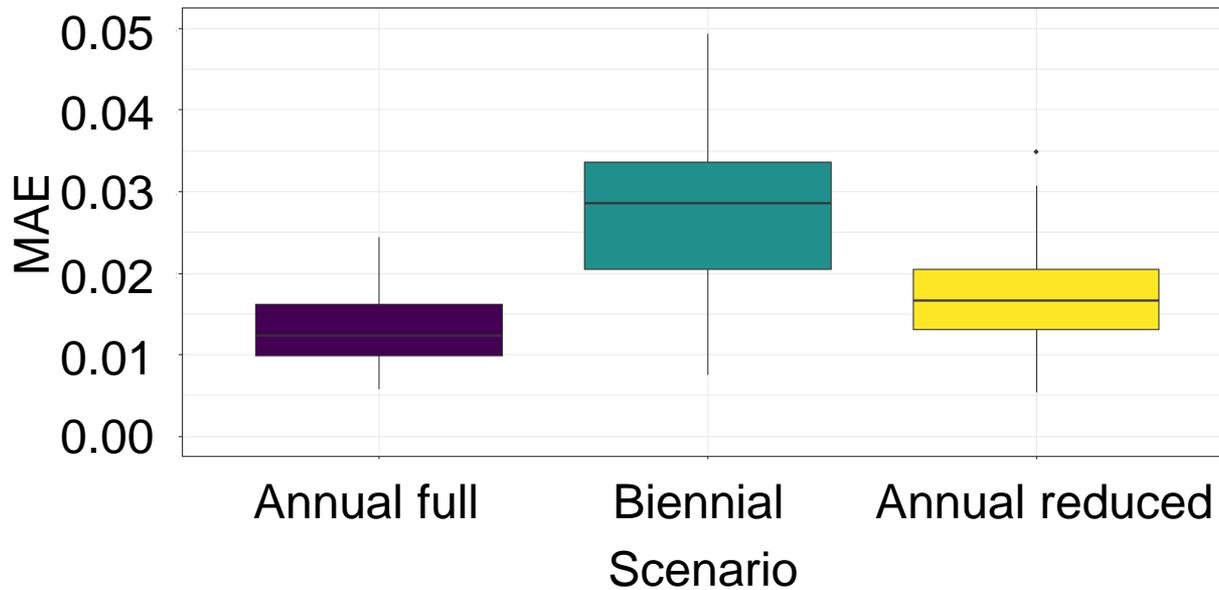
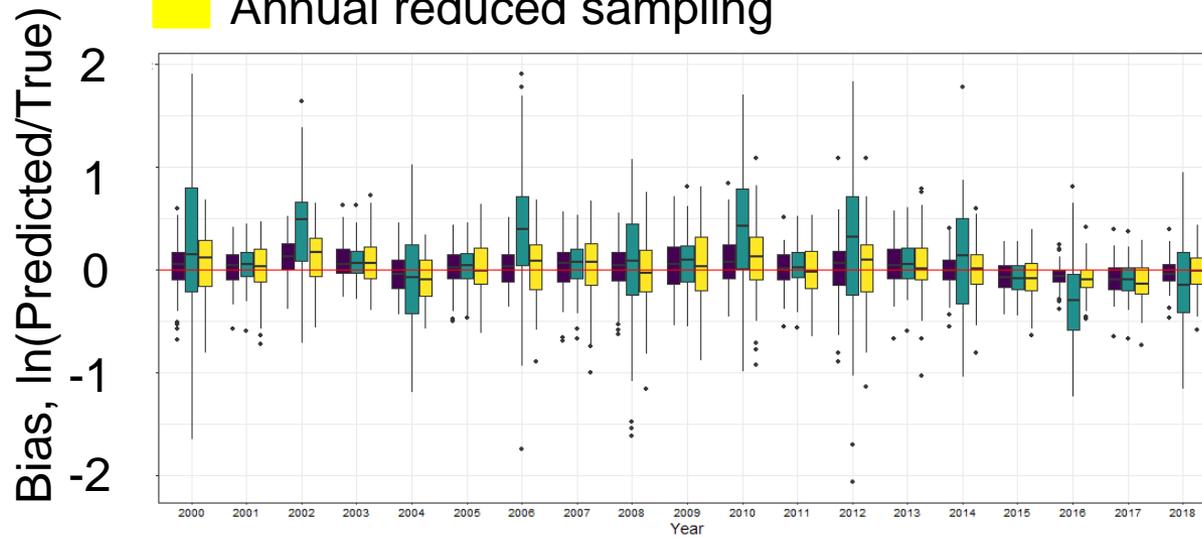
- Reduced time series (2000-2018)

100 iterations for each data scenario



Annual full sampling Biennial sampling

Annual reduced sampling



Conclusions

Combination of empirical and simulation analyses provides a more comprehensive view of how well a spatio-temporal model estimates density when missing survey data

Empirical analysis

- Scale and trends are generally similar between the reduced and all data scenarios
- Reducing the survey footprint leads to greater uncertainty in density estimates especially in areas central to the distribution of a species

Simulation experiment

- Annual sampling results in less biased density estimates and should be considered when developing future survey strategies