Workshop on Unavoidable Survey Effort Reduction

Chairs:
Stan Kotwicki,
Wayne Palsson,
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WKUSER, 13-17 January 2020

Workshop on Unavoidable Survey Effort Reduction

- These reductions typically compromise the long-term objectives of survey series in terms of accuracy, precision, and consistency of population estimation.
- Usually these reductions leave little time for planning and quantitative evaluation
- Need to develop methods for better understanding of the reductions.

- WKUSER examined existing and sought new methods that can minimize the amount of information loss, when unexpected events force changes, to facilitate better contingency planning, and to convey the likely consequences to assessment scientists and policy makers.

Terms of Reference (TORs)

- **TOR 1: Current processes.** The current processes dealing with unavoidable reductions (and often subsequent increase) in survey effort and examining the existing coping strategies (e.g. spatial coverage, survey frequency, or sampling density) and their qualitative consequences.
- **TOR 2: Survey uncertainty.** Develop key quality metrics that can be used to describe "total survey uncertainty" for common survey designs and indices of abundance.
- **TOR 3: Survey continuity.** Define "changes to survey designs" that require inter-survey calibration and what changes can be resolved by a model-based approach to index generation.
- **TOR 4: Decision making tools.** Develop methods that can provide quantitative, decision-making tools describing impacts on the quality of survey data and advisory products.

Consequences

- Reduced information/input from fishery-independent survey data.
- Increased uncertainty in model outcomes (if uncertainty is propagated correctly)
- Biased outcomes (in non-random surveys) and reduced value for management advice.
- Reduced ability to detect sudden changes in the ecosystem
- Loss of data for EBFM and ecosystem studies

Overarching challenge

Challenge

- Understanding the uncertainty associated with survey sampling processes (operational, environmental & biological) and use of survey data products in assessment and advice.

Change brings complex challenges

- Priorities (data products, species, environmental vs biological data)
- Methods (survey design, sampling density, spatial coverage, survey frequency)
- Evaluation of consequences (value of the lost information?)
- Optimization (How to minimize loss of information)
- Survey continuity (minimize changes in q?)
- Value of information (minimum effort required for useful information)
- Variance propagation
- New survey methods and technologies
- New estimation methods
- Increased needs for new data types
- Ability to adapt to environmental change
- Technical and administrative difficulties

WKUSER Summary

- Review of available research, evaluating current practices, and recommending future directions on four key topics: Decision Making Processes, Survey Uncertainty, Index Continuity, and Evaluation Tools.
- Evaluated what strategic preparations and actions are required because of surveys vulnerability to effort reductions due to funding shortfalls, vessel unavailability, weather, etc.
- Developped decision trees and tables to assist survey managers in decision making at the various timescales. These tools deliver assessments of the impact of survey reductions on data and advice quality.

WKUSER conclusions, best practices

- Develop methods to perform survey evaluations. Perform prioritization of monitoring tasks in relation to objectives by exploring possible methods for gains in survey efficiencies (e.g. reducing the number of biological samples, shortening tow duration, increase in catch subsampling while also considering station thinning, excluding areas, reducing survey frequency, or changing the survey design).
- Perform studies on estimation of total survey uncertainty (include sampling design, sampling efficiency, spatial availability, density dependence, vessel effects, timing, and environmental conditions). To improve assessment and provide insight into addressing changes and a long-term strategy for improved surveys.
- Develop and expand simulation studies and research on model-based capabilities that can be used to inform on the methods for survey effort reduction, aid in estimations of total survey uncertainty, and help with the inter-calibration studies.

WKUSER conclusions, best practices

- Survey and assessment groups together should develop quantitative applications that can be used for any survey and assessment combination to determine the impacts of different monitoring strategies both in terms of the inputs (cost) and the outputs (uncertainty). They should include functions to process abundance data, and to incorporate ecosystem data for use in model-based estimation and in process studies, multi-species/multi-objective optimization, and evaluation of trade-offs between different survey and estimation approaches.
- Survey managers are recommended to intensify preparation for response to the ecosystem change, which is already underway in many areas. These preparations should include strategies for surveys expansions into new areas (or reductions on other areas) to assure continued relevance of survey information to the fisheries management and research.

WKUSER I main goal

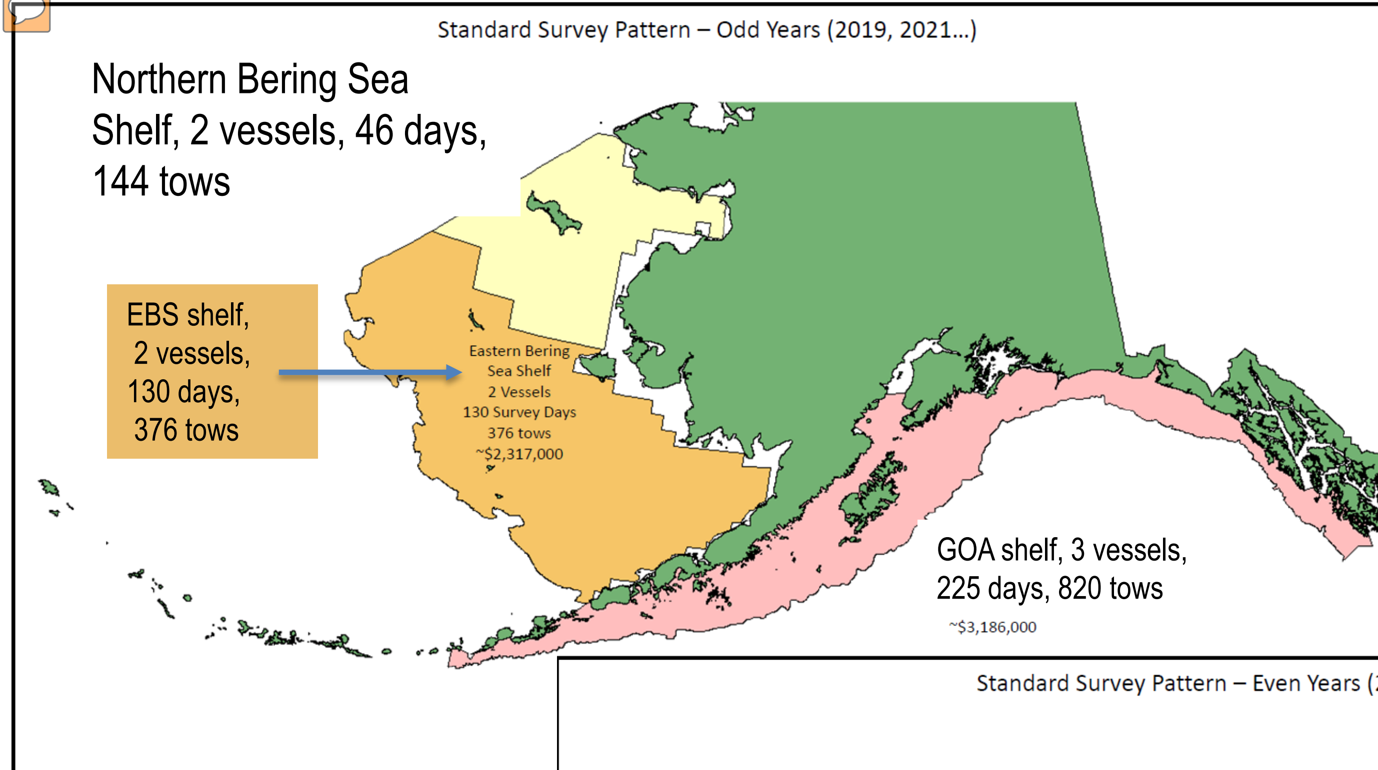
ROADMAP

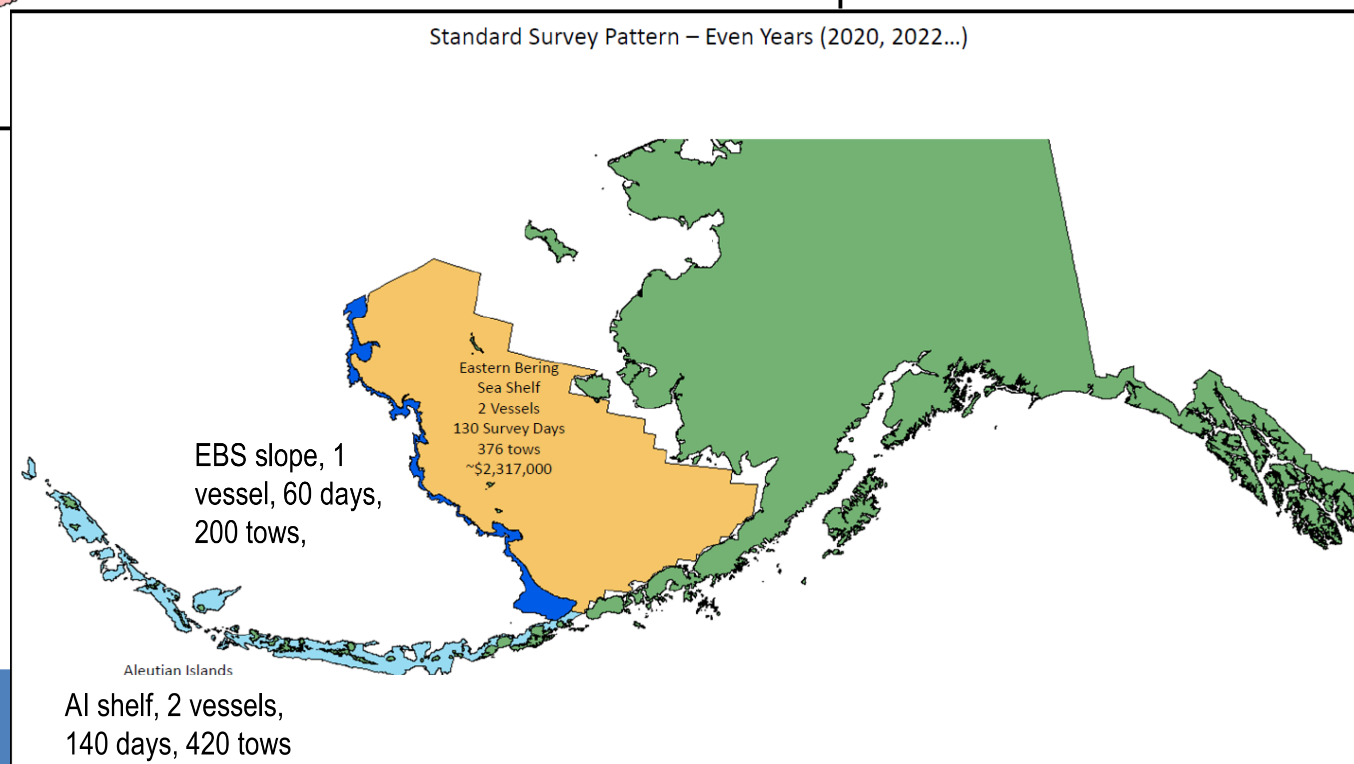
How to prepare for short- and long- term changes in survey effort?

General (every year) AFSC Questions for SSC

Priorities:

- LMEs
- areas to sample within LMEs
- species
- data products (biological and environmental)
- environmental change considerations (distribution shifts to new areas, management and country boundaries, catchability, spatial availability issues, international issues)

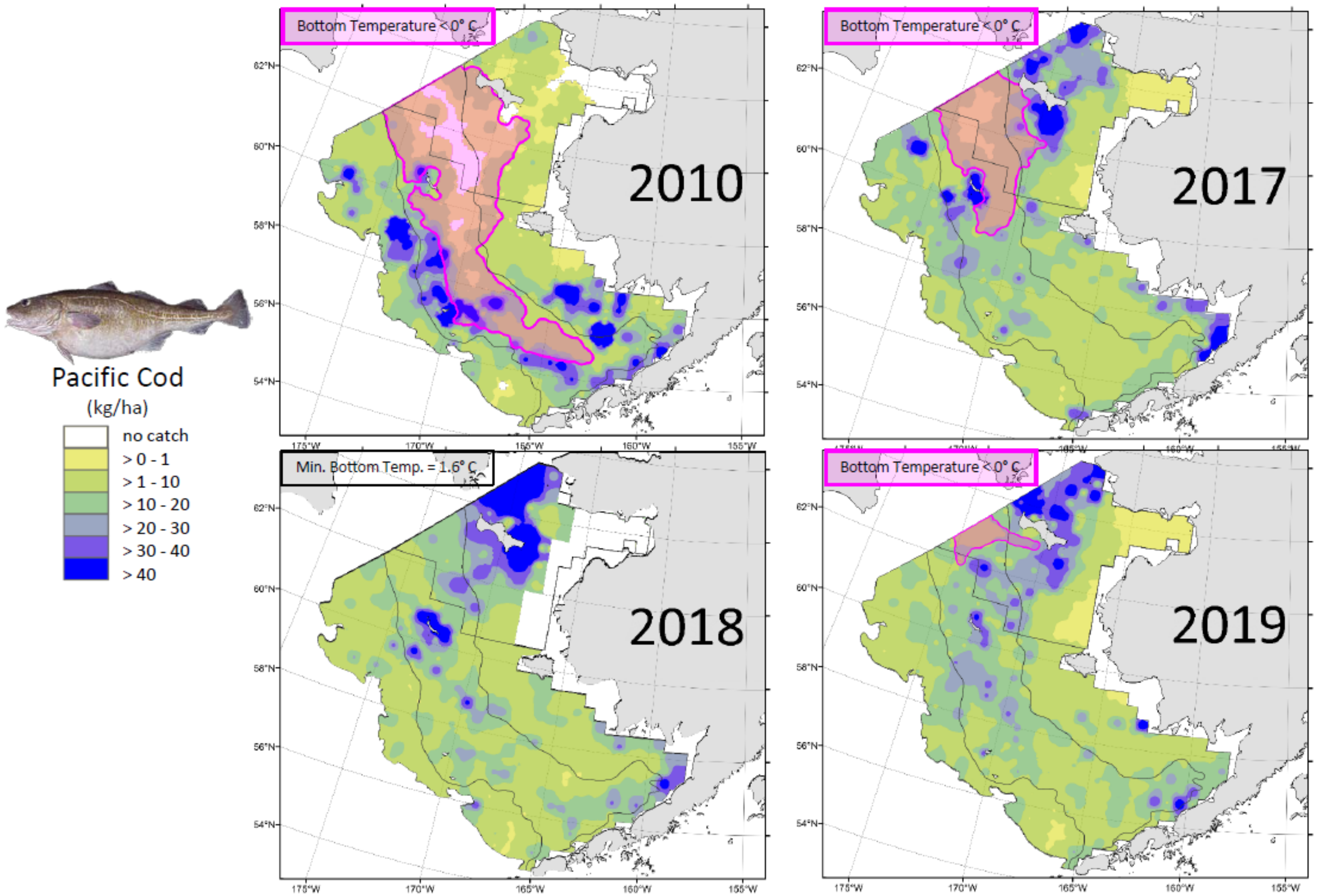

Standard Survey Pattern – Odd Years (2019, 2021…)
Northern Bering Sea Shelf, 2 vessels, 46 days, 144 tows
EBS shelf, 2 vessels, 130 days, 376 tows
Eastern Bering Sea Shelf
2 Vessels
130 Survey Days
376 tows
~$2,317,000
GOA shelf, 3 vessels, 225 days, 820 tows
~$3,186,000


Standard Survey Pattern – Even Years (2020, 2022…)
Eastern Bering Sea Shelf
2 Vessels
130 Survey Days
376 tows
~$2,317,000
EBS slope, 1 vessel, 60 days, 200 tows,
Aleutian Islands
AI shelf, 2 vessels, 140 days, 420 tows

Abrupt Warming in the Bering Sea in Recent Years resulted in in groundfish distribution shifts.

Source L. Britt Alaska Fisheries Science Center

Bering Sea Pacific Cod Distribution



Key findings of SSC – Sub-committee

- Stock trawl surveys should be considered the highest priority level for the NPFMC Critical Ongoing Monitoring.
- The trawl survey enterprise, "*creates and maintains indispensable data that substantially contribute to scientific understanding and management of fish and crab populations, fisheries, and the communities dependent upon those fisheries*".
- Discontinuation or diminishment of the research that provides these datasets would leave a significant gap in the science needed to support sustainable and successful fisheries management in the North Pacific.
- In addition, surveys yield information needed for determinations of essential fish habitat and many other research questions that contribute directly and indirectly to sustainable fishery management.

Recent SSC feedback to AFSC

SSC priorities list:

1. Eastern Bering Sea shelf, 2. Gulf of Alaska, 3. Aleutian Islands, 4. Northern Bering Sea, 5.Bering Sea Slope

2. Noted concerns with Greenland turbot, skates, and rebuilding rockfish if slope dropped. Ecosystem importance.

3. "*Critical to develop time series of (10-12 years) of trawl surveys for northern components to adequately predict proportion in non-surveyed years*".


Change is inevitable.
Growth is optional.
John C. Maxwell
quotefancy

WKUSER

- Planned for 2019, cancelled due to shutdown.
- Move to 2020 resulted in some loss of participation from abroad, but also enabled more contributions from Alaska LMEs (16).
- 45 participants
- 7 countries
- US state and federal agencies)

WKUSER highlights - How do we prepare for change?

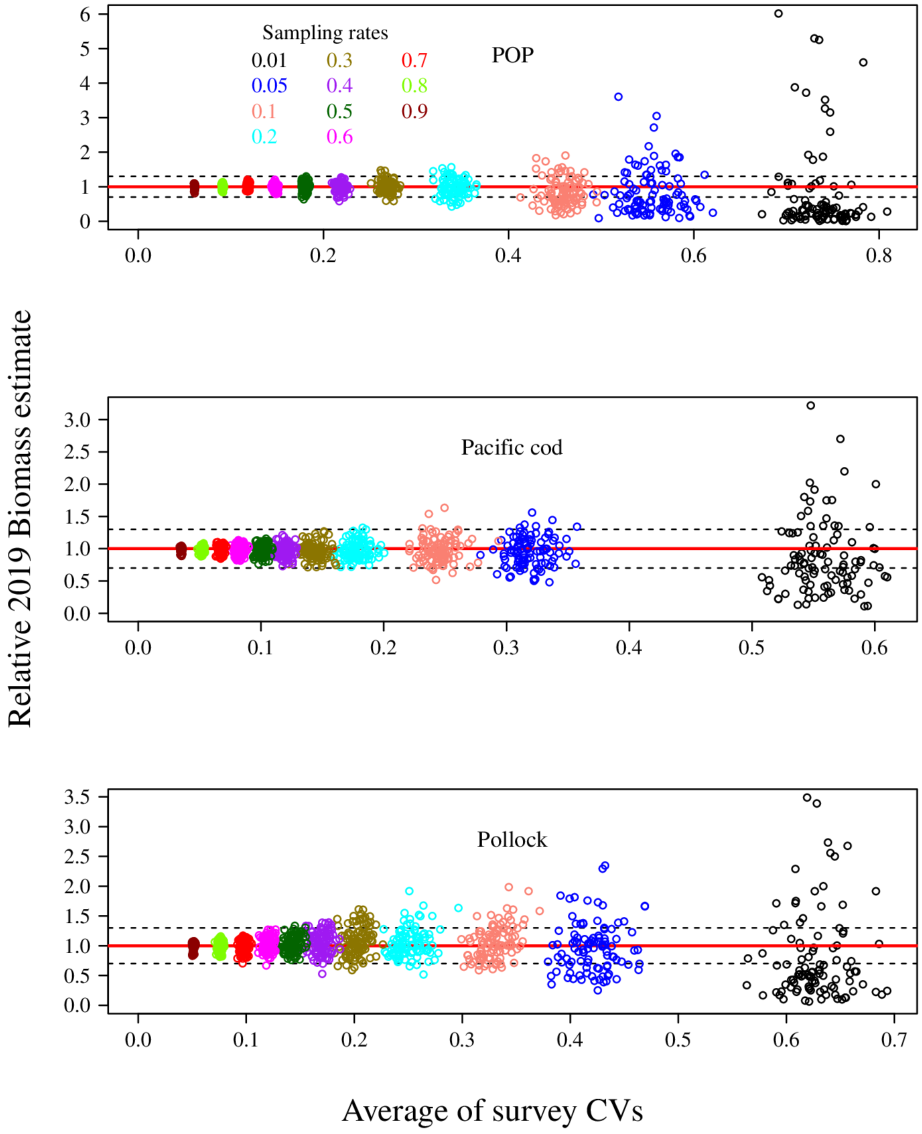
- Good survey design, which allows for changes with minimal disruption to management process.
  - Allows for flexibility (random)
  - Assures continuity (random)
  - Provides reliable variance estimates (design- or model-based) – measure of quality.
- Develop effective and various estimation techniques, e.g.:
  - Design-based estimators (sample average, median, Kappenman's estimator, geometric mean)
  - Model-based estimators (VAST, GAM, needs validation)

All studies to date are preliminary, not published.

Efficiency of four estimators of change in mean trawl survey catch per unit effort (CPUE), evaluated using empirical Mean Squared Errors (MSE) (Munro)

- Compare performances of four estimators of change in abundance (sample average, median, Kappenman's estimator, geometric mean)
- Arithmetic mean is unbiased and well understood (Law of Large Numbers and the Central Limit Theorem) but is inefficient for skewed distributions with many zeros
- The other three estimators may be biased but likely lower variances
- Unbiased estimators of change (trend) can come from biased CPUE estimators
- Kappenman's estimator may work better when a lot of zeros and more skew

Variance propagation - Trade-off between precision of survey estimates and variability in assessment results (Spencer)



Dashed lines are 30% errors in the 2019 biomass estimate

For a given sampling rate or CV, the relative error in biomass differs between stocks

The standard for assessment precision may also differ between stocks

Key information for survey planning: What is the required level of survey CV to obtain reliable assessment outcome?

Conclusions, and future work

- As sampling intensity decreases, estimated CVs of biomass may underestimate the variability in the biomass index. (not shown)

- The ability to detect trends is a function of the estimated signal to noise ratio, and the strength of the underlying trend.

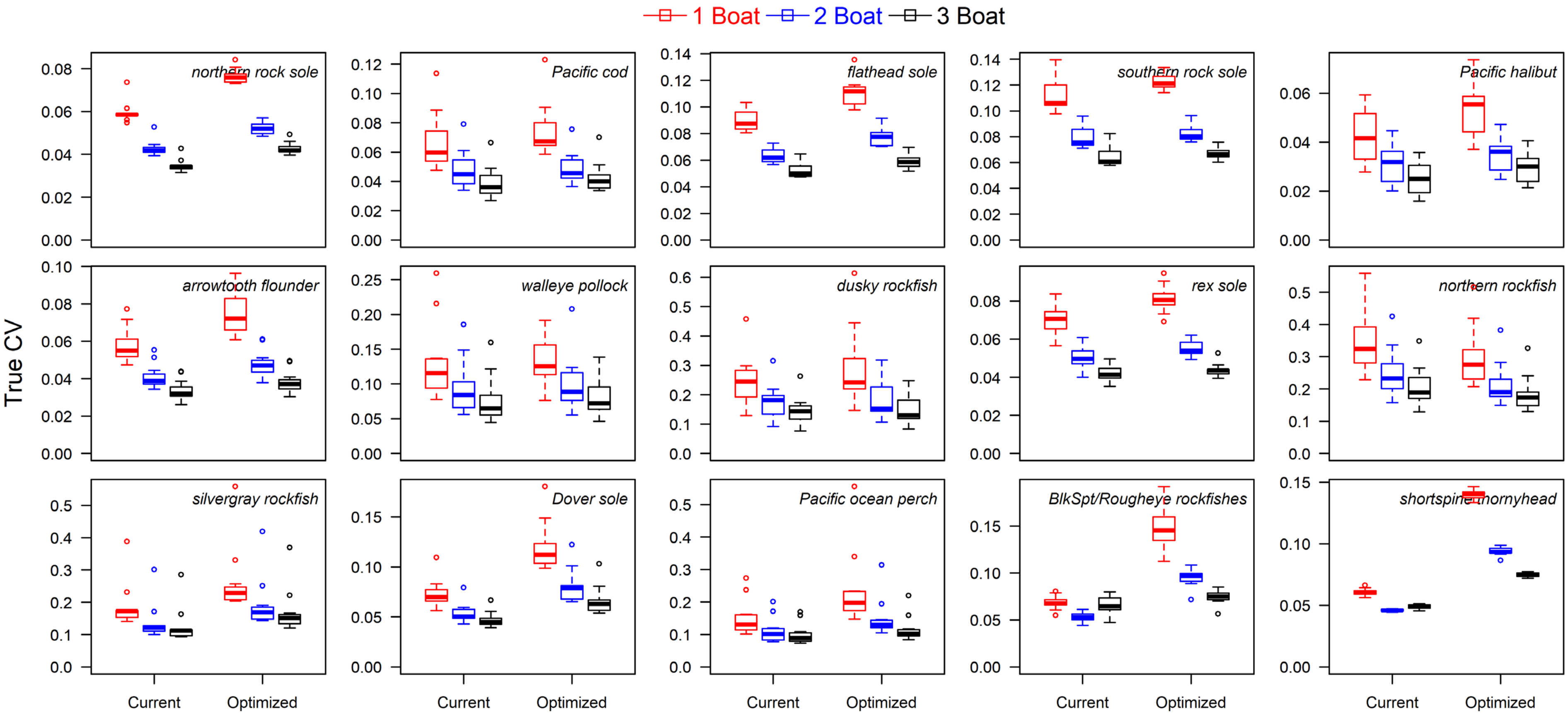
- **Studies of this type can be used to evaluate the sampling intensity required for specified levels of assessment precision.**

- **Future work: more detailed spatial simulations, age-structured populations, variability in survey process error.**

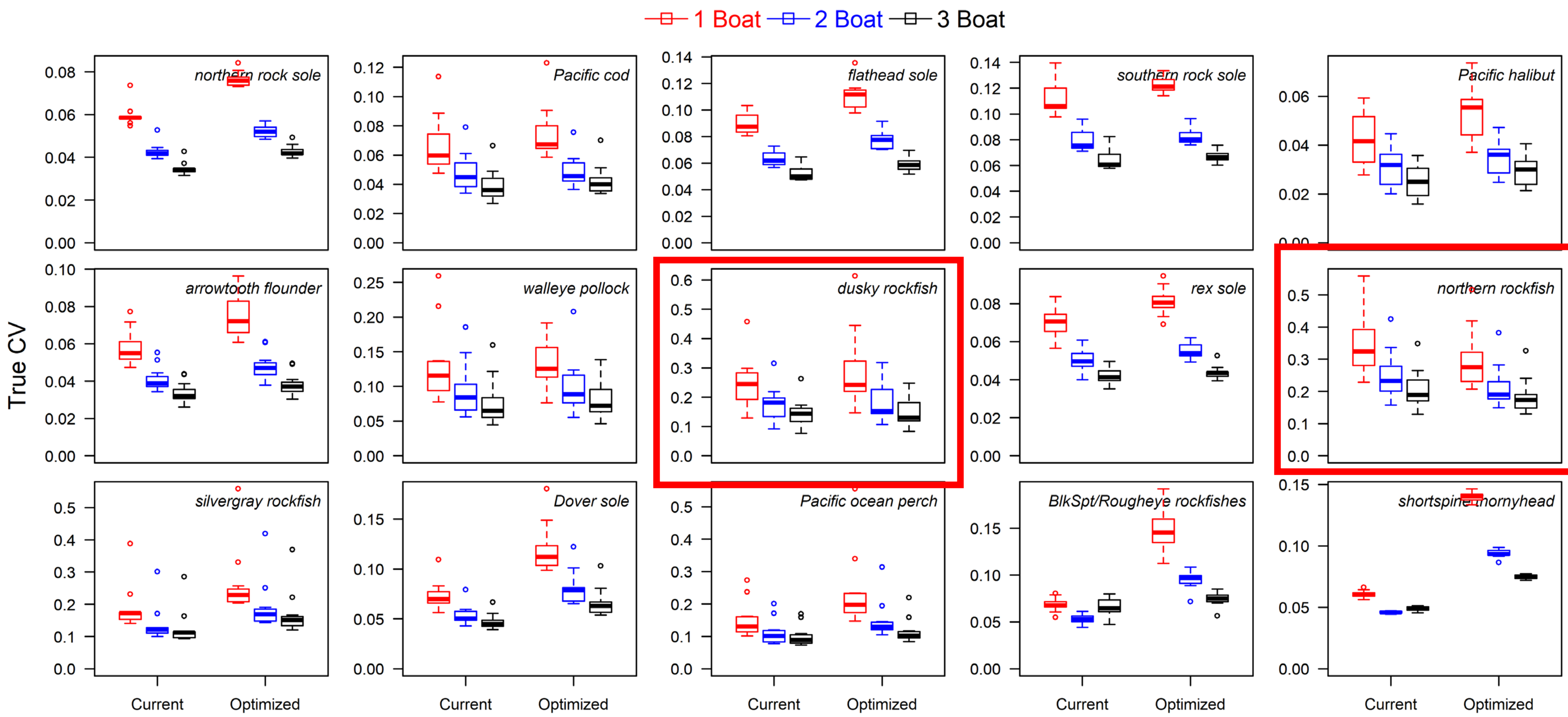
GOA survey (Laman, Von Szalay, Barnett, Oyafuso, Rooper, Williams, Ono)

- Reduced sampling occurred in GOA in 2001, 13, 17 and 19
- GOA is the easiest survey to change the effort because of stratified random design. Design-based estimators are unbiased resulting in flexibility in effort allocation between and within strata.
- 2 boat survey produces reasonable CVs for most species but not for all
- Bias is of concern for current design of 2 boat survey
- Some CVs from 2 or 3 boat survey under current design are highly uncertain

True CV

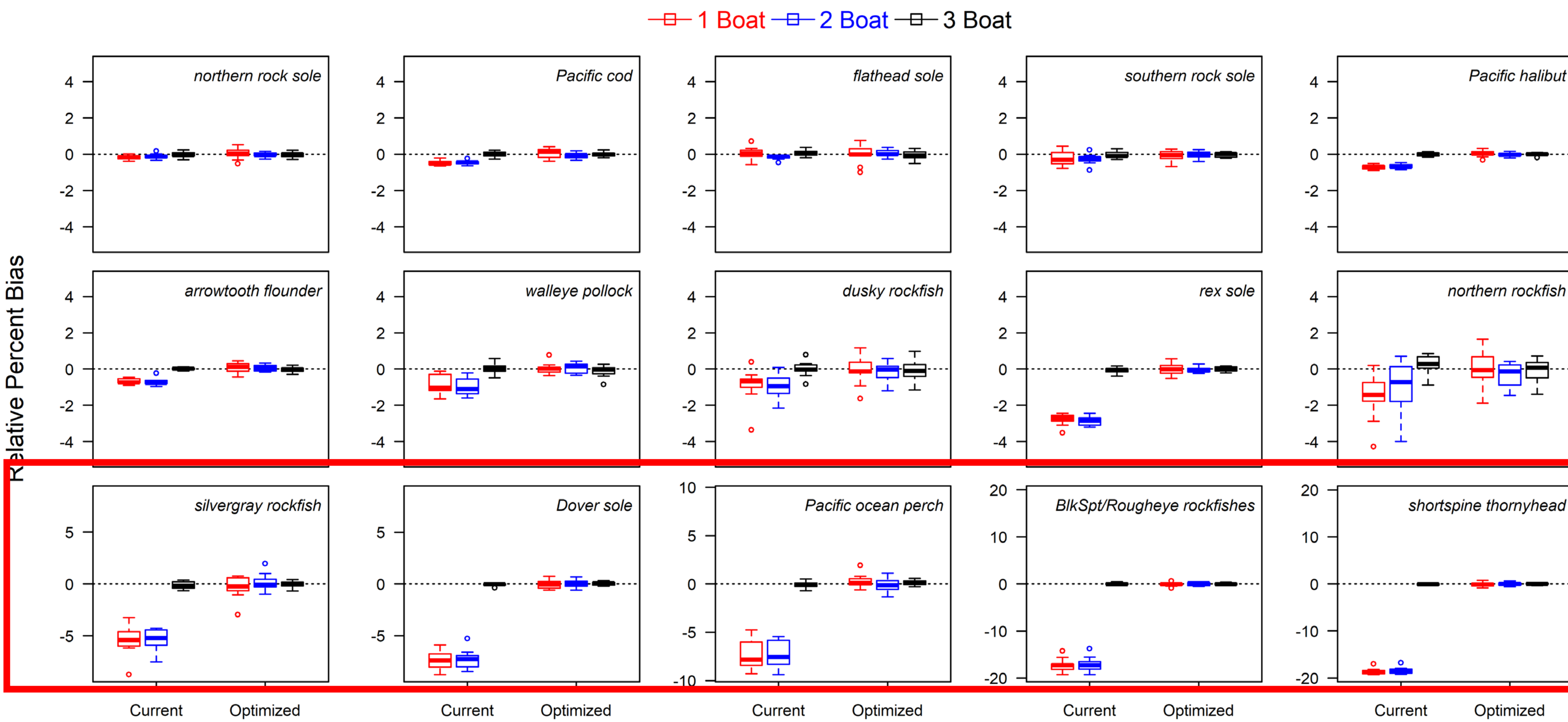

1 Boat
2 Boat
3 Boat
True CV
northern rock sole
Pacific cod
flathead sole
southern rock sole
Pacific halibut
arrowtooth flounder
walleye pollock
dusky rockfish
rex sole
northern rockfish
silvergray rockfish
Dover sole
Pacific ocean perch
BlkSpt/Rougheye rockfishes
shortspine thornyhead
Current
Optimized

True CV

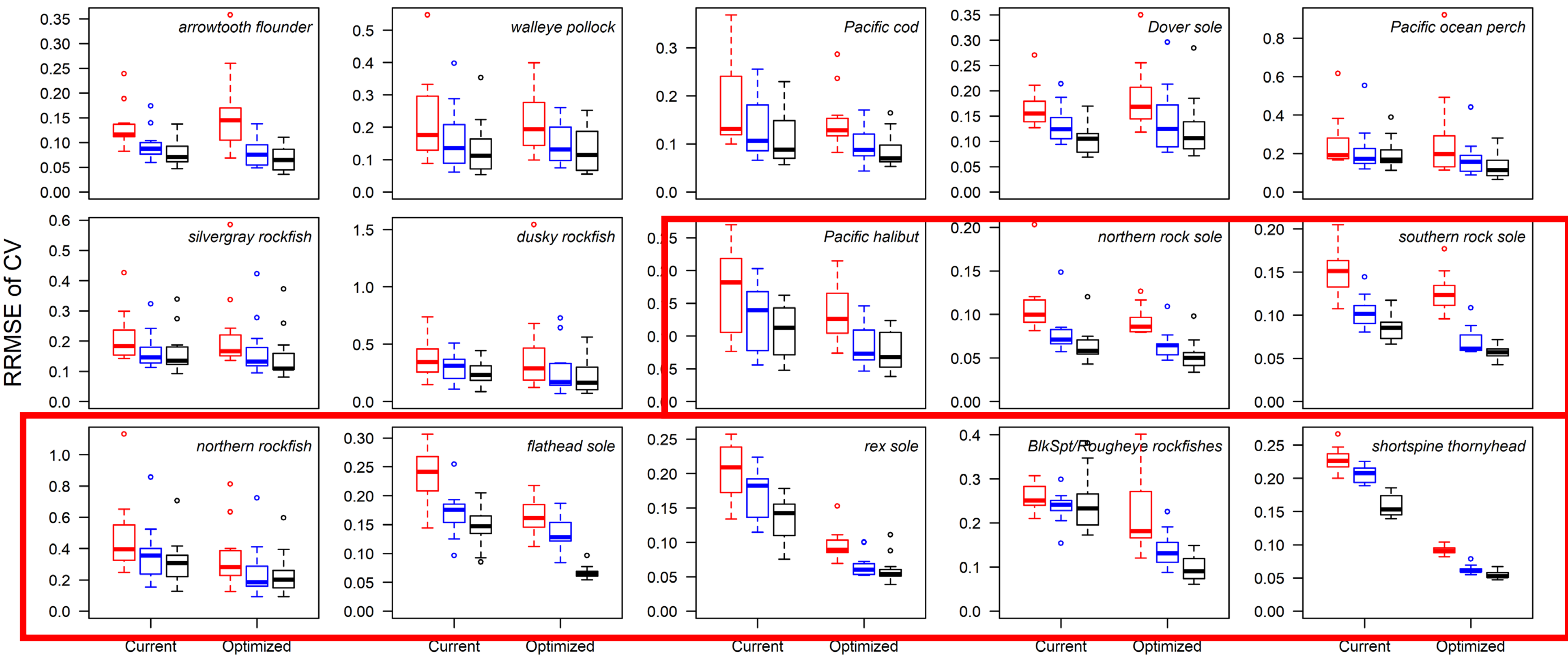


1 Boat
2 Boat
3 Boat
True CV
northern rock sole
Pacific cod
flathead sole
southern rock sole
Pacific halibut
arrowtooth flounder
walleye pollock
dusky rockfish
rex sole
northern rockfish
silvergray rockfish
Dover sole
Pacific ocean perch
BlkSpt/Rougheye rockfishes
shortspine thornyhead
Current
Optimized

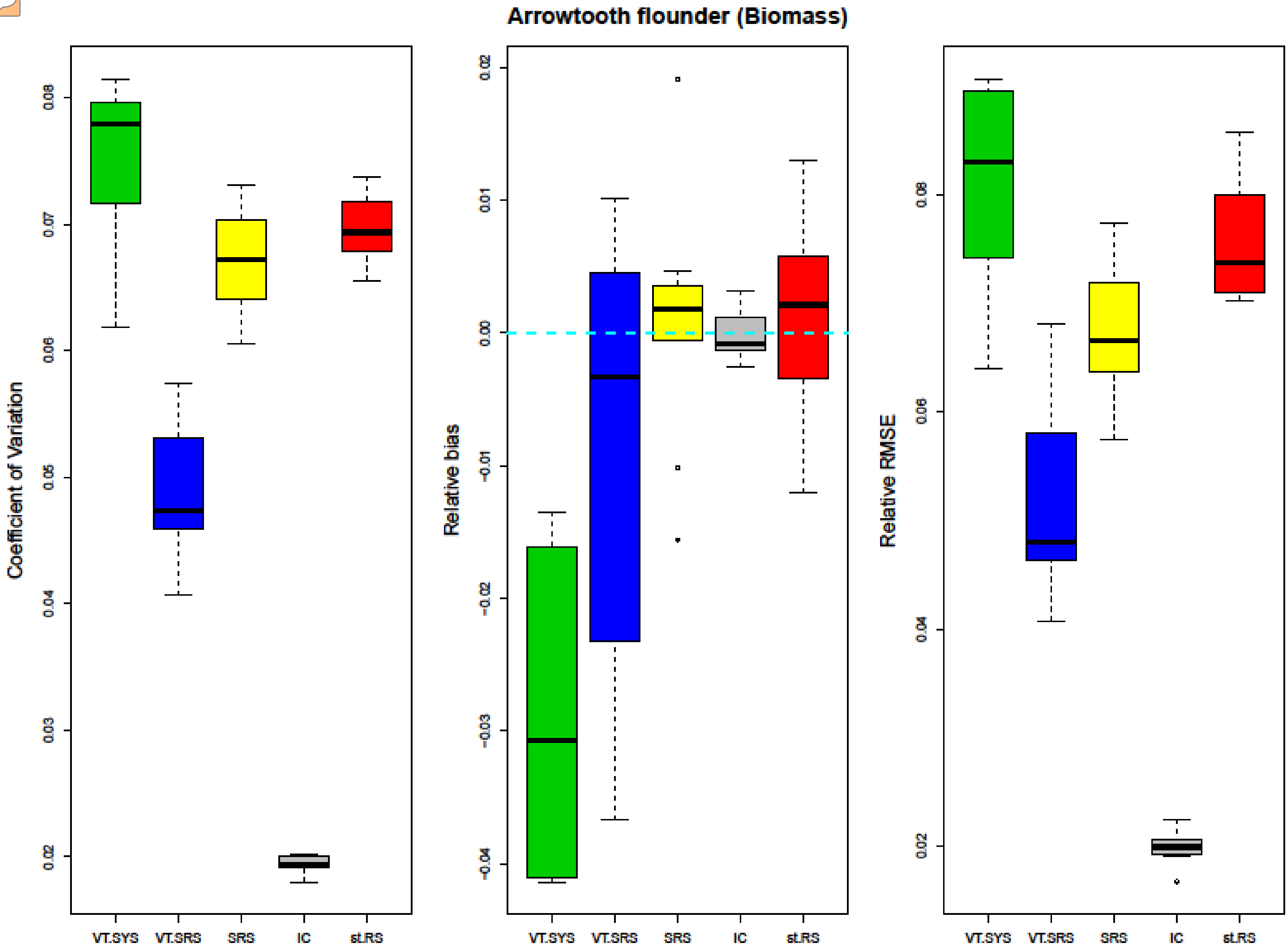
Bias in Mean Density Estimate



RRMSE of CV

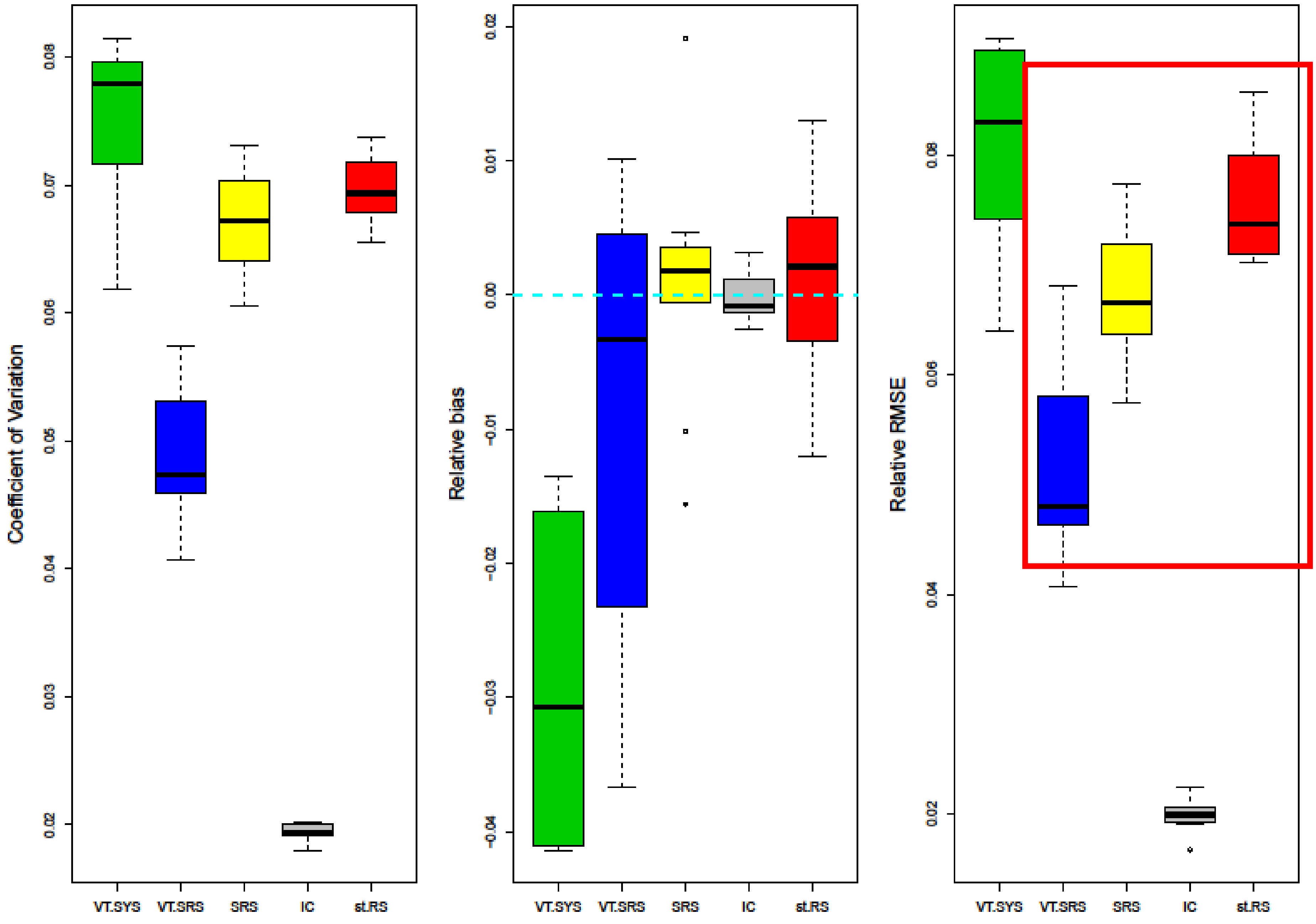


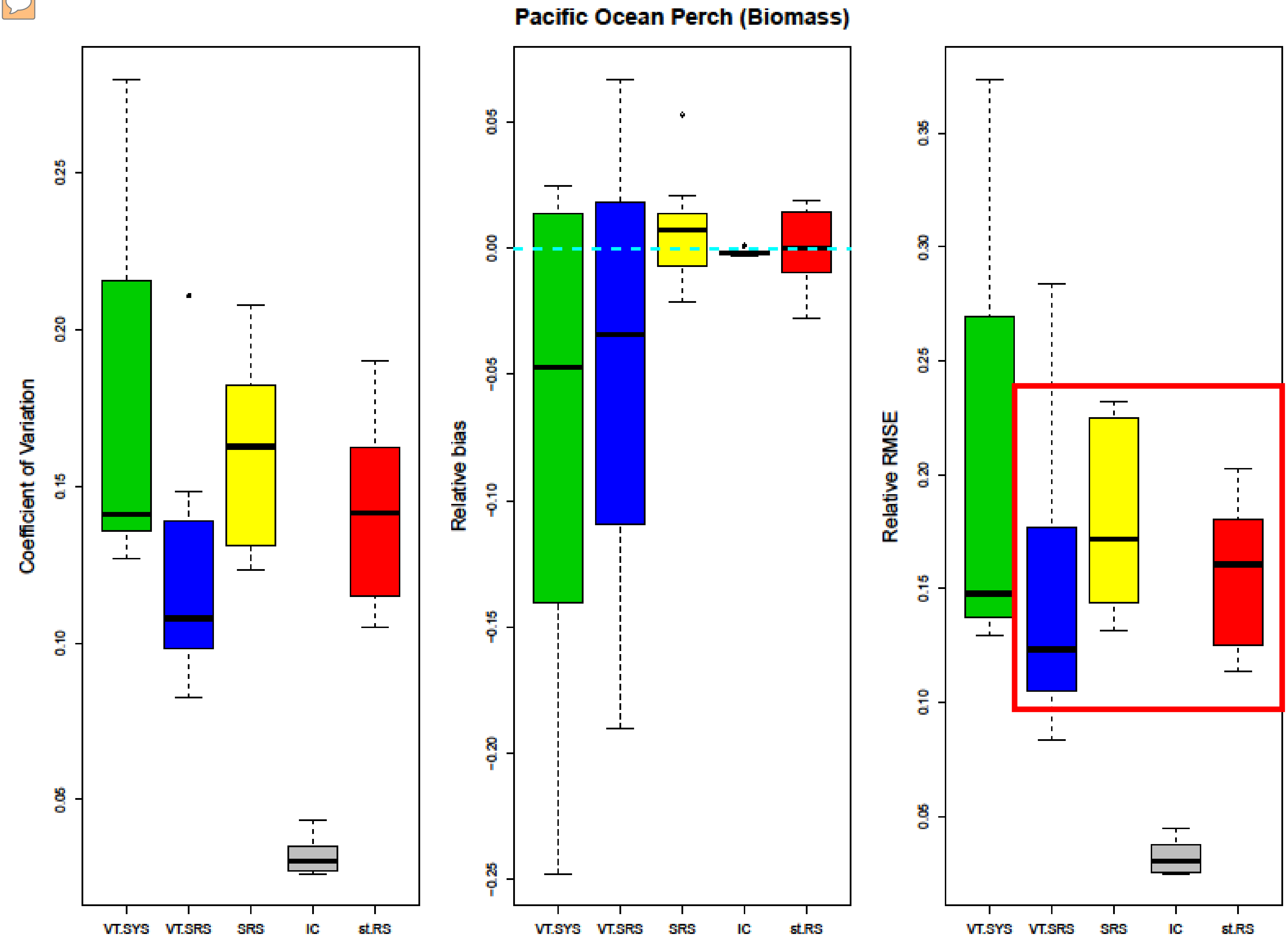
RRMSE of CV
arrowtooth flounder
walleye pollock
Pacific cod
Dover sole
Pacific ocean perch
silvergray rockfish
dusky rockfish
Pacific halibut
northern rock sole
southern rock sole
northern rockfish
flathead sole
rex sole
BlkSpt/Rougheye rockfishes
shortspine thornyhead
Current
Optimized



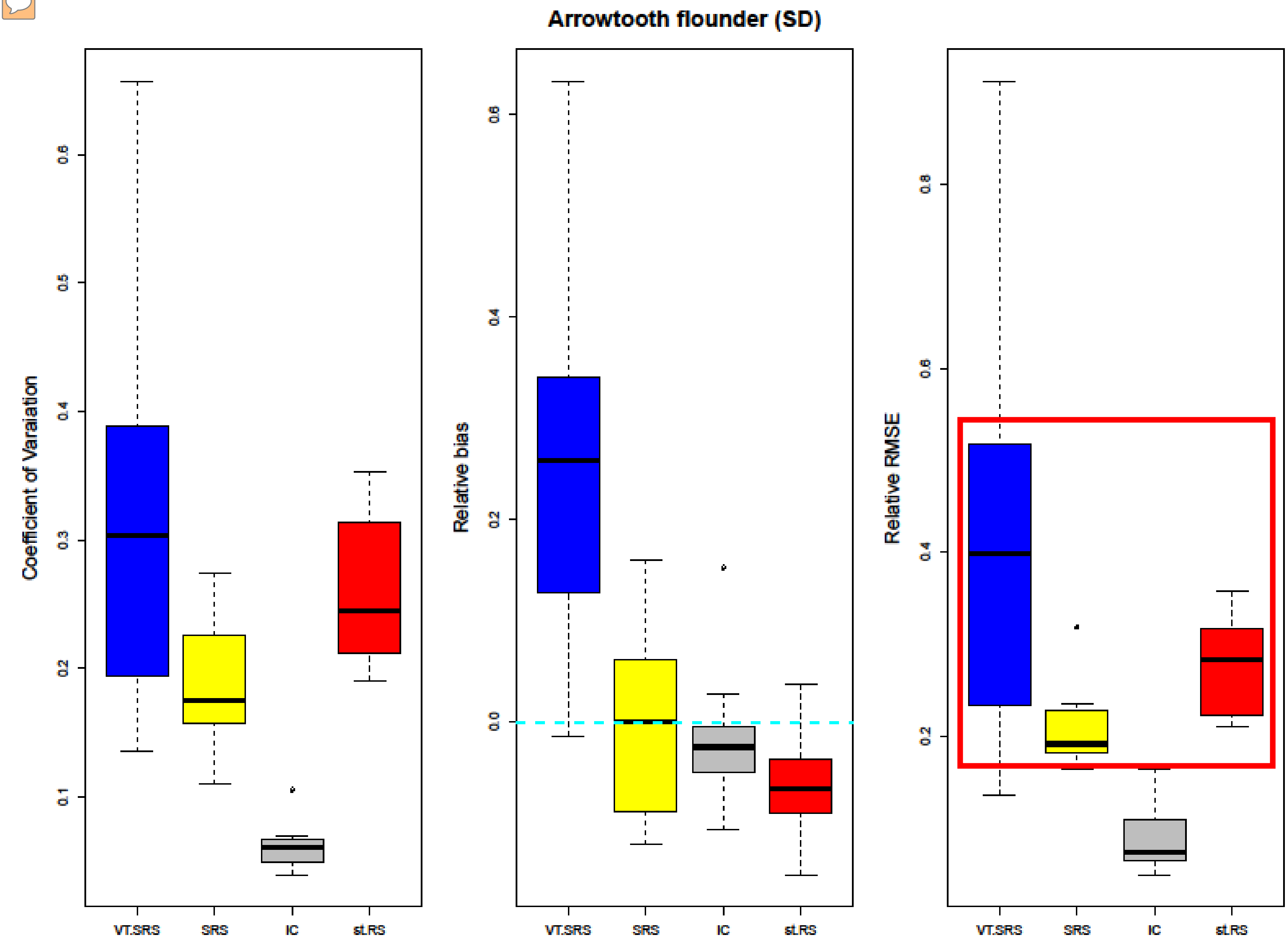
Arrowtooth flounder (Biomass)
Coefficient of Variation
0.08
0.07
0.06
0.05
0.04
0.03
0.02
VT.SYS
VT.SRS
SRS
IC
st.RS
Relative bias
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
Relative RMSE
0.08
0.06
0.04
0.02

Arrowtooth flounder (Biomass)

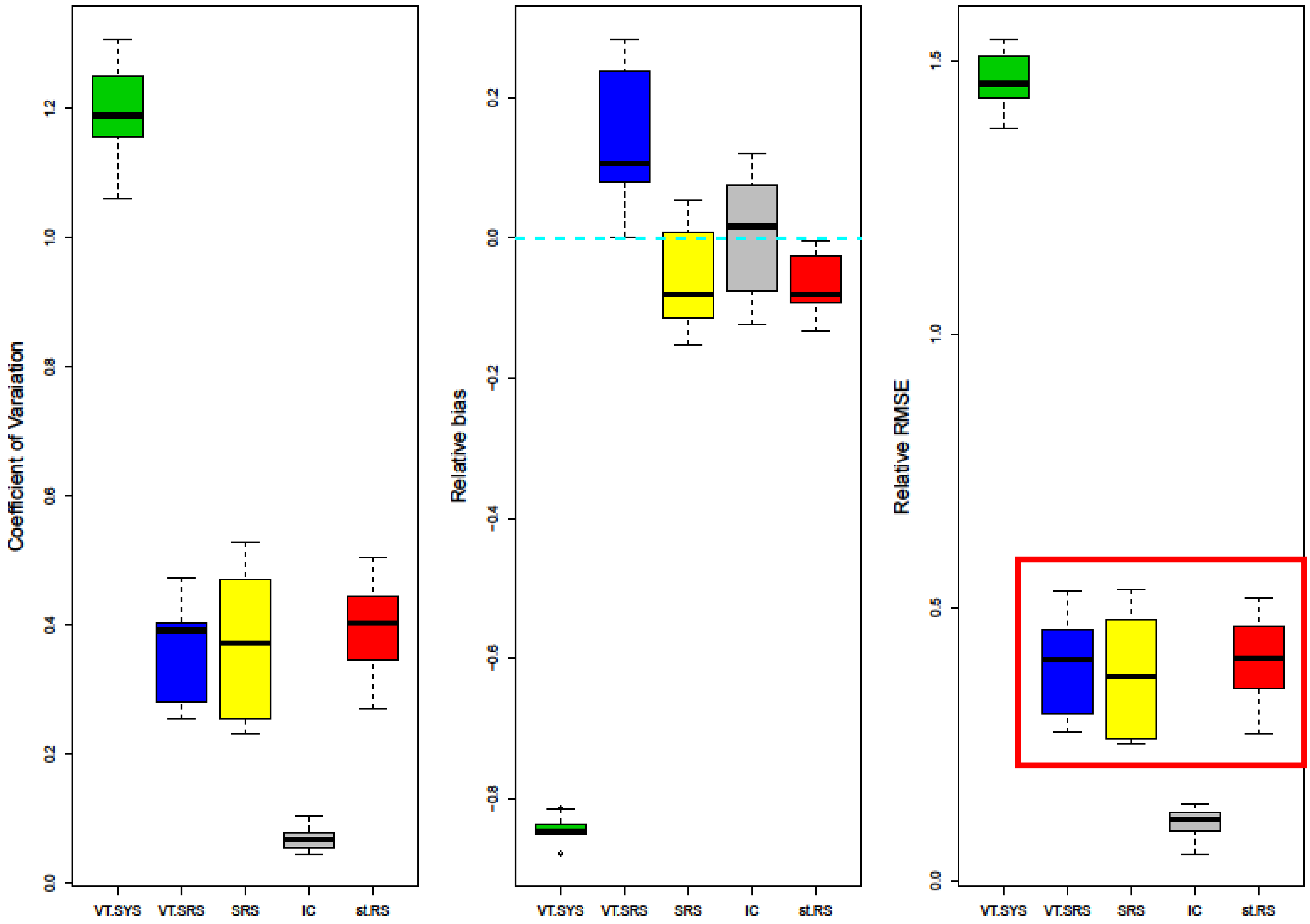




Pacific Ocean Perch (Biomass)
Coefficient of Variation
Relative bias
Relative RMSE
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
VT.SYS
VT.SRS
SRS
IC
st.RS


Arrowtooth flounder (SD)
Coefficient of Varaiation
0.1
0.2
0.3
0.4
0.5
0.6
VT.SRS
SRS
IC
stRS
Relative bias
0.0
0.2
0.4
0.6
VT.SRS
SRS
IC
stRS
Relative RMSE
0.2
0.4
0.6
0.8
VT.SRS
SRS
IC
stRS

Pacific Ocean Perch (SD)



GOA survey conclusions

- 2 boat survey produces reasonable CVs for most species, but not for all.
- Bias in index is of concern for current design of 2 boat survey
- Some CVs from 2 or 3 boat survey under current design are highly uncertain. Bias in CV or biomass estimates more likely when using VAST compared to design-based estimate.
- Care advised when using variance estimates when the estimate is uncertain (Northern RF, Rougheye RF)
- VAST can provide a reasonable alternative to design-based estimators for some Gulf species

GOA survey conclusions

- More experimentation and tuning with the VAST model is needed
- Additional estimators will be explored (GAM, alternative design-based estimators)
- The nexus between multi-species surveys and survey effort reductions results in trade-offs. Importance to clarify priorities with respect to the species and desired (needed) CVs.
- Possible to focus surveys on particular year specific needs.
- GOA survey adjustment/changes are easy because of random design

Bering Sea (Bryan, Richar, Jorgensen, Conner, Cunningham, Williams, Rogers, Yeung, Ono, Kotwicki)

Difficult to change effort because of the bias associated with systematic sampling, but there are some options:

- use information criterion to drop least informative stations (easiest to implement, can use modeling of past data to estimate additional uncertainty and expected bias)
- eliminate corner stations (easy to implement, increased uncertainty for some species, mostly crab)
- reduce towing to 15 minutes (recommended by CIE, easy to implement, minor savings in overall cost, but would reduce total error, reduce cost related to ergonomic injuries and overtime)
- reduce sampling density (difficult to implement, would likely require calibration)
- redesign survey from systematic to random (difficult to implement, but would eliminate bias and allow flexibility in the future)

The impact of survey frequency and intensity on detecting environmental variability and shifts in abundance (Bryan, Thorson)

Objectives:

VAST performance in detecting shifts in abundance in an inconsistently surveyed area (NBS)

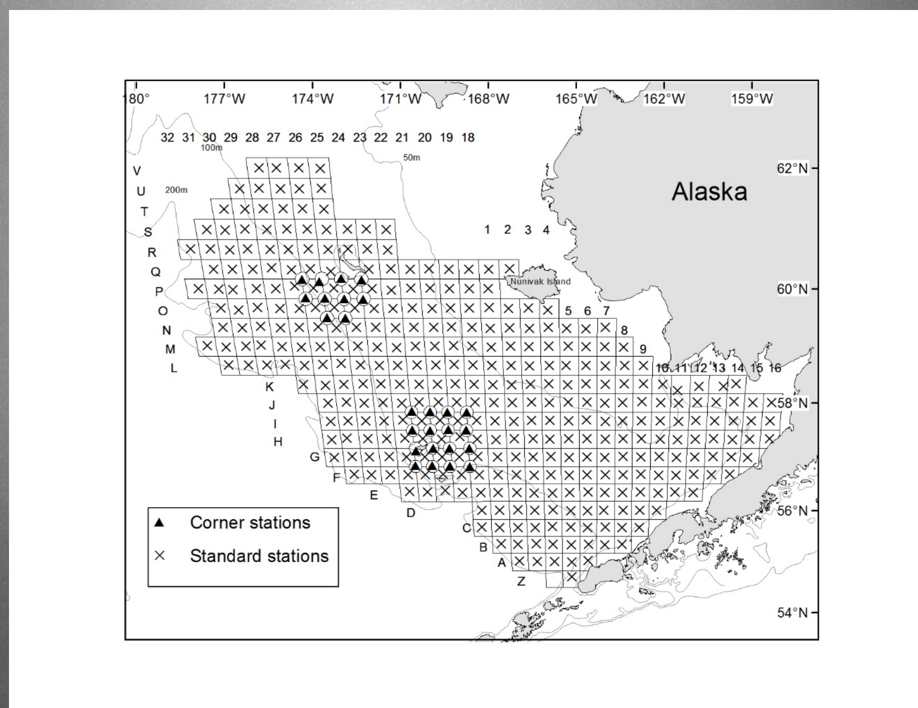
Determine the impact of survey frequency and intensity on our ability to estimate the abovementioned variables

Bering Sea (Bryan, Thorson)

- Annual surveys, even with reduced sampling intensity are better.
- VAST can accurately estimate the proportion of abundance in the NBS when survey data are missing.
- Indices of abundance that include NBS for Bering Sea walleye pollock and Pacific cod are currently being developed using this same spatio-temporal model.

Considering changes in sampling density and survey frequency, and their effects on eastern Bering Sea crab population time series

Jonathan Richar and Robert Foy



Corner drop

- Major stocks (opilio, bairdi)
  - Variable, but overall, limited effects on index estimates
  - Uncertainty estimates moderately affected (0-50% CV increase)
- Minor stocks (St. Matthew, Pribilof BKC, Pribilof RKC)
  - Population estimates more strongly impacted
  - Uncertainty estimates severely affected in many years
  - VAST may address uncertainty estimates, but not lost sampling data/reduced sampling resolution

Biennial

- Strong autocorrelation in time series
  - Statistically significant correlations suggests calculating a proxy for following year's survey biomass from a given year's estimate *may* be viable…at least at coarse size-bins
- **However:** Differences between groups in correlation strength for given size classes suggests sequence is important (e.g. larger male opilio)
  - Recruitment cycles for a given size/maturity group/species better captured by one sequence than the other
  - Also, lost supporting data: Size frequency data, chela-carapace width data for maturity…….

Impact of reducing sample density on the accuracy and precision of design-based estimators of an abundance index for a bottom trawl survey in the eastern Bering Sea (Conner)

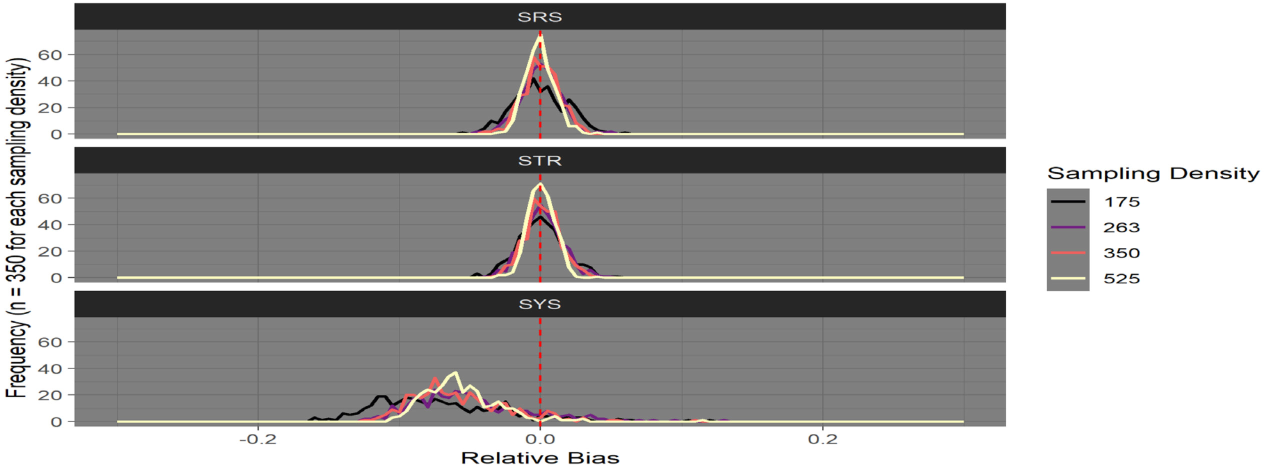
350 – Present sample size, 132 vessel-days

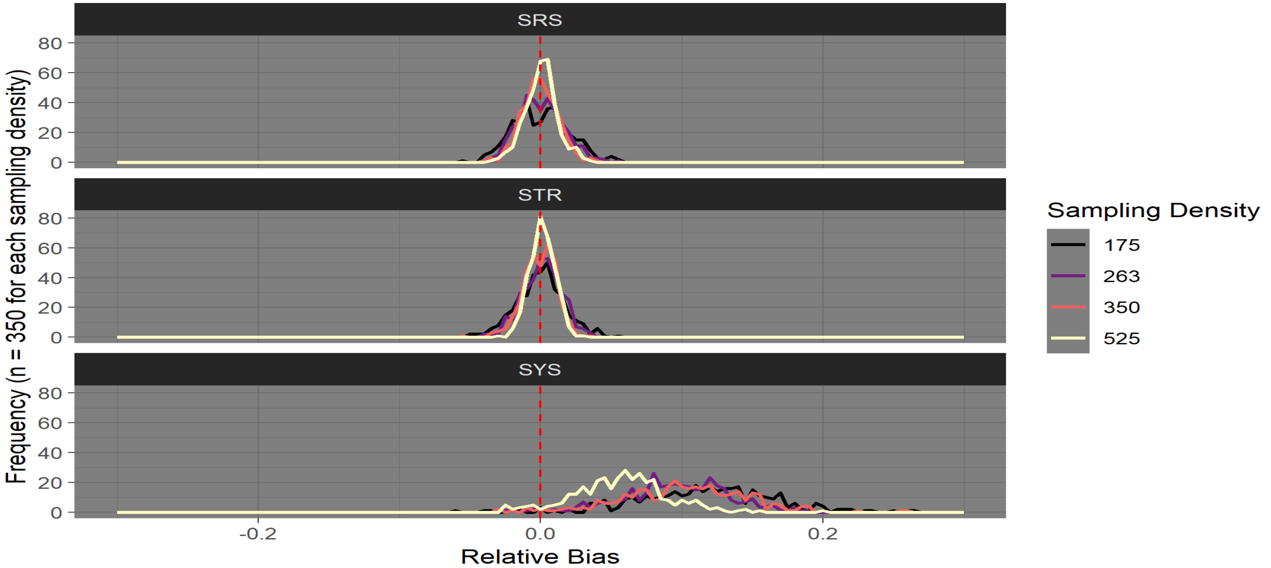
263 – Sampling reduced to 88 vessel-days

175 – Sampling reduced to 66 vessel-days

525 – Sampling increased to 198 vessel-days

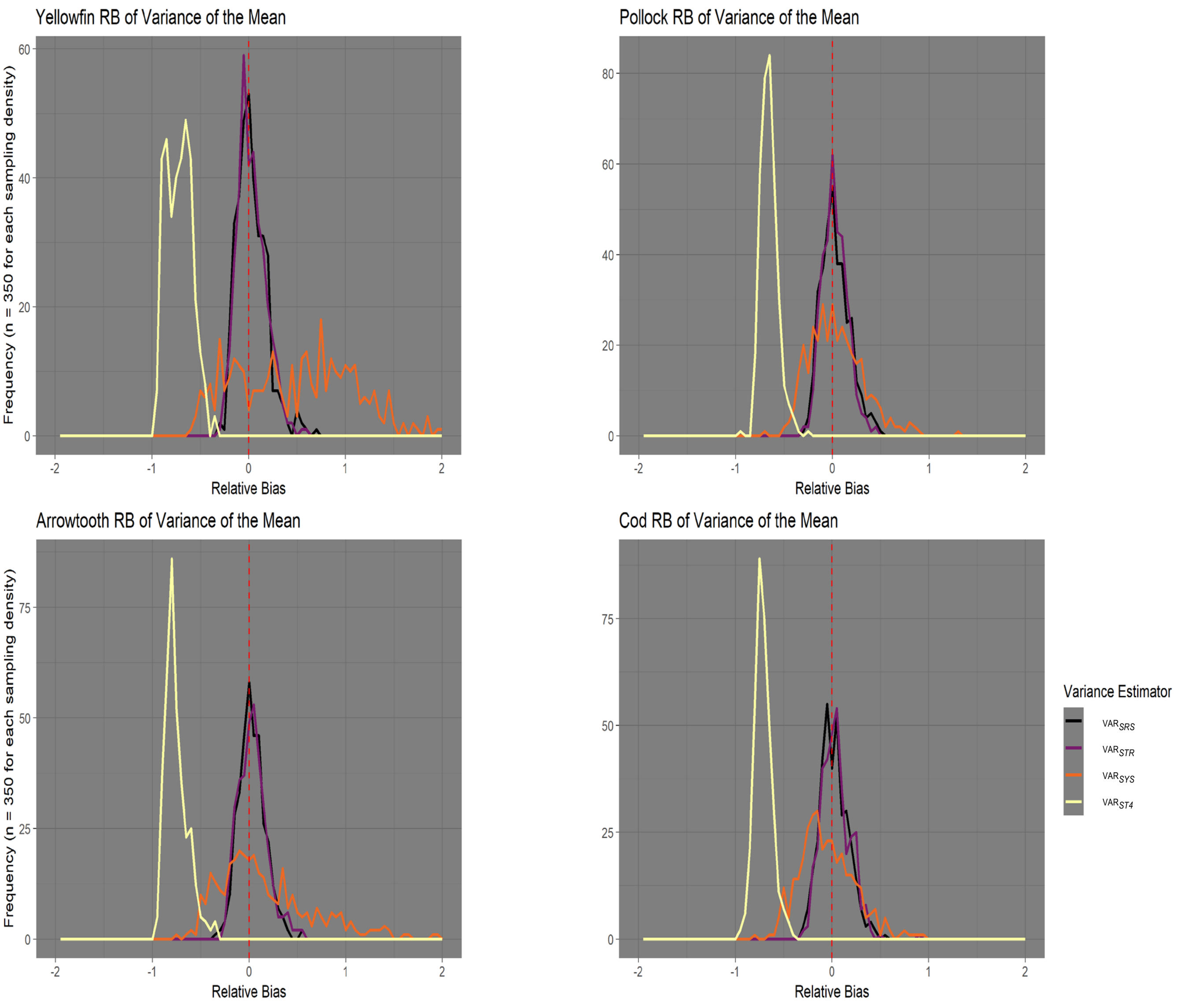
Walleye Pollock and Arrowtooth





- For all species, SYS produces biased mean estimates with larger error
- Sample size matters for all designs,
- STR will give us lower variance estimates in most cases
- Given a SYS survey with ample sampling, which is a better variance estimator for stock assessment: unbiased-high-variance **or** biased-low-variance

RB of Variance of the Estimate

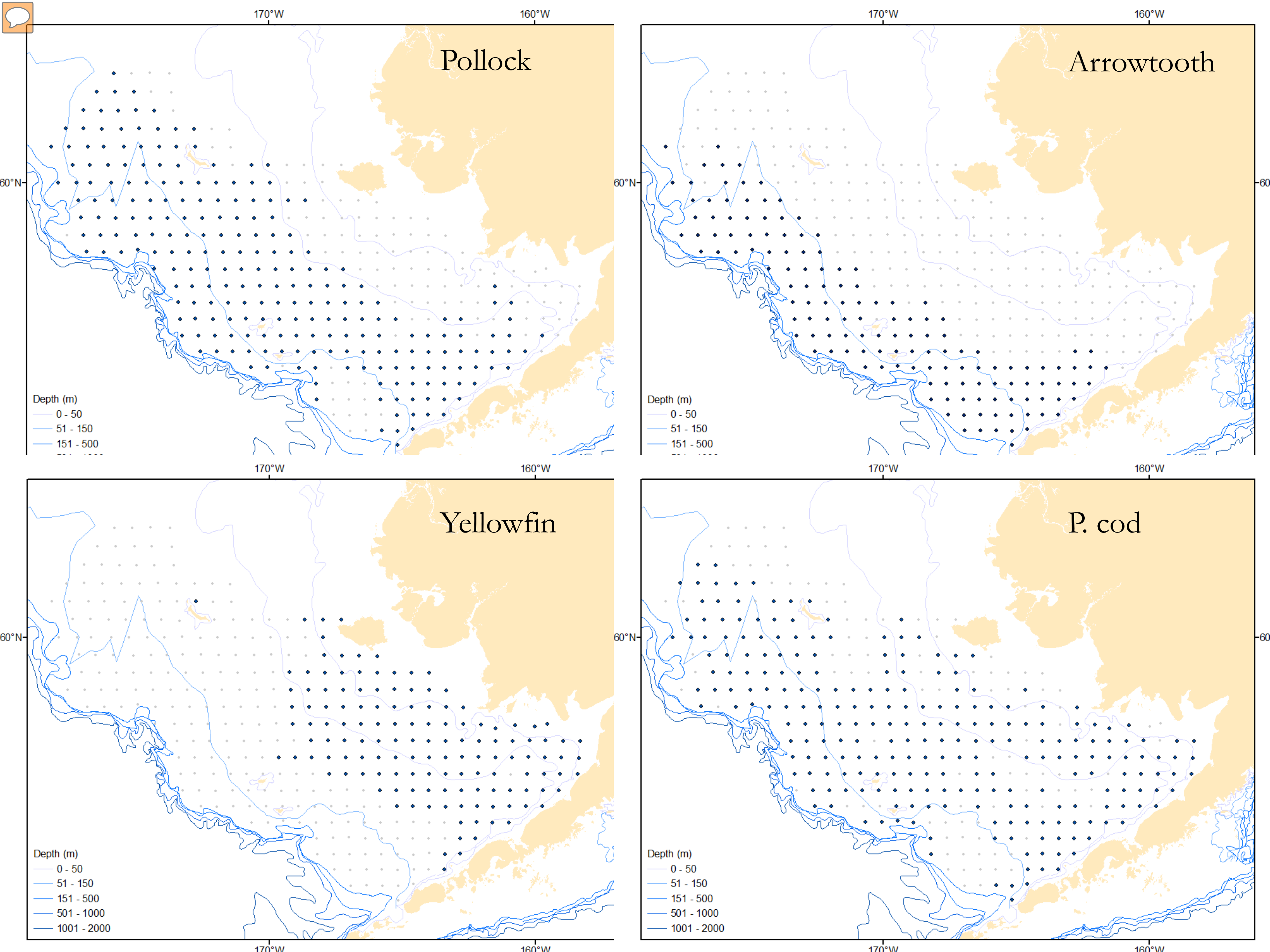


In SYS, ST4 estimator is highly biased but precise Naïve estimator is less bias but imprecise.

Need to better understand needs

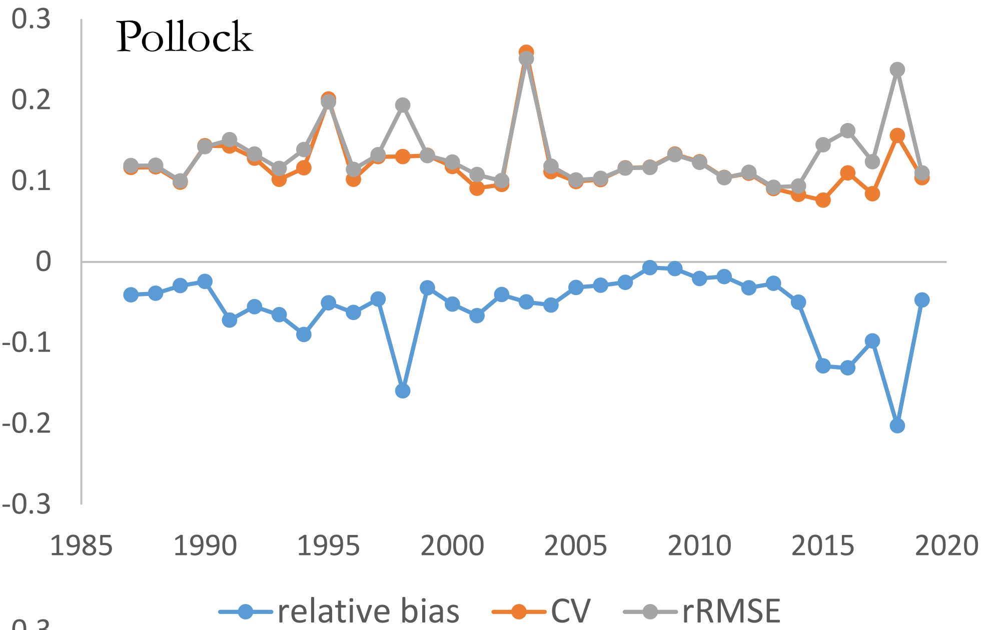
Reducing spatial coverage of Eastern Bering Sea Shelf survey (Jorgensen)

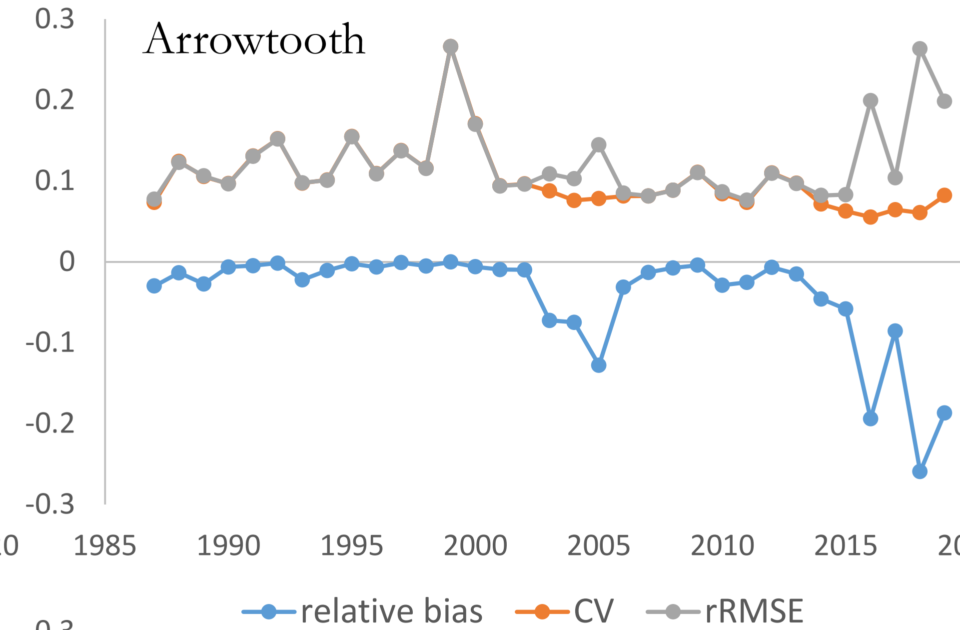
- Objective: develop methods to reduce the footprint of the EBS survey based on station importance criterion.
- Information Criterion: (mean CPUE)^2 + variance CPUE
- Incorporates both abundance and trend, ranks relative importance of each station for each species.
- Can facilitate combining species based on weights.

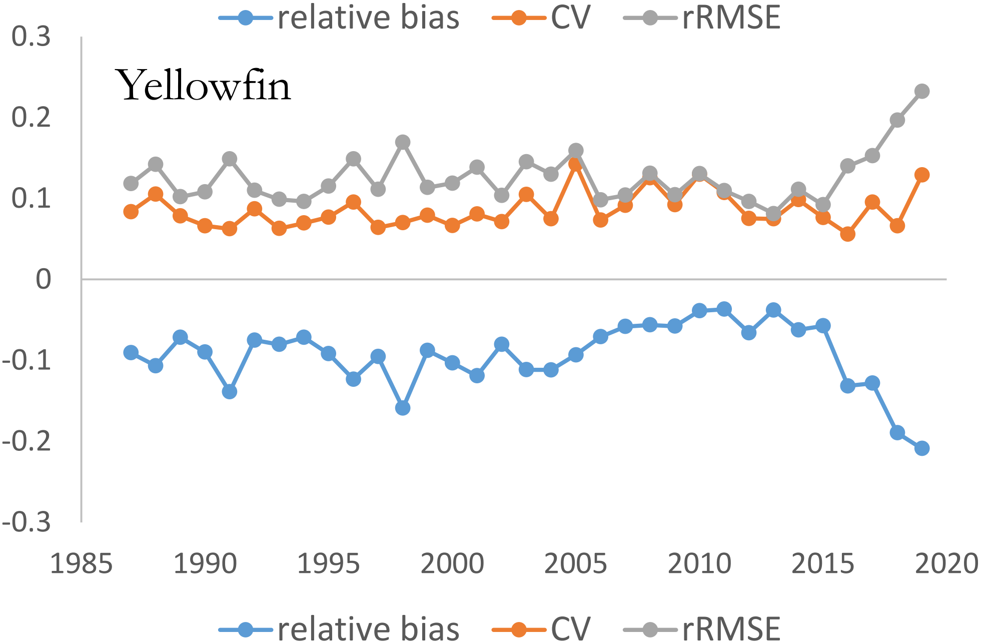


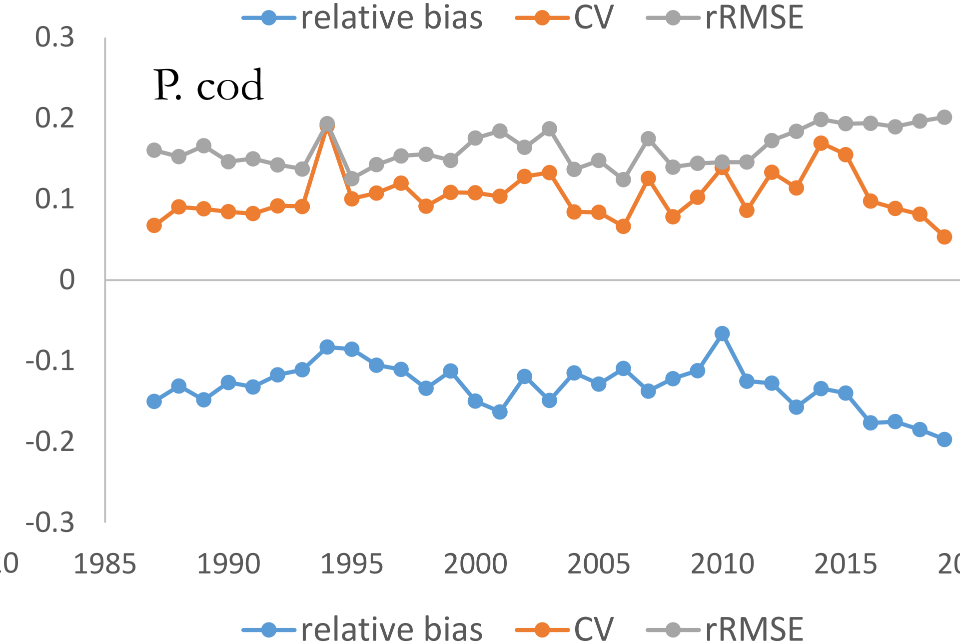
Pollock
Arrowtooth
Yellowfin
P. cod
170°W
160°W
60°N
Depth (m)
0 - 50
51 - 150
151 - 500
501 - 1000
1001 - 2000

Performance



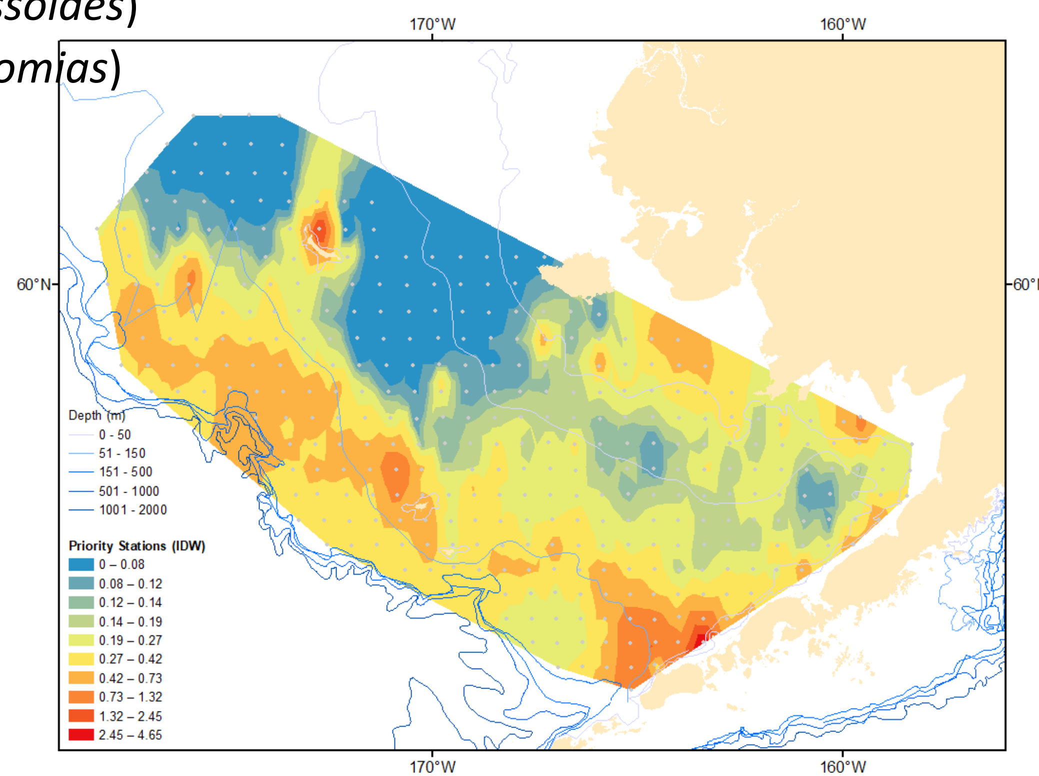






Stations priority (equal weight for all species)

- 95% of all fish biomass represented by 8 species
  - Walleye pollock (*Gadus chalcogrammus*)
  - Yellowfin sole (*Limanda aspera*)
  - Northern rock sole (*Lepidopsetta polyxystra*)
  - Pacific cod (*Gadus macrocephalus*)
  - Flathead sole (*Hippoglossoides elassodon*)
  - Alaska plaice (*Hippoglossoides platessoides*)
  - Arrowtooth flounder (*Atheresthes stomias*)
  - Skate complex (*Rajidae*)



AI, NBS, Slope considerations

- AI difficult to reduce due to already high uncertainty and "index survey" design (no simulations were performed to date)
- NBS – simulations indicate that it maybe preferable to do annual survey, random design, with possibility of reducing number of stations. VAST can mitigate some issues with missing data.
- Slope – survey was completely dropped recently resulted in serious consequences typical to missing survey data (likely affected: ATF, Kamchatka, G. Turbot, Skates). Research on value of Slope survey data is undergoing.

Key conclusions

- Knowledge of priorities is a key for planning (LMEs, areas within LMEs, species, data products (biological and environmental), environmental change considerations
- Develop key quality metrics for survey an assessment outcome (total survey uncertainty, variance propagation, assessment uncertainty, measures of value of information – money and scientific value)
- Assuring survey continuity in changing world – consider survey design that allows for flexibility (e.g. random), take advantage of modelling and fish stocks – environment linkages
- Develop decision making tools

THANK YOU AND THANKS TO ALL CONTRIBUTORS

- SSC-sub-committee: Anne Hollowed (co-chair)[1], Gordon Kruse (co-chair)[2], George Hunt[3], Alison Whitman[4], Dayv Lowry[5], and Dana Hanselman[6]
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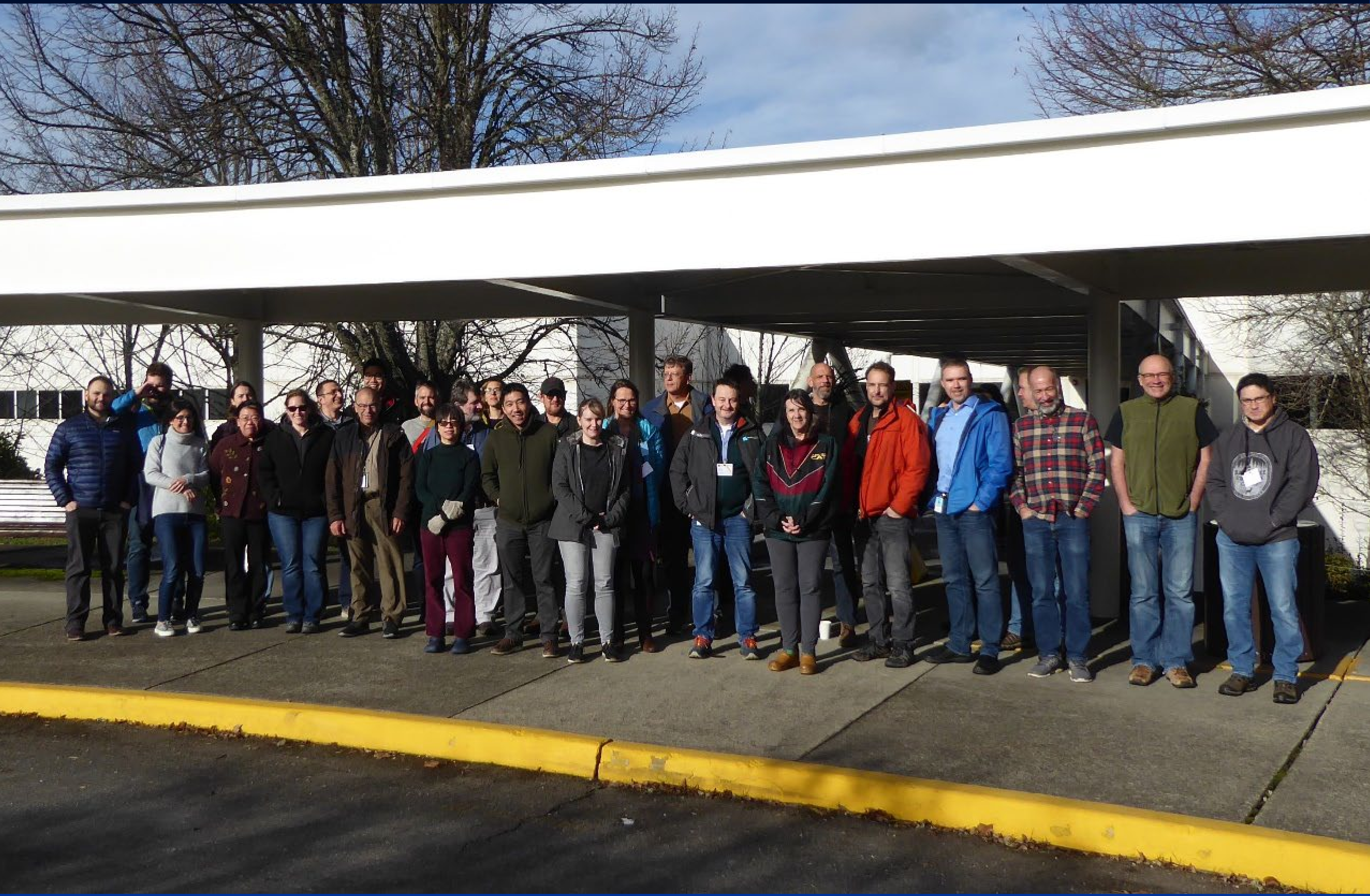



QuotesGram.com
START BY DOING
WHAT'S NECESSARY;
THEN DO WHAT'S
POSSIBLE; AND
SUDDENLY YOU ARE
DOING THE
IMPOSSIBLE
Francis of Assisi

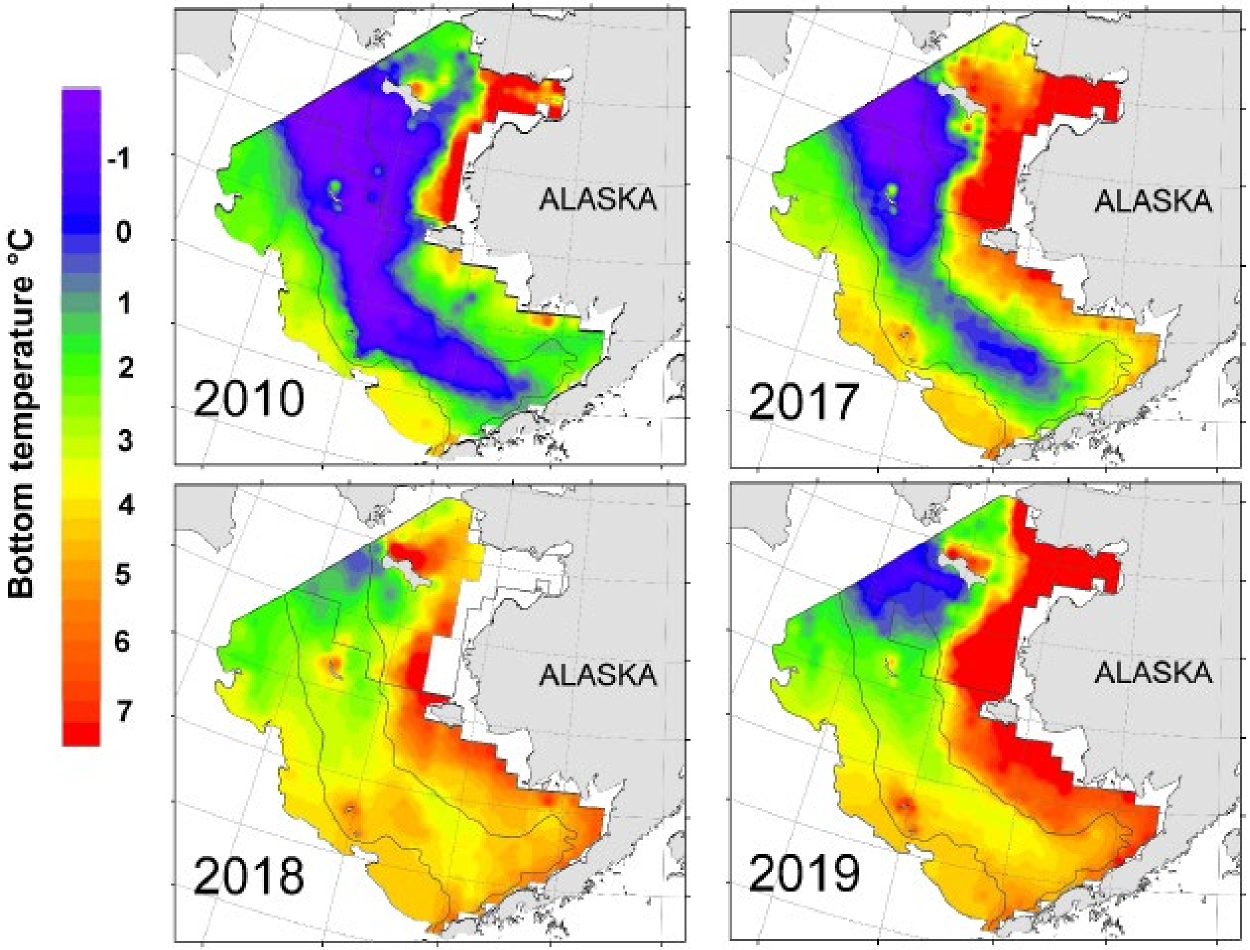
Abrupt Warming in the Bering Sea in Recent Years

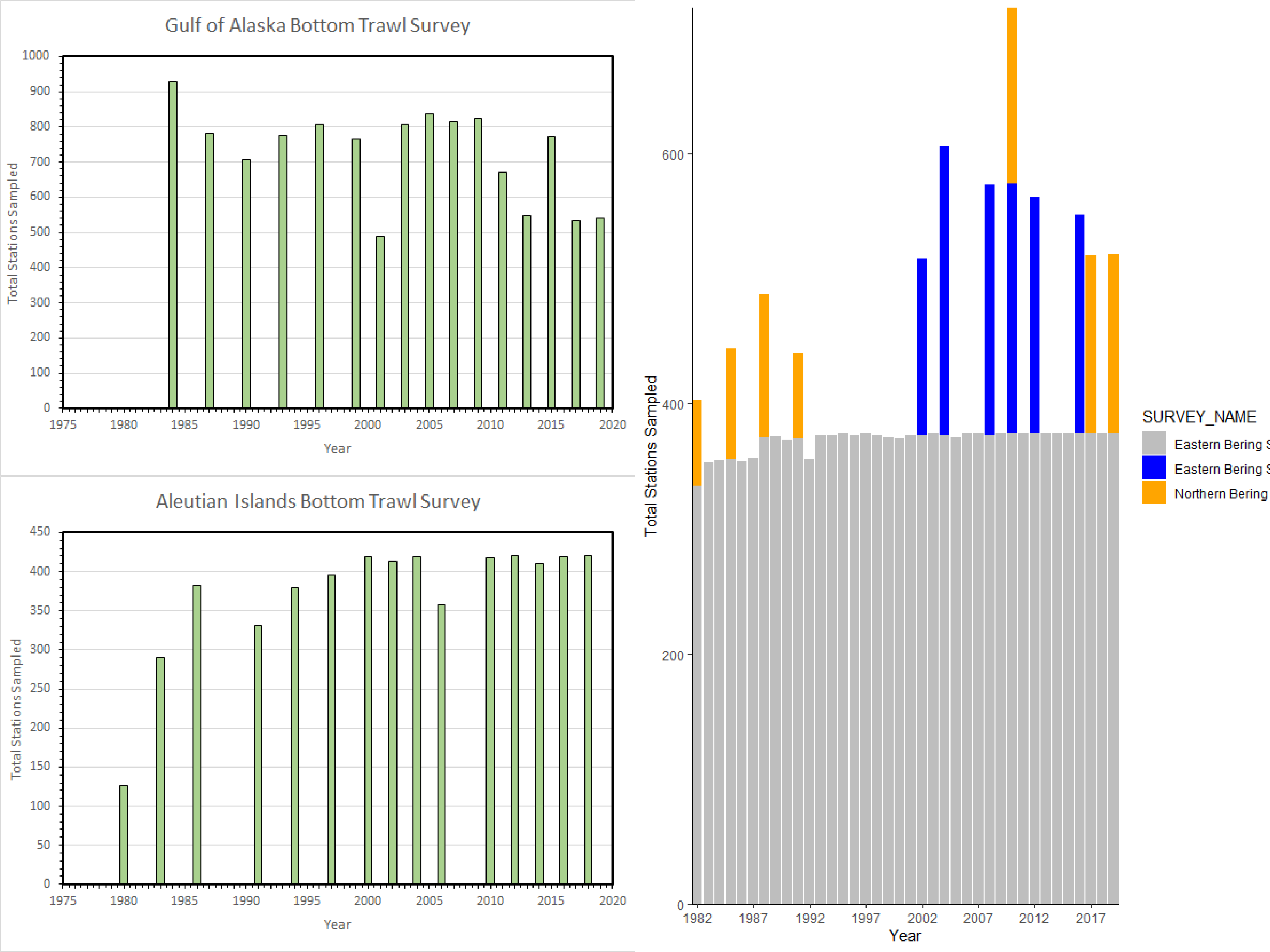
Stabeno and Bell 2019 Geophysical Research Letters, 46, 8952–8959

“Rapid changes in environmental conditions and fish abundance and distribution in response to Marine Heat Waves accentuates the need to continue or increase trawl survey frequency and sampling density (SSC report, 2018).”

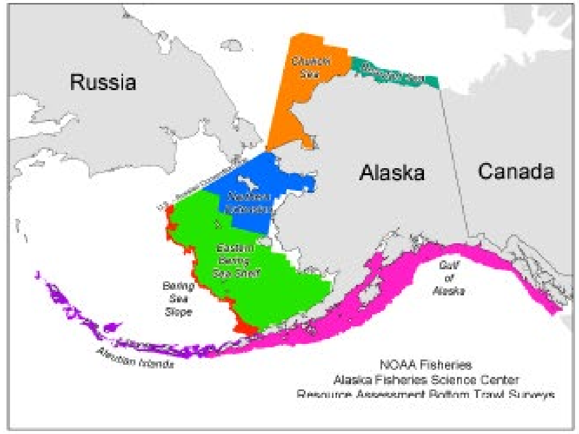
Eastern Bering Sea Bottom Trawl Survey Bottom Temperature

Source: Lyle Britt, Alaska Fisheries Science Center





Gulf of Alaska Bottom Trawl Survey
Total Stations Sampled
Year
Aleutian Islands Bottom Trawl Survey
Total Stations Sampled
Year
Total Stations Sampled
Year
SURVEY_NAME
Eastern Bering
Eastern Bering
Northern Bering



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Implications of Changes in Bottom Trawl Survey Effort On the Quality of Stock Assessment Results

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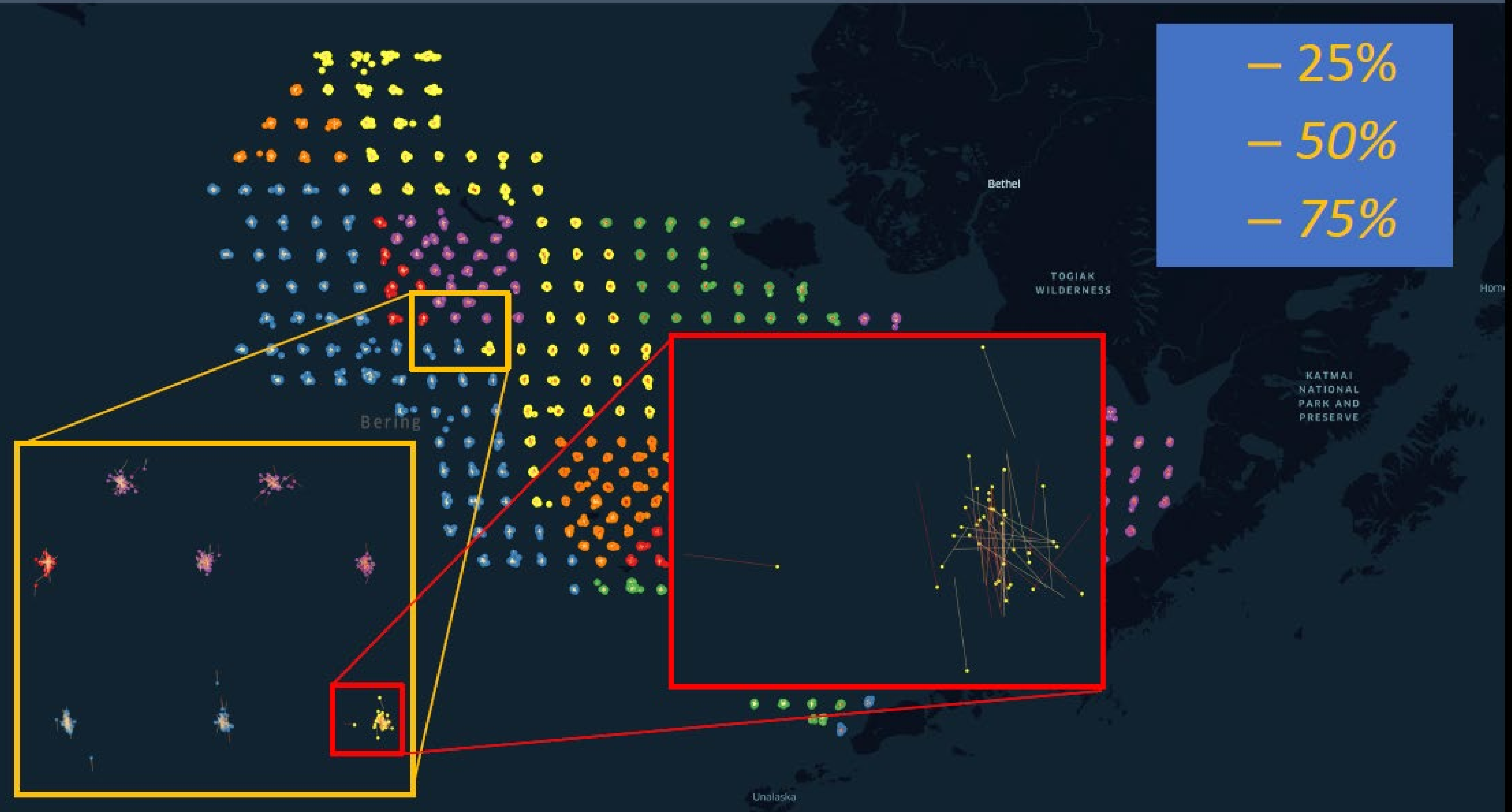
Removal Scenarios: Random

- Randomly remove samples in each year
  - 25%
  - 50%
  - 75%



Summary

- Larger difference in SSB, $B_{40\%}$ vs. $F_{40\%}$, $F_{35\%}$
- Random removal scenarios
  - Moderate reductions in survey effort (<26%) result in similar SAM estimates
  - Greater reductions = higher variability in estimates among realizations
  - P. cod: higher removal rates = increasing SSB est.
- Strata removal scenarios
  - Pollock
    - Least difference: Removing inner/outer strata
  - P. cod
    - Least difference: Removing middle domain strata
  - Optimal strata to remove appears species dependent

AFSC Questions for SSC

1. **What are the ranked order of priorities for our present suite of bottom trawl surveys: the eastern Bering Sea shelf, eastern Bering Sea slope, northern Bering Sea shelf, Gulf of Alaska, and Aleutian Islands?**
2. **If the Center has four, rather than five charter vessels on contract in FY19,we propose to put two vessels on the eastern Bering Sea shelf and two in the Gulf of Alaska. If additional funds are available, then these will be used to support a northern Bering Sea survey. Do you agree?**
3. Given the answer to Question #2, which surveys should we prioritize for FY20 under a four-boat scenario?
4. If the Center is only able to fund 3 charter vessels in FY19, which survey(s) should we attempt?
5. Given the answer to Question #4, which surveys should we attempt inFY20 under a three boat scenario?

The effect of variable sampling efficiency on reliability of the observation error as a measure of uncertainty in abundance indices from scientific surveys.

Authors:
Stan Kotwicki and Kotaro Ono

Can we trust design-based variance estimates from fishery surveys?

Authors:
Stan Kotwicki and Kotaro Ono

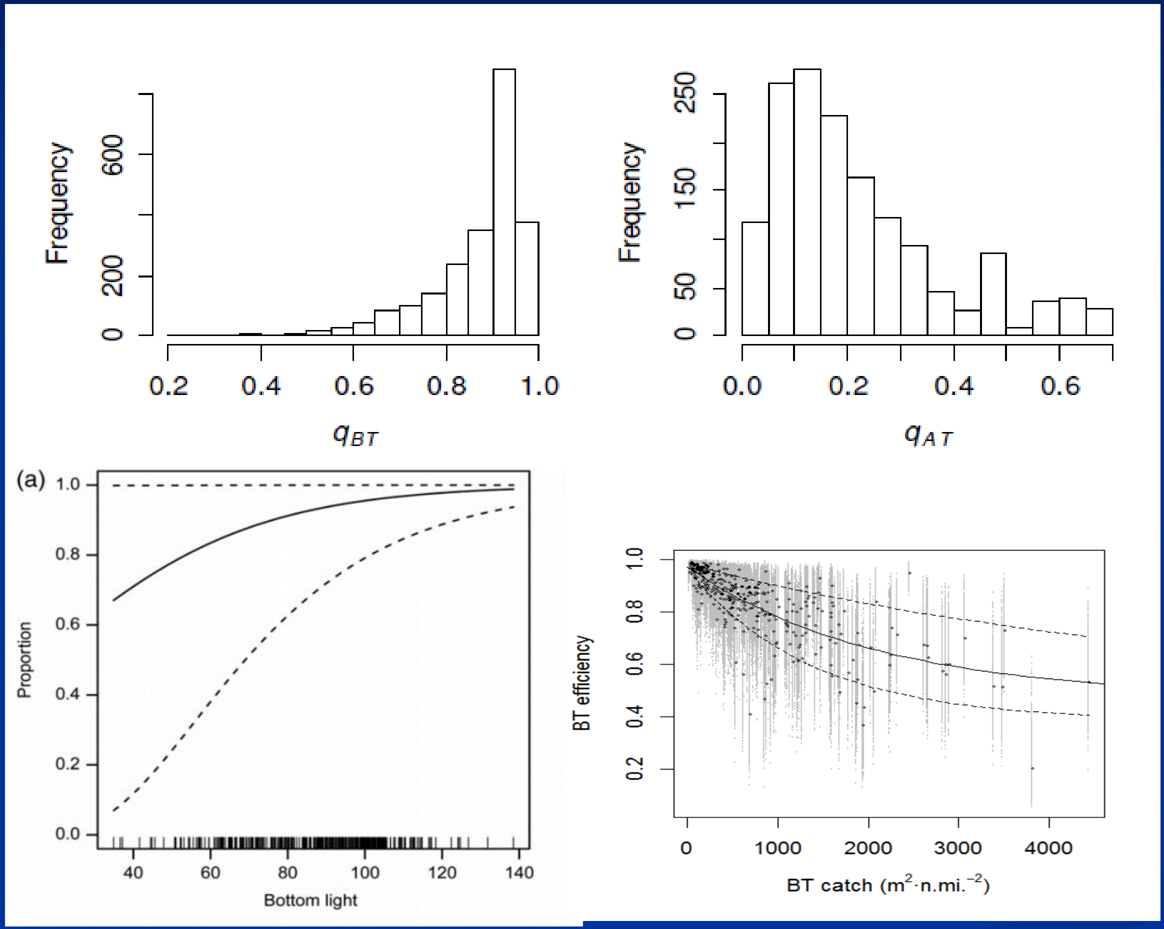
It depends.

- On degree of violation of assumptions for the design-based estimates, i.e.:
  - Efficiency, selectivity, catchability are constant
  - Survey encompasses entire extend on the stock (availability)
  - Other survey design assumptions are met (e.g. sampling design, i.i.d. in SRS)

- Sampling efficiency (q_e) = survey selectivity *

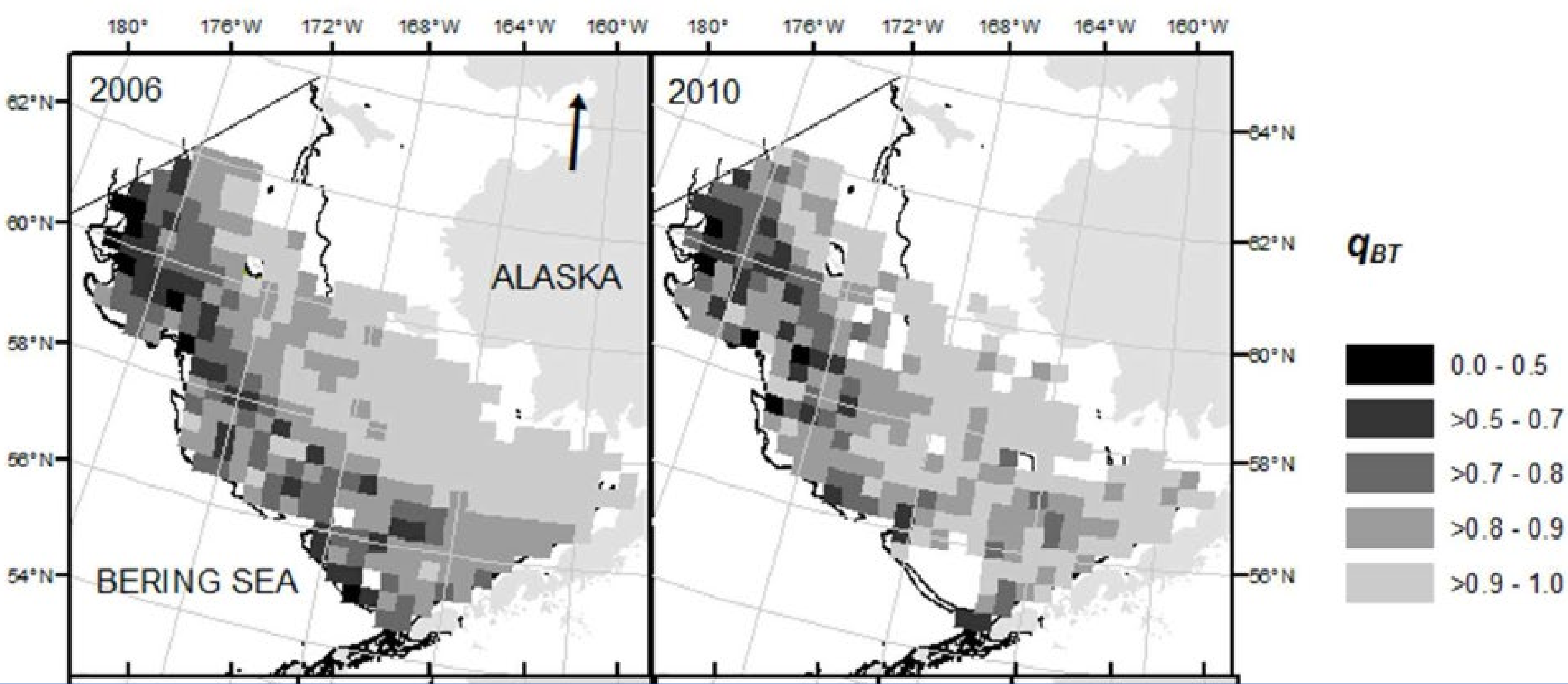
Examples

EBS Pollock



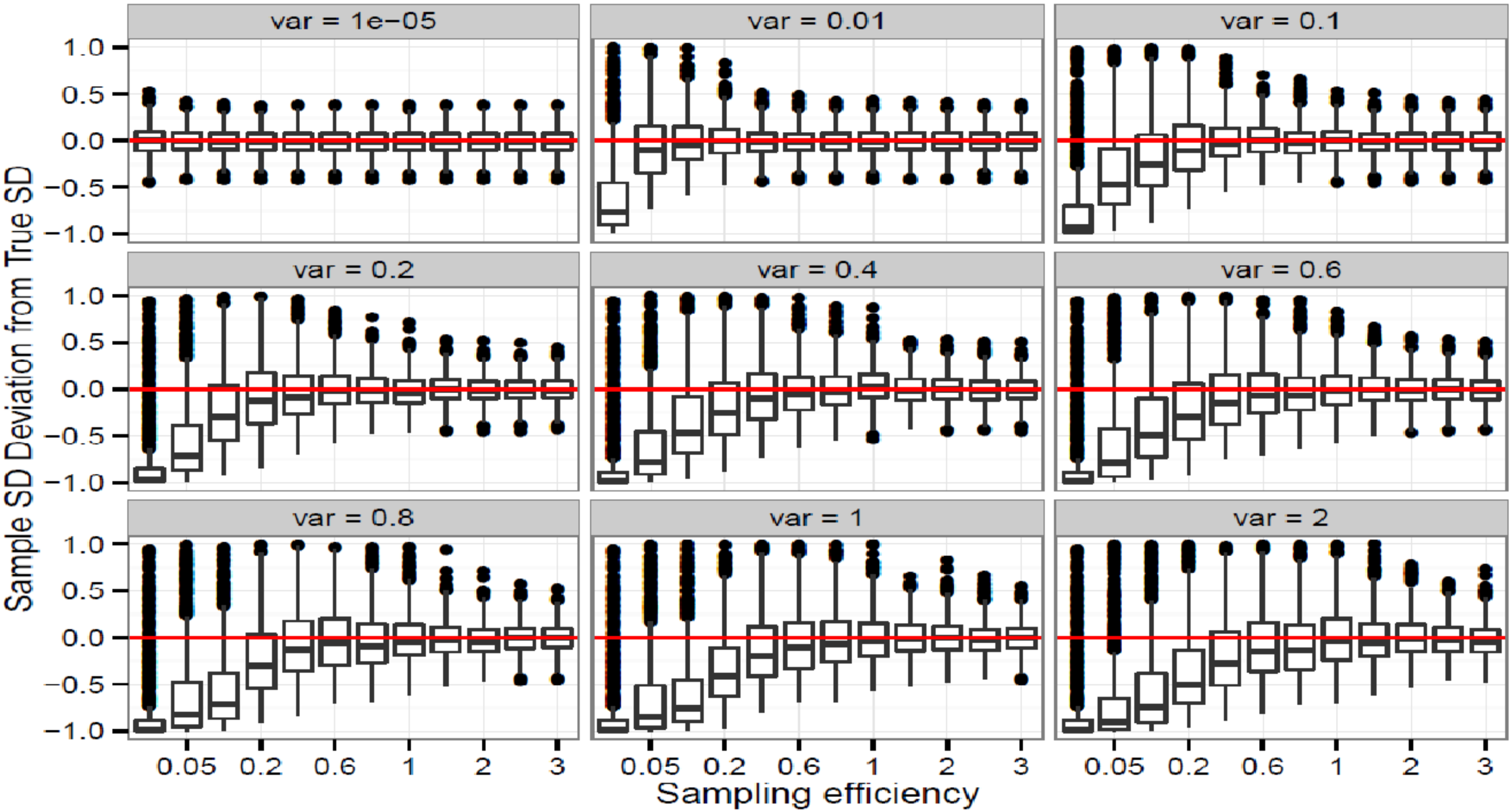
Kotwicki, S, Horne, J. K., Punt, A. E., and Ianelli, J.N. 2015. Factors affecting the availability of walleye pollock to acoustic and bottom trawl survey gear. ICES J. Mar. Sci.

Spatial distribution of q_e



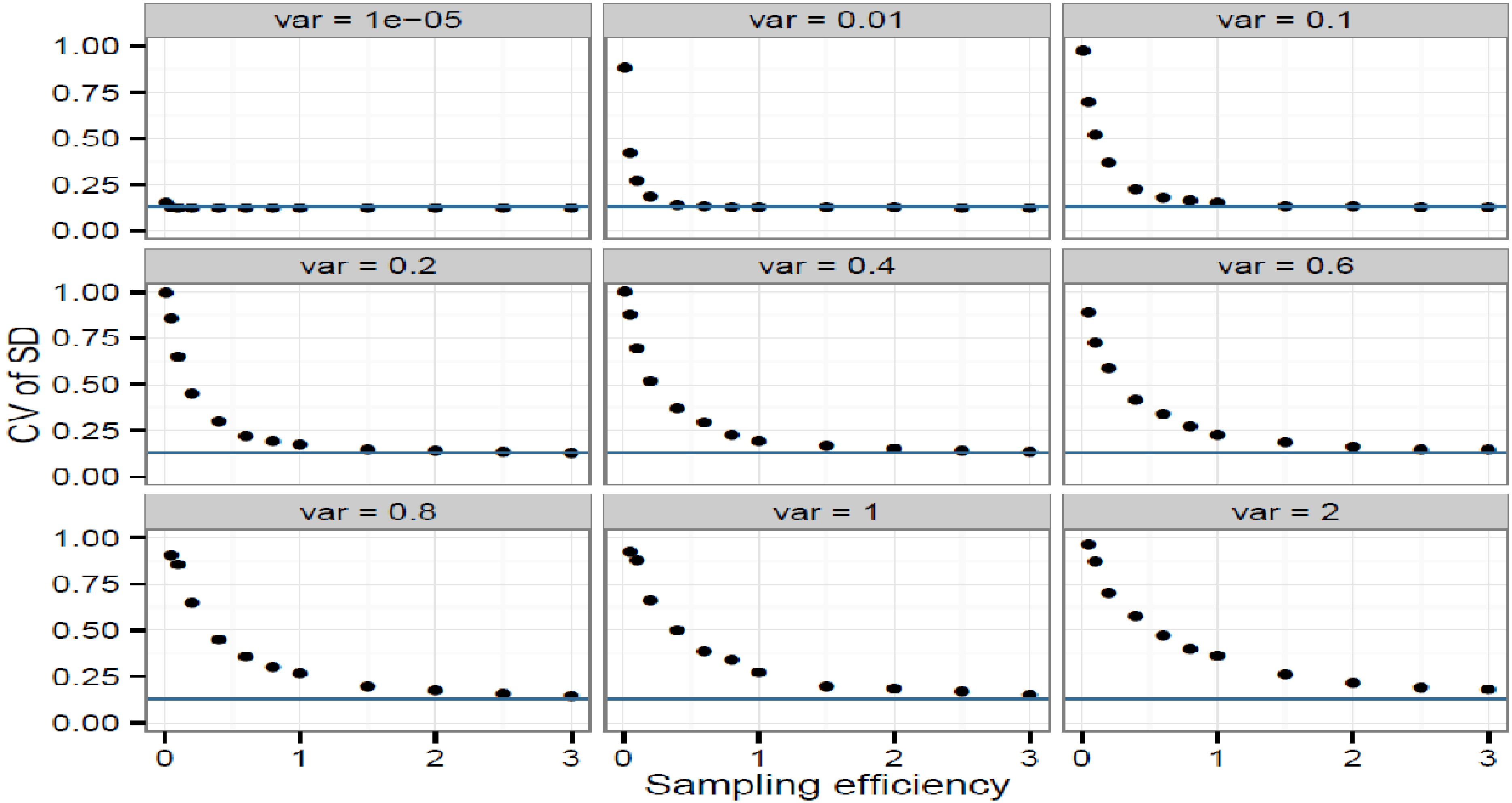
Kotwicki, S, Ressler, P.H., Ianelli J. N., Punt, A. E., and Horne, J. K. 2018. Combining data from bottom trawl and acoustic surveys to improve reliability of the abundance estimates. CJFAS.

Deviation of survey SD from true SD



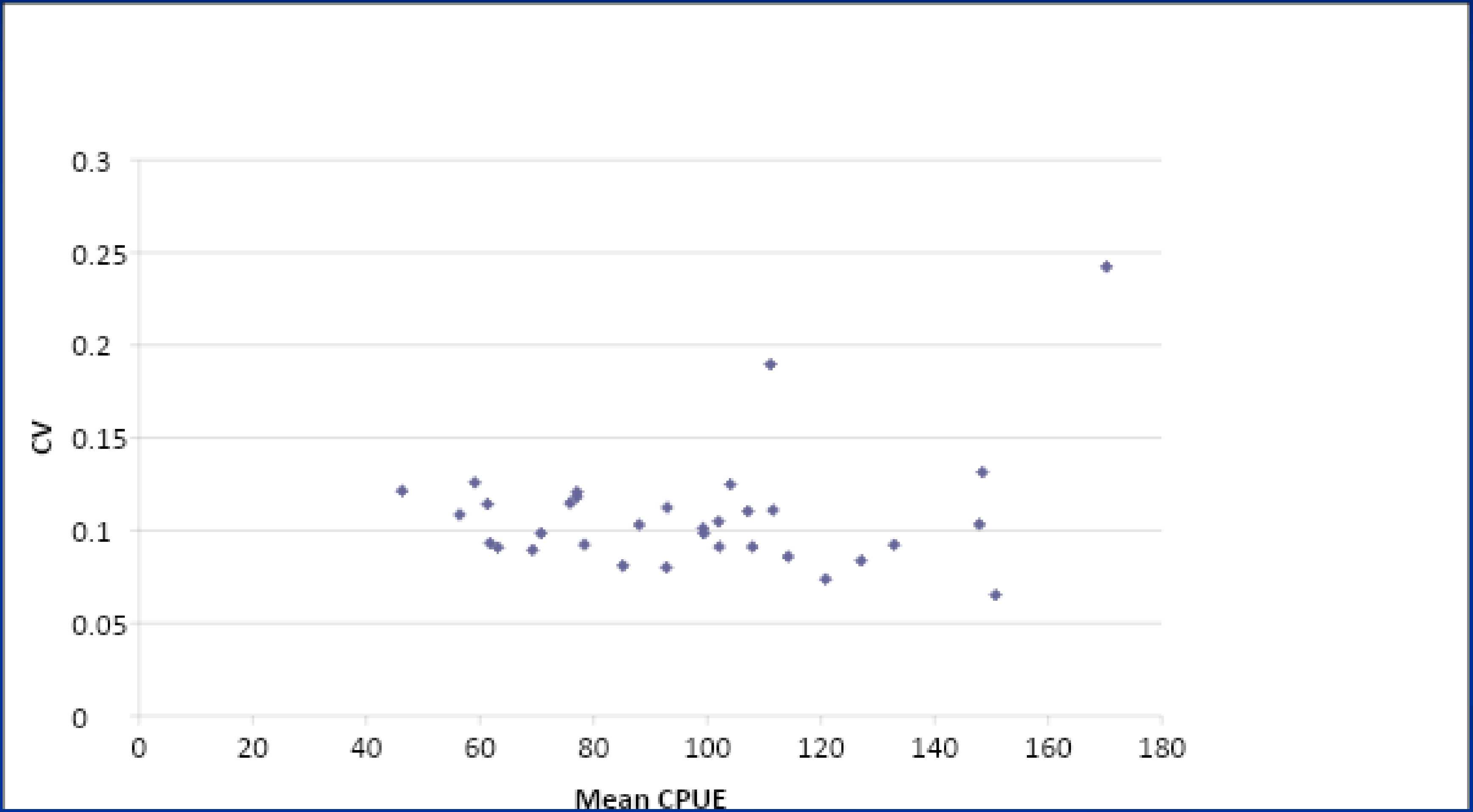
- Low q_e - SD biased low. High q_e - SD unbiased .
- Increase in V(q_e) – increase V(SD)

CV of survey SD



- Constant efficiency does not assure good precision of the SD estimate.
- Increase in $V(q_e)$ – increase V(SD)

Are these just spurious?



Can we trust design-based variance estimates from fishery surveys?

Random error in q_e

	Yes	No
q	High	Low
V(q)	Low	High

Non-random error in q_e - **No**

Model-based estimates are needed

Accounting for habitat variables to improve abundance indices in trawl surveys using multiple modeling methodologies

Chris Rooper, Pam Goddard, Rachel Wilborn, Curry Cunningham, Sean Anderson, Jim Thorson

Fisheries and Oceans Canada
Pêches et Océans Canada

Introduction

Objectives:

1) Standardize abundance indices using habitat information

2) Compare results from multiple modeling methods

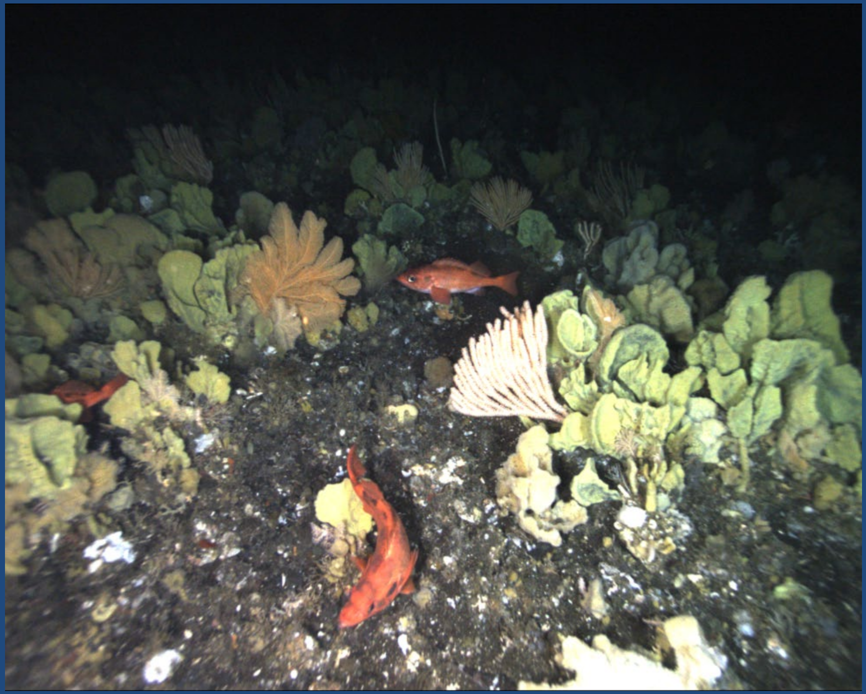
3) Create ensemble results from multiple methods

4) Compare to design-based estimates

5) For AI compare to design-based estimates accounting for untrawlable areas

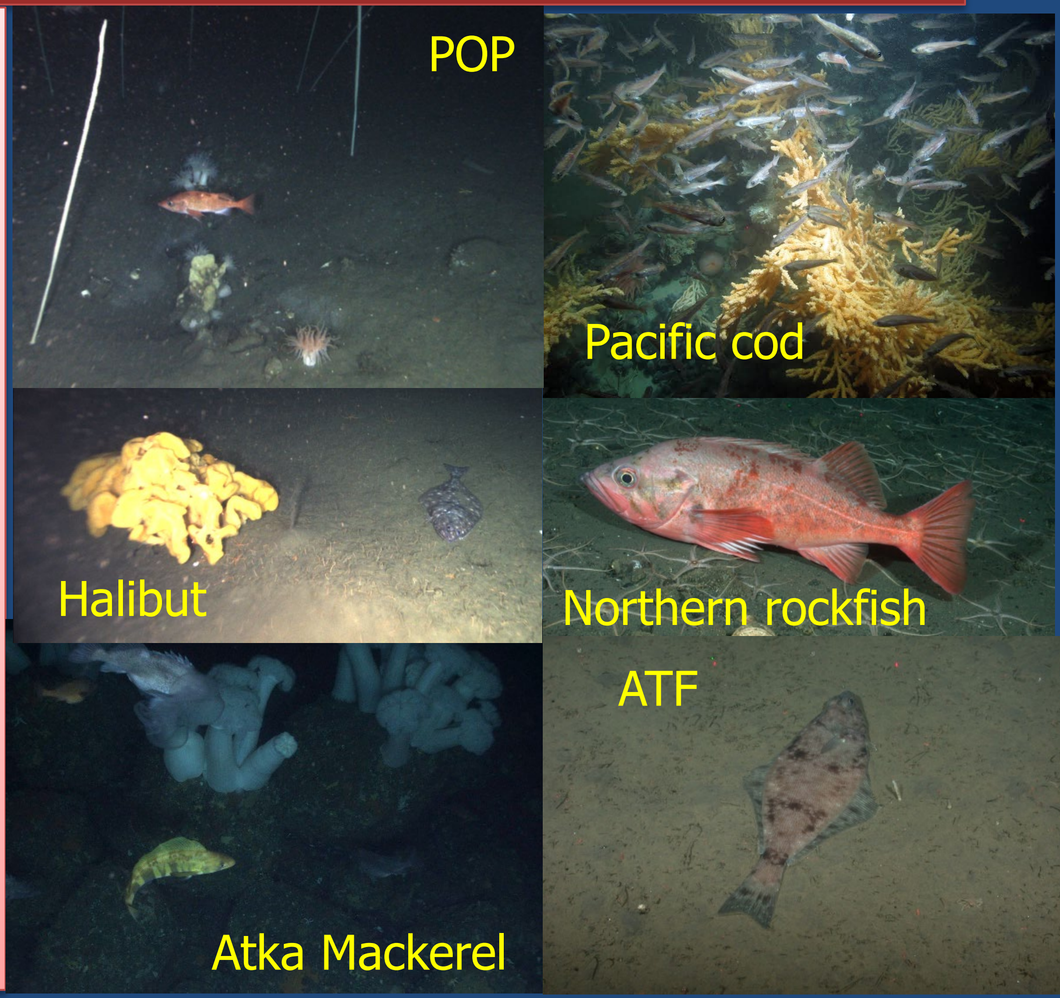
Index standardization

- Models & comparisons
  - VAST
  - VAST w/ Habitat
  - Delta-GLM, Delta-GAM
  - Random Forest
  - Oddball
  - Design Based
  - Design Based w/ Untrawlable removed



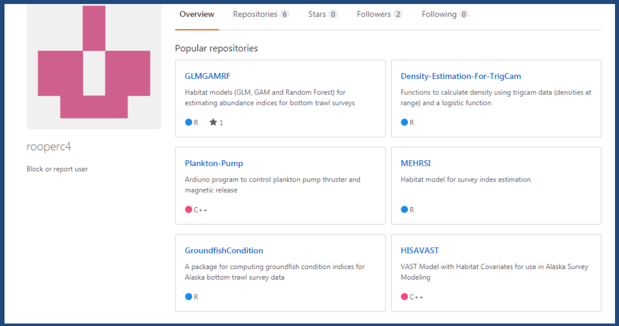
Standardizing Variables - Aleutians

- Slope
- Depth
- Temperature
- Invertebrate CPUE
- Tidal currents
- Longitude
- *Year*



Conclusions

- Survey design is the most important consideration
- Survey standardization is fun and can help with troublesome species
- Useful for awkward survey designs too (multispecies, bad stratification, changing methodology, etc.)
- Most of the answers for the GOA, AI and BC surveys were the same regardless of the model used
  - **Code available**
  - www.github.com/rooperc4
- Follow-up projects
  - Survey workshop on spatial modelling (Halifax, April-May)
  - Application to BC stocks
  - Update some github issues



Science, Service, Stewardship

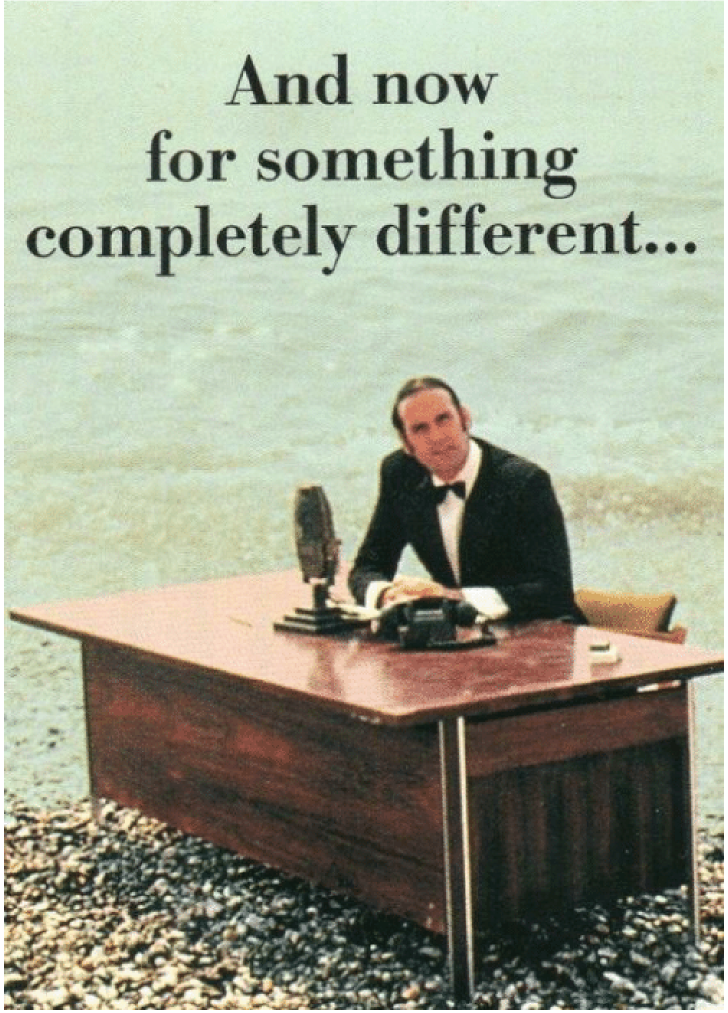
Cameras vs Catch: potential effects of implementing open codend tows for acoustic midwater fish surveys

Kresimir Williams

Alaska Fisheries Science Center
NOAA Fisheries
Seattle, Washington

Workshop on Unavoidable Survey Effort Reduction - Jan 2020

NOAA FISHERIES SERVICE



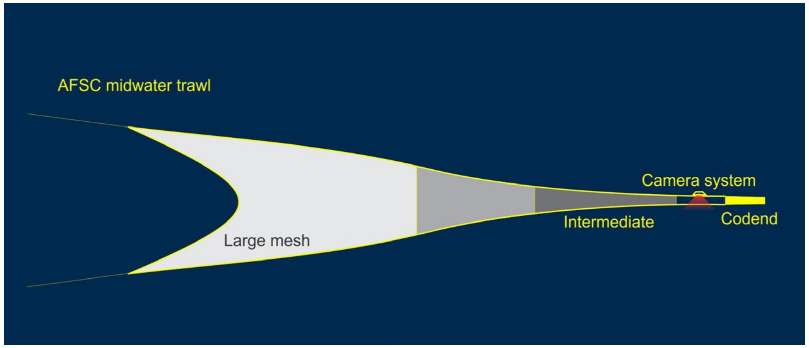
Overview:

- It is possible to replace some aspects of at- sea sampling with advanced technology camera systems
- This approach would reduce the amount of physical specimen samples used for survey analysis
- The effect of these reductions can be evaluated on existing data using subsampling

Talk layout:

- CamTrawl description
- Acoustic survey methodology (in brief)
- Specimen data subsampling methods
- Results
- What Now? Conclusions and future work

CamTrawl - camera – trawl combination for sampling midwater



Advantages:

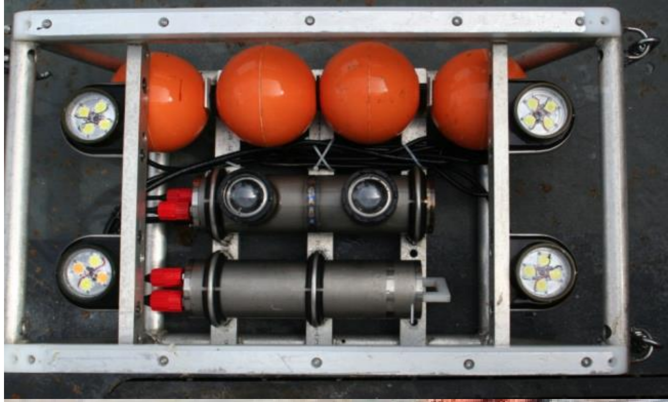
- Fine scale sampling of the water column
  discrete acoustic layers separable

- Reduced selectivity compared with codend catch
  Non-retained organisms observed in images

- Possibility of "open codend" tows
  No retention and ship-board processing

"Open Codend" Disadvantages:

- No physical specimen data available
  e.g. individual fish weight, age structure, maturity state



Conclusions

Sensitivity study – which components of specimen-derived data are most affected by reductions

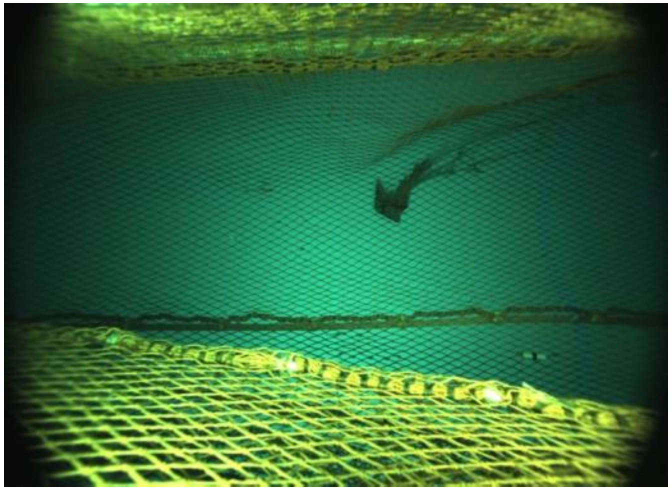
For acoustic-based biomass estimation (using Length-Weight relationships), less data is not a substantial concern

In Shelikof Strait, maturity shows some sensitivity in single survey year (2013)

Age data more variable but annual trends are preserved

EBS much more robust to subsampling, although effects on smaller spatial scales may be larger

Substituting image-based data comes at a cost: reduced taxonomic resolution, measurement and classification errors greater than physical sampling



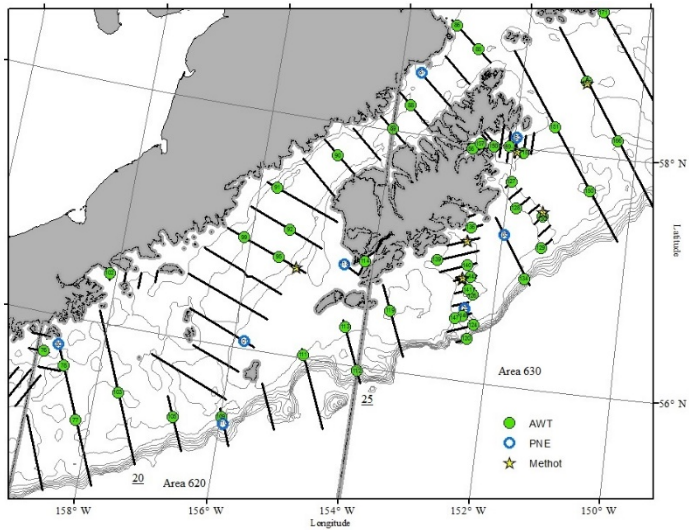
Future Work

Real problem – reduction in vessel time = reduction in available trackline

Survey trackline optimization
- Zigzags vs boustrophedonic
- Transect spacing (effort)
- Requires survey simulation approach

Total uncertainty project (starting this spring)
Combining all sources of uncertainty in survey including:
- Acoustic target strength
- Acoustic backscatter classification
- Geospatial sampling variance
- Haul placement/density
- Trawl selectivity

Alternative acoustic platforms
- Saildrones (Mordy, et al, 2017)
- Unmanned motorized surface craft



Eastern Bering Sea Survey Effort Reduction Impacts on Assessing the Thermal State of the Ecosystem

Cynthia Yeung
Alaska Fishery Science Center
Groundfish Assessment Program

A spatiotemporal operating model for simulation testing Alaskan bottom trawl survey effort and design

Kotaro Ono

WKUSER meeting, Seattle
01/14/20

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NOAA FISHERIES

Alaska Fisheries Science Center

Evaluation of a survey with an adaptive sampling domain to capture climate-driven shifts in larval fish distributions

Lauren Rogers, Kathy Mier

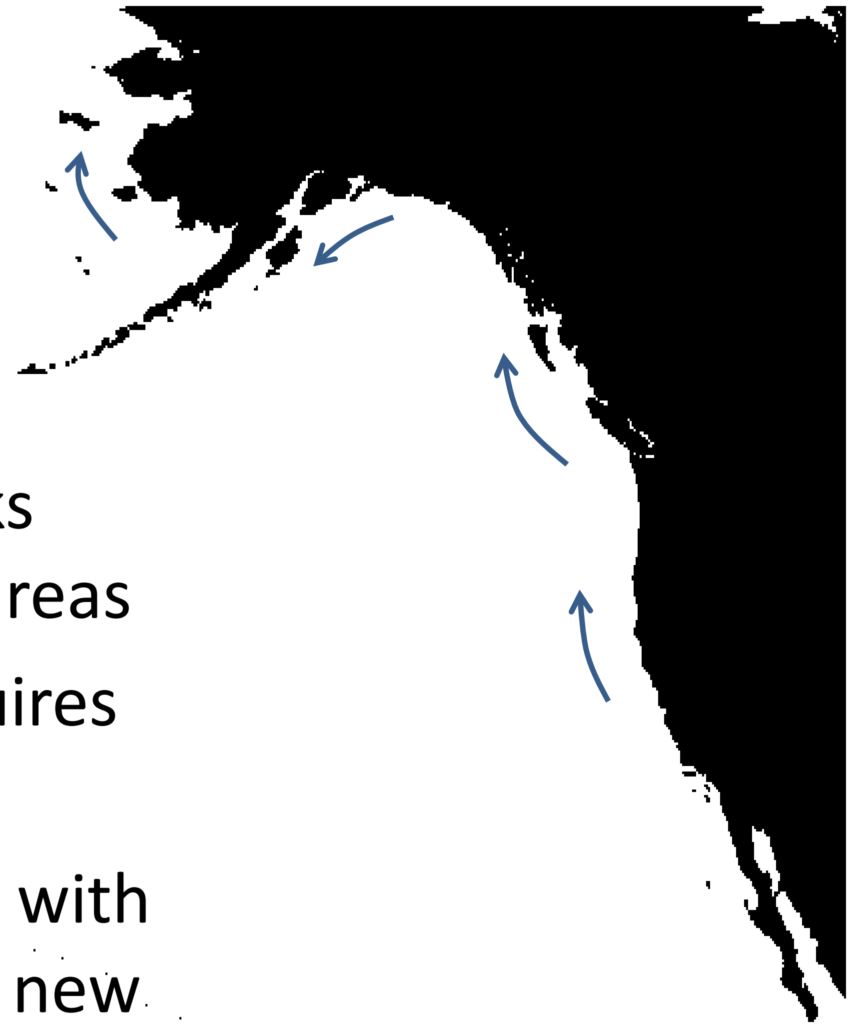
January 2020

WKUSER, Seattle

EcoFOCI

lauren.rogers@noaa.gov

Species on the move



- Challenges for surveys as stocks move out of historical survey areas
- Expanding survey domain requires more resources
- Tradeoff: maintain consistency with historical sampling or adapt to new conditions?

Larval walleye pollock

Photo: Steve Porter, AFSC

EcoFOCI

Ecosystems & Fisheries-Oceanography Coordinated Investigations

Joint research program: Alaska Fisheries Science Center (NOAA-NMFS) and Pacific Marine Environmental Laboratory (NOAA-OAR)

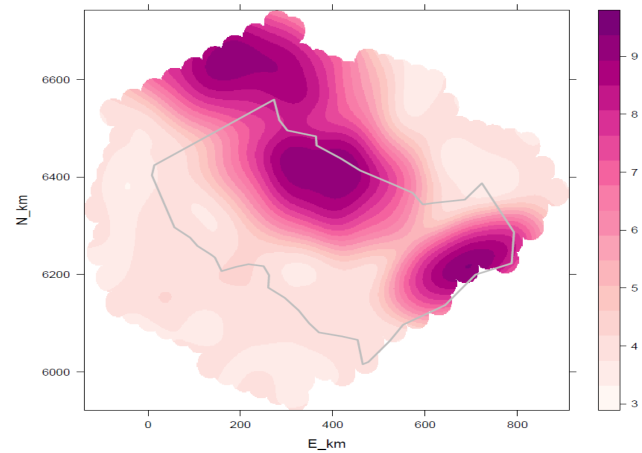
Recruitment processes, ecosystem dynamics, and climate change in Alaska's Large Marine Ecosystems

How does the adaptive survey design compare to a fixed design?

Simulation study to evaluate adaptive survey design and select appropriate estimator:

1. Simulate “true” pollock larval distribution and abundance.
   a) Simulate E/W shifts in patches.
   b) Random fields
   c) Delta model
2. Sample the population
   a) Use adaptive survey design
   b) Use fixed survey design with same number of stations.
3. Assess survey performance:
   a) Model-based (VAST) estimators
   b) Naïve design-based estimators
   c) Adaptive estimators

Simulated log(pos density)



Simulated CPUE