Fisheries and Oceans Canada | Pêches et Océans Canada
Ecosystems and Oceans Science | Sciences des écosystèmes et des océans

Canadian Science Advisory Secretariat
Maritimes Region **Science Response 2021/005**

STOCK STATUS UPDATE OF SCALLOP (*PLACOPECTEN MAGELLANICUS*) IN SCALLOP PRODUCTION AREAS 1 TO 6 IN THE BAY OF FUNDY

Context

Advice on the status of Scallop in Scallop Production Areas (SPAs) 1 to 6 in the Bay of Fundy (BoF) is requested annually by Fisheries and Oceans Canada (DFO) Resource Management to help determine a Total Allowable Catch (TAC, meat weight) in support of the fishery. Scallop in SPAs 1 to 6 is assessed on a multiyear assessment schedule, with update reports produced in interim years. The last full assessment of the BoF Scallop occurred in 2015 (DFO 2016, Nasmith et al. 2016). A stock status update was provided for the 2018/2019 fishing season in 2018 (DFO 2019).

The objectives of this report are to: identify the consequences of different harvest levels in SPAs 1A, 1B, 3, 4, 5, and 6 from the 2019/2020 season, provide advice on the interim harvest levels for the start of the 2020/2021 season for SPAs 1A, 1B, 3, and 4, and identify all information on fishery bycatch of non-target species. If information is available, identify any notable changes in occurrence of bycatch species relative to previous years. Interim harvest levels are provided for the following fishing year to allow the fishery to start in October prior to final TACs being set (December). The fishery season runs from October 1 to September 30 of the following year. Fishery data from the 2019/2020 season are preliminary (as of June 15, 2020) and do not cover the full fishing year.

This Science Response Report results from the Science Response Process of August 24, 2020, on the Stock Status Update of Bay of Fundy Scallop in Scallop Production Areas (SPAs) 1A, 1B, and 3-6.

Background

Population surveys are conducted annually by DFO Science. The population dynamics of commercial and recruit scallops for all SPAs (Appendix 1) were modelled using a Bayesian state-space model with modifications presented in Smith et al. (2012) and Smith and Hubley (2014). A detailed description of survey design and strata boundaries is presented in Nasmith et al. (2016). In this report, scallops with a shell height of 80 mm and greater are referred to as commercial size. Scallops with a shell height of 65-79 mm are referred to as recruits and are expected to grow to be commercial size in the following year. Scallops less than 65 mm are defined as pre-recruits.

Scallop removals accounted for in assessments include commercial landings from all three inshore scallop fleets, and Food, Social and Ceremonial (FSC) catch by scallop drag. There was no FSC catch by drag caught in the BoF in the 2018/2019 fishing season (hereafter referred to as the 2019 fishing year), or in the 2019/2020 fishing season as of June 15, 2020 (hereafter referred to as the 2020 fishing year). Landed recreational and FSC catch by dip netting, diving, tongs, and hand are not available and are not accounted for in the assessment.

There were 4 fisheries observer trips in the BoF Scallop fishery in the 2019 fishing year and 2 fisheries observer trips in the 2020 fishing year as of June 15, 2020. Currently, there is no DFO requirement that Scallop Fishing Areas (SFA) 28A-D (Appendix 1) trips be observed. Refer to Sameoto and Glass (2012) for past analysis of discards from the inshore scallop fishery.

Description of the Fishery

There are three fleets (Full Bay, Mid Bay, and Upper Bay) in the inshore BoF Scallop fishery. Full Bay license holders are permitted to fish throughout the BoF. Mid Bay license holders have access to all areas north of the Mid Bay line. Upper Bay license holders are restricted to the upper reaches of the Bay (Appendix 1). The fishery is managed using limited entry, drag gear size limits, seasonal closures, minimum shell height, and meat count. The drag gear width limit is 5.5 metres (m) with a ring size of not less than 82 mm inside diameter. The Full Bay Fleet operates under an Individual Transferable Quota (ITQ) system, while the Mid Bay and Upper Bay fleets fish with competitive quotas. Landings and TACs are reported in terms of meat weights (adductor muscles).

Analysis and Response

Indicators of Stock Status

Scallop Production Area 1A Stock Status

The Full Bay Fleet caught a total of 467.49 tonnes (t) against a TAC of 455.02 t (450 t before post-quota reconciliation) during the 2019 fishery in SPA 1A, of which 29% came from outside the area used for the population model of SPA 1A. In the 2020 fishery as of June 15, 2020, preliminary landings were 289.29 t against a TAC of 415 t; of which 3% have come from outside the modelled area. Recent TAC and landings are summarized in Appendix 2. The commercial catch rate in the 2019 fishing year was 27.7 kilograms per hour (kg/h), a decrease from 2018 (29.6 kg/h). As of June 15, 2020, the preliminary catch rate for 2020 was 26.1 kg/h.

In 2019, survey condition (measured in grams per a 100 mm shell height scallop) was 10.0 g, a decrease from 2018 (11.4 g) and below the long-term (1997-2018) mean of 11.2 g. Pre-recruits were observed in patches in SPA 1A; there were small pre-recruits (25-35 mm shell height) near the northern border of Mid Bay South (Figure 1, Appendix 1; see Nasmith et al. 2016 for detailed description of the strata). The biomass estimate of recruit scallops in 2019 was 12.1 t, a decline from 2018 (25.3 t) and below the long-term (1997-2018) median of 58.4 t. Recruits were absent from large portions of SPA 1A (Figure 2). Commercial scallop biomass was predominately observed in the 8 to 16-mile strata, with localized regions of relatively high abundance observed in the eastern portion of the 8 to 16-mile strata and the Middle Bay South stratum (Figure 3). The biomass estimate of commercial scallops in 2019 was 2268 t (meats), a decline from 2018 (3365 t), but above the long-term median of 1732 t, and in the Healthy Zone (Figure 4).

Catch scenarios for the 2019/2020 fishing season are presented in Table 1. Biomass projections use the current year estimates of growth, and natural mortality is the average over the last 5 years. The 2019/2020 TAC for SPA 1A was 415 t; for this catch level, Table 1 is interpreted as follows: a catch of 415 t corresponds to an exploitaiton of 0.18 and is projected to result in a 16% decline in commercial biomass, the probability of commercial biomass increase is 27%, the probability that a catch of 415 t will result in the population remaining above the Lower Reference Point (LRP) is >99%, and the probability of the population remaining above

the Upper Stock Reference (USR) is 94%. In the following fishing year (2020/2021), a catch of 172 t would have a probability of 10% of exceeding a reference exploitation of 0.15.

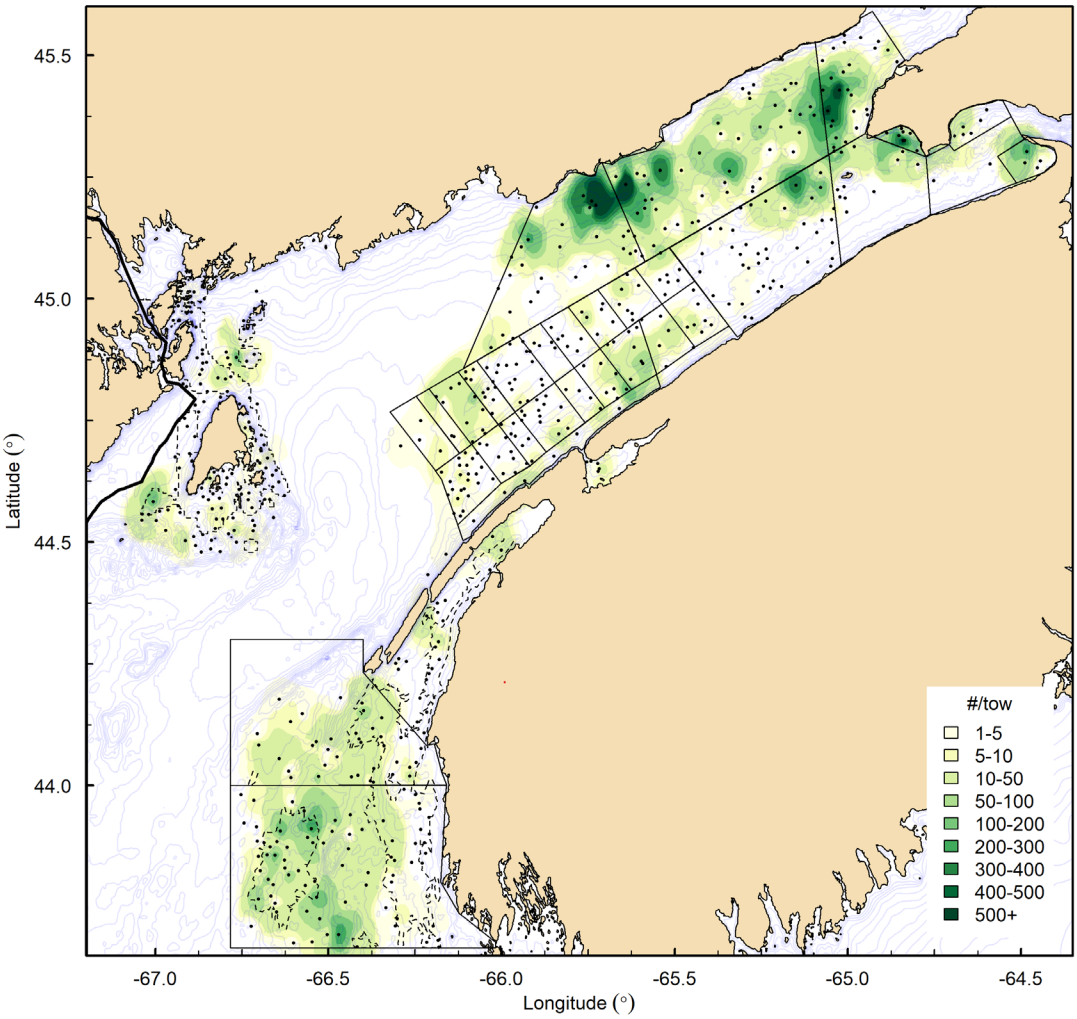

Figure 1. Spatial distribution (number/tow) of pre-recruit scallops (< 65 mm shell height) in the Bay of Fundy and approaches in 2019. Dots represent survey stations. Solid black lines are survey strata; dashed black lines are survey strata representing high (inside dashed lines) and low (outside dashed lines) fishing effort, based on Vessel Monitoring System (VMS) analysis (see: Smith et al. 2012).

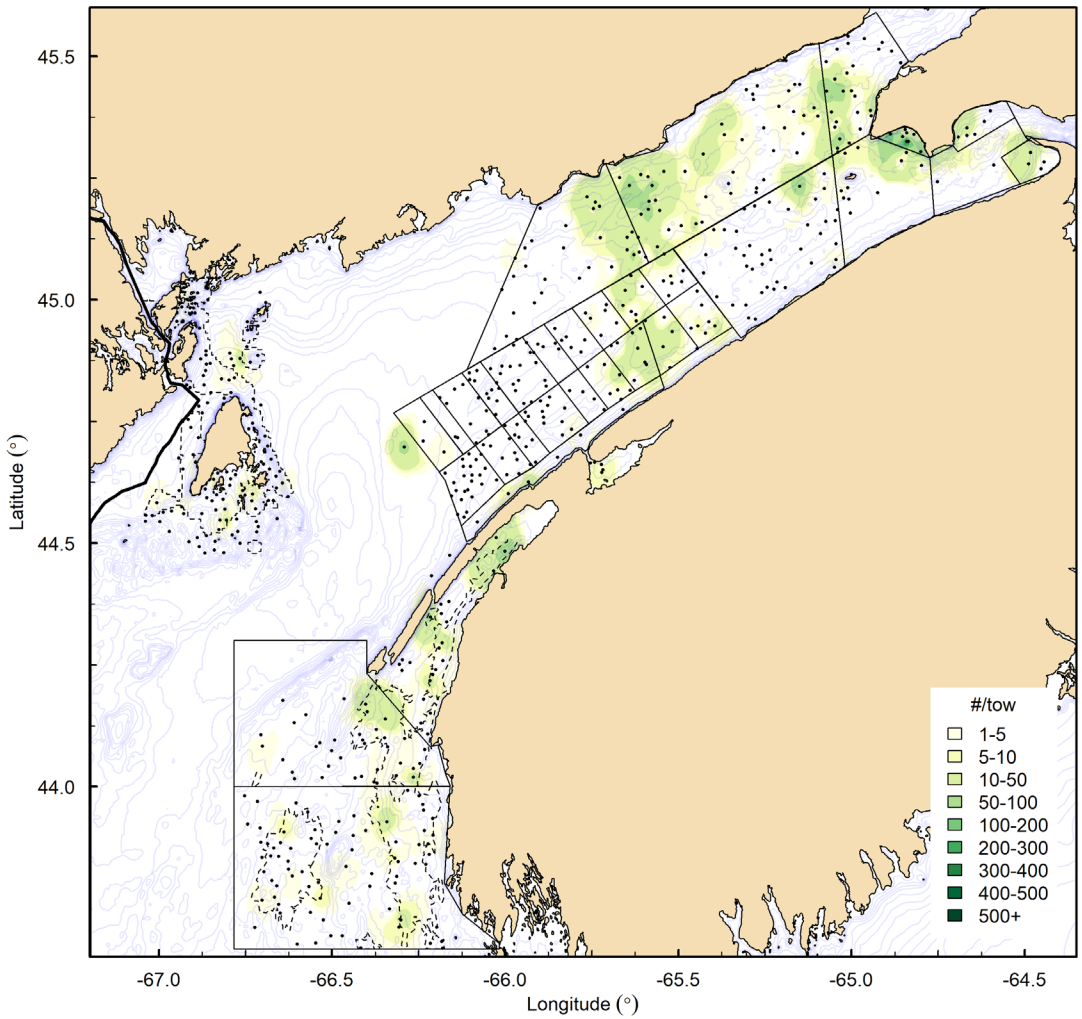

Figure 2. Spatial distribution (number/tow) of recruit scallops (65-79 mm shell height) in the Bay of Fundy and approaches in 2019. Dots represent survey stations. Solid black lines are survey strata; dashed black lines are survey strata representing high (inside dashed lines) and low (outside dashed lines) fishing effort, based on Vessel Monitoring System (VMS) analysis (see: Smith et al. 2012).

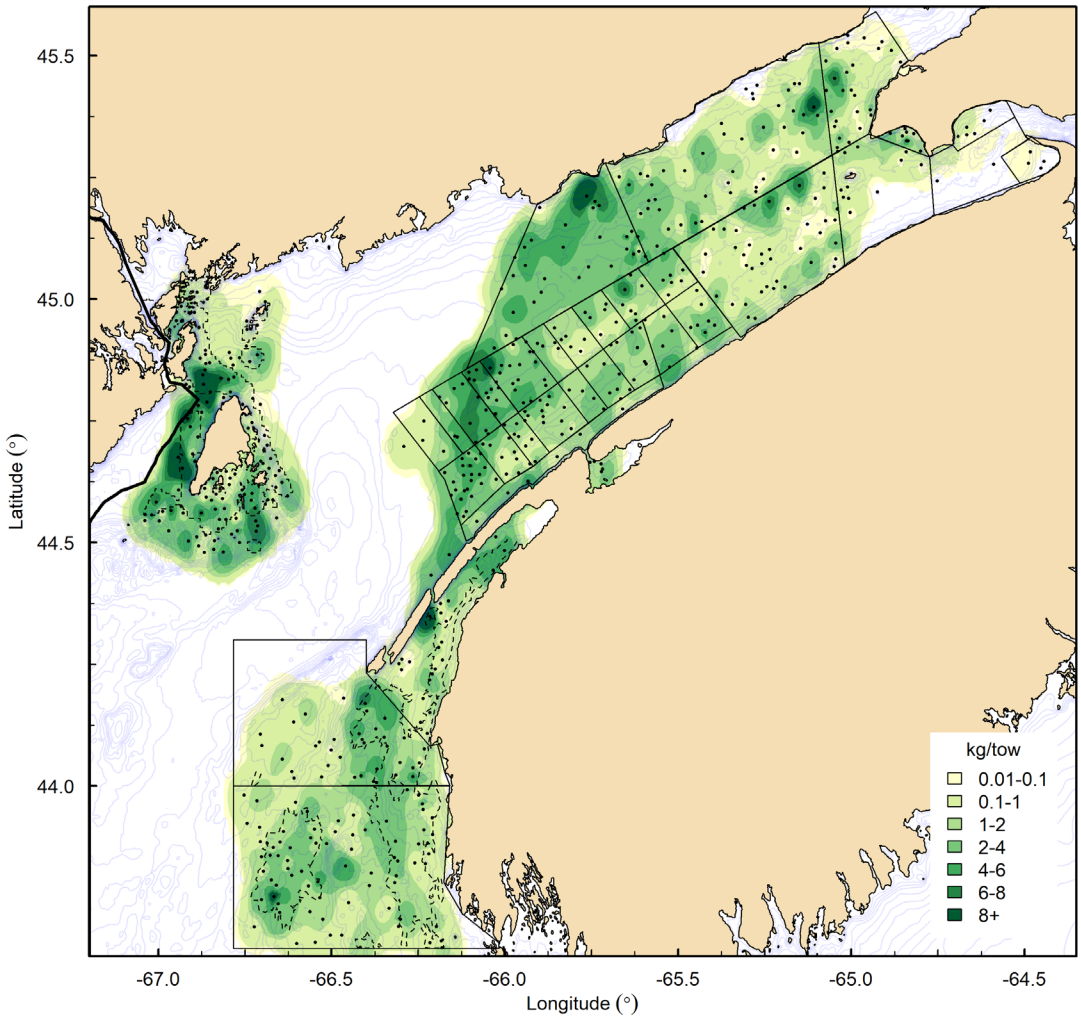

Figure 3. Spatial distribution of commercial (≥ 80 mm shell height) biomass (kg/tow) in the Bay of Fundy and approaches in 2019. Dots represent survey stations. Solid black lines are survey strata; dashed black lines are survey strata representing high (inside dashed lines) and low (outside dashed lines) fishing effort, based on Vessel Monitoring System (VMS) analysis (see: Smith et al. 2012).

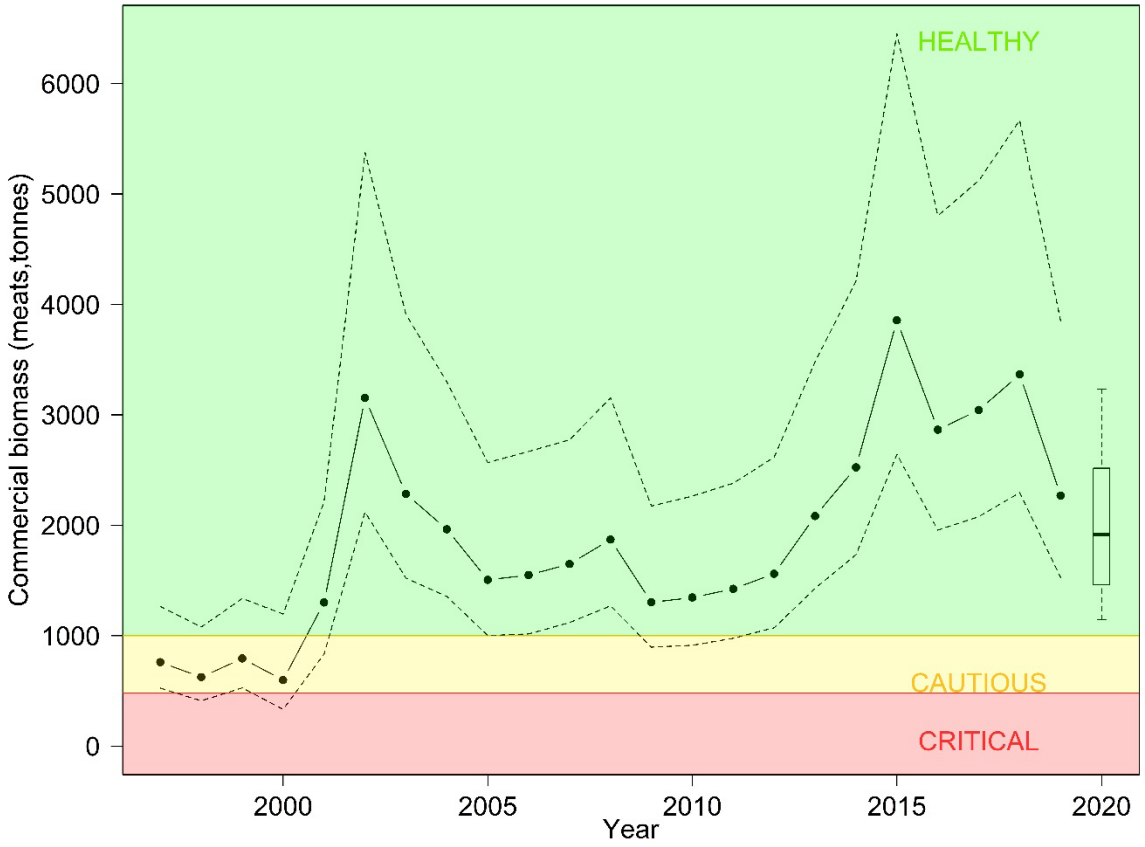

Figure 4. Median biomass estimates in SPA 1A for commercial size scallops in meat weight (tonnes) from the assessment model fit to the survey and commercial data. Dashed lines are the upper and lower 95% credible limits on the estimates. The predicted commercial size biomass for 2020, assuming the 2019/2020 TAC of 415 t, is displayed as a box plot with median, 50% credible limits (box) and 80% credible limits (whiskers). The green-shaded area represents the Healthy Zone (based on an Upper Stock Reference (USR) of 1000 t), the yellow-shaded area represents the Cautious Zone, and red-shaded area represents the Critical Zone (based on Lower Reference Point (LRP) of 480 t; Nasmith et al. 2014).

Table 1. Harvest scenario table for SPA 1A to evaluate 2019/2020 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; 1000 t), and above the Lower Reference Point (LRP; 480 t). Potential catches (t) in 2020/2021 are evaluated in terms of the posterior probability of exceeding an exploitation rate of 0.15. The catch level and associated scenario that corresponds to the TAC from 2019/2020 is shown in bold.

2019/2020 Fishing Season						2020/2021 Fishing Season					
Catch (t)	*e*	% Change	Pr Increase	Pr >LRP	Pr >USR	**Probability Exploitation >0.15** *Potential Catch (t)*					
						0.1	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**
290	0.12	-11	0.34	>0.99	0.96	186	221	250	278	307	339
315	0.14	-12	0.33	>0.99	0.96	183	219	248	275	304	336
340	0.15	-13	0.31	>0.99	0.96	180	215	244	272	300	330
365	0.16	-14	0.29	>0.99	0.95	178	212	240	268	295	326
390	0.17	-15	0.28	>0.99	0.95	175	209	237	263	292	323
415	**0.18**	**-16**	**0.27**	**>0.99**	**0.94**	**172**	**205**	**234**	**260**	**288**	**319**

Scallop Production Area 1B Stock Status

The total 2019 landings for all fleets in SPA 1B was 739.85 t against a combined TAC of 772.89 t (750 t before post-quota reconciliation). The Full Bay Fleet caught 380.85 t against a quota of 384.87 t (380.63 before post-quota reconciliation), the Mid Bay Fleet caught 301.25 t against a quota of 290.99 t (267.90 t before post quota-reconciliation), and the Upper Bay Fleet caught 57.75 t against a quota of 97.03 t (101.48 t before post-quota reconciliation). In the 2020 fishery as of June 15, 2020, Full Bay Fleet has caught 191.89 t against a quota of 304.50 t, Mid Bay Fleet has caught 206.20 t against a quota of 212.92 (214.32 t before post-quota reconciliation), and Upper Bay Fleet has caught 21.07 t against a quota of 96.40 t (81.18 t before post-quota reconciliation). Recent TAC and landings are summarized in Appendix 2.

Catch rates in SFA 28B decreased from 40.7 kg/h in 2018 to 32.4 kg/h in 2019 for the Full Bay Fleet and 38.3 kg/h to 31.3 kg/h for the Mid Bay Fleet. As of June 15, 2020, preliminary catch rates for 2020 in SFA 28B were 26.8 kg/h for Full Bay and 20.1 kg/h for Mid Bay. In SFA 28C, catch rates for the Upper Bay Fleet decreased from 18.5 kg/h in 2018 to 16.3 kg/h in 2019, and were 35.9 kg/h in 2019 for the Mid Bay Fleet. The Full Bay Fleet did not fish SFA 28C in 2019. As of June 15th, 2020, there has been no fishing by the Full Bay Fleet in SFA 28C in the 2020 fishing year and not enough records from the Mid Bay Fleet to report a catch rate for this subarea due to *Privacy Act* considerations. Preliminary 2020 catch rates for SFA 28C are 13.5 kg/h for the Upper Bay Fleet. In SFA 28D, catch rates for the Upper Bay Fleet remained similar between 2018 and 2019 (16.9 kg/h and 17.0 kg/h, respectively). There are not enough records from the Full Bay Fleet in 2019 to summarize these data for this subarea. As of June 15, 2020, the 2020 catch rate for the Upper Bay Fleet in SFA 28D was 11.8 kg/h, and there has been no fishing by the Full Bay Fleet.

Condition from the survey declined throughout SPA 1B in 2019. Over the entire SPA 1B, condition declined from 11.1 g in 2018 to 10.1 g in 2019, and it was below the long-term (1997-2018) mean of 11.6 g. Pre-recruits were observed throughout SPA 1B, with the highest densities in Advocate Harbour (28D), SFA 28C, and along the boundary between Mid Bay North and Cape Spencer (28B; Figure 1, Appendix 1; see Nasmith et al. 2016 for detailed description of the strata). The biomass estimate of recruit scallops in 2019 was 84.5 t, a decrease from 96.3 t in 2018, and below the long-term (1997-2018) median of 144.2 t. Recruits were observed in all subareas of SPA 1B (Figure 2). Commercial biomass was spread throughout SPA 1B with the beds of highest biomass observed in Cape Spencer (28B) (Figure 3). The biomass estimate of commercial scallops in 2019 was 3286 t (meats), which was lower than 2018 (4945 t), above the long-term median of 2593 t, and in the Healthy Zone (Figure 5).

Catch scenarios for the 2019/2020 fishing season are presented in Table 2. Biomass projections use the current year estimates of growth, and natural mortality is the average over the last 5 years. The 2019/2020 TAC for SPA 1B was 614 t; the catch level from Table 2 that corresponds most closely is 615 t and is interpreted as follows: a catch of 615 t corresponds to an exploitaiton of 0.19 and is projected to result in a 19% decline in commercial biomass, the probability of commercial biomass increase is 17%, the probability that a catch of 615 t will result in the population remaining above the Lower Reference Point (LRP) is >99%, and the probability of the population remaining above the Upper Stock Reference (USR) is 87%. In the following fishing year (2020/2021), a catch of 254 t would have a probability of 10% of exceeding a reference exploitation of 0.15.

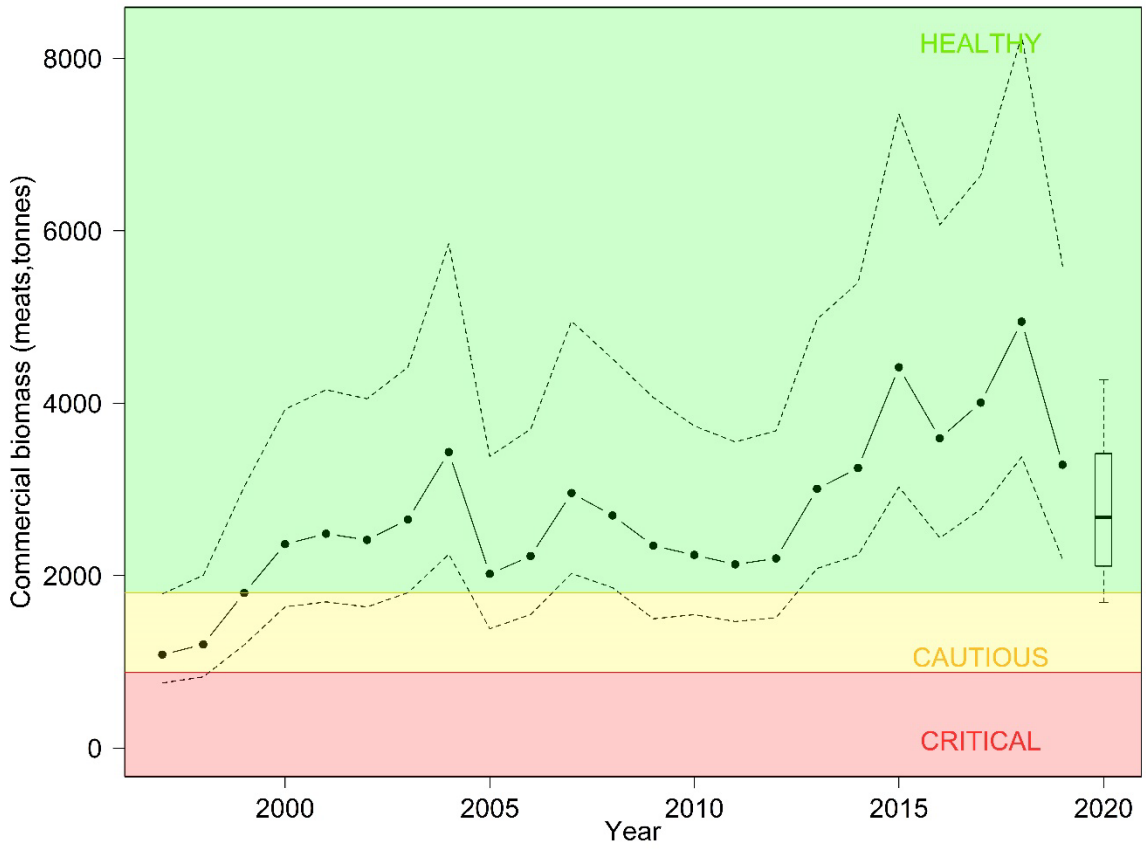

Figure 5. Median biomass estimates in SPA 1B for commercial size scallops in meat weight (tonnes) from the assessment model fit to the survey and commercial data. Dashed lines are the upper and lower 95% credible limits on the estimates. The predicted commercial size biomass for 2020, assuming the 2019/2020 TAC of 614 t, is displayed as a box plot with median, 50% credible limits (box), and 80% credible limits (whiskers). The green-shaded area represents the Healthy Zone (based on an Upper Stock Reference of 1800 t), the yellow-shaded area represents the Cautious Zone, and the red-shaded area is the Critical Zone (based on a Lower Reference Point of 880 t; Nasmith et al. 2014).

Table 2. Harvest scenario table for SPA 1B to evaluate 2019/2020 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; 1800 t), and above the Lower Reference Point (LRP; 880 t). Potential catches (t) in 2020/2021 are evaluated in terms of the posterior probability of exceeding an exploitation rate of 0.15. The catch level and associated scenario that corresponds most closely to the TAC from 2019/2020 is shown in bold.

2019/2020 Fishing Season						2020/2021 Fishing Season					
Catch (t)	*e*	% Change	Pr Increase	Pr >LRP	Pr >USR	**Probability Exploitation >0.15** *Potential Catch (t)*					
						0.1	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**
405	0.12	-13	0.26	>0.99	0.92	279	324	362	397	433	472
435	0.13	-14	0.25	>0.99	0.91	275	320	357	392	428	467
465	0.14	-15	0.24	>0.99	0.90	271	315	353	389	424	463
495	0.15	-16	0.22	>0.99	0.90	268	313	350	385	420	457
525	0.16	-17	0.21	>0.99	0.89	264	308	344	379	414	454
555	0.17	-18	0.19	>0.99	0.88	261	305	341	374	409	448
585	0.18	-19	0.18	>0.99	0.87	256	301	337	370	406	445
615	**0.19**	**-19**	**0.17**	**>0.99**	**0.87**	**254**	**298**	**334**	**367**	**401**	**440**

Scallop Production Area 2

Scallop Production Area 2 is considered to be marginal habitat for scallops and is not monitored regularly. This area was last assessed in 2006 (DFO 2007).

Scallop Production Area 3 Stock Status

Total landings for the 2019 fishing year in SPA 3 were 75.46 t against a TAC of 125 t. In the 2020 fishery (as of June 15, 2020), preliminary landings were 36.81 t against a TAC of 175 t. Recent TAC and landings are summarized in Appendix 2. The commercial catch rate in 2019 for St. Mary's Bay was 23.3 kg/h, an increase from 2018 (20.1 kg/h). Summer catch rates for SPA 3 outside of St. Mary's Bay (Brier/Lurcher area; see Nasmith et al. 2016) in 2019 were 17.2 kg/h, a decrease from 2018 (18.0 kg/h). In accordance with *Privacy Act* considerations, there are not enough fishing records from SPA 3 outside of St. Mary's Bay to summarize these data for the fall of 2018. For the 2020 fishing year (as of June 15, 2020), the preliminary catch rate for St. Mary's Bay is 30.7 kg/h. In SPA 3, outside of St. Mary's Bay, the catch rate for the fall of 2019 was 24.2 kg/h. As of June 15, 2020, there are not enough records from the area of SPA 3 outside of St. Mary's Bay to summarize for the summer of 2020 in accordance with the *Privacy Act*.

The survey and analysis for SPA 3 is based on two areas defined by Vessel Monitoring System (VMS) fishing patterns from 2002-2010 (Smith et al. 2012). The highest condition was observed in St. Mary's Bay (13.8 g). In 2019, condition for SPA 3 within the modelled area (11.4 g) increased from 2018 (10.9 g) and was above the long-term (1996-2018) mean of 11.1 g. Pre-recruits were predominately observed west of 66.4˚W (Figure 1). The biomass estimate of recruit scallops for 2019 was 42.1 t, an increase from 2018 (31.4 t), and below the long-term (1996-2018) median of 63.5 t. Recruits were found in low abundances in isolated patches that were largely confined to the Inside VMS area (Figure 2). Commercial biomass was distributed throughout SPA 3 with higher biomass within the Inside VMS areas (Figure 3). The biomass estimate of commercial scallops in 2019 was 2062 t (meats), similar to 2018 (2103 t), above the long-term median of 1488 t, and in the Healthy Zone (Figure 6).

Catch scenarios for the 2019/2020 fishing season are presented in Table 3. Biomass projections use the current year estimates of growth, and natural mortality is the average over the last 5 years. The 2019/2020 TAC for SPA 3 was 175 t; from Table 3 a catch of 175 t corresponds to an exploitation of 0.09 and is projected to result in a 13% decline in commercial biomass, the probability of commercial biomass increase is 30%, the probability that a catch of 175 t will result in the population remaining above the Lower Reference Point (LRP) is >99%, and the probability of the population remaining above the Upper Stock Reference (USR) is 94%. In the following fishing year (2020/2021), a catch of 166 t would have a 10% probability of exceeding a reference exploitation of 0.15.

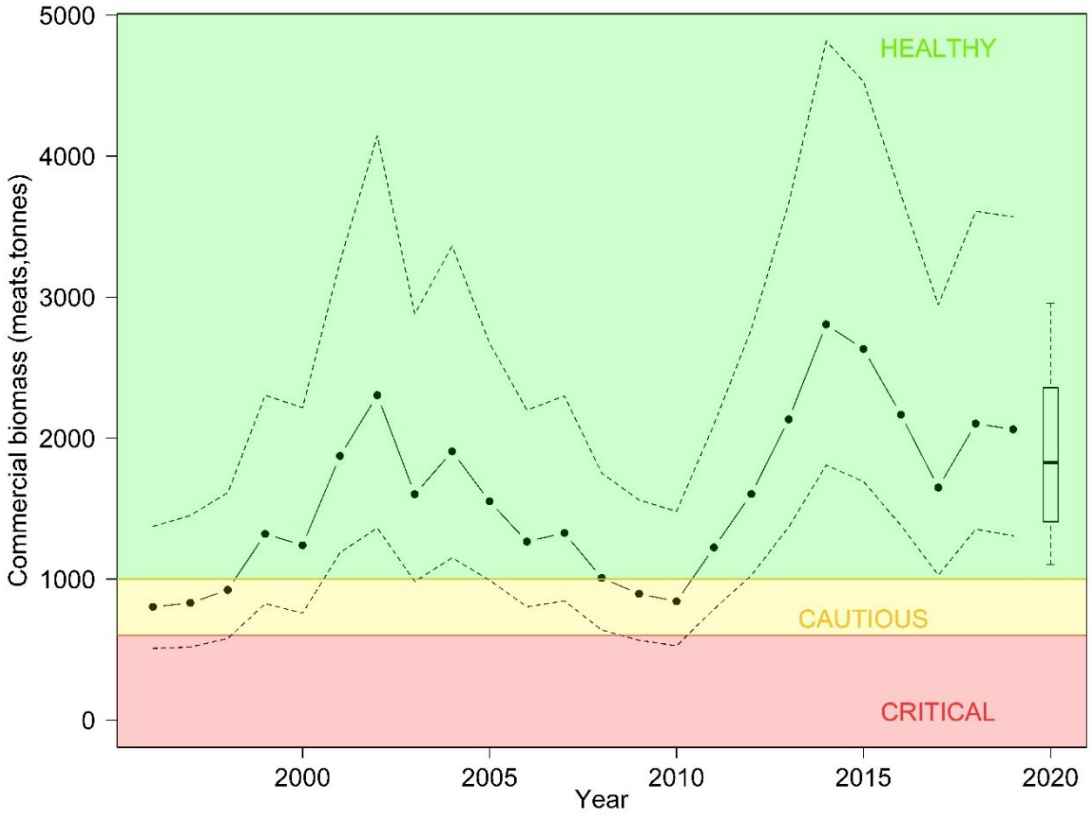

Figure 6. Median biomass estimates in SPA 3 for commercial size scallops in meat weight (tonnes) from the assessment model fit to the survey and commercial data. Dashed lines are the upper and lower 95% credible limits on the estimates. The predicted commercial size biomass for 2020, assuming the 2019/2020 TAC of 175 t, is displayed as a box plot with median, 50% credible limits (box), and 80% credible limits (whiskers). The green-shaded area represents the Healthy Zone (based on an Upper Stock Reference of 1000 t), the yellow-shaded area represents the Cautious Zone, and the red-shaded area represents the Critical Zone (based on Lower Reference Point of 600 t; Nasmith et al. 2014).

Table 3. Harvest scenario table for SPA 3 to evaluate 2019/2020 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; 1000 t), and above the Lower Reference Point (LRP; 600 t). Potential catches (t) in 2020/2021 are evaluated in terms of the posterior probability of exceeding an exploitation rate of 0.15. The catch level and associated scenario that corresponds to the TAC from 2019/2020 is shown in bold.

2019/2020 Fishing Season						2020/2021 Fishing Season					
Catch (t)	*e*	% Change	Pr Increase	Pr >LRP	Pr >USR	**Probability Exploitation >0.15** *Potential Catch (t)*					
						0.1	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**
100	0.05	-9	0.36	>0.99	0.95	174	208	235	260	285	313
125	0.06	-10	0.34	>0.99	0.95	172	204	231	256	281	310
150	0.08	-11	0.32	>0.99	0.94	169	202	228	253	279	307
175	**0.09**	**-13**	**0.30**	**>0.99**	**0.94**	**166**	**198**	**224**	**249**	**274**	**302**
200	0.10	-14	0.29	>0.99	0.93	164	195	221	246	271	299
225	0.11	-15	0.27	>0.99	0.92	160	192	218	243	268	295
250	0.13	-16	0.25	>0.99	0.92	159	190	215	239	263	290
275	0.14	-17	0.24	>0.99	0.91	155	186	212	236	261	288
300	0.15	-18	0.23	>0.99	0.91	152	183	208	232	257	284

Scallop Production Areas 4 and 5 Stock Status

As of the 2014 fishing year, SPA 5 was joined with SPA 4 under one TAC. Total landings in the 2019 fishing year were 105.64 t in SPA 4 and 7.45 t in SPA 5 against a combined TAC of 124.56 t (125 t before post-quota reconciliation). For the 2020 fishing year as of June 15, 2020, preliminary landings were 111.33 t in SPA 4 and 15.72 t in SPA 5 against a combined TAC of 135 t. Recent TAC and landings are summarized in Appendix 2. Commercial catch rates in SPA 4 and SPA 5 increased from 2018 to 2019, from 24.0 kg/h to 30.9 kg/h and 22.7 kg/h to 29.9 kg/h, respectively. In the 2020 fishing year as of June 15, 2020, catch rates were 28.7 kg/h in SPA 4 and 28.1 kg/h in SPA 5.

Condition in SPA 4 decreased from 11.5 g in 2018 to 10.0 g in 2019 and was below the long-term (1996-2018) mean of 11.1 g. Pre-recruit abundances were low throughout most of SPA 4 and were mostly observed towards the east of SPA 4 (Figure 1, Appendix 1; see Nasmith et al. 2016 for detailed description of the strata). The biomass estimate of recruit scallops in 2019 was 9.2 t, similar to 2018 (7.0 t) and below the long-term (1983-2018) median of 31.8 t. Recruits were mainly observed in the east (Figure 2), whereas the distribution of commercial biomass was relatively uniform throughout the area (Figure 3). The biomass estimate of commercial scallops in 2019 was 1252 t (meats), a decline from 2018 (1528 t), above the long-term median of 1061 t, and in the Healthy Zone (Figure 7).

Catch scenarios for the 2019/2020 fishing season are presented in Table 4. Biomass projections use the current year estimates of growth, and natural mortality is the average over the last 5 years. The 2019/2020 TAC for SPA 4 was 135 t; from Table 4 a catch of 135 t corresponds to an exploitation of 0.11 and is projected to result in a 12% decline in commercial biomass, the probability of commercial biomass increase is 35%, the probability that a catch of 135 t will result in the population remaining above the Lower Reference Point (LRP) is 97%, and the probability of the population remaining above the Upper Stock Reference (USR) is 84%. In the following fishing year (2020/2021), a catch of 99 t would have a probability of 10% of exceeding a reference exploitation of 0.15.

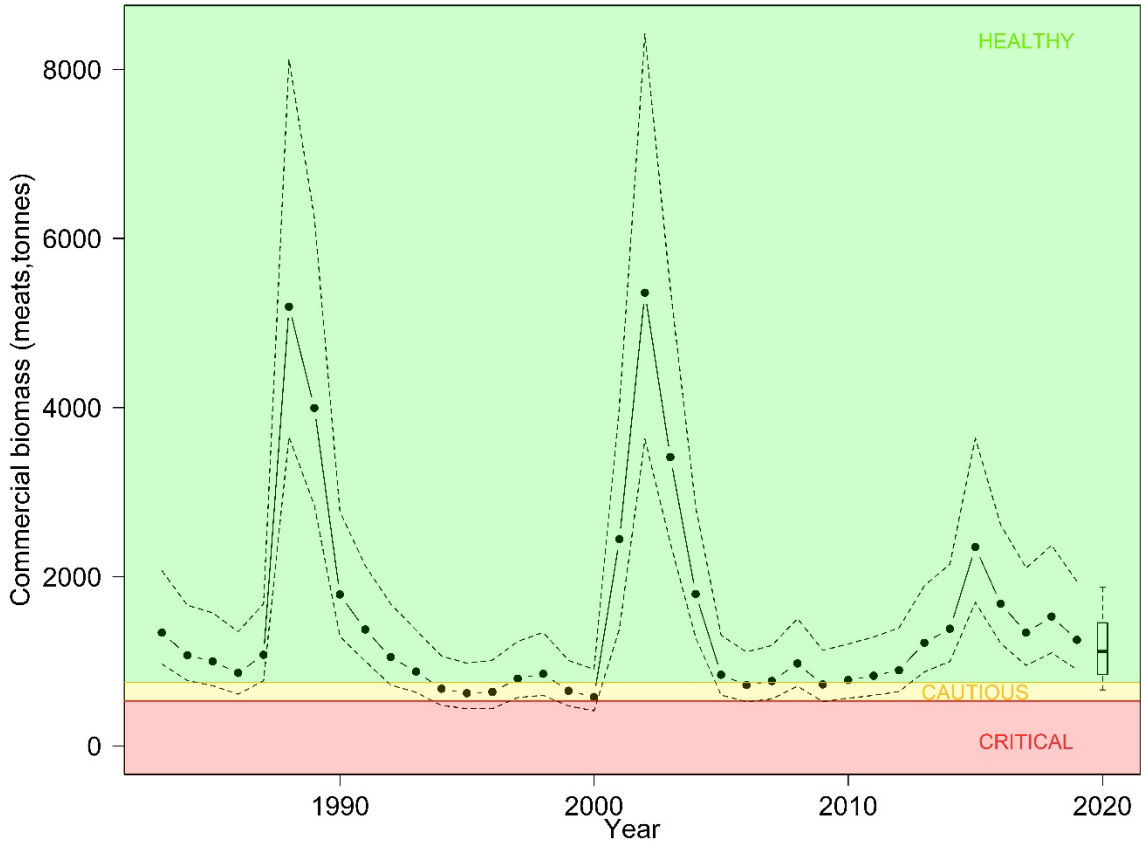

Figure 7. Median biomass estimates in SPA 4 for commercial size scallops in meat weight (tonnes) from the assessment model fit to the survey and commercial data. Dashed lines are the upper and lower 95% credible limits on the estimates. The predicted commercial size biomass for 2020, assuming the 2019/2020 TAC of 135 t, is displayed as a box plot with median, 50% credible limits (box), and 80% credible limits (whiskers). The green-shaded area represents the Healthy Zone (based on an Upper Stock Reference of 750 t), the yellow-shaded area represents the Cautious Zone, and the red-shading area represents the Critical Zone (based on Lower Reference Point of 530 t; Nasmith et al. 2014).

Table 4. Harvest scenario table for SPA 4 to evaluate 2019/2020 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; 750 t), and above the Lower Reference Point (LRP; 530 t). Potential catches (t) in 2020/2021 are evaluated in terms of the posterior probability of exceeding an exploitation rate of 0.15. The catch level and associated scenario that corresponds to the TAC from 2019/2020 is shown in bold.

2019/2020 Fishing Season						2020/2021 Fishing Season					
Catch (t)	*e*	% Change	Pr Increase	Pr >LRP	Pr >USR	**Probability Exploitation >0.15** *Potential Catch (t)* **0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**
95	0.08	-9	0.39	0.97	0.86	103	124	140	157	173	192
115	0.09	-11	0.37	0.97	0.85	102	121	138	154	170	188
135	**0.11**	**-12**	**0.35**	**0.97**	**0.84**	**99**	**119**	**135**	**151**	**167**	**184**
155	0.13	-14	0.33	0.96	0.82	97	116	132	148	163	181
175	0.14	-15	0.31	0.96	0.81	95	114	130	145	161	179
195	0.16	-17	0.30	0.95	0.80	93	112	127	142	158	175

The annual survey in SPA 5 was discontinued in 2009 after consultation with industry, and the sampling effort was redirected to other areas in the BoF. Since the 2014 survey, a small number of tows have been conducted in SPA 5 annually. The average number of commercial size scallop declined, from 217.7 scallops per tow (scallops/tow) in 2018 to 130.1 per tow in 2019, and it is above the long-term (1990-2018) median of 104.4 per tow. The weight per tow declined, from 3.0 kilograms per tow (kg/tow) in 2018 to 1.9 kg/tow in 2019, and it is near the long-term (1990-2018) median of 1.8 kg/tow. The average number of recruit sized scallops per tow (recruits/tow) declined from 15.8 per tow in 2018 to 6.2 per tow in 2019 and is below the long-term (1990-2018) recruit median of 26.9 recruits/tow. Recruit weight per tow declined, from 0.08 kg/tow in 2018 to 0.03 kg/tow in 2019, and it is below the long-term (1990-2018) recruit median of 0.1 kg/tow.

Scallop Production Area 6 Stock Status

Total landings in SPA 6 for Full Bay and Mid Bay fleets in the 2019 fishing year were 214.53 t against a combined TAC of 216.20 t (200 t before post-quota reconciliation). The Full Bay Fleet caught 32.66 t against a quota of 30.34 t (30 t before post-quota reconciliation), and the Mid Bay Fleet caught 181.87 t against a quota of 185.86 t (170 t before post-quota reconciliation). Preliminary landings for the 2020 fishing year (as of June 15, 2020) for both fleets in SPA 6 are 212.20 t against a combined TAC of 204.37 t. The Full Bay Fleet caught 29.88 t against a quota of 30 t and the Mid Bay Fleet caught 182.32 t against a quota of 174.37 t (170 t before post-quota reconciliation). Recent TAC and landings are summarized in Appendix 2.

The commercial catch rate series starting in 1997 for all subareas combined is the stock status indicator for this area, the LRP is 6.2 kg/h, the lowest catch rate observed in the time series since 1997, and the USR is 9.1 kg/h based on the average catch rate from 2005 to 2011. The stock status indicator catch rate was above the USR and in the Healthy Zone in 2018 (26.3 kg/h), 2019 (26.6 kg/h), and 2020 (27.6 kg/h) (Figure 8). Catch rates from 1997 to 2001 are not presented in Figure 8 due to a change in the commercial log system implemented in 2002.

The survey and analysis for SPA 6 is based on two areas defined by VMS fishing patterns from 2002-2014 (Smith et al. 2012; Nasmith et al. 2016). Indices were calculated separately for the fished area (Inside VMS stratum) and the unfished areas (Outside VMS stratum). Condition in the Inside VMS stratum was 9.6 g in 2019, a decrease from 2018 (10.3 g) and below the long-term (1997-2018) mean of 10.9 g. Condition in the Outside VMS stratum in 2019 was 9.5 g, a decrease from 2018 (10.2 g) and below the long-term (1997-2018) mean of 10.8 g. In 2019, pre-recruit abundances were low throughout most of SPA 6 (Figure 1, Appendix 1). The modelled area for SPA 6 is for the Inside VMS stratum only. In 2019, recruit biomass was 5.3 t, a decrease from 14.7 t in 2018 and below the long-term (2006-2018) median of 50.8 t. Recruit abundances were low throughout the area (Figure 2), whereas commercial biomass was well distributed throughout the surveyed area with higher biomasses observed west of Grand Manan (Figure 3). The biomass estimate of commercial scallops in 2019 was 992 t (meats), a decrease from 2018 (1048 t) and above the long-term median of 568 t (Figure 9).

Usable logbook data was spatially allocated by its reported latitude and longitude to either the Inside or Outside VMS strata or designated as not falling within a strata, and it was then used to determine the proportion of landings between areas as per the methods described in Nasmith et al. (2016). In 2019, the proportion of landings were 74%, 15%, and 11% for the Inside VMS stratum, Outside VMS stratum, and not falling within a strata, respectively. In 2020, the proportion of landings were 76%, 11%, and 13% for the Inside VMS stratum, Outside VMS stratum, and not falling within a strata, respectively.

Catch scenarios for 2019/2020 are presented in Table 5. Biomass projections use the current year estimates of growth, and natural mortality is the average over the last 5 years. The 2019/2020 estimated removals from the modelled area was 161 t; the catch level from Table 5 that corresponds most closely is 160 t and is interpreted as follows: a catch of 160 t corresponds to an exploitation of 0.15 and is projected to result in a 11% decline in commercial biomass, the probability of commercial biomass increase is 37%.

Figure 8. Annual commercial catch rate (kilogram/hour [kg/h]) for SPA 6 for all subareas and both fleets combined. The green-shaded area represents the Healthy Zone (based on an Upper Stock Reference of 9.1 kg/h), the yellow-shaded area represents the Cautious Zone, and the red-shaded area represents the Critical Zone (based on Lower Reference Point of 6.2 kg/h).

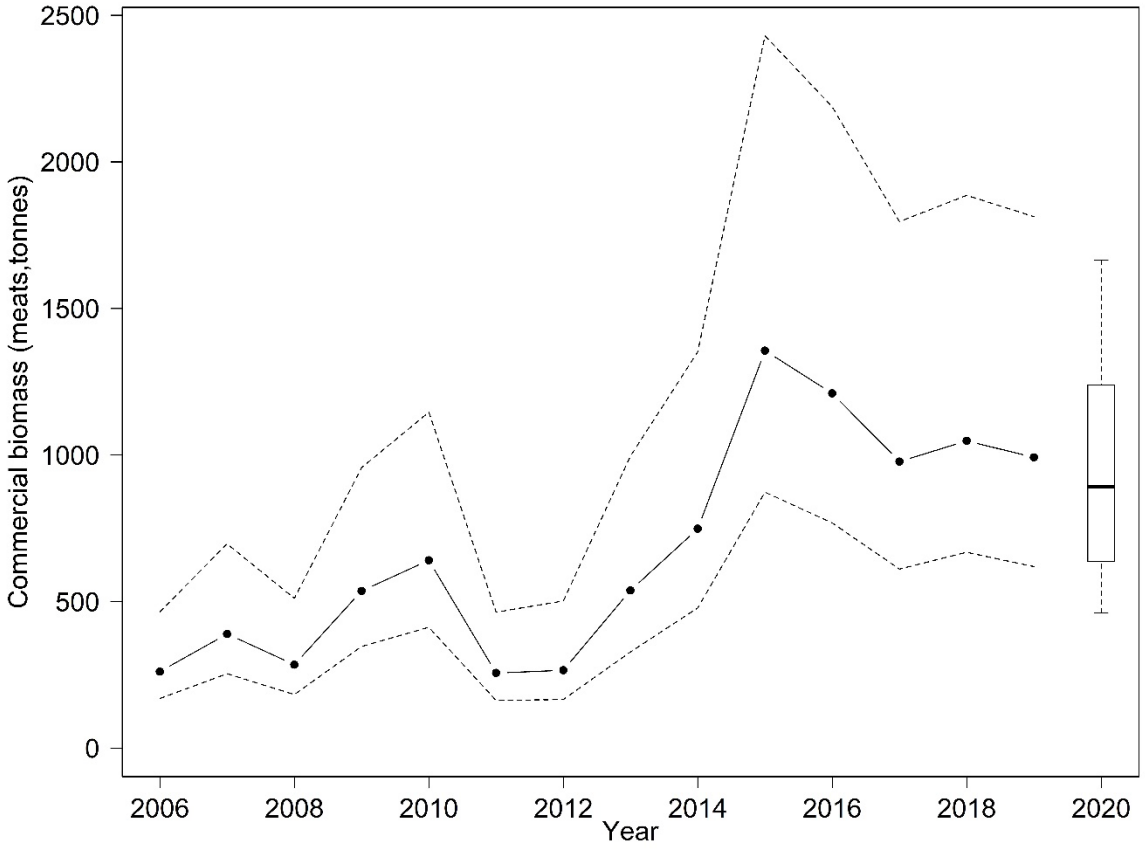

Figure 9. Median biomass estimates (solid line) in the SPA 6 modelled area for commercial size scallops in meat weight (tonnes) from the assessment model fit to the survey and commercial data. Dashed lines are the upper and lower 95% credible limits on the estimates. The predicted commercial size biomass for 2020, assuming a catch of 161 t in 2020, is displayed as a box plot with median, 50% credible limits (box), and 80% credible limits (whiskers).

Table 5. Harvest scenario table for SPA 6 to evaluate 2019/2020 catch levels in terms of resulting exploitation (e), expected changes in commercial biomass (%), and probability (Pr) of commercial biomass increase.

2019/2020 Fishing Season			
Catch (t)	*e*	% Change	Pr Increase
100	0.10	-5	0.44
120	0.11	-8	0.42
140	0.13	-10	0.40
160	**0.15**	**-11**	**0.37**
180	0.17	-14	0.35
200	0.19	-16	0.33

Ecosystem Considerations

There were 4 fisheries observer trips in the BoF Scallop fishery in the 2019 fishing year and 2 as of June 15, 2020, in the 2020 fishing year. Due to *Privacy Act* considerations, discard rates for bycatch cannot be reported. Currently, there is no DFO requirement that SFAs 28A-D trips

be observed. Refer to Sameoto and Glass (2012) for past analysis of discards from the inshore scallop fishery.

Conclusions

From 2018 to 2019, scallop condition decreased in all SPAs with the exception of SPA 3 in which condition increased. The biomass estimate of recruit scallops in 2019 decreased in SPAs 1A, 1B, and 6, was similar to 2018 in SPA 4, and increased in SPA 3. Commercial biomass decreased in all modelled SPAs with the exception of SPA 3, which remained similar to 2018. In 2019, estimates of commercial biomass for all SPAs remained in the Healthy Zone; however, recruitment for all SPAs was below their respective long-term medians and coincident with low levels of pre-recruits.

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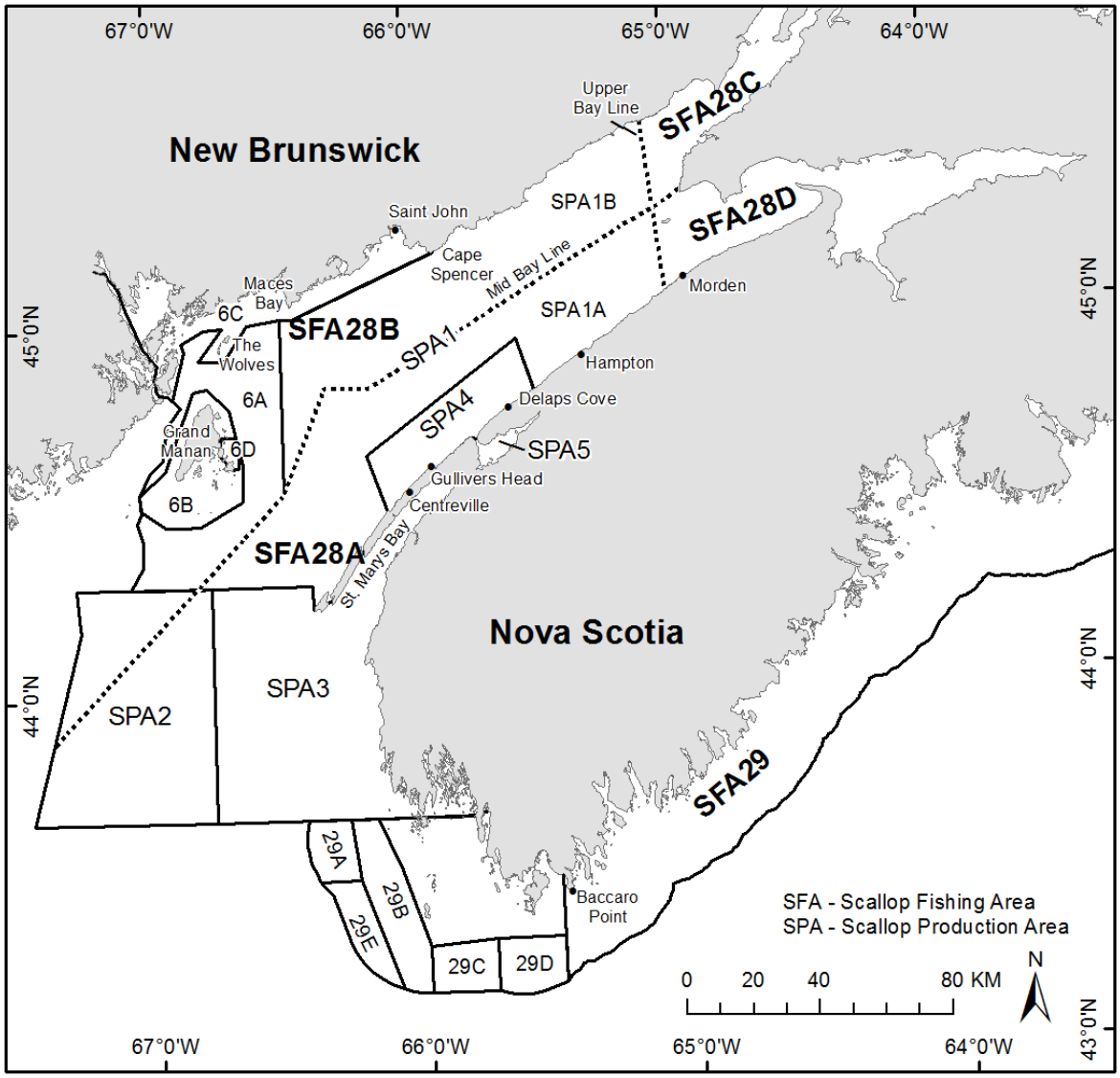
Appendices

Appendix 1

Map of Scallop Production Areas (SPAs) and Scallop Fishing Areas (SFAs) in the Bay of Fundy and approaches.



Appendix 2

Summary of Total Allowable Catch (TAC) and landings in tonnes (t), for Full Bay, Mid Bay, and Upper Bay fleets by Scallop Production Area (SPA) for 2015 to 2020. Landing values in 2020 are preliminary (as of June 15, 2020) and are post-quota reconciliation.

Area	Fleet		2015	2016	2017	2018	2019	2020
SPA 1A	Full Bay	Landings	361.55	422.31	395.88	427.15	467.49	289.29
		TAC	350	425	400	419.79	455.02	415
SPA 1B	Full Bay	Landings	303.96	314.04	235.95	297.95	380.85	191.89
		TAC	301.76	312.21	243.60	292.93	384.87	304.50
SPA 1B	Mid Bay	Landings	164.02	255.86	130.89	181.27	301.25	206.20
		TAC	175.59	229.55	143.18	196.46	290.99	212.92
SPA 1B	Upper Bay	Landings	78.19	84.05	69.01	72.57	57.75	21.07
		TAC	72.68	83.24	64.08	69.48	97.03	96.40
SPA 3	Full Bay	Landings	234.96	223.69	158.60	112.55	75.46	36.81
		TAC	250	225	175	157.42	125	175
SPA 4 and 5	Full Bay	Landings	132.35	233.56	190.94	151.55	113.09	127.05
		TAC	135	250	200	157.81	124.56	135
SPA 6	Full Bay	Landings	23.99	13.57	26.26	28.76	32.66	29.88
		TAC	37.77	38.76	33	29.91	30.34	30
SPA 6	Mid Bay	Landings	207.01	213.25	217.27	112.22	181.87	182.32
		TAC	202.23	211.24	184.82	129.03	185.86	174.37

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