

# Operating Models Summary Report

North Atlantic Swordfish MSE

Adrian Hordyk [adrian@bluematterscience.com](mailto:adrian@bluematterscience.com)

May 28, 2020

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## Operating Model Scenarios

### Base Case Model

Table 1. Key parameter values for the base case analysis. The column names are: Natural mortality (M) - fixed parameter; standard error of recruitment deviations (sigmaR) - fixed parameter; Steepness (h) - estimated in the base case model; Coefficient of variation for the indices (CPUE CV) - varied between indices and years (range of values shown here); Effective sample size of length composition (Len. Comp. Eff. Samp. Size) - fixed; Q Increase assumed for indices (Q increase); Environmental covariate included for some indices (Env. Covariate).

M	sigmaR	h	CPUE CV	Len. Comp. Eff. Samp. Size	Q increase	Env. Covariate
0.2	0.2	0.823509	0.16 - 0.38	20	FALSE	TRUE

## Uncertainty Grid

Table 2. The uncertainty grid is a full factorial design with the following 7 factors, resulting in 288 OMs. M and h were fixed in the uncertainty grid. CPUE CV was fixed for all indices.

M	sigmaR	h	CPUE CV	Len. Comp. Eff. Samp. Size	Q increase	Env. Covariate
0.1	0.2	0.60	0.3	2	1	FALSE
0.2	0.6	0.75	0.6	20	1.01	TRUE
0.3		0.90				

## Convergence

All 288 OMs in the uncertainty grid converged (invertible hessian).

## Check for Parameters at Bounds

73 OMs had parameters that were close to the specified bounds (defined here as within 1% of the bounds). This only occurred for 3 parameters, all related to the size-selectivity parameters of the Japan Early and US fishing fleets.

Table 3. Table of parameters where the estimated values were within 1% of the specified minimum and maximum bounds. Filters at the top of each column can be used to subset the results. The table can be downloaded as a CSV file using the 'CSV' button.

NOTE: Dynamic tables are only available in HTML version of this report. Click here<sup>1</sup> to download the table in CSV format (After opening link, right-click and Save As .csv).

<sup>1</sup>[https://github.com/ICCAT/nsw-mse/raw/master/docs/Reports/OM\\_Summary/Table3.csv](https://github.com/ICCAT/nsw-mse/raw/master/docs/Reports/OM_Summary/Table3.csv)

CSV

Show 10 entries

Search:

OM	Parameter	Value	Min	Max
All	All	All	All	All
3	SizeSel_5P_1_JPN_ERLY_5	316.811	70	317
6	SizeSel_5P_1_JPN_ERLY_5	316.793	70	317
9	SizeSel_5P_1_JPN_ERLY_5	316.894	70	317
12	SizeSel_5P_1_JPN_ERLY_5	316.867	70	317
14	SizeSel_5P_1_JPN_ERLY_5	316.536	70	317
15	SizeSel_5P_1_JPN_ERLY_5	316.914	70	317
17	SizeSel_5P_1_JPN_ERLY_5	316.178	70	317
18	SizeSel_5P_1_JPN_ERLY_5	316.887	70	317
27	SizeSel_5P_1_JPN_ERLY_5	315.158	70	317
33	SizeSel_5P_1_JPN_ERLY_5	316.441	70	317

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## Parameter and Likelihood Table

Table 4. The parameters and the total and component likelihood values for the base case model and the 288 OMs from the uncertainty grid. Filters at the top of each column can be used to subset the results. The table can be downloaded as a CSV file using the ‘CSV’ button.

NOTE: Dynamic tables are only available in HTML version of this report. Click here<sup>2</sup> to download the table in CSV format (After opening link, right-click and Save As .csv).

<sup>2</sup>[https://github.com/ICCAT/nsw-mse/raw/master/docs/Reports/OM\\_Summary/Table4.csv](https://github.com/ICCAT/nsw-mse/raw/master/docs/Reports/OM_Summary/Table4.csv)

CSV

Show 10 entries

Search:

Parameter Values									Likelihood Values				
OM	M	sigmaR	h	CPUE CV	Len. Comp. Eff. Samp. Size	Q increase	Env. Covariate		Total	Survey	Mean_body_wt	Length_comp	Recruitment
All		All	All	All	All	All	All		All	All	All	All	All
base_case	0.2	0.2	0.823509	0.2701595	20	1	TRUE		379.897	-188.35	122.919	480.688	-37.537
1	0.1	0.2	0.6	0.3	2	1	FALSE		-23.2488	-185.743	123.713	71.9124	-33.1381
2	0.2	0.2	0.6	0.3	2	1	FALSE		-46.1227	-183.918	121.006	52.8787	-36.093
3	0.3	0.2	0.6	0.3	2	1	FALSE		-45.963	-181.251	121.383	51.6647	-37.7726
4	0.1	0.6	0.6	0.3	2	1	FALSE		-3.80535	-190.121	123.429	73.5251	-10.6455
5	0.2	0.6	0.6	0.3	2	1	FALSE		-27.9336	-191.055	121.265	53.8414	-11.9904
6	0.3	0.6	0.6	0.3	2	1	FALSE		-26.6171	-187.491	121.684	51.7292	-12.5492
7	0.1	0.2	0.75	0.3	2	1	FALSE		-31.0563	-187.25	122.27	69.7248	-35.8075
8	0.2	0.2	0.75	0.3	2	1	FALSE		-49.9767	-186.628	121.273	53.1095	-37.7378
9	0.3	0.2	0.75	0.3	2	1	FALSE		-49.2933	-181.448	121.287	50.5191	-39.6651

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## Reference Points Table

Table 5. Summary table of the biological reference points for the base case model and the 288 models from the uncertainty grid. Filters at the top of each column can be used to subset the results. The table can be downloaded as a CSV file using the ‘CSV’ button.

NOTE: Dynamic tables are only available in HTML version of this report. Click here<sup>3</sup> to download the table in CSV format (After opening link, right-click and Save As .csv).

<sup>3</sup>[https://github.com/ICCAT/nsw-mse/raw/master/docs/Reports/OM\\_Summary/Table5.csv](https://github.com/ICCAT/nsw-mse/raw/master/docs/Reports/OM_Summary/Table5.csv)

CSV

Show 10 entries

Search:

Parameter Values									Reference Points						
OM	M	sigmaR	h	CPUE CV	Len. Comp. Eff. Samp. Size	Q increase	Env. Covariate		MSY	SB <sub>MSY</sub>	F <sub>MSY</sub>	F/F <sub>MSY</sub>	SB/SB <sub>MSY</sub>	SB <sub>MSY</sub> /SB <sub>0</sub>	Depletion
All		All	All	All	All	All	All		All	All	All	All	All	All	All
base_case	0.2	0.2	0.823509	0.2701595	20	1	TRUE		12303.8	27046.7	0.14	0.85	1.12	0.22	0.24
1	0.1	0.2	0.6	0.3	2	1	FALSE		10546.2	148652	0.04	0.98	1.08	0.34	0.37
2	0.2	0.2	0.6	0.3	2	1	FALSE		12384.6	57655.4	0.08	0.71	1.32	0.31	0.41
3	0.3	0.2	0.6	0.3	2	1	FALSE		13174.6	28709.3	0.11	0.64	1.45	0.3	0.43
4	0.1	0.6	0.6	0.3	2	1	FALSE		11244.6	156292	0.04	1.03	0.98	0.34	0.33
5	0.2	0.6	0.6	0.3	2	1	FALSE		14180.6	65589.4	0.08	0.68	1.2	0.31	0.37
6	0.3	0.6	0.6	0.3	2	1	FALSE		15889.6	34630.6	0.11	0.56	1.37	0.3	0.4
7	0.1	0.2	0.75	0.3	2	1	FALSE		11323.4	105289	0.06	0.87	1.15	0.28	0.33
8	0.2	0.2	0.75	0.3	2	1	FALSE		12784.7	36699	0.12	0.66	1.42	0.25	0.36
9	0.3	0.2	0.75	0.3	2	1	FALSE		13716	17685.5	0.16	0.58	1.68	0.23	0.39

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## SB/SB<sub>MSY</sub> Timeseries Plots

Time-series plots of the spawning biomass (SB) relative to spawning biomass corresponding with maximum sustainable yield (SB<sub>MSY</sub>) for the seven factors examined in the uncertainty grid.

## Natural Mortality

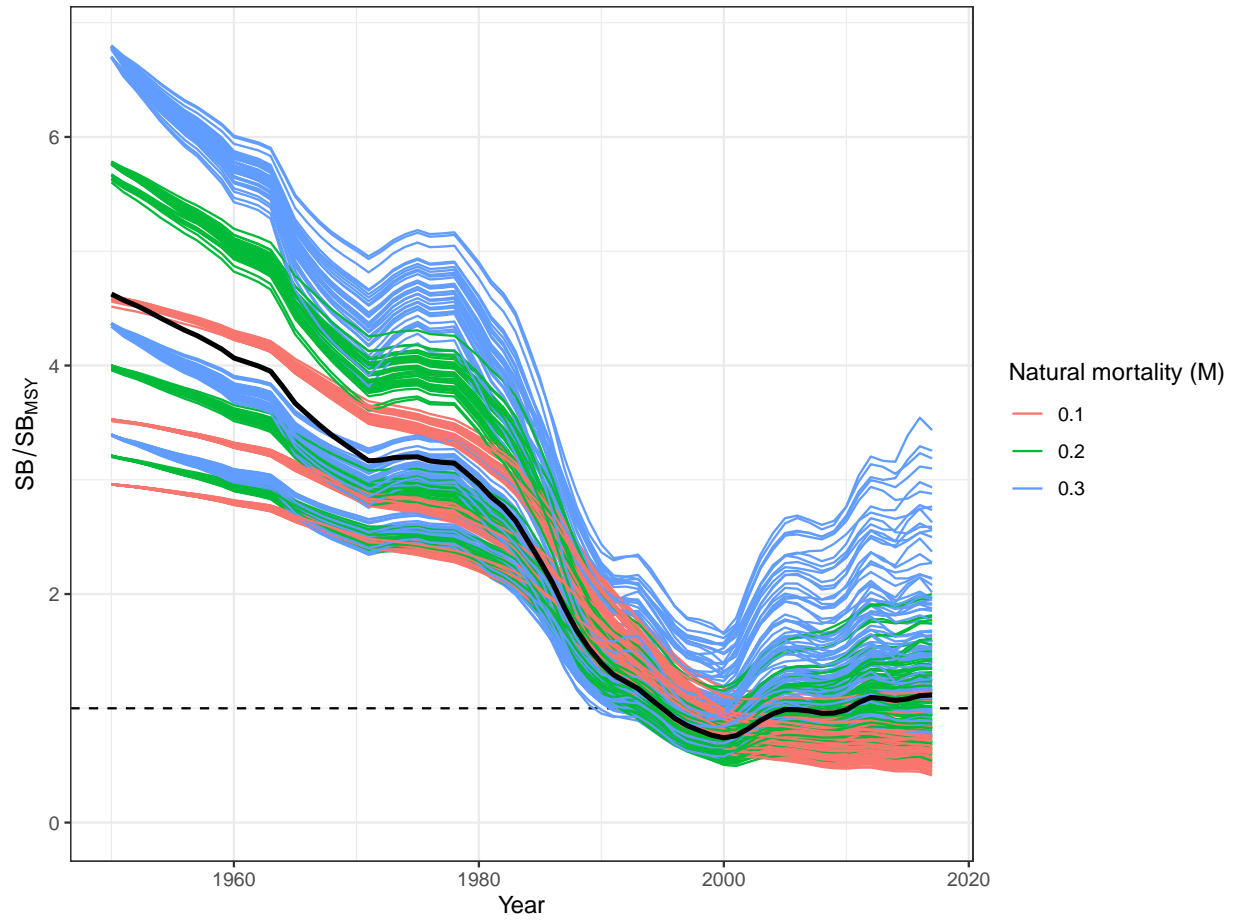


Figure 1. Predicted spawning biomass (SB) relative to spawning biomass at maximum sustainable yield ( $SB_{MSY}$ ) for the 288 OM from the uncertainty grid with the 3 levels of Natural mortality (M) shown as coloured lines. The base case OM is shown as the thick black line.

## Recruitment Variability

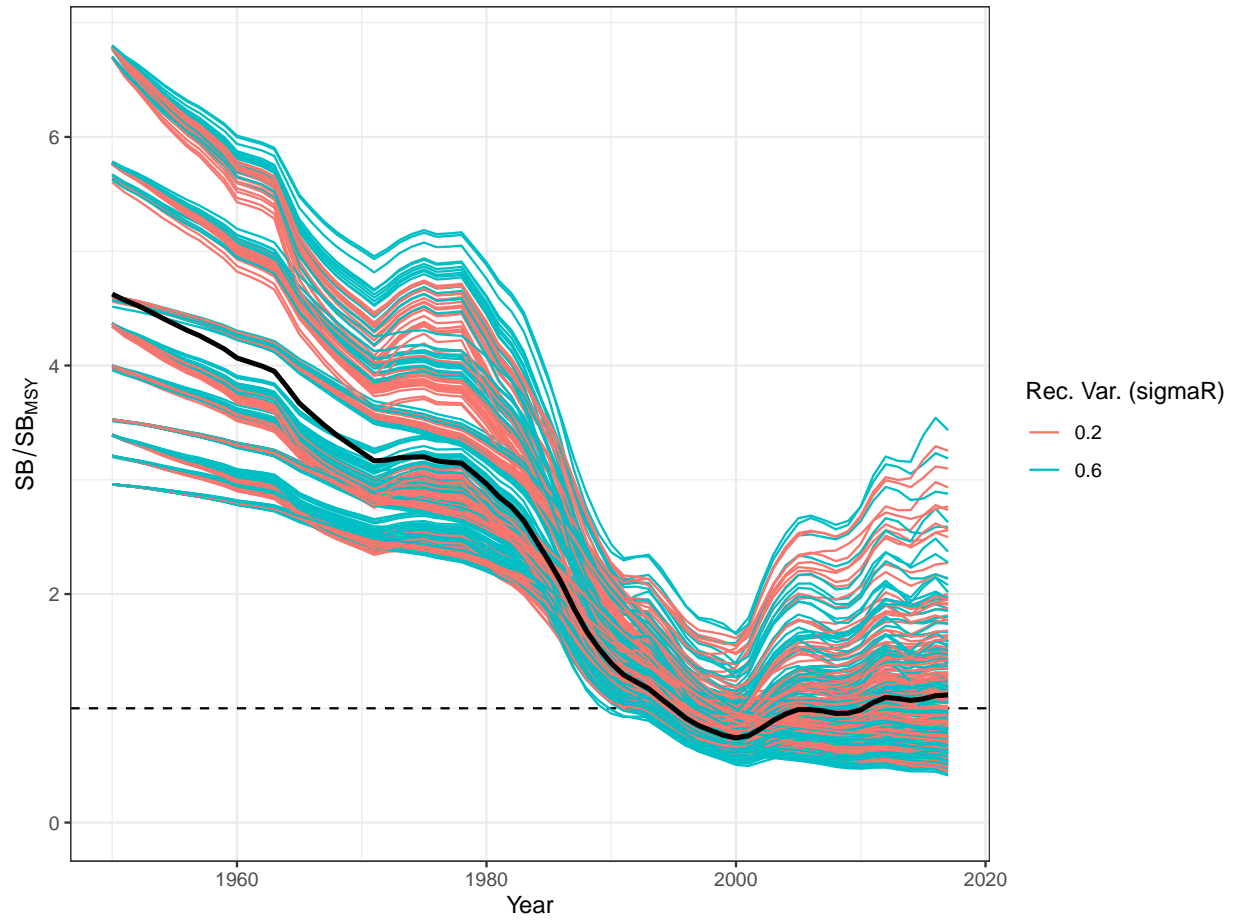


Figure 2. Predicted spawning biomass (SB) relative to spawning biomass at maximum sustainable yield ( $SB_{MSY}$ ) for the 288 OMs from the uncertainty grid with the 2 levels of Rec. Var. ( $\sigma_R$ ) shown as coloured lines. The base case OM is shown as the thick black line.

## Steepness

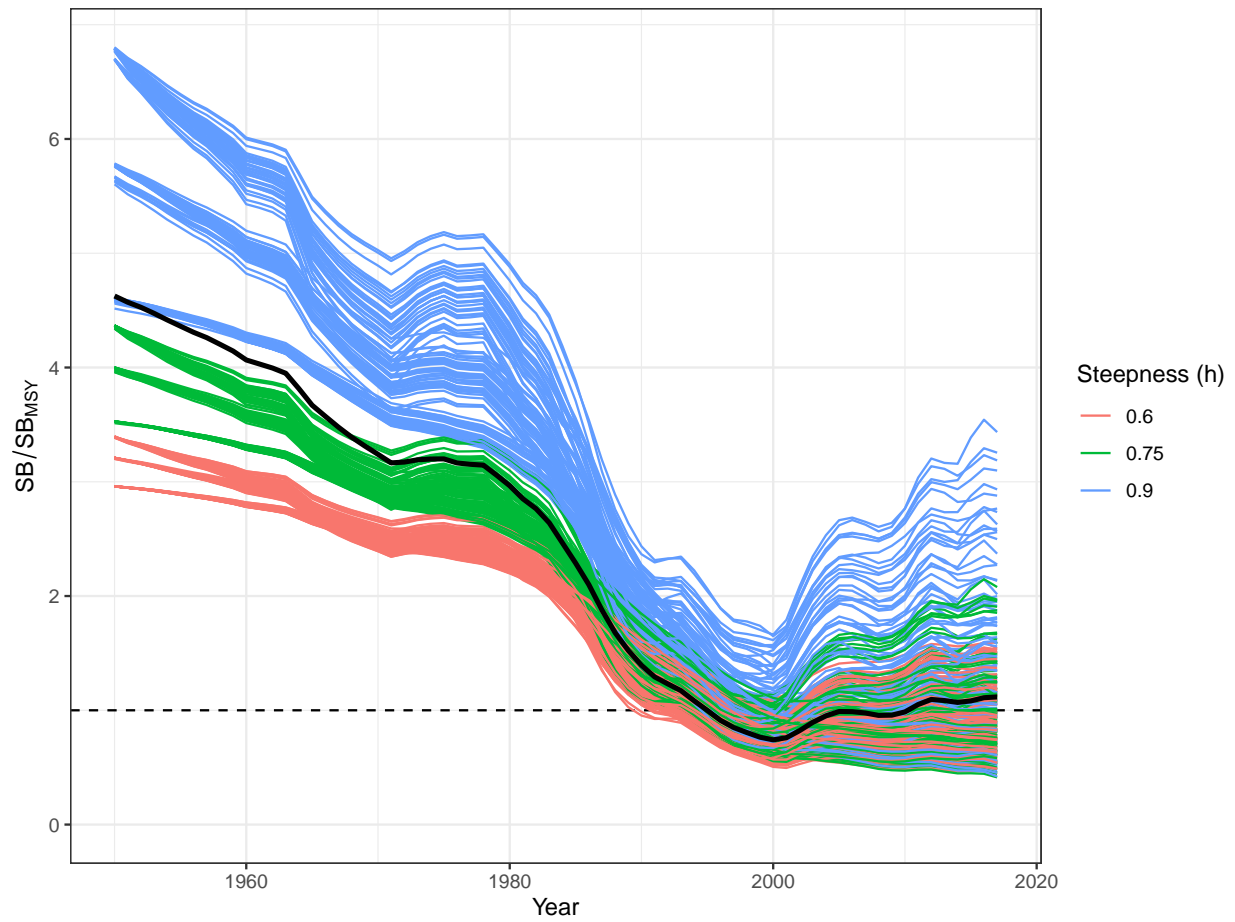


Figure 3. Predicted spawning biomass (SB) relative to spawning biomass at maximum sustainable yield ( $SB_{MSY}$ ) for the 288 OMs from the uncertainty grid with the 3 levels of Steepness ( $h$ ) shown as coloured lines.



## CPUE CV

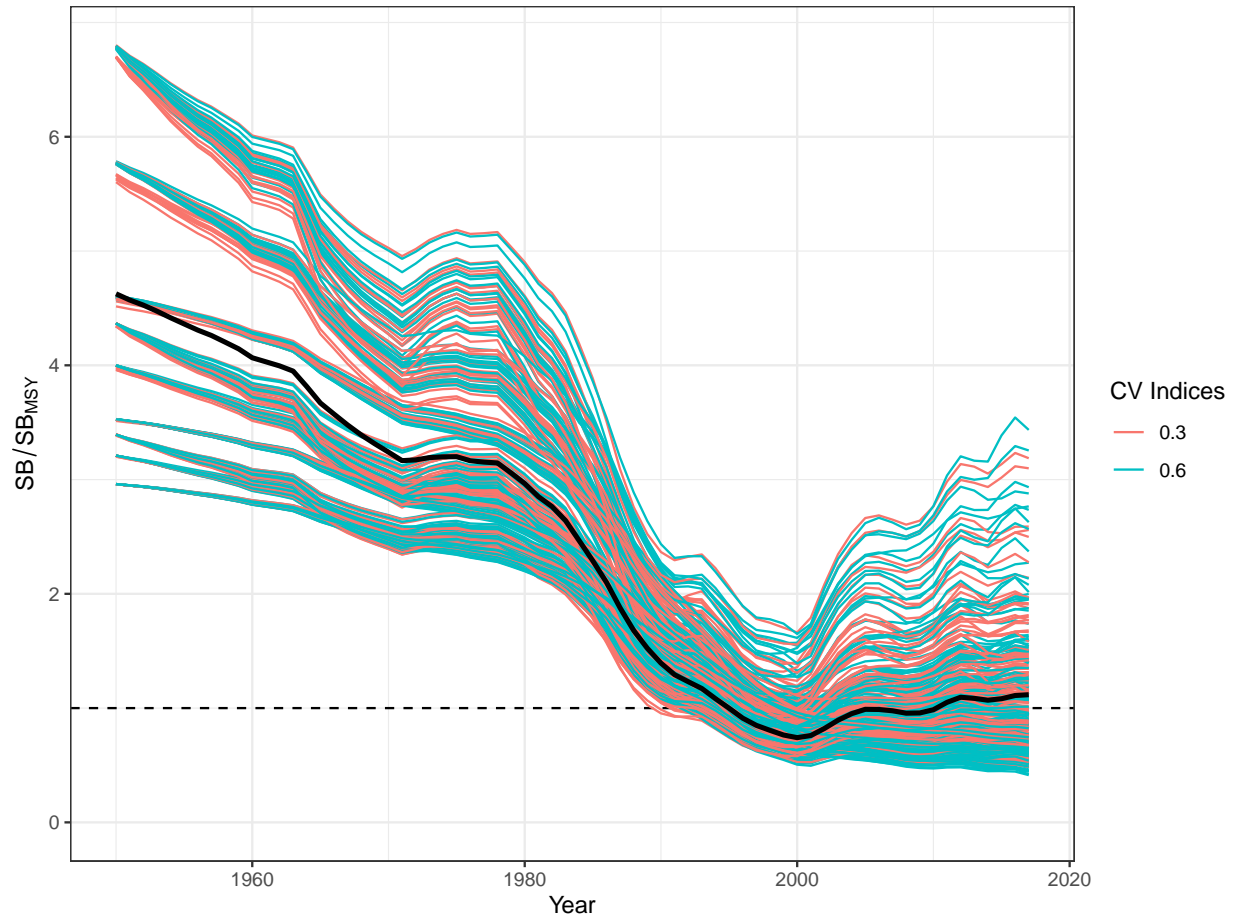


Figure 4. Predicted spawning biomass (SB) relative to spawning biomass at maximum sustainable yield ( $SB_{MSY}$ ) for the 288 OMs from the uncertainty grid with the 2 levels of CV Indices shown as coloured lines. The base case OM is shown as the thick black line.

## Length Comp. ESS

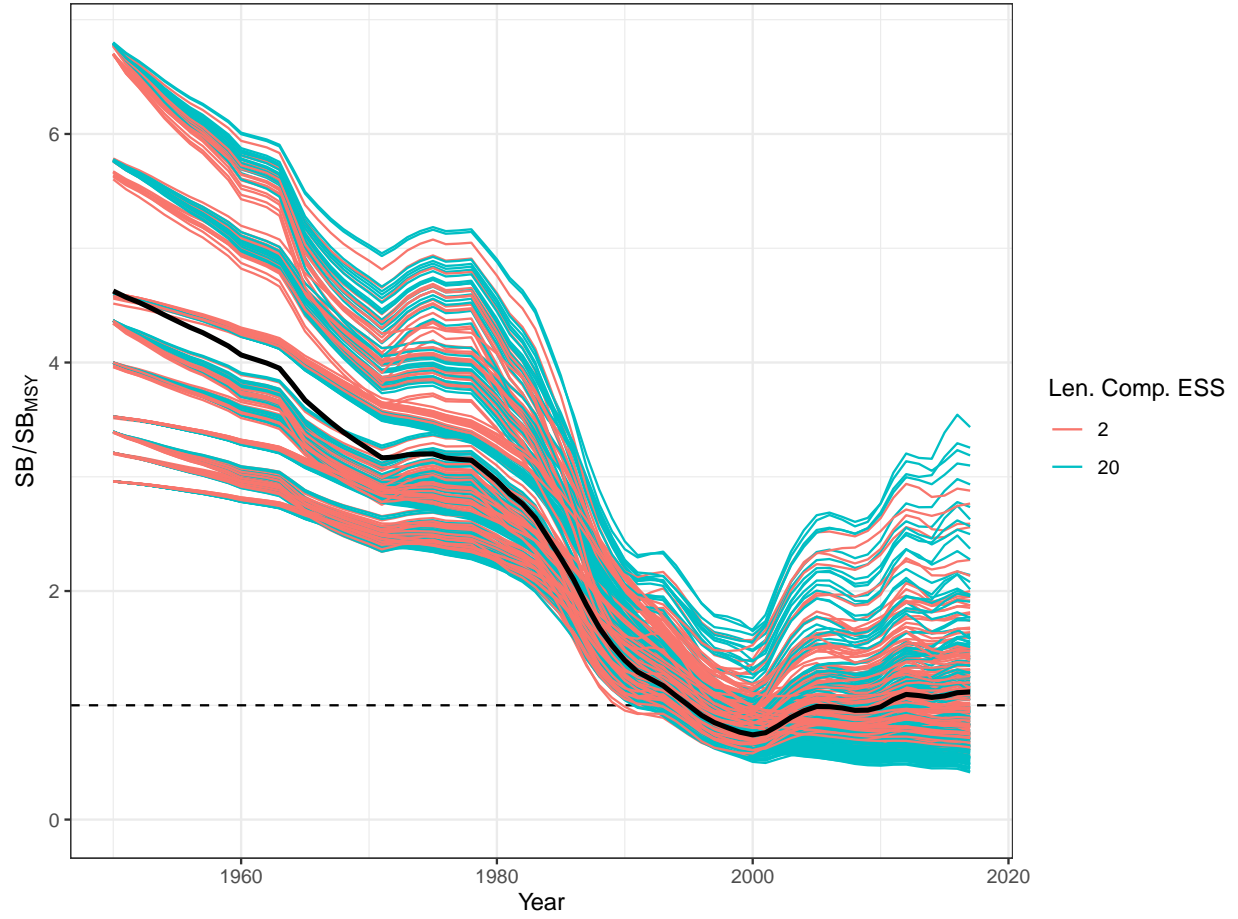


Figure 5. Predicted spawning biomass (SB) relative to spawning biomass at maximum sustainable yield ( $SB_{MSY}$ ) for the 288 OMs from the uncertainty grid with the 2 levels of Len. Comp. ESS shown as coloured lines. The base case OM is shown as the thick black line.

## Catchability Increase

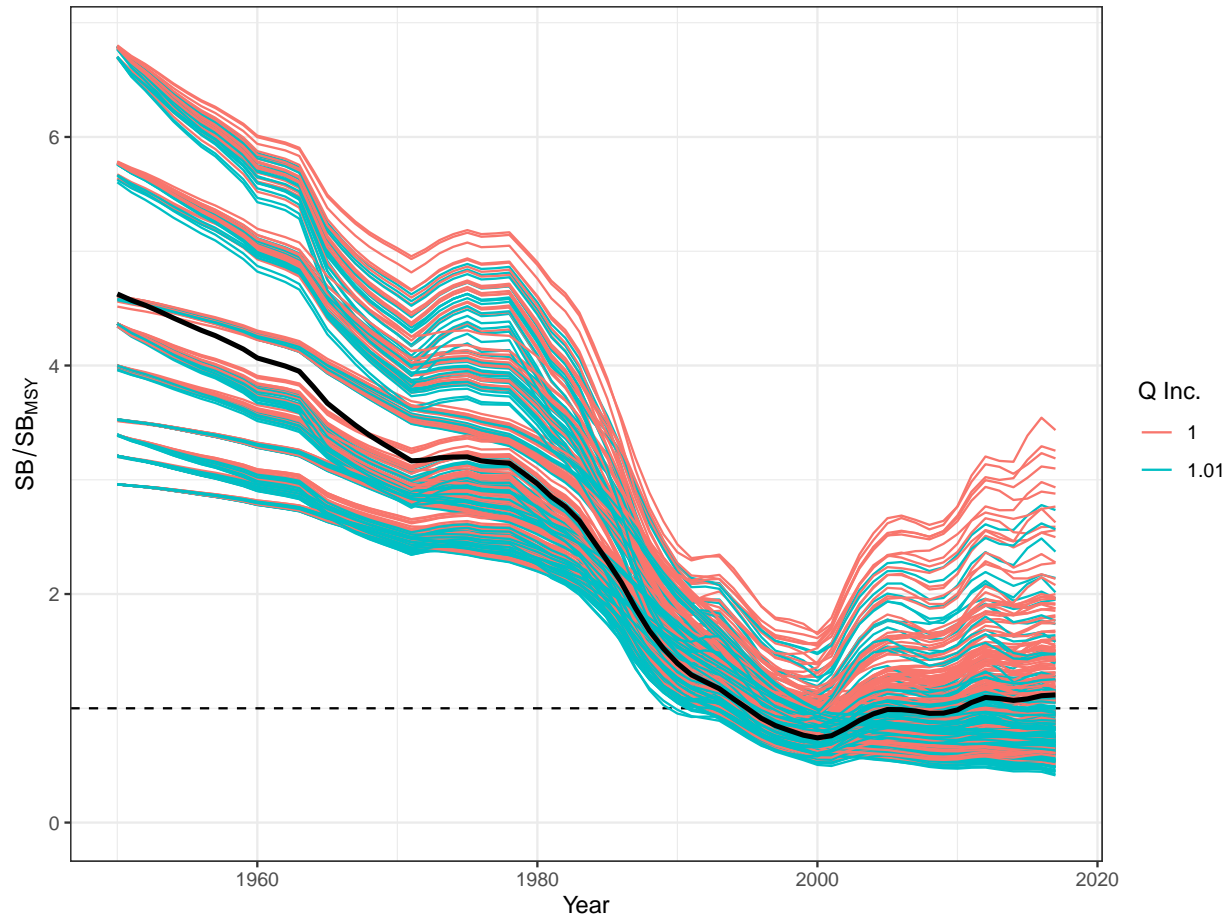


Figure 6. Predicted spawning biomass (SB) relative to spawning biomass at maximum sustainable yield ( $SB_{MSY}$ ) for the 288 OMs from the uncertainty grid with the 2 levels of Q Inc. shown as coloured lines. The base case OM is shown as the thick black line.

## Environmental Covariate

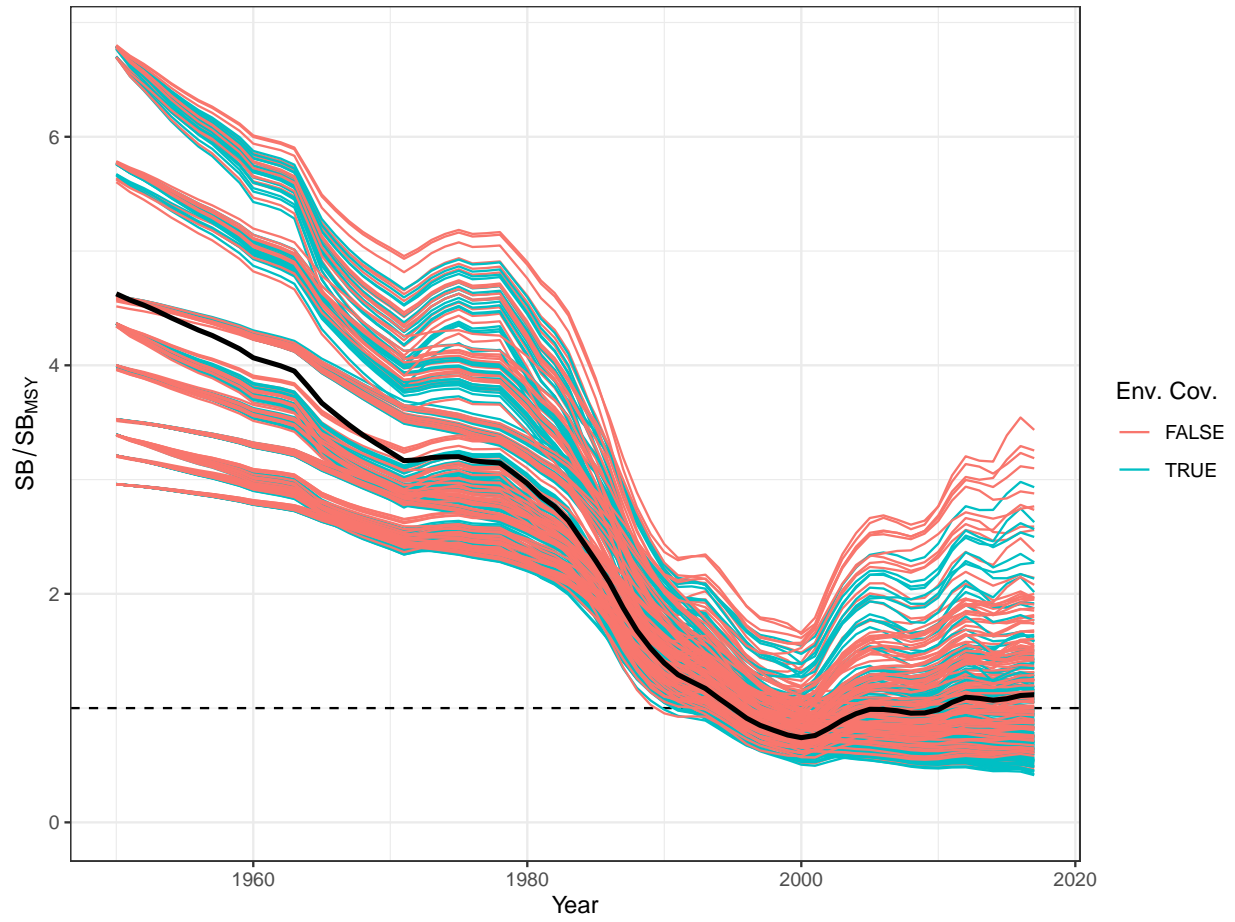


Figure 7. Predicted spawning biomass (SB) relative to spawning biomass at maximum sustainable yield ( $SB_{MSY}$ ) for the 288 OMs from the uncertainty grid with the 2 levels of Env. Cov. shown as coloured lines.

## Current $SB/SB_{MSY}$ Boxplots

Bivariate boxplots of the spawning biomass (SB) relative to spawning biomass corresponding with maximum sustainable yield ( $SB_{MSY}$ ) for the factors examined in the uncertainty grid.

## Natural Mortality

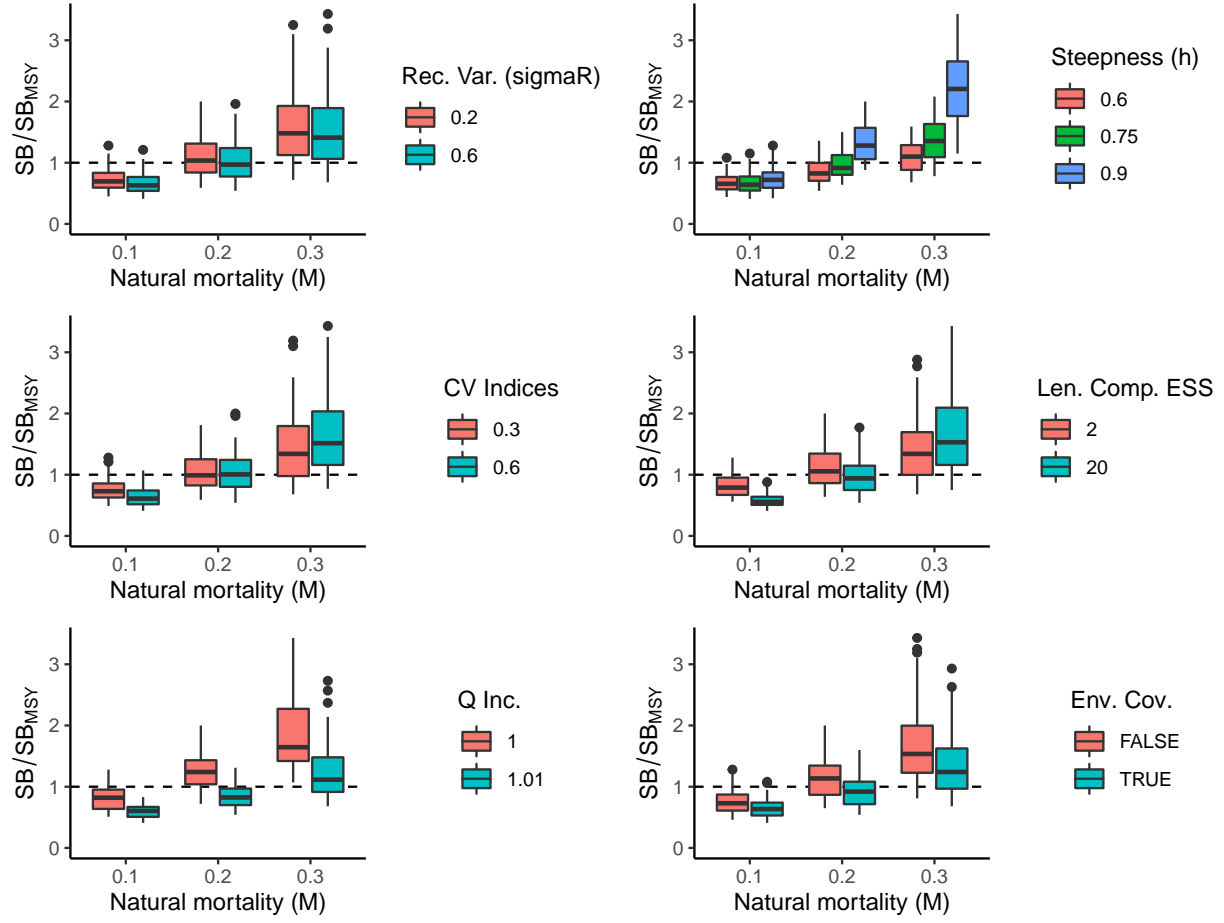


Figure 8. Boxplots of predicted spawning biomass (SB) relative to spawning biomass at maximum sustainable yield ( $SB_{MSY}$ ) for the 288 OMs from the uncertainty grid with the 3 levels of Natural Mortality shown as factors on the x-axis and colours indicating the other factors.

## Recruitment Variability

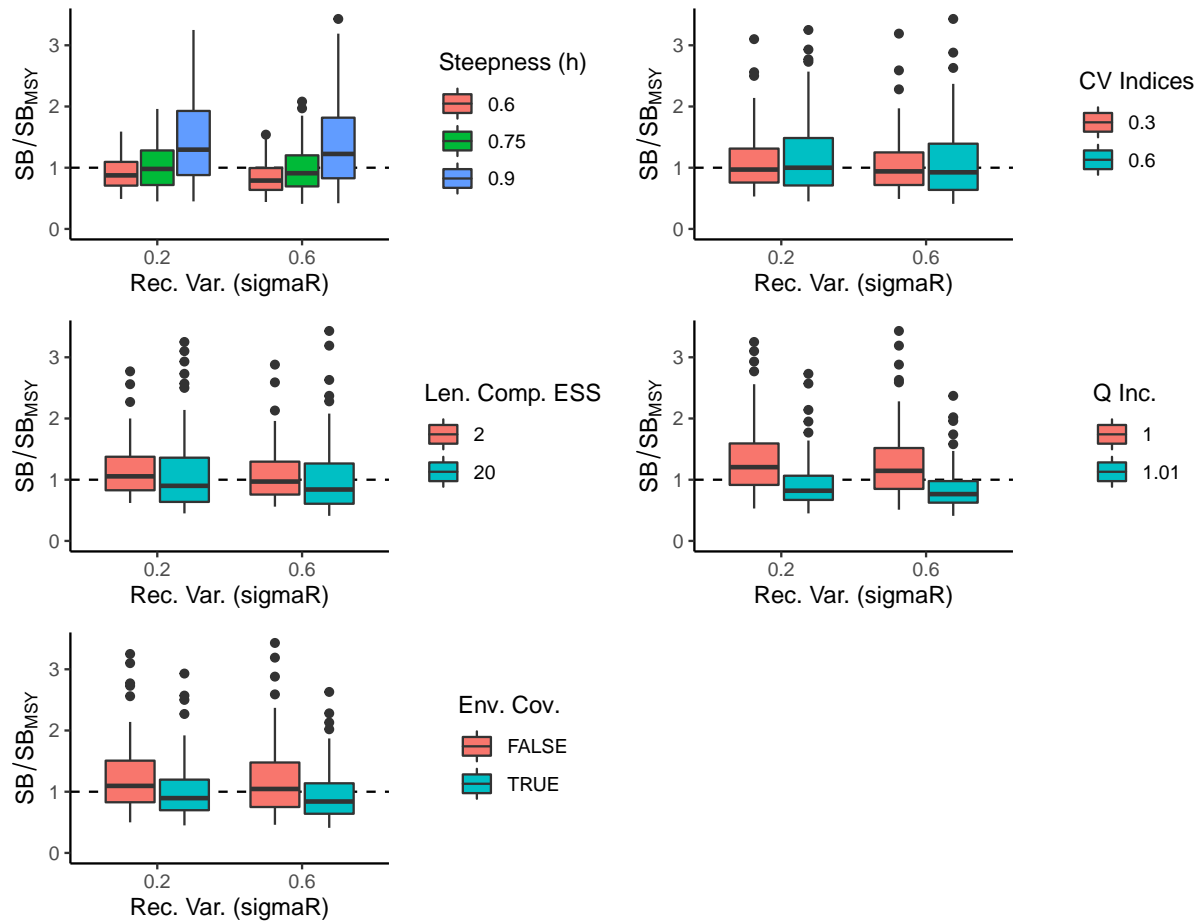


Figure 9. Boxplots of predicted spawning biomass (SB) relative to spawning biomass at maximum sustainable yield ( $SB_{MSY}$ ) for the 288 OMs from the uncertainty grid with the 2 levels of Recruitment Variability shown as factors on the x-axis and colours indicating the other factors.

## Steepness

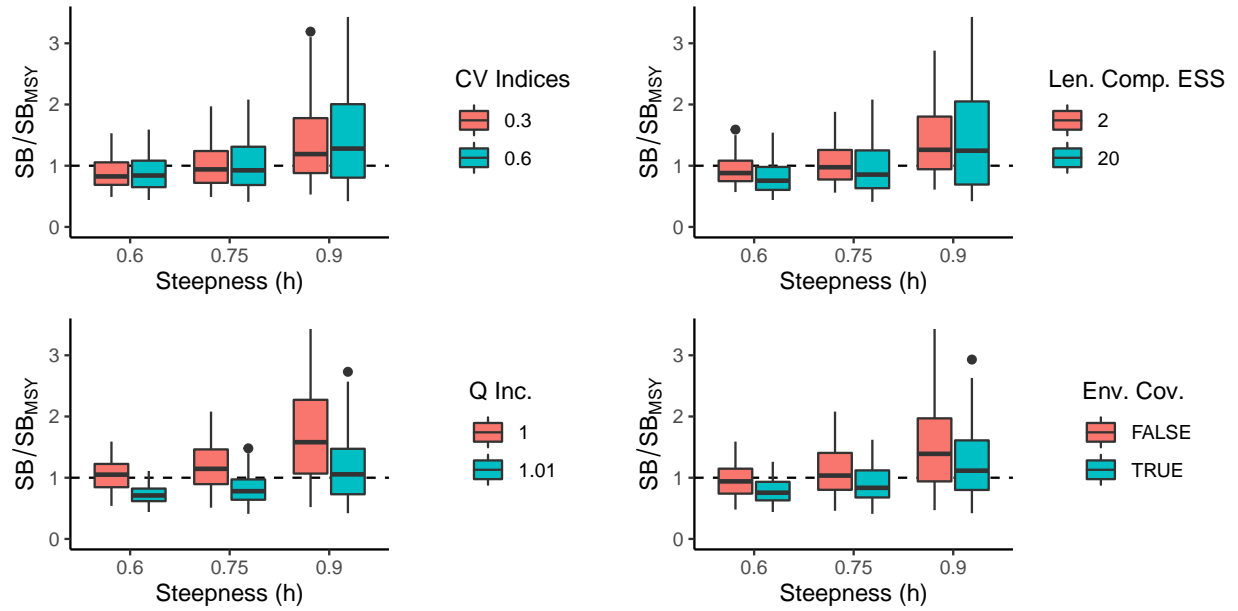


Figure 10. Boxplots of predicted spawning biomass (SB) relative to spawning biomass at maximum sustainable yield ( $SB_{MSY}$ ) for the 288 OMs from the uncertainty grid with the 3 levels of Steepness shown as factors on the x-axis and colours indicating the other factors.

## CPUE CV

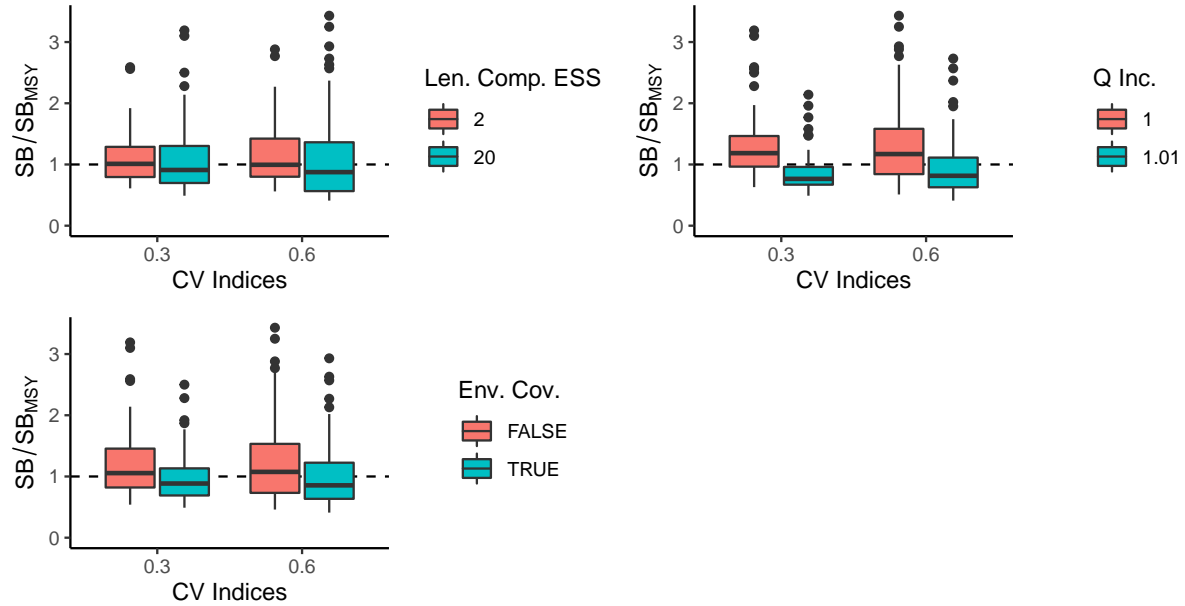


Figure 11. Boxplots of predicted spawning biomass (SB) relative to spawning biomass at maximum sustainable yield ( $SB_{MSY}$ ) for the 288 OMs from the uncertainty grid with the 2 levels of CV Indices shown as factors on the x-axis and colours indicating the other factors.

## Length Comp. ESS

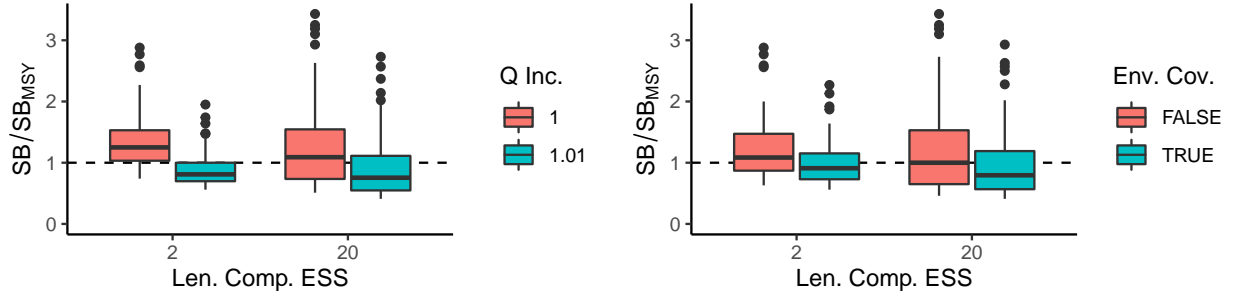


Figure 12. Boxplots of predicted spawning biomass (SB) relative to spawning biomass at maximum sustainable yield ( $SB_{MSY}$ ) for the 288 OMs from the uncertainty grid with the 2 levels of Length Composition Effective Sample Size shown as factors on the x-axis and colours indicating the other factors.

## Catchability Increase

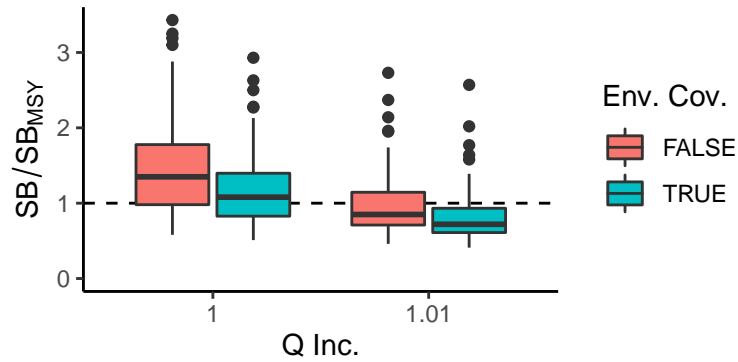


Figure 13. Boxplots of predicted spawning biomass (SB) relative to spawning biomass at maximum sustainable yield ( $SB_{MSY}$ ) for the 288 OMs from the uncertainty grid with the 2 levels of Q Increase shown as factors on the x-axis and colours indicating the other factors.