Oregon State University
College of Earth, Ocean, and Atmospheric Sciences

NOAA FISHERIES

OCEAN SCIENCES MEETING | 16–21 FEBRUARY 2020 SAN DIEGO, CA, USA

Accounting for spatiotemporal variability in somatic growth in age composition estimation for stock assessment models

Giancarlo M. Correa[1], Lorenzo Ciannelli[1], Lewis Barnett[2], Stan Kotwicki[2]

[1]College of Earth, Ocean, and Atmospheric Sciences. Oregon State University.
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Stock assessment models

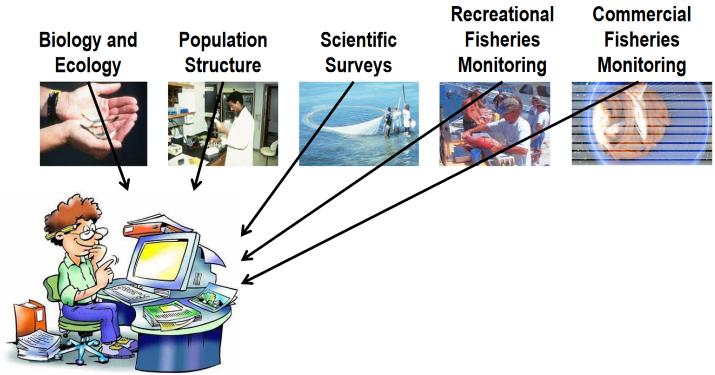
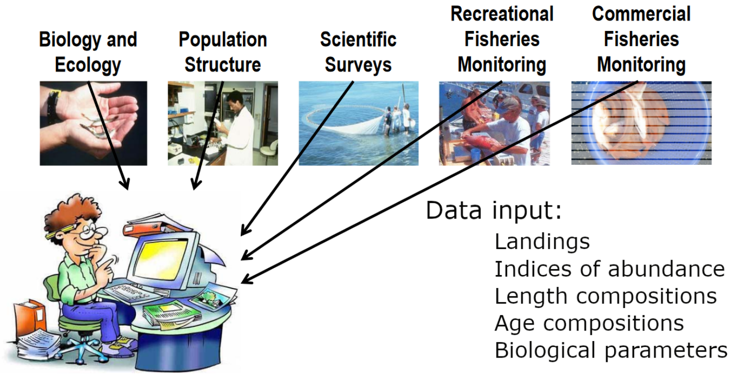


Figure: NOAA Fisheries

Stock assessment models



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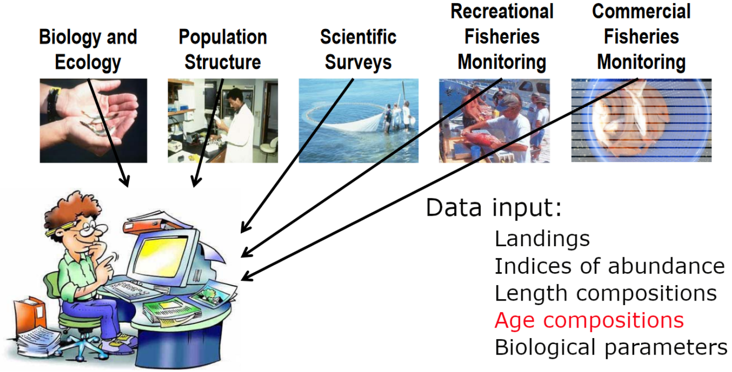
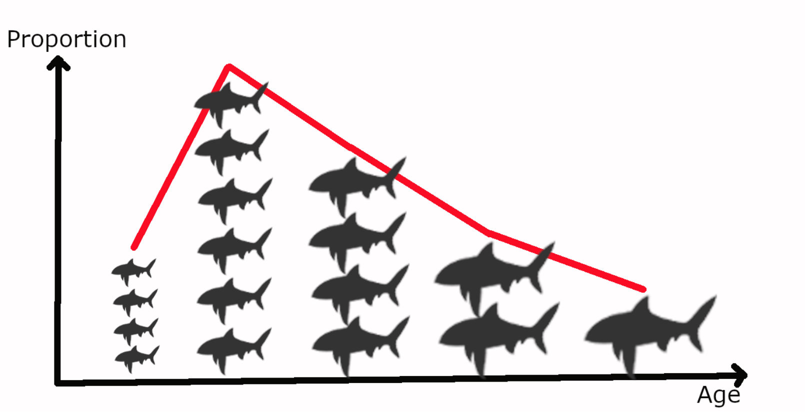


Figure: NOAA Fisheries

Age compositions: definition

Proportion of individuals in each age class:



Age compositions: what do they inform?

Provide information about Status of the stock:

- Recruitment
- Mortality
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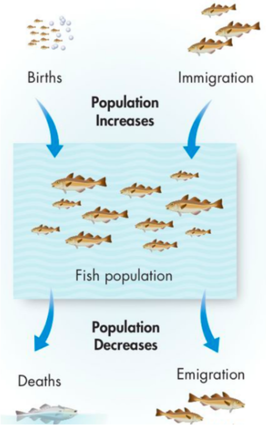

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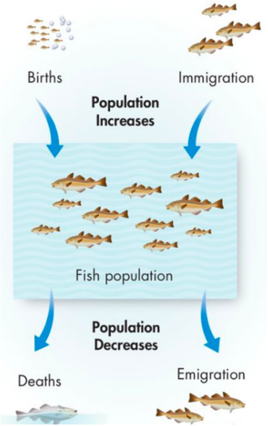

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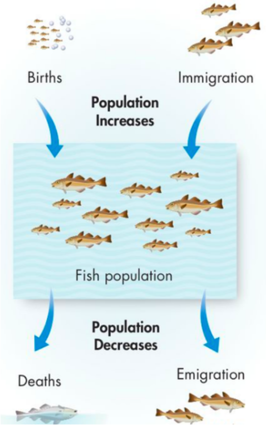

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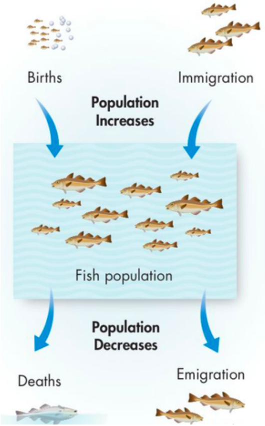

Age compositions: estimation

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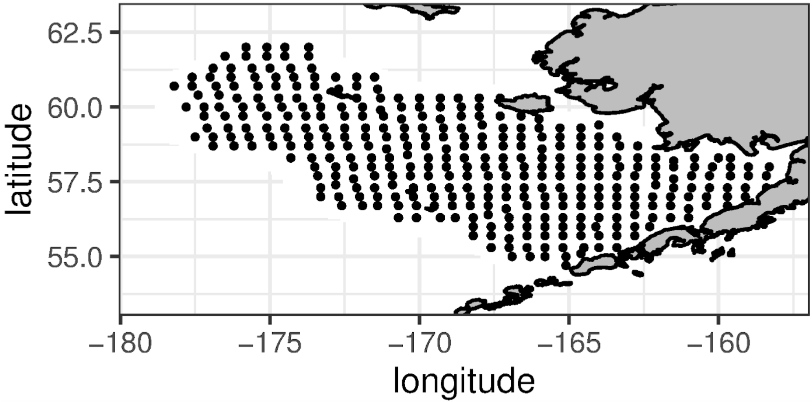

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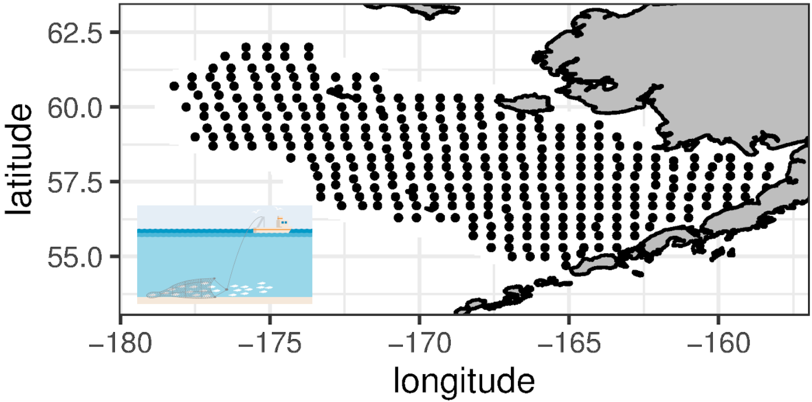
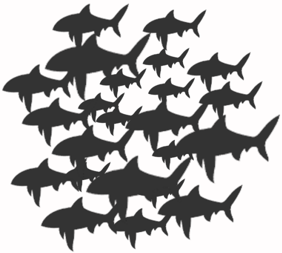


Age compositions: estimation

At each station:



Number of fish caught

Age compositions: estimation

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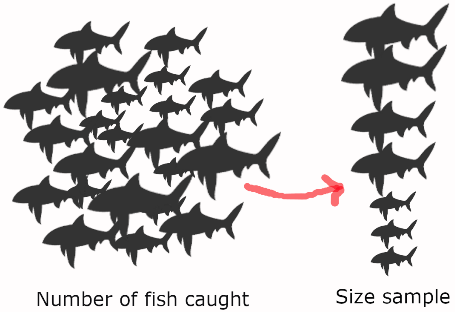

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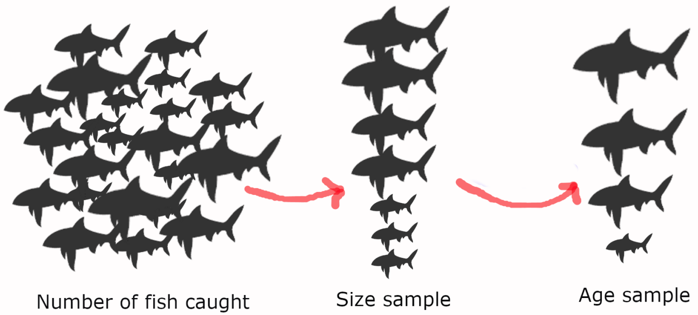

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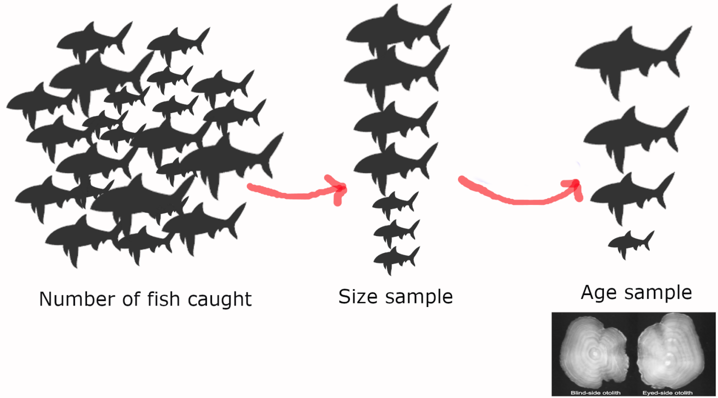

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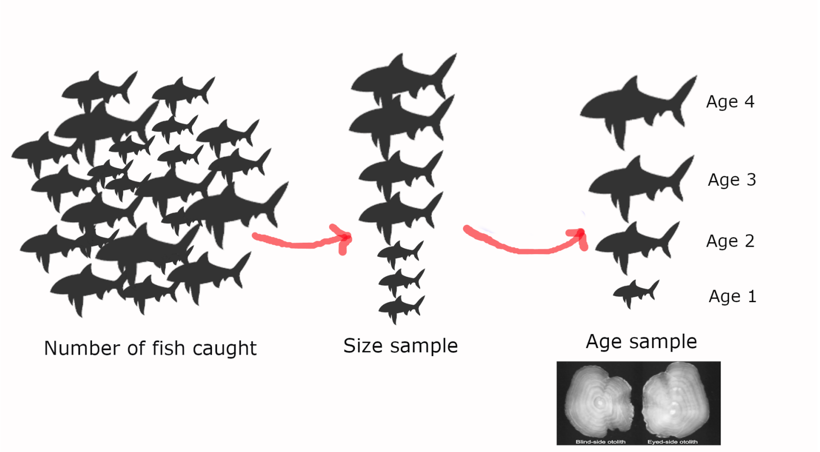

Age compositions: Age length key (ALK)

Using ALL age samples collected in a survey (or in many years):

Length (cm)	Age							
	1	2	3	4	5	6	7	8
10	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.99	0.01	0.00	0.00	0.00	0.00	0.00	0.00
17	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	0.99	0.01	0.00	0.00	0.00	0.00	0.00	0.00
22	0.98	0.02	0.00	0.00	0.00	0.00	0.00	0.00
23	0.97	0.03	0.00	0.00	0.00	0.00	0.00	0.00
24	0.95	0.05	0.00	0.00	0.00	0.00	0.00	0.00
25	0.91	0.09	0.00	0.00	0.00	0.00	0.00	0.00
26	0.88	0.12	0.00	0.00	0.00	0.00	0.00	0.00
27	0.81	0.19	0.00	0.00	0.00	0.00	0.00	0.00
28	0.73	0.27	0.00	0.00	0.00	0.00	0.00	0.00
29	0.58	0.42	0.00	0.00	0.00	0.00	0.00	0.00
30	0.40	0.60	0.01	0.00	0.00	0.00	0.00	0.00

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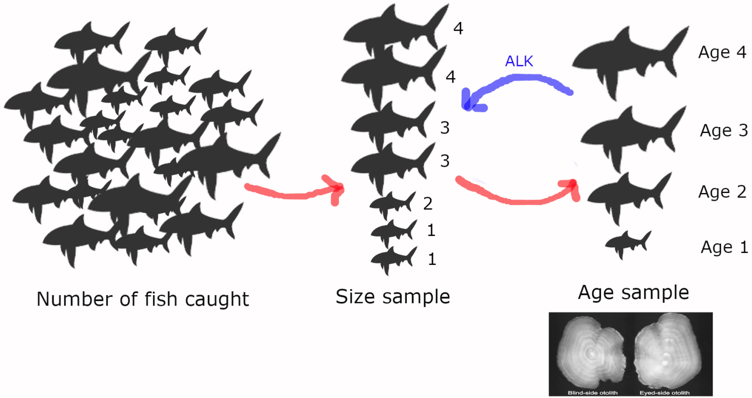

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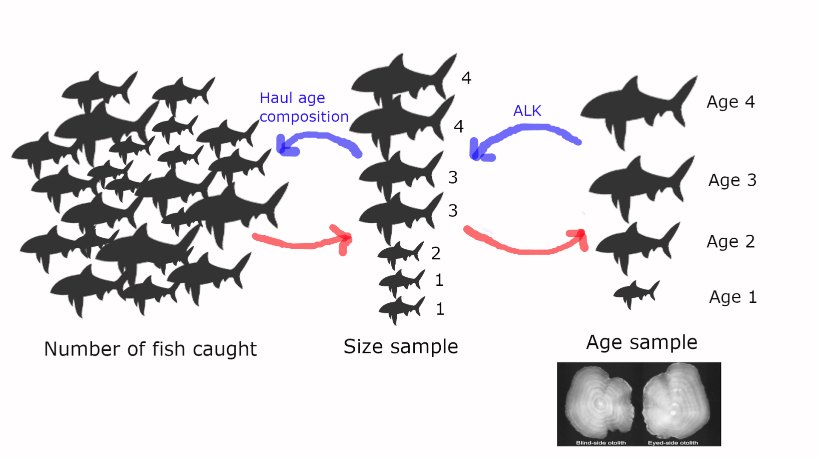

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Age composition estimates can be influenced by three processes:

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Objectives

- Evaluate the performance of classic ALKs and two statistical models to estimate age compositions of a fish population with a substantial spatiotemporal variability in somatic growth.
- Assess the effects of different age compositions estimated by ALKs or statistical models on stock assessment outputs uncertainties.

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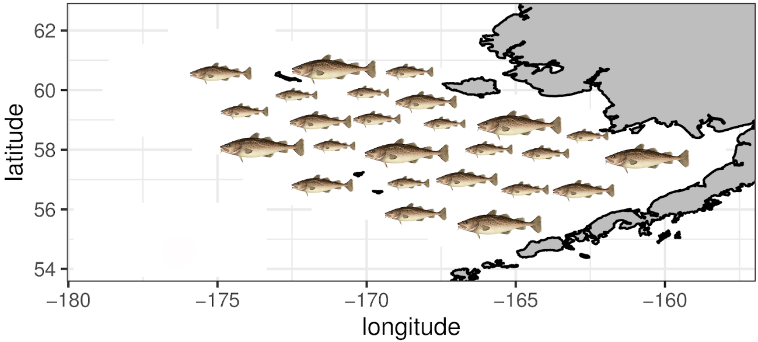
We simulate the dynamics of a fish population in time (40 years) and space. We use Pacific cod biological parameters in the eastern Bering Sea (EBS).



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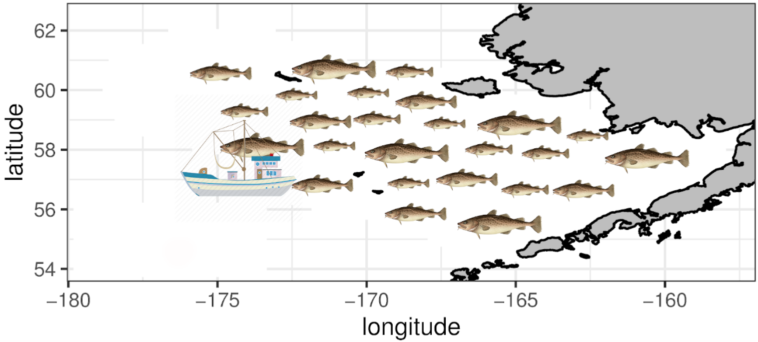

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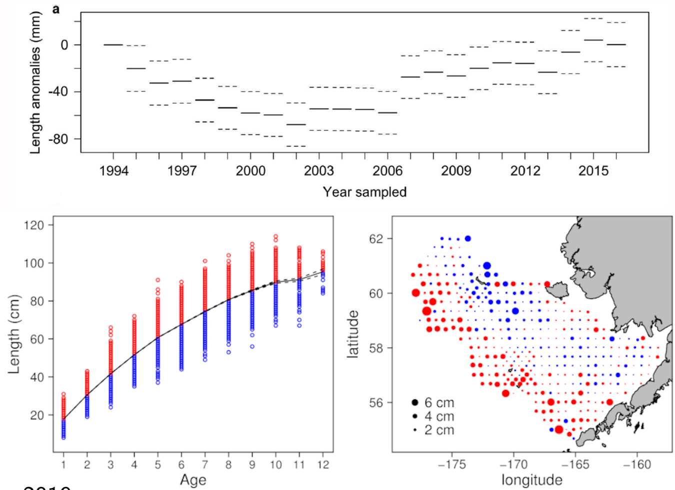
Why Pacific cod in the EBS?



Ciannelli et al., 2019

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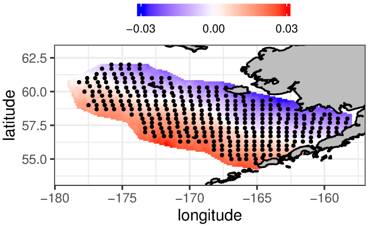
Spatial field (ω_i):



Methods

Using simulated survey age sample data, we compared these methods:

- Design-based approaches:
  - Pooled ALK: combines information of many years. Helps to reduce data gaps.
  - Annual ALK: uses year-specific information.
- Model-based approaches (Puerta et al., 2018, Berg et al., 2012):
  - GAMs: $Age_{y,i} = \alpha_y + s_{1_y}(l_i) + s_{2_y}(lon_i, lat_i) + \epsilon_i$
  - CRLs[1]: $\pi_{a,y,i} = \alpha_{a,y} + \beta_{a,y} l_i + s_{a,y}(lon_i, lat_i) + \epsilon_i$

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We ran 250 replicates and compared performance of these methods.

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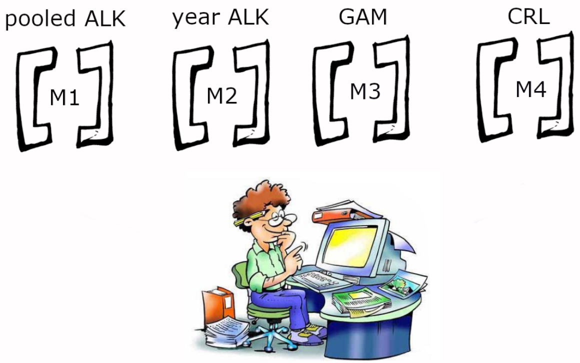

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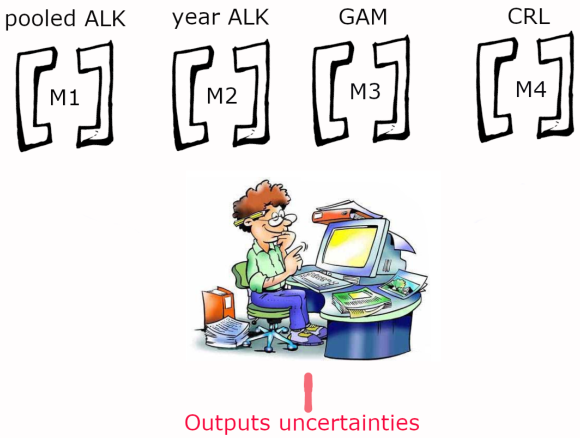
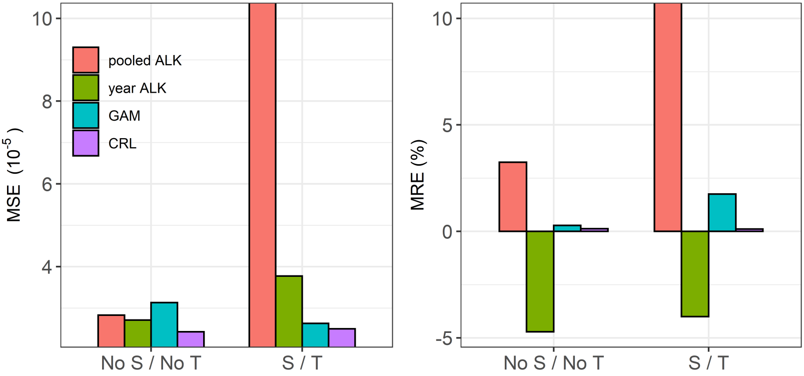


Results: simulation experiment



MSE = measure of error. MRE = measure of bias.

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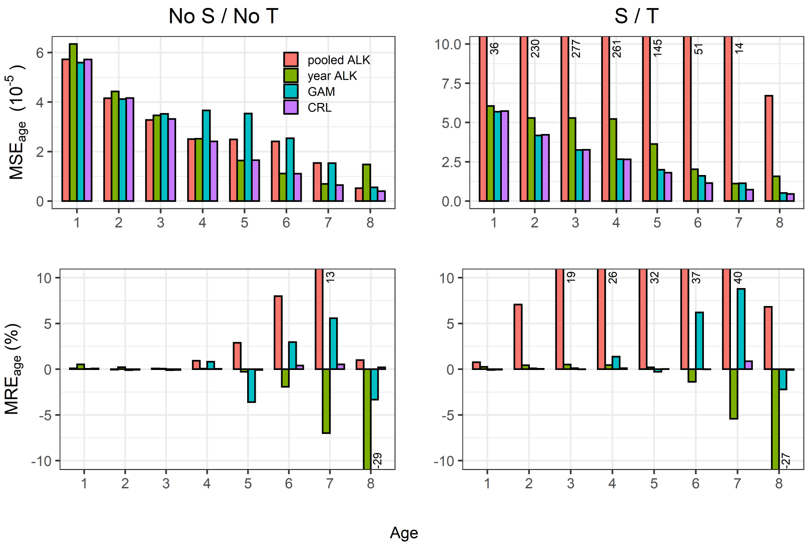

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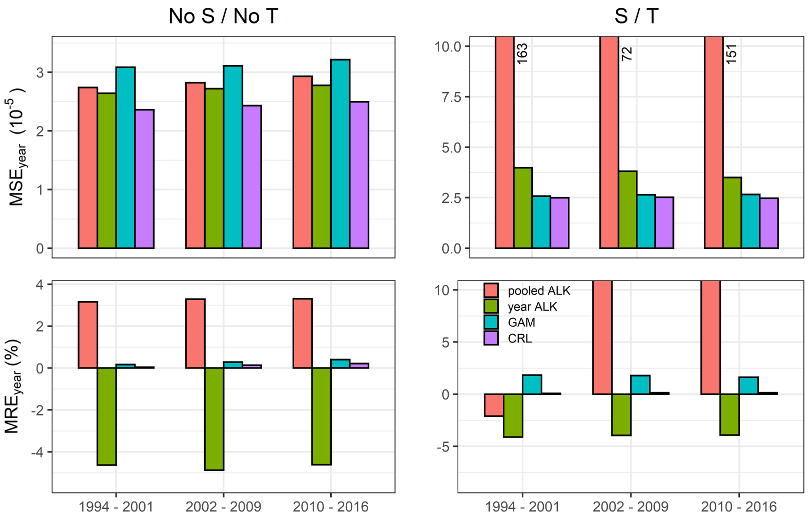

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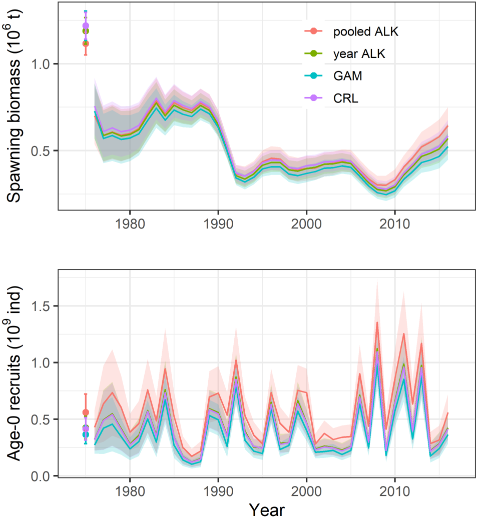
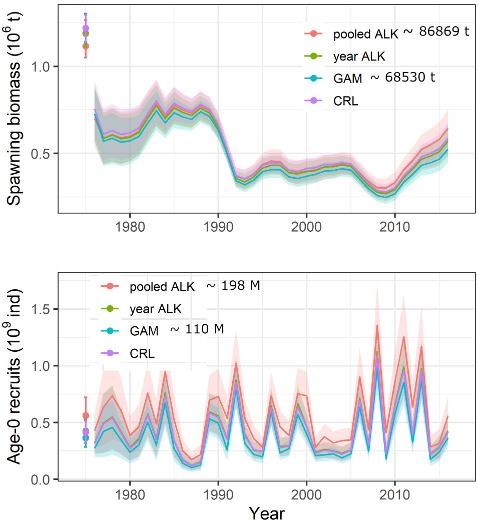


Results: stock assessment

Average of standard deviations of the entire time series.



Results: stock assessment

Parameters influenced by age composition data:

Model name	L_∞	$Ln(R_0)$
pooled ALK	113.2 (13.2)	13.2 (0.29)
year ALK	109.8 (13.8)	12.96 (0.24)
GAM	106 (**12.7**)	12.8 (**0.22**)
CRL	110 (13.6)	12.94 (0.24)

Table: Estimated parameters: Mean (Sd)

Conclusions

- Somatic growth spatiotemporal variability impacts ALKs.
- Performance of alternative approaches has not been evaluated yet.
- Using a simulation experiment, we showed that these alternative approaches are more robust to estimate age compositions.
- Lower uncertainties in stock assessment models.
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Picture from ellaquaint