Effects of removing the St. Mathew and Pribilof Island corner stations from the EBS survey grid

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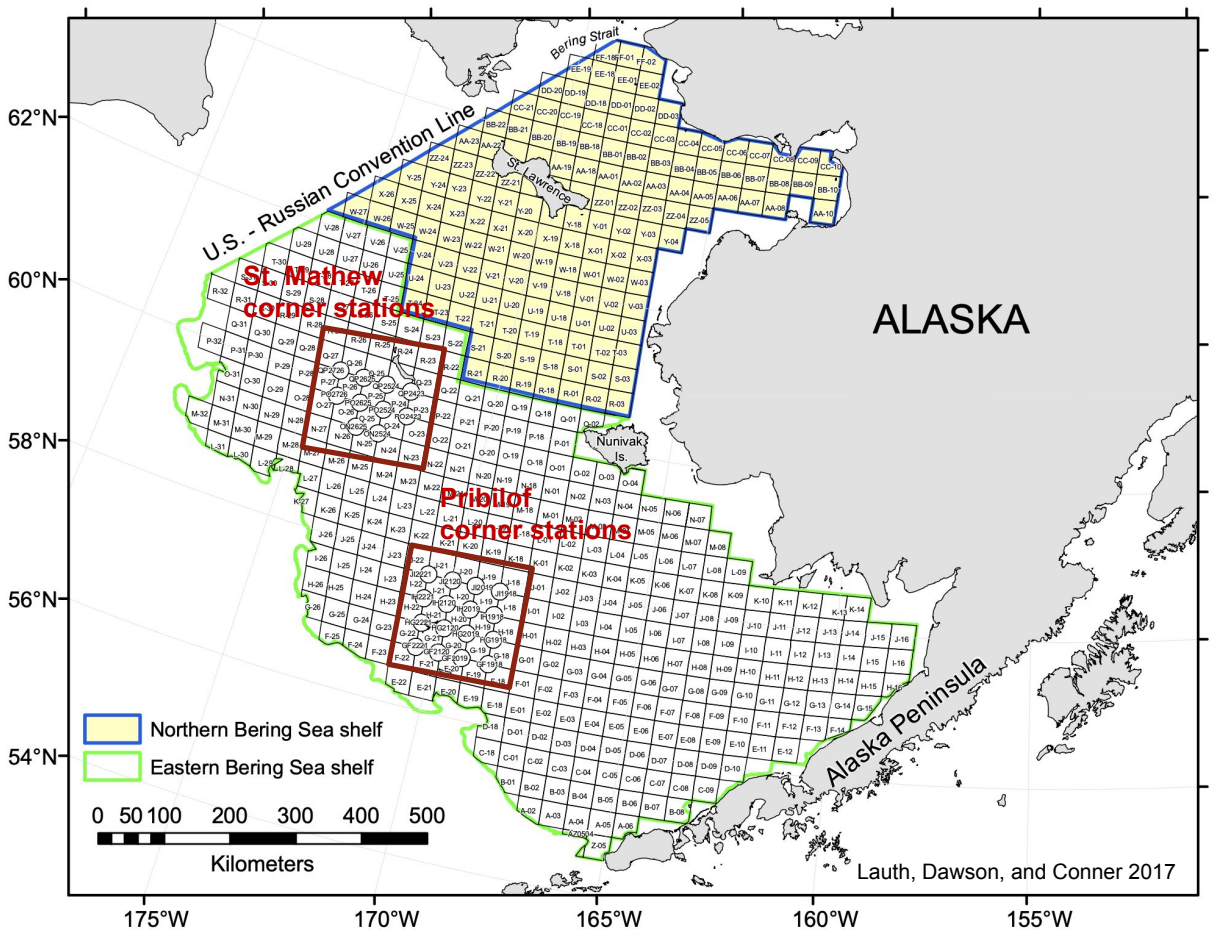
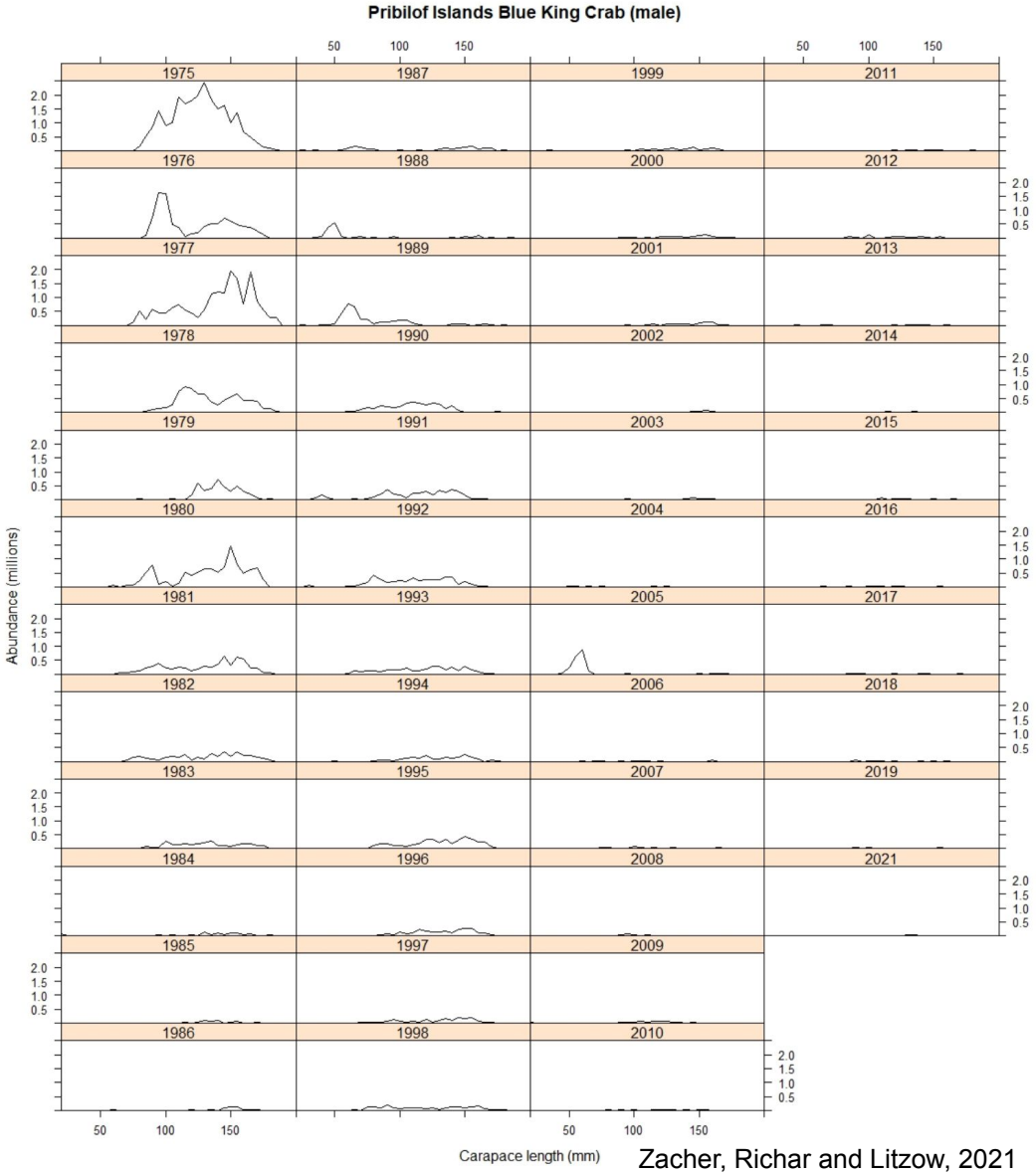
Background

- Blue king crab (*Paralithodes platypus*)
- Populations associated with St. Mathew and Pribilof Islands historically supported commercial fisheries
- Sparse, patchy distribution; large variance in abundance estimates
- High density sampling of grid corners in addition to centers
  1) Improved ability to encounter high density patches
  2) Increased sample size



Background

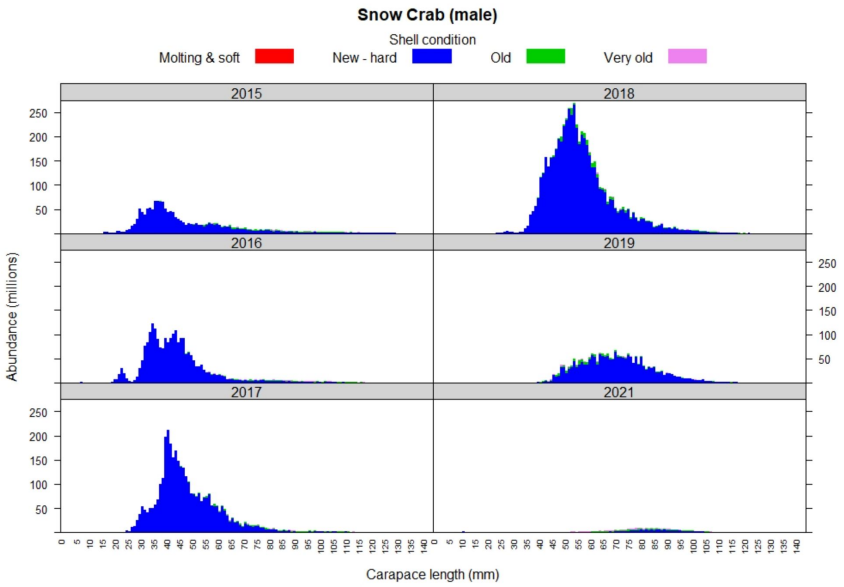
- Pribilof blue king crab stock closed to fishing since 2000
- St. Mathew stock closed to fishing in 1999, opened in 2009 and closed again since 2016
- Fisheries for either stock not likely in the near future
- 26 corner stations, requires 6-7 vessel days (~$100,000)
- In the absence of active blue king crab fisheries, effort/funds could be re-directed elsewhere



Zacher, Richar and Litzow, 2021

Background

- Snow crab (*Chionoecetes opilio*)
- **2018** → increases in biomass, particularly for mature (47,054 tons, a 60% increase from 2017) and immature males (458,902 tons, an >140% increase from 2017)
- **2019** → reduction in biomass for immature males (down to 284,181 tons) and an increase in mature males (to 54,550 tons)
- **2020** → no survey (covid)
- **2021** → steep declines for immature males (down >80% to 49,158 tons), and mature males (down >50% to 24,387 tons)
- Mortality or migration beyond survey extent?



Zacher, Richar and Litzow, 2021

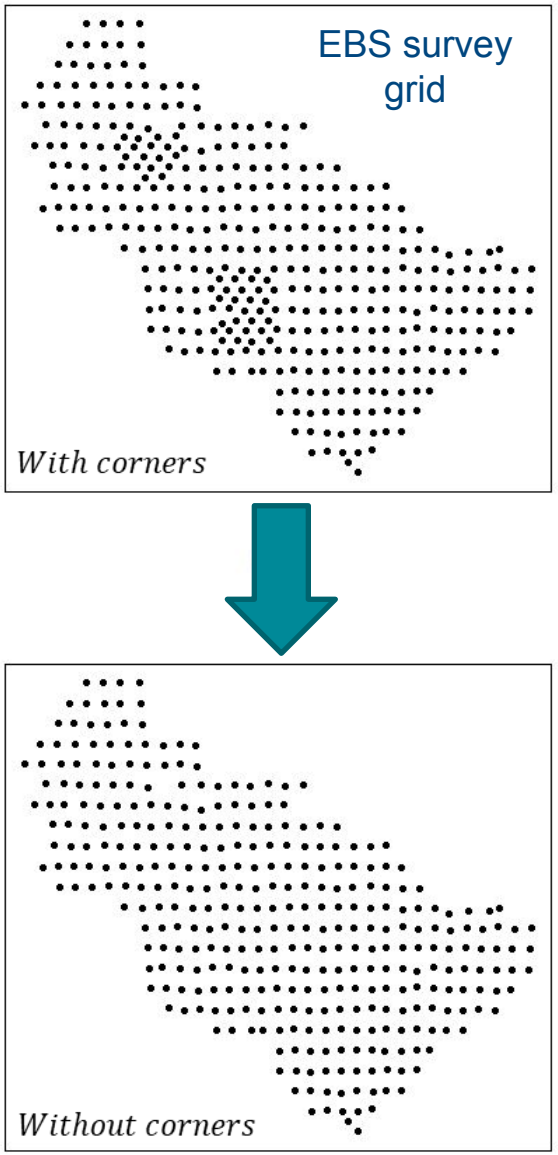
Question

- What are the effects of removing the Pribilof and St. Mathew Island corner stations on the precision and accuracy of design and model-based abundance estimates for EBS crab stocks?

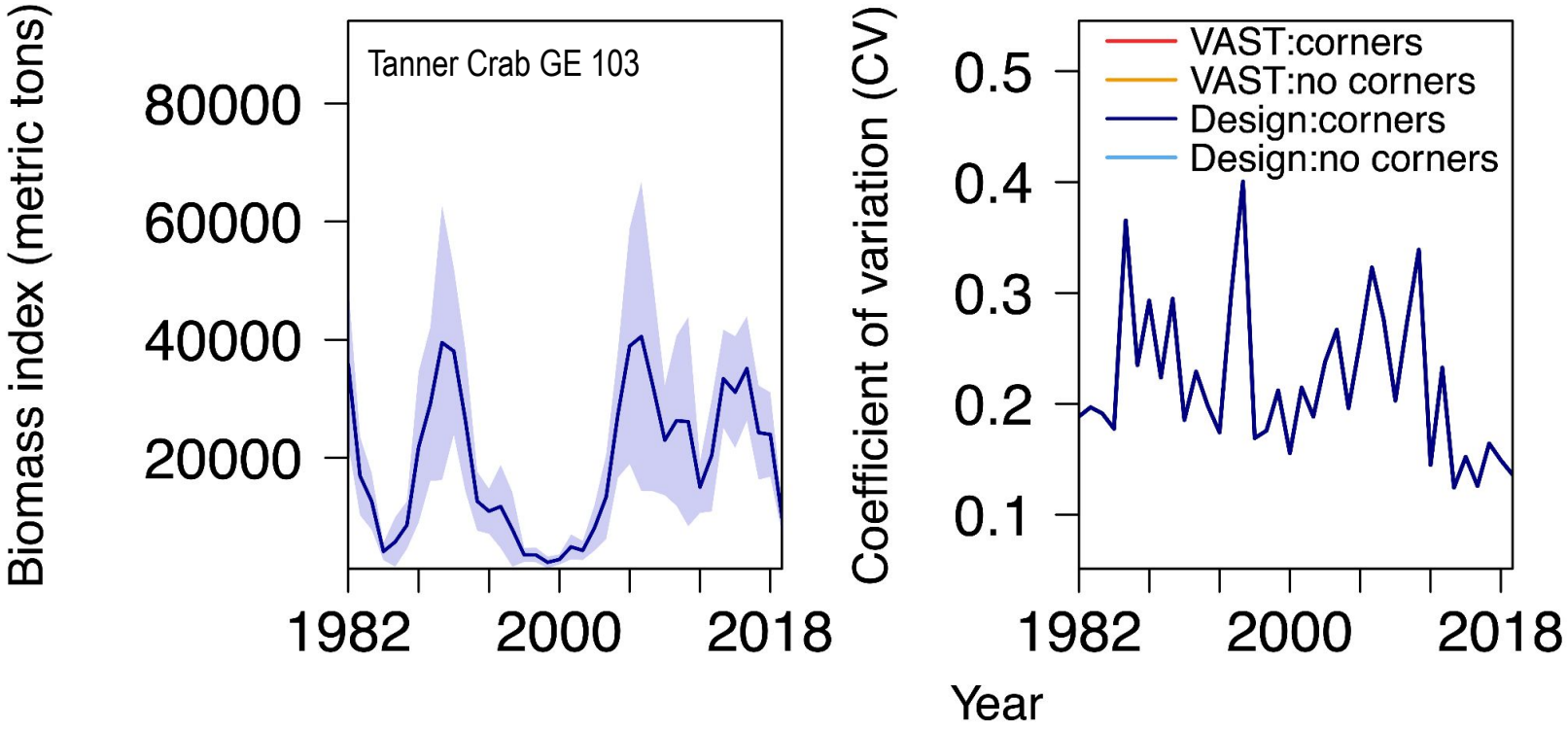
Approach: Empirical analysis

- Compare retrospective biomass estimates and CVs across four scenarios:

1) Design-based, corner stations included
2) Design-based, corner stations removed
3) Model-based (VAST), corner stations included
4) Model-based (VAST), corner stations removed



Results: Empirical analysis



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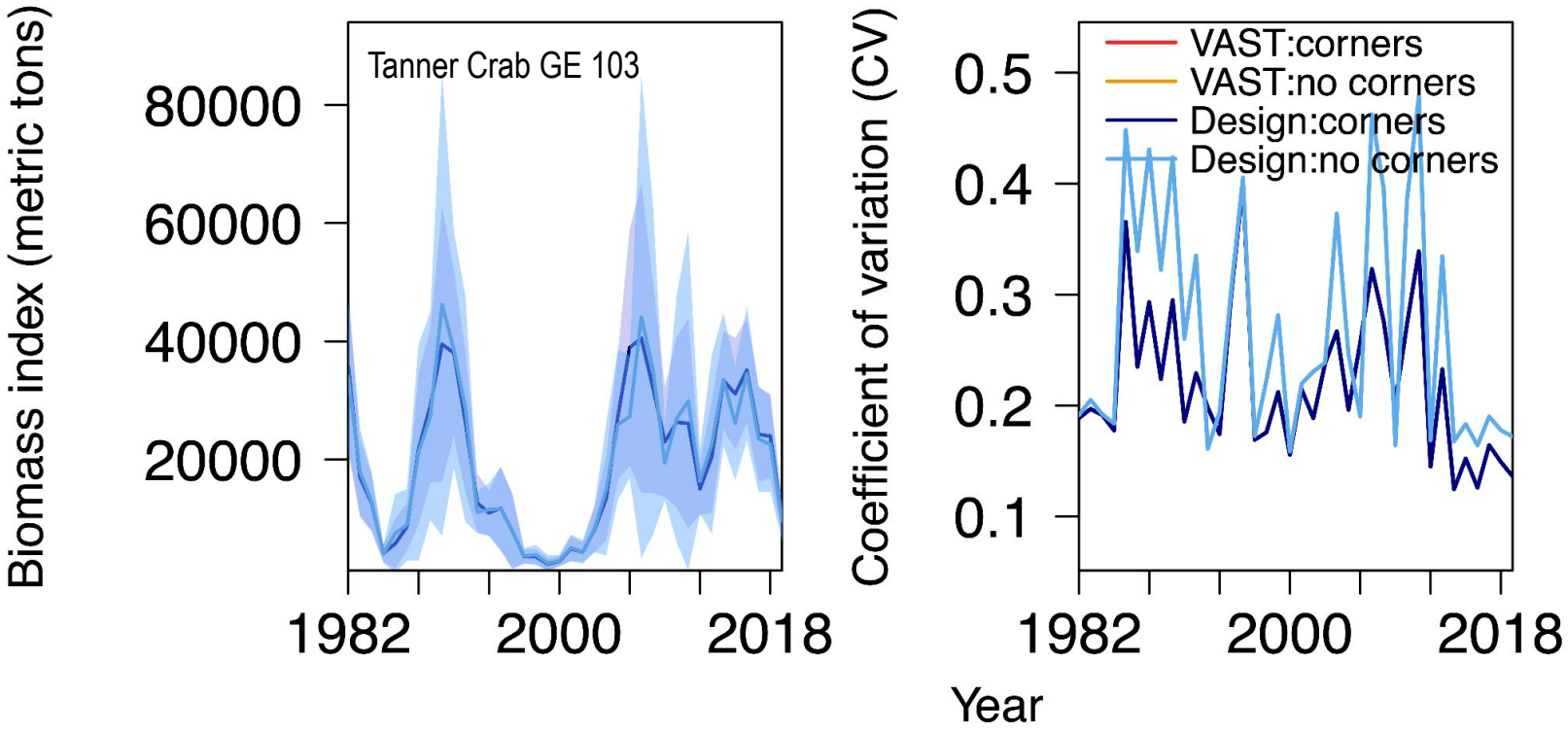

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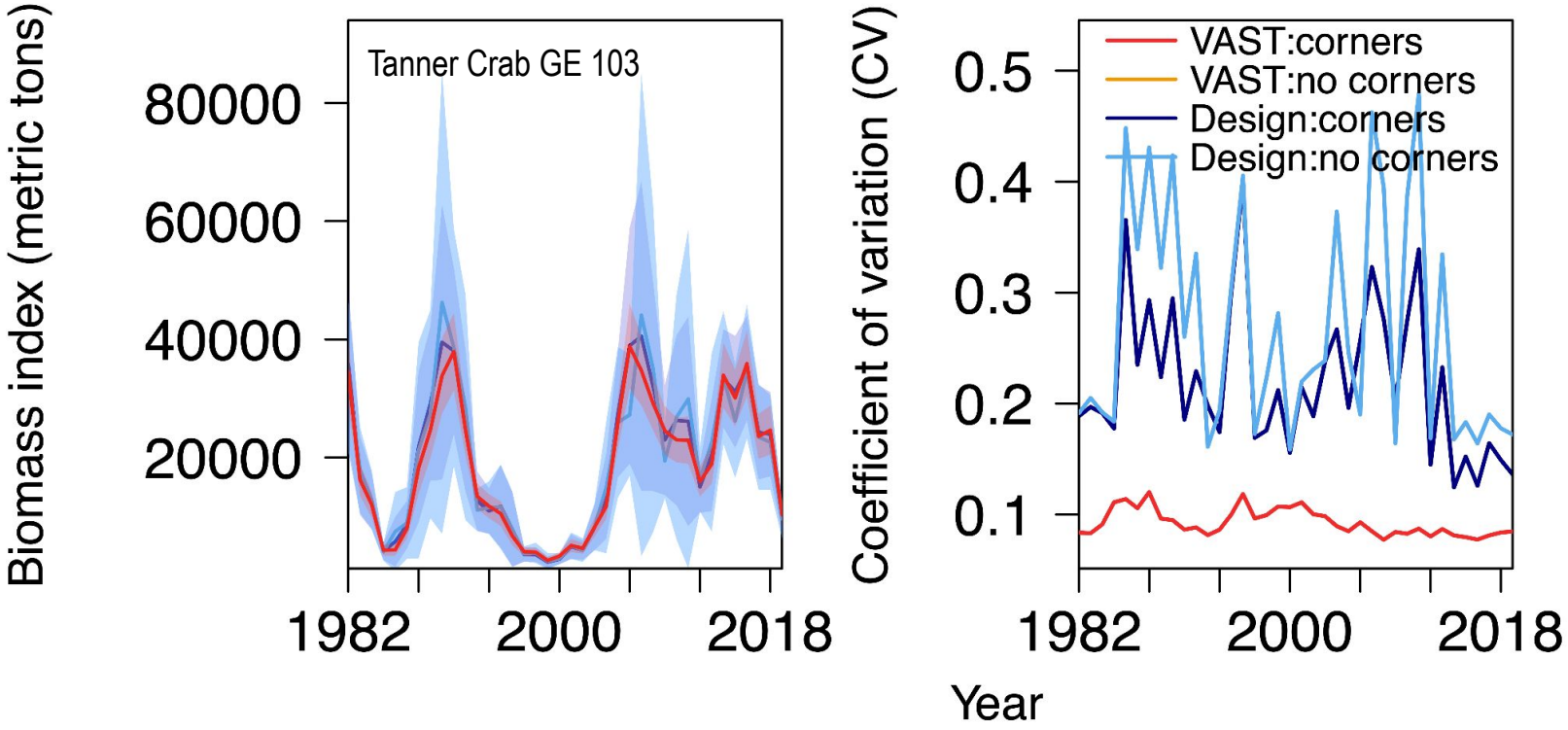
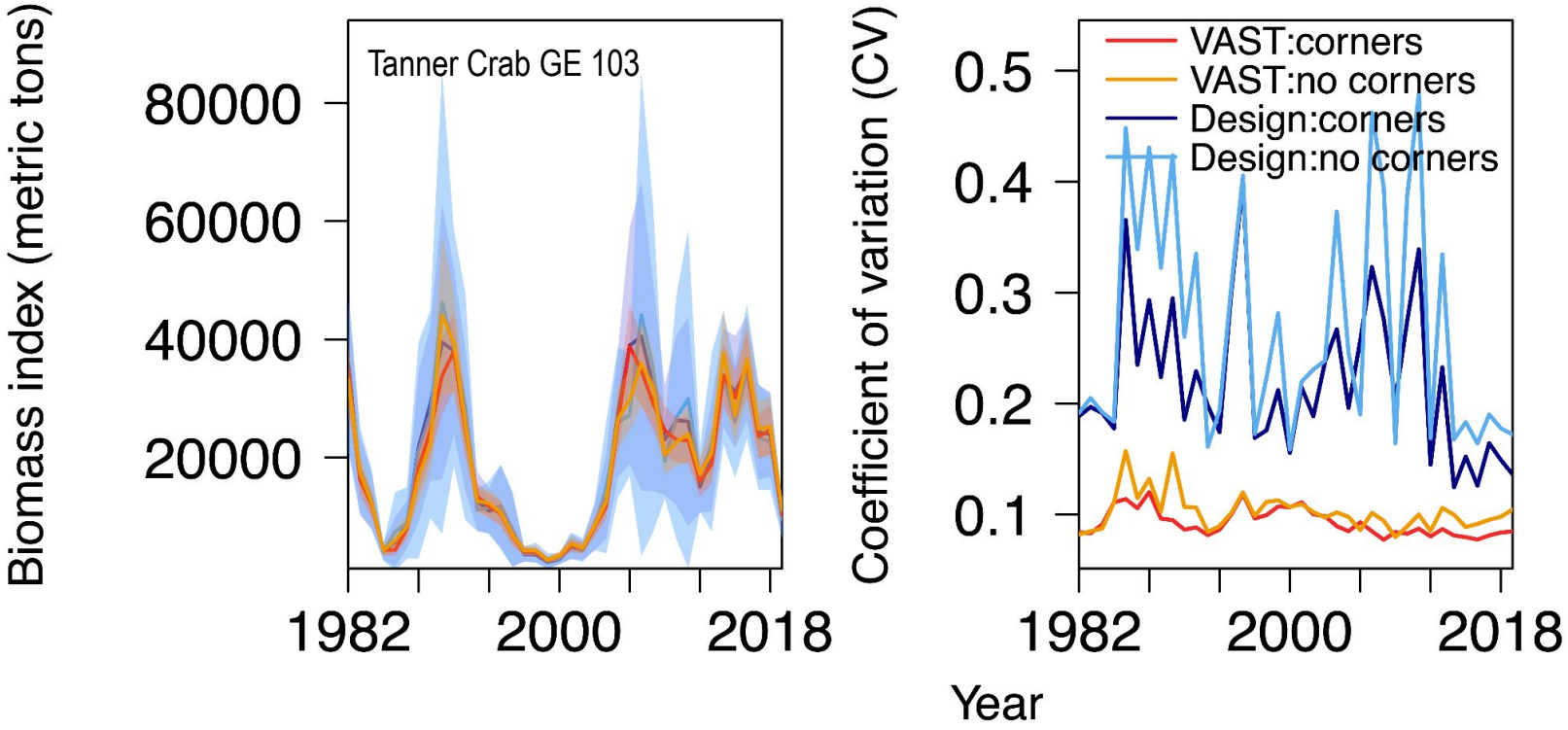
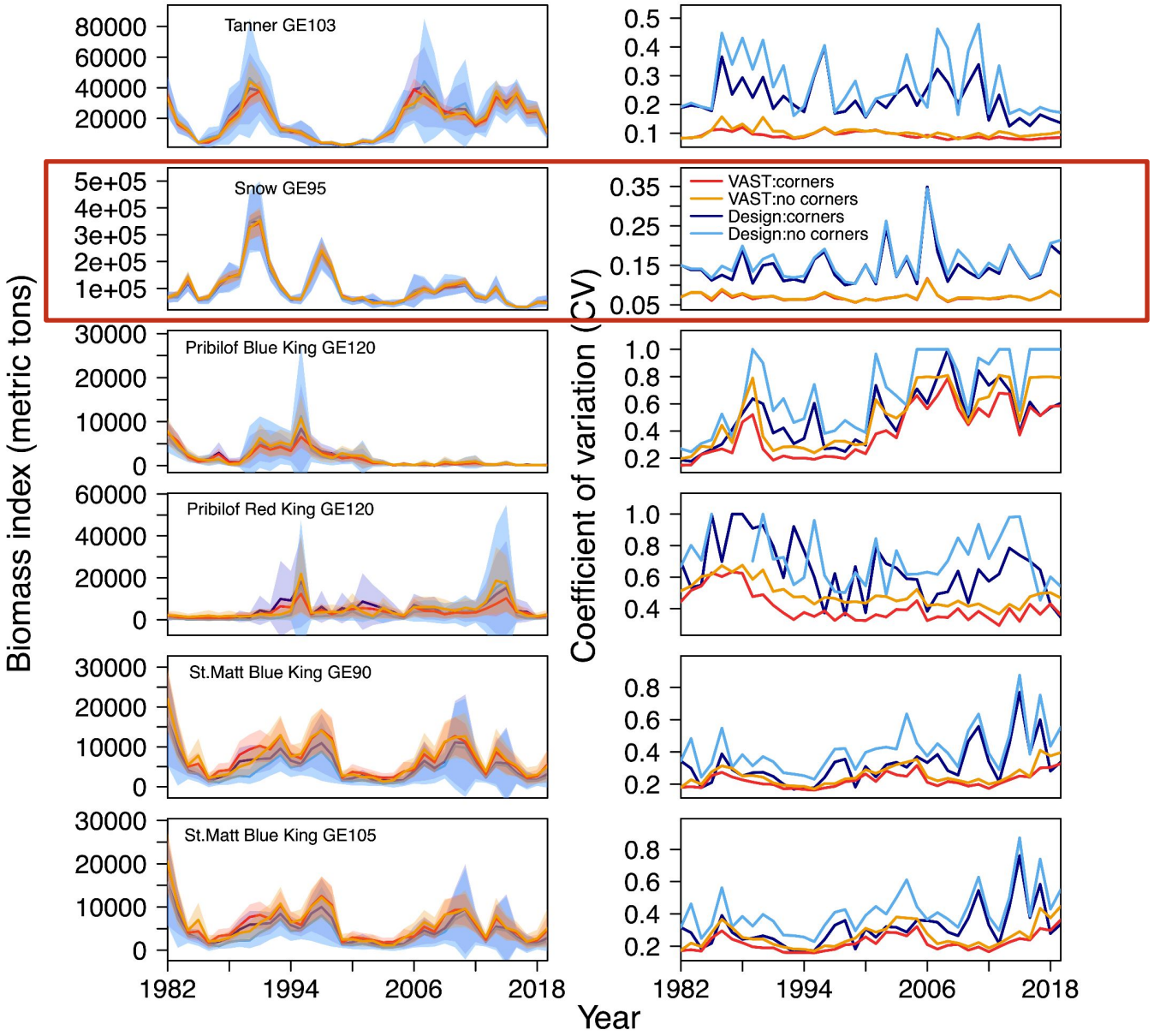
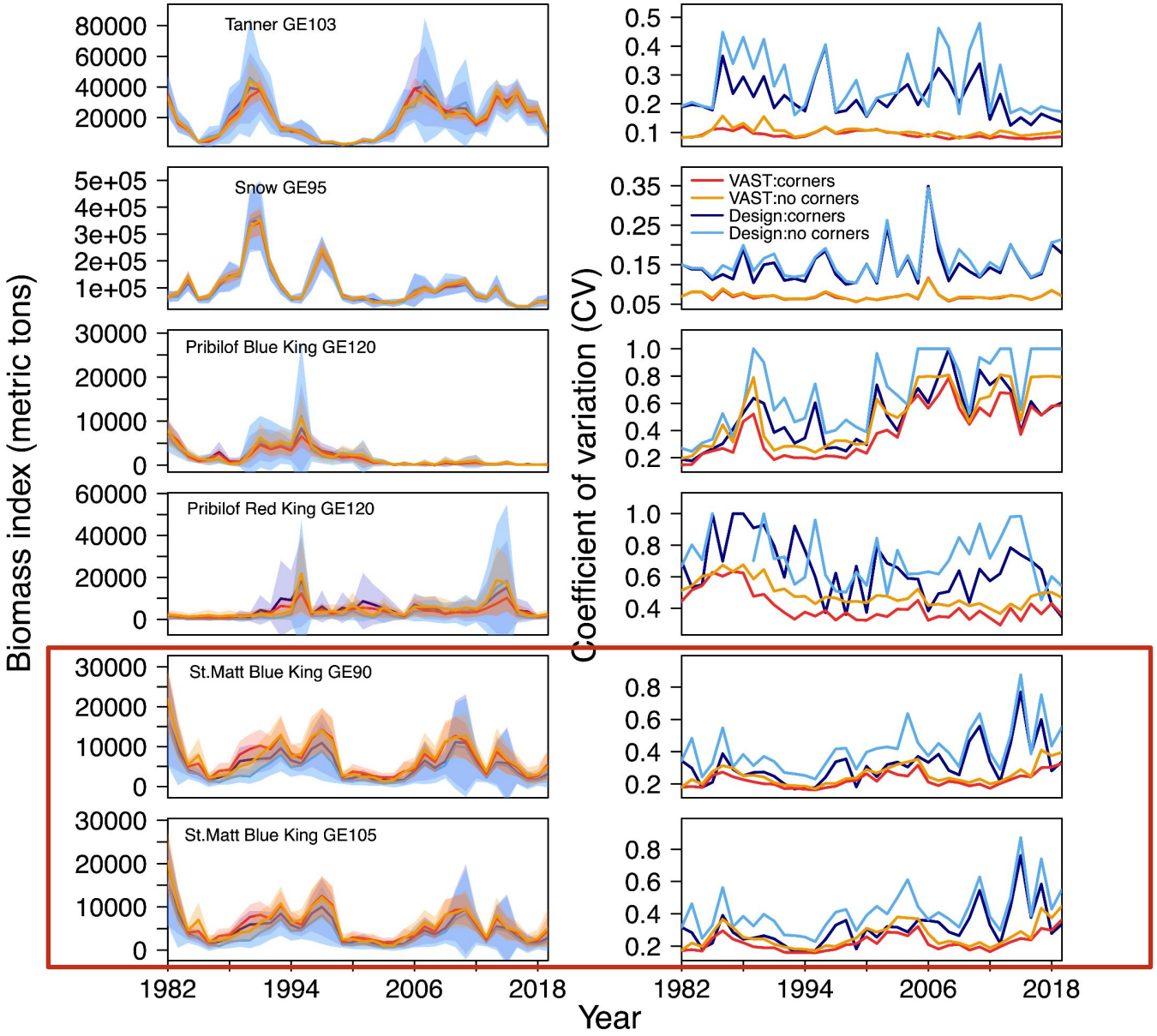


Results: Empirical analysis




Tanner GE103
Snow GE95
Pribilof Blue King GE120
Pribilof Red King GE120
St.Matt Blue King GE90
St.Matt Blue King GE105
Biomass index (metric tons)
Coefficient of variation (CV)
VAST:corners
VAST:no corners
Design:corners
Design:no corners
1982
1994
2006
2018
Year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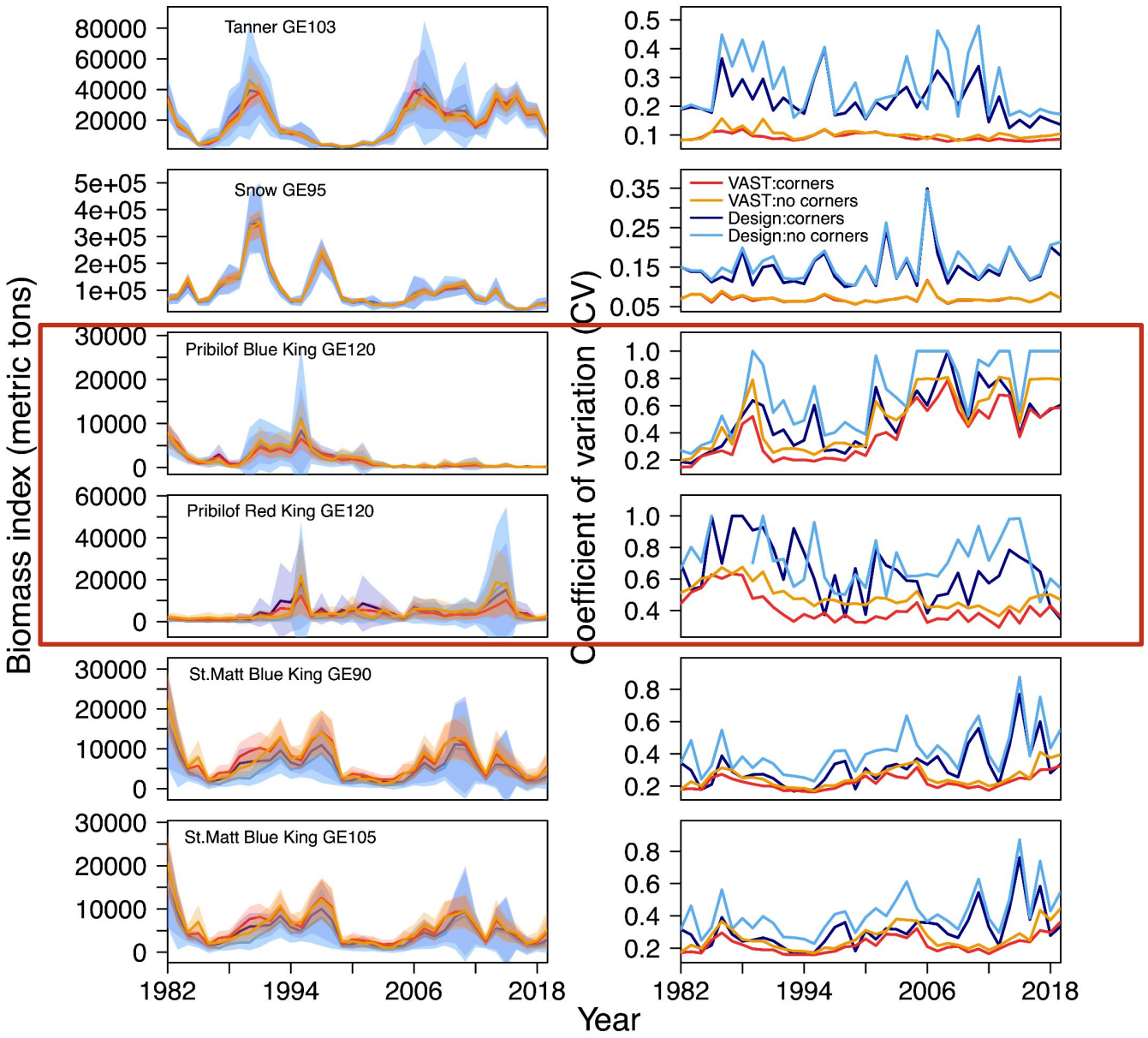
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Biomass index (metric tons)
Coefficient of variation (CV)
VAST:corners
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1982
1994
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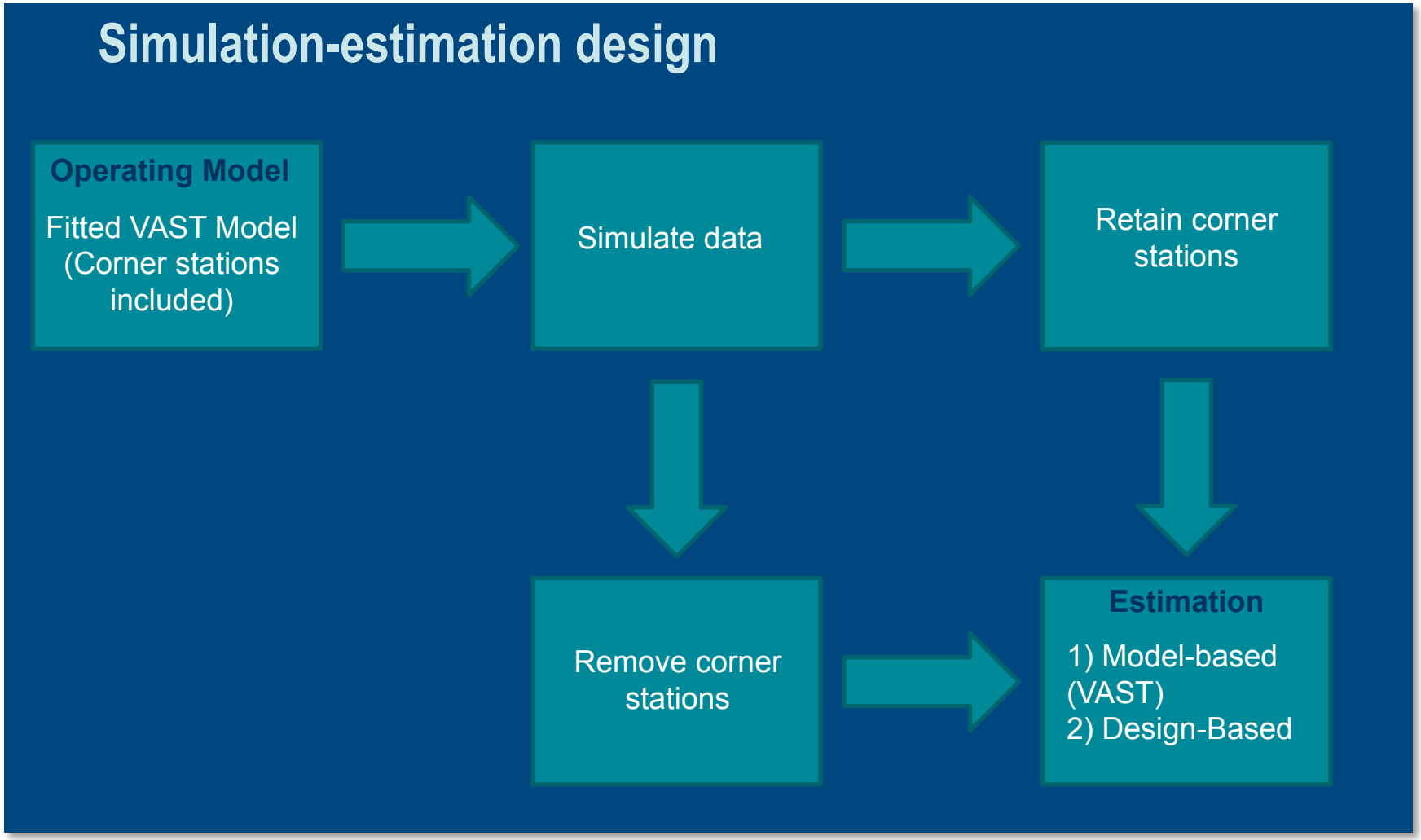
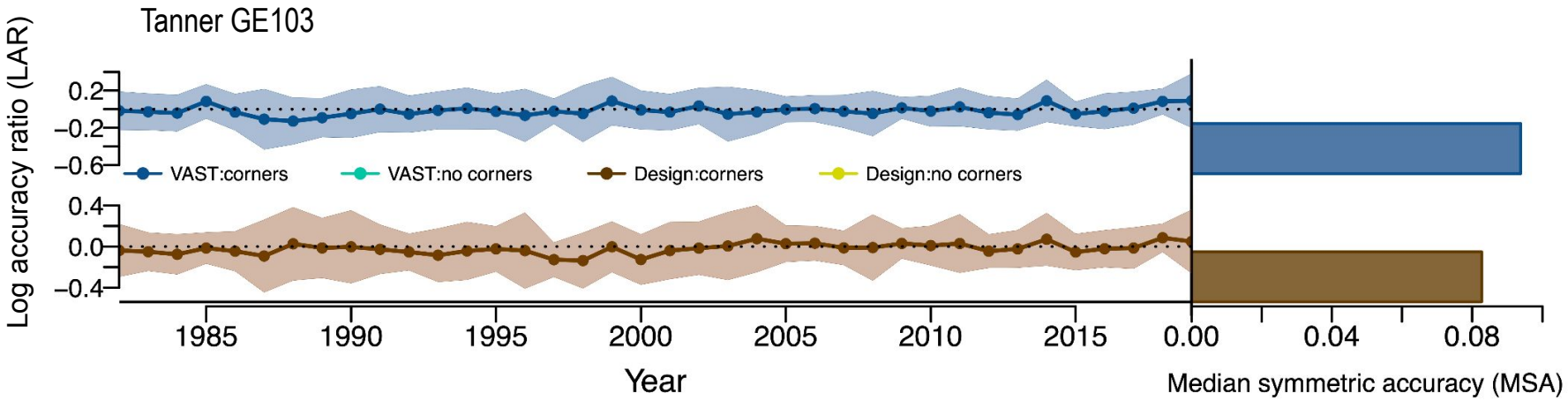
Year

Species/Size Class	Estimator	Mean CV (corners)	Mean CV (no corners)	Δ CV	% Δ CV
Tanner GE103	Design-based	0.22	0.27	0.05	22.73%
	Model-based	0.09	0.10	0.01	11.11%
Snow GE95	Design-based	0.15	0.16	0.01	6.67%
	Model-based	0.07	0.07	0	0%
Prib Blue King GE120	Design-based	0.50	0.69	0.19	38%
	Model-based	0.40	0.51	0.11	27.50%
Prib Red King GE120	Design-based	0.65	0.72	0.07	10.77%
	Model-based	0.41	0.49	0.08	19.51%
St. Matt Blue King GE90	Design-based	0.32	0.42	0.1	31.25%
	Model-based	0.22	0.25	0.03	13.64%
St. Matt Blue King GE105	Design-based	0.31	0.41	0.1	32.26%
	Model-based	0.22	0.26	0.04	18.18%

Approach: Simulation analysis



Results: Simulation analysis



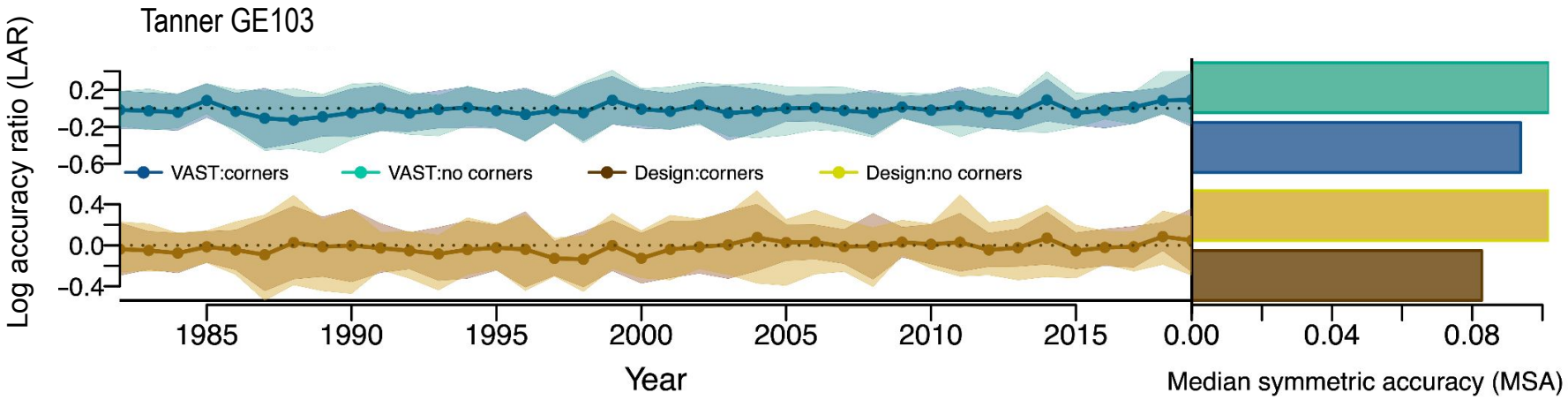
Biomass estimate

$$LAR(t,r) = log(\frac{\hat{B}(t,r)}{B(t,r)})$$

'True' biomass

$$MSA = (\exp(\mathrm{M}(|LAR|)) - 1)$$

Results: Simulation analysis



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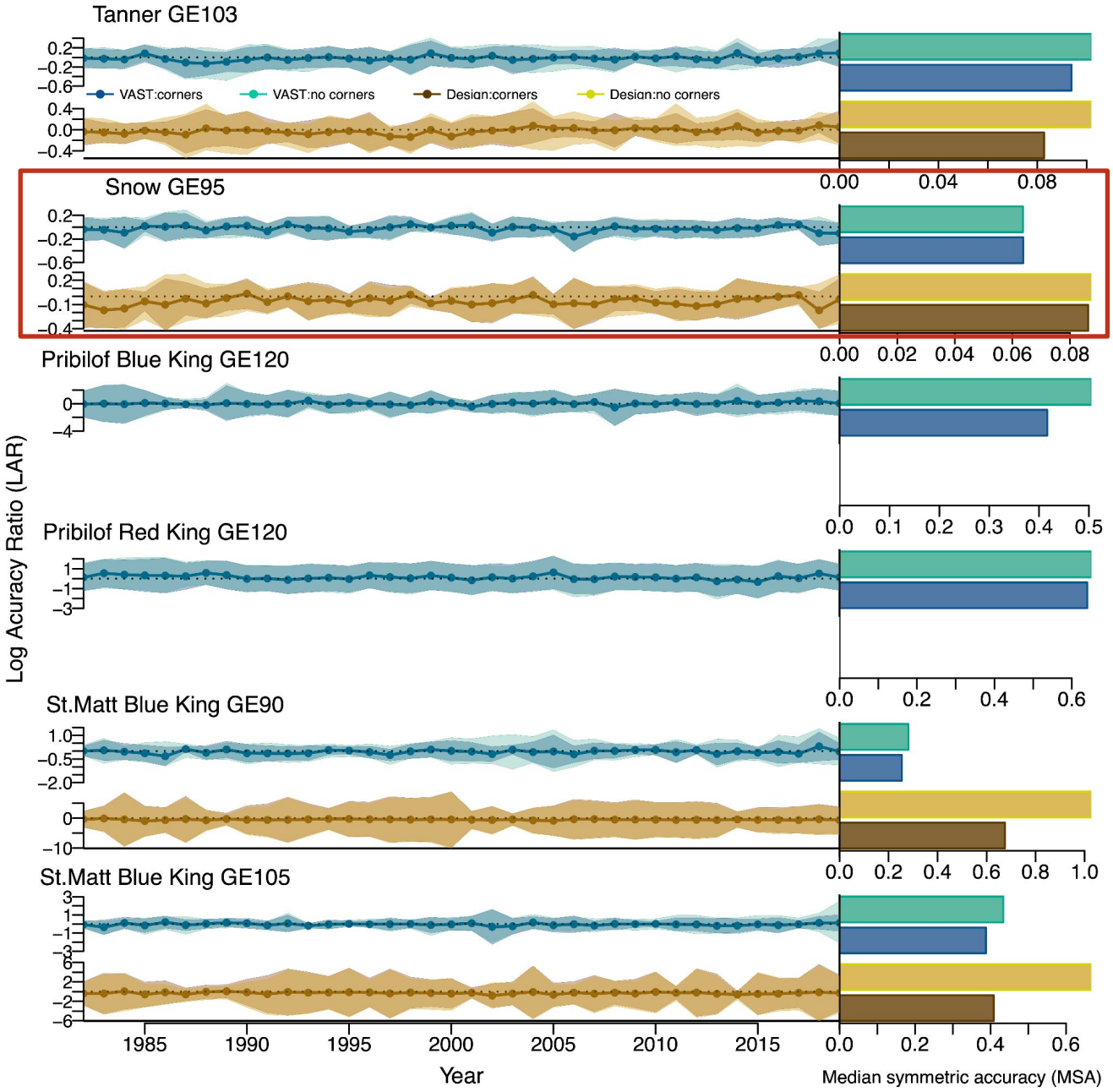
Tanner GE103
VAST:corners
VAST:no corners
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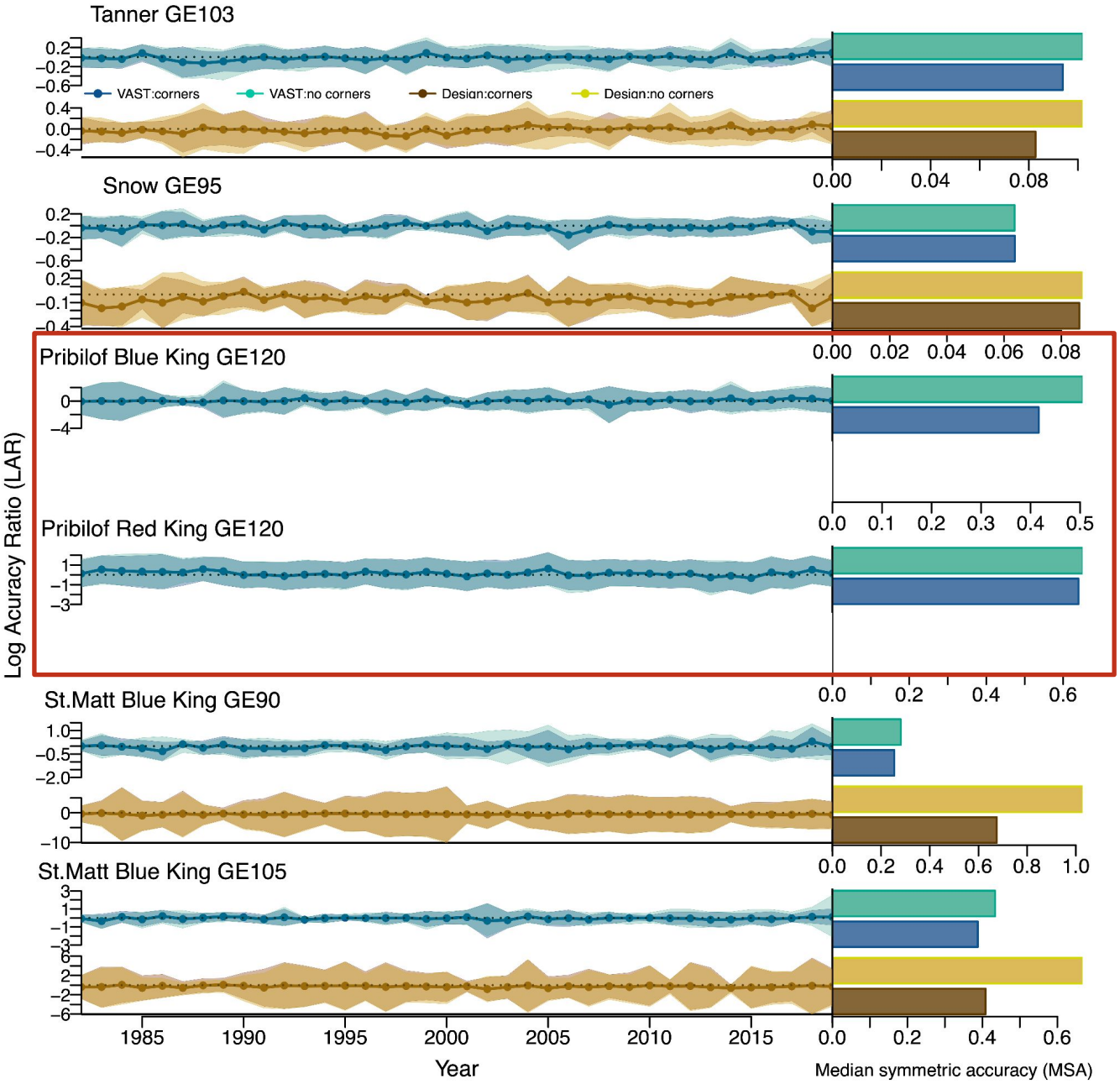
Delsan:no corners
Snow GE95
Pribilof Blue King GE120
Pribilof Red King GE120
St.Matt Blue King GE90
St.Matt Blue King GE105
Log Acuracy Ratio (LAR)
Year
Median symmetric accuracy (MSA)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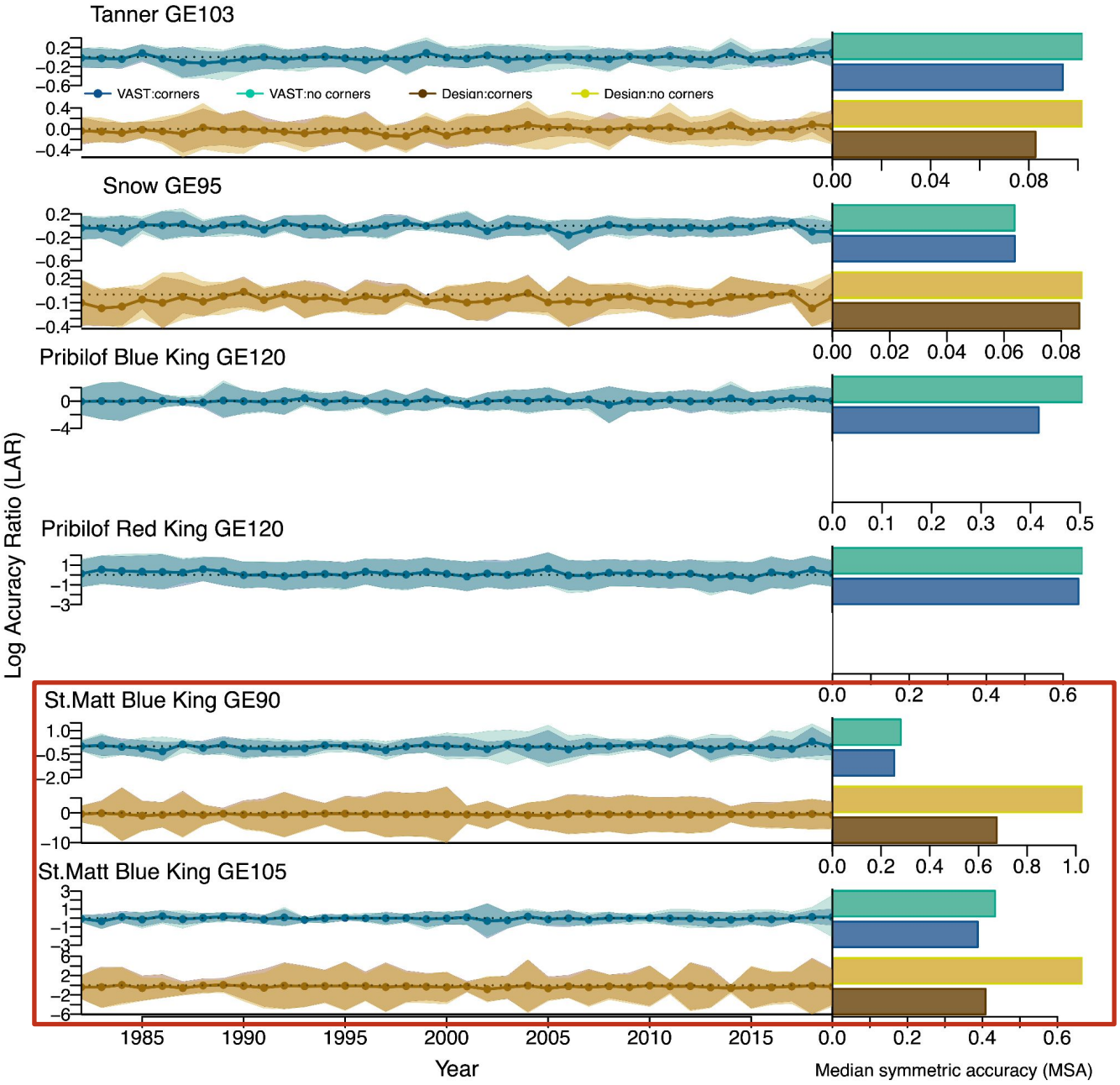
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Log Acuracy Ratio (LAR)
Year
Median symmetric accuracy (MSA)

Results: Simulation analysis

Species	Estimator	MSA (corners)	MSA (no corners)	Δ MSA	% Δ MSA
Tanner GE103	Design-based	0.083	0.102	0.019	22.89%
	Model-based	0.078	0.084	0.006	7.69%
Snow GE95	Design-based	0.086	0.087	0.001	1.16%
	Model-based	0.063	0.063	0	0%
Prib Blue King GE120	Design-based				
	Model-based	0.416	0.505	0.089	21.39%
Prib Red King GE120	Design-based				
	Model-based	0.64	0.651	0.011	1.72%
St. Matt Blue King GE90	Design-based	0.675	1.028	0.353	52.30%
	Model-based	0.167	0.185	0.018	10.78%
St. Matt Blue King GE105	Design-based	0.409	0.668	0.259	63.33%
	Model-based	0.237	0.266	0.029	12.23%

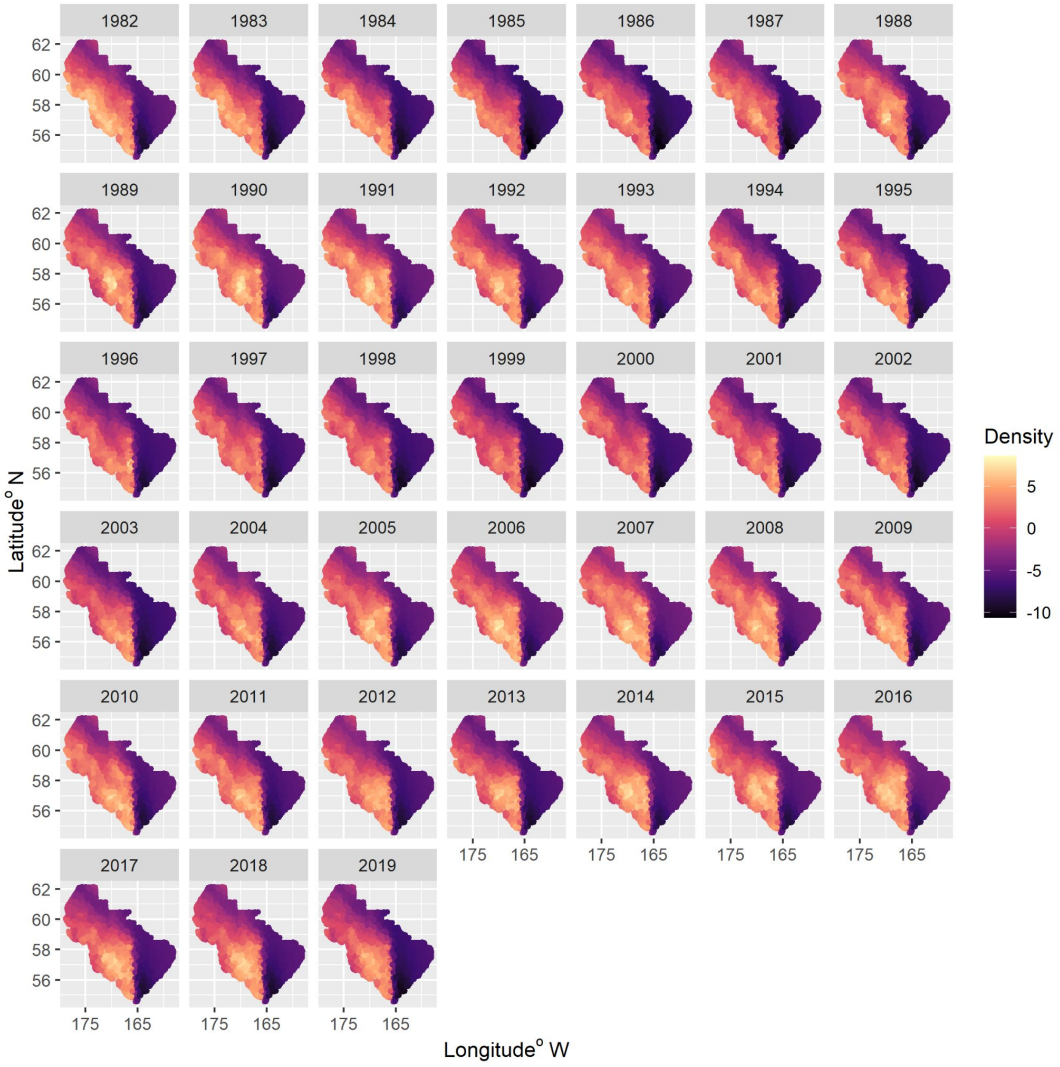
Conclusions

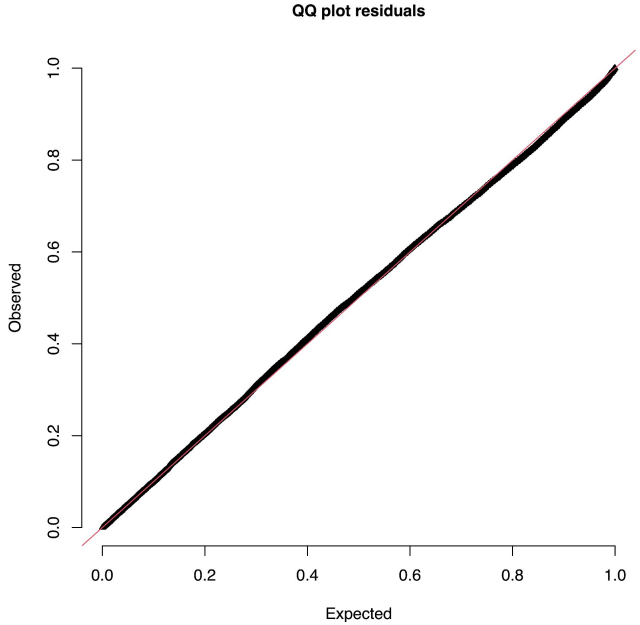
- Removal of corner stations had little qualitative effect on biomass estimates
- Little effect on precision + accuracy for tanner and snow crab
- Larger effects on precision + accuracy for Pribilof, St. Matthew king crab stocks, particularly design-based estimates
- Biggest effects were generally for species/estimators in which the precision/accuracy was low, regardless of corner station inclusion
- Often declines in precision/ accuracy from corner stations removal could be mitigated by using model-based estimates
- Similar analysis for groundfish species found little effect from removing corner stations (*https://meetings.npfmc.org/Meeting/Details/2673*)

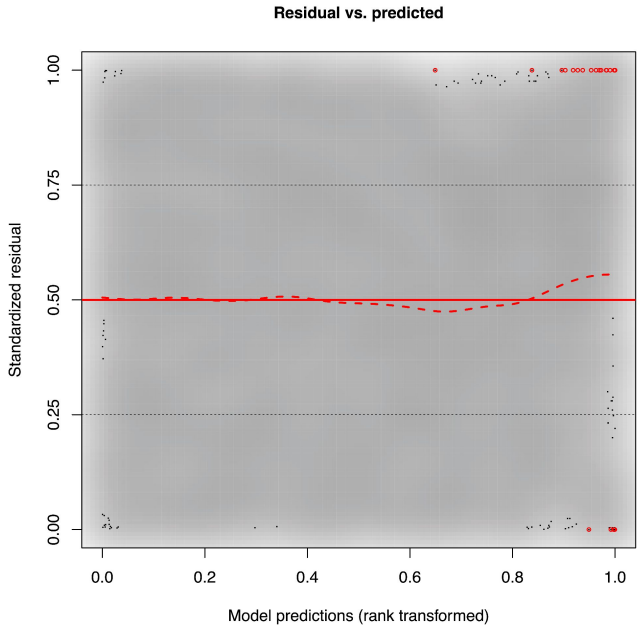
Questions for Crab Plan Team:

- Should sampling effort be redirected from the St. Mathew and Pribilof Island corner stations towards other priorities?

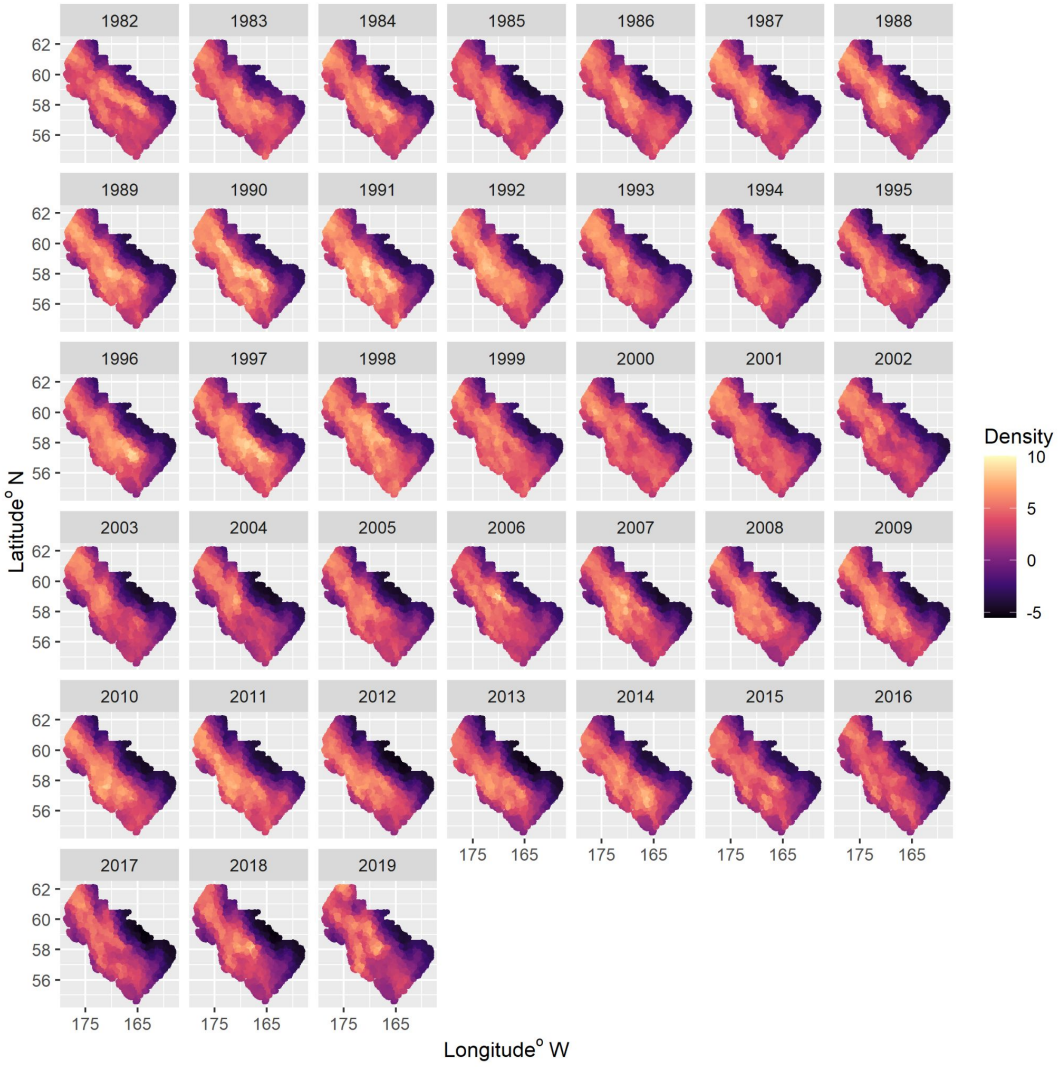
Tanner GE103







Snow GE95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Latitude° N
Longitude° W
Density
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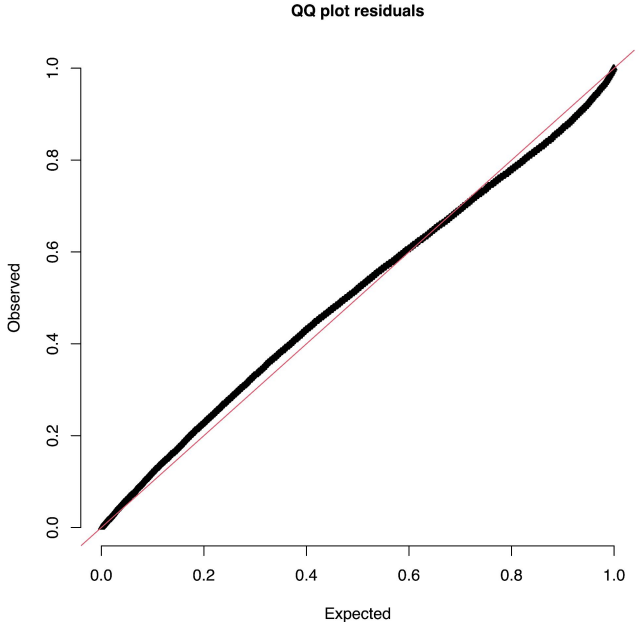
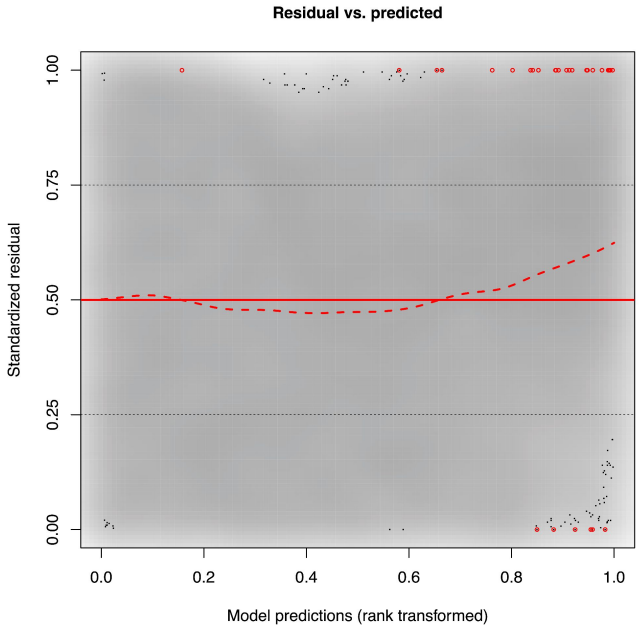
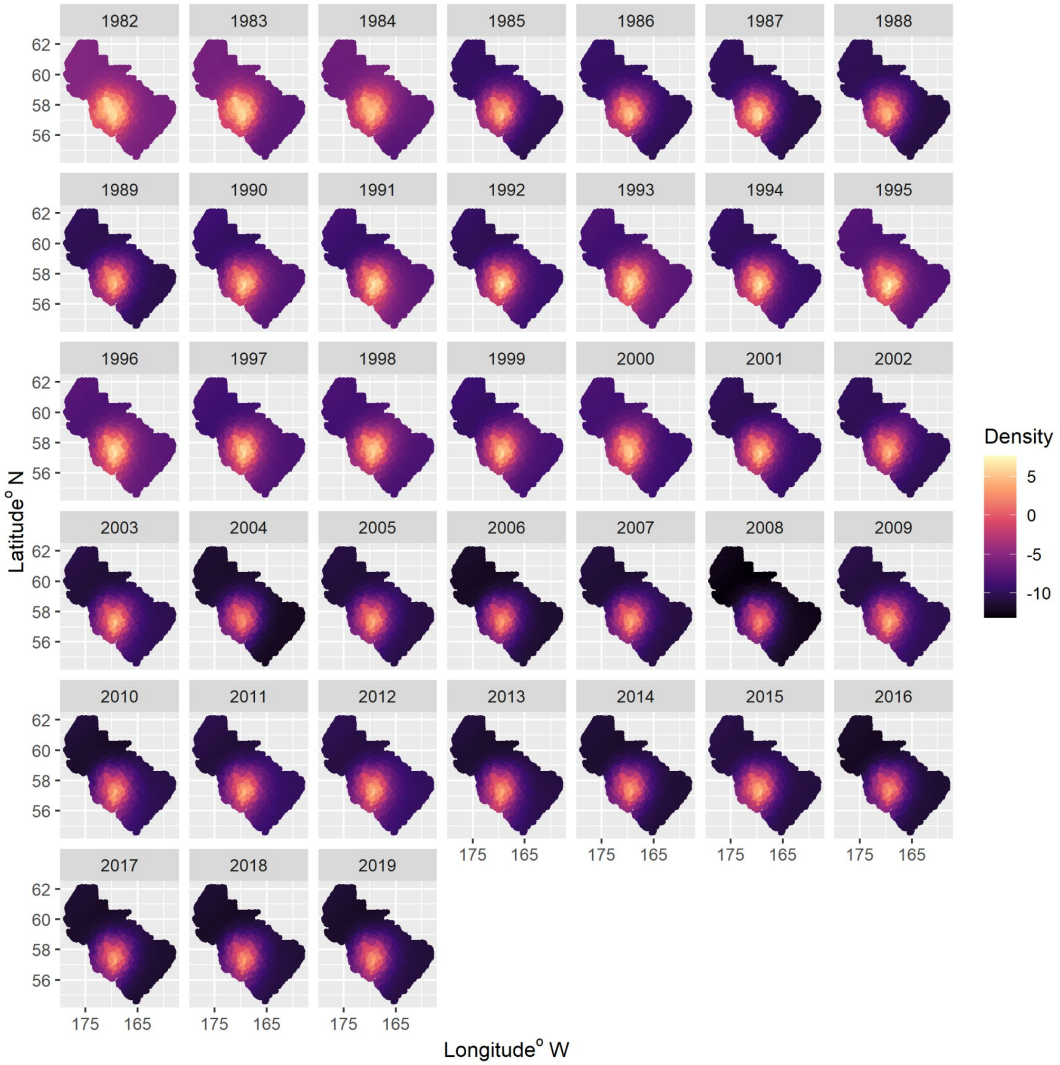
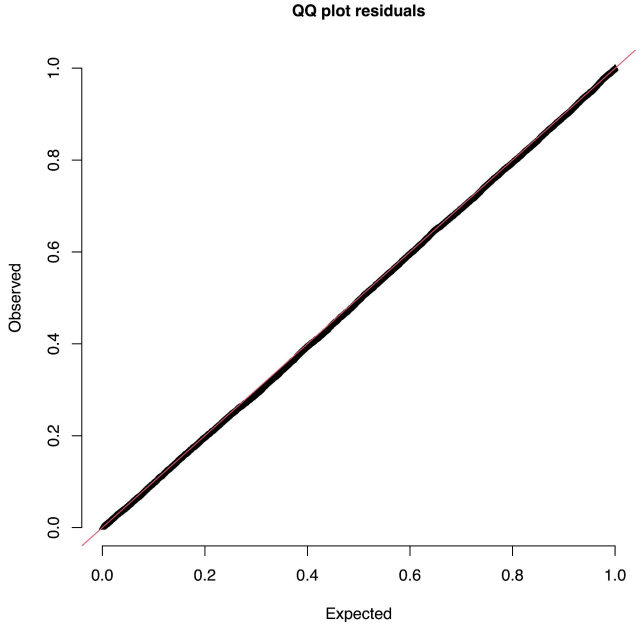
0
-5

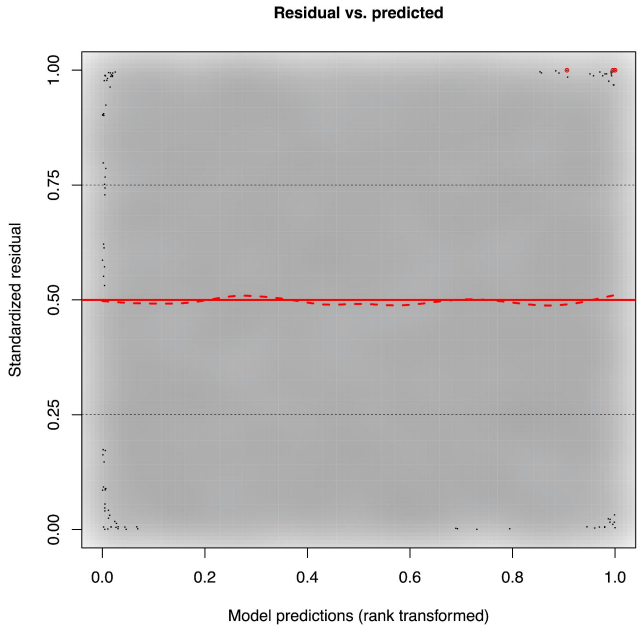

QQ plot residuals
Observed
Expected
0.0
0.2
0.4
0.6
0.8
1.0


Residual vs. predicted
Standardized residual
Model predictions (rank transformed)
0.00
0.25
0.50
0.75
1.00
0.0
0.2
0.4
0.6
0.8
1.0

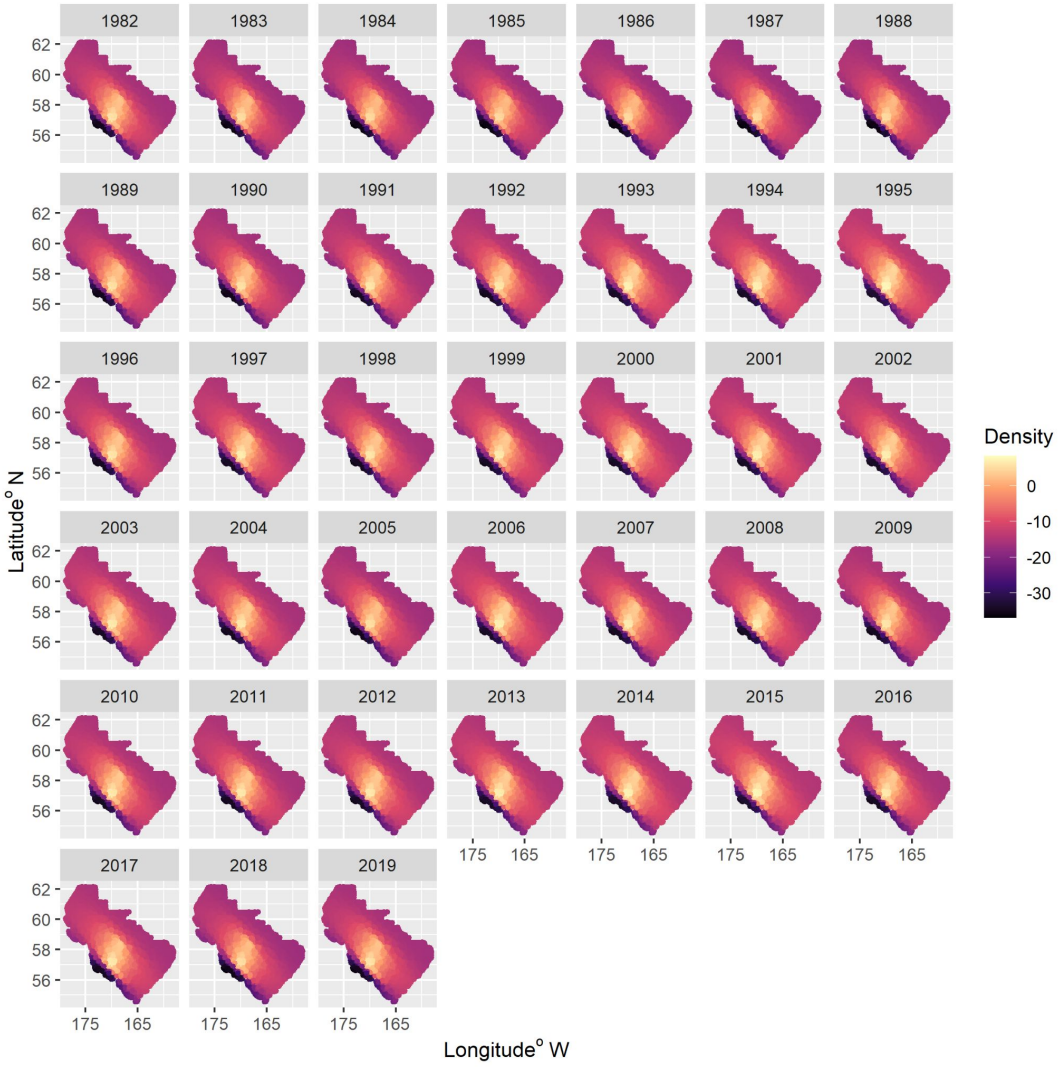
Pribilof Blue King GE120

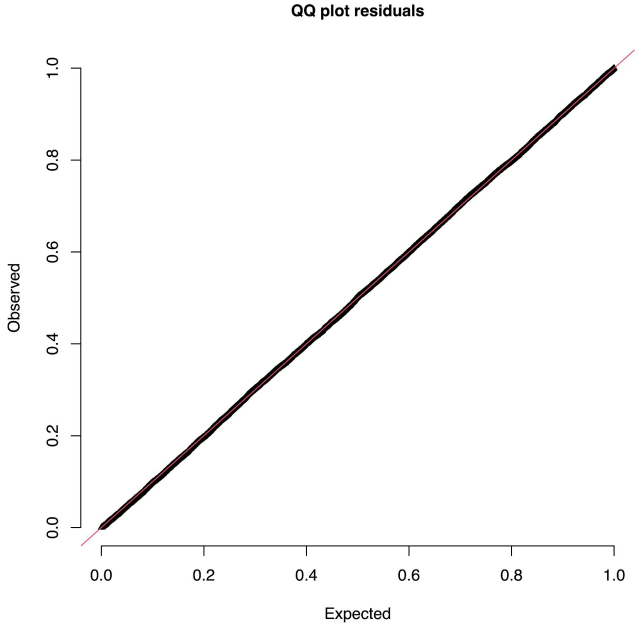


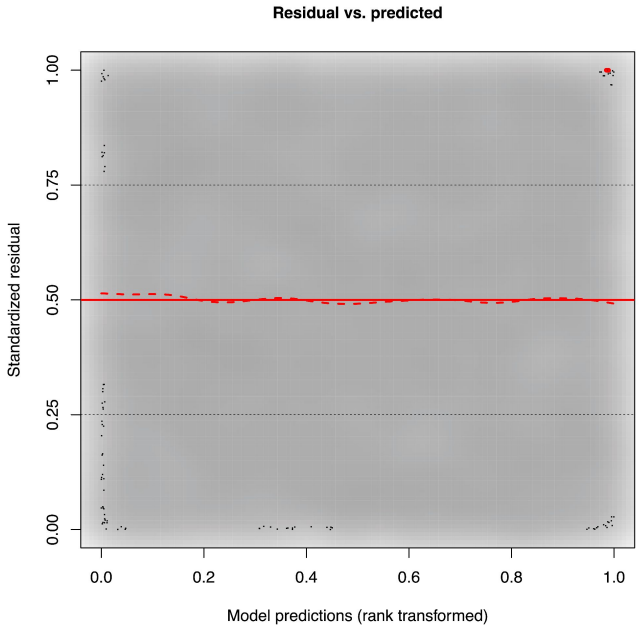




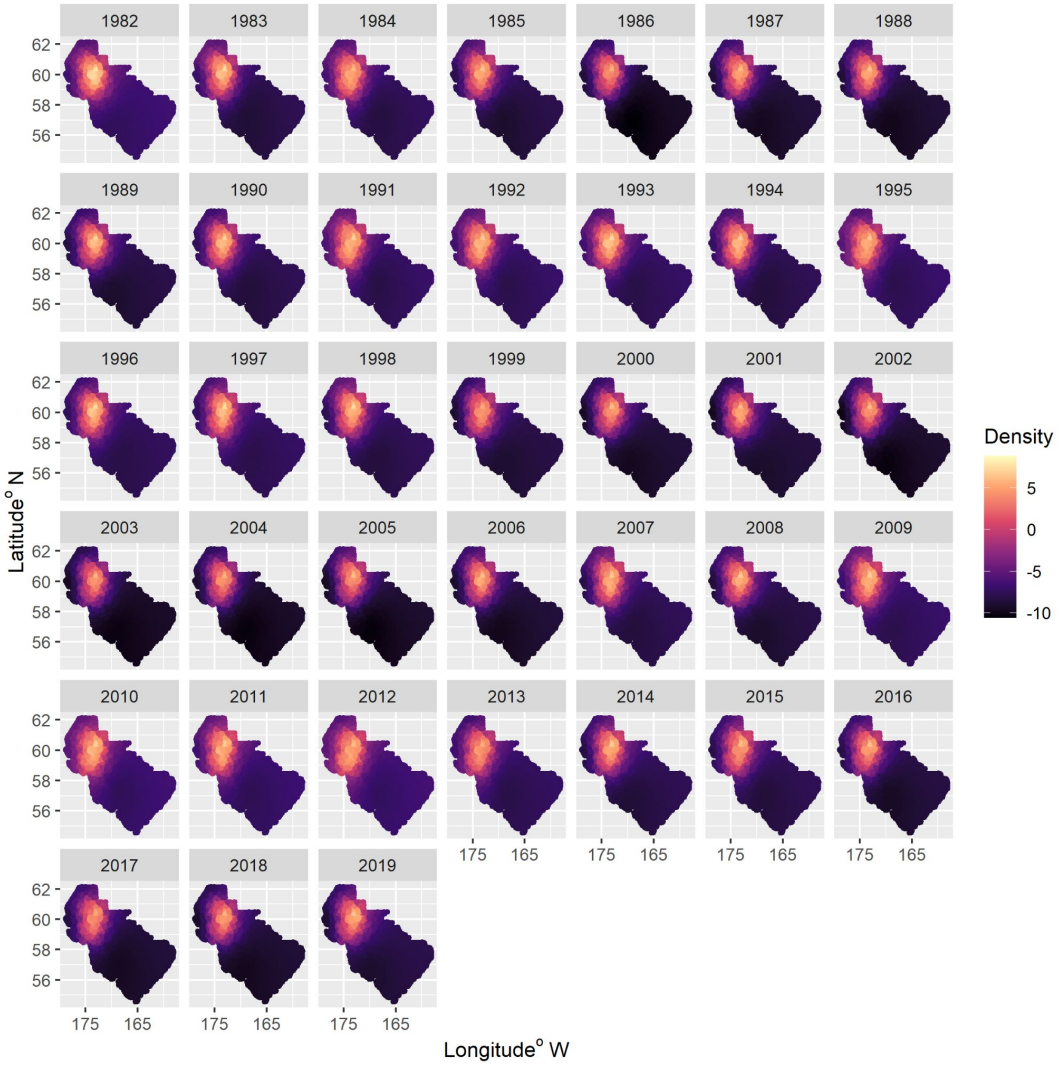
Pribilof Red King GE120

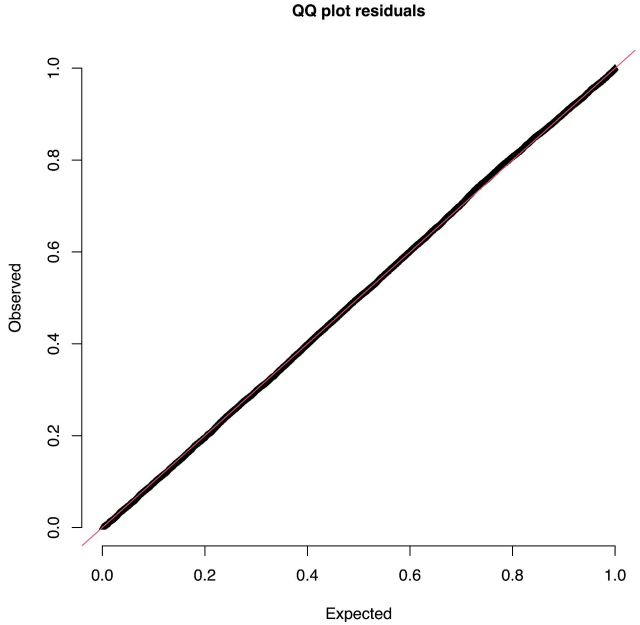


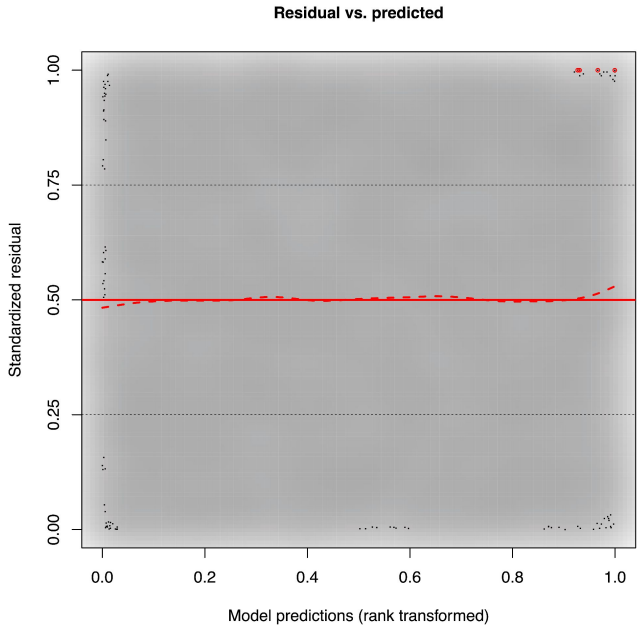




St. Matt Blue King GE90







St. Matt Blue King GE105