



## EVALUATION OF TWO-YEAR MODEL PROJECTIONS FOR BAY OF FUNDY AND SFA 29W SCALLOP FISHERIES

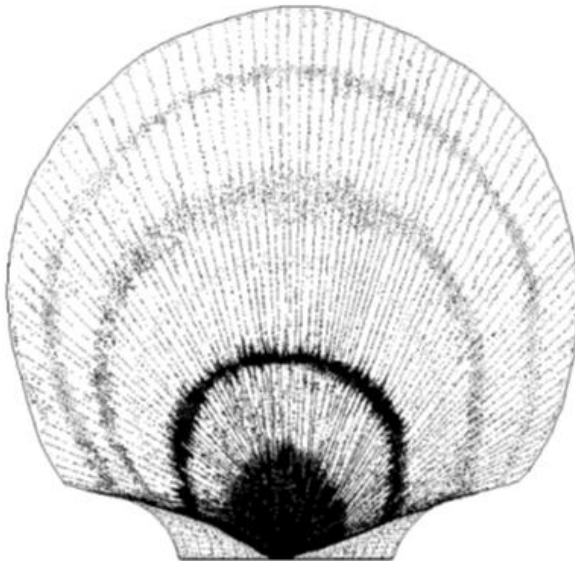


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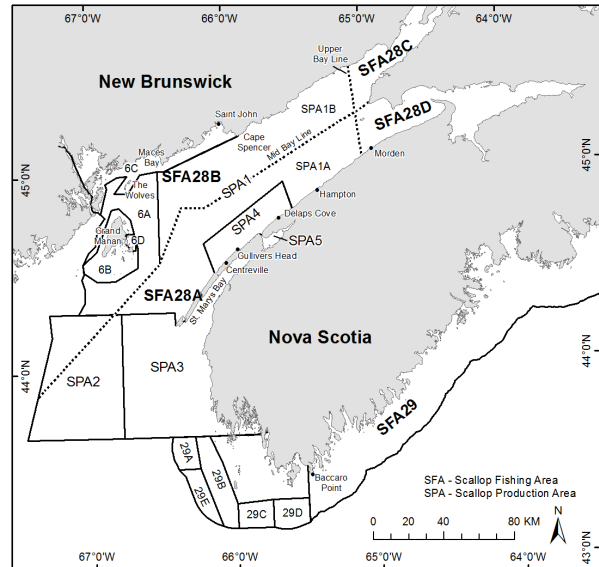


Figure 1. Scallop Production Areas (SPAs) in the Bay of Fundy and Scallop Fishing Area (SFA) 29 west of longitude 65°30'W.

### Context:

The quota management system for scallop fisheries in the Maritimes Region depends on the timely provision of current year science advice. The time frame between data acquisition from the Inshore Scallop surveys (June to October, year  $t$ ) and the provision of science advice required to set management targets (fall in year  $t$  for Bay of Fundy and winter in year  $t+1$  for SFA 29 West) means that catch advice is based on one-year projections. However, in 2020, the DFO Science Inshore Scallop surveys were cancelled. In the absence of survey data, two-year model projections were used to update the stock status for the Bay of Fundy and SFA 29 West Scallop fisheries for the 2020/21 fishing season.

The objectives of this meeting were to: (1) evaluate the productivity of the modelled stock areas and (2) evaluate the impact and uncertainty of two-year model projections on the science advice for the Bay of Fundy and SFA 29 West Scallop fisheries using established reference points, harvest strategies, and indicators.

This Science Advisory Report is from the March 31, 2021, regional peer review meeting on the Evaluation of Two-year Model Projections for Bay of Fundy and SFA 29W Scallop Fisheries. Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#) as they become available.

## SUMMARY

- The Bay of Fundy (BoF) Scallop Production Areas (SPAs) 1A, 1B, 3, 4, and 6, and Scallop Fishing Area 29 West (SFA 29W) are managed using total allowable catches (TAC).
- The annual assessments use modified versions of a state-space delay-difference population model fit to survey and commercial catch data.
- In 2020, the DFO Science Inshore Scallop surveys for the BoF and SFA 29W were cancelled. In the absence of survey data, two-year model projections are needed to inform the scallop fisheries in these areas for the 2020/21 season.
- The scallop stocks in the BoF and SFA 29W demonstrate substantial interannual variability in their productivity. There is limited temporal autocorrelation in model parameters and in surplus production beyond a 1-year lag for most areas. If used over the long-term as a basis for management decisions, harvest advice based on two-year projections could result in substantial risk of either loss in potential catch or overharvesting.
- Although the usefulness of 2-year projections is limited for long-term advice, for the BoF stocks (SPAs 1A, 1B, 3, 4, 6), they provide context for decision making in 2021 in the absence of 2020 survey data.
- For SFA 29W, two-year projections are not sufficiently reliable given challenges associated with projecting low biomasses and not recommended to inform the 2021 harvest levels for SFA 29W.
- For SPA 1A, for the two-year projection scenarios evaluated, the probability that the 2021 commercial biomass would be above the upper stock reference (USR) and in the healthy zone after removing 270 mt (the 2021 interim TAC) was between 0.78 and 0.87, the probability that the 2021 biomass would be above the LRP was between 0.97 and 0.98, and the expected exploitation ranged between 12% and 14%.
- For SPA 1B, for the two-year projection scenarios evaluated, the probability that the 2021 commercial biomass would be above the USR and in the healthy zone after removing 400 mt (the 2021 interim TAC) was between 0.67 to 0.80, the probability that the 2021 biomass would be above the LRP was between 0.96 to 0.98, and the expected exploitation ranged between 12% and 15%.
- For SPA 3, for the two-year projection scenarios evaluated, the probability that the 2021 commercial biomass would be above the USR and in the healthy zone after removing 200 mt (the 2021 interim TAC) was between 0.77 to 0.86, the probability that the 2021 biomass would be above the LRP was between 0.94 to 0.97, and the expected exploitation ranged between 9% and 11%.
- For SPA 4, for the two-year projection scenarios evaluated, the probability that the 2021 commercial biomass would be above the USR and in the healthy zone after removing 175 mt (the 2021 interim TAC) was between 0.61 to 0.70, the probability that the 2021 biomass would be above the LRP was between 0.78 to 0.84, and the expected exploitation ranged between 14% and 16%.
- For SPA 6, reference points are set in terms of the commercial catch rate and not the modelled biomass; therefore, an evaluation of stock status relative to the population model is not possible. For the two-year projection scenarios evaluated for 2021, assuming the total allowable catch of 210 mt is caught from the modeled area, the exploitation range is

expected to be between 20% and 24%, which corresponds to an expected range of biomass change between -28% and -11%.

## BACKGROUND

The Bay of Fundy (BoF) Scallop Production Areas (SPAs) 1A, 1B, 3, 4, and 6, and Scallop Fishing Area 29 West (SFA 29W) Subareas A, B, C, and D (Figure 1), comprise the majority of catches from the Inshore Scallop fishery in the Fisheries and Oceans Canada (DFO) Maritimes Region. Each stock area (i.e., the BoF SPAs, SFA 29W) is managed using total allowable catches (TACs) and have annual analytical assessments, which use modified versions of a state-space delay-difference population model (Nasmith et al. 2016, Smith and Sameoto 2016). The operational models for both the BoF SPAs and for the subareas in SFA 29W are used to estimate population biomass (and biomass density for SFA 29W), recruitment (to the fishery), exploitation rate, and provide advice on catch levels in the following year ( $t+1$ ). For SPAs 1A, 1B, 3, and 4, the model is also projected ahead two years ( $t+2$ ) under an assumption of zero surplus production to provide interim harvest advice and inform the setting of interim TACs for when the fishery starts in October prior to the final TACs being set (December). The use of two-year projections in the BoF to inform interim TACs was first implemented in 2005 as advice for setting the 2006/07 interim TAC for SPA 4 (Smith et al. 2005); however, to date, the model process error has not been propagated to the second-year forecasts.

Indices used in the population model come from annual DFO Science surveys and commercial catch data. DFO Science surveys occur annually in June through August for SPAs within the BoF and in September–October for SFA 29W. The timelines from data collection to advice for the BoF stocks is that survey data collected in summer (year  $t$ ) are processed, analyzed, and combined with fishing season data up to September 30 (year  $t$ ), within an analytical assessment presented through the Canadian Science Advisory Secretariat (CSAS) in late November of the same year ( $t$ ) to inform the setting of final TACs in December. For SFA 29W, survey (September–October) and fishery data (summer) (year  $t$ ) are presented through a formal CSAS process in March ( $t+1$ ) to inform the setting of the TAC for the fishing season in summer ( $t+1$ ). Final TACs are typically informed by one-year projections from the models; thus, data up to year  $t$  are used by the model to forecast commercial biomass for fishing season  $t+1$ . The present time frame between data acquisition from the Inshore Scallop surveys (June to October year  $t$ ) and operational science advice to set management targets (fall in year  $t$  for Bay of Fundy and Winter in year  $t+1$  for SFA 29 West) means that catch advice is based on one-year projections. However, in 2020, the DFO Science Inshore Scallop surveys were cancelled. In the absence of survey data, two-year model projections were used to update the stock status for the Bay of Fundy and SFA 29 West Scallop fisheries for 2020/21.

## ASSESSMENT

The productivity of the SPAs in the BoF and subareas of SFA 29W were evaluated using two approaches: an evaluation of the long-term surplus production rates and the use of zero-change results in the biomass analyses. For the BoF SPAs, the median surplus production rates were 0.22, 0.20, 0.19, 0.14, and 0.21, for SPA 1A, 1B, 3, 4, and 6, respectively (Figure 2). The predicted exploitations corresponding to zero change in biomass over the time series were 0.16, 0.13, 0.20, 0.22, and 0.18, for SPA 1A, 1B, 3, 4, and 6, respectively (Figure 3). For SFA 29W, the median surplus production rates were 0.07, 0.17, 0.02, and 0.15, for Subareas A, B, C, and D, respectively (Figure 4). The predicted exploitations corresponding to zero change in biomass

over the time series were 0.05, 0.17, 0.17, and 0.21, for Subareas A, B, C, and D, respectively (Figure 5).

An analysis of productivity parameters based on the stock assessment model and three surplus production scenarios was conducted and used to inform the two-year projections. The selection of the three surplus production scenarios was based on an evaluation of productivity parameters (e.g., commercial biomass, recruit biomass, natural mortality, growth, and surplus production). The two-year projections were evaluated relative to one-year projections. One-year projections assume natural mortality is the average of the last five years (e.g.,  $m_{2020} = \bar{m}_{2015:2019}$ ) and use the growth of commercial ( $g$ ) and recruit ( $g_r$ ; BoF only) size scallop calculated from the most recent survey. To derive two-year model projections, the one-year projections of the commercial biomass posteriors (where catch was set to the realized catch for each respective year) were projected forward under 3 scenarios: 1) zero surplus production, 2) median surplus production (for the respective stock), and 3) assuming the same recruitment, mortality, growth, and process error as the one-year projection (i.e., same conditions as the one-year projection), hereafter referred to as the ‘status quo’ assumption. The performance of the two-year model projections was evaluated relative to the one-year model projections for 2012–2019 and the stock status in 2020/21 was evaluated using the two-year projections.

The scallop stocks in the BoF and SFA 29W demonstrate substantial interannual variability in their productivity and there is limited temporal autocorrelation in model parameters and in surplus production beyond a 1-year lag for most areas. Relative to the use of one-year projections, use of two-year projections as the basis for management decisions over the long term would result in substantial risk of either loss in potential catch or overharvesting. However, in the context of tactical one-year decision making and in the absence of 2020 survey data, these two-year projections provide context for decision making for the 2021 harvest levels for the BoF stocks. For SFA 29W, the two-year projections are not sufficiently reliable given challenges associated with projecting low biomasses, which is described in the SFA 29 West section of this document. Therefore, these projections are not recommended to be used for the 2021 harvest levels for SFA 29W.

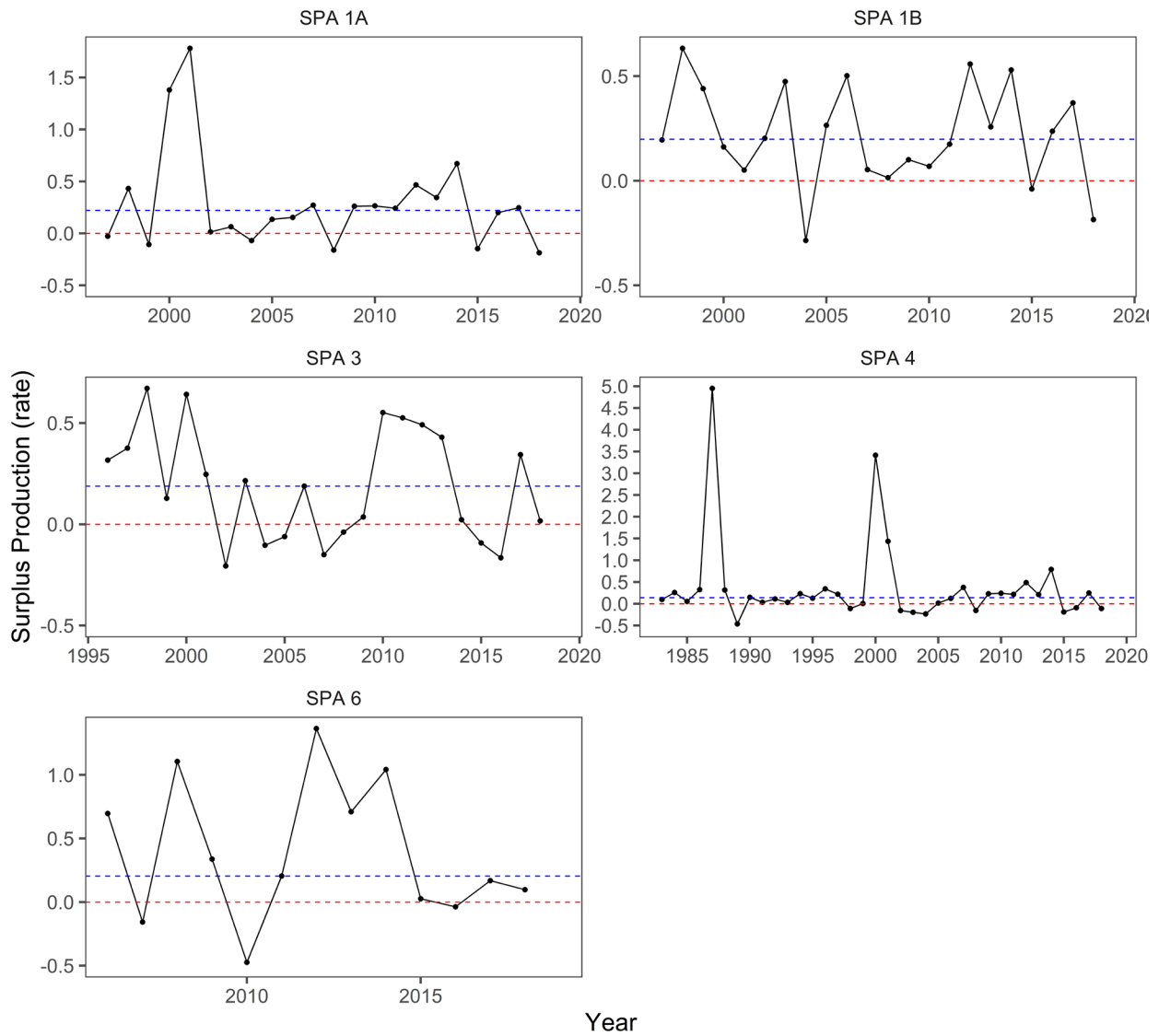


Figure 2. Time series of surplus production rate of commercial biomass for SPAs 1A, 1B, 3, 4, and 6. The blue dashed lines represent the long-term medians (0.22, 0.20, 0.19, 0.14, and 0.21 for SPAs 1A, 1B, 3, 4, and 6, respectively) and the red dashed lines represent zero surplus production.

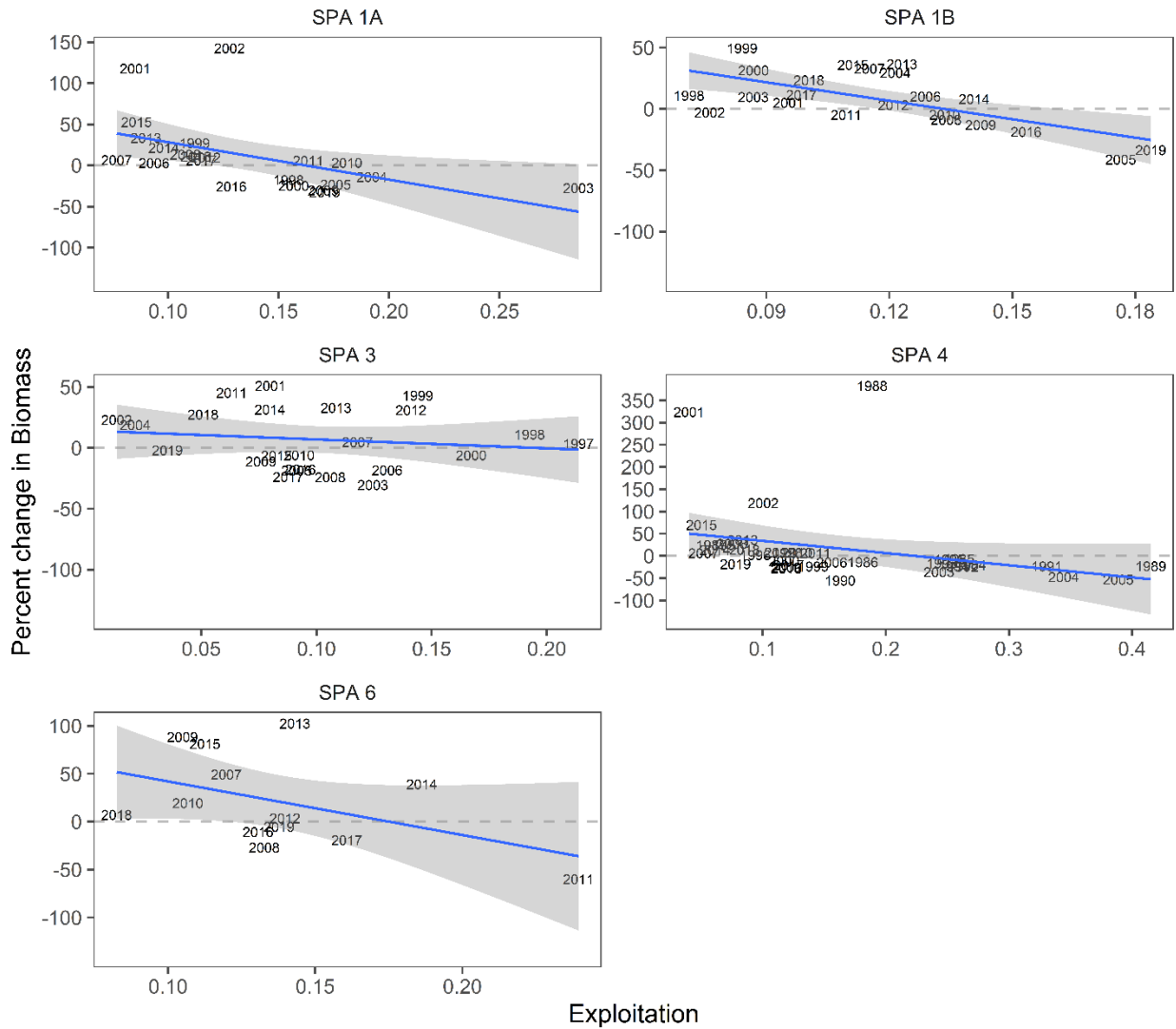


Figure 3. Change in commercial biomass with exploitation for SPAs 1A, 1B, 3, 4, and 6. Labels of year  $t$  represent change from year  $t-1$  to  $t$ . For each SPA (panel), the exploitation rate at zero biomass change (0.16, 0.13, 0.20, 0.22, and 0.18, for SPAs 1A, 1B, 3, 4, and 6, respectively) is based on a linear model (blue line) with a 95% confidence interval (gray ribbon).

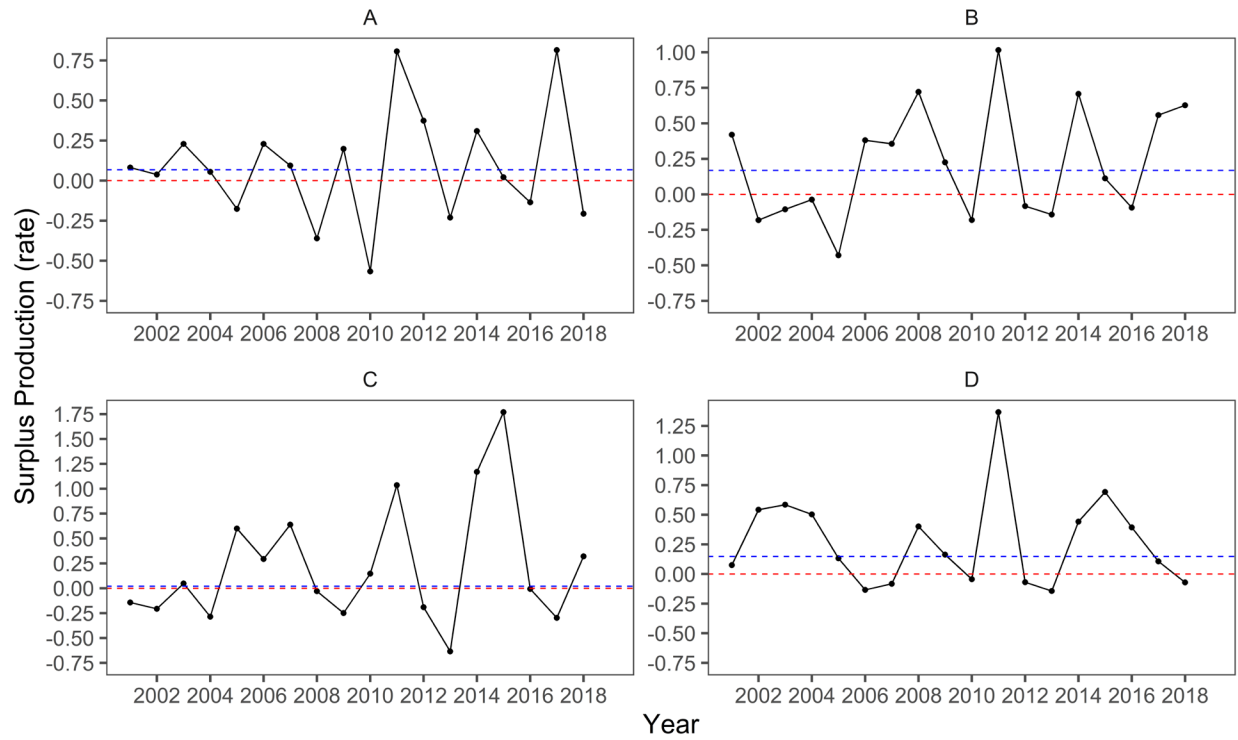


Figure 4. Time series of surplus production rate of commercial biomass for SFA 29W Subareas A, B, C, and D. The blue dashed lines represent the long-term medians (0.07, 0.17, 0.02, and 0.15, for subareas A, B, C, and D, respectively) and the red dashed lines represent zero surplus production.

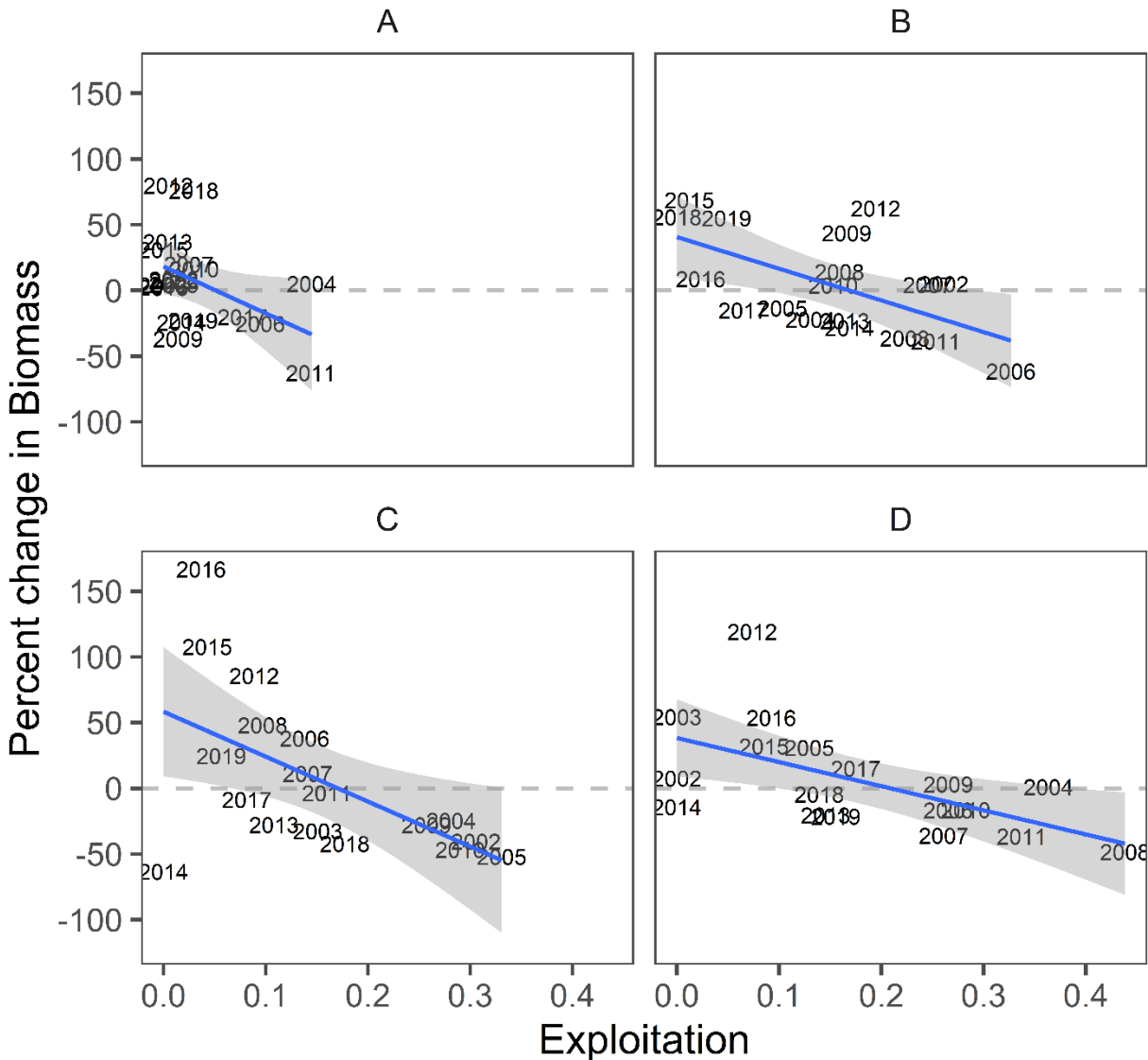


Figure 5. Change in commercial biomass with exploitation for SFA 29W Subareas A, B, C, and D. Labels of year  $t$  represent change from year  $t-1$  to  $t$ . For each Subarea (panel), the exploitation rate at zero biomass change (0.05, 0.17, 0.17, and 0.21, for subareas A, B, C, and D, respectively) is based on a linear model (blue line) with a 95% confidence interval (gray ribbon).

**Scallop Production Area 1A**

For all three two-year projection scenarios in SPA 1, the probability that the 2021 commercial biomass would be above the USR and in the healthy zone after removing 270 mt (the 2021 interim TAC) was between 0.78 and 0.87, the probability that the 2021 biomass would be above the LRP was between 0.97 and 0.98, and the expected exploitation ranged between 12 and 14% (Figure 6, Tables 1–3).

One- and two-year projections of biomass for the same year varied substantially across all three two-year projection scenarios for the evaluated period of 2012–2019. The relative difference in median biomass of the one- and two-year projections ranged from –50% to 11% (–1,530 mt to



215 mt), -39% to 33% (-1,200 mt to 626 mt), and -47% to 13% (-1,450 mt to 376 mt) for the zero surplus production, median surplus production, and status quo scenarios, respectively.

The simulated impact of two-year projections on harvest advice was evaluated as the relative difference in potential catch between one- and two-year projections for a fixed exploitation rate of 0.15. The relative difference in catch of the one- and two-year projections ranged from -44% to 7.2% (-220 mt to 25 mt), -33% to 26 (-170 mt to 90 mt), -42% to 12% (-210 mt to 58 mt), for the zero surplus production, median surplus production, and status quo scenarios, respectively.

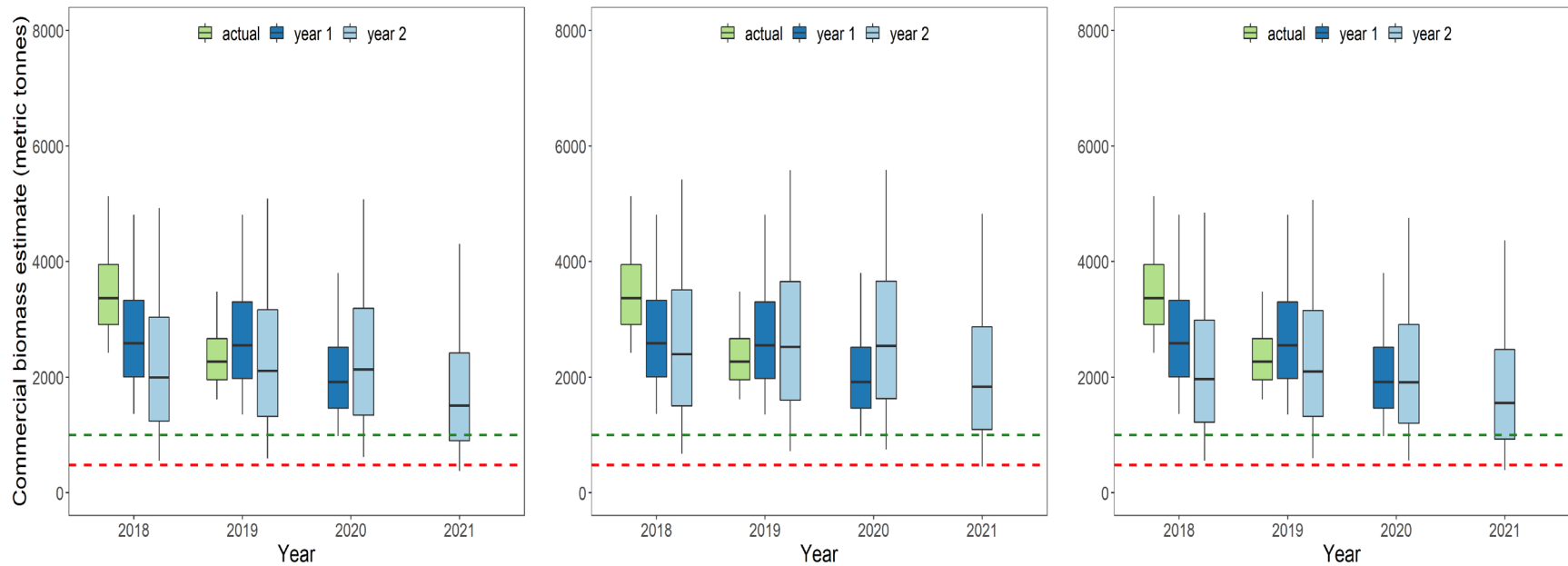


Figure 6. Evaluation of the model projection performance from 2018 to 2021 for SPA 1A relative to the upper stock reference (USR; green dashed line) and limit reference point (LRP; red dashed line). Green box and whisker plots summarize the posterior distribution of the commercial biomass in year  $t$  using data up to and including year  $t$  (e.g., 2018 predictions based on data up to and including 2018). The dark blue box and whisker plots summarize posterior distributions of commercial biomass in year  $t$  based on model fit to year  $t-1$  (e.g., 2018 predictions based on data up to and including 2017). The light blue box and whisker plots summarize posterior distributions of commercial biomass in year  $t$  based on model fit to year  $t-2$  (e.g., 2018 predictions based on data up to and including 2016). The box plots show median (horizontal line), 50% credible limits (box), and 90% credible limits (whiskers). The projections for 2020 assumes landings of 415 mt is caught, and for 2021 the total allowable catch of 270 mt is caught. Prediction evaluations are presented for three two-year projection scenarios; zero surplus production (left panel), median surplus production (middle panel), and the status quo assumption (i.e., same conditions as the one-year projections in year  $t-1$ ; right panel).

Table 1. Catch scenarios for SPA 1A to evaluate 2020/21 catch levels in terms of resulting exploitation (e), expected changes in commercial biomass (%), probability (Pr) of commercial biomass increase, probability that after removal the stock will be above the upper stock reference (USR), and above the limit reference point (LRP). These probabilities account for uncertainty in the biomass forecasts and are presented assuming zero surplus production from 2020 to 2021.

Catch (mt)	e	Pr Increase	% Change	Pr > LRP	Pr > USR
0	0.00	0.46	-2.4	0.98	0.84
20	0.01	0.45	-3.4	0.98	0.84
40	0.02	0.43	-4.4	0.98	0.84
60	0.03	0.42	-5.3	0.98	0.83
80	0.04	0.40	-6.3	0.98	0.83
100	0.05	0.39	-7.3	0.97	0.82
110	0.06	0.37	-8.3	0.97	0.82
130	0.07	0.36	-9.2	0.97	0.82
150	0.08	0.34	-10.2	0.97	0.81
170	0.09	0.32	-11.2	0.97	0.81
190	0.10	0.31	-12.2	0.97	0.80
210	0.11	0.29	-13.1	0.97	0.80
230	0.12	0.28	-14.1	0.97	0.79
250	0.13	0.26	-15.1	0.97	0.79
270	0.14	0.25	-16.1	0.97	0.78
290	0.15	0.23	-17.0	0.96	0.78
310	0.16	0.22	-18.0	0.96	0.77
330	0.17	0.20	-19.0	0.96	0.77
340	0.18	0.19	-20.0	0.96	0.76
360	0.19	0.18	-21.0	0.96	0.76
380	0.20	0.16	-21.9	0.96	0.75

Table 2. Catch scenarios for SPA 1A to evaluate 2020/21 catch levels in terms of resulting exploitation (e), expected changes in commercial biomass (%), probability (Pr) of commercial biomass increase, probability that after removal the stock will be above the upper stock reference (USR), and above the limit reference point (LRP). These probabilities account for uncertainty in the biomass forecasts and are presented assuming median surplus production from 2020 to 2021.

Catch (mt)	e	Pr Increase	% Change	Pr > LRP	Pr > USR
0	0.00	0.72	16.8	0.99	0.90
20	0.01	0.71	15.7	0.99	0.90
50	0.02	0.69	14.5	0.99	0.90
70	0.03	0.68	13.3	0.99	0.90
90	0.04	0.67	12.2	0.99	0.89
120	0.05	0.65	11.0	0.98	0.89
140	0.06	0.64	9.8	0.98	0.89
160	0.07	0.62	8.7	0.98	0.88
180	0.08	0.61	7.5	0.98	0.88
210	0.09	0.59	6.3	0.98	0.88
230	0.10	0.58	5.2	0.98	0.87
250	0.11	0.56	4.0	0.98	0.87
280	0.12	0.54	2.8	0.98	0.87
300	0.13	0.52	1.7	0.98	0.86
320	0.14	0.51	0.5	0.98	0.86
350	0.15	0.49	-0.7	0.98	0.86
370	0.16	0.47	-1.9	0.98	0.85
390	0.17	0.45	-3.0	0.98	0.85
420	0.18	0.43	-4.2	0.98	0.84
440	0.19	0.41	-5.4	0.98	0.84
460	0.20	0.39	-6.5	0.98	0.83

Table 3. Catch scenarios for SPA 1A to evaluate 2020/21 catch levels in terms of resulting exploitation (e), expected changes in commercial biomass (%), probability (Pr) of commercial biomass increase, probability that after removal the stock will be above the upper stock reference (USR), and above the limit reference point (LRP). These probabilities account for uncertainty in the biomass forecasts and are presented assuming the status quo assumption (same recruitment, mortality, and growth as for the 2020 projection).

Catch (mt)	e	Pr Increase	% Change	Pr > LRP	Pr > USR
0	0.00	0.50	0.2	0.98	0.85
20	0.01	0.49	-0.8	0.98	0.85
40	0.02	0.47	-1.8	0.98	0.85
60	0.03	0.46	-2.8	0.98	0.84
80	0.04	0.44	-3.8	0.98	0.84
100	0.05	0.43	-4.8	0.98	0.84
120	0.06	0.41	-5.8	0.98	0.83
140	0.07	0.39	-6.8	0.98	0.83
160	0.08	0.38	-7.8	0.97	0.82
180	0.09	0.36	-8.8	0.97	0.82
200	0.10	0.35	-9.8	0.97	0.81
220	0.11	0.33	-10.8	0.97	0.81
240	0.12	0.31	-11.8	0.97	0.81
260	0.13	0.30	-12.8	0.97	0.80
280	0.14	0.28	-13.8	0.97	0.80
300	0.15	0.27	-14.8	0.97	0.79
310	0.16	0.25	-15.8	0.97	0.79
330	0.17	0.23	-16.8	0.96	0.78
350	0.18	0.22	-17.8	0.96	0.78
370	0.19	0.20	-18.8	0.96	0.77
390	0.20	0.19	-19.8	0.96	0.76

### Scallop Production Area 1B

For SPA 1B, for all three two-year projection scenarios, the probability that the 2021 commercial biomass would be above the USR and in the healthy zone after removing 400 mt (the 2021 interim TAC) was between 0.67 to 0.80, the probability that the 2021 biomass would be above the LRP was between 0.96 to 0.98, and the expected exploitation ranged between 12 and 15% (Figure 7, Tables 4–6).

One- and two-year projections of biomass for the same year varied substantially across all three two-year projection scenarios for the evaluated period of 2012–2019. The relative difference in median biomass of the one- and two-year projections ranged from -50% to 18% (-2,080 mt to 477 mt), -40% to 40% (-1,670 mt to 1,080 mt), and -47% to 34% (-1,940 mt to 1,260 mt), for the zero surplus production, median surplus production, and status quo scenarios, respectively.

The simulated impact of two-year projections on harvest advice was evaluated as the relative difference in potential catch between one- and two-year projections for a fixed exploitation rate of 0.15. The relative difference in catch of the one- and two-year projections ranged from -45% to 15% (-326 mt to 72 mt), -35% to 36% (-249 mt to 176 mt), -44% to 31% (-314 mt to 195 mt), for the zero surplus production, median surplus production, and status quo scenarios, respectively.

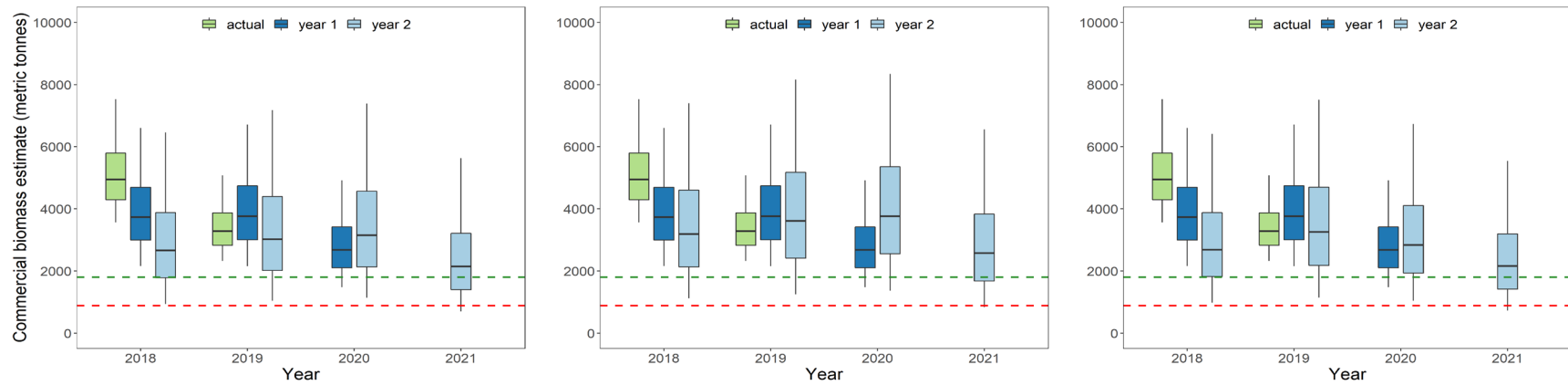


Figure 7. Evaluation of the model projection performance from 2018 to 2021 for SPA 1B relative to the upper stock reference (USR; green dashed line) and limit reference point (LRP; red dashed line). The green box and whisker plots summarize the posterior distribution of the commercial biomass in year  $t$  using data up to and including year  $t$  (e.g., 2018 predictions based on data up to and including 2018). The dark blue box and whisker plots summarize posterior distributions of commercial biomass in year  $t$  based on model fit to year  $t-1$  (e.g., 2018 predictions based on data up to and including 2017). The light blue box and whisker plots summarize posterior distributions of commercial biomass in year  $t$  based on model fit to year  $t-2$  (e.g., 2018 predictions based on data up to and including 2016). The box plots show median (horizontal line), 50% credible limits (box), and 90% credible limits (whiskers). The projections for 2020 assumes landings of 545 mt, and the total allowable catch of 400 mt is caught in 2021. Prediction evaluations are presented for three two-year projection scenarios; zero surplus production (left panel), median surplus production (middle panel), and the status quo assumption (i.e., same conditions as the one-year projections in year  $t-1$ ; right panel).

Table 4. Catch scenarios for SPA 1B to evaluate 2020/21 catch levels in terms of resulting exploitation (e), expected changes in commercial biomass (%), probability (Pr) of commercial biomass increase, probability that after removal the stock will be above the upper stock reference (USR), and above the limit reference point (LRP). These probabilities account for uncertainty in the biomass forecasts and are presented assuming zero surplus production from 2020 to 2021.

Catch (mt)	e	Pr Increase	% Change	Pr > LRP	Pr > USR
0	0.00	0.49	-0.4	0.98	0.77
30	0.01	0.47	-1.4	0.98	0.77
50	0.02	0.46	-2.4	0.98	0.76
80	0.03	0.44	-3.4	0.97	0.76
110	0.04	0.42	-4.4	0.97	0.75
130	0.05	0.40	-5.4	0.97	0.75
160	0.06	0.38	-6.4	0.97	0.74
190	0.07	0.36	-7.4	0.97	0.73
220	0.08	0.34	-8.4	0.97	0.73
240	0.09	0.32	-9.4	0.97	0.72
270	0.10	0.30	-10.4	0.97	0.71
300	0.11	0.29	-11.4	0.96	0.71
320	0.12	0.27	-12.4	0.96	0.70
350	0.13	0.25	-13.4	0.96	0.69
380	0.14	0.23	-14.3	0.96	0.68
400	0.15	0.22	-15.3	0.96	0.68
430	0.16	0.20	-16.3	0.96	0.67
460	0.17	0.19	-17.3	0.96	0.66
490	0.18	0.17	-18.3	0.95	0.65
510	0.19	0.16	-19.3	0.95	0.64
540	0.20	0.15	-20.3	0.95	0.63

Table 5. Catch scenarios for SPA 1B to evaluate 2020/21 catch levels in terms of resulting exploitation (e), expected changes in commercial biomass (%), probability (Pr) of commercial biomass increase, probability that after removal the stock will be above the upper stock reference (USR), and above the limit reference point (LRP). These probabilities account for uncertainty in the biomass forecasts and are presented assuming median surplus production from 2020 to 2021.

Catch (mt)	e	Pr Increase	% Change	Pr > LRP	Pr > USR
0	0.00	0.78	18.8	0.99	0.86
30	0.01	0.77	17.6	0.99	0.86
60	0.02	0.76	16.4	0.99	0.85
100	0.03	0.74	15.2	0.99	0.85
130	0.04	0.73	14.1	0.99	0.84
160	0.05	0.71	12.9	0.99	0.84
190	0.06	0.70	11.7	0.98	0.83
230	0.07	0.68	10.5	0.98	0.83
260	0.08	0.66	9.3	0.98	0.82
290	0.09	0.64	8.1	0.98	0.82
320	0.10	0.62	6.9	0.98	0.81
360	0.11	0.60	5.7	0.98	0.81
390	0.12	0.58	4.6	0.98	0.80
420	0.13	0.56	3.4	0.98	0.80
450	0.14	0.54	2.2	0.98	0.79
480	0.15	0.52	1.0	0.98	0.78
520	0.16	0.50	-0.2	0.98	0.78
550	0.17	0.47	-1.4	0.98	0.77
580	0.18	0.45	-2.6	0.98	0.76
610	0.19	0.43	-3.8	0.97	0.76
650	0.20	0.41	-5.0	0.97	0.75



Table 6. Catch scenarios for SPA 1B to evaluate 2020/21 catch levels in terms of resulting exploitation (e), expected changes in commercial biomass (%), probability (Pr) of commercial biomass increase, probability that after removal the stock will be above the upper stock reference (USR), and above the Limit Reference Point (LRP). These probabilities account for uncertainty in the biomass forecasts and are presented assuming the status quo assumption (same recruitment, mortality, and growth as for the 2020 projection).

Catch (mt)	e	Pr Increase	% Change	Pr > LRP	Pr > USR
0	0.00	0.49	-0.8	0.98	0.78
30	0.01	0.47	-1.8	0.98	0.77
50	0.02	0.45	-2.8	0.98	0.76
80	0.03	0.43	-3.8	0.98	0.76
110	0.04	0.41	-4.7	0.97	0.75
130	0.05	0.39	-5.7	0.97	0.75
160	0.06	0.37	-6.7	0.97	0.74
190	0.07	0.35	-7.7	0.97	0.73
210	0.08	0.33	-8.7	0.97	0.73
240	0.09	0.31	-9.7	0.97	0.72
270	0.10	0.29	-10.7	0.97	0.71
300	0.11	0.27	-11.7	0.97	0.70
320	0.12	0.26	-12.7	0.96	0.70
350	0.13	0.24	-13.7	0.96	0.69
380	0.14	0.22	-14.7	0.96	0.68
400	0.15	0.21	-15.7	0.96	0.67
430	0.16	0.19	-16.7	0.96	0.67
460	0.17	0.18	-17.6	0.96	0.66
480	0.18	0.16	-18.6	0.95	0.65
510	0.19	0.15	-19.6	0.95	0.64
540	0.20	0.14	-20.6	0.95	0.63

### Scallop Production Area 3

For SPA 3, for all three two-year projection scenarios, the probability that the 2021 commercial biomass would be above the USR and in the healthy zone after removing 200 mt (the 2021 interim TAC) was between 0.77 to 0.86, the probability that the 2021 biomass would be above the LRP was between 0.94 to 0.97, and the expected exploitation ranged between 9 and 11% (Figure 8, Tables 7–9).

One- and two-year projections of biomass for the same year varied substantially across all three two-year projection scenarios for the evaluated period of 2012–2019. The relative difference in median biomass of the one- and two-year projections ranged from -45% to 35% (-1,190 mt to 636 mt), -35% to 59% (-875 mt to 1,010 mt), and -41% to 48% (-1,110 mt to 976 mt), for the zero-surplus production, median surplus production, and status quo scenarios, respectively.

The simulated impact of two-year projections on harvest advice was evaluated as the relative difference in potential catch between one- and two-year projections for a fixed exploitation rate of 0.15. The relative difference in catch of the one- and two-year projections ranged from -39% to 33% (-177 mt to 94 mt), -28% to 56% (-126 mt to 151 mt), -40% to 43% (-165 mt to 145 mt), for the zero-surplus production, median surplus production, and status quo scenarios, respectively.

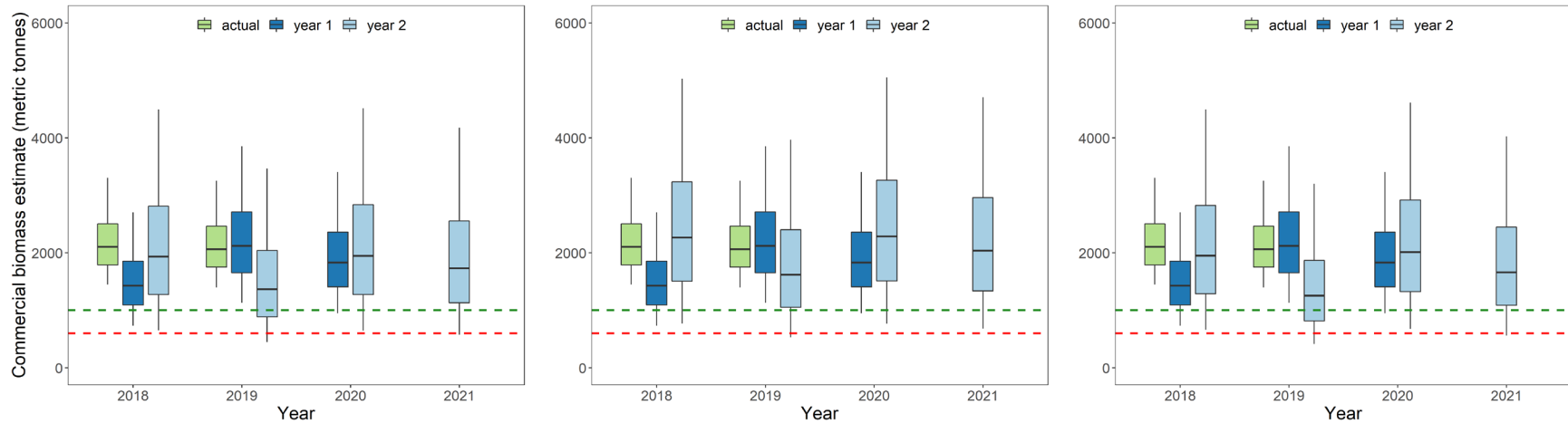


Figure 8. Evaluation of the model projection performance from 2018 to 2021 for SPA 3 relative to the upper stock reference (USR; green dashed line) and Limit Reference Point (LRP; red dashed line). The green box and whisker plots summarize the posterior distribution of the commercial biomass in year  $t$  using data up to and including year  $t$  (e.g., 2018 predictions based on data up to and including 2018). The dark blue box and whisker plots summarize posterior distributions of commercial biomass in year  $t$  based on model fit to year  $t-1$  (e.g., 2018 predictions based on data up to and including 2017). The light blue box and whisker plots summarize posterior distributions of commercial biomass in year  $t$  based on model fit to year  $t-2$  (e.g., 2018 predictions based on data up to and including 2016). Box plots show median (horizontal line), 50% credible limits (box), and 90% credible limits (whiskers). The projections for 2020 assumes landings of 108 mt, and the total allowable catch of 200 mt is caught in 2021. Prediction evaluations are presented for three two-year projection scenarios; zero surplus production (left panel), median surplus production (middle panel), and the status quo assumption (i.e., same conditions as the one-year projections in year  $t-1$ ; right panel).

**Two-year Projections for Bay of Fundy and SFA 29W Scallop**

**Maritimes Region**

*Table 7. Catch scenarios for SPA 3 to evaluate 2020/21 catch levels in terms of resulting exploitation (e), expected changes in commercial biomass (%), probability (Pr) of commercial biomass increase, probability that after removal the stock will be above the upper stock reference (USR), and above the Limit Reference Point (LRP). These probabilities account for uncertainty in the biomass forecasts and are presented assuming zero surplus production from 2020 to 2021.*

<b>Catch (mt)</b>	<b>e</b>	<b>Pr Increase</b>	<b>% Change</b>	<b>Pr &gt; LRP</b>	<b>Pr &gt; USR</b>
0	0.00	0.48	-1.5	0.96	0.84
20	0.01	0.46	-2.5	0.96	0.83
40	0.02	0.44	-3.5	0.96	0.83
60	0.03	0.43	-4.5	0.96	0.83
70	0.04	0.41	-5.5	0.95	0.82
90	0.05	0.39	-6.5	0.95	0.82
110	0.06	0.38	-7.4	0.95	0.81
130	0.07	0.36	-8.4	0.95	0.81
150	0.08	0.34	-9.4	0.95	0.80
170	0.09	0.33	-10.4	0.95	0.80
180	0.10	0.31	-11.4	0.94	0.80
200	0.11	0.29	-12.4	0.94	0.79
220	0.12	0.28	-13.3	0.94	0.78
240	0.13	0.26	-14.3	0.94	0.78
260	0.14	0.25	-15.3	0.94	0.77
280	0.15	0.23	-16.3	0.94	0.77
290	0.16	0.22	-17.3	0.93	0.76
310	0.17	0.20	-18.3	0.93	0.76
330	0.18	0.19	-19.3	0.93	0.75
350	0.19	0.18	-20.2	0.92	0.74
370	0.20	0.16	-21.2	0.92	0.74

**Two-year Projections for Bay of Fundy and SFA 29W Scallop**

**Maritimes Region**

*Table 8. Catch scenarios for SPA 3 to evaluate 2020/21 catch levels in terms of resulting exploitation (e), expected changes in commercial biomass (%), probability (Pr) of commercial biomass increase, probability that after removal the stock will be above the upper stock reference (USR), and above the limit reference point (LRP). These probabilities account for uncertainty in the biomass forecasts and are presented assuming median surplus production from 2020 to 2021.*

<b>Catch (mt)</b>	<b>e</b>	<b>Pr Increase</b>	<b>% Change</b>	<b>Pr &gt; LRP</b>	<b>Pr &gt; USR</b>
0	0.00	0.72	15.5	0.98	0.90
20	0.01	0.70	14.3	0.97	0.89
40	0.02	0.69	13.2	0.97	0.89
60	0.03	0.67	12.0	0.97	0.89
90	0.04	0.66	10.9	0.97	0.88
110	0.05	0.64	9.7	0.97	0.88
130	0.06	0.63	8.6	0.97	0.88
150	0.07	0.61	7.4	0.97	0.87
170	0.08	0.60	6.3	0.97	0.87
190	0.09	0.58	5.1	0.97	0.86
220	0.10	0.56	4.0	0.97	0.86
240	0.11	0.55	2.8	0.96	0.86
260	0.12	0.53	1.6	0.96	0.85
280	0.13	0.51	0.5	0.96	0.85
300	0.14	0.49	-0.7	0.96	0.85
320	0.15	0.47	-1.8	0.96	0.84
350	0.16	0.45	-3.0	0.96	0.84
370	0.17	0.43	-4.1	0.96	0.83
390	0.18	0.41	-5.3	0.96	0.83
410	0.19	0.39	-6.4	0.95	0.82
430	0.20	0.37	-7.6	0.95	0.82

**Maritimes Region**

*Table 9. Catch scenarios for SPA 3 to evaluate 2020/21 catch levels in terms of resulting exploitation (e), expected changes in commercial biomass (%), probability (Pr) of commercial biomass increase, probability that after removal the stock will be above the upper stock reference (USR), and above the Limit Reference Point (LRP). These probabilities account for uncertainty in the biomass forecasts and are presented assuming the status quo assumption (same recruitment, mortality, and growth as for the 2020 projection).*

<b>Catch (mt)</b>	<b>e</b>	<b>Pr Increase</b>	<b>% Change</b>	<b>Pr &gt; LRP</b>	<b>Pr &gt; USR</b>
0	0.00	0.41	-5.4	0.96	0.82
20	0.01	0.39	-6.3	0.95	0.82
40	0.02	0.38	-7.3	0.95	0.82
50	0.03	0.36	-8.2	0.95	0.81
70	0.04	0.35	-9.2	0.95	0.81
90	0.05	0.33	-10.1	0.95	0.80
110	0.06	0.31	-11.1	0.95	0.80
120	0.07	0.30	-12.0	0.94	0.79
140	0.08	0.28	-13.0	0.94	0.79
160	0.09	0.27	-13.9	0.94	0.78
180	0.10	0.25	-14.9	0.94	0.78
190	0.11	0.24	-15.8	0.94	0.77
210	0.12	0.22	-16.7	0.94	0.77
230	0.13	0.21	-17.7	0.93	0.76
250	0.14	0.20	-18.6	0.93	0.76
260	0.15	0.18	-19.6	0.93	0.75
280	0.16	0.17	-20.5	0.93	0.74
300	0.17	0.16	-21.5	0.92	0.74
320	0.18	0.14	-22.4	0.92	0.73
330	0.19	0.13	-23.4	0.92	0.72
350	0.20	0.12	-24.3	0.92	0.72

**Scallop Production Area 4**

For SPA 4, for all three two-year projection scenarios, the probability that the 2021 commercial biomass would be above the USR and in the healthy zone after removing 175 mt (the 2021 interim TAC) was between 0.61 to 0.70, the probability that the 2021 biomass would be above the LRP was between 0.78 to 0.84, and the expected exploitation ranged between 14 and 16% (Figure 9, Tables 10–12).

One- and two-year projections of biomass for the same year varied substantially across all three two-year projection scenarios for the evaluated period of 2012–2019. The relative difference in median biomass of the one- and two-year projections ranged from -44% to 18% (-759 mt to

201 mt), -36% to 35% (-626 mt to 378 mt), and -47% to 12% (-804 mt to 218 mt), for the zero-surplus production, median surplus production, and status quo scenarios, respectively.

The simulated impact of two-year projections on harvest advice was evaluated as the relative difference in potential catch between one- and two-year projections for a fixed exploitation rate of 0.15. The relative difference in catch of the one- and two-year projections ranged from -42% to 18% (-118 mt to 32 mt), -34% to 34% (-95 mt to 62 mt), -45% to 15% (-125 mt to 43 mt), for the zero-surplus production, median surplus production, and status quo scenarios, respectively.

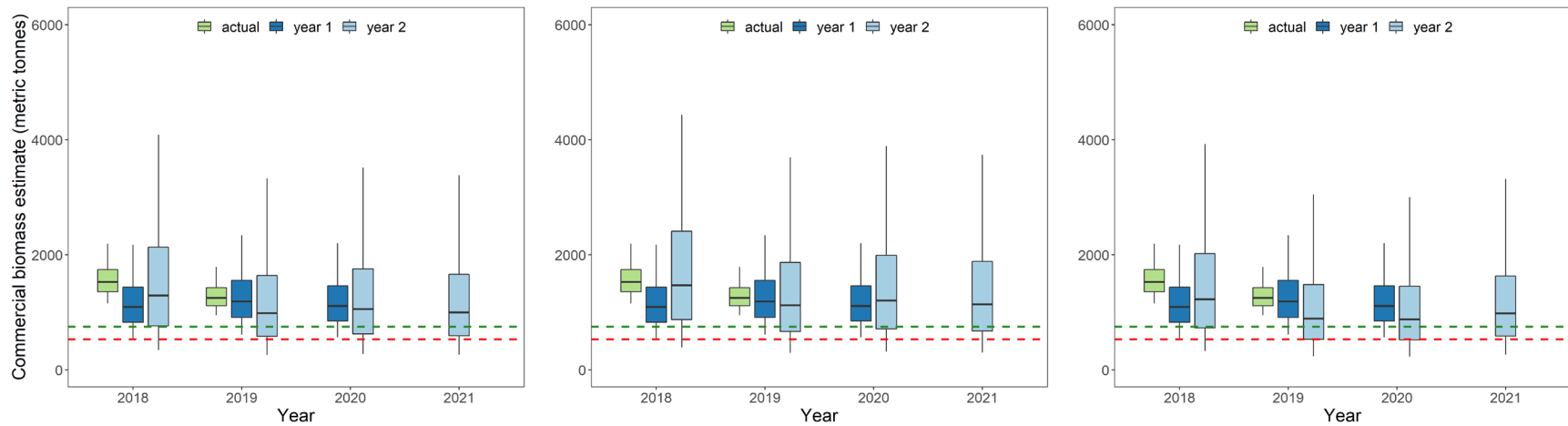


Figure 9. Evaluation of the model projection performance from 2018 to 2021 for SPA 4 relative to the upper stock reference (USR; green dashed line) and Limit Reference Point (LRP; red dashed line). The green box and whisker plots summarize the posterior distribution of the commercial biomass in year  $t$  using data up to and including year  $t$  (e.g., 2018 predictions based on data up to and including 2018). The dark blue box and whisker plots summarize posterior distributions of commercial biomass in year  $t$  based on model fit to year  $t-1$  (e.g., 2018 predictions based on data up to and including 2017). The light blue box and whisker plots summarize posterior distributions of commercial biomass in year  $t$  based on model fit to year  $t-2$  (e.g., 2018 predictions based on data up to and including 2016). Box plots show median (horizontal line), 50% credible limits (box), and 90% credible limits (whiskers). The projections for 2020 assumes landings of 113 mt, and the total allowable catch of 175 mt is caught in 2021. Prediction evaluations are presented for three two-year projection scenarios; zero surplus production (left panel), median surplus production (middle panel), and the status quo assumption (i.e., same conditions as the one-year projections in year  $t-1$ ; right panel).

Table 10. Catch scenarios for SPA 4 to evaluate 2020/21 catch levels in terms of resulting exploitation (e), expected changes in commercial biomass (%), probability (Pr) of commercial biomass increase, probability that after removal the stock will be above the upper stock reference (USR), and above the Limit Reference Point (LRP). These probabilities account for uncertainty in the biomass forecasts and are presented assuming zero surplus production from 2020 to 2021.

Catch (mt)	e	Pr Increase	% Change	Pr > LRP	Pr > USR
0	0.00	0.49	-0.6	0.85	0.71
10	0.01	0.48	-1.6	0.84	0.70
20	0.02	0.47	-2.6	0.84	0.70
30	0.03	0.46	-3.6	0.84	0.69
40	0.04	0.45	-4.6	0.83	0.69
60	0.05	0.43	-5.6	0.83	0.68
70	0.06	0.42	-6.6	0.83	0.68
80	0.07	0.41	-7.6	0.82	0.67
90	0.08	0.40	-8.6	0.82	0.66
100	0.09	0.38	-9.5	0.81	0.66
110	0.10	0.37	-10.5	0.81	0.65
120	0.11	0.36	-11.5	0.81	0.65
130	0.12	0.35	-12.5	0.80	0.64
140	0.13	0.33	-13.5	0.80	0.64
160	0.14	0.32	-14.5	0.79	0.63
170	0.15	0.31	-15.5	0.79	0.63
180	0.16	0.30	-16.5	0.78	0.62
190	0.17	0.28	-17.5	0.78	0.61
200	0.18	0.27	-18.5	0.78	0.61
210	0.19	0.26	-19.5	0.77	0.60
220	0.20	0.25	-20.5	0.76	0.59



Table 11. Catch scenarios for SPA 4 to evaluate 2020/21 catch levels in terms of resulting exploitation (e), expected changes in commercial biomass (%), probability (Pr) of commercial biomass increase, probability that after removal the stock will be above the upper stock reference (USR), and above the Limit Reference Point (LRP). These probabilities account for uncertainty in the biomass forecasts and are presented assuming median surplus production from 2020 to 2021.

Catch (mt)	e	Pr Increase	% Change	Pr > LRP	Pr > USR
0	0.00	0.64	12.9	0.88	0.77
10	0.01	0.63	11.7	0.88	0.76
30	0.02	0.62	10.6	0.88	0.76
40	0.03	0.60	9.5	0.88	0.75
50	0.04	0.59	8.4	0.87	0.75
60	0.05	0.58	7.2	0.87	0.74
80	0.06	0.57	6.1	0.87	0.74
90	0.07	0.56	5.0	0.86	0.74
100	0.08	0.54	3.8	0.86	0.73
110	0.09	0.53	2.7	0.86	0.72
130	0.10	0.52	1.6	0.85	0.72
140	0.11	0.51	0.5	0.85	0.72
150	0.12	0.49	-0.7	0.85	0.71
160	0.13	0.48	-1.8	0.84	0.70
180	0.14	0.47	-2.9	0.84	0.70
190	0.15	0.45	-4.1	0.84	0.69
200	0.16	0.44	-5.2	0.83	0.69
210	0.17	0.42	-6.3	0.83	0.68
230	0.18	0.41	-7.4	0.82	0.67
240	0.19	0.40	-8.6	0.82	0.67
250	0.20	0.38	-9.7	0.81	0.66

Table 12. Catch scenarios for SPA 4 to evaluate 2020/21 catch levels in terms of resulting exploitation (e), expected changes in commercial biomass (%), probability (Pr) of commercial biomass increase, probability that after removal the stock will be above the upper stock reference (USR), and above the Limit Reference Point (LRP). These probabilities account for uncertainty in the biomass forecasts and are presented assuming the status quo assumption (same recruitment, mortality, and growth as for the 2020 projection).

Catch (mt)	e	Pr Increase	% Change	Pr > LRP	Pr > USR
0	0.00	0.47	-2.2	0.84	0.70
10	0.01	0.46	-3.2	0.84	0.70
20	0.02	0.45	-4.2	0.84	0.69
30	0.03	0.44	-5.2	0.83	0.69
40	0.04	0.43	-6.1	0.83	0.68
50	0.05	0.41	-7.1	0.82	0.68
70	0.06	0.40	-8.1	0.82	0.67
80	0.07	0.39	-9.1	0.82	0.66
90	0.08	0.38	-10.1	0.81	0.66
100	0.09	0.36	-11.0	0.81	0.65
110	0.10	0.35	-12.0	0.81	0.65
120	0.11	0.34	-13.0	0.80	0.64
130	0.12	0.33	-14.0	0.80	0.64
140	0.13	0.32	-14.9	0.79	0.63
150	0.14	0.30	-15.9	0.79	0.62
160	0.15	0.29	-16.9	0.78	0.62
170	0.16	0.28	-17.9	0.78	0.61
190	0.17	0.27	-18.9	0.78	0.60
200	0.18	0.25	-19.8	0.77	0.60
210	0.19	0.24	-20.8	0.76	0.59
220	0.20	0.23	-21.8	0.76	0.58

### Scallop Production Area 6

For SPA 6, reference points are set in terms of the commercial catch rate and not the modelled biomass (DFO 2021); therefore, an evaluation of stock status relative to the population model is not possible. However, for all three two-year projection scenarios for 2021, assuming the total allowable catch of 210 mt is caught from the modeled area, the exploitation range is expected to be between 20 and 24% which corresponds to an expected range of biomass change between -28% and -11% (Figure 10, Tables 13–15).

One- and two-year projections of biomass for the same year varied substantially across all three two-year projection scenarios for the evaluated period of 2012–2019. The relative difference in median biomass of the one- and two-year projections ranged from –76% to 20% (–728 mt to 202 mt), –71% to 37% (–603 mt to 374 mt), and –55% to 51% (–486 mt to 459 mt), for the zero-surplus production, median surplus production, and status quo scenarios, respectively.

The simulated impact of two-year projections on harvest advice was evaluated as the relative difference in potential catch between one- and two-year projections for a fixed exploitation rate of 0.18. The relative difference in catch of the one- and two-year projections ranged from –57% to 16% (–124 mt to 31 mt), –49% to 31% (–96 mt to 62 mt), –36% to 38% (–79 mt to 75 mt), for the zero-surplus production, median surplus production, and status quo scenarios, respectively.

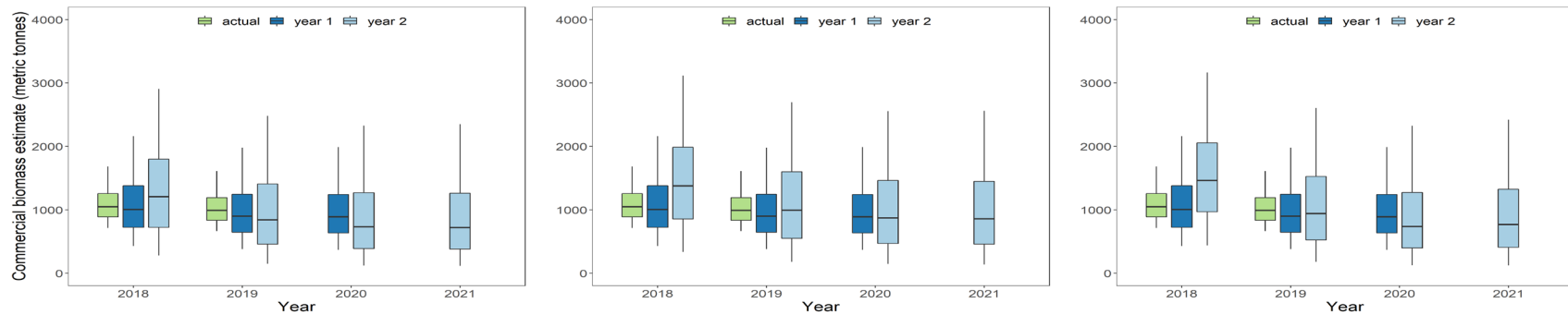


Figure 10. Evaluation of the model projection performance from 2018 to 2021 for SPA 6. The green box and whisker plots summarize the posterior distribution of the commercial biomass in year  $t$  using data up to and including year  $t$  (e.g., 2018 predictions based on data up to and including 2018). The dark blue box and whisker plots summarize posterior distributions of commercial biomass in year  $t$  based on model fit to year  $t-1$  (e.g., 2018 predictions based on data up to and including 2017). The light blue box and whisker plots summarize posterior distributions of commercial biomass in year  $t$  based on model fit to year  $t-2$  (e.g., 2018 predictions based on data up to and including 2016). Box plots show median (horizontal line), 50% credible limits (box), and 90% credible limits (whiskers). The projections for 2020 assumes landings of 164 mt from the modeled area, and the total allowable catch of 210 mt is caught from the modeled area in 2021. Prediction evaluations are presented for three two-year projection scenarios; zero surplus production (left panel), median surplus production (middle panel), and the status quo assumption (i.e., same conditions as the one-year projections in year  $t-1$ ; right panel).

Table 13. Catch scenarios for SPA 6 to evaluate 2020/21 catch levels in terms of resulting exploitation (e), expected changes in commercial biomass (%), probability (Pr) of commercial biomass increase. These probabilities account for uncertainty in the biomass forecasts and are presented assuming zero surplus production from 2020 to 2021.

Catch (mt)	e	Pr Increase	% Change
0	0.00	0.44	-5.0
10	0.01	0.43	-5.9
20	0.02	0.42	-6.9
30	0.03	0.40	-7.8
40	0.04	0.39	-8.8
40	0.05	0.38	-9.7
50	0.06	0.37	-10.7
60	0.07	0.36	-11.6
70	0.08	0.34	-12.6
80	0.09	0.33	-13.5
90	0.10	0.32	-14.5
100	0.11	0.30	-15.4
110	0.12	0.29	-16.4
110	0.13	0.28	-17.3
120	0.14	0.27	-18.3
130	0.15	0.25	-19.2
140	0.16	0.24	-20.2
150	0.17	0.23	-21.1
160	0.18	0.22	-22.1
170	0.19	0.21	-23.0
180	0.20	0.20	-24.0
180	0.21	0.18	-24.9
190	0.22	0.17	-25.9
200	0.23	0.16	-26.8
210	0.24	0.15	-27.8
220	0.25	0.14	-28.7
230	0.26	0.13	-29.7
240	0.27	0.12	-30.6
250	0.28	0.11	-31.6
250	0.29	0.10	-32.5
260	0.30	0.09	-33.5

Table 14. Catch scenarios for SPA 6 to evaluate 2020/21 catch levels in terms of resulting exploitation (e), expected changes in commercial biomass (%), probability (Pr) of commercial biomass increase. These probabilities account for uncertainty in the biomass forecasts and are presented assuming median surplus production from 2020 to 2021.

Catch (mt)	e	Pr Increase	% Change
0	0.00	0.62	11.3
10	0.01	0.61	10.2
20	0.02	0.60	9.1
30	0.03	0.59	7.9
40	0.04	0.58	6.8
50	0.05	0.57	5.7
60	0.06	0.55	4.6
70	0.07	0.54	3.5
80	0.08	0.53	2.4
90	0.09	0.52	1.3
100	0.10	0.50	0.2
110	0.11	0.49	-1.0
120	0.12	0.47	-2.1
130	0.13	0.46	-3.2
140	0.14	0.45	-4.3
160	0.15	0.43	-5.4
170	0.16	0.42	-6.5
180	0.17	0.40	-7.6
190	0.18	0.39	-8.7
200	0.19	0.37	-9.9
210	0.20	0.36	-11.0
220	0.21	0.34	-12.1
230	0.22	0.33	-13.2
240	0.23	0.31	-14.3
250	0.24	0.30	-15.4
260	0.25	0.28	-16.5
270	0.26	0.26	-17.7
280	0.27	0.25	-18.8
290	0.28	0.23	-19.9
300	0.29	0.22	-21.0
310	0.30	0.20	-22.1

Table 15. Catch scenarios for SPA 6 to evaluate 2020/21 catch levels in terms of resulting exploitation (e), expected changes in commercial biomass (%), probability (Pr) of commercial biomass increase. These probabilities account for uncertainty in the biomass forecasts and are presented assuming the status quo assumption (same recruitment, mortality, and growth as for the 2020 projection).

Catch (mt)	e	Pr Increase	% Change
0	0.00	0.51	0.4
10	0.01	0.49	-0.6
20	0.02	0.48	-1.6
30	0.03	0.47	-2.6
40	0.04	0.46	-3.6
50	0.05	0.44	-4.6
60	0.06	0.43	-5.6
60	0.07	0.42	-6.6
70	0.08	0.40	-7.6
80	0.09	0.39	-8.6
90	0.10	0.38	-9.6
100	0.11	0.37	-10.6
110	0.12	0.35	-11.6
120	0.13	0.34	-12.6
130	0.14	0.33	-13.6
140	0.15	0.31	-14.6
150	0.16	0.30	-15.6
160	0.17	0.29	-16.6
170	0.18	0.27	-17.6
180	0.19	0.26	-18.7
190	0.20	0.25	-19.7
190	0.21	0.23	-20.7
200	0.22	0.22	-21.7
210	0.23	0.21	-22.7
220	0.24	0.19	-23.7
230	0.25	0.18	-24.7
240	0.26	0.17	-25.7
250	0.27	0.16	-26.7
260	0.28	0.15	-27.7
270	0.29	0.14	-28.7
280	0.30	0.13	-29.7

## SFA 29 West

In areas in which the biomass is relatively low (e.g., habitat categories within subareas of SFA 29W), the 90% credible interval of the two-year projection was often smaller than the 90% credible interval for the one-year projection. This occurred when the median biomass from the two-year projection was smaller than the one-year projection and began to approach 0. The process error term used for the two-year projections is log-normally distributed. As the data approach 0, the range of the data will decline due to this distribution having a lower bound at 0. Rather than being evidence of more certainty in the estimates of these two-year projections, these cases indicate years in which the biomass from the two-year projection is unrealistically low. This was often observed for the two-year projections for the subareas of SFA 29W. As such, the two-year projections for SFA 29W are not deemed sufficiently reliable for the provision of advice. Therefore, these projections are not recommended to inform the 2021 harvest levels for SFA 29W.

## Sources of Uncertainty

For one-year biomass projections, assumptions must be made regarding expected biomass growth and natural mortality. These estimates are based on current survey data and mortality is assumed to be the mean of the previous five years. These estimates may not reflect actual changes over the following year(s). Two-year projections were evaluated for three scenarios, 1) zero surplus production, 2) median surplus production, and 3) 'status quo' – assuming the same assumptions as the one-year projection in year  $t-1$ . This range of scenarios is expected to cover a likely range of potential outcomes; however, no negative surplus production scenario was evaluated, although negative surplus production has been observed in these stocks.

## CONCLUSIONS AND ADVICE

For the BoF SPAs, the median surplus production rates were 0.22, 0.20, 0.19, 0.14, and 0.21, for SPA 1A, 1B, 3, 4, and 6, respectively. The predicted exploitations corresponding to zero change in biomass over the time series were 0.16, 0.13, 0.20, 0.22, and 0.18, for SPA 1A, 1B, 3, 4, and 6, respectively. For SFA 29W, the median surplus production rates were 0.07, 0.17, 0.02, and 0.15, for Subareas A, B, C, and D, respectively. The predicted exploitations corresponding to zero change in biomass over the time series were 0.05, 0.17, 0.17, and 0.21, for Subareas A, B, C, and D, respectively.

The scallop stocks in the BoF and SFA 29W demonstrate substantial interannual variability in their productivity and this is reflected in the lack of autocorrelation in the primary model parameters and in surplus production beyond a one-year lag for most areas. Relative to the use of one-year projections, use of two-year projections as the basis for management decisions over the long term would result in substantial risk of either loss in potential catch or overharvesting. However, for the BoF stocks and in the context of tactical one-year decision making and in the absence of 2020 survey data, these two-year projections provide context for decision making for the 2021 harvest levels. For SFA 29W, the two-year projections are not sufficiently reliable given challenges associated with projecting low biomasses. Therefore, these projections are not recommended to inform the 2021 harvest levels for SFA 29W.



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**SOURCES OF INFORMATION**

This Science Advisory Report is from the March 31, 2021, regional peer review on the Evaluation of Two-year Model Projections for Bay of Fundy and SFA 29W Scallop Fisheries. Additional publications from this meeting will be posted on the [Fisheries and Oceans Canada \(DFO\) Science Advisory Schedule](#) as they become available.

Nasmith, L., Sameoto, J.A., and Glass, A. 2016. [Scallop Production Areas in the Bay of Fundy: Stock Status for 2015 and Forecast for 2016](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2016/021. vi + 140.

Smith, S.J., and Sameoto, J.A. 2016. [Incorporating Habitat Suitability into Productivity Estimates for Sea Scallops in Scallop Fishing Area 29 West](#). DFO Can. Sci. Advis. Sec. Res. Doc. 2016/107. v + 23p.

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