



STOCK STATUS UPDATE FOR SCALLOP (*PLACOPECTEN MAGELLANICUS*) IN SCALLOP FISHING AREA 29 WEST OF LONGITUDE 65°30'

Context

Advice on the status of Scallops in Scallop Fishing Area (SFA) 29 West of Longitude 65°30' (herein referred to as SFA 29 West) is requested annually by Fisheries and Oceans Canada (DFO) Resource Management to help determine a Total Allowable Catch (TAC) and estimate risk of different harvest scenarios. Scallop in SFA 29 West are assessed on a multiyear schedule, with update reports produced in interim years. The last full assessment of SFA 29 West was conducted in 2015 (DFO 2015; Sameoto et al. 2015) and has been updated annually (DFO 2016, 2017, 2018, 2019).

The objectives of this Science Response are to update the status of the SFA 29 West Scallop stocks in 2019, evaluate the bycatch of non-target species from the 2019 fishery, and evaluate the consequence of various harvest levels for the 2020 fishery.

This Science Response Report results from the Science Response Process of April 7, 2020, on the Stock Status Update of Scallop in Scallop Fishing Area (SFA) 29 West of 65°30'.

Background

Population surveys have been conducted annually in SFA 29 West by DFO Science since 2001. The survey occurs in September/October after the fishery has closed. The current survey design uses the Scallop habitat suitability map developed by Brown et al. (2012) and bins habitat suitability probabilities into three categories defined by the following ranges: Low [0, 0.3), Medium [0.3, 0.6), and High [0.6, 1.0). Habitat suitability represents a relative probability scale of suitable Scallop habitat, with the lowest suitable Scallop habitat indicated by 0 and the highest suitable habitat indicated by 1. The population dynamics of commercial and recruit Scallops are modelled using the state-space habitat-based assessment model as defined by Smith et al. (2015). Throughout this update, Scallops with a shell height of 100 mm and greater are referred to as commercial size. Scallops with a shell height of 90–99 mm are referred to as recruits and are expected to grow to commercial size in the following year. Scallops with a shell height of less than 90 mm are considered pre-recruits.

In this update, Scallop removals include all commercial landings from SFA 29 West and Food, Social, and Ceremonial (FSC) catch by scallop drag. Landed recreational and FSC catch by dip netting, diving, tongs, and hand are not available and not accounted for in the assessment.

Description of the Fishery

Scallop Fishing Area 29 encompasses a large area inside the 12-mile territorial sea, from the south of Yarmouth (latitude 43°40'N) to Cape North in Cape Breton. This update refers to only that portion of SFA 29 West of longitude 65°30'W continuing north to Scallop Production Area 3 at latitude 43°40'N (Figure 1). The fishing season generally runs from the third week of June to

Maritimes Region

the end of August with the duration of the fishery variable each year. This area is fished by the Full Bay (FB) Fleet and inshore East of Baccaro licence holders who are authorized to fish in SFA 29 West (hereafter referred to as the EoB Fleet). The SFA 29 West fishery has occurred since 2001. The fishery is managed using limited entry, seasonal closures, minimum shell height, and meat count. Both fleets operate under an Individual Transferable Quota (ITQ) system in this area. The TACs are set, and landings are reported in terms of meat weights (adductor muscles).

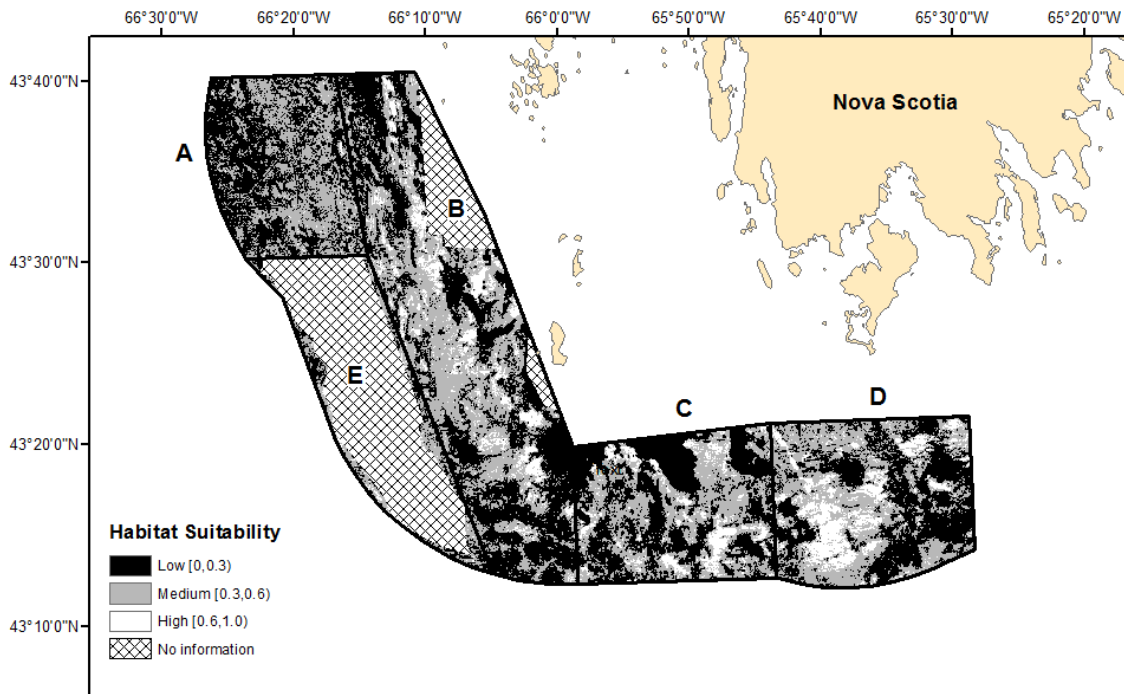


Figure 1. The SFA 29 West Subareas A to E. Shaded areas show habitat suitability probability categories: Low [0, 0.3) in black, Medium [0.3, 0.6) in grey, and High [0.6, 1.0) in white (see Brown et al. 2012). Note: SFA 29 extends along the shoreline to Cape North in Cape Breton.

Analysis and Response

Commercial Fishery

Since 2002, the TAC has been shared between the FB and EoB fleets. As of 2010, the TAC and landings are reported for both fleets combined. In 2019, a total of 141.2 tonnes (t) were landed against the TAC of 150 t. There was an additional FSC catch of 10.5 t, which does not count against the TAC (Figure 2).

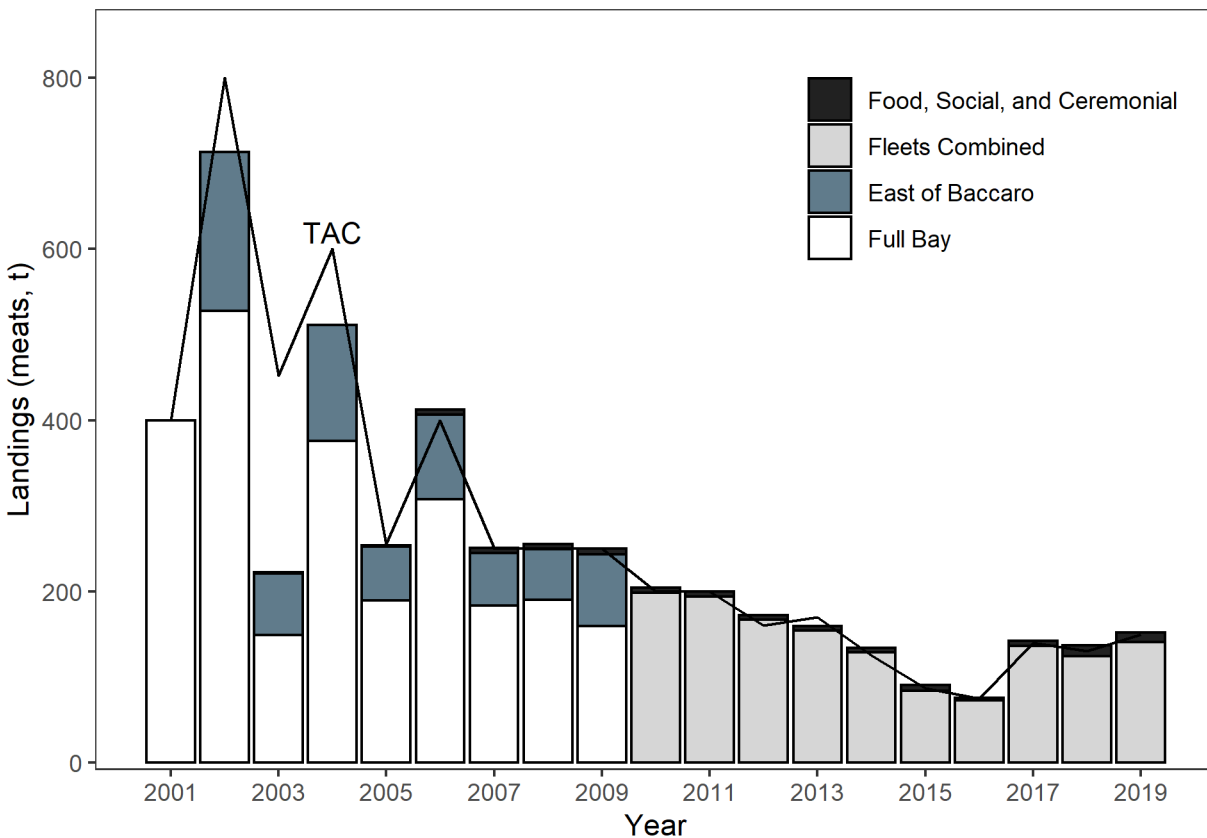


Figure 2. Annual Scallop landings (meats, t) from 2001 to 2019 for Scallop Fishing Area 29 West and the Total Allowable Catch (TAC, black line). Note that the Food, Social, and Ceremonial landings do not count against the TAC.

In 2019, all subareas (A–E) in SFA 29 West were open and were fished (Appendix). For Subarea A, commercial biomass was projected to decline in each year since 2015, even with zero catch in this Subarea (DFO 2015; 2016; 2017; 2018; 2019). The fishery in Subarea A was subsequently closed in 2015 and 2016. In 2017, the fishery in Subarea A reopened, using a fishing plan that included a dedicated quota of 15 t, and fishing trips to Subarea A could not hail and move to any other subarea (i.e., vessels could not fish Subarea A and another subarea during the same trip). This fishing plan was adopted in 2018 and 2019; however, the dedicated quota was 10 t each year.

In 2019, the Subarea A catch rate calculated from fishing logs for the FB Fleet increased from 16.7 kg/h in 2018 to 20.3 kg/h in 2019. In Subarea B, the catch rate for the FB Fleet was 47.3 kg/h in 2019; catch rate was not available in 2018 as the fishery was closed. In Subarea C, catch rates remained similar from 2018 to 2019 for the FB Fleet (34.3 kg/h in 2018 to 35.5 kg/h in 2019). Due to *Privacy Act* considerations, the 2019 catch rates for Subareas A, B, and C for the EoB Fleet cannot be reported. In Subarea D, the catch rate increased for both fleets, from 66.1 kg/h in 2018 to 76.9 kg/h in 2019 for the FB Fleet and from 60.6 kg/h to 63.6 kg/h for the EoB Fleet. The catch rates in Subarea E for 2019 cannot be reported due to *Privacy Act* considerations.

Research Survey

In 2019, commercial sized Scallops were observed throughout the majority of the survey area in SFA 29 West, with the highest density patches located in Subareas B and D (Figure 3). In Subarea A, the number of commercial sized Scallops decreased in the Medium and Low habitat categories (there is no High category habitat in Subarea A). In Subarea B, commercial sized Scallop abundances increased in the High, decreased in the Medium, and remained similar in the Low habitat categories. In Subarea C, commercial sized Scallop abundances increased in the High and Medium habitat categories, and remained similar in the Low. In Subarea D, commercial sized Scallop abundances decreased in all habitat categories.

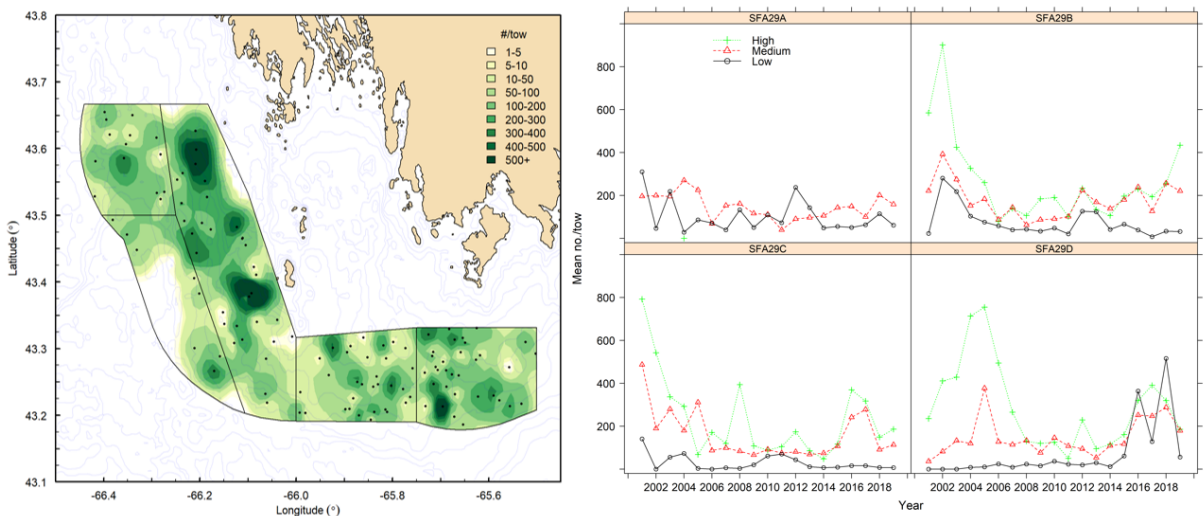


Figure 3. Commercial Scallops (≥ 100 mm shell height). On left: spatial density (numbers/tow) distribution from the 2019 survey for SFA 29 West. Points represent tow locations. On right: mean number per tow by subarea from 2001 to 2019 for Low [0, 0.3] (black circles), Medium [0.3, 0.6] (red triangle), and High [0.6, 1.0] (green crosses) categories of habitat suitability probabilities.

In 2019, the distribution of recruit sized Scallops was patchy, with the highest densities in Subarea B (Figure 4). In Subarea A, recruit abundances remained near zero in both the Medium and Low habitat category. In Subarea B, recruit abundance increased in the High, decreased in the Medium, and remained similar in the Low habitat category. In Subarea C, recruit abundance decreased in the High and Medium habitat, and remained similar in the Low habitat. In Subarea D, recruit abundance decreased in all habitat categories.

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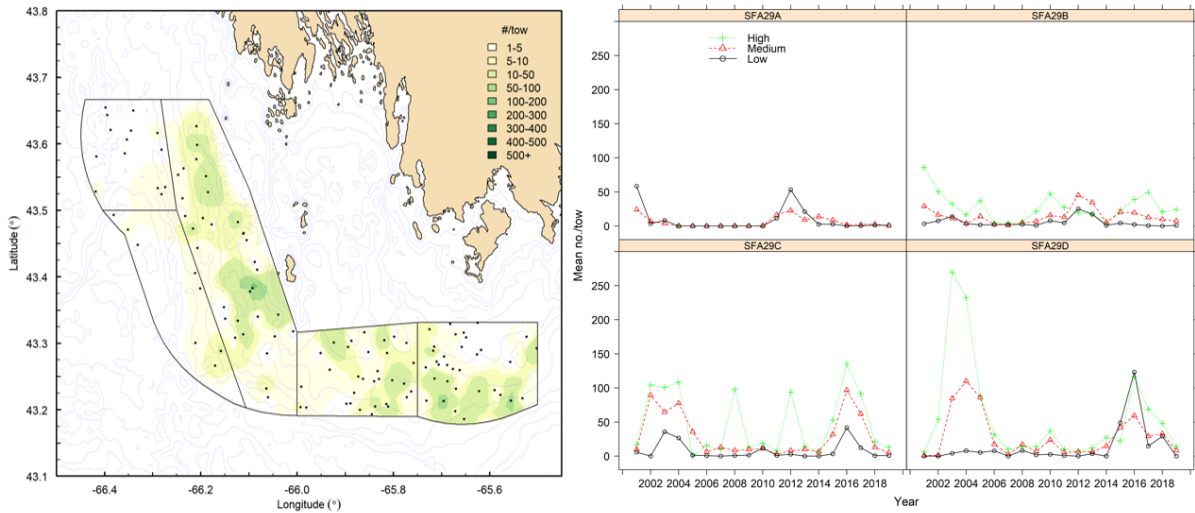


Figure 4. Recruit Scallops (90–99 mm shell height). On left: spatial density (numbers/tow) distribution from the 2019 survey for SFA 29 West. Points represent tow locations. On right: mean number per tow by subarea from 2001 to 2019 for Low [0, 0.3) (black circles), Medium [0.3, 0.6) (red triangle), and High [0.6, 1.0) (green crosses) categories of habitat suitability probabilities.

In 2019, the distribution of pre-recruit sized Scallops was patchy, with the highest densities observed in Subarea C (Figure 5). In Subarea A, pre-recruit abundances in 2019 decreased from 2018 in the Low and Medium habitat. Pre-recruit abundances increased in all habitat categories in Subareas B and C. In Subarea D, pre-recruit abundances increased in the High habitat, and decreased in Medium and Low habitat categories.

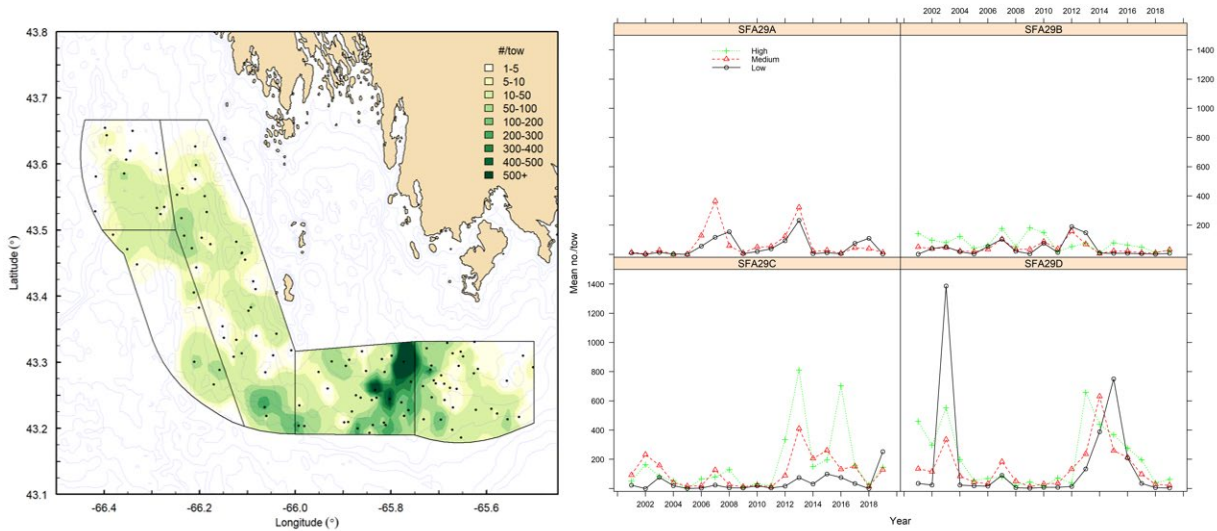


Figure 5. Pre-recruit Scallops (<90 mm shell height). On left: spatial density (numbers/tow) distribution from the 2019 survey for SFA 29 West. Points represent tow locations. On right: mean number per tow by subarea from 2001 to 2019 for Low [0, 0.3) (black circles), Medium [0.3, 0.6) (red triangle), and High [0.6, 1.0) (green crosses) categories of habitat suitability probabilities.

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Subarea E was not surveyed between 2005–2012, as it was considered a marginal area and less of a survey priority. Since 2012, a small number of stations (5–8 per year) have been surveyed each year. Since 2014, the tows have been allocated within a portion of Subarea E known to have been historically fished. Therefore, trends in survey abundance in Subarea E may not be indicative of trends in the subarea as a whole. Scallop numbers increased for commercial (81.1/tow in 2018 to 109.7/tow in 2019) and recruit (2.4/tow in 2018 to 3.3/tow in 2019) scallops, and decreased for pre-recruit size scallops (38.4/tow in 2018 to 25.3/tow in 2019).

Throughout SFA 29 West, Scallop condition during the survey (defined as meat weight, in grams, of a 100 mm shell height Scallop) ranged from 10.9 g (Subarea A) to 12.1 g (Subarea C). Condition decreased in all subareas from 2018 to 2019; this decrease ranged from 10–13%.

Assessment Model

The state-space habitat-based population model accepted at the framework assessment in February 2014 (Smith et al. 2015) was fit within each habitat suitability category for Subareas A to D. The model was fit to the commercial catch, effort derived from vessel monitoring systems, and survey data. Subarea E is not covered by the habitat suitability map and is not modelled.

Indicators of the Stock Status

The index associated with stock productivity for the DFO precautionary approach for SFA 29 West is commercial biomass density (t/km^2) in the High habitat suitability areas of Subareas B, C, and D (Figure 6). The approach is to manage exploitation in the high habitat areas (Smith and Sameoto 2016), and removal references are in relation to exploitation in the high habitat. Lower Reference Points (LRPs) for Subareas B, C, and D were established in the fall of 2015, and Upper Stock Reference Points (USRs) were established in the fall of 2016. In 2019, Harvest Control Rules (HCRs) were established for Subareas B, C, and D. If the biomass density is above the respective biomass density at Maximum Sustainable Yield (where $D_{MSY} = 3.75, 4.68, 4.32 t/km^2$ for Subareas B, C, and D, respectively) then the maximum exploitation would be 0.16, 0.17, and 0.22, for Subareas B, C, and D, respectively. If the biomass density is below D_{MSY} then the maximum exploitation would be 0.06, 0.06, and 0.09 for Subareas B, C, and D, respectively. There are no reference points for Subareas A and E. Since there is no High habitat suitability in Subarea A, the stock productivity index is provided for the Medium habitat suitability area of Subarea A (Figure 6).

In 2019, Subarea A commercial biomass density was 0.64 t/km^2 in the Low and 1.45 t/km^2 in the Medium habitat, a decrease from the 2018 biomass density in both habitat categories. Commercial biomass density in Subarea B increased in the High habitat category and remained similar in the Medium and Low habitat categories. In 2019, commercial biomass density in the High habitat category of Subarea B was 5.06 t/km^2 , which is above the USR of 2.24 t/km^2 . Commercial biomass density in Subarea C increased in the High and Medium habitat categories and remained similar in the Low habitat category. Commercial biomass density in the High habitat category of Subarea C was 3.73 t/km^2 in 2019, which is above the USR of 2.82 t/km^2 . Commercial biomass density in Subarea D decreased in all three habitat categories. Commercial biomass density in the High category of Subarea D in 2019 was 2.91 t/km^2 , which is above the USR of 2.6 t/km^2 .

Maritimes Region



Figure 6. Commercial biomass densities (t/km^2) in SFA 29 West. In Subarea A the Medium suitability category is shown, while the High suitability categories are shown for Subareas B, C, and D. The Lower Reference Points (LRPs) are indicated by the solid (red) line and Upper Stock References (USRs) indicated by the dashed (black) line and the Density associated with Maximum Sustainable Yield (D_{MSY}) is indicated by the dot-dashed (blue) line for Subareas B, C, and D. The LRPs and USRs are $1.12 t/km^2$ and $2.24 t/km^2$ Subarea B, $1.41 t/km^2$ and $2.82 t/km^2$ for Subarea C, and $1.3 t/km^2$ and $2.6 t/km^2$ for Subarea D, respectively. The D_{MSY} values are 3.75 , 4.68 , $4.32 t/km^2$ for Subareas B, C, and D, respectively.

Exploitation

Model estimated exploitation was less than 0.2 in 2019 (Figure 7). Subarea A exploitation in the Medium habitat was 0.03 in 2019, as in 2018. Subarea B was closed to fishing in 2018, but it reopened in 2019. In 2019, exploitation in the High habitat was 0.05. In Subarea C, exploitation in High habitat decreased from 0.18 in 2018 to 0.06 in 2019. In Subarea D, exploitation in the High habitat increased from 0.14 in 2018 to 0.16 in 2019.

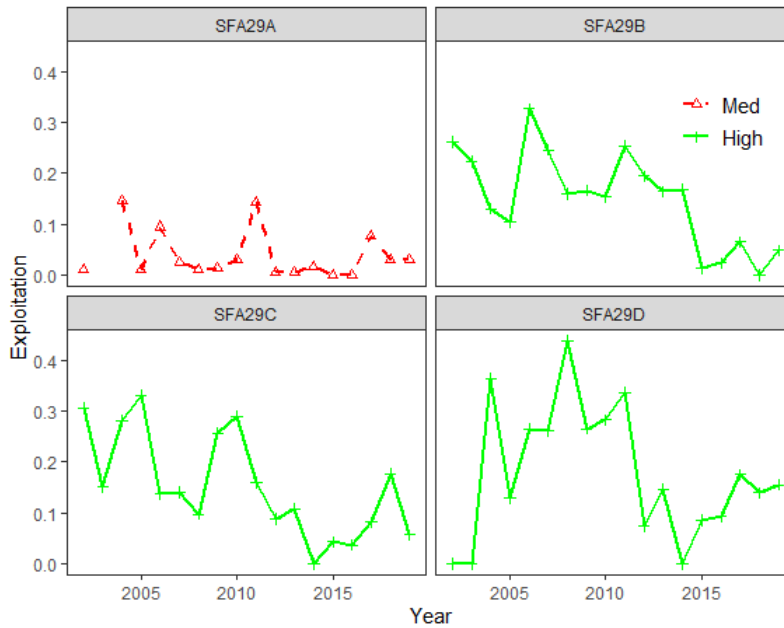


Figure 7. Model estimates of exploitation for the Medium [0.3, 0.6) habitat category in Subarea A, and for the High [0.6, 1.0) habitat category in Subareas B, C, and D in SFA 29 West from 2001 to 2019.

Natural mortality

In all modeled subareas, the natural mortality (instantaneous) model estimates were above their respective long-term medians (2001–2018; Figure 8). In 2019, the estimated natural mortality for Subarea A was 0.43, an increase from 2018 (0.39). In Subarea B, the natural mortality estimate increased from 0.22 in 2018 to 0.24 in 2019. The estimated 2019 natural mortality in Subarea C (0.35) was significantly higher than the long-term median (0.17) but lower than observed in 2018 (0.56). In Subarea D, the natural mortality estimate in 2019 was 0.22, which is above the long-term median (0.16), but represents a decrease since 2018 (0.30).



Figure 8. Modeled natural mortality (instantaneous rate) in SFA 29 West. In Subarea A the Medium suitability category is shown, while the High suitability categories are shown for Subareas B, C, and D. The 5-year (2015–2019) mean natural mortality is indicated by the dashed black line and the long-term median (2001–2018) is indicated by the solid black line.

Harvest Level Scenarios for 2020

Catch scenarios for 2020 assume current year (2019) estimates of condition and growth, estimates of observed recruit abundance, and the mean of natural mortality estimates from the last 5 years (2015 to 2019) within each subarea.

Catch, exploitation, percent change in commercial biomass, probability of biomass decline, and the probability of exceeding the reference points were determined from the model for a range of potential catches, and these are presented as catch scenario tables for Subareas A–D in Tables 1–4.

There is no assessment model for Subarea E. The only available data to assess this area include survey data, commercial catch rate, and landings. In this subarea, abundance of commercial and recruit sized Scallop increased in 2019, relative to 2018. Due to *Privacy Act* considerations, catch rate data cannot be reported. The commercial fleet landed 2.2 t against a catch limit of 15 t in 2019.

For Subarea A, biomass declines are predicted, even if no catch is taken in 2020. This is partially due to the elevated natural mortality in the subarea (>0.2 since 2014) and the continued low levels of recruitment.

An example of how to interpret the catch scenarios in Tables 1–4 is presented using Table 2 for Subarea B. In this subarea, a catch of 32 t corresponds to an exploitation of 0.06 in the High habitat category, and is projected to result in a 15.8% biomass decrease in the High habitat

**Science Response: Stock Status Update
for Scallop in SFA 29 West of 65°30'**

Maritimes Region

category. The probability of a biomass increase in the High habitat category is 0.37. The model predicts a decrease in biomass, for all of Subarea B, of 10.1%; the associated probability of biomass increase for all of Subarea B is 0.37. After 32 t of catch is removed, the probability of being above the LRP is 0.97, and the probability of being above the USR is 0.84.

Table 1. Catch scenario table for SFA 29 West Subarea A to evaluate 2020 total subarea catch levels in terms of exploitation (e), expected changes in biomass (%), and probability (Pr.) of biomass increase. Note, Subarea A has no High suitability habitat.

Catch (t)	Medium Habitat Suitability Category			Whole Subarea	
	e	Expected % Change	Pr. Increase	Expected % Change	Pr. Increase
0	0	-30.9	0.25	-26.6	0.23
3	0.02	-32.1	0.24	-27.6	0.22
7	0.04	-33.0	0.23	-28.7	0.21
10	0.06	-34.5	0.22	-30.1	0.20
14	0.08	-35.6	0.21	-31.0	0.19
17	0.10	-37.2	0.20	-32.2	0.18
21	0.12	-38.1	0.19	-33.4	0.17

Table 2. Catch scenario table for SFA 29 West Subarea B to evaluate 2020 total subarea catch levels in terms of exploitation (e), expected changes in biomass (%), probability (Pr.) of biomass increase, and probability of being above the Lower Reference Point (LRP: 1.12 t/km²) and Upper Stock Reference (USR: 2.24 t/km²).

Catch (t)	High Habitat Suitability Category					Whole Subarea	
	e	Expected % Change	Pr. Increase	Pr. > LRP	Pr. > USR	Expected % Change	Pr. Increase
0	0	-10.9	0.41	0.98	0.86	-7.6	0.40
11	0.02	-12.0	0.40	0.98	0.85	-8.5	0.39
22	0.04	-14.1	0.38	0.97	0.85	-9.3	0.38
32	0.06	-15.8	0.37	0.97	0.84	-10.1	0.37
43	0.08	-17.2	0.36	0.97	0.83	-11.0	0.35
54	0.10	-18.8	0.34	0.97	0.83	-11.9	0.34
65	0.12	-20.3	0.33	0.97	0.82	-12.8	0.33
76	0.14	-22.4	0.31	0.97	0.81	-13.8	0.32
86	0.16	-23.7	0.30	0.96	0.80	-14.5	0.31

Table 3. Catch scenario table for SFA 29 West Subarea C to evaluate 2020 total subarea catch levels in terms of exploitation (e), expected changes in biomass (%), probability (Pr.) of biomass increase, and probability of being above the lower reference point (LRP: 1.41 t/km²) and upper stock reference (USR: 2.82 t/km²).

Catch (t)	High Habitat Suitability Category					Whole Subarea	
	e	Expected % Change	Pr. Increase	Pr. > LRP	Pr. > USR	Expected % Change	Pr. Increase
0	0	-17.5	0.40	0.82	0.55	-4.3	0.46
5	0.02	-19.0	0.39	0.82	0.54	-5.6	0.44
10	0.04	-20.3	0.38	0.81	0.53	-6.6	0.43
15	0.06	-22.1	0.37	0.81	0.52	-7.9	0.42
19	0.08	-23.8	0.36	0.80	0.51	-9.0	0.41

Maritimes Region

Table 4. Catch scenario table for SFA 29 West Subarea D to evaluate 2020 total subarea catch levels in terms of exploitation (e), expected changes in biomass (%), probability ($Pr.$) of biomass increase, and probability of being above the lower reference point (LRP: 1.3 t/km²) and upper stock reference (USR: 2.6 t/km²).

Catch (t)	High Habitat Suitability Category					Whole Subarea	
	e	Expected % Change	Pr. Increase	Pr. > LRP	Pr. > USR	Expected % Change	Pr. Increase
0	0	-16.0	0.35	0.86	0.47	-22.5	0.22
6	0.02	-17.7	0.34	0.85	0.46	-23.2	0.21
12	0.04	-19.3	0.32	0.84	0.45	-24.1	0.20
19	0.06	-21.1	0.31	0.84	0.43	-25.1	0.20
25	0.08	-22.7	0.29	0.83	0.42	-26.0	0.19
31	0.10	-24.1	0.28	0.82	0.40	-26.9	0.18
37	0.12	-26.1	0.26	0.81	0.39	-27.8	0.17

Ecosystem Considerations

In 2019, there were 35 active vessels in the fishery, 248 observed tows, 13 observed days and 3 trips observed. Due to *Privacy Act* considerations, discard rates for bycatch cannot be reported. Discard rates from the fishery in 2018 and 2017 can be found in DFO (2019). For data prior to 2017 see DFO (2016, 2017), Sameoto et al. (2014, 2015) and Sameoto and Glass (2012).

Conclusions

In 2019, commercial biomass densities in Subareas B, C, and D are above their USRs and are considered to be in the Healthy Zone. Indications for Subarea E are that the commercial abundance is relatively stable at the current level of removals. For all Subareas, biomass declines are predicted, even if no catch is taken in 2020.

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Appendix

Appendix 1. Commercial Scallop fishery landings, Total Allowable Catch (TAC), and landings for Food, Social and Ceremonial purposes (FSC) (meats, t) for Scallop Fishing Area (SFA) 29 West from 2013 to 2019. The TACs for Subareas A and E are sometimes combined. Dash (-) indicates no catch. Asterisk (*) indicates preliminary data.

Year	Subarea	TAC (t)	Landings (t)	FSC (t)	Total Landings (t)
2013	A	35.0	0.9	-	0.9
	E		13.5	-	13.5
	B		82.6	4.9	87.5
	C		18.3	-	18.3
	D		38.8	-	38.8
	Total		170.0	154.1	4.9
2014	A	45.0	3.0	-	3.0
	E		27.3	-	27.3
	B		98.1	5.3	103.4
	C		-	-	-
	D		-	-	-
	Total		135.0	128.4	5.3
2015	A	0	-	-	-
	E		27.3	0.4	27.7
	B		14.9	0.7	15.6
	C		13.2	1.4	14.6
	D		29.0	3.7	32.7
	Total		87.0	84.4	6.2
2016	A	0.0	-	-	-
	E		9.5	-	9.5
	B		16.6	-	16.6
	C		14.9	0.6	15.5
	D		31.5	3.0	34.5
	Total		75.0	72.5	3.6
2017	A	15.0	13.2	-	13.2
	E		0.1	-	0.1
	B		21.7	-	21.7
	C		26.3	-	26.3
	D		74.6	9.9	84.5
	Total		140.0	135.9	9.9
2018	A	10.0	8.7	-	8.7
	E		12.8	-	12.8
	B		0.01	-	0.01
	C		46.8	-	46.8
	D		56.0	13.1	69.1
	Total		130.0	124.3	13.1
2019*	A	10.0	6.8	-	6.8
	E		2.2	-	2.2
	B		41.2	-	41.2
	C		15.0	-	15.0
	D		76.0	10.5	86.5
	Total		150.0	141.2	10.5

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