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Canadian Science Advisory Secretariat
Maritimes Region **Science Response 2018/046**

STOCK STATUS UPDATE FOR ARCTIC SURFCLAM (*MACTROMERIS POLYNYMA*) ON BANQUEREAU AND GRAND BANK

Context

An update on the status of the offshore Arctic Surfclam (*Mactromeris polynyma*) resource was requested by Maritimes Region Resource Management to support decisions about harvest levels in the Arctic Surfclam fishery. Surfclam is assessed on a multi-year assessment schedule, with Updates produced in interim years. The basis for assessing Arctic Surfclam on Banquereau and Grand Bank was examined at a framework meeting on June 28-29, 2016. During the framework review, a fisheries-dependent assessment methodology was developed for Banquereau using a spatially disaggregated surplus production model (Hubley and Heaslip 2018). This method was used to provide an assessment of the stock status on Banquereau and potential harvest levels based on two removal values ($0.5F_{MSY}$ and 0.33M). This report updates fisheries information (landings, Catch Per Unit Effort (CPUE), fishery footprint) and secondary indicators to the end of the 2017 fishing season for both Grand Bank and Banquereau, as well as biomass model results from Banquereau, and assesses them against agreed upon reference points and thresholds. These banks were last assessed in 2017 (DFO 2017, Hubley et al. 2018).

This Science Response Report results from the Science Response Process of May 8, 2018, on the Stock Status Update for Arctic Surfclam on Banquereau and Grand Bank.

Background

The offshore Arctic Surfclam fishery takes place on Banquereau and Grand Bank (Figure 1). Grand Bank refers to the Eastern Grand Banks fishing area, in NAFO Area 3LNO, with some restrictions as outlined in the License conditions. Historically, the banks were managed with Total Allowable Catches (TACs) set based on bank-wide estimates of biomass. These biomass estimates were made from scientific surveys, the most recent of which were in 2009 for Grand Bank (Roddick et al. 2011) and 2010 for Banquereau (Roddick et al. 2012). In the absence of new survey data, an assessment approach was developed for Banquereau that restricted biomass estimates to areas of commercially viable densities (a historically fished area) identified from Vessel Monitoring System (VMS) satellite positional data. This method is not currently applied to Grand Bank since fishing effort, specifically area fished, is less than on Banquereau and it is spread out over a greater area. The stock on Grand Bank is monitored with a set of fishery dependent secondary indicators for biomass, fishery footprint, and size composition.

Description of the Fishery

Following a three month test fishery in 1986, an Offshore Clam Enterprise Allocation Program was developed for Arctic Surfclam on Banquereau. The fishery expanded to Grand Bank in 1989. In 2017, there were three licences for offshore clam, with two vessels fishing on Banquereau and one vessel fishing on Grand Bank. Currently, temporary transfers of quota are

permitted between licenses within a single fishing season. Effort has moved between the Banks over time, with effort currently split between the 2 banks. Fishing is conducted from large freezer processors using hydraulic dredges on sandy substrates located at 60-110 m depth. The main management tools for the offshore clam fishery are limited entry licences; TAC divided into enterprise allocations, 100% industry-funded dockside monitoring, mandatory logbooks, and 100% VMS coverage (DFO 2014). There were no at-sea Fisheries Observer trips in 2017. See Hubley et al. (2018) for the most recent review of at-sea Observer data.

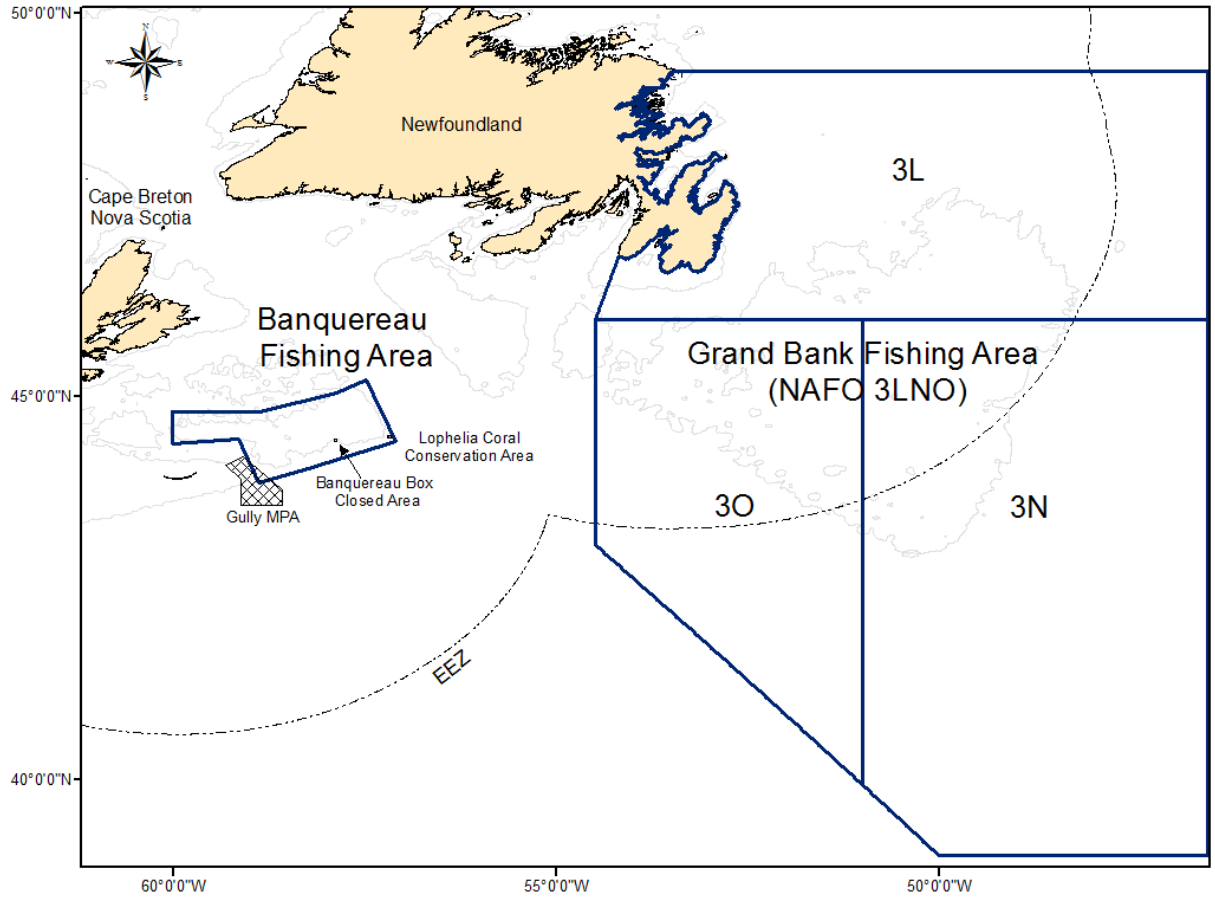

Figure 1. Banquereau and Grand Bank Arctic Surfclam fishing areas (solid lines) from licence conditions.

Analysis and Response

Commercial Fishery

From 2007 to 2015, fishing effort and landings on Grand Bank were low (range: 0-730 t), effort and landings increased in 2016 and were sustained in 2017. In 2017, landings from the logbook records on Grand Bank were 13,738 tonnes (t) against a TAC of 14,756 t. The mean CPUE was 146 g/m^2, an increase from 142 g/m^2 in 2016. In 2017, landings from the logbook records on Banquereau were 21,817 t against a TAC of 24,000 t. The mean CPUE was 115.8 g/m^2, an increase from 110 g/m^2 in 2016. Landings and CPUE time series for both banks are shown in Figure 2.

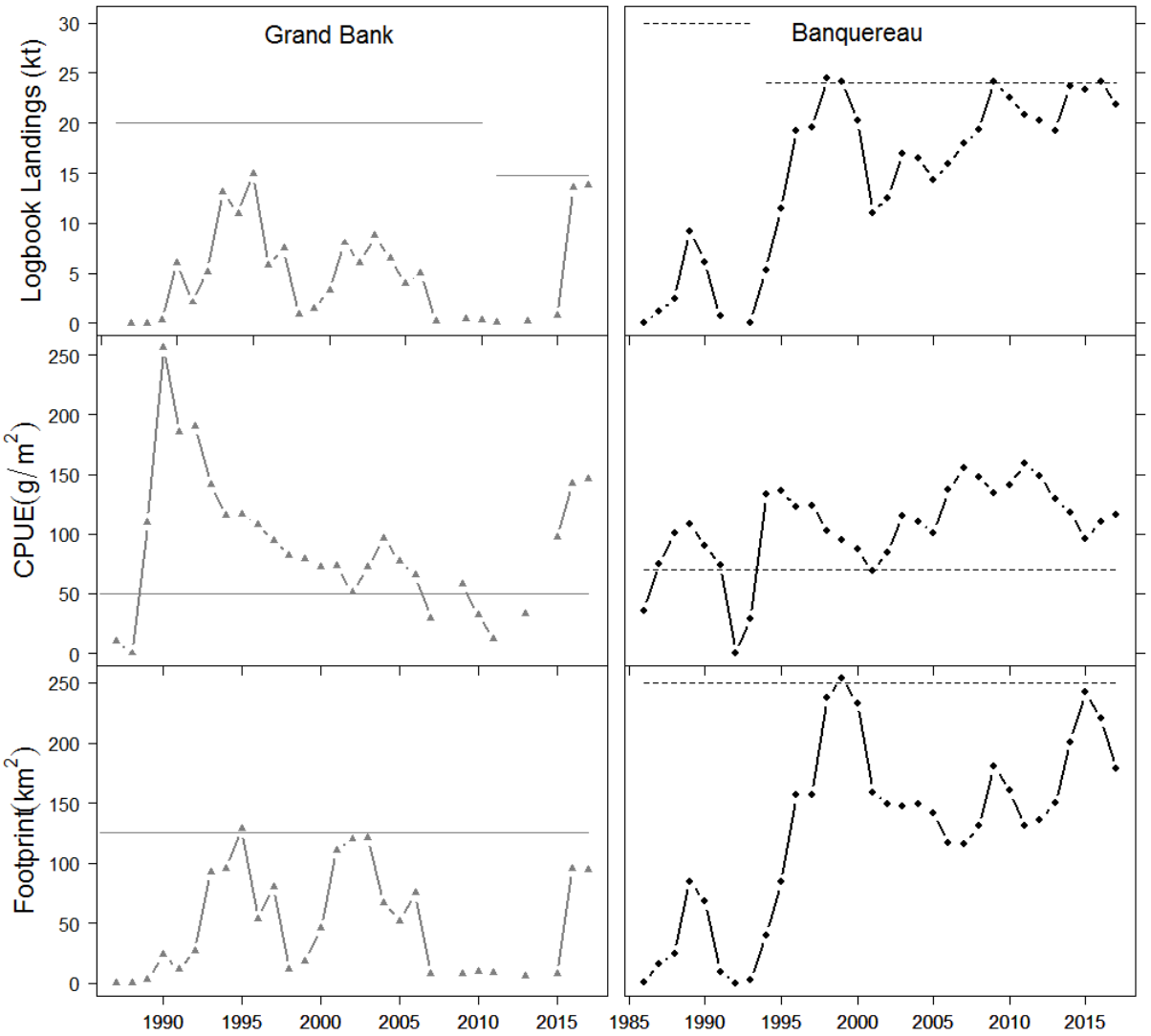

Figure 2. Logbook landings in kilotonnes (kt), Catch Per Unit Effort (CPUE; g/m^2), and fishery footprint (km^2) for Grand Bank (left) from 1987 to 2017 and Banquereau (right) from 1986 to 2017. Horizontal lines represent Bank-specific Total Allowable Catch (top panels) or threshold levels for secondary indicators (bottom four panels; see: Indicators of Stock Status).

Spatial Production Model for Banquereau

As a result of the framework review (Hubley and Heaslip 2018), the stock definition for Banquereau has been restricted to the area directly under exploitation. Five spatial assessment areas are used to divide Banquereau (Figure 3). Within these areas, the fished (exploited) areas are determined using VMS data, which is used as a proxy for Surfclam habitat (Figure 4). For each of the five assessment areas, a surplus production model was fit to a time series of CPUE data, and areal expansion of the Surfclam density (g/m^2) was limited to the fished area.

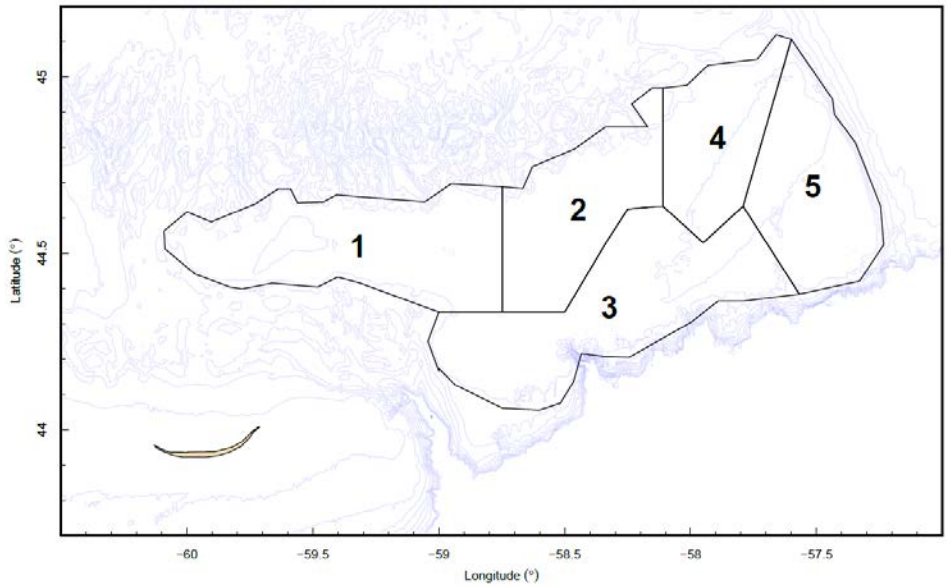

Figure 3. Five spatial assessment areas on Banquereau used in the assessment.

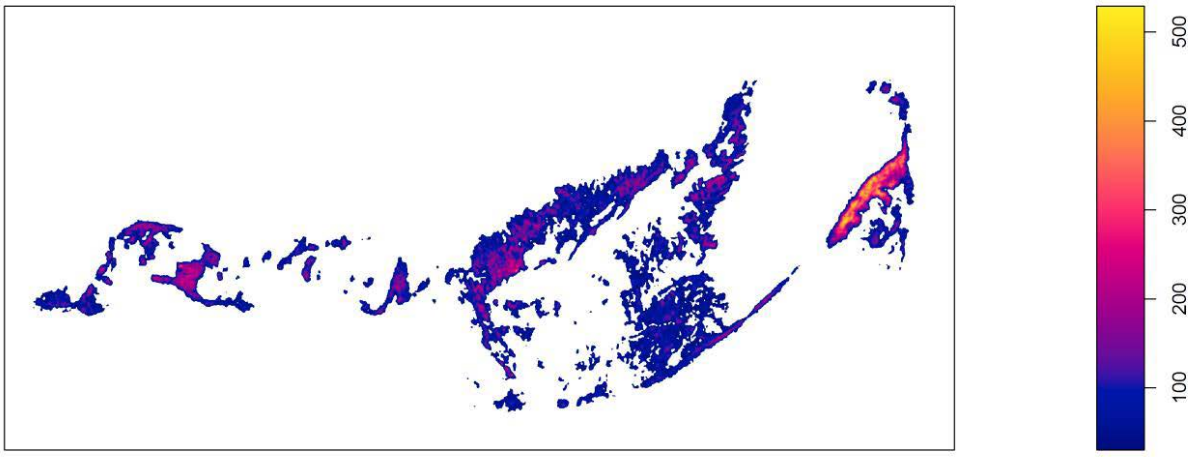

Figure 4. Vessel Monitoring System (VMS) density on Banquereau estimated from a kernel smoothed intensity function with a standard deviation of 0.2 on a 100 m^2 resolution. The scale bar shows VMS intensity expressed as the number of transmissions (pings) per km^2 for 2004–2016. The colored region shows the area where VMS intensity is greater than 30 pings/km^2.

The annual CPUE index used in the model is shown in Figure 5. In 2017, catch rates declined in areas 1 to 4. The largest decline was in Area 3, where catch rates declined from 119.2 t/km^2 in 2016 to 98.9 t/km^2 in 2017. Catch rates in Area 5 in 2017 (135.7 t/km^2) were similar to 2016 values (135.2 t/km^2), and the highest of all five areas.

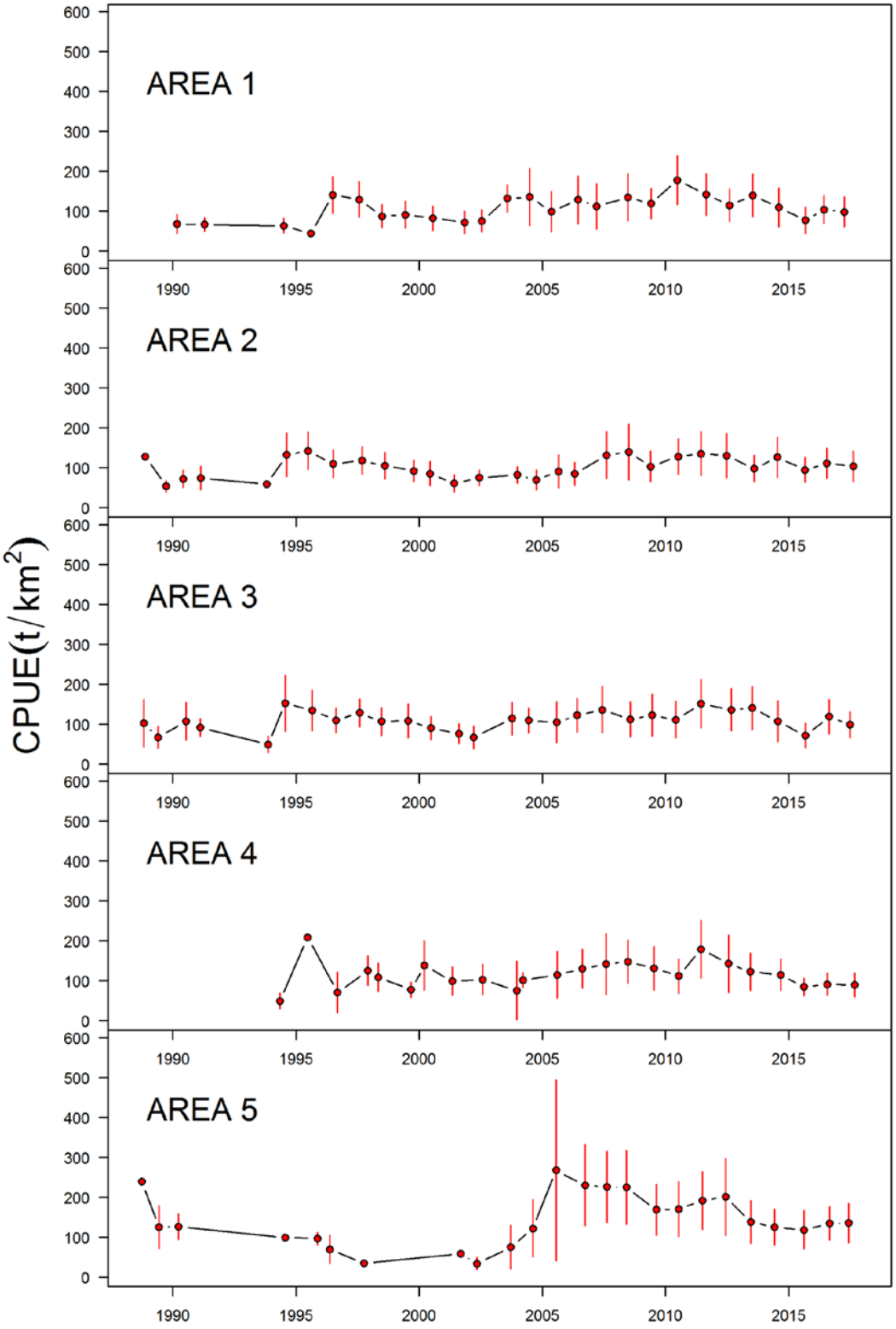

Figure 5. Banquereau catch per unit effort (CPUE; tonnes per km^2) by spatial assessment area (1 to 5) showing the annual mean values (red points) ± 1 standard error (red lines).

The modelled estimate of exploitation rates (catch divided by biomass, from the model) for each assessment area demonstrates the movement of the fishery among the different areas in different years (Figure 6). Increases in exploitation rate within an assessment area are generally followed by reduced rate in subsequent years, and do not typically occur in multiple areas in the same year. In 2017, exploitation rates decreased in Areas 1 to 3, and increased in Areas 4 and 5. Exploitation rate in Area 5 was the highest overall at 0.17. Exploitation rates in the other areas ranged from 0.02 to 0.03.

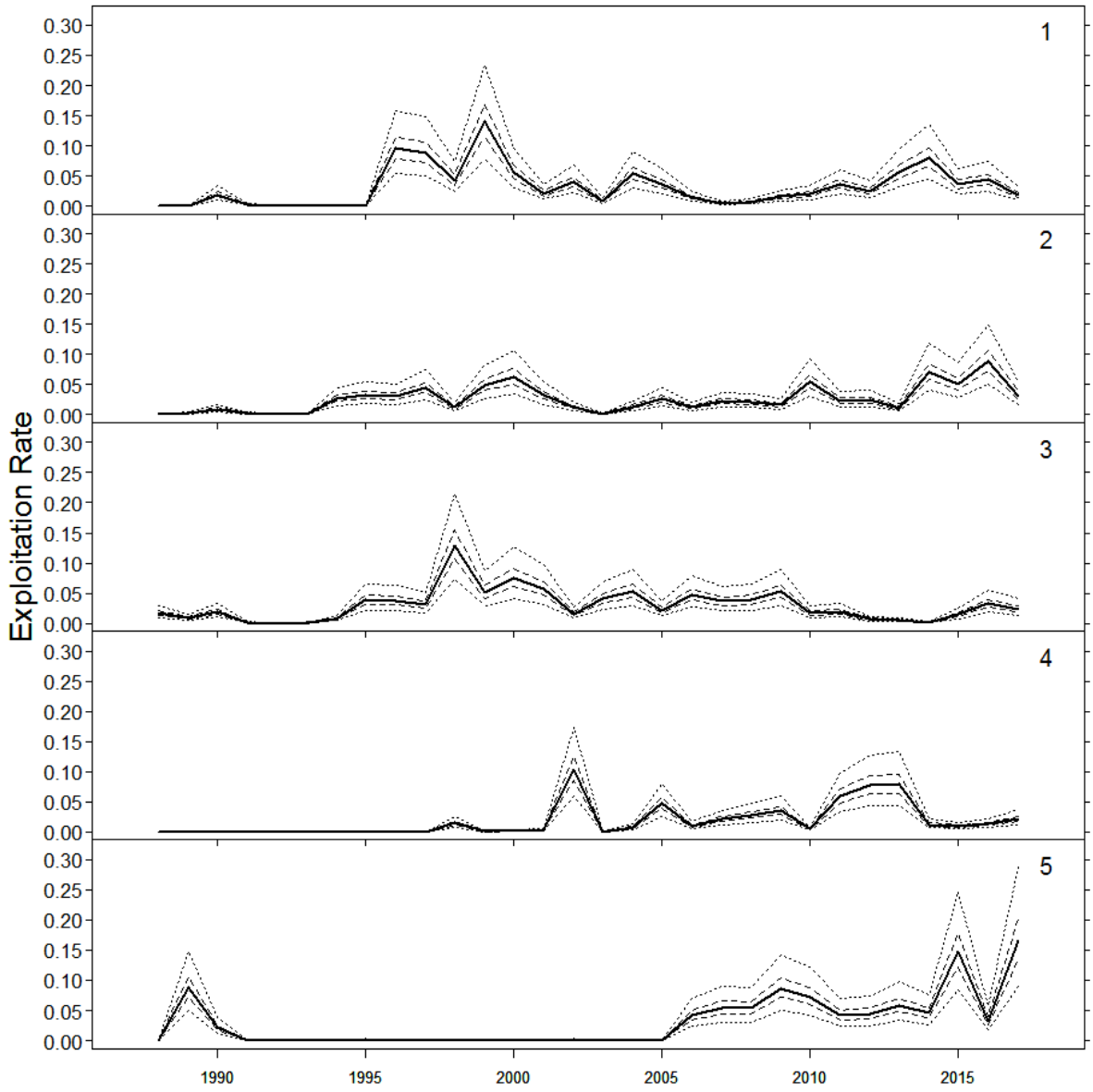

Figure 6. Estimates of exploitation rate on Banquereau for 1988–2017 from the spatial production model by assessment area. Lines denote the median (solid), 50% credible interval (dashed), and 95% credible interval (dotted).

Median areal biomass estimates from the model in 2017 indicate only slight changes in biomass since 2016 (Figure 7). The highest biomass was in Areas 2 and 3, which are the two largest assessment areas (436 and 442 km^2, respectively). Area 5, which had the highest CPUE in 2017, has the second lowest biomass of the 5 areas and is the smallest in size (189 km^2). However, densities in this area are the highest of the five areas (369 t/km^2), which is coincident with high catch rates.

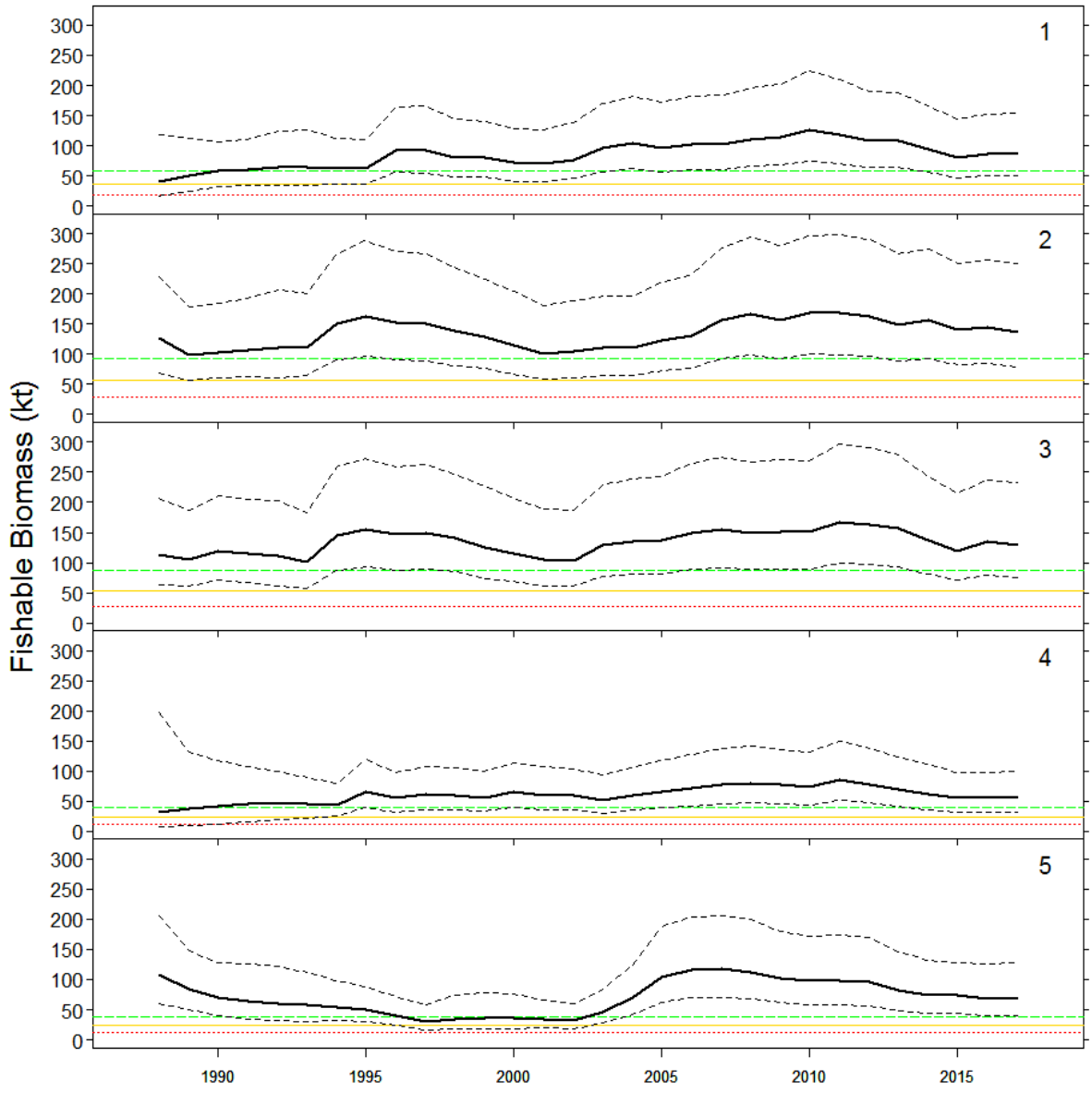

Figure 7. Estimates of fishable biomass (kilotonnes) on Banquereau from the spatial production model by assessment area. Black lines denote the median estimate (solid) and 95% credible interval (dotted). The colored lines represent (from top to bottom): $CPUE_{70}$ reference (green), upper stock reference (yellow), and limit reference point (red).

Indicators of the Stock Status

Three secondary indicators of stock status were developed for Banquereau and Grand Bank based on commercial fishery data provided annually to DFO. Data for the secondary indicators are not restricted to the fished area used for biomass modelling. Catch per unit effort is the biomass indicator, and the thresholds are 70 g/m^2 for Banquereau and 50 g/m^2 for Grand Bank. Both Banks were above the CPUE indicator threshold in 2017 (Figure 2). Fishery footprint is an indicator of the spatial extent of the fishery and stock density – as densities decline the footprint will increase as more area needs to be fished to maintain landings, or as the fishery searches for new high density areas. The footprint thresholds are 250 km^2 for Banquereau and 125 km^2 for Grand Bank. Both banks were below the footprint threshold in 2017 (Figure 2). The relative abundance of old, large clams is monitored as the size composition indicator. This maintains older age classes in the stock. The size composition indicator is 1% of the unsorted catch being greater than or equal to 120 mm for Banquereau, or 105 mm for Grand Bank. Both banks were above the size composition indicator threshold in 2017 (Table 1). Large changes in the size composition indicator between years could be a function of fishing location, as the size composition of the stock can vary across the bank.

Table 1. Percent of large clams in unsorted commercial catch and sample size (n) for Grand Bank and Banquereau. Threshold for both banks is 1%.

	Grand Bank		Banquereau	
Year	%>105 mm	n	%>120 mm	n
2000	22.54	1,393	4.29	5,343
2001	39.19	1,697	4.75	1,517
2002	7.84	714	6.31	2,597
2003	10.79	621	1.66	2,533
2004	3.06	1,243	1.36	3,318
2005	1.16	172	0.85	828
2006	0.45	662	1.14	528
2007	-	-	5.1	804
2008	-	-	2.24	7,416
2009	-	-	3.87	17,940
2010	1.34	224	3.64	16,683
2011	0	251	7.31	10,841
2012	-	-	4.5	12,129
2013	6.67	180	2.76	21,290
2014	-	-	1.57	14,127
2015	19.17	600	1.55	13,741
2016	16.65	8,600	2.31	18,967
2017	15.61	7,298	2.31	16,695

– no data available

Biomass based reference points have been presented for Banquereau (Hubley et al. 2018) based on the default 0.4 and 0.8 B_{MSY} (Biomass at Maximum Sustainable Yield) often used to define the Limit Reference Point (LRP) and Upper Stock Reference (USR). These biomass reference points are based on the fished area biomass, not the entire Bank. Due to the potential that these values are underestimated for this stock, it was proposed that the stock status also be assessed against the previously established CPUE threshold level of 70 g/m^2. This reference value ($CPUE_{70}$) was translated into biomass estimates for each assessment area (i.e., green line in Figure 7). In 2017, the probability that the biomass estimate was above the USR was >0.99 for all areas. The probability that the biomass estimate for each of the 5 assessment areas was greater than their respective $CPUE_{70}$ reference line ranged from 0.88-0.98 (Table 2).

The fishery on Banquereau does not operate based on individual TACs for each assessment area. Fishing can occur anywhere on the bank; therefore, the TAC is determined from the total biomass in all fished areas of the bank (Figure 8). In 2017, the estimated median total biomass in the fished areas was 476,512 t (95% Confidence Interval (CI): 275,236 – 864,590 t).The probability that the total bank biomass from the five assessment areas combined was above the USR was >0.99, and the probability that it was above the $CPUE_{70}$ reference lines was 0.96 (Table 2).

Table 2. Probability that median biomass estimates are above the limit reference point (LRP), upper stock reference (USR), and a CPUE of 70 g/m^2 ($CPUE_{70}$) for each assessment area (1-5) and for total area on Banquereau.

Area	LRP	USR	$CPUE_{70}$
1	>0.99	>0.99	0.90
2	>0.99	>0.99	0.91
3	>0.99	>0.99	0.93
4	>0.99	>0.99	0.88
5	>0.99	>0.99	0.98
Total	>0.99	>0.99	0.96

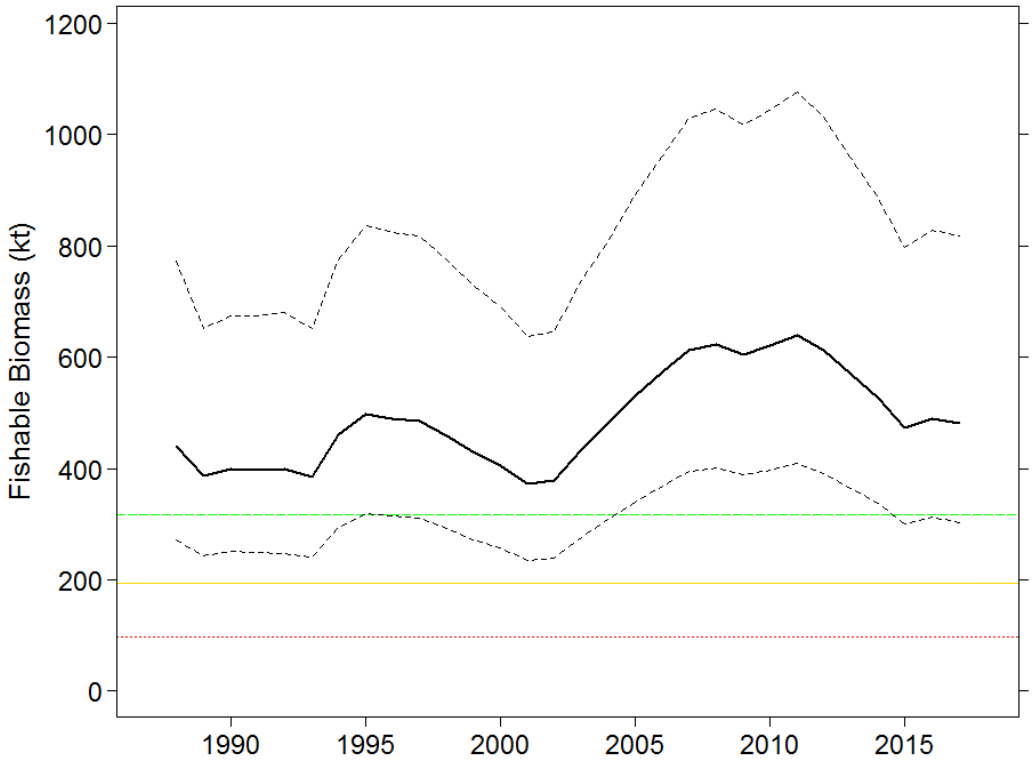

Figure 8. Estimate of fishable biomass (kilotonnes) on Banquereau from 1988 to 2017 from the spatial production model for the total fished area. Black lines denote the median estimate (solid) and 95% credible interval (dotted). The colored lines represent (from top to bottom): $CPUE_{70}$ reference (green), upper stock reference (yellow), and limit reference point (red).

Other Retained Catch in the Fishery

The Offshore Clams Integrated Fishery Management Plan (DFO 2014) allows for the retention of other clam species. Since 2005, there has been no limit on the bycatch of Northern Propeller

clam (*Cyrtodaria silique*) or Greenland Cockle (*Serripes groenlandicus*). Northern Propeller clam is more often caught on Banquereau, where landings increased annually from 2010 to 2014. Since 2014, landings on Banquereau have fluctuated but remain high relative to earlier years. Greenland Cockle is more often caught on Grand Bank, and landings tend to have large fluctuations. Ocean Quahog (*Arctica islandica*) landings have been minimal on both banks since the late 1990s. Ocean Quahog catch is limited on Grand Bank to 10% of Surfclam catch, to a maximum of 500 t. On Banquereau there is an Ocean Quahog TAC of 800 t. In 2017, the TAC was not exceeded for Ocean Quahog on either bank (Figure 9).

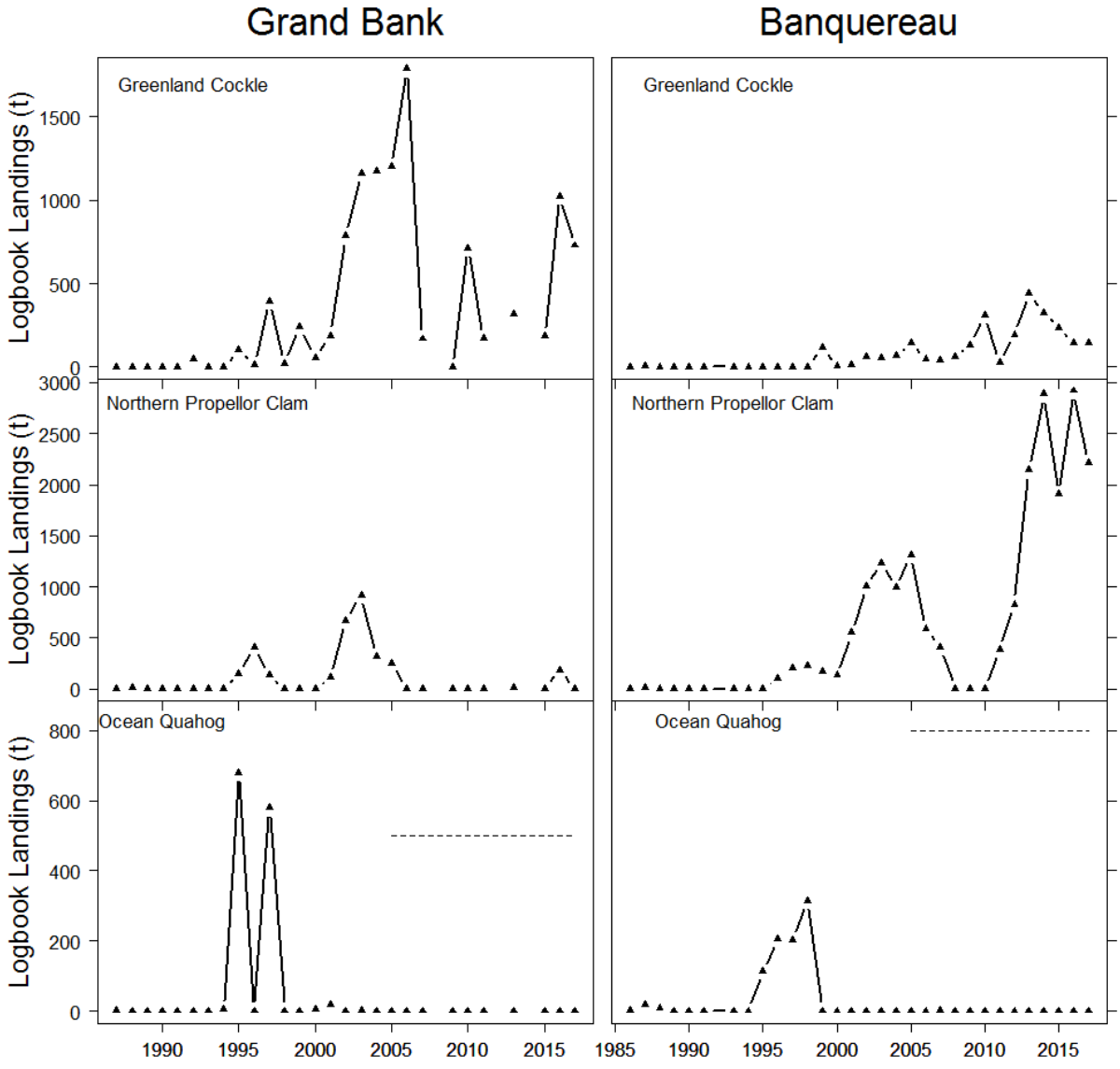

Figure 9. Landings from the fishery logbooks for three other clam species on Grand Bank (left column) and Banquereau (right column) from 1987 to 2017. Dashed horizontal line is maximum limit for Grand Bank and total allowable catch for Banquereau. Note different axes.

Sources of Uncertainty

As fishing becomes more efficient, catchability is likely increasing over time leading to a bias in CPUE based indicators. Changes in efficiency and catchability could mask actual biomass trends. The spatial production model parameters for growth rate and carrying capacity are partly confounded and potentially biased because a high growth rate and low carrying capacity give the model more flexibility to fit the data. If the growth rate estimate is too high and carrying capacity too low, reference points are likely to be overly optimistic (higher F_{MSY} and lower B_{MSY}). This is likely happening with the reference points for Banquereau.

Conclusions

The Banquereau fished area stock is in the Healthy Zone, the 2017 biomass estimate is above the LRP, USR, and $CPUE_{70}$ references, and this is supported by the secondary indicators. All the secondary indicators for Grand Bank are positive relative to their respective thresholds.

A removal level of $0.5F_{MSY}$ would result in a TAC that is comparable to the 2018 TAC for Banquereau (20,943 t), while the lower F level of 0.33M (0.0264) would result in a much lower TAC when applied to the fished area biomass (Table 3). Previous analyses based on the surplus production model have estimated F_{MSY} near 0.09; however, catch rates tend to decline when F is greater than 0.045 ($0.5F_{MSY}$). The removal reference level of 0.5 F_{MSY} was proposed as an intermediate value between 0.33M (which was developed for a larger less productive stock area) and F_{MSY} (Hubley and Heaslip 2018).

Table 3. Areal removals in tonnes for removal reference levels (F) for assessment areas (1-5) on Banquereau calculated using the 2017 biomass estimates from the spatial production model.

Removal Reference (F)	Area 1	Area 2	Area 3	Area 4	Area 5	Total
$0.5F_{MSY}$ (0.045)	3,769	6,026	5,695	2,415	3,072	20,976
0.33M (0.026)	2,198	3,515	3,322	1,408	1,792	12,235

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Sources of information

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