Fisheries and Oceans Canada

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Ecosystems and Oceans Science

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Maritimes Region

Canadian Science Advisory Secretariat
Science Response 2021/033

STOCK STATUS UPDATE OF SCOTIAN SHELF SNOW CRAB (*CHIONOECETES OPILIO,* O.FABRICIUS)
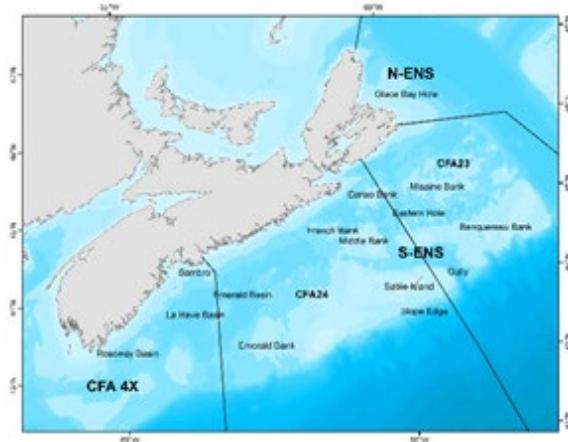

Snow Crab (Chionoecetes opilio, O. Fabricius)

Figure 1. Map of the Scotian Shelf and Crab Fishing Areas (CFAs).

Context

In support of the Scotian Shelf Snow Crab fishery, Fisheries and Oceans Canada (DFO) Maritimes Fisheries Management requests from DFO Science annual advice on the status of Scotian Shelf Snow Crab. This resource was last assessed in February 2020. The assessment of the status of Scotian Shelf Snow Crab is based on fishery-independent surveys using indicators of abundance, reproductive potential, recruitment, and exploitation rates. Ecosystem and environmental indicators are also incorporated into the assessment. Commercial catch rates and other fishery statistics are reported in this document; however, due to COVID-19 restrictions in place during the time the survey is conducted, the 2020 Snow Crab Survey did not take place. Impacts due to COVID-19 on landings and At-Sea-Observer data collection are also noted in this report.

This Science Response Report results from the regional Science Response Process on the Stock Status Update of Scotian Shelf Snow Crab, held February 24, 2021.

Background

Snow Crab (*Chionoecetes opilio*, O. Fabricius) is a subarctic species with a distribution from northern Labrador to near the Gulf of Maine. Habitat preference is for soft mud bottoms. Smaller crabs are found in more complex habitats with shelter. Commercial-sized crab (male, > 95 mm Carapace Width [CW]) are found at depths from 60 to 280 m and temperatures from -1 to 6 °C in the Scotian Shelf Ecosystem (SSE). Temperatures greater than 7 °C are metabolically

detrimental. Their primary food items are shrimp, fish (Capelin and Lumpfish), starfish, sea urchins, worms, detritus, large zooplankton, other crabs, molluscs, sea snails, and sea anemones. Predators include, Atlantic Halibut, skates (especially Thorny Skate), Atlantic Cod, seals, American Plaice, squids, and other crabs. Crab in the size range of 3 to 30 mm CW are particularly vulnerable to predation, as are soft-shelled crab in the spring moulting season. Snow Crab have been a dominant macro-invertebrate in the SSE since the decline of groundfish abundance during the late 1980s and early 1990s. The SSE Snow Crab are near the southern-most extreme of their spatial distribution in the northwest Atlantic and, as such, are susceptible to increasing ocean temperatures and environmental variability.

Fishery

The Snow Crab fishery in eastern Canada began in 1960, with incidental bycatches by groundfish draggers near Gaspé, Quebec. Its development was slow until the 1980s, when it began expanding rapidly to become one of the largest fisheries in Canada in terms of landings and landed value.

The fishery has been in existence since the early 1970s in Nova Scotia. Management of the fishery was based on effort controls (season, license, trap limits) from 1982 to 1993, with harvesting during June–November of hard-shelled males larger than 95 mm CW. Additional management measures were introduced from 1994 to 1999: individual boat quotas, Total Allowable Catches (TACs), 100% dockside monitoring, mandatory logbooks, and at-sea monitoring by certified observers. There is also a concerted effort by fishers to avoid areas of newly moulted (soft-shelled) crab and to discard immature males

In 2005, many Crab Fishing Areas (CFAs) and subareas were merged, with the resulting divisions being North-Eastern Nova Scotia (N-ENS) (CFAs 20–22), South-Eastern Nova Scotia (S-ENS) (CFAs 23 and 24), and 4X (Figure 1). The N-ENS and S- ENS fisheries are conducted within a calendar year, with spring fishing efforts now representing a large portion of overall landings. The 4X fishery is conducted over a fall-to-winter fishing season spanning calendar years. Total landings increased to record levels of approximately 10,000 tonnes (t) each year in the early 2000s and increased further to approximately 14,000 t in 2010 (Figure 2).

TACs in 2020 were 848 t, 8,161 t, and 80 t in N-ENS, S-ENS, and 4X, respectively. The 2020–2021 4X season is currently ongoing. Landings in 2020 for N-ENS, S-ENS, and 4X were 836 t, 7,943 t, and 76 t, respectively, representing an increase of 33%, 20%, and 46%, relative to the previous year (Figure 2, Tables 1–3). Landings occurred in a similar spatial extent to those in 2019 (Figure 2). In response to concerns about the ability to safely conduct fishing activities in light of the COVID-19 pandemic, DFO Fisheries Management approved a carry-forward of up to 25% of the 2020 quota to the 2021 season for all licence holders in the N-ENS and S-ENS snow crab fishery. This was intended to alleviate potential operational and safety risks to harvesters, and likely accounts for the amount of the TAC that was not landed in these areas.

Table 1. Summary of Snow Crab fisheries in North-Eastern Nova Scotia. (TAC = Total Allowable Catch; CPUE = Catch Per Unit Effort)

Year	Number of Licences	Active Vessels	TAC (t)	Landings (t)	CPUE (kg/trap haul)	Effort (x1000 trap hauls)
2010	78	61	576	576	55	10.5
2011	78	58	534	536	110	4.8
2012	78	61	603	603	117	5.1
2013	78	58	783	783	106	7.4
2014	78	58	783	778	104	7.4
2015	78	55	620	619	103	6.0
2016	78	50	286	290	110	2.6
2017	78	50	825	813	90	9.0
2018	78	48	786	742	62	12.0
2019	78	47	631	629	87	7.2
2020	78	46	848	836	108	7.7

Table 2. Summary of Snow Crab fisheries in South-Eastern Nova Scotia. (TAC = Total Allowable Catch; CPUE = Catch Per Unit Effort)

Year	Number of Licences	Active Vessels	TAC (t)	Landings (t)	CPUE (kg/trap haul)	Effort (x1000 trap hauls)
2010	116	103	13,200	13,150	103	128.3
2011	116	90	12,120	12,135	106	118.8
2012	116	83	11,707	11,733	98	120.0
2013	116	70	11,311	11,309	104	108.7
2014	116	69	11,311	11,267	112	100.2
2015	116	76	11,311	11,292	106	106.5
2016	116	67	9,614	9,606	106	90.6
2017	116	54	6,730	6,719	94	71.5
2018	116	59	6,057	6,064	116	52.3
2019	116	51	6,663	6,632	105	63.2
2020	116	51	8161	7,943	118	67.3

Table 3. Summary of the Snow Crab fishery in NAFO Division 4X. (TAC = Total Allowable Catch; CPUE = Catch Per Unit Effort)

Season	Number of Licences	Active Vessels	TAC (t)	Landings (t)	CPUE (kg/trap haul)	Effort (x1000 trap hauls)
2010–2011	9	7	346	345	38	9.0
2011–2012	9	7	346	344	29	11.8
2012–2013	9	6	263	118	13	9.6
2013–2014	9	7	80	79	15	5.1
2014–2015	9	5	80	82	34	1.7
2015–2016	9	6	150	142	31	4.6
2016–2017	9	7	80	80	25	3.2
2017–2018	9	7	110	55	12	4.6
2018–2019[1]	9	-	0	-	-	-
2019–2020	9	5	55	59	51	1.0
2020–2021[2]	9	5	80	76	52	1.5

[1] No fishery (0 TAC) due to low commercial biomass. Dash (-) represents no data.
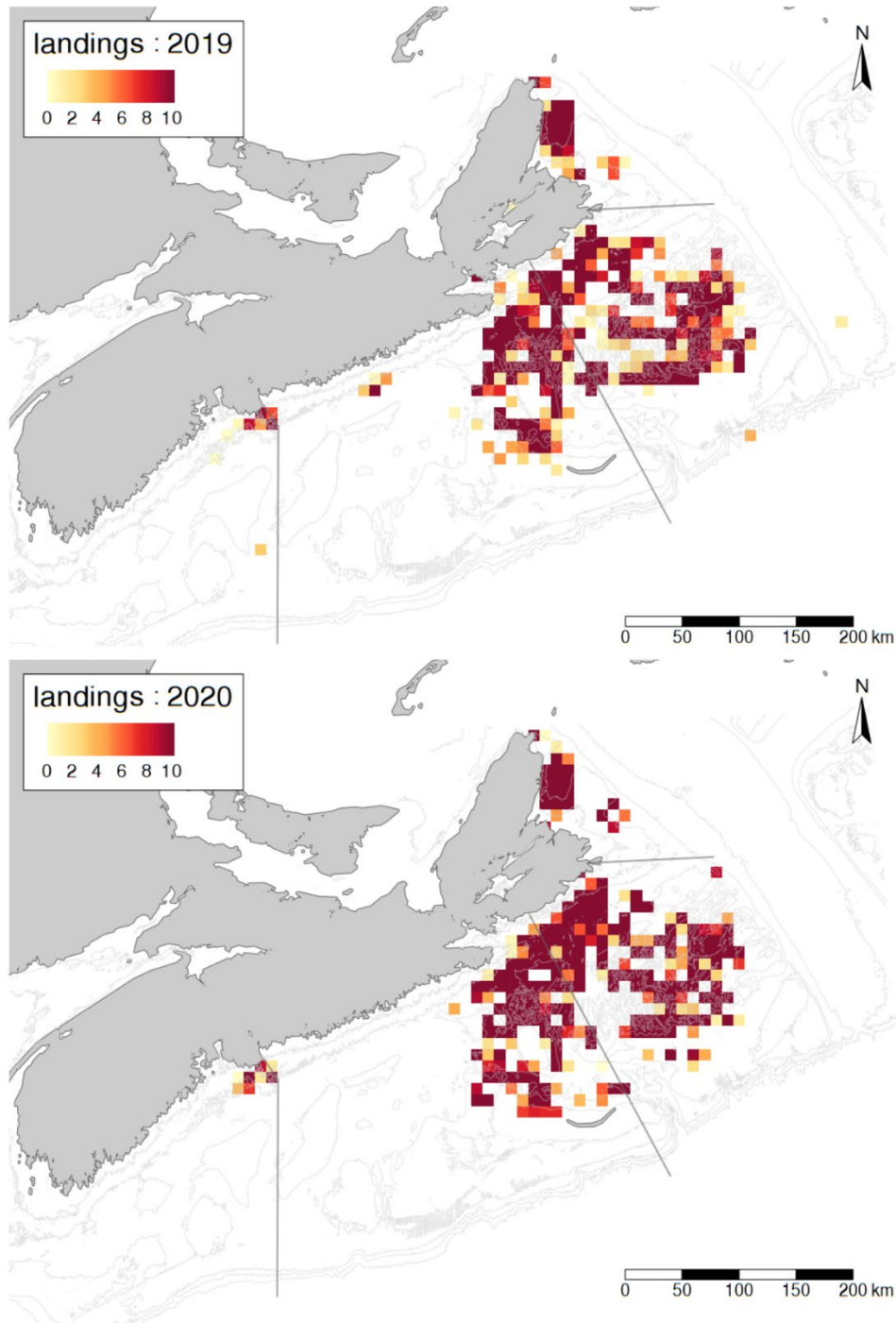[2] Season ongoing.

Figure 2. Landings (tons/grid; grid is 10 x 10 km^2) in 2019 (top) and 2020 (bottom).

Non-standardized catch rates in 2020 were 108 kg/trap-haul in N-ENS, 118 kg/trap-haul in
S-ENS, and 52 kg/trap-haul in 4X, at the time of production of the report. These catch rates
represent an increase of 24% (N-ENS), 12% (S-ENS), and approximately the same catch rate in
area 4X, relative to the previous year (Tables 1–3, Figure 3). These increases were most
notable nearer to shore and the south-eastern margins of CFA 24.
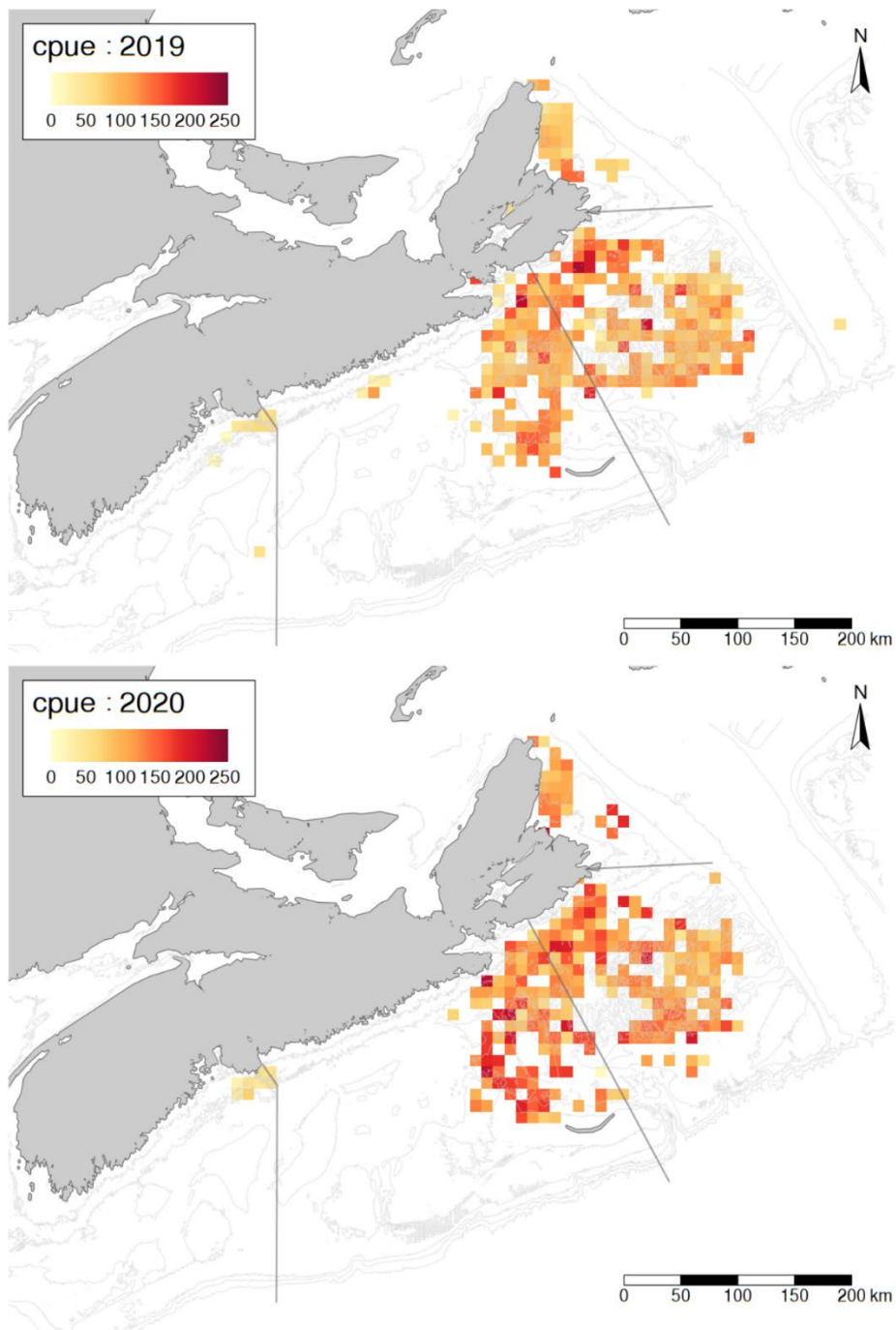
Figure 3. Catch Per Unit Effort (CPUE; kg/trap-haul) in 2019 (top) and 2020 (bottom).

Due to COVID 19, At-Sea Observer activities were suspended for most of the 2020 Snow Crab season. They resumed at the end of July when the TAC in most areas was almost caught and the seasons were coming to an end. Four Snow Crab trips, one in N-ENS and three in S-ENS, were observed. These trips took place in a short span of time and represent a very small portion of Snow Crab catches, 0.5% in N-ENS and 1% in S-ENS. This limited amount of data is not

comparable to the complete datasets from previous years. Due to this, analysis of this data is not provided in this update.

Analysis and Response

The Snow Crab fishery-independent survey provides indicators of abundance, reproductive potential, recruitment, exploitation rates, and environmental indicators. Due to COVID-19 restrictions in place during the time the survey is conducted, the 2020 Snow Crab Survey did not take place. Consequently, key findings from the previous assessment (DFO 2020) will herein be discussed in the context of the year 2021.

Indicators of stock status

Size-frequency distributions of male Snow Crab (Figure 4) from previous surveys suggest continued recruitment into the fishery that should be steady and last for at least another four years. The gap in the 40 mm CW range identified in N-ENS and S-ENS will take five to six years to influence fishable biomass. In 4X, there is a pulse of recruitment in this size range (5–6 years away) with potential recruitment in the shorter-term being variable and uncertain.

The size-frequency distributions of female Snow Crab (Figure 5) suggest that egg production should continue for at least another three years in most areas. The gap between the strong year-classes found in the 42 mm CW range for N-ENS and S-ENS suggests a potential gap in egg production in 2020–2022. In 4X, this gap is in the 52 mm range and suggests low recruitment into the mature reproductive female population in 2020–2021.
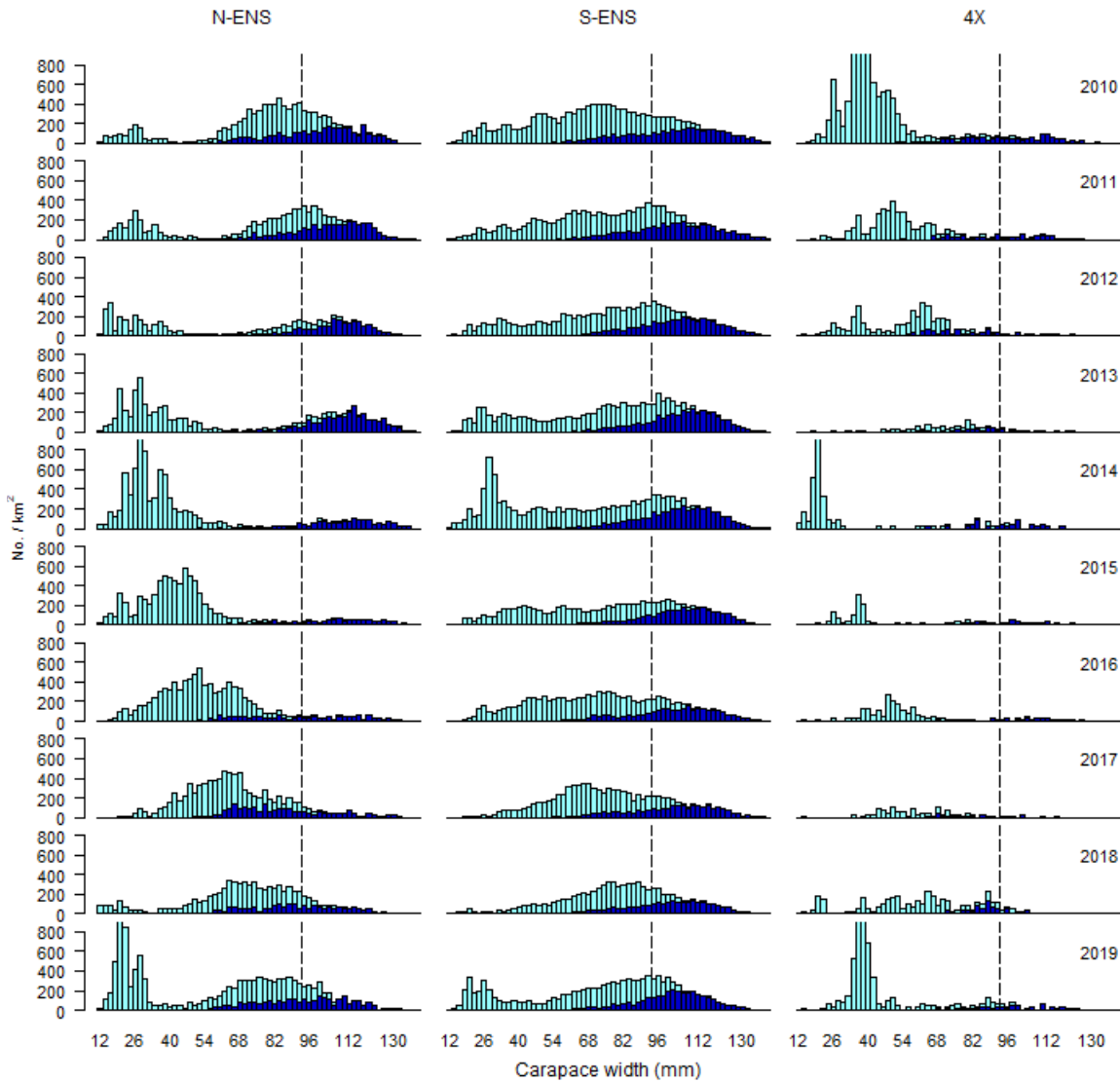
Figure 4. Size-frequency histograms of carapace width of male Snow Crab. The vertical line represents the legal size (95 mm). Immature animals: light-coloured bars. Mature animals: dark-coloured bars. (Source: Figure 7 in DFO 2020).
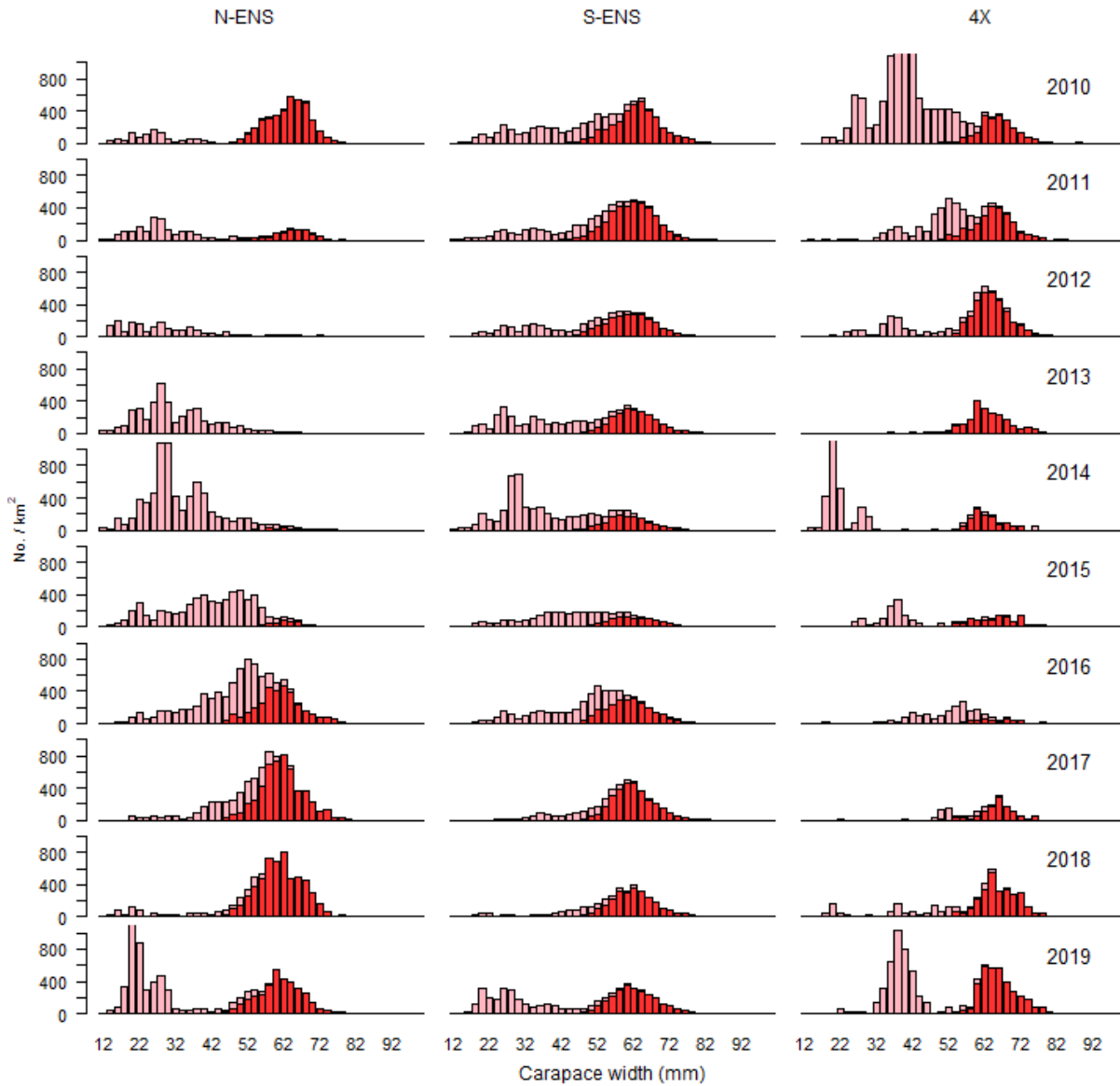
Figure 5. Size-frequency histograms of carapace width of female Snow Crab. Immature animals: light-coloured bars. Mature animals: dark-coloured bars. (Source: Figure 8 in DFO 2020).

Modelled fishable biomass (Figure 6) from the 2020 assessment (DFO 2020) indicated an increasing trend following the lows experienced in 2017–2019. There is an expectation for continued increase in most areas based upon the size-frequency distributions (Figure 4). In 4X, this expectation is tempered by extreme bottom-temperature variability. Fishing mortality is estimated to be below the level at maximum sustainable yield in all areas (Figure 7).
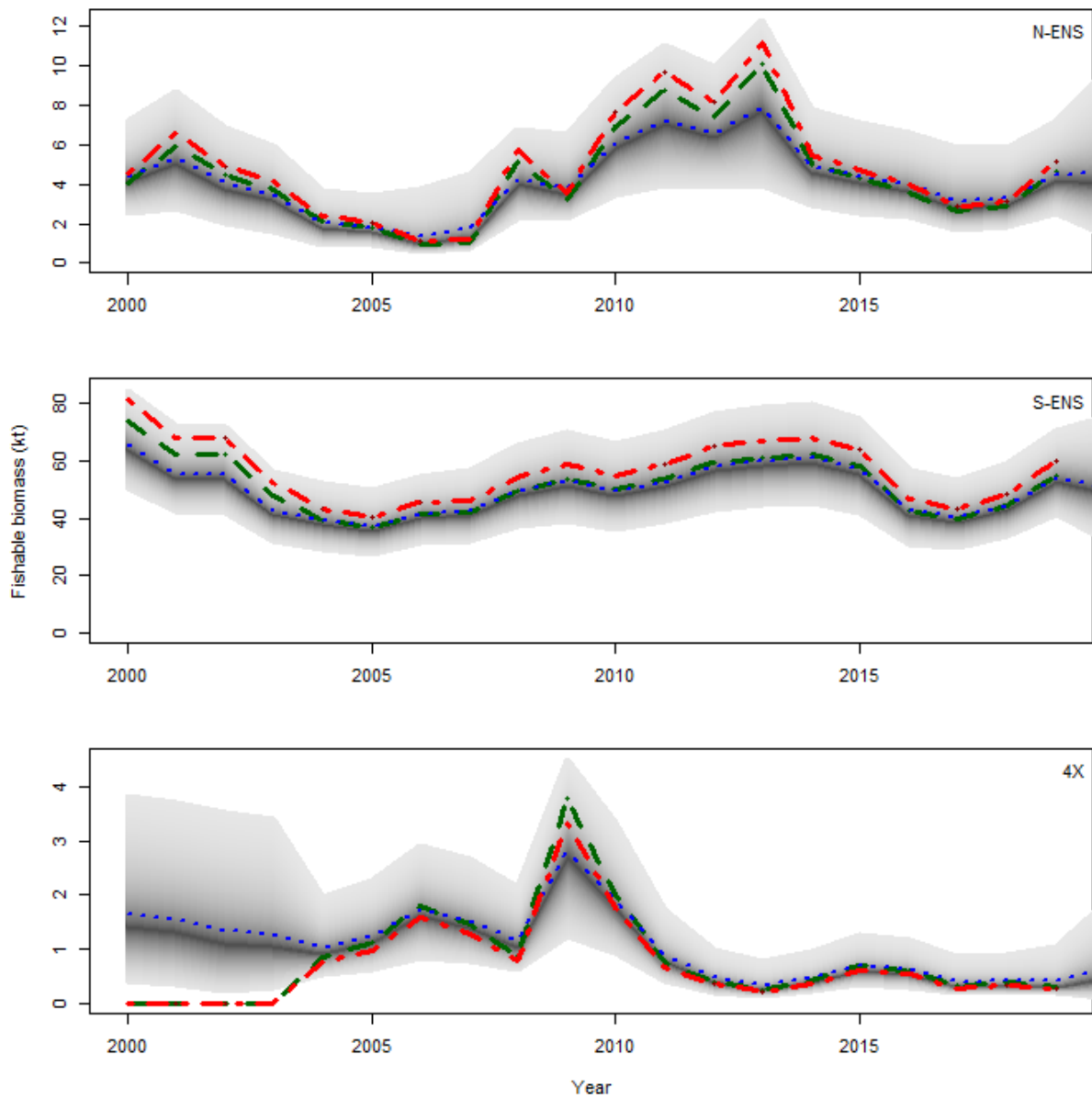
Figure 6. Time series of mean-modelled fishable biomass (blue dotted lines) for North-Eastern Nova Scotia (top), South-Eastern Nova Scotia (middle), and 4X (bottom). The fishable biomass index is shown in red dashed lines. The q-corrected (model catchability coefficient) fishable biomass index is shown in green dashed lines.

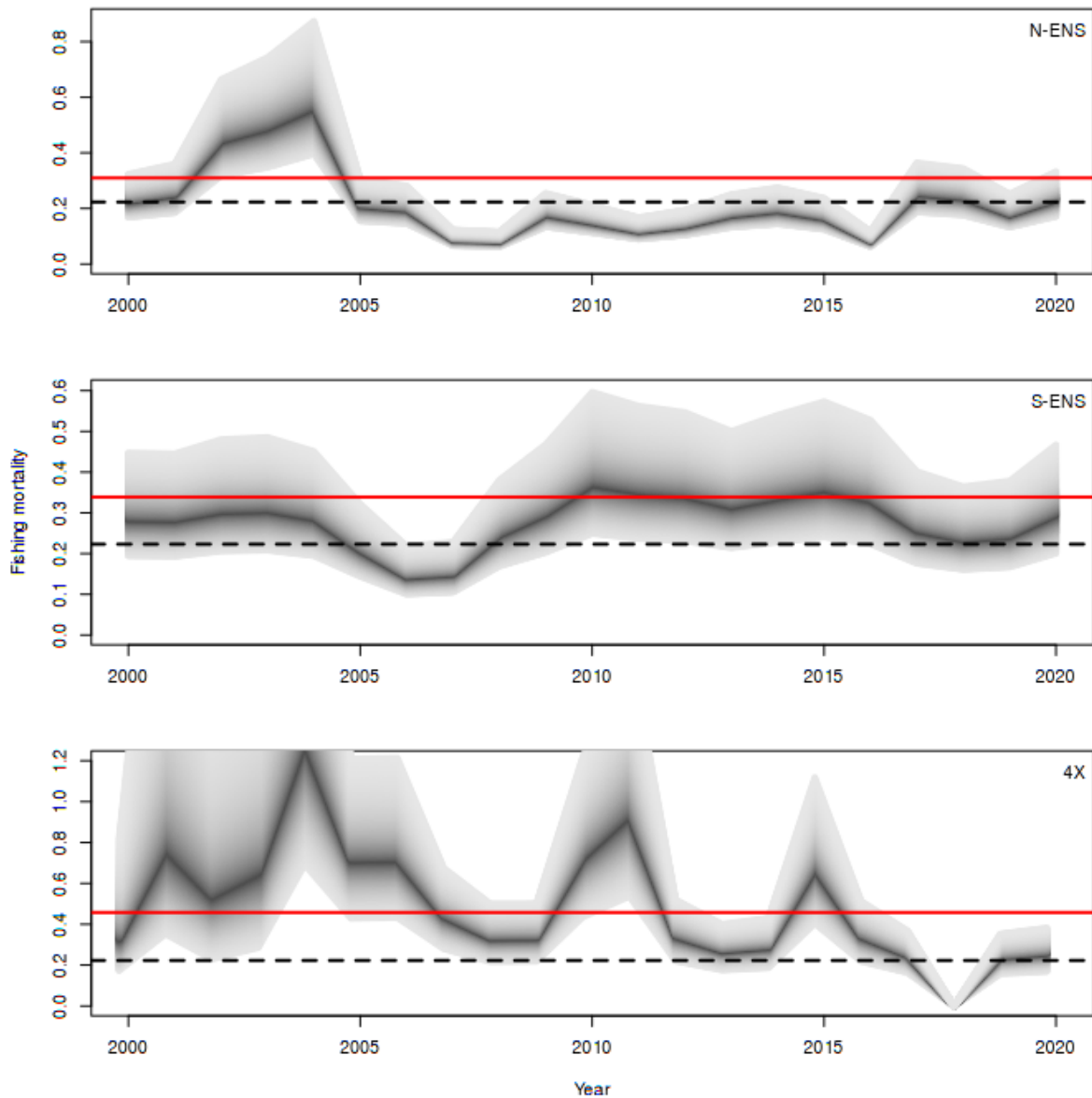*Figure 7. Time-series of fishing mortality from the logistic population models for North-Eastern Nova Scotia (top), South-Eastern Nova Scotia (middle), and 4X (bottom). Posterior density distributions are presented in gray, with the darkest line being the median with 95% Confidence Interval shading. The solid (red) line is the estimated fishing mortality at maximum sustainable yield and the stippled (black) line is the 20% harvest rate.*

Based upon environmental data from various DFO surveys and other sources (e.g., temperatures monitored by fishers), there is an expectation that this continued increase in abundance will not be tempered by extreme temperature variations in 2020 (Figure 8), nor will it be tempered by variations in Snow Crab habitat, as represented by the probability of occurrence (Figure 9).
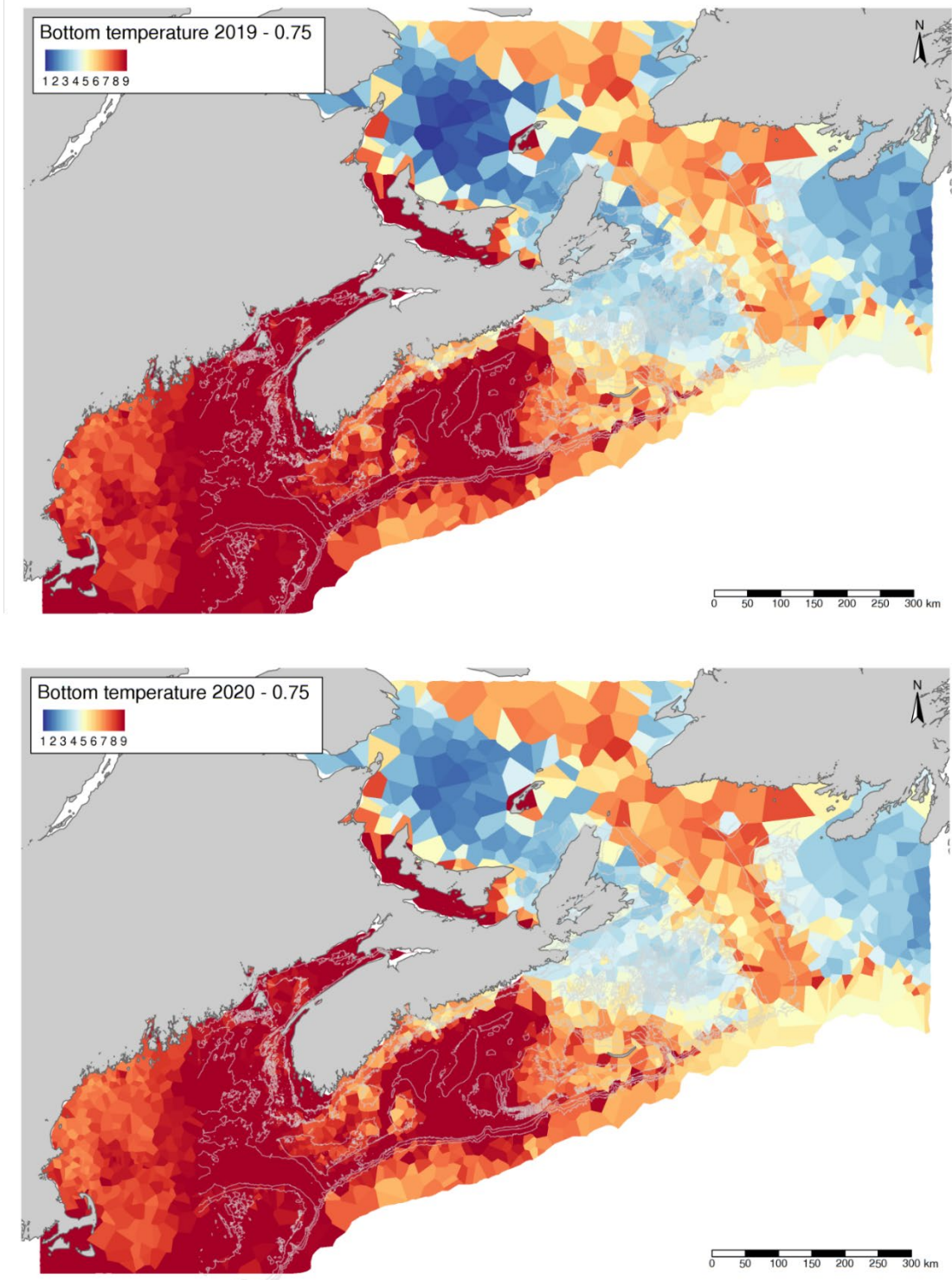
Figure 8. Predicted bottom temperatures for the 1st of September 2019 (top) and 2020 (bottom) from the conditional, auto-regressive spatio-temporal model.
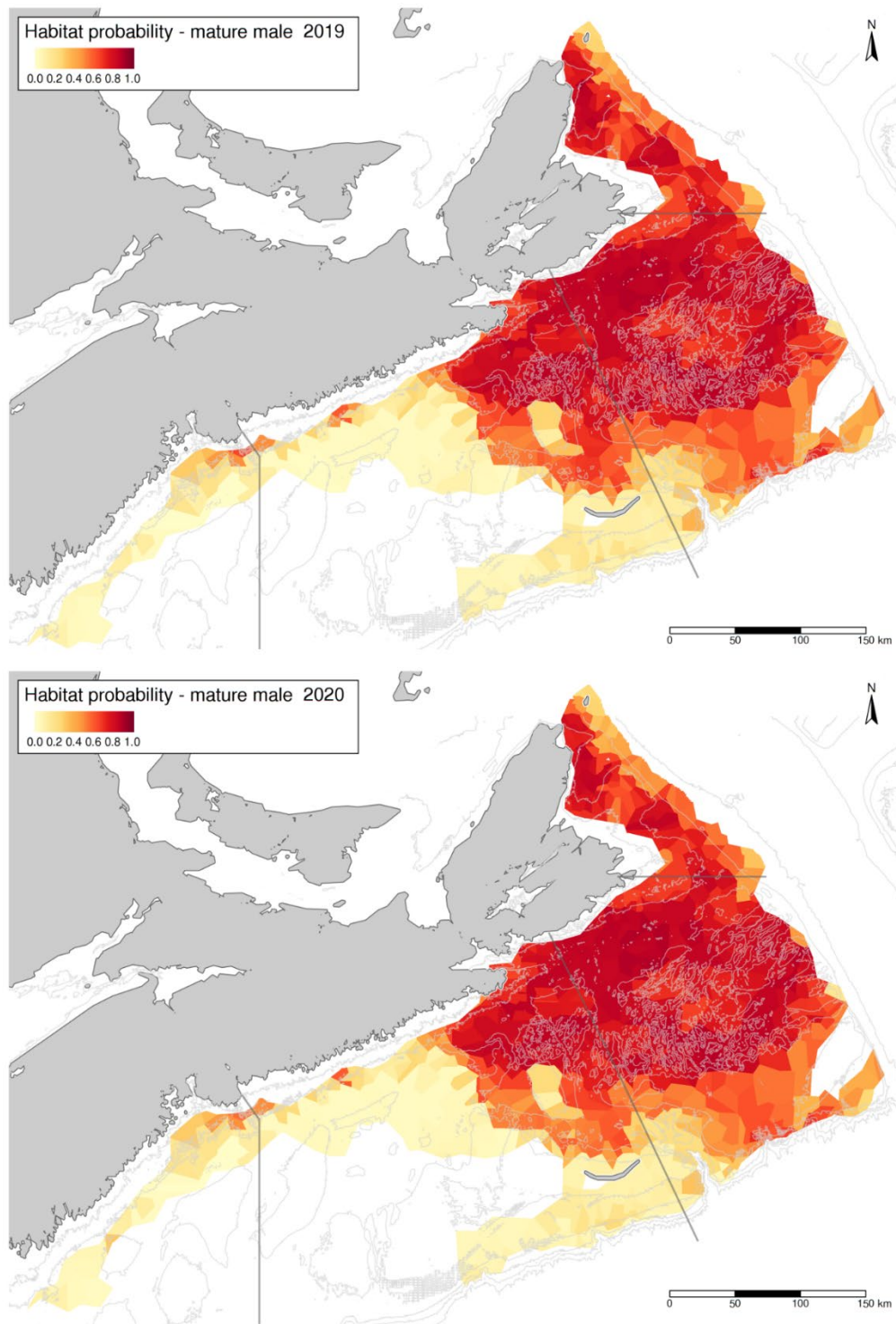
Figure 9. Predicted probability of observing mature male snow crab > 95 mm CW for 1st of September in 2019 (top) and 2020 (bottom) from the conditional, auto-regressive spatio-temporal model.

Conclusions

The trends were quite positive, overall, in the 2020 assessment; fishery performance indicators (landings and CPUE) were higher for the 2020 fishery compared to the 2019 fishery; and there are no ecosystem-level indications of change that would temper this trend. However, adherence to a status-quo approach for all fisheries would reduce risk/uncertainty resulting from the absence of survey-based information of stock status, and would be consistent with the core principle of a Precautionary Approach to fisheries management (Figure 10).
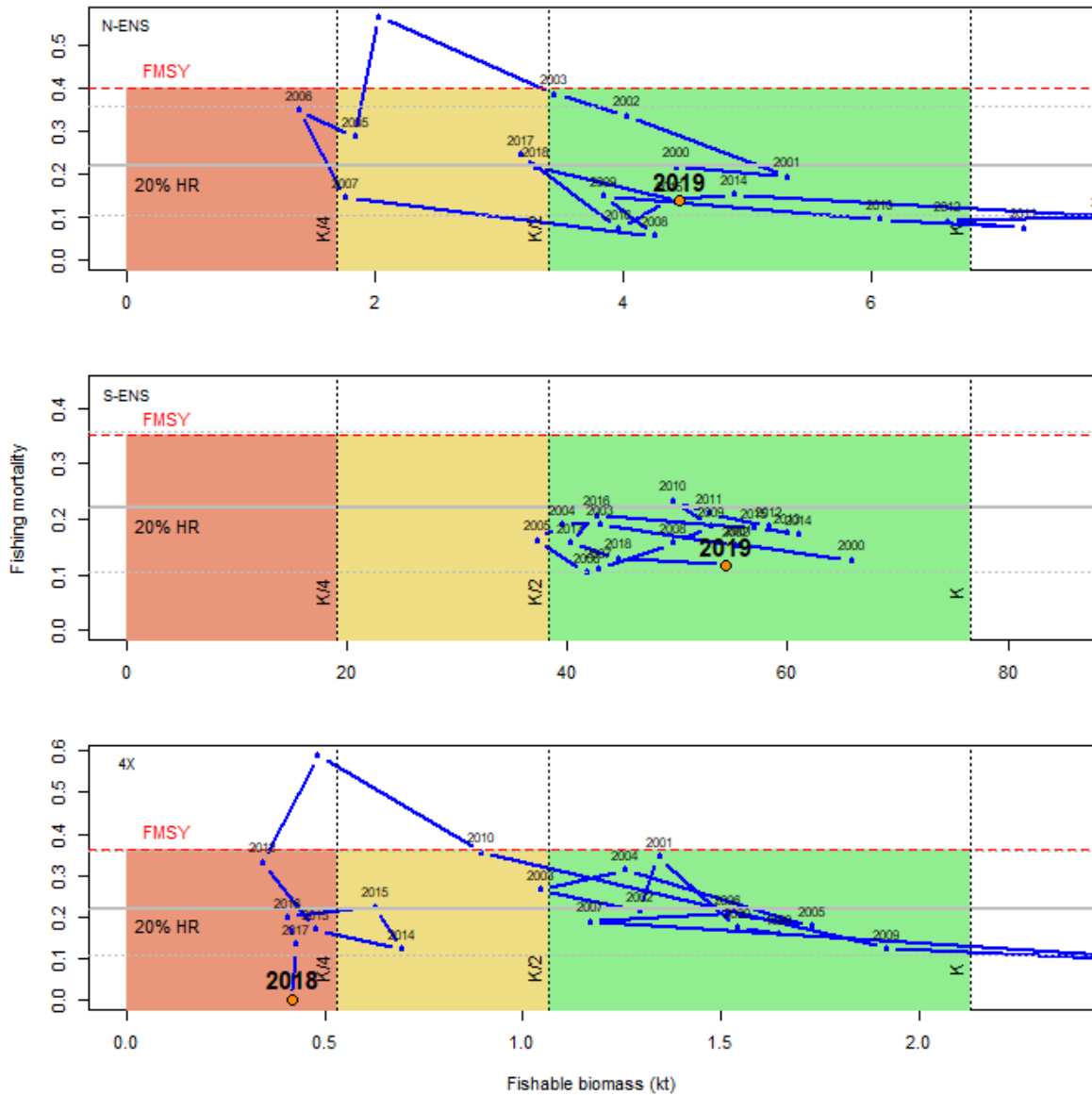

Figure 10. Time series of fishing mortality and fishable biomass for North-Eastern Nova Scotia (N-ENS, top), South-Eastern Nova Scotia (S-ENS, middle), and 4X (bottom). The large red dot in each panel indicates most recent year—last updated using last year of available survey data, 2019. (Source: Figure 15 in DFO 2020).

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Date: March 17, 2021

Sources of Information

This Science Response Report results from the regional Science Response Process on the Stock Status Update of Scotian Shelf Snow Crab, held February 24, 2021.

DFO. 2020. Assessment of Scotian Shelf Snow Crab. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2020/042.

This Report is Available from the:

Correct Citation for this Publication

DFO. 2021. Stock Status Update of Scotian Shelf Snow Crab (*Chionoecetes opilio,*
O.Fabricius). DFO Can. Sci. Advis. Sec. Sci. Resp. 2021/033.

Aussi disponible en français :

*MPO. 2021. Mise à jour de l'état du stock de crabe des neiges du plateau néo-écossais
(Chionoecetes opilio, o.Fabricius). Secr. can. de consult. sci. du MPO. Rép. des Sci.
2021/033.*