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 2017/2018 season in 2017 (DFO 2018).

The objectives of this report are to: identify the consequences of different harvest levels in SPAs 1A, 1B, 3, 4, 5, and 6 for the 2018/2019 season, provide advice on the interim harvest levels for the start of the 2019/2020 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 before annual assessment or update results are available (November). Landing values from 2018 reported here are preliminary (as of October 10, 2018) and are post-quota reconciliation.

This Science Response Report results from the Science Response Process of November 26, 2018, on the Stock Status Update of Bay of Fundy Scallop.

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 2017/2018 fishing season (hereafter referred to as the 2018 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 no fisheries observer trips in the Bay of Fundy Scallop fishery in the 2018 fishing year. Currently, there is no DFO requirement that Scallop Fishing Area (SFA) 28 (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. Total Allowable Catches (TACs) and landings 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 427.15 tonnes (t) against a TAC of 419.79 t (400 t before post-quota reconciliation) during the 2018 fishery in SPA 1A. Recent TAC and landings are summarized in Appendix 2. The commercial catch rate in the 2018 fishing year was 29.6 kilograms per hour (kg/h), a decrease from 2017 (32.1 kg/h). Survey condition (measured in grams per a 100 mm shell height scallop) in 2018 was 11.4 g, an increase from 2017 (11.0 g) and similar to the long-term (1997-2017) mean of 11.2 g. Pre-recruits were observed in patches in SPA 1A with the majority of pre-recruits in the 8 to 16 mile survey strata and along 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 2018 was 24.9 t, which was similar to 2017 (25.5 t) and below the long-term (1997-2017) median of 62.6 t. Recruits were observed in isolated patches and were absent from large portions of SPA 1A (Figure 2). Commercial scallop biomass was greatest in the south-west portion of the 8 to 16 mile strata, and was patchy in the Mid Bay South stratum (Figure 3). The biomass estimate of commercial scallops in 2018 was 3314 t (meats), which was higher than 2017 (2995 t), above the long-term median of 1644 t, and in the Healthy Zone (Figure 4).

Catch scenarios for the 2018/2019 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. For example, Table 1 is interpreted as follows: a catch of 300 t corresponds to an exploitaiton 0.09 and is projected to result in a 8% decline in commercial biomass, the probability of commercial biomass increase is 37%, the probability that a catch of 300 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 >99%. In the following fishing year (2019/2020), a catch of 286 t would have a probability of 10% of exceeding a reference exploitation of 0.15.

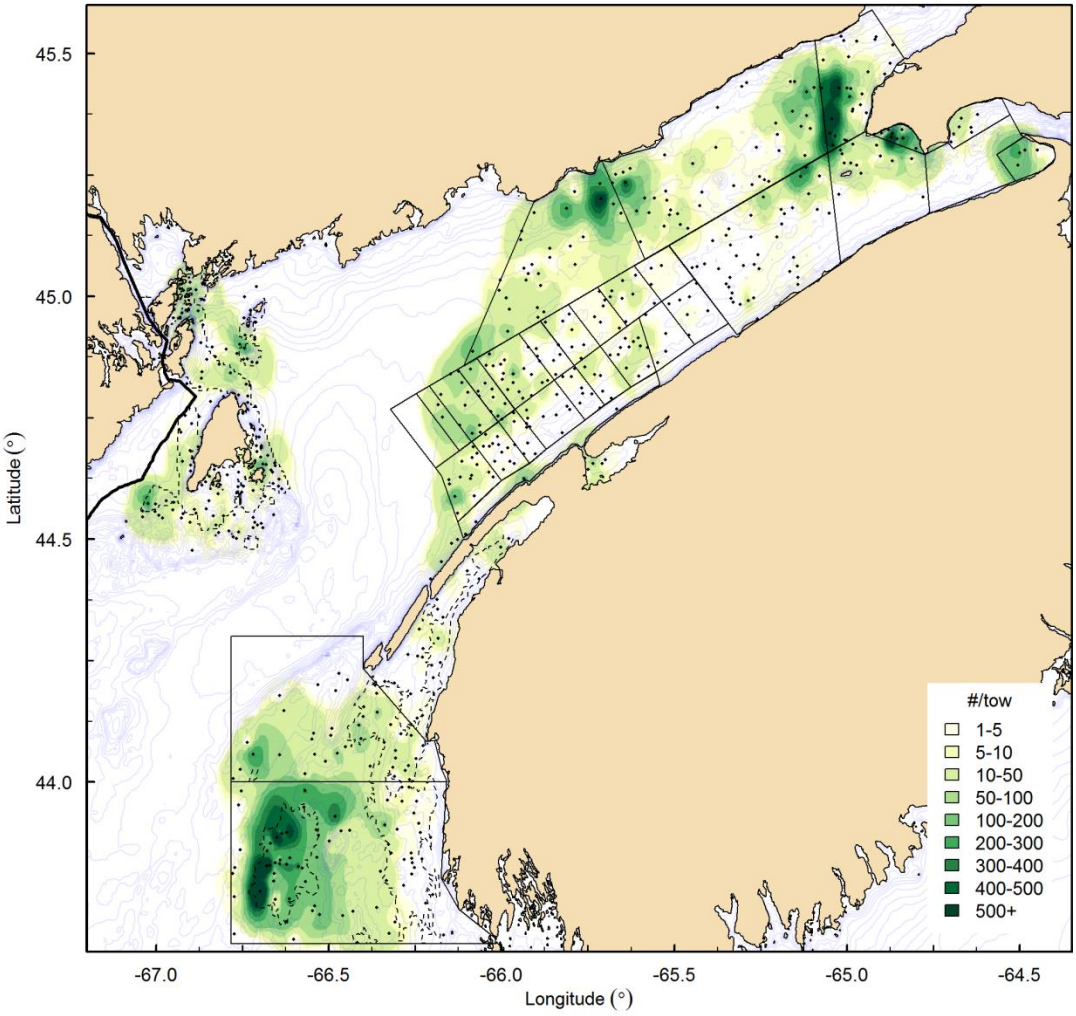

Figure 1. Spatial distribution (number/tow) of pre-recruit scallops (< 65 mm shell height) in the Bay of Fundy and approaches in 2018. Dots represent survey stations. Solid black lines are survey strata, dashed black lines are survey strata representing high (inside dashed lines) and low (outside dashed lines) fishing effort, based on Vessel Monitoring System (VMS) analysis (see: Smith et al. 2012).

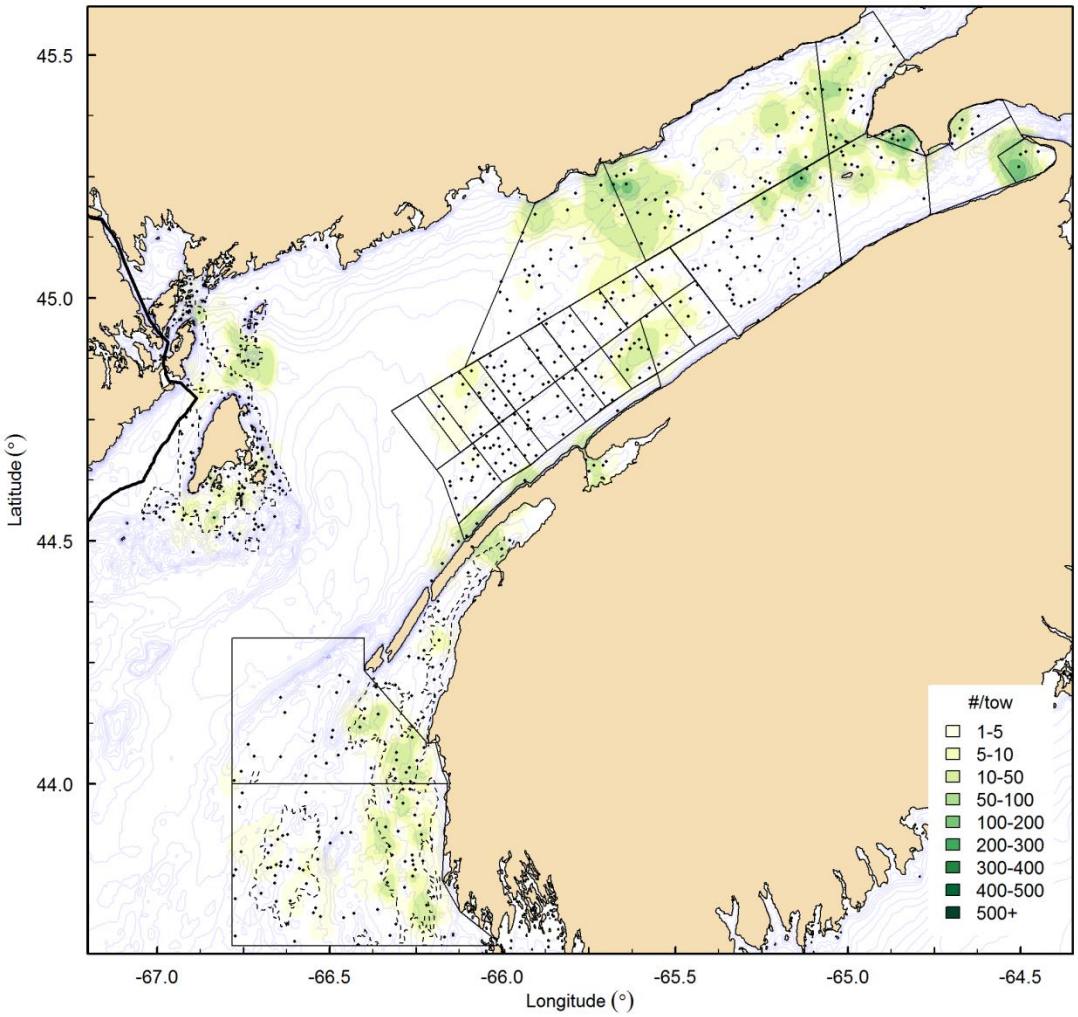

Figure 2. Spatial distribution (number/tow) of recruit scallops (65-79 mm shell height) in the Bay of Fundy and approaches in 2018. Dots represent survey stations. Solid black lines are survey strata, dashed black lines are survey strata representing high (inside dashed lines) and low (outside dashed lines) fishing effort, based on Vessel Monitoring System (VMS) analysis (see: Smith et al. 2012).

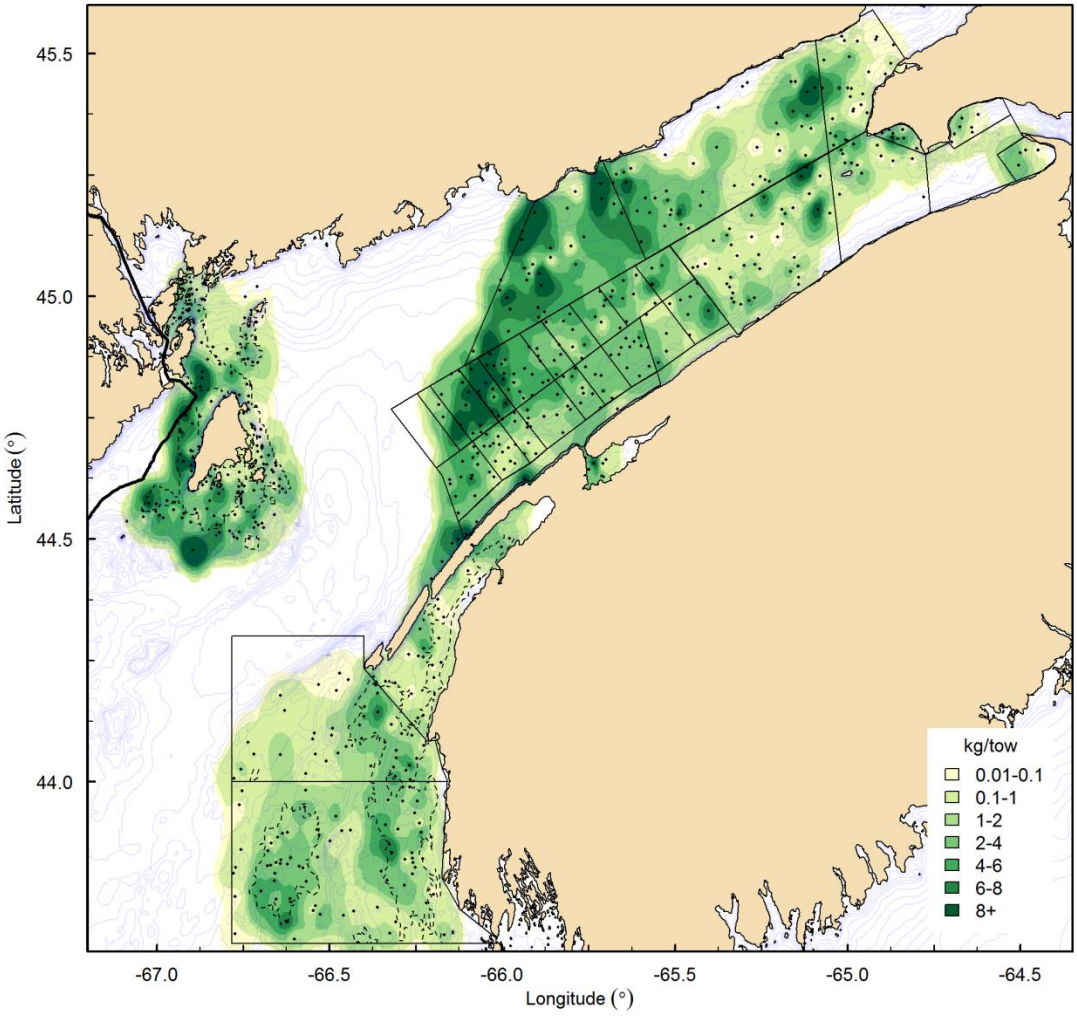

Figure 3. Spatial distribution of commercial (≥ 80 mm shell height) biomass (kg/tow) in the Bay of Fundy and approaches in 2018. Dots represent survey stations. Solid black lines are survey strata, dashed black lines are survey strata representing high (inside dashed lines) and low (outside dashed lines) fishing effort, based on Vessel Monitoring System (VMS) analysis (see: Smith et al. 2012).

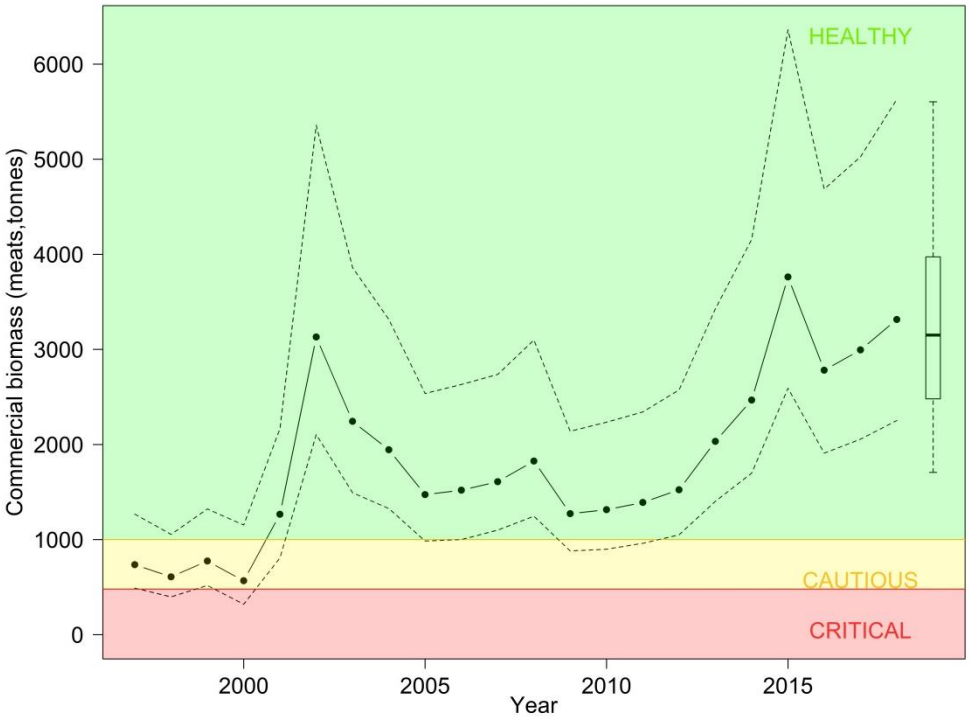

Figure 4. Median biomass estimates in SPA 1A for commercial size scallops in meat weight (tonnes) from the assessment model fit to the survey and commercial data. Dashed lines are the upper and lower 95% credible limits on the estimates. The predicted commercial size biomass for 2019, assuming the 2018/2019 interim TAC (200 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) point 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 2018/2019 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 2019/2020 are evaluated in terms of the posterior probability of exceeding exploitation rate of 0.15.

2018/2019 Fishing Season						2019/2020 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**
250	0.07	-7	0.39	>0.99	>0.99	291	345	388	427	467	510
300	0.09	-8	0.37	>0.99	>0.99	286	339	382	421	460	503
350	0.10	-10	0.35	>0.99	>0.99	280	333	374	413	453	496
400	0.12	-11	0.33	>0.99	>0.99	276	327	369	408	448	490
450	0.13	-12	0.32	>0.99	>0.99	271	321	363	402	442	485
500	0.15	-13	0.29	>0.99	>0.99	264	316	356	395	434	477

Scallop Production Area 1B Stock Status

The total 2018 landings for all fleets in SPA 1B was 551.79 t against a combined TAC of 558.87 t (550 t before post-quota reconciliation). Full Bay Fleet caught 297.95 t against a quota of 292.93 t (279.13 before post-quota reconciliation), Mid Bay Fleet caught 181.27 t against a quota of 196.46 t (196.46 t before post quota-reconciliation) and Upper Bay Fleet caught 72.57 t

against a quota of 69.48 t (74.42 t before post-quota reconciliation). Recent TAC and landings are summarized in Appendix 2. Catch rates in Scallop Fishing Area (SFA) 28B have been generally increasing for both Full Bay and Mid Bay fleets since 2012. In 2018, the catch rate in SFA 28B was the highest either fleet has had in that subarea (40.7 kg/h for Full Bay and 38.3 kg/h for Mid Bay). In SFA 28C, catch rates for the Upper Bay Fleet decreased from 21.7 kg/h in 2017 to 18.5 kg/h in 2018. Full Bay Fleet did not fish SFA 28C in 2018, and there were not enough records from Mid Bay Fleet to summarize for this subarea in accordance with *Privacy Act* considerations. In SFA 28D, catch rates for Upper Bay Fleet decreased from 19.5 kg/h in 2017 to 16.9 kg/h in 2018. There are not enough records from Full Bay Fleet to summarize these data for this subarea. Condition from the survey increased throughout SPA 1B in 2018 after declining for several years. Over the entire SPA 1B, condition increased from 10.1 g in 2017 to 11.1 g in 2018, and was below the long-term (1997-2017) mean of 11.7 g. Pre-recruits were observed throughout SPA 1B, with the highest densities in Advocate Harbour (28D), SFA 28C, 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 increased from 67.2 t in 2017 to 96.6 t in 2018, and was below the long-term (1997-2017) median of 152.6 t. Recruits were observed in patches 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) and near the Upper Bay line (Figure 3). The biomass estimate of commercial scallops in 2018 was 5170 t (meats), which was higher than 2017 (4048 t), above the long-term median of 2565 t, and in the Healthy Zone (Figure 5). Growth rate parameters used in the assessment model in 2018 were recalculated using the average depth of SPA 1B.

Catch scenarios for the 2018/2019 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. See SPA 1A Stock Status section in this document for an example of interpreting the table.

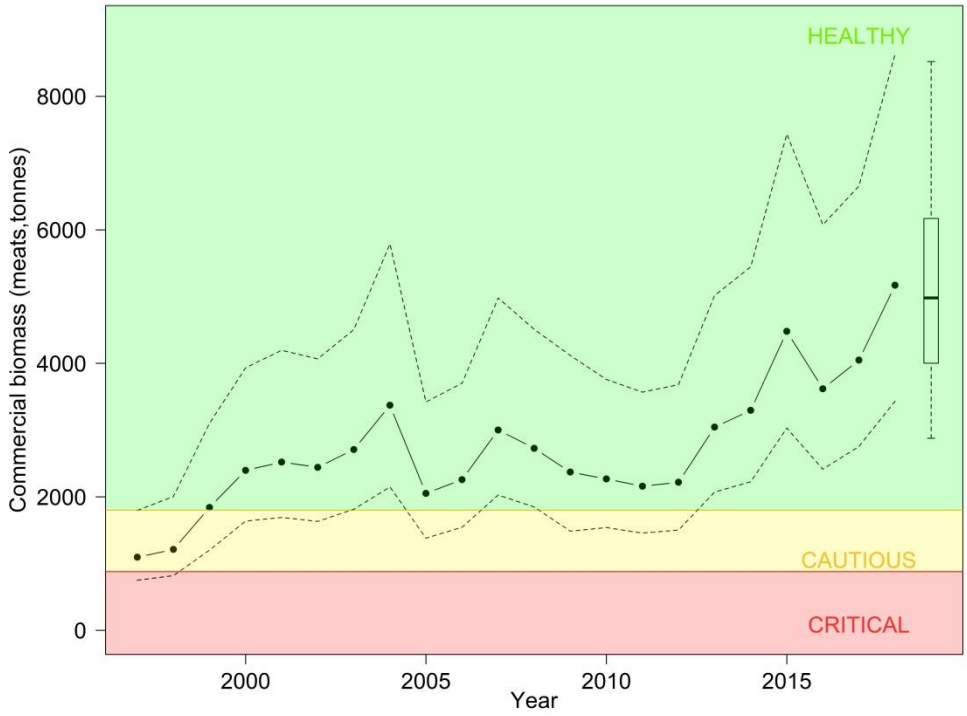

Figure 5. Median biomass estimates in SPA 1B for commercial size scallops in meat weight (tonnes) from the assessment model fit to the survey and commercial data. Dashed lines are the upper and lower 95% credible limits on the estimates. The predicted commercial size biomass for 2019, assuming the 2018/2019 interim TAC (150 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 2018/2019 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 USR (1800 t), and above the LRP (880 t). Potential catches (t) in 2019/2020 are evaluated in terms of the posterior probability of exceeding exploitation rate of 0.15.

2018/2019 Fishing Season						2019/2020 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**
300	0.06	-7	0.37	>0.99	>0.99	474	550	611	667	726	788
350	0.07	-8	0.35	>0.99	>0.99	467	543	603	659	717	781
400	0.08	-9	0.34	>0.99	>0.99	461	537	597	655	712	774
450	0.09	-10	0.33	>0.99	>0.99	456	531	591	647	704	767
500	0.10	-10	0.31	>0.99	>0.99	450	526	586	643	700	764
550	0.11	-11	0.3	>0.99	>0.99	444	519	579	636	693	755
600	0.12	-12	0.28	>0.99	>0.99	439	514	572	629	687	748
650	0.13	-13	0.27	>0.99	>0.99	433	507	565	620	679	740
700	0.14	-14	0.25	>0.99	>0.99	427	501	560	616	672	733
750	0.15	-15	0.24	>0.99	>0.99	420	492	551	607	664	726

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 2018 fishing year in SPA 3 were 112.55 t against a TAC of 157.42 t (150 t before post-quota reconciliation). Recent TAC and landings are summarized in Appendix 2. Commercial catch rate in 2018 for St. Mary's Bay was 20.1 kg/h, a decrease from 2017 (21.6 kg/h). Summer catch rates for SPA 3 outside of St. Mary's Bay (Brier/Lurcher area; see Nasmith et al. 2016) in 2018 were 18.0 kg/h, a decrease from 2017 (18.8 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 2017. 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 (11.8 g). Overall condition for SPA 3 in 2018 (10.9 g) was lower than in 2017 (11.3 g) and below the long-term (1996-2017) mean of 12.0 g. Pre-recruits were predominately observed west of 66.4°W (Figure 1). The biomass estimate of recruit scallops for 2018 was 31.2 t, similar to 2017 (28.7 t), and below the long-term (1996-2017) median of 65.7 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 in isolated patches within the Inside VMS areas (Figure 3). The biomass estimate of commercial scallops in 2018 was 2081 t (meats), an increase from 2017 (1621 t), above the long-term median of 1441 t, and in the Healthy Zone (Figure 6).

Catch scenarios for the 2018/2019 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. See SPA 1A Stock Status section in this document for an example of interpreting the table.

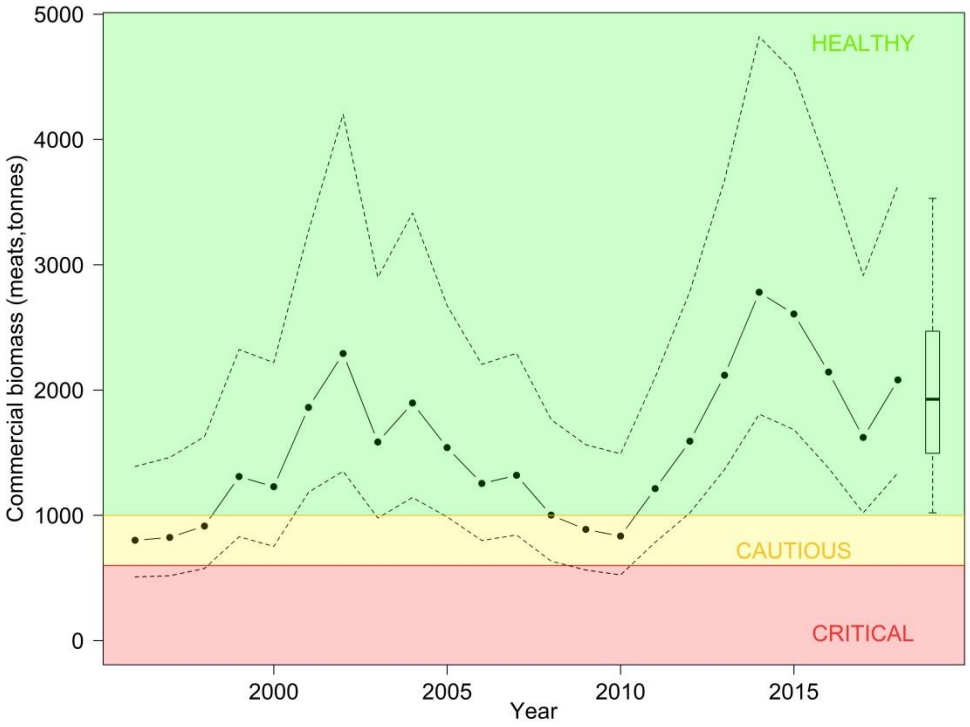

Figure 6. Median biomass estimates in SPA 3 for commercial size scallops in meat weight (tonnes) from the assessment model fit to the survey and commercial data. Dashed lines are the upper and lower 95% credible limits on the estimates. The predicted commercial size biomass for 2019, assuming the 2018/2019 interim TAC (100 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 2018/2019 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 2019/2020 are evaluated in terms of the posterior probability of exceeding exploitation rate of 0.15.

2018/2019 Fishing Season						2019/2020 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	176	209	236	262	288	317
120	0.06	-10	0.34	>0.99	0.95	174	207	233	258	285	314
140	0.07	-11	0.33	>0.99	0.95	172	205	232	257	283	311
160	0.08	-12	0.32	>0.99	0.94	169	202	229	254	280	308
180	0.09	-13	0.30	>0.99	0.94	167	200	226	251	276	305
200	0.10	-14	0.29	>0.99	0.94	165	198	224	249	274	302
220	0.11	-14	0.27	>0.99	0.93	163	195	222	246	271	299
240	0.12	-15	0.26	>0.99	0.93	162	193	219	243	268	296
260	0.13	-16	0.25	>0.99	0.92	159	189	215	240	265	292
280	0.14	-17	0.24	>0.99	0.92	157	188	213	237	262	289
300	0.15	-18	0.22	>0.99	0.91	155	185	210	234	259	286

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 2018 fishing year were 142.15 t in SPA 4 and 9.40 t in SPA 5 against a combined TAC of 157.81 t (150 t before post-quota reconciliation). Recent TAC and landings are summarized in Appendix 2. Commercial catch rates in SPA 4 in 2018 were 24.0 kg/h, a decrease from 2017 (27.3 kg/h). Commercial catch rate in SPA 5 in 2018 was 22.7 kg/h, a decrease from 2017 (30.1 kg/h) and above the long-term (1977-2017) median of 19.7 kg/h. Condition in SPA 4 in 2018 was 11.5 g, similar to 2017 (11.3 g) and near the long-term (1996-2017) mean of 11.1 g. Pre-recruit abundances were low throughout most of SPA 4 with localized patches along the east, west, and near shore edges of the area (Figure 1, Appendix 1; see Nasmith et al. 2016 for detailed description of the strata). The biomass estimate of recruit scallops in 2018 was 6.5 t, an increase from 3.2 t in 2017 and below the long-term (1983-2017) median of 33.0 t. Recruits were observed in localized patches to the northeast and near shore and were absent from the majority of the area (Figure 2), whereas the distribution of commercial biomass was relatively uniform (Figure 3). The biomass estimate of commercial scallops in 2018 was 1413 t (meats), an increase from 2017 (1242 t), and above the long-term median of 962.6 t, and in the Healthy Zone (Figure 7).

Catch scenarios for the 2018/2019 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. See SPA 1A Stock Status section in this document for an example of interpreting the table.

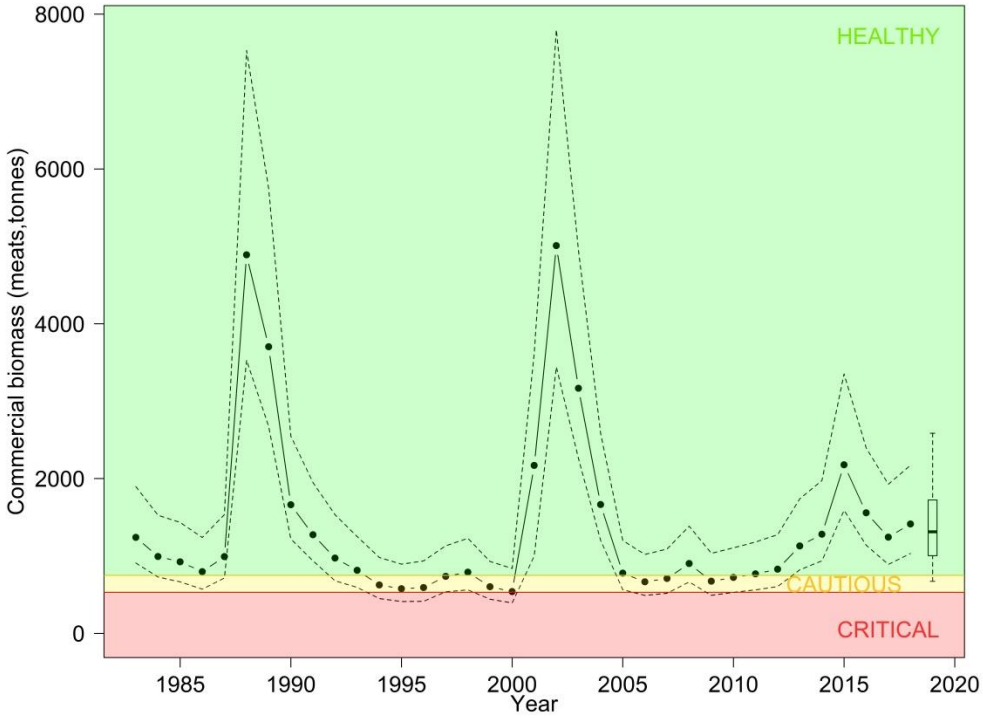

Figure 7. Median biomass estimates in SPA 4 for commercial size scallops in meat weight (tonnes) from the assessment model fit to the survey and commercial data. Dashed lines are the upper and lower 95% credible limits on the estimates. The predicted commercial size biomass for 2019, assuming the 2018/2019 interim TAC (100 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 2018/2019 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 2019/2020 are evaluated in terms of the posterior probability of exceeding exploitation rate of 0.15.

2018/2019 Fishing Season						2019/2020 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	0.07	-9	0.40	0.99	0.92	117	140	159	177	196	218
120	0.09	-10	0.38	0.98	0.91	115	138	157	175	194	215
140	0.10	-11	0.37	0.98	0.90	113	136	154	172	191	211
160	0.11	-12	0.35	0.98	0.90	111	133	152	170	188	209
180	0.13	-14	0.33	0.98	0.89	109	131	149	167	185	205
200	0.14	-16	0.31	0.98	0.88	107	129	147	163	181	201
220	0.16	-17	0.30	0.97	0.87	104	126	144	161	178	198

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 scallops per tow (scallops/tow) in 2018 was 217.7, down from 268.7 per tow in 2017 but above the historic long-term (1990-2008) median of 79.5 per tow. The weight per tow in 2018 was

3.0 kilograms per tow (kg/tow), a decrease from 2017 (3.8 kg/tow) and above the historic long-term (1990-2008) median of 1.4 kg/tow. The average number of recruit sized scallops per tow (recruits/tow) was 15.8, down from 40.5 per tow in 2017 and below the historic long-term (1990-2008) recruit median of 22.3 recruits/tow. Recruit weight per tow in 2018 was 0.08 kg/tow, down from 0.17 kg/tow in 2017 and below the historic long-term (1990-2008) 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 2018 fishing year were 140.98 t against a combined TAC of 158.94 t (190 t before post-quota reconciliation). Full Bay Fleet caught 28.76 t against a quota of 29.91 t (28.5 t before post-quota reconciliation), and Mid Bay Fleet caught 112.22 t against a quota of 129.03 t (161.5 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. In 2018, the catch rate across all areas was 26.3 kg/h, the same rate as in 2017, above the USR, and in the Healthy Zone (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 10.3 g in 2018, an increase from 2017 (9.8 g) and below the long-term (1997-2017) mean of 10.9 g. Condition in the Outside VMS stratum in 2018 was 10.2 g, an increase from 2017 (9.7 g) and below the long-term (1997-2017) mean of 10.8 g. Pre-recruits were observed throughout much of the survey area (Figure 1, Appendix 1). In 2018, recruit biomass was 13.7 t, a decrease from 20.9 t in 2017 and below the long-term (2006-2017) median of 51.9 t. Recruit abundances were generally low with most of the patches occurring north of Grand Manan Island (Figure 2), whereas commercial biomass was well distributed throughout the surveyed area with higher biomass patches found in the west (Figure 3). The biomass estimate of commercial scallops in 2018 was 969 t (meats), an increase from 2017 (904 t), and above the long-term median of 489 t (Figure 9).

The modelled area for SPA 6 is for the Inside VMS stratum only. 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 then used to determine the proportion of landings between areas as per the methods described in Nasmith et al. (2016). In 2018, the proportion of landings were 68%, 17%, and 15% for the Inside VMS stratum, Outside VMS stratum, and not falling within a strata, respectively. Catch scenarios for 2018/2019 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. For example, Table 5 is interpreted as follows: a TAC of 140 t corresponds to an exploitaiton of 0.14, and is projected to result in a 10% decrease in commercial biomass, and the probability of commercial biomass increase is 42%.

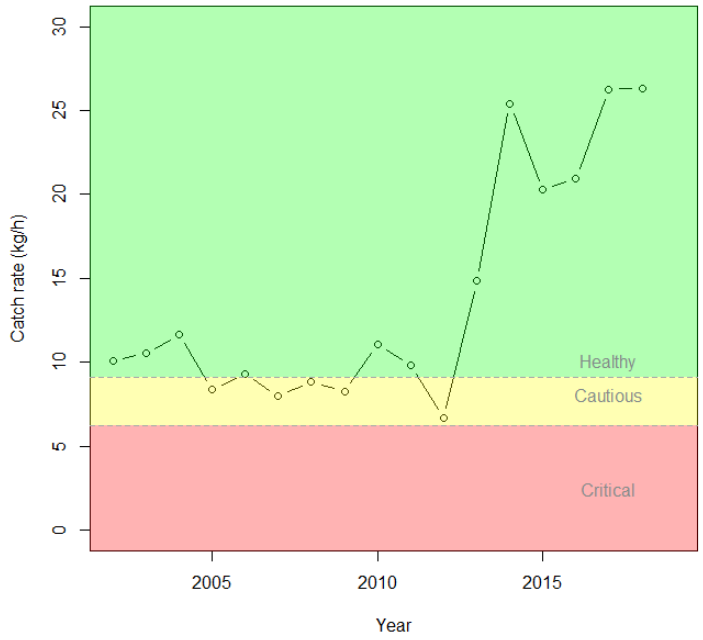

Figure 8. Annual commercial catch rate (kilogram/hour [kg/h]) for SPA 6 for all subareas and both fleets combined. The green-shaded area represents the Healthy Zone (based on an Upper Stock Reference of 9.1 kg/h), the yellow-shaded area represents the Cautious Zone, and the red-shaded area represents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

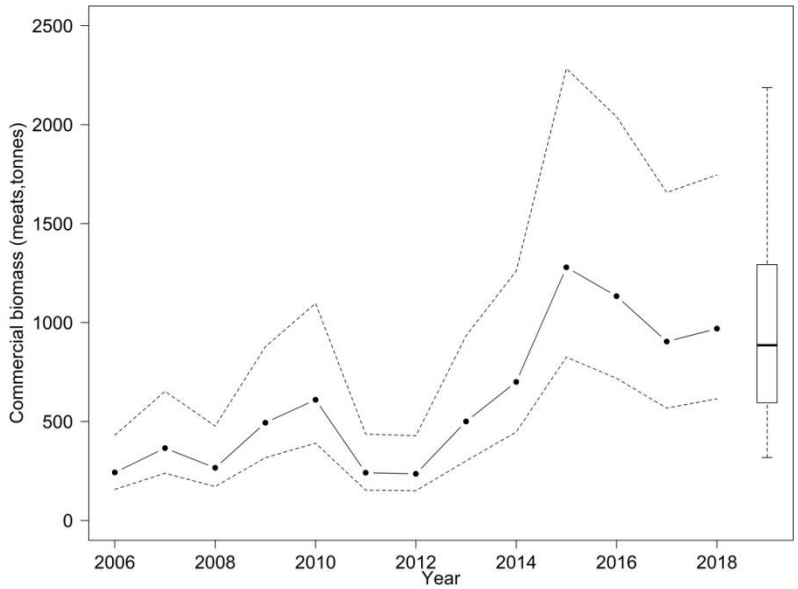

Figure 9. Median biomass estimates (solid line) in the SPA 6 modelled area for commercial size scallops in meat weight (tonnes) from the assessment model fit to the survey and commercial data. Dashed lines are the upper and lower 95% credible limits on the estimates. The predicted commercial size biomass for 2019, assuming a catch of 150 t in 2019, is displayed as a box plot with median, 50% credible limits (box) and 80% credible limits (whiskers).

Table 5. Harvest scenario table for the SPA 6 modelled area to evaluate 2018/2019 fishing season catch levels in terms of resulting exploitation (e), expected changes in commercial biomass (%), and probability (Pr) of commercial biomass increase.

Catch (t)	*e*	% Change	Pr Increase
80	0.08	-4	0.47
100	0.10	-6	0.45
120	0.12	-8	0.43
140	0.14	-10	0.42
160	0.16	-11	0.40
180	0.18	-14	0.38
200	0.19	-16	0.36
220	0.21	-18	0.34

Ecosystem Considerations

There were no fisheries observer trips in the Bay of Fundy Scallop fishery in the 2018 fishing year. Currently, there is no DFO requirement that SFA 28 trips be observed. Refer to Sameoto and Glass (2012) for past analysis of discards from the inshore scallop fishery.

Conclusions

From 2017 to 2018, scallop condition increased or was similar within each SPA in the Bay of Fundy except for a decrease in SPA 3. The biomass estimate of recruit scallops in 2018 increased in SPAs 1B and 4, was similar to 2017 in SPAs 1A and 3, and declined in SPA 6. Commercial biomass increased in all modelled SPAs. Estimates of commercial biomass for all SPAs remain in the Healthy Zone; however, in 2018, overall recruitment across the BoF is below average and coincident with low levels of pre-recruits.

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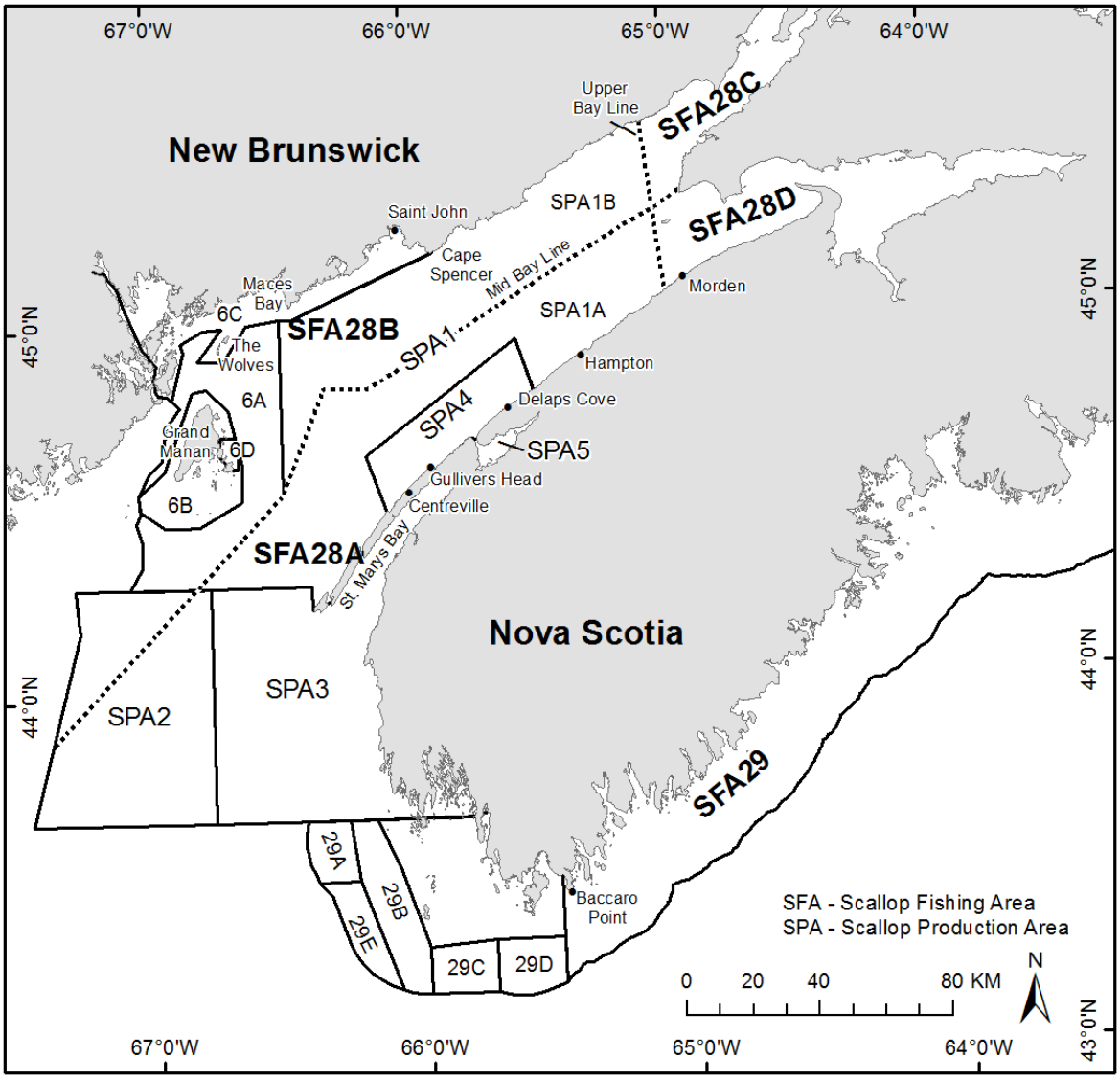
Appendices

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 2011 to 2018. Note SPA 4 and 5 were joined under one TAC in 2014, for landings and TAC prior to 2014 (represented by a dash (-)) see Nasmith et al. (2016). Landing values in 2018 are preliminary (as of October 10, 2018), and are post-quota reconciliation.

Area	Fleet		2011	2012	2013	2014	2015	2016	2017	2018
SPA 1A	Full Bay	Landings	278.1	206.4	206.02	274.49	361.55	420.37	396.43	427.15
		TAC	300	200	200	275	350	425	400	419.79
SPA 1B	Full Bay	Landings	84.2	159.9	202.8	229.4	303.96	317.35	236.24	297.95
		TAC	203	152.3	190.3	228.4	301.8	312.21	243.60	292.93
SPA 1B	Mid Bay	Landings	123.3	103.1	162.7	197.7	164.02	259.33	133.03	181.27
		TAC	142.9	107.2	133.95	160.74	175.6	229.6	143.18	196.46
SPA 1B	Upper Bay	Landings	54.7	39.97	57.4	68.9	78.2	84.10	68.56	72.57
		TAC	54.1	40.6	50.7	60.9	72.7	83.24	64.08	69.48
SPA 3	Full Bay	Landings	72.96	264.8	261	265.1	234.96	225.29	158.74	112.55
		TAC	50	300	260	260	250	225	175	157.42
SPA 4 and 5	Full Bay	Landings	-	-	-	102.5	132.35	233.68	192.04	151.55
		TAC	-	-	-	110	135	250	200	157.81
SPA 6	Full Bay	Landings	0	0.88	8.1	18.2	23.99	13.44	26.26	28.76
		TAC	21	21	21	32.55	37.77	38.76	33	29.91
SPA 6	Mid Bay	Landings	103.9	54.7	117.5	196.8	207.01	212.77	216.19	112.22
		TAC	119	119	119	184.45	202.23	211.24	184.82	129.03

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MPO. 2019. Mise à jour de l'état du stock de pétoncles (*Placopecten Magellanicus*) des zones de production de pétoncles 1 à 6 de la baie de Fundy. Secr. can. de consult. sci. du MPO, Rép. des Sci. 2019/039.