# STOCK STATUS UPDATE FOR 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 2016/2017 season in 2016 (DFO 2017).

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 2017/2018 season, provide advice on the interim harvest levels for the start of the 2018/2019 season for SPAs 1A, 1B, 3, and 4, and identify all information on fishery by-catch 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 2017 reported here are preliminary (as of Nov. 10, 2017) and are post-quota reconciliation.

This Science Response Report results from the Science Response Process of 29 November, 2017, 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 Fisheries and Oceans Canada (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). 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 2016/2017 fishing season (hereafter referred to as the 2017 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 three fisheries observer trips in the Bay of Fundy Scallop fishery in the 2017 fishing year, arranged by the Full Bay Fleet to fulfil their Marine Stewardship Council certification requirements.

### Description of the Fishery

The BoF inshore scallop fishery is fished by three scallop fleets: Full Bay, Mid Bay, and Upper Bay (Appendix 1). 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. 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) are set and landings are reported in terms of meat weights (adductor muscles).

## Analysis and Response

### Scallop Production Area 1A Stock Status

The Full Bay Fleet caught a total of 395.88 tonnes (t) against a TAC of 400 t during the 2017 fishery in SPA 1A. Recent TAC and landings are summarized in Appendix 2. The commercial catch rate in the 2017 fishing year was 32.1 kilograms per hour (kg/h), a decrease from 2016 (39.3 kg/h) and above the long-term (1998 to 2016) median of 16.3 kg/h. Survey condition (measured in grams per a 100 mm shell height scallop) in 2017 was 11.0 g, down slightly from 2016 (11.3 g) and slightly below the long-term (1997-2016) mean of 11.2 g. Pre-recruits were observed in patches throughout SPA 1A with the majority of pre-recruits in the 8 to 16 mile survey strata (Figure 1, Appendix 1). The biomass estimate of recruit scallops in 2017 was 25.1 t, which was slightly lower than 2016 (26.5 t) and below the long-term (1997-2016) median of 64.1 t. Recruits were observed in highly localized patches and were absent from large portions of SPA 1A (Figure 2, Appendix 1). Commercial scallop were predominately observed in the 8 to 16 mile strata, and their distribution was most patchy in the Middle Bay South stratum, which is the Northern portion of SPA 1A (Figure 3, Appendix 1). The biomass estimate of commercial scallops in 2017 was 2885 t (meats), which was higher than 2016 (2755 t), above the long-term median of 1570 t, and in the Healthy Zone (Figure 4).

Catch scenarios for the 2017/2018 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 200 t corresponds to an exploitaiton 0.07 and is projected to result in a 2% decline in biomass, the probability of biomass increase is 47%, the probability that a catch of 200 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 (2018/2019), a catch of 263 t would have a probability of 10% of exceeding a reference exploitation of 0.15.

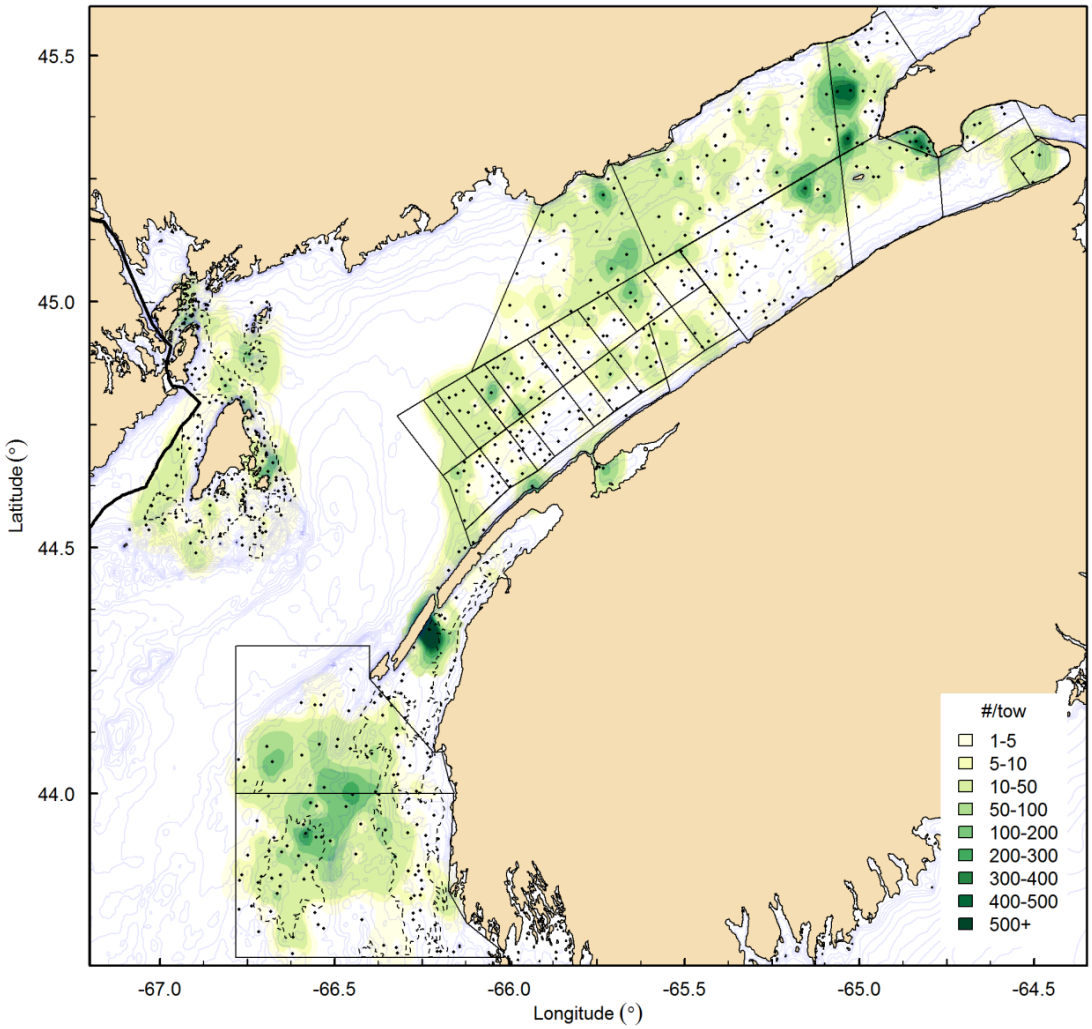


*Figure 1. Spatial distribution (number/tow) of pre-recruit scallops (< 65 mm shell height) in the Bay of Fundy and approaches in 2017. Solid black lines are survey strata, dashed black lines are survey strata representing high (inside dashed lines) and low (outside dashed lines) fishing effort, based on Vessel Monitoring System (VMS) analysis (see: Smith et al. 2012).*

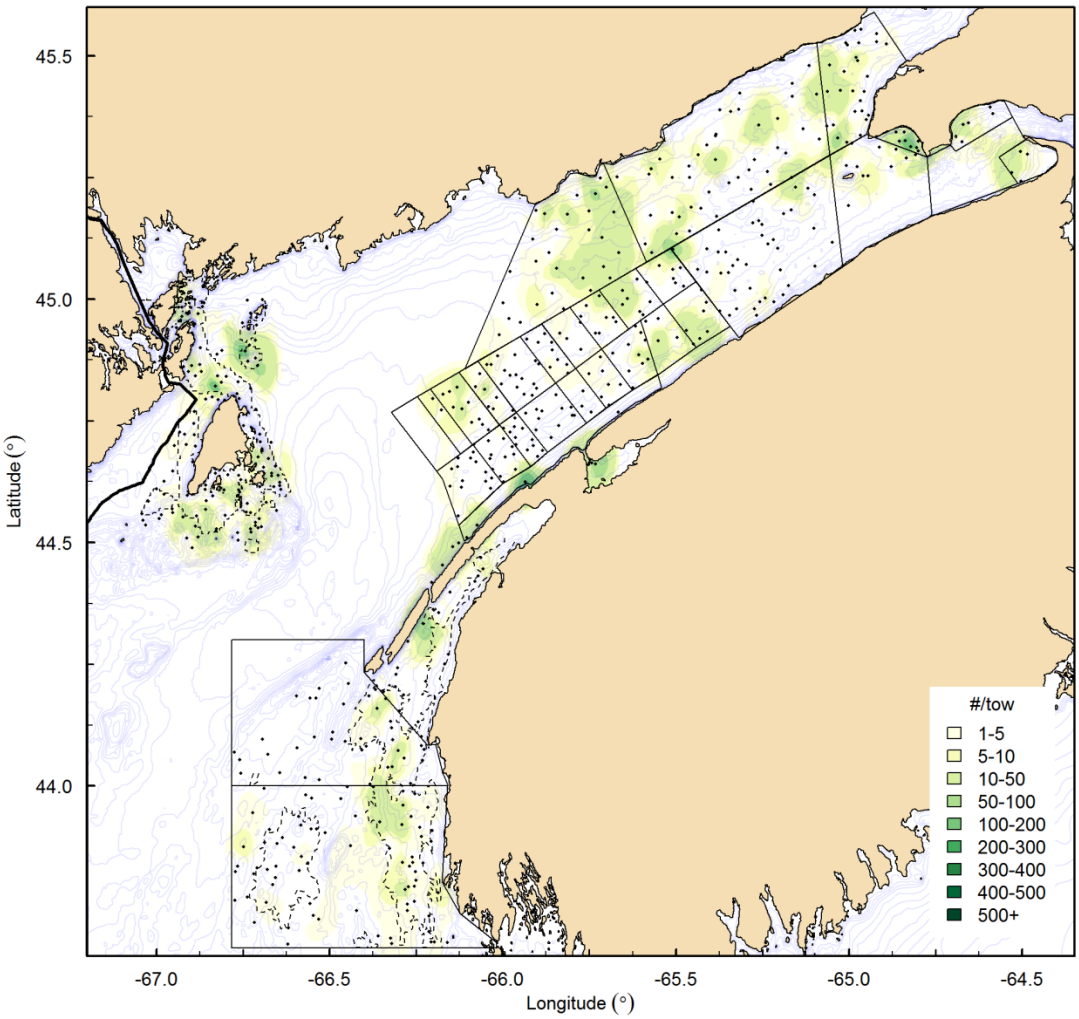


*Figure 2. Spatial distribution (number/tow) of recruit scallops (65-79 mm shell height) in the Bay of Fundy and approaches in 2017. Solid black lines are survey strata, dashed black lines are survey strata representing high (inside dashed lines) and low (outside dashed lines) fishing effort, based on Vessel Monitoring System (VMS) analysis (see: Smith et al. 2012).*

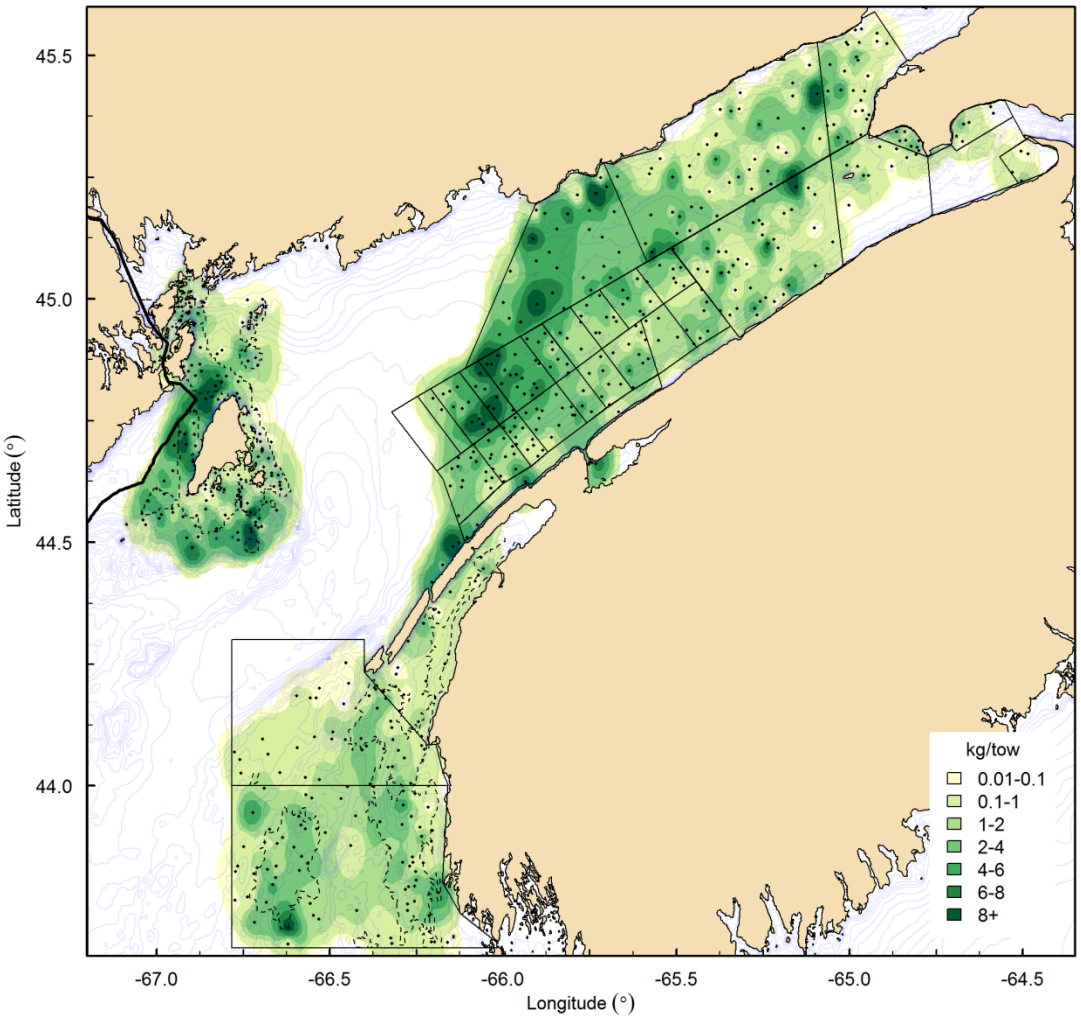


*Figure 3. Spatial distribution of commercial (≥ 80 mm shell height) biomass (kg/tow) in the Bay of Fundy and approaches in 2017. Solid black lines are survey strata, dashed black lines are survey strata representing high (inside dashed lines) and low (outside dashed lines) fishing effort, based on Vessel Monitoring System (VMS) analysis (see: Smith et al. 2012).*

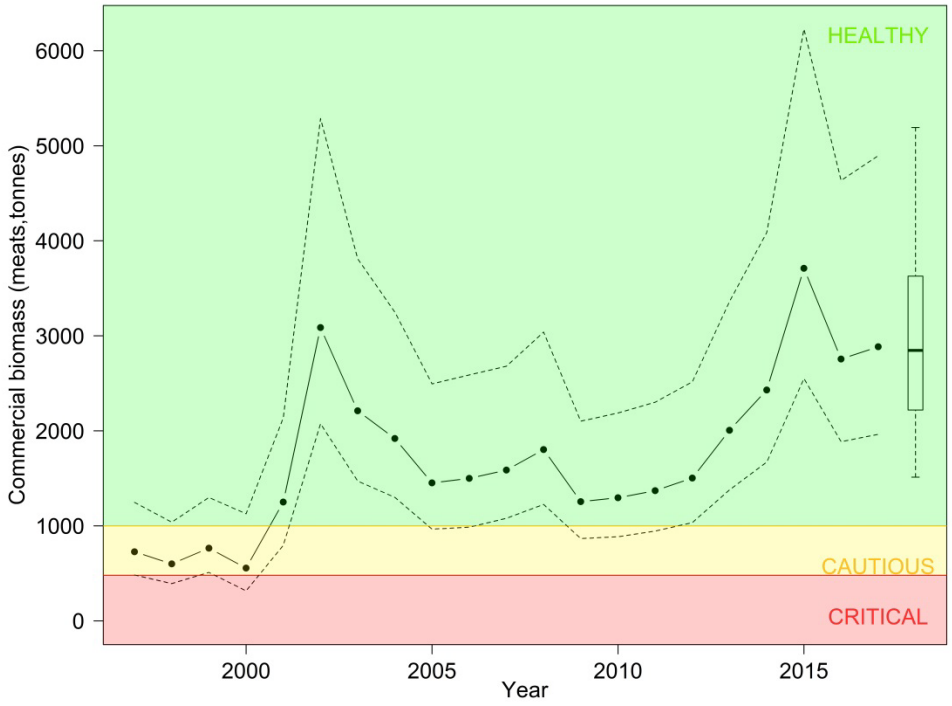


*Figure 4. Median biomass estimates in SPA 1A for commercial size scallops in meat weight (tonnes) from the assessment model fit to the survey and commercial data. Dashed lines are the upper and lower 95% credible limits on the estimates. The predicted commercial size biomass for 2018, assuming the 2017/2018 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 2017/2018 catch levels in terms of resulting exploitation (e), expected changes in biomass (%), probability (Pr) of 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 2018/2019 are evaluated in terms of the posterior probability of exceeding exploitation rate of 0.15.*

| 2017/2018 Fishing Season | | | | | | 2018/2019 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** |
| 200 | 0.07 | -2 | 0.47 | >0.99 | >0.99 | 263 | 312 | 353 | 390 | 427 | 468 |
| 225 | 0.07 | -3 | 0.46 | >0.99 | >0.99 | 260 | 309 | 349 | 386 | 424 | 465 |
| 250 | 0.08 | -4 | 0.44 | >0.99 | >0.99 | 258 | 306 | 345 | 382 | 419 | 460 |
| 275 | 0.09 | -4 | 0.43 | >0.99 | >0.99 | 255 | 304 | 343 | 379 | 416 | 457 |
| 300 | 0.10 | -5 | 0.42 | >0.99 | >0.99 | 253 | 300 | 340 | 376 | 413 | 453 |
| 325 | 0.11 | -6 | 0.41 | >0.99 | >0.99 | 249 | 297 | 336 | 372 | 410 | 451 |
| 350 | 0.12 | -7 | 0.39 | >0.99 | >0.99 | 247 | 294 | 332 | 368 | 405 | 446 |
| 375 | 0.12 | -8 | 0.38 | >0.99 | >0.99 | 245 | 292 | 330 | 366 | 402 | 443 |
| 400 | 0.13 | -9 | 0.37 | >0.99 | 0.99 | 241 | 288 | 325 | 361 | 398 | 438 |
| 425 | 0.14 | -10 | 0.36 | >0.99 | 0.99 | 238 | 284 | 322 | 357 | 395 | 435 |
| 450 | 0.15 | -11 | 0.34 | >0.99 | 0.99 | 235 | 281 | 318 | 354 | 391 | 430 |

## Scallop Production Area 1B Stock Status

The total 2017 landings for all fleets in SPA 1B was 435.85 t against a combined TAC of 450.86 (480 t before post-quota reconciliation). Full Bay Fleet caught 235.95 t against a quota of 243.60 t, Mid Bay Fleet caught 130.89 t against a quota of 143.18 (171.456 t before post-quota reconciliation), and Upper Bay Fleet caught 69.01 t against a quota of 64.08 t (64.944 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 the Full Bay and Mid Bay fleets since 2012. In 2017, the catch rate in SFA 28B was the highest either fleet has had in that subarea (39.3 kg/h for Full Bay and 37.3 kg/h for Mid Bay). In SFA 28C, catch rates for the Upper Bay Fleet increased from 16.8 kg/h in 2016 to 21.7 kg/h in 2017. Full Bay did not fish SFA 28C in 2017, 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 increased from 16.1 kg/h to 19.5 kg/h. There are not enough records from Full Bay Fleet to summarize these data for this subarea. Condition from the survey decreased throughout SPA 1B in 2017, and condition has been declining in this area since 2013. Over the entire SPA, condition decreased slightly from 10.5 g in 2016 to 10.1 g in 2017, and was below the long-term (1997-2016) mean of 11.8 g. Pre-recruits were observed throughout SPA 1B, with the highest densities in Advocate Harbour and Upper Bay within SFA 28C and 28D, respectively (Figure 1, Appendix 1). The biomass estimate of recruit scallops decreased from 90.9 t in 2016 to 63 t in 2017, and was below the long-term (1997-2016) median of 151.5 t. Recruits were found in all subareas, with the highest densities occurring in Advocate Harbour within SFA 28D (Figure 2, Appendix 1). Commercial biomass was spread throughout SPA 1B with the beds of highest biomass observed in the Cape Spencer area (Figure 3, Appendix 1). The biomass estimate of commercial scallops in 2017 was 3688 t (meats), which was higher than 2016 (3364 t), above the long-term median of 2361 t, and in the Healthy Zone (Figure 5).

Catch scenarios for the 2017/2018 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.

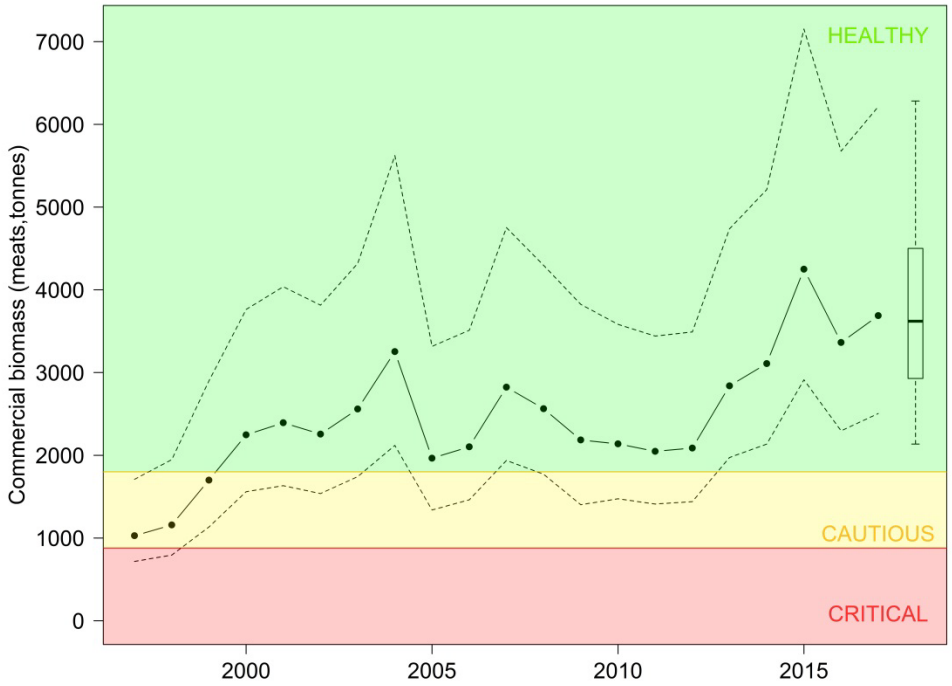


*Figure 5. Median biomass estimates in SPA 1B for commercial size scallops in meat weight (tonnes) from the assessment model fit to the survey and commercial data. Dashed lines are the upper and lower 95% credible limits on the estimates. The predicted commercial size biomass for 2018, assuming the 2017/2018 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 2017/2018 catch levels in terms of resulting exploitation (e), expected changes in biomass (%), probability (Pr) of 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 2018/2019 are evaluated in terms of the posterior probability of exceeding exploitation rate of 0.15.*

| 2017/2018 Fishing Season | | | | | | 2018/2019 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** |
| 150 | 0.04 | -3 | 0.45 | >0.99 | >0.99 | 361 | 416 | 460 | 501 | 543 | 589 |
| 200 | 0.05 | -4 | 0.42 | >0.99 | >0.99 | 355 | 409 | 453 | 493 | 535 | 581 |
| 250 | 0.07 | -5 | 0.40 | >0.99 | >0.99 | 349 | 403 | 446 | 487 | 529 | 574 |
| 300 | 0.08 | -7 | 0.37 | >0.99 | >0.99 | 344 | 396 | 439 | 479 | 520 | 566 |
| 350 | 0.09 | -8 | 0.35 | >0.99 | >0.99 | 337 | 390 | 432 | 472 | 513 | 558 |
| 400 | 0.11 | -9 | 0.32 | >0.99 | >0.99 | 331 | 383 | 425 | 465 | 506 | 550 |
| 450 | 0.12 | -11 | 0.30 | >0.99 | >0.99 | 325 | 376 | 418 | 457 | 498 | 542 |
| 500 | 0.13 | -12 | 0.28 | >0.99 | >0.99 | 318 | 370 | 411 | 451 | 491 | 535 |
| 550 | 0.15 | -13 | 0.26 | >0.99 | >0.99 | 313 | 363 | 404 | 443 | 482 | 526 |

## 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 2017 fishing year in SPA 3 were 158.6 t against a TAC of 175 t. Recent TAC and landings are summarized in Appendix 2. Commercial catch rate in 2017 for St. Mary's Bay was 21.6 kg/h, a decrease from 2016 (23.7 kg/h). Summer catch rates for the SPA 3 outside of St. Mary's Bay (Brier/Lurcher area) in 2017 were 18.8 kg/h, an increase from 2016 (17.2 kg/h). There were no fishing records from SPA 3 outside of St. Mary's Bay in the fall of 2016. 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 (14.7 g). Overall condition for SPA 3 in 2017 was similar to 2016 (11.2 g in 2016 to 11.3 g in 2017) and below the long-term (1996-2016) mean of 12.1 g. Pre-recruits were predominately observed outside the VMS strata (Figure 1). The biomass estimate of recruit scallops for 2017 was 29.5 t, a decrease from 35.2 t in 2016, and below the long-term (1996-2016) median of 71.2 t. Recruits were generally low and patchy and were mainly distributed in the Inside VMS area and St. Mary's Bay; very few recruits were observed west of 66.5˚W (Figure 2, Appendix 1). Commercial biomass was distributed in patches and was mostly observed inside the VMS areas (Figure 3). The biomass estimate of commercial scallops in 2017 was 1621 t (meats), a decrease from 2016 (2214 t), but above the long-term median of 1476 t, and in the Healthy Zone (Figure 6).

Catch scenarios for the 2017/2018 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.

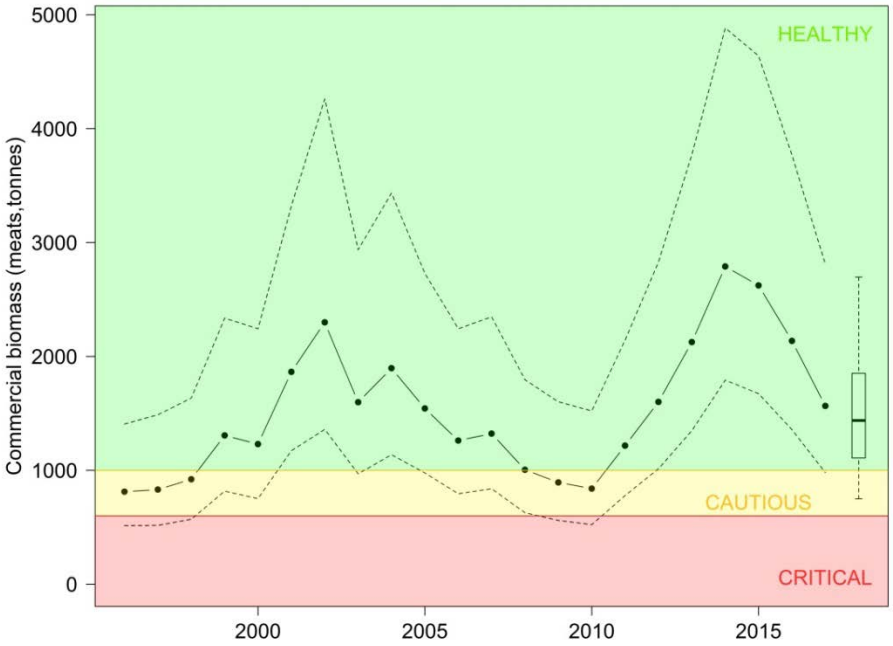


*Figure 6. Median biomass estimates in SPA 3 for commercial size scallops in meat weight (tonnes) from the assessment model fit to the survey and commercial data. Dashed lines are the upper and lower 95% credible limits on the estimates. The predicted commercial size biomass for 2018, assuming the 2017/2018 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 2017/2018 catch levels in terms of resulting exploitation (e), expected changes in biomass (%), probability (Pr) of 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 2018/2019 are evaluated in terms of the posterior probability of exceeding exploitation rate of 0.15.*

| 2017/2018 Fishing Season | | | | | | 2018/2019 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 | 0.06 | -10 | 0.34 | 0.99 | 0.85 | 135 | 161 | 183 | 203 | 224 | 246 |
| 120 | 0.07 | -11 | 0.32 | 0.99 | 0.85 | 134 | 160 | 181 | 200 | 220 | 242 |
| 130 | 0.08 | -12 | 0.32 | 0.99 | 0.84 | 133 | 158 | 179 | 199 | 219 | 241 |
| 140 | 0.09 | -12 | 0.30 | 0.99 | 0.84 | 132 | 158 | 178 | 197 | 217 | 239 |
| 150 | 0.10 | -13 | 0.29 | 0.99 | 0.83 | 132 | 157 | 177 | 196 | 215 | 237 |
| 170 | 0.11 | -14 | 0.28 | 0.98 | 0.82 | 129 | 154 | 173 | 193 | 212 | 234 |
| 200 | 0.12 | -15 | 0.25 | 0.98 | 0.80 | 126 | 151 | 171 | 189 | 209 | 230 |
| 220 | 0.14 | -17 | 0.23 | 0.98 | 0.79 | 122 | 147 | 168 | 186 | 205 | 226 |
| 230 | 0.15 | -17 | 0.23 | 0.97 | 0.79 | 122 | 147 | 166 | 185 | 204 | 226 |

## 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 2017 fishing year were 183.96 t in SPA 4 and 6.98 t in SPA 5 against a combined TAC of 200 t. Recent TAC and landings are summarized in Appendix 2. Commercial catch rates in SPA 4 in 2017 were 27.3 kg/h, a decrease from 2016 (31.2 kg/h) and above the long-term (1982-2016) median of 18.6 kg/h. Commercial catch rate in SPA 5 in 2017 was 30.1 kg/h, an increase from 2016 (24.1 kg/h) and above the long-term (1977-2016) median of 19.5 kg/h. Condition in SPA 4 in 2017 was 11.3 g, similar to 2016 (11.4 g) and near the long-term (1996-2016) mean of 11.1 g. Pre-recruits were distributed in patches along the edges of SPA 4 (Figure 1). The biomass estimate of recruit scallops in 2017 was 3.2 t, a decrease from 9.5 t in 2016 and below the long-term (1983-2016) median of 35.2 t. Recruits were observed in localized patches and were absent from the majority of the area (Figure 2, Appendix 1), whereas the distribution of commercial biomass was relatively uniform (Figure 3, Appendix 1). The biomass estimate of commercial scallops in 2017 was 1219 t (meats), a decrease from 2016 (1560 t), but above the long-term median of 949 t, and in the Healthy Zone (Figure 7).

Catch scenarios for the 2017/2018 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.

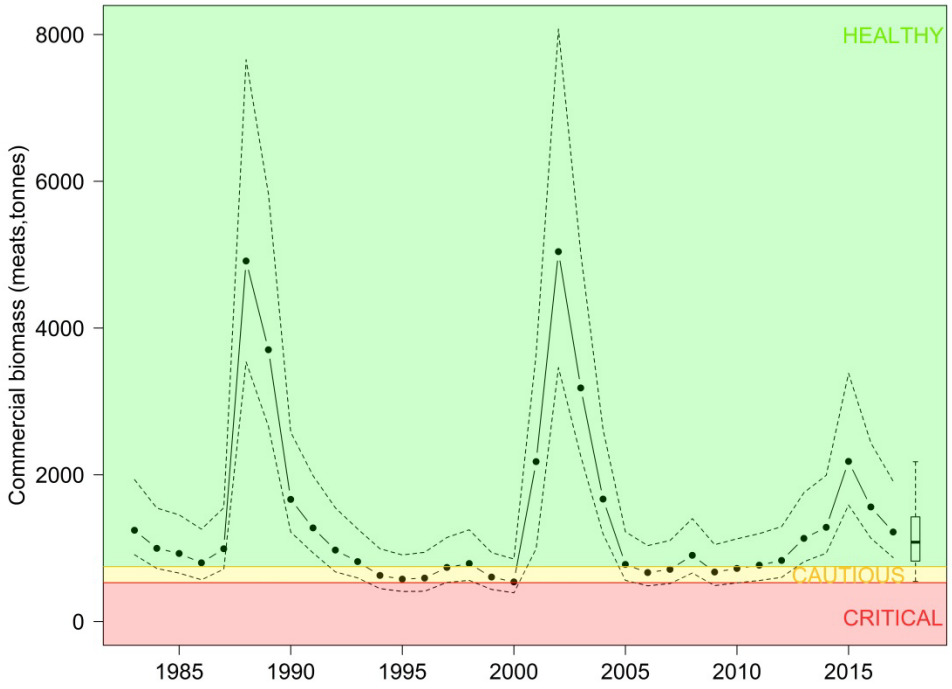


*Figure 7. Median biomass estimates in SPA 4 for commercial size scallops in meat weight (tonnes) from the assessment model fit to the survey and commercial data. Dashed lines are the upper and lower 95% credible limits on the estimates. The predicted commercial size biomass for 2018, assuming the 2017/2018 interim TAC (125 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 2017/2018 catch levels in terms of resulting exploitation (e), expected changes in biomass (%), probability (Pr) of 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 2018/2019 are evaluated in terms of the posterior probability of exceeding exploitation rate of 0.15.*

| 2017/2018 Fishing Season | | | | | | 2018/2019 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** |
| 120 | 0.10 | -12 | 0.36 | 0.96 | 0.82 | 97 | 116 | 133 | 148 | 163 | 180 |
| 130 | 0.11 | -13 | 0.34 | 0.95 | 0.81 | 95 | 114 | 130 | 145 | 161 | 179 |
| 140 | 0.12 | -14 | 0.33 | 0.95 | 0.80 | 93 | 113 | 129 | 144 | 159 | 176 |
| 150 | 0.12 | -15 | 0.33 | 0.95 | 0.80 | 93 | 112 | 128 | 142 | 158 | 175 |
| 160 | 0.13 | -16 | 0.31 | 0.94 | 0.79 | 92 | 111 | 126 | 141 | 156 | 174 |
| 170 | 0.14 | -17 | 0.30 | 0.94 | 0.78 | 90 | 109 | 124 | 139 | 154 | 171 |
| 180 | 0.15 | -17 | 0.29 | 0.94 | 0.77 | 90 | 108 | 123 | 138 | 153 | 171 |
| 190 | 0.16 | -18 | 0.29 | 0.94 | 0.77 | 90 | 108 | 123 | 138 | 153 | 170 |
| 200 | 0.17 | -19 | 0.28 | 0.93 | 0.76 | 87 | 105 | 121 | 136 | 150 | 167 |

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 2017 was 268.7, down from 290.9 per tow in 2016 but above

the historic long-term (1990-2008) median of 79.5 per tow. The weight per tow in 2017 was 3.8 kilograms per tow (kg/tow), similar to 2016 (3.5 kg/tow) and also 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 40.5, down from 58.6 per tow in 2016 but above the historic long-term (1990-2008) recruit median of 22.3 recruits/tow. Recruit weight per tow in 2017 was 0.17 kg/tow, down from 0.26 kg/tow in 2016 but above 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 2017 fishing year were 243.53 t against a combined TAC of 217.82 t (220 t before post-quota reconciliation). Full Bay Fleet caught 26.26 t against a quota of 33 t, and Mid Bay Fleet caught 217.27 t against a quota of 184.82 t (187 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 2017, the catch rate across all areas was 26.3 kg/h, an increase from 2016 (20.8 kg/h) and above the LRP (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.

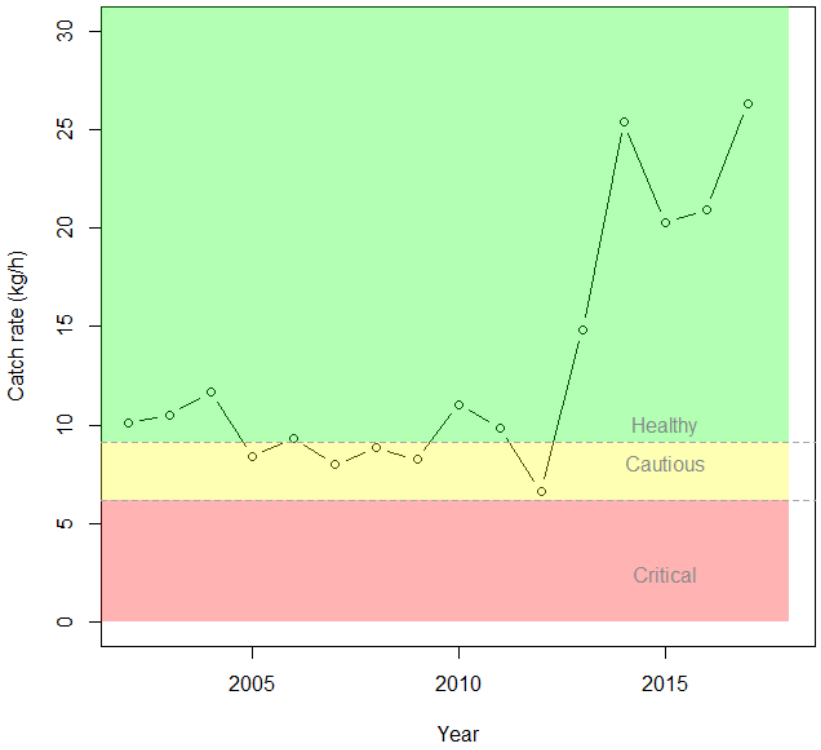


*Figure 8. Annual commercial catch rate (kilogram/hour [kg/h]) for SPA 6 for all subareas and both fleets combined. The green-shaded area represents the Healthy Zone (based on an Upper Stock Reference of 9.1 kg/h), the yellow-shaded area represents the Cautious Zone, and the red-shaded area represents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

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 9.8 g in 2017, a decrease from 2016 (10.4 g) and below the long-term (1997-2016) mean of 11 g. Condition in the Outside VMS stratum in 2017 was 9.7 g, a decrease from 2016 (10.3 g) and below the long-term (1997-2016) mean of 10.9 g. Pre-recruits were observed in patches throughout the survey area, with the highest densities near SPA 6D (Figure 1, Appendix 1). In 2017, the biomass estimate of recruit scallops declined significantly, by approximately 90%. In 2017, recruit biomass was 20.6 t, a decrease from 213 t in 2016 and below the long-term (2006-2016) median of 56.3 t. Recruits were observed in localized patches with the highest density occurring north of Grand Manan Island (Figure 2), whereas commercial biomass was well distributed throughout the surveyed area (Figure 3). The biomass estimate of commercial scallops in 2017 was 880 t (meats), a decrease from 2016 (1108 t), but above the long-term median of 442 t.

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 2017, the proportion of landings were 84%, 9%, and 7% for the Inside VMS stratum, Outside VMS stratum, and not falling with a strata, respectively. Catch scenarios for 2017/2018 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 7% decrease in biomass, and the probability of biomass increase is 44%.

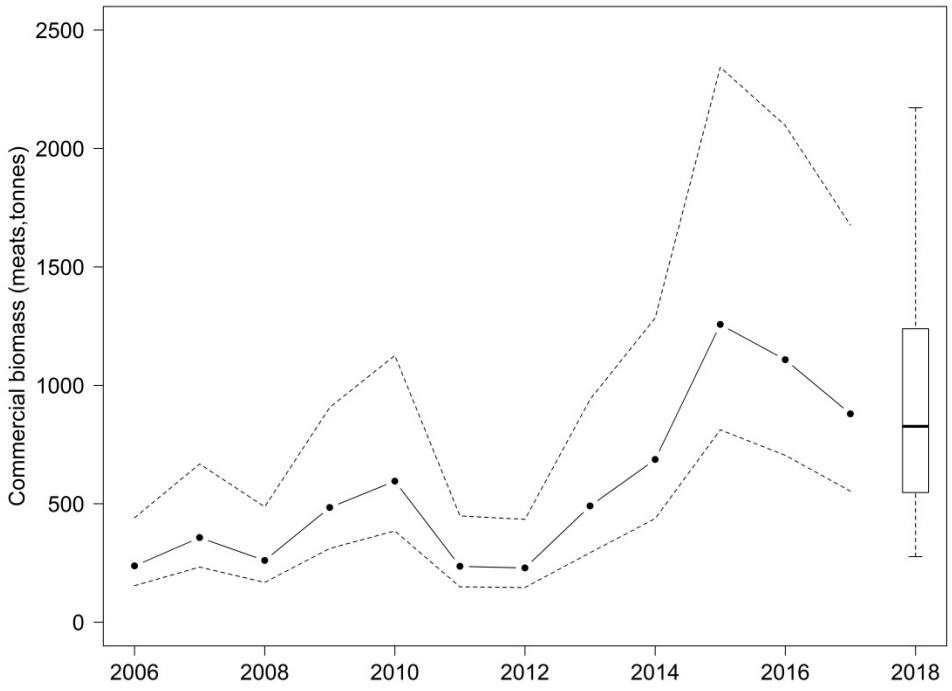


*Figure 9. Median biomass estimates in SPA 6 for commercial size scallops in meat weight (tonnes) from the assessment model fit to the survey and commercial data. Dashed lines are the upper and lower 95% credible limits on the estimates. The predicted commercial size biomass for 2018, assuming a catch of 150 t in 2018, 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 2017/2018 fishing season catch levels in terms of resulting exploitation (e), expected changes in biomass (%), and probability (Pr) of biomass increase.*

| Catch (t) | e | % Change | Pr Increase |
|---|---|---|---|
| 100 | 0,10 | -2 | 0.49 |
| 110 | 0,11 | -3 | 0,48 |
| 120 | 0,12 | -5 | 0,46 |
| 130 | 0,13 | -6 | 0,45 |
| 140 | 0,14 | -7 | 0,44 |
| 150 | 0,15 | -7 | 0,44 |
| 160 | 0,16 | -9 | 0,43 |
| 170 | 0,17 | -11 | 0,41 |
| 180 | 0,18 | -12 | 0,40 |
| 190 | 0,19 | -13 | 0,39 |
| 200 | 0,20 | -14 | 0,38 |
| 210 | 0,21 | -14 | 0,38 |
| 220 | 0,22 | -16 | 0,36 |

### Ecosystem Considerations

There were three fisheries observer trips in the Bay of Fundy Scallop fishery during the 2017 fishing year. Currently, there is no DFO requirement that SFA 28 trips be observed; however, the Full Bay Fleet organized these three trips to meet Marine Stewardship Council certification requirements. Two trips were observed in SPA 3, and one trip was observed in SPA 1A. Due to the low number of trips, these data cannot be summarized in accordance with *Privacy Act* considerations. Refer to Sameoto and Glass (2012) for past analysis of discards from the inshore scallop fishery.

## Conclusions

From 2016 to 2017, scallop condition declined or was similar within each SPA in the Bay of Fundy. The biomass estimate of recruit scallops declined in all modelled SPAs. Commercial biomass declined in SPAs 3, 4 and 6, and increased in SPAs 1A and 1B. Estimates of commercial biomass for all SPAs remain in the Healthy Zone; however, in 2017, overall recruitment across the BoF is low and coincident with low levels of pre-recruits.

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Date: December 1, 2017

## Sources of Information

DFO. 2007. Stock Assessment Report on Scallops (*Placopecten magellanicus*) in Scallop Production Areas 1 to 6 in the Bay of Fundy. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2007/013.

DFO. 2016. Assessment of Scallops (*Placopecten magellanicus*) in Scallop Production Areas 1 to 6 in the Bay of Fundy. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2016/004.

DFO. 2017. Scallop (*Placopecten magellanicus*) in Scallop Production Areas 1 to 6 in the Bay of Fundy: Stock Status Update for 2016. DFO Can. Sci. Advis. Sec. Sci. Resp. 2017/002.

Nasmith, L., B. Hubley, S.J. Smith, and A. Glass. 2014. Scallop Production Areas in the Bay of Fundy: Stock Status for 2013 and Forecast for 2014. DFO Can. Sci. Advis. Sec. Res. Doc. 2014/016. vii + 139 p.

Nasmith, L., J. Sameoto, and A. Glass. 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 p.

Sameoto, J.A., and A. Glass. 2012. An Overview of Discards from the Canadian Inshore Scallop Fishery in SFA 28 and SFA 29 West for 2002 to 2009. Can. Tech. Rep. Fish. Aquat. Sci. 2979. vi + 39 p.

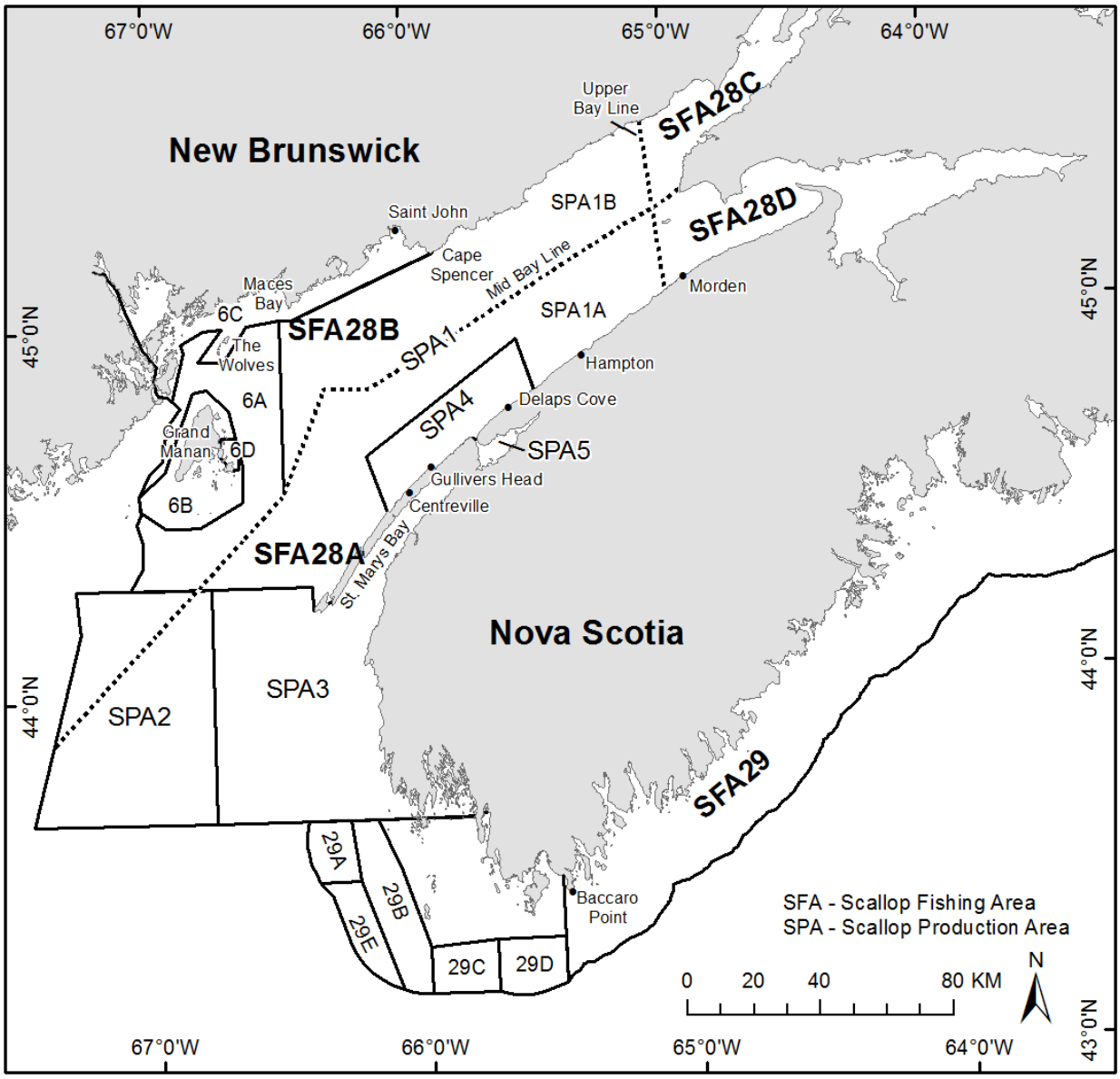
Smith, S.J., and B. Hubley. 2014. Impact of Survey Design Changes on Stock Assessment Advice: Sea Scallops. ICES J. Mar. Sci. 71: 320–327.

Smith, S.J., P.B. Hubley, L. Nasmith, J.A. Sameoto, H. Bourdages, and A. Glass. 2012. Scallop Production Areas in the Bay of Fundy: Stock Status for 2011 and Forecast for 2012. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/009. vii +123 p.

# 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 2010 to 2017. 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 2017 are preliminary (as of Nov. 10, 2017), and are post-quota reconciliation.

| Area | Fleet | | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|---|---|---|---|
| SPA 1A | Full Bay | Landings | 297 | 278.1 | 206.4 | 206.02 | 274.49 | 361.55 | 422.31 | 395.88 |
| | | TAC | 300 | 300 | 200 | 200 | 275 | 350 | 425 | 400 |
| SPA 1B | Full Bay | Landings | 151.9 | 84.2 | 159.9 | 202.8 | 229.4 | 303.96 | 314.04 | 235.95 |
| | | TAC | 205.5 | 203 | 152.3 | 190.3 | 228.4 | 301.8 | 312.21 | 243.60 |
| SPA 1B | Mid Bay | Landings | 138.6 | 123.3 | 103.1 | 162.7 | 197.7 | 164.02 | 255.86 | 130.89 |
| | | TAC | 144.7 | 142.9 | 107.2 | 133.95 | 160.74 | 175.6 | 229.6 | 143.18 |
| SPA 1B | Upper Bay | Landings | 54.4 | 54.7 | 39.97 | 57.4 | 68.9 | 78.2 | 84.05 | 69.01 |
| | | TAC | 54.8 | 54.1 | 40.6 | 50.7 | 60.9 | 72.7 | 83.236 | 64.08 |
| SPA 3 | Full Bay | Landings | 56 | 72.96 | 264.8 | 261 | 265.1 | 234.96 | 223.69 | 158.60 |
| | | TAC | 50 | 50 | 300 | 260 | 260 | 250 | 225 | 175 |
| SPA 4 and 5 | Full Bay | Landings | - | - | - | - | 102.5 | 132.35 | 234.277 | 190.94 |
| | | TAC | - | - | - | - | 110 | 135 | 250 | 200 |
| SPA 6 | Full Bay | Landings | 0.07 | 0 | 0.88 | 8.1 | 18.2 | 23.99 | 13.57 | 26.26 |
| | | TAC | 21 | 21 | 21 | 21 | 32.55 | 37.77 | 38.754 | 33 |
| SPA 6 | Mid Bay | Landings | 102.5 | 103.9 | 54.7 | 117.5 | 196.8 | 207.01 | 213.25 | 217.27 |
| | | TAC | 119 | 119 | 119 | 119 | 184.45 | 202.23 | 211.242 | 184.82 |

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ISSN 1919-3769


Correct Citation for this Publication:

DFO. 2018. Stock Status Update of Scallop (*Placopecten magellanicus*) in Scallop Production Areas 1 to 6 in the Bay of Fundy. DFO Can. Sci. Advis. Sec. Sci. Resp. 2018/003.

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*MPO. 2018. Mise à jour sur 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. 2018/003.*