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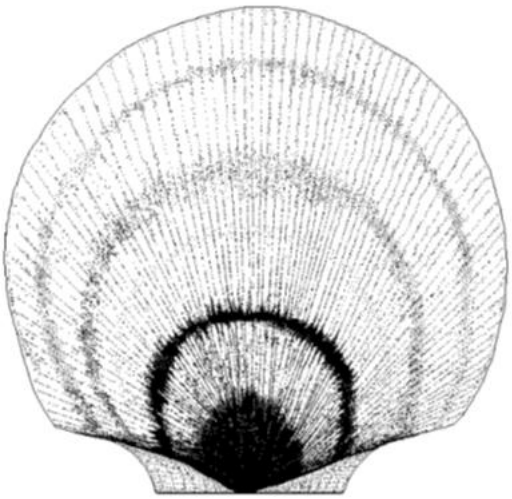
Maritimes Region

Canadian Science Advisory Secretariat
Science Advisory Report 2016/004

ASSESSMENT OF SCALLOPS (*PLACOPECTEN MAGELLANICUS*) IN SCALLOP PRODUCTION AREAS 1 TO 6 IN THE BAY OF FUNDY



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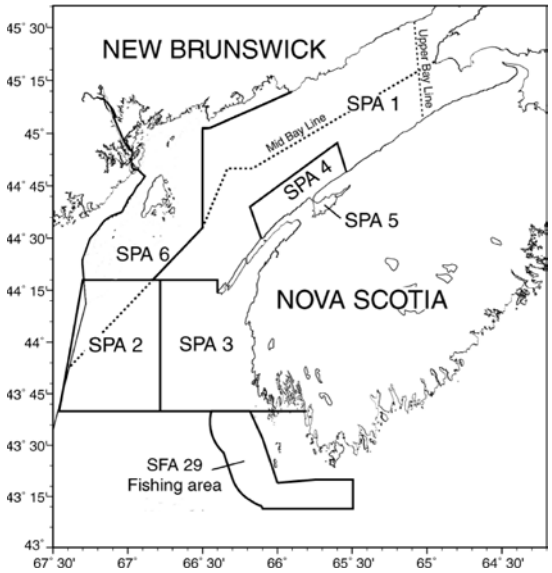

Figure 1. Scallop Production Areas (SPAs) in the Bay of Fundy. Refer to full detail map in Appendix 1 for place names.

Context:

The Bay of Fundy is fished by three scallop fleets: the Full Bay Fleet, the Mid Bay Fleet, and the Upper Bay Fleet. Full Bay license holders are permitted to fish throughout the Bay of Fundy. Mid Bay license holders have access to areas north of the Mid Bay line. Upper Bay license holders are restricted to the upper reaches of the Bay. The fishery has been managed using limited entry, gear size limits, seasonal closures, minimum shell height, and meat (adductor muscle) count. The gear width limit is 5.5 m with a ring size of not less than 82 mm inside diameter. Quotas were introduced in 1997. The Full Bay Fleet operates under an Individual Transferable Quota system, while the Mid and Upper Bay fleets fish with competitive quotas. Total Allowable Catches are set and landings are reported in terms of meat weight.

Scallop Production Areas in the Bay of Fundy are assessed according to a framework (DFO 2002).

This Science Advisory Report is from the November 17-18, 2015, Assessment of Bay of Fundy Scallop in Scallop Production Areas (SPAs) 1A, 1B, and 3-6. The objectives of this meeting were to: (1) assess the status of scallop stocks by SPA, taking into account available commercial and survey information, (2) using established reference points, harvest strategies and indicators, assess the outcomes of different harvest levels in the SPAs for the 2015/2016 season, (3) assess the consequences of different harvest levels in SPAs 1A, 1B, 3 and 4 for the 2016/2017 season, and (4) summarize available bycatch of non-target species information and identify any notable changes in occurrence of these bycatch species relative to previous years. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SUMMARY

General

- Models used in this assessment have been reviewed previously, and changes have been documented and reviewed.
- Scallop Production Area (SPA) 2 is considered to be marginal habitat for scallops and is not monitored regularly. SPA 2 was last assessed in 2006.
- SPA 6 was modelled for the first time using the Bay of Fundy stock assessment model.
- Harvest scenario tables that assess the consequences of different harvest levels in SPAs 1A, 1B, and 3 to 6 for 2015/2016 are presented.

SPA 1A

- The Full Bay Fleet caught a total of 361.55 tonnes (t) against a Total Allowable Catch (TAC) of 350 t during the 2014/2015 fishing year in SPA 1A.
- Commercial catch rate in this area has been increasing since 2011/2012; the catch rate in 2014/2015 was the highest in over a decade.
- The number and weight per tow of commercial scallop in the survey increased in both the 2 to 8 and 8 to 16 mile subareas. In Middle Bay South there was a decrease in the number and weight per tow of commercial scallop in 2015. The number and weight per tow of recruit size scallops in 2015 were less than in 2014 for all subareas of SPA 1A. Prerecruit scallop abundance decreased from 2014.
- Condition increased in all subareas of SPA 1A.
- Population biomass estimated by the model was 3,790 t (meats) in 2015, an increase of 54% from the estimate of 2,462 t in 2014.
- Commercial biomass in SPA 1A is currently in the healthy zone.

SPA 1B

- In 2014/2015 fishing year, the TAC in SPA 1B was 550.024 t. The Full Bay Fleet caught a total of 303.96 t against a quota of 301.8 t, the Mid Bay Fleet caught 164.02 t against a quota of 175.6 t, and the Upper Bay Fleet caught 78.2 t against a quota of 72.7 t.
- In Scallop Fishing Area (SFA) 28B, catch rates for the Full Bay Fleet have been similar over the last three years, while Mid Bay Fleet catch rates declined in 2015. In SFA 28C, Mid Bay catch rate in 2015 was among a high in the time series for this subarea. The catch rate for the Upper Bay Fleet in SFA 28C decreased in 2015 relative to 2014.
- The number and weight of commercial scallops per tow in 2015 increased overall in SPA 1B, although the trend differed among subareas. With the exception of Middle Bay North, number and weight per tow of recruit scallops decreased from, or was similar to, 2014 in all subareas of SPA 1B. Prerecruit scallops were less abundant in 2015.
- Condition increased in all subareas of SPA 1B.
- Population biomass estimated by the model was 4,350 t (meats) in 2015, an increase of 27% from the estimate of 3,197 t in 2014.
- Commercial biomass in SPA 1B is currently in the healthy zone.

SPA 3

- The Full Bay Fleet caught a total of 234.96 t against a TAC of 250 t in the 2014/2015 fishing year.
- Catch rates in St. Mary's Bay have been relatively similar over the last 3 years. Catch rates in the Brier/Lurcher area, both in the summer and fall, have been similar for the last three years.
- Number per tow of commercial scallops in the survey decreased in 2015 relative to 2014 in all subareas of SPA 3. Weight per tow of commercial scallops decreased in 2015 relative to 2014 in St. Mary's Bay and the Outside Vessel Monitoring System (VMS) Stratum, and increased slightly in the Inside VMS Stratum. Number and weight per tow of recruit scallops decreased in St. Mary's Bay, and increased in both VMS strata. Prerecruits were less abundant in 2015 than in 2014.
- Condition increased in all subareas of SPA 3.
- Population biomass estimated by the model was 2,620 t (meats) in 2015, a decrease of 7% from the estimate of 2,814 t for 2014.
- Commercial biomass in SPA 3 is currently in the healthy zone.

SPAs 4 and 5

- Before the start of the 2013/2014 fishing year, SPAs 4 and 5 were joined under one TAC. In 2014/2015, the Full Bay Fleet caught a total of 124.09 t in SPA 4 and 8.26 t in SPA 5 against a combined TAC of 135 t.
- The 2015 catch rate in SPA 4 was virtually unchanged from the catch rate in 2014. The catch rate in SPA 5 declined in 2015 relative to 2014.
- The number per tow of commercial scallop in SPA 4 increased greatly in 2015. Weight per tow of commercial scallop also increased in 2015. Number and weight per tow of recruit scallops decreased in 2015 relative to 2014. Prerecruit scallops were less abundant in 2015 than in 2014.
- The survey results for SPA 5 are presented with reference to the medians of the survey series from 1996 to 2008. The annual survey in SPA 5 started in 1990 and was discontinued in 2009. Starting in 2014, survey tows resumed in this area. The number and weight per tow of commercial scallop were above the medians in 2014 and 2015, while recruit number and weight per tow were near the medians in 2014, and increased in 2015.
- Condition in 2015 increased in SPA 4.
- Population biomass estimated by the model was 2,213 t (meats) in 2015, an increase of 70% from the estimate of 1,300 t for 2014.
- Commercial biomass in SPA 4 is currently in the healthy zone.

SPA 6

- A total of 231 t was landed against a combined TAC of 240 t in SPA 6 in 2014/2015.
- Catch rates for Mid Bay decreased in 2015 relative to 2014 across all subareas but are still at the second highest level observed over the Mid Bay time series. For Full Bay, catch rates increased in 2015 relative to 2014 in subareas 6A, 6B, and 6C.

- Until 2014, SPA 6 was assessed based on management areas. In 2014, the survey index was improved by restratifying the survey according to VMS “fishing” intensity from 2002 to 2014 and defining two VMS strata. In 2015, the survey index was further improved by refining the Inside VMS Stratum and redefining the Outside VMS Stratum.
- Commercial and recruit numbers and weight per tow increased in the Inside and Outside VMS strata in 2015. With the exception of commercial biomass in the Outside VMS Stratum, biomass and abundances of both commercial and recruit scallops observed in 2015 are at time series (since 1997) highs. In 2015, prerecruit abundances of between 10 to 100 per tow were found throughout the survey area.
- Condition remained relatively similar from 2014 to 2015.
- This is the first time the Bay of Fundy stock assessment model has been used in SPA 6, and the model fits the survey mean estimates well and gave reasonable parameter estimates.
- Population biomass estimated by the model was 1,361 t (meats) in 2015, an increase over the average of 368 t from 2006 to 2012.
- Reference points in SPA 6 are defined in terms of commercial catch rate. The catch rate index is currently in the healthy zone.

BACKGROUND

The Bay of Fundy scallop fisheries have a long and well documented history of peer reviewed assessments, and the assessment approach used in Scallop Production Areas (SPAs) 1A, 1B, and 3 to 6 has been accepted in previous advisory meetings. Models used in this assessment have been reviewed previously (Smith and Lundy 2002), and changes have been documented and reviewed (Smith et al. 2012, Smith and Hubley 2013, Nasmith et al. 2014). In 2015, the method of modelling meat weight-shell height (i.e., condition) changed from a model that assumed that scallop condition was the ratio of meat weight over the cube of shell height to a generalized linear mixed model that allows the slope to differ from 3 (Sameoto et al. 2015). In addition, SPA 6 was modelled for the first time using the Bay of Fundy stock assessment model. SPA 2 is considered to be marginal habitat for scallops and is not monitored regularly. SPA 2 was last assessed in 2006 (DFO 2007).

In 2012, biomass reference points in terms of a Lower Reference Point (LRP) were proposed for SPAs 1A, 1B, 3, and 4 (excluding 5). In 2013, Upper Stock References (USR) were proposed for SPAs 1A, 1B, 3, and 4 (excluding 5; Nasmith et al. 2014). The LRPs and USRs were adopted for implementation in the 2014/2015 fishing season at an Inshore Scallop Advisory Committee (ISAC) meeting held in December 2013. In SPA 6, there was no model established to estimate biomass, and an LRP was proposed based on the catch rate time series (Nasmith et al. 2014). An USR based on the same catch rate time series was later adopted through an ISAC process in December 2014. At the time reference points were established it was the intention of DFO Science that they would be reviewed and revised as necessary. Where there have been continuous small changes and improvements to the assessment methods and model, the perception of the Bay of Fundy stocks has changed slightly and reference points will need to be revaluated for all the SPAs. However, given the work to improve the model, and in the case of SPA 6 fit the model for the first time, there was not time to conduct a reassessment of reference points for the current assessment. Advice is therefore presented here with respect to the established reference points, and although some changes are expected, the current reference points as they stand are still reflective of the overall productivity and status of these stocks.

Harvest scenario tables that assess the consequences of different harvest levels in SPAs 1A, 1B, and 3 to 6 for 2015/2016 are presented.

In this report, scallops with a shell height of 80 mm and greater will be referred to as commercial size, and scallops with a shell height of 65 to 79 mm will be referred to as recruits, and are expected to grow to commercial size in the following year. Scallops less than 65 mm are defined as prerecruits. The size limit of the survey gear is approximately 40 mm (38 mm mesh liner), and counts of scallops smaller than this are considered to be relatively qualitative.

Scallop removals accounted for in the assessment include landings from all three inshore scallop fleets and Food, Social and Ceremonial (FSC) catch by scallop drag, when applicable. There was no FSC catch by scallop drag in the Bay of Fundy in the 2014/2015 fishing year.

ASSESSMENT, CONCLUSIONS, AND ADVICE

SPA 1 – Inner/Upper Bay of Fundy

SPA 1 covers most of the mid to inner Bay of Fundy. Since 2002, it has been managed as two separate areas: SPA 1A and SPA 1B (Appendix 1). The Full Bay Fleet can fish throughout SPAs 1A and 1B. However, the other fleets are restricted to SPA 1B, the Mid Bay Fleet fishing only north of the Mid Bay line, and the Upper Bay Fleet fishing only east of the Upper Bay line.

SPA 1A – Southwest Bay of Fundy

Fishery

The Full Bay fleet caught a total of 361.55 tonnes (t) against a Total Allowable Catch (TAC) of 350 t during the 2014/2015 fishing year in SPA 1A (Figure 2). Commercial catch rate in this area has been increasing since 2011/2012 (12.1 kg/h); the catch rate in 2014/2015 of 25.9 kg/h was the highest in over a decade. Effort has been increasing since 2012/2013 (9,824 hours), and in 2015 (14,023 hours) was near the long-term median (1997/1998 to 2013/2014) of 14,700 h.

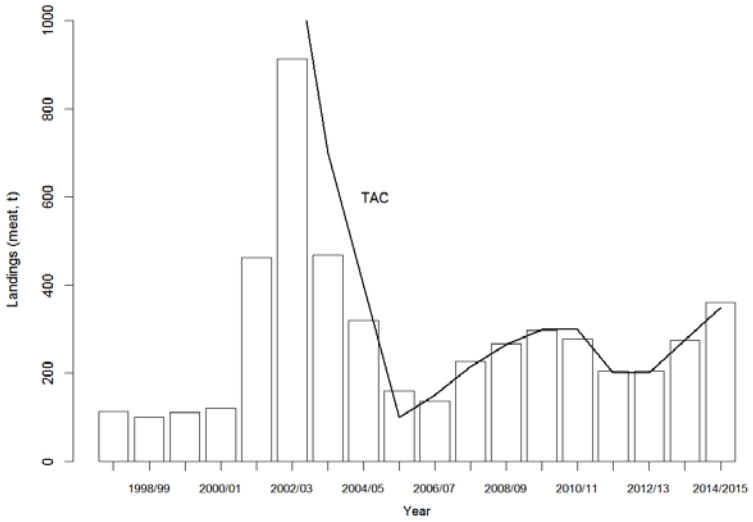

Figure 2. SPA 1A landings (meats, t) by the Full Bay Fleet (white bars) from 1997/1998 to 2014/1015. TAC is indicated by the black line.

Assessment

Most of SPA 1A has benefitted from recruitment entering the fishery in 2015. The number and weight per tow of commercial scallop in the survey increased in both the 2 to 8 and 8 to 16 mile subareas. In Middle Bay South there was a decrease in the number and weight per tow of commercial scallop in 2015, but this area tends to have lower biomass than other parts of SPA 1A. The number and weight per tow of recruit size scallops in 2015 were less than in 2014 for all subareas of SPA 1A. Prerecruit scallop abundance decreased from 2014 and distribution was similar in 2015 to 2014. Condition, presented as predicted weight in grams for a 100 mm shell height, increased in all subareas of SPA 1A.

The population model was fit to the combined survey biomass data and catch data from 1997 to 2015. Population biomass estimated by the model was 3,790 t (meats) in 2015, an increase of 54% from the estimate of 2,462 t in 2014. In 2015 the recuit biomass estimate was 83.6 t, which is high relative to recent years in this area, but below the long-term (1997 to 2014) mean of 176.5 t.

Conclusions and Advice

Commercial biomass in SPA 1A is currently in the healthy zone (USR 1000 t). Harvest scenarios for 2015/2016, as well as the catches that correspond to various probabilities of exceeding an exploitation rate of 0.15 in the following year (2016/2017), are presented in Table 1. For example, Table 1 is interpreted as follows: a catch of 180 t corresponds to an exploitaiton 0.05, and is projected to result in a 0.9% decrease in biomass, the probability of biomass increase is neutral (46%), the probability that a catch of 180 t will result in the population remaining above the LRP is >99%, and the probability of the population remaining above the USR is >99%. In the following fishing year (2016/2017), a catch of 333 t would have a 10% probability of exceeding a reference exploitation of 0.15.

Table 1. Harvest scenario table for SPA 1A to evaluate 2015/2016 catch levels in terms of exploitation (e), expected change in biomass (%), probability (Pr) of biomass increase, probability that after the removal the stock will be above the USR and above the LRP. These calculations assume a USR of 1000 t and a LRP of 480 t. Potential catches in 2016/2017 are evaluated in terms of the posterior probability of exceeding an exploitation rate of 0.15.

2015/2016						Potential catch (t) 2016/2017					
						Pr ($e_{2016/2017}$) > 0.15					
Catch (t)	e	***% Change***	***Pr Increase***	***Pr > LRP***	***Pr > USR***	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**
180	0.05	-0.9	0.46	>0.99	>0.99	333	395	443	488	532	581
200	0.05	-1.4	0.46	>0.99	>0.99	331	394	441	486	531	578
225	0.06	-1.6	0.46	>0.99	>0.99	329	392	441	485	531	579
250	0.06	-2.0	0.45	>0.99	>0.99	327	390	439	483	528	576
275	0.07	-2.5	0.44	>0.99	>0.99	326	387	436	481	525	574
300	0.08	-3.1	0.43	>0.99	>0.99	323	384	431	476	520	569
325	0.08	-3.5	0.42	>0.99	>0.99	320	381	430	475	520	567
350	0.09	-4.2	0.41	>0.99	>0.99	318	377	426	472	517	564
375	0.09	-4.6	0.41	>0.99	>0.99	315	376	425	469	512	560
400	0.1	-4.9	0.40	>0.99	>0.99	313	375	423	466	511	561
425	0.11	-5.6	0.39	>0.99	>0.99	309	371	419	463	507	556
450	0.11	-6.1	0.39	>0.99	>0.99	309	368	416	461	505	552
610	0.15	-9.3	0.33	>0.99	>0.99	293	353	401	445	488	534

SPA 1B – Northern/Upper Bay of Fundy

Fishery

In 2007/2008, a TAC sharing formula for the three fleets in SPA 1B was implemented that allocated shares by three subareas: Scallop Fishing Area (SFA) 28B, SFA 28C, and SFA 28D (Appendix 1). In 2014/2015 fishing year, the TAC in SPA 1B was 550.024 t. The Full Bay Fleet caught a total of 303.96 t against a quota of 301.8 t, the Mid Bay Fleet caught 164.02 t against a quota of 175.6 t, and the Upper Bay Fleet caught 78.2 t against a quota of 72.7 t (Figure 3).

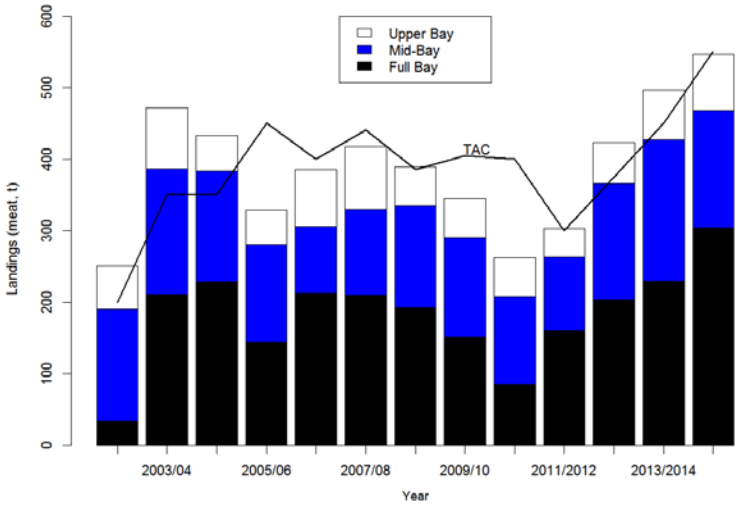

Figure 3. SPA 1B landings (meats, t) by the Full Bay (black bars), Mid Bay (blue bars), and Upper Bay (white bars) fleets from 2002/2003 to 2014/2015. TAC is indicated by the black line.

In SFA 28B, catch rate for the Full Bay Fleet have been similar over the last three years, around 26 kg/h, while Mid Bay Fleet catch rates declined in 2015 to 21 kg/h from a time series high (since 2002) of 27.96 kg/h in 2014. In SFA 28C, Mid Bay catch rates have been increasing since 2012 (12.9 kg/h), and in 2015 were 27.4 kg/h, among a high in the time series for this subarea. The catch rate for the Upper Bay Fleet in SFA 28C decreased from 20.5 kg/h in 2014 to 17.9 kg/h in 2015. In SFA 28D, Upper Bay Fleet catch rates decreased, from 19.8 kg/h in 2014 to 17.0 kg/h in 2015. The Full Bay Fleet fished in both 28C and 28D in the 2014/2015 fishing year, but there were not enough records to present these data consistent with *Privacy Act* considerations.

Assessment

The number and weight of commercial scallops per tow in 2015 increased overall in SPA 1B, although the trend differed among subareas. The number and weight of commercial scallops per tow in 2015 increased from 2014 in Cape Spencer, was similar to 2014 in Middle Bay North, Upper Bay 28C, 28D Outer Bay, and decreased from 2014 in Advocate Harbour, Scots Bay, and Spencer's Island. With the exception of Middle Bay North, number and weight per tow of recruit scallops decreased (Upper Bay 28C, Advocate Harbour, Scots Bay and Spencer's Island) from, or was similar (28D Outer Bay) to, 2014 in all subareas of SPA 1B. Prerecruit scallops were less abundant in 2015, but had a similar distribution to 2014. Condition, presented as predicted weight in grams for a 100 mm shell height, increased in all subareas of SPA 1B.

The population model was fit to the combined survey biomass data and catch data from 1997 to 2015. Population biomass estimated by the model was 4,350 t (meats) in 2015, an increase of

27% from the estimate of 3,197 t in 2014. In 2015, the estimate of recruit biomass was 242.9 t, which is above the long-term (1997 to 2014) average for this area of 186 t.

Conclusions and Advice

Commercial biomass in SPA 1B is currently in the healthy zone (USR 1800 t). Harvest scenarios for 2015/2016, as well as the catches that correspond to various probabilities of exceeding an exploitation rate of 0.15 in the following year (2016/2017), are presented in Table 2. For example, Table 2 is interpreted as follows: a catch of 200 t corresponds to an exploitaiton 0.04, and is projected to result in a 6.8% increase in biomass, the probability of biomass increase is 59%, the probability that a catch of 200 t will result in the population remaining above the LRP is >99%, and the probability of the population remaining above the USR is >99%. In the following fishing year (2016/2017), a catch of 445 t would have a probability of 10% of exceeding a reference exploitation of 0.15.

Table 2. Harvest scenario table for SPA 1B to evaluate 2015/2016 catch levels in terms of exploitation (e), expected change in biomass (%), probability (Pr) of biomass increase, probability that after the removal the stock will be above the USR and above the LRP. These calculations assume a USR of 1800 t and a LRP of 880 t. Potential catches in 2016/2017 are evaluated in terms of the posterior probability of exceeding an exploitation rate of 0.15.

2015/2016						Potential catch (t) 2016/2017 $Pr(e_{2016/2017}) > 0.15$					
Catch (t)	e	***% Change***	***Pr Increase***	***Pr > LRP***	***Pr > USR***	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**
200	0.04	6.8	0.59	>0.99	>0.99	445	507	562	611	661	716
250	0.05	5.8	0.56	>0.99	>0.99	437	501	554	604	653	709
300	0.06	4.7	0.55	>0.99	>0.99	433	497	547	596	645	699
350	0.07	3.5	0.53	>0.99	>0.99	424	491	542	590	640	695
400	0.08	2.6	0.51	>0.99	0.99	419	483	537	584	632	686
450	0.09	0.7	0.48	>0.99	0.99	414	475	527	574	622	676
500	0.10	0.1	0.47	>0.99	0.99	410	471	521	569	617	669
550	0.11	-1.3	0.44	>0.99	0.99	400	462	512	561	609	662
600	0.12	-2.6	0.41	>0.99	0.99	395	456	507	553	602	654
650	0.13	-3.6	0.40	>0.99	0.99	389	451	500	546	595	647
700	0.14	-4.8	0.37	>0.99	0.99	380	443	494	541	588	640
727	0.15	-5.8	0.35	>0.99	0.99	378	438	486	535	582	633

SPA 3 – Brier Island, Lurcher Shoal, and St. Mary's Bay

Fishery

The Full Bay Fleet caught a total of 234.96 t against a TAC of 250 t in the 2014/2015 fishing year (Figure 4). Catch rates in St. Mary's Bay have been relatively similar over the last 3 years, approximately 26.6 kg/h. Catch rates in the Brier/Lurcher area, both in the summer and fall, have been similar for the last three years at approximately 22.5 kg/h.

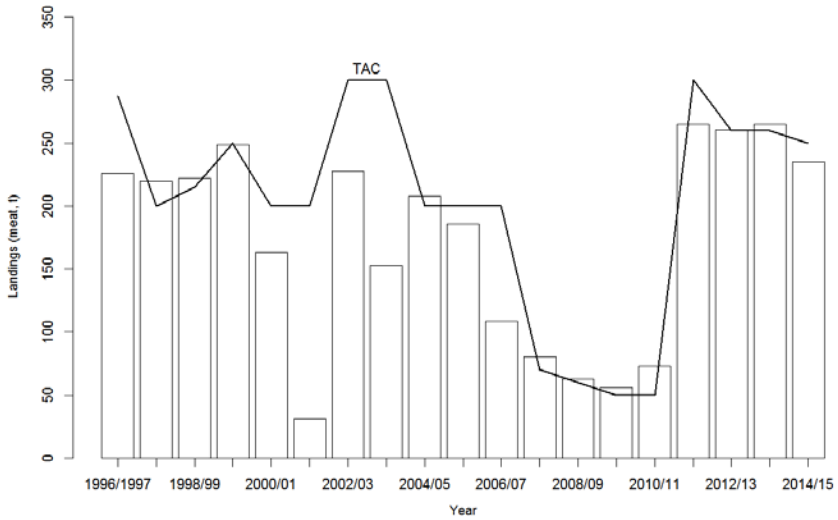

Figure 4. SPA 3 landings (meats, t) by the Full Bay Fleet (white bars) from 1996/1997 to 2014/2015. TAC is indicated by the black line.

Assessment

Current survey strata in SPA 3 have been in effect since 2011 when two previous survey strata known as Brier/Lurcher (Appendix 1) were restratified based on Vessel Monitoring System (VMS) information to create two strata (Smith et al. 2012). The Inside VMS Stratum represents areas historically fished, and the Outside VMS stratum represents areas rarely fished.

Number per tow of commercial scallops in the survey decreased in 2015 relative to 2014 in all subareas of SPA 3. Weight per tow of commercial scallops decreased in 2015 relative to 2014 in St. Mary's Bay and the Outside VMS Stratum, and increased slightly in the Inside VMS Stratum. Number and weight per tow of recruit scallops decreased in St. Mary's Bay, and increased in both VMS strata. Prerecruits were less abundant in 2015 than in 2014, and were less widely distributed. Condition, presented as predicted weight in grams for a 100 mm shell height, increased in all subareas of SPA 3.

The population model was fit to the combined survey biomass for just St. Mary's Bay and Inside VMS Stratum and catch data from 1996 to 2015. Population biomass estimated by the model was 2,620 t (meats) in 2015, a decrease of 7% from the estimate of 2,814 t for 2014. In 2015 the recuit biomass was estimated at 123 t, which is above the long-term (1996 to 2014) average for this area of 116 t.

Conclusions and Advice

Commercial biomass in SPA 3 is currently in the healthy zone (USR 1000 t). Harvest scenarios for 2015/2016, as well as the catches that correspond to various probabilities of exceeding an exploitation rate of 0.15 in the following year (2016/2017), are presented in Table 3. For example, Table 3 is interpreted as follows: a catch of 150 t corresponds to an exploitaiton 0.05, and is projected to result in a 1.4% decrease in biomass, the probability of biomass increase is 43%, the probability that a catch of 150 t will result in the population remaining above the LRP is >99%, and the probability of the population remaining above the USR is 99%. In the following fishing year (2016/2017), a catch of 220 t would have a probability of 10% of exceeding a reference exploitation of 0.15.

Table 3. Harvest scenario table for SPA 3 to evaluate 2015/2016 catch levels in terms of exploitation (e), expected change in biomass (%), probability (Pr) of biomass increase, probability that after the removal the stock will be above the USR and above the LRP. These calculations assume a USR of 1000 t and a LRP of 600 t. Potential catches in 2016/2017 are evaluated in terms of the posterior probability of exceeding an exploitation rate of 0.15.

2015/2016						Potential catch (t) 2016/2017					
						Pr ($e_{2016/2017}$) > 0.15					
Catch (t)	e	***% Change***	***Pr Increase***	***Pr > LRP***	***Pr >USR***	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**
150	0.05	-1.4	0.43	>0.99	0.99	220	265	299	331	364	399
175	0.06	-2.1	0.42	>0.99	0.98	218	261	296	329	361	397
200	0.07	-2.9	0.42	>0.99	0.98	217	259	294	326	361	395
225	0.08	-3.8	0.39	>0.99	0.98	215	256	289	322	355	390
250	0.09	-4.8	0.38	>0.99	0.98	210	252	286	319	351	387
275	0.1	-6.2	0.36	>0.99	0.98	207	248	283	314	346	382
300	0.11	-6.8	0.35	>0.99	0.98	206	247	280	312	344	380
325	0.12	-7.7	0.34	>0.99	0.98	202	242	277	309	341	376
350	0.13	-8.4	0.33	>0.99	0.97	200	241	274	305	338	373
375	0.14	-9.6	0.31	>0.99	0.97	197	238	269	301	333	369
400	0.15	-10.5	0.29	>0.99	0.97	194	235	267	298	330	364

SPAs 4 and 5 – Digby and Annapolis Basin

Fishery

Before the start of the 2013/2014 fishing year, SPAs 4 and 5 (Appendix 1) were joined under one TAC. In 2014/2015, the Full Bay Fleet caught a total of 124.09 t in SPA 4 and 8.26 t in SPA 5 against a combined TAC of 135 t (Figure 5).

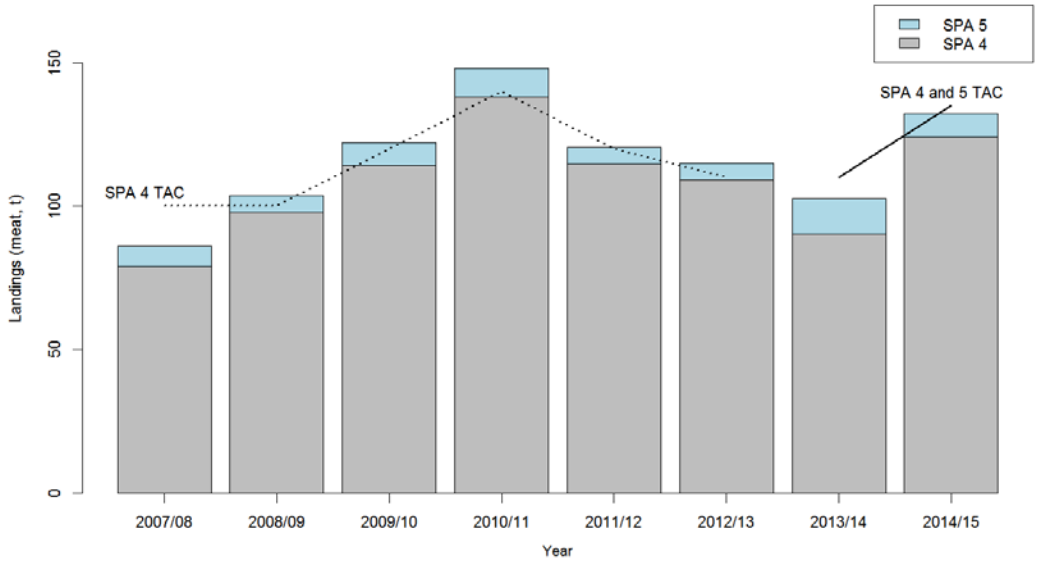

Figure 5. TAC (t) and landings (meats, t) in SPAs 4 (gray bars) and 5 (blue bars) from 2007/2008 to 2014/2015. SPAs 4 and 5 were joined under one TAC starting in the 2013/2014 fishing year, and the combined TAC is indicated by the solid black line. SPA 4 TAC from 2007/2008 to 2012/2013 is indicated by the dashed line. SPA 5 TAC over the 2007/2008 to 2012/2013 time period was 10 t.

The 2015 catch rate in SPA 4 was 22.5 kg/h, virtually unchanged from the catch rate of 22.8 kg/h in 2014. Effort in SPA 4 in 2015 was 5,441 hours, which is below the long term (1982/1983 to 2014/2015) median (10,155 h). The catch rate in SPA 5 declined from 22.5 kg/h

in 2014 to 19.9 kg/h in 2015, which is close to the long-term (1976/1977 to 2014/2015) median (18.9 kg/h). Effort in SPA 5 in 2015 decreased to 419 hours, which is close to the long-term (1976/1977 to 2014/2015) median (426 hours).

Assessment

The number per tow of commercial scallop in SPA 4 increased greatly in 2015. Weight per tow of commercial scallop also increased in 2015. Number and weight per tow of recruit scallops decreased in 2015 relative to 2014. Prerecruit scallops were less abundant in 2015 relative to 2014. Condition in 2015, presented as predicted weight in grams for a 100 mm shell height, increased in SPA 4.

The survey results for SPA 5 are presented with reference to the medians of the survey series from 1996 to 2008. The annual survey in SPA 5 started in 1990 and was discontinued in 2009. Starting in 2014, survey tows resumed in this area. The number and weight per tow of commercial scallop were above the medians (79.5/tow and 1.6 kg/tow for 1990-2008, respectively) in 2014 and 2015, while recruit number and weight per tow were near the medians (22.3/tow and 0.13 kg/tow for 1990-2008, respectively) in 2014, and increased in 2015.

The population model was fit to the survey biomass data and catch data for just SPA 4 from 1983 to 2015. Population biomass estimated by the model was 2,213 t (meats) in 2015, an increase of 70% from the estimate of 1,300 t for 2014. In 2015 the recuit biomass estimate was 23.6 t, which is near the recent time series (2003 to 2014) mean. The long-term (1983 to 2014) mean for recruitment in SPA 4 is 235 t, but the mean from 2003 to 2014 is only 29 t.

Conclusions and Advice

Commercial biomass in SPA 4 is currently in the healthy zone (USR 750 t). Harvest scenarios for 2015/2016, as well as the catches that correspond to various probabilities of exceeding an exploitation rate of 0.15 in the following year (2016/2017), are presented in Table 4. For example, Table 4 is interpreted as follows: a catch of 80 t corresponds to an exploitaiton 0.03, and is projected to result in a 5.7% increase in biomass, the probability of biomass change is neutral (49%), the probability that a catch of 80 t will result in the population remaining above the LRP is >99%, and the probability of the population remaining above the USR is 99%. In the following fishing year (2016/2017), a catch of 194 t would have a probability of 10% of exceeding a reference exploitation of 0.15.

Table 4. Harvest scenario table for SPA 4 to evaluate 2015/2016 catch levels in terms of exploitation (e), expected change in biomass (%), probability (Pr) of biomass increase, probability that after the removal the stock will be above the USR and above the LRP. These calculations assume a LRP of 530 t and a USR of 750 t. Potential catches in 2016/2017 are evaluated in terms of the posterior probability of exceeding an exploitation rate of 0.15.

2015/2016						Potential catch (t) 2016/2017					
						Pr **($e_{2016/2017}$) > 0.15**					
Catch (t)	e	***% Change***	***Pr Increase***	***Pr > LRP***	***Pr > USR***	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**
80	0.03	5.7	0.49	>0.99	0.99	194	230	263	292	323	359
100	0.04	5.1	0.48	>0.99	0.99	191	230	260	292	325	357
125	0.05	3.5	0.47	>0.99	0.99	190	229	258	288	315	349
150	0.06	1.9	0.46	>0.99	0.99	182	220	250	280	314	345
175	0.07	1.4	0.44	>0.99	0.99	185	221	251	282	311	344
200	0.08	-1.7	0.41	>0.99	0.99	173	213	242	272	303	336
225	0.09	-1.5	0.41	>0.99	0.99	180	216	245	273	300	332
250	0.10	-2.4	0.40	>0.99	0.99	176	210	240	268	297	333
275	0.12	-4.2	0.39	>0.99	0.99	170	206	236	264	296	328
300	0.13	-5.5	0.37	>0.99	0.98	170	205	233	259	289	320
360	0.15	-7.7	0.35	>0.99	0.98	163	198	228	257	287	317

SPA 6 – Grand Manan and Southwest New Brunswick

Fishery

The areas around Grand Manan and off southwest New Brunswick are designated as SPA 6. This area is further divided into management subareas 6A, 6B, 6C, and 6D (Appendix 1). A total of 231 t was landed against a combined TAC of 240 t in SPA 6 in 2014/2015. The Mid Bay Fleet reported a total of 207.01 t against a quota of 202.23 t and the Full Bay reported a total of 23.99 t against a quota of 37.77 t (Figure 6).

Catch rates for Mid Bay decreased in 2015 relative to 2014 across all subareas but are still at the second highest level observed over the Mid Bay time series (6A: 22.6 to 17.9 kg/h, 6B: 23.4 to 21.8 kg/h, 6C: 24.7 to 19.7 kg/h and 6D: 34.2 to 25.0 kg/h, for 2015 to 2014, respectively). For Full Bay, catch rates increased in 2015 relative to 2014 in subareas 6A (10.7 to 15.2 kg/h), 6B (22.2 to 25.5 kg/h), and 6C (14.7 to 19.2 kg/h); although there was fishing by Full Bay in 6D in 2015 there were not enough records to present these data consistent with *Privacy Act* considerations. When interpreting catch rates, it is important to note that Mid Bay records constitute the majority of the total catch records in SPA 6 (95% vs. 5%, Mid Bay vs. Full Bay records, respectively).

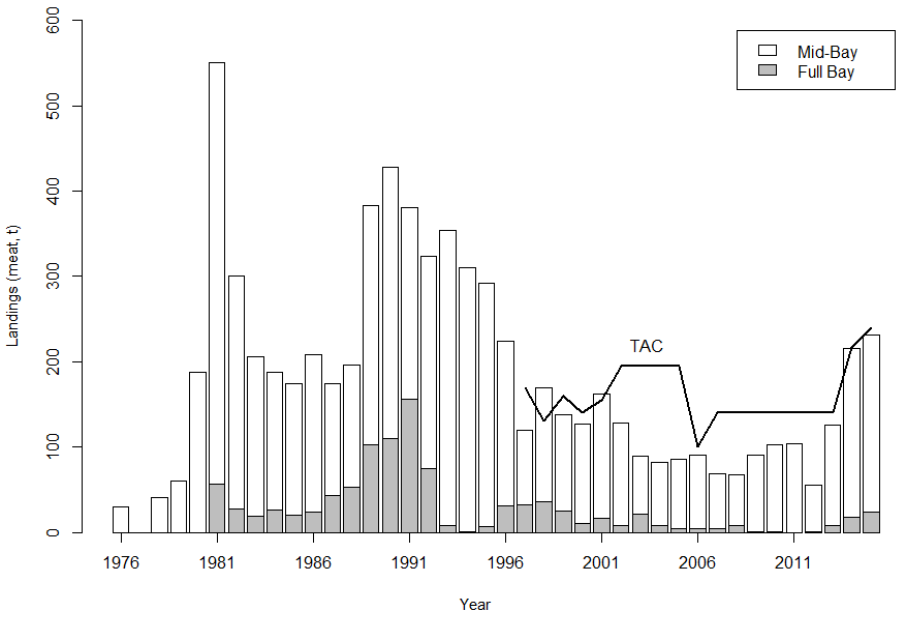

Figure 6. SPA 6 landings (meats, t) by the Full Bay Fleet (grey bars) from 1981 to 2015, and the Mid Bay Fleet (white bars) from 1976, 1978 to 2015. Combined TAC (t) is indicated by the black line.

Assessment

Until 2014, SPA 6 was assessed based on management areas: 6A, 6B, and 6C. In 2014, the survey index was improved by restratifying the survey according to VMS “fishing” intensity from 2002 to 2014 and defining two VMS strata. In 2015, the survey index was further improved by refining the Inside VMS Stratum and redefining the Outside VMS Stratum.

Commercial and recruit numbers and weight per tow increased in the Inside and Outside VMS strata in 2015. With the exception of commercial biomass in the Outside VMS Stratum, biomass and abundances of both commercial and recruit scallops observed in 2015 are at time series (since 1997) highs. In 2015, prerecruit abundances of between 10 to 100 per tow were found throughout the survey area with a few localized patches of >200 per tow. Condition, presented as predicted weight in grams for a 100 mm shell height, remained relatively similar from 2014 to 2015.

The population model was fit to the survey biomass data from the Inside VMS Stratum and catch data associated with that Inside VMS Stratum of SPA 6 from 2006 to 2015. This is the first time the Bay of Fundy stock assessment model has been used in SPA 6, and the model fits the survey mean estimates well and gave reasonable parameter estimates. Population biomass estimated by the model was 1,361 t (meats) in 2015, an increase over the average of 368 t from 2006 to 2012. In 2015 the recruit biomass was estimated at 158 t.

Conclusions and Advice

Other SPAs in the Bay of Fundy have defined reference points based on the population biomass estimates from the model, whereas this is the first year in which the assesment model has been used in SPA 6. Further work and consultation with Industry will be required if reference points are to be defined in terms of population biomass. Currently, reference points in SPA 6 are defined in terms of commercial catch rate. The catch rate index is the overall catch rate for all of SPA 6 for both fleets combined. 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 2015, the catch rate was well above the USR at 20.2 kg/h but was down from 2014 (25.4 kg/h; Figure 7).

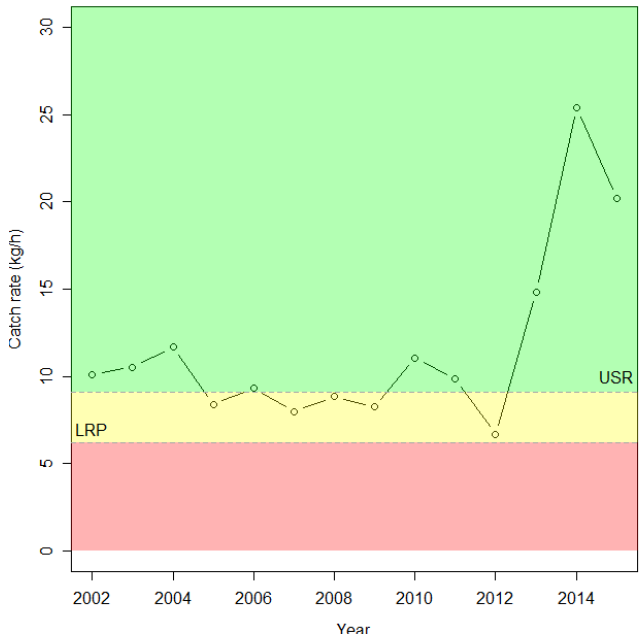

Figure 7. Annual commercial catch rate (kg/h) for SPA 6 for all subareas and both fleets combined. The red area represents the critical zone below the LRP of 6.2 kg/h, the yellow area represents the cautious zone between the LRP and USR of 9.1 kg/h, and the green area represents the healthy zone above the USR.

The catch rate index is currently in the healthy zone (USR 9.1 kg/h). Harvest scenarios for 2015/2016 are presented in Table 5. For example, Table 5 is interpreted as follows: a catch of 140 t corresponds to an exploitaiton of 0.08, and is projected to result in a 12.4% increase in biomass, and the probability of biomass increase is 53%.

Table 5. Harvest scenario table for Scallop Production Area 6 to evaluate 2015/2016 catch levels in terms of exploitation (e), expected change in biomass (%), and probability (Pr) of biomass increase.

2015/2016			
Catch (t)	e	***% Change***	***Pr Increase***
140	0.08	12.4	0.53
160	0.09	11.4	0.52
180	0.11	10.0	0.51
200	0.12	8.9	0.50
220	0.13	7.6	0.49
240	0.14	6.4	0.48
260	0.15	5.4	0.47

Sources of Uncertainty

Biomass projections require estimates of expected biomass growth (and condition) and natural mortality for future years. These estimates are based on current year's meat weight-shell height (i.e., growth) relationship and mortality is estimated from the mean of the previous three years. These estimates may not reflect actual changes over the following year(s).

CONSIDERATIONS

Landed recreational and FSC catch by dip netting, diving, tongs, and hand are not available and not accounted for in the assessment. In the 2014/2015 fishing year, there were no fishery observer trips in the Bay of Fundy; therefore, refer to Sameoto and Glass (2012) for past analysis of discards from the inshore scallop fishery.

SOURCES OF INFORMATION

This Science Advisory Report is from the November 17-18, 2015, Assessment of Bay of Fundy Scallop in Scallop Production Areas (SPAs) 1A, 1B, and 3-6. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

DFO. 2002. Proceedings of a Maritimes Regional Advisory Process Meeting on SPA 1-4 Scallops. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2002/018: 19 pp.

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Smith, S.J., and Hubley, B. 2013. Impact of survey design changes on stock assessment advice: Sea scallops. ICES J. Mar. Sci. 71:320-327. doi.10.1093/icesjms/fst115.

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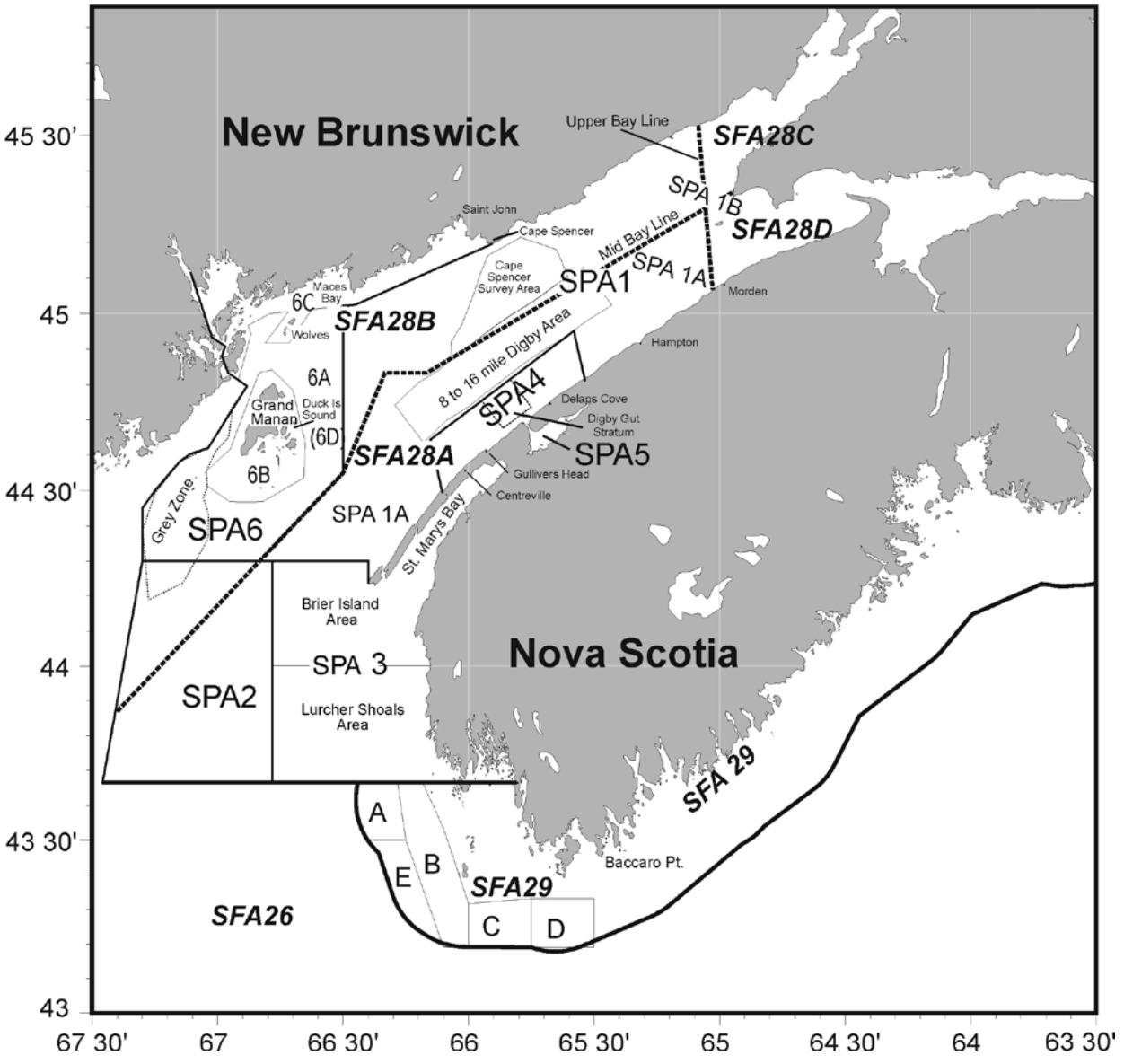
APPENDIX 1

Map showing the locations and place names for inshore scallop grounds.



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MPO. 2016. Évaluation des stocks 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, Avis sci. 2016/004.