Fisheries and Oceans Canada / Pêches et Océans Canada
Ecosystems and Oceans Science / Sciences des écosystèmes et des océans

Quebec Region
Canadian Science Advisory Secretariat
Science Advisory Report 2023/015

ASSESSMENT OF THE NORTHERN CONTINGENT OF ATLANTIC MACKEREL (*SCOMBER SCOMBRUS*) IN 2022

*Atlantic mackerel (*Scomber scombrus *L.). Photo credit: Claude Nozères.*

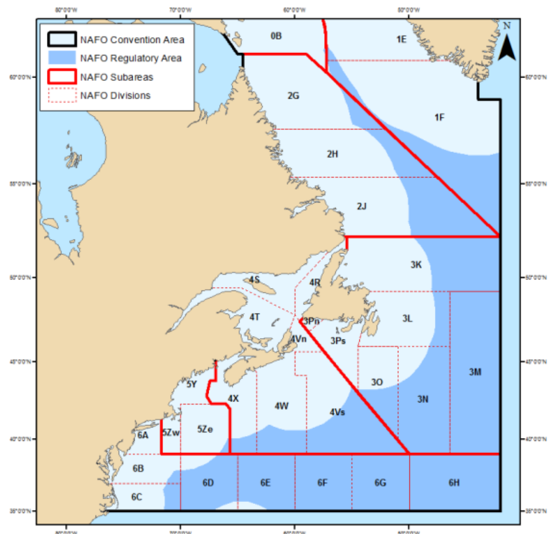

Figure 1. NAFO subareas and divisions

Context:

*Northwest Atlantic mackerel (*Scomber scombrus *L.) can be found in waters from North Carolina to Labrador. They overwinter in deeper warmer waters at the edge of the continental shelf and migrate inshore during the spring to spawn and then disperse to feed during the summer. There are two spawning contingents in the Northwest Atlantic. The northern contingent spawns in Canada, primarily in the Southern Gulf of St. Lawrence during June and July. The southern contingent spawns in the U.S. off the coast of southern New England and in the western Gulf of Maine, between mid-April and June. Although both contingents mix in winter on the U.S. shelf, the presented science advice is specific to the northern contingent.*

Canada closed the commercial and bait mackerel fisheries in 2022. Prior to this, fishing took place across all Maritime provinces and Quebec (primarily in NAFO subareas 3–4, Figure 1). It is an inshore, open competitive fishery that employs a variety of fixed and mobile gear types (e.g., traps, gillnets, various hand and mechanized hook and lines, as well as purse and tuck seines) the predominance of which varies by region and season. Across the same area, mackerel are also targeted by a recreational fishery that remained open.

The stock is assessed with a custom statistical catch-at-age model, fitted to three key data sources: an egg survey index, catch-at-age and landings. The last assessment was completed in February 2021, and determined that the stock was in the Critical Zone of DFO's Precautionary Approach framework. The Fisheries and Aquaculture Management Branch has requested scientific advice on the Canadian Atlantic mackerel quota for the 2023 and 2024 fishing seasons.

SUMMARY

- Based on preliminary data, mackerel landings in Canadian waters totalled 4,505 t in 2021 (TAC = 4,000 t) and 74 t were landed in 2022 (TAC = 0 t). Mackerel landings in U.S. waters totalled 8,053 t in 2021 and 3,302 t in 2022, of which 20–80% is assumed to be from the northern contingent.
- The Spawning Stock Biomass (SSB) of the northern contingent of mackerel estimated with the revised assessment model was at its lowest values in 2021 and 2022 (40% and 42% of the Limit Reference Point; LRP), relative to 79% and 56% of the LRP in 2019 and 2020, respectively.
- Recent average recruitment (2012–2022) is at 27% of previous levels (1969–2011). There have been no signs of a substantial recruitment event since 2015.
- The probability of the SSB exiting the Critical Zone by 2025 ranges from 37.5% under a TAC of 0 t to 17.5% under a TAC of 8,000 t. The probability that the SSB in 2025 will be greater than in 2023 ranges from 78.5% (75–82%) under a TAC of 0 t to 32.5% (29–36%) under a TAC of 8,000 t.
- The probability of the SSB exiting the Critical Zone by 2025 under a baseline scenario assuming no Canadian fisheries removals is 38.5% (38–39%). The probability that the SSB in 2025 will be greater than in 2023 in the same scenario is 81% (78–84%).
- An investigation of predation pressure on mackerel by various predators in Canadian and U.S. waters suggests an overall increase in predation-induced mackerel mortality over time, with high interannual variability.
- The stock's decline into the Critical Zone (2005–2011) was associated with high total landings and estimated fishing mortality above the reference level, with no further reduction in stock productivity and no known evidence of habitat degradation or loss.
- The northern contingent of mackerel has been in or near the Critical Zone since 2011. The available evidence indicates the stock rebuilding potential is currently limited by a truncated age structure, low recruitment, and high predation pressure.

INTRODUCTION

Species Biology and Ecology

Atlantic Mackerel (henceforth mackerel) are a highly migratory, pelagic, temperate water, forage fish, in the *Scombridae* family. They play a key role in the ecosystem through the transfer of energy from lower trophic levels to higher order predators including a large range of fish, marine mammals, and sea birds (Studholme et al. 1999). Most northern contingent mackerel reach sexual maturity around 2–3 years old and can live over 10 years. For further information on the general biology and ecology of the species, see Atlantic Mackerel web page as well as the review by Van Beveren et al. 2022.

Population Structure

Mackerel occurs on both sides of the North Atlantic. Individuals from each side can be genetically differentiated and there is no evidence for trans-Atlantic migration (Rodríguez-Ezpeleta et al. 2016; Gíslason et al. 2020; Bourret et al. 2023).

In the Northwest Atlantic (NWA), there are two spawning contingents; a northern contingent which spawns predominantly in the southern Gulf of St. Lawrence in June–July (Van Beveren et al. 2022) and a southern contingent which spawns mostly in the Western Gulf of Maine and offshore southern New England, from mid-April to June (Studholme et al. 1999). Both contingents mix in winter in deeper waters, including parts of the U.S. shelf, where they are subject to the U.S. fishing fleet. Recent evidence indicates small but significant genetic differentiation between the northern and southern contingents (Bourret et al. 2023). The level of mixing during winter remains uncertain, but is expected to be substantial (Redding et al. 2020; Arai et al. 2021; Bourret et al. 2023).

ASSESSMENT

Landings

Recorded commercial and bait landings of mackerel within Canadian waters ranged between 55 kt and 4.3 kt prior to the 2022 fishery closure (1968–2021; Figure 2). Although historically, most landings were recorded from the Scotian Shelf (NAFO 4VWX5YZ), by the late 90s the southern Gulf (4T) became the dominant region for mackerel fishing. Annual landings increased substantially from 2000 to 2010, reaching record highs of around 53–55 kt between 2004 and 2007. This period of greater landings was due to a marked increase in fishing effort by small and large seiners off the coasts of Newfoundland (3KL and 4R), and coincided with the arrival of the large 1999 year class. This period was followed by a large drop in landings that reached a low of 4,272 t in 2015. The TAC was reached for the first time the year after (2016 TAC of 8,000 t) and has since limited total landings, with the exception for 2017. At the time of this assessment, recorded Canadian mackerel landings for 2021 and 2022 were 4,505 t (TAC 4,000 t) and 56 t (fishery closure, number excluding landings under S52 licenses), respectively. In 2021, the three dominant fisheries, in order of importance, were the Gulf gillnet fleet, the Maritimes fixed gear fleet and the Newfoundland seiners. In 2022, landings were limited to mackerel caught as by-catch in various fisheries, and 38 t out of 55 t was caught during only two fishing trips. Mackerel caught in and used for bait in the 2022 tuna fishery were not yet included. On top of the 55 t recorded under the standard monitoring system, 19 t was landed under Section 52 licenses. Landings for 2021 and 2022 are preliminary.

Historically, not all landings were recorded and the above numbers are underestimated. Recreational landings in Canada remain unreported.

Total U.S. mackerel landings, including commercial, recreational and discard estimates, were low (< 5 kt) at the start of the assessed period (1968–1983). They varied between 10 and 32 kt during 1985–2002 and reached record highs around 50 kt shortly after (2003–2006). Over the last decade (2012–2021), U.S. landings remained stable at around 10 kt and lowered in 2022 (3.3 kt under a TAC of 4,963 t).

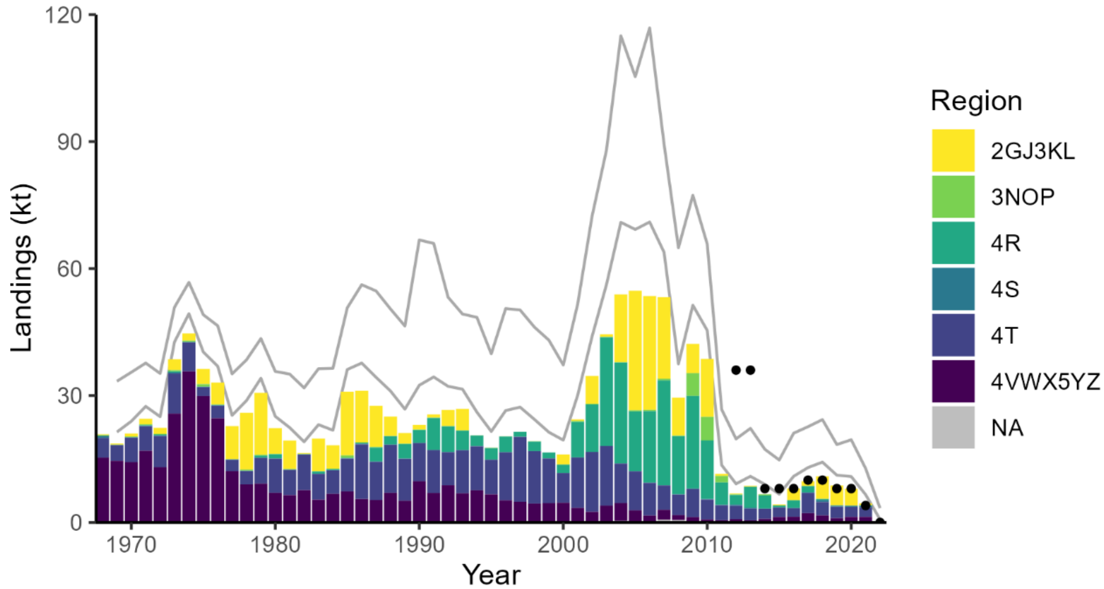

Figure 2. Mackerel landings (1968–2022) from Canadian waters (kt). Bars show recorded landings by NAFO division(s). Dots indicate the Total Allowable Catch (TAC; earlier TACs are not shown because they were set for the entire West-Atlantic mackerel stock). The grey lines represent the upper and lower bounds between which total removals are estimated in the stock assessment model.

Catch-at-age

Before 2000, fish of age 8 and older were relatively more common occurrence in the landings. Since the early 2010s, fish older than 6 have been uncommon (Figure 3). The 2015 cohort is the last one that could easily be tracked, but fish spawned that year were not important anymore in the landings from 2021 and 2022 (< 7%). In 2021, landings were not dominated by a particular age class, as the proportions of fish ages 2, 3 and 4 were fairly balanced (23–32%) and together they constituted 81% of landings. Because of the fishery closure and a likely abrupt change in fishery selectivity, the proportions of fish by age in the 2022 landings are not directly comparable to previous years. There was however strong indication that age 2 mackerel dominated or would have dominated the fishery.

Total Egg Production

The total egg production index (TEP), calculated based on egg density observations made during the annual mackerel egg survey, showed a clearly declining trend, reaching historic lows in the past decade (Figure 4). Prior to 1995, egg production was around 500 billion eggs, before TEP dropped by about an order of magnitude over the period 1994–1999. Between 2002 and 2004 TEP was at higher levels again (average of 260 billion eggs), before a second decrease was observed. Since 2006, TEP has remained low (< 100 billion eggs). The estimated value for 2021 (16 billion eggs) is the second lowest value in the series (2012, at 11 billion eggs). Although the 2022 index was higher (37 billion eggs), it remained among the lowest values observed.

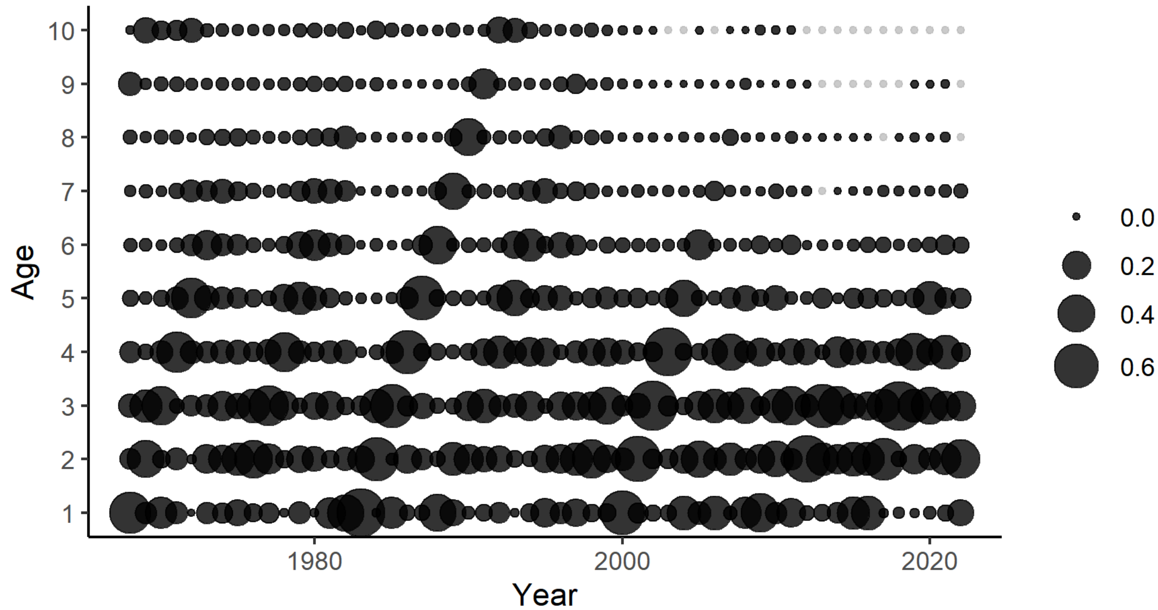

Figure 3. Bubble plot of mackerel catch-at-age data (ages 1–10+) from 1968–2022 (annual proportions). Grey bubbles represent zeros. Note that 2022 is distinctive from previous years and based on a theoretical distribution of landings.

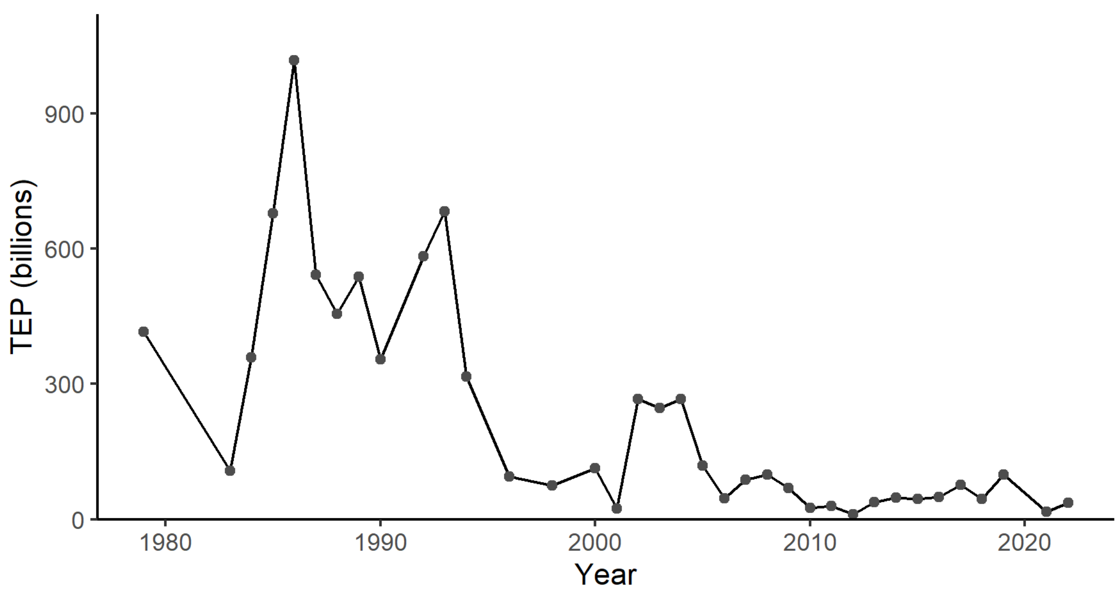

Figure 4. Annual total egg production (TEP) estimated from egg density observations made during the spring mackerel egg survey in the southern Gulf of St. Lawrence.

Analytical Assessment

An analytical assessment was performed with a custom statistical catch-at-age model (Van Beveren et al. 2017), which was updated from the last stock assessment (Smith et al. 2022). Population dynamics were estimated from catch-at-age proportions, TEP, and the upper and lower limit of total removals (Figures 2–4). Note that the removals are explicitly assumed to be within certain limits, rather than around the reported landings, to reflect the uncertainty and bias created by the sources of unaccounted-for catch (unreported bait and recreational catches, discards, U.S. landings of northern contingent mackerel).

Stock Status

The estimated SSB dropped below the LRP in 2011 (Figure 5A) and remained stable for multiple years. With the arrival of the 2015 cohort, SSB increased and was around the LRP in 2017 and 2018. During the two following years (2019 and 2020), SSB declined again to levels similar to just before this stock growth (79% and 56% of the LRP, respectively). In 2019 and 2020, SSB was estimated to be at 40% and 42% of the LRP, respectively. The biomasses in both years were the lowest estimated within the time series.

The estimated recruitment of age 1 fish into the stock has fluctuated over time and has been punctuated by episodic occurrences of strong year classes (Figure 5C). The last notable recruitment event occurred in 2015 (age 1 in 2016) but fish belonging to this cohort only represented a minor proportion (3% or less) of the stock's abundance in 2021 and 2022 (Figure 5B). Recruitment has been weak since, in relation with the low SSB (Beverton-Holt stock recruitment curve; Figure 5D).

Estimates of numbers-at-age highlight the periodic occurrence of dominant year classes as well as the truncation of the age structure of the population which began in the late 1990s (Figure 5B). This erosion of the age-structure of the population has increased over time and there were very few fish over age 5 in 2021 and 2022 (3% or less). The age structure of the population in 2021 and 2022 was not dominated by a particular cohort.

The mean fishing mortality rate ($F_{\overline{5-10}}$; Figure 5E) of fully exploited mackerel (ages 5 to 10+) dropped below the reference level in 2022 because of the Canadian fishery closure and the relatively low biomass of mackerel landed in the U.S. The estimated fishing mortality rate on fully exploited mackerel (ages 5 to 10) in 2022 was 0.42 (0.15–1.20 95%CI). Although exploitation rate is usually given for fish that are fully recruited to the fishery, these mackerel do not compose a large fraction of the population anymore. The fishing mortality rate across all age classes, unweighted by their abundance, equalled 0.32 for 2022. Note that estimates of fishing mortality for the terminal assessment year are highly uncertain, due to explicitly acknowledged uncertainty in total removals (censored approach).

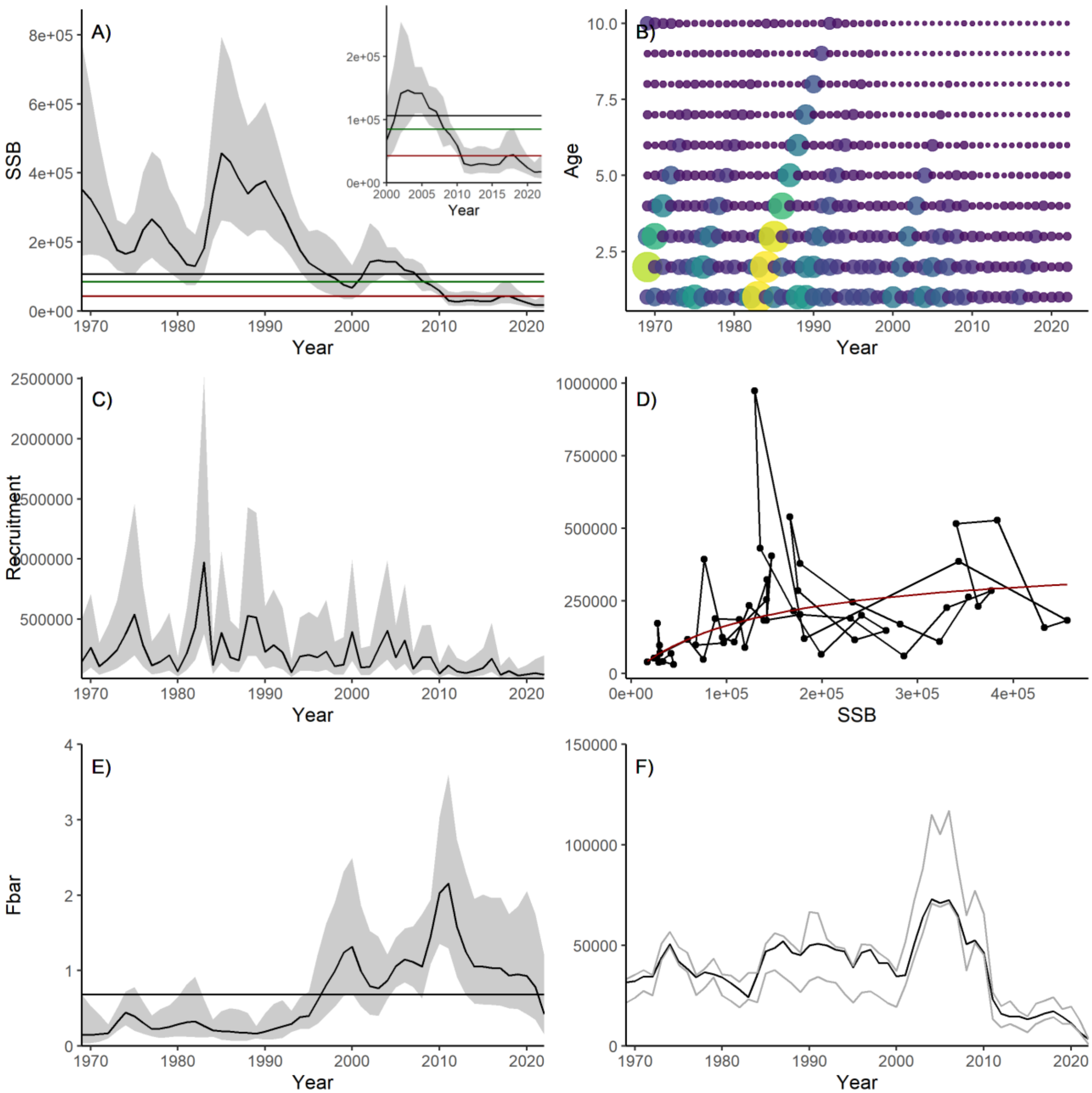

Figure 5. Model output: (A) Spawning Stock Biomass in June (kg) with a zoom for 2000–2022 and horizontal lines indicating the target reference point ($SSB_{F40\%}$; black), the Upper Stock Reference point ($80\%SSB_{F40\%}$; green) and the Limit Reference Point ($40\%SSB_{F40\%}$; red), (B) numbers-at-age in the stock, (C) recruitment (age 1, numbers), (D) stock-recruitment, (E) fishing mortality $F_{\overline{5-10}}$ (averaged over the fully selected age classes 5–10) with indication of Fref ($F_{40\%}$ = 0.68), (F) estimated catch (black) between the pre-determined bounds (grey).

Projections

Projections were made over a three-year period to estimate the impact of different TACs (0–8,000 t). Future recruitment levels are highly uncertain and therefore two different scenarios were selected (based on average recruitment from the last decade or a long-term Beverton-Holt stock-recruitment relationship). The output table shows the average of both approaches, as well as the range of estimated probabilities, to reflect a minimal amount of uncertainty associated with the presented values. Projections included stochastically forecasted unaccounted-for catches of both Canada (limited to recreational fishing) and the U.S. (based on the 2023 TAC of 3,639 t) separately (Table 1). The first line is however an exception and shows a baseline scenario in which the TAC is zero and there is no unaccounted-for Canadian catch (no recreational fishing or other source of removals within Canada), although U.S. fishing continued. This time-invariant implementation error was added to the TAC to calculate total future removals and the resulting next years' stock biomass. The fraction of northern contingent mackerel in the U.S. catches was presumed to be 20–80%, in correspondence to range assumed within the assessment model. Note that because in terms of Canadian implementation error only recreational fishing was considered, an opening of the fishery (TAC > 0) did not go in hand with an addition of unaccounted for catch (discards, illegal or unreported landings).

The probability of reaching the LRP by 2025 with a TAC of 0 t (but with a recreational and U.S. fishery) was estimated around 37.5% (37–38%; Table 1). This probability decreased to 25.5% (25–26%) with a TAC of 4,000 t (TAC of 2021). With a TAC of 0 t, there is a high likelihood that the biomass will increase by 2025 (> 75% probability). With a TAC between 1,000 t and 3,000 t this likelihood is moderately high, whereas for higher TACs there is either a neutral or low change of stock growth. The difference in terms of probability of growth (2.5%) and probability of growing out of the Critical zone (1%) by 2025 between a scenario with a TAC of zero that includes or excludes recreational fishing is small and within statistical uncertainty.

T_{min}

Estimates of T_{min} are intended to help determine the timeline to rebuild the stock to a rebuilding target and are provided to support the update of the mackerel rebuilding plan. The minimum time required for the stock to rebuild above the LRP with a 75% likelihood in the absence of all fishing (F = 0) was estimated at 6 to 7 years (7 years for the base model). Under a scenario in which the U.S. would remove up to 3,639 t (2023 TAC) annually but there is no mackerel fishing in Canada (including recreational fishing), this rebuilding time would increase to between 7 and 9 years (9 years for the base model). Because of the low fishing mortality rate in 2022, which defines in part stock biomass for 2023, the probability of getting out of the Critical Zone increases directly from 2023 onwards.

Table 1. Three-year projections under different constant Total Allowable Catch (TAC). Projections were performed under the assumption that mackerel will also be caught outside of the TAC, by both the Canadian (recreational fishing) and U.S. fleets (shaded columns; 95%CI, time-invariant). For a TAC of 0 there is a scenario with and without recreational fishing in Canada, whereas for a TAC > 0 t recreational fishing is always included. Recruitment was projected using two different methods, and the average of both values (black) together with their range (grey) is provided. For each TAC scenario, the probabilities of June spawning stock biomass being greater than the Limit Reference Point (SSB/LRP) in 2022 and 2023 are provided. The probabilities of SSB growth from 2023 to 2025 are also provided (SSB_{2025} > SSB_{2023}). The ratios between SSB with respect to the LRP (SSB/LRP) for each scenario are likewise given for 2024 and 2025.

TAC 2023–2025	SSB > LRP 2024 (%)	SSB > LRP 2025 (%)	SSB_{2025} > SSB_{2023} 2023→2025 (%)	SSB/LRP 2024	SSB/LRP 2025	Unaccounted-for landings			
						Canada		U.S.A.	
						2.5%	97.5%	2.5%	97.5%
0	28.5 (28–29)	38.5 (38–39)	81 (78–84)	0.68 (0.67–0.68)	0.8 (0.79–0.82)	0	0	489	2,682
0	27.5 (27–28)	37.5 (37–38)	78.5 (75–82)	0.66 (0.65–0.67)	0.78 (0.77–0.79)	192	674	489	2,682
1,000	25.5 (25–26)	33.5 (33–34)	70.5 (67–74)	0.62 (0.61–0.63)	0.72 (0.71–0.73)	192	674	489	2,682
2,000	24 (24–24)	31.5 (31–32)	63 (59–67)	0.58 (0.57–0.59)	0.66 (0.64–0.67)	192	674	489	2,682
3,000	22.5 (22–23)	28.5 (28–29)	56 (52–60)	0.54 (0.54–0.55)	0.59 (0.57–0.61)	192	674	489	2,682
4,000	20.5 (20–21)	25.5 (25–26)	50 (46–54)	0.5 (0.5–0.51)	0.52 (0.51–0.54)	192	674	489	2,682
5,000	19.5 (19–20)	23.5 (23–24)	45 (41–49)	0.46 (0.45–0.47)	0.46 (0.44–0.48)	192	674	489	2,682
6,000	18.5 (18–19)	21.5 (21–22)	40.5 (37–44)	0.42 (0.42–0.43)	0.4 (0.38–0.42)	192	674	489	2,682
7,000	17.5 (17–18)	19.5 (19–20)	35.5 (32–39)	0.38 (0.38–0.39)	0.34 (0.32–0.36)	192	674	489	2,682
8,000	16 (16–16)	17.5 (18–17)	32.5 (29–36)	0.34 (0.34–0.35)	0.3 (0.27–0.32)	192	674	489	2,682

ECOSYSTEM CONSIDERATIONS

Ecosystem Effects on the Stock

This section summarises available knowledge on how ecosystem factors affect three fundamental productivity processes (recruitment, natural mortality and growth) which determine the rate at which the mackerel stock will rebuild, and how this knowledge was integrated within the assessment.

The drivers of northern contingent mackerel **recruitment** variability have been analysed several times (Runge et al. 1999; Castonguay et al. 2008; Plourde et al. 2015). The latest and most in-depth study demonstrated that mackerel recruitment is determined by stock state (including SSB and maternal body condition) and larval food conditions; the intensity of the spatial and temporal match between specific larval prey and egg production is correlated to recruitment strength (match- mismatch hypothesis; Brosset et al. 2020). This knowledge could theoretically be used to inform one-year ahead predictions of recruitment. However, projections are currently performed over a three-year period and although the first projected year is most influential, the demonstrated fine-scale nature of the recruitment process make ecosystem-informed longer-term projections extremely hard. In the absence of directional trends in known environmental drivers, we acknowledge uncertainty in future recruitment by stochastically projecting this process under different statistical assumptions.

Natural mortality (M) caused by a range of predators can be substantial, especially when SSB is low (Van Beveren et al., in prep.). There is currently no evidence that natural mortality had a key role in causing the stock decline (no corresponding increase). Under lower SSB, predators are however likely to remove a relatively larger proportion of the stock and an increase in M will affect stock rebuilding. Although an effort was made to estimate the minimal biomass removed by predators for the presented assessment, this information remains uncertain and this uncertainty, compounded with technical challenges, currently prevent its explicit incorporation into the assessment model.

The ecosystem factors affecting northern contingent mackerel **growth** have not yet been specifically investigated. However, between-year changes and within-year gains in body condition show correlation with plankton abundance (Plourde et al. 2015; Smith et al. 2020). Mackerel WAA, used as an assessment input, also does not display prominent patterns over time, and small-amplitude variations caused by changing environmental conditions do not significantly affect the assessment. Although ecosystem components associated with mackerel growth are currently unaccounted for, they are considered to be of minor importance in determining stock productivity relative to recruitment and natural mortality.

Although environmental conditions drive the annual mackerel migration pattern (see Van Beveren et al. 2022 for a summary of available knowledge), there is currently no evidence that changes in spatial distribution have a direct impact on stock productivity and thus rebuilding.

Fishery Effects on the Ecosystem

Atlantic mackerel is a forage fish species at the middle of the food web (e.g., Savenkoff et al. 2005). They play a key role in the ecosystem through the transfer of energy from lower trophic levels to higher-order predators. The effect of fishery induced changes in mackerel stock state on most predators is unknown, with the exception of northern gannets. This seabird species is the only predator known to feed predominantly on mackerel when they are available. The decline in breeding success of northern gannets in the southern Gulf has been associated with the decrease in mackerel SSB (Guillemette et al. 2018).

By-catch of other species in the mackerel fishery is small and not known to significantly affect these stocks.

PROBABLE CAUSES OF STOCK DECLINE

During the stock’s decline into the Critical Zone (2005–2011), total landings were high and estimated fishing pressure was above the reference level. There is currently no evidence that natural mortality increased during that period (Van Beveren et al., in prep.) or that recruitment was on average low (Figure 5). Although the variance around recruitment might have decreased prior the decline, there was relatively strong recruitment between 2003–2006.

Habitat loss or degradation is of no known concern to this stock.

Sources of Uncertainty

Many of the key uncertainties within the data highlighted in previous assessments (e.g., related to total removals), as well as our knowledge of stock dynamics, have in large part been accounted for through the use of the current stock assessment model. Although uncertainties remain, stock status trends across different indices are consistent and large enough to lend confidence as to stock status. The trends and derived conclusions were consistent across a range of sensitivity analyses, applied to the estimation of the indices and to the assessment model.

During the assessment, FFAW (Fish, Food & Allied Workers) presented results from an online survey targeting commercial fishers, to which 185 individuals responded. Results demonstrated that among Newfoundland harvesters there was wide-spread agreement (83% of survey participants) that compared to the past 5 years, mackerel were more or much more abundant in their area in 2022. During the peer-review there was consensus that observations of high mackerel abundance in one region does not contradict the presented evidence for low stock state, as mackerel are highly migratory schooling fish that even at low stock abundance can be perceived as plentiful, especially if there is a change in spatial distribution. For example, over the last couple of decades and relative to the other regions, interannual variability in landings from Newfoundland has been high, demonstrating that at the more northern extend of mackerel's distribution the presence of mackerel biomass is less stable and not indicative of overall stock state.

CONCLUSIONS AND ADVICE

The northern contingent of west-Atlantic mackerel is currently in the Critical Zone as defined by DFO's PA framework (DFO 2009) and has been in or around this zone since 2011. The age structure of the stock is truncated and average recruitment has been low, in relation with SSB. Stock projections provided in Table 1 will allow decision makers to weigh the trade-offs between SSB and different TACs over a period of three years.

LIST OF MEETING PARTICIPANTS

Name	Affiliation	February 20th	February 21th	February 22th
Beaudry-Sylvestre, Manuelle	DFO Science	x	x	x
Bernier, Denis	DFO Science	x	-	-
Bois, Samantha	ACPG	x	x	-
Boudreau, Mathieu	DFO Science	x	x	x
Boudreau, Mélanie	DFO Science	x	x	x
Bourret, Audrey	DFO Science	x	x	x
Burbank, Jacob	DFO Science	x	-	-
Castonguay, Martin	DFO Science	x	x	x
Cawthray, Jenness	DFO Fisheries Management	x	x	x
Chamberland, Jean-Martin	DFO Science	x	x	x
Cogliati, Karen	DFO Science	x	x	x
Corbett, Emma	Prov. of Newfoundland	x	x	x
Curti, Kiersen	NOAA	x	x	x
Cyr, Charley	DFO Science	x	x	x
Dubé, Sonia	DFO Science	x	x	X
Dunn, Erin	DFO Fisheries Management	x	x	x
Duplisea, Daniel	DFO Science	x	x	X
Emblanc, Quentin	DFO Science	x	x	x
Ferguson, Annie	Prov. of New Brunswick	x	-	-
Ferguson, Louis	MFU-UPM	x	x	x
Giard, David	DFO Fisheries Management	x	x	x
Giffin, Melanie	PEIFA	x	x	x
Girard, Linda	DFO Science	x	x	-
Jones, Trevor	Fisher	x	x	x
Lagacé, Nicolas	Prov. of New Brunswick	-	x	x
Lehoux, Caroline	DFO Science	x	x	-
Lelièvre, Lauréat	Fisher	x	x	x
Lévesque, Laurence	DFO Science	x	x	x
MacMilllan, Robert	Prov. of PEI	x	x	x
Martin, Lucas	UQAR	x	x	x
Monger, Julie	LNSFA	x	-	-
Mitchell, Vanessa	Maritime Aboriginal Aquatic Resources Secretariate	x	-	-
Munden, Jenna	Herring Science Council	x	x	x

Name	Affiliation	February 20th	February 21th	February 22th
Murphy, Hannah	DFO Science	x	x	-
Nadeau, Paul	LNSFA	x	-	-
Nicholas, Hubert	Membertou First Nation	-	x	-
Pardo, Sebastian	Ecology Action	x	x	x
Pellerin, Mathieu	DFO Fisheries Management	x	x	x
Plourde, Stéphane	DFO Science	x	x	x
Rousseau, Shani	DFO Science	x	x	x
Roux, Marie-Julie	DFO Science	x	x	X
Scarratt, Michael	DFO Science	x	x	x
Schijns, Rebecca	OCEANA	x	x	x
Schleit, Katie	Oceansnorth	x	-	-
Senay, Caroline	DFO Science	x	-	-
Smith, Andrew	DFO Science	x	x	x
Solberg, Abe	FFAW	x	x	x
Townsed, Kathryn	Maritime Aboriginal Aquatic Resources Secretariate	-	x	x
Turcotte, François	DFO Science	x	x	x
Vautier, Jeffrey	Processor	x	x	x
Van Beveren, Elisabeth	DFO Science	x	x	X
Zabihi-Seissan, Sana	DFO Science	x	x	x

SOURCES OF INFORMATION

This Science Advisory Report is from the February 20–22, 2023 regional peer review on the Assessment of the northern contingent of Atlantic Mackerel (*Scomber scombrus*). Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

Brosset, P., Smith, A.D., Plourde, S., Castonguay, M., Lehoux, C. and Van Beveren, E. 2020. A fine-scale multi-step approach to understand fish recruitment variability. Sci. Rep. 10:16064. doi:10.1038/s41598-020-73025-z

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APPENDIX

Table S1. Recorded landings of Atlantic mackerel.

Year	Canada	Canada Foreign	Total	Commercial	Recreational	U.S.A. Discards	Total	Foreign
1968	11,118	9,720	20,838	3,929	NA	NA	3,929	65,747
1969	13,257	5,379	18,636	4,364	NA	NA	4,364	114,189
1970	15,710	5,296	21,006	4,049	NA	NA	4,049	210,864
1971	14,942	9,554	24,496	2,406	NA	NA	2,406	355,892
1972	16,253	6,107	22,360	2,006	NA	NA	2,006	391,464
1973	21,566	16,984	38,550	1,336	NA	NA	1,336	396,759
1974	16,701	27,954	44,655	1,042	NA	NA	1,042	321,837
1975	13,540	22,718	36,258	1,974	NA	NA	1,974	271,719
1976	15,746	17,319	33,065	2,712	NA	NA	2,712	223,275
1977	19,852	2,913	22,765	1,377	NA	NA	1,377	56,067
1978	25,429	470	25,899	1,605	NA	NA	1,605	841
1979	30,244	368	30,612	1,990	NA	NA	1,990	440
1980	22,135	161	22,296	2,683	NA	NA	2,683	566
1981	19,294	61	19,355	2,941	2,627	NA	5,568	5,361
1982	16,380	3	16,383	3,330	1,877	NA	5,207	6,647
1983	19,797	9	19,806	3,805	2,792	NA	6,597	5,955
1984	17,320	913	18,233	5,954	2,716	NA	8,670	15,045
1985	29,855	1,051	30,906	6,632	4,088	NA	10,720	32,409
1986	30,325	772	31,097	9,637	7,661	NA	17,298	26,507
1987	27,488	71	27,559	12,310	7,555	NA	19,865	36,564
1988	24,060	956	25,016	12,309	5,420	NA	17,729	42,858
1989	20,795	347	21,142	14,556	2,829	160	17,545	36,823
1990	19,190	3,857	23,047	31,261	3,252	827	35,340	30,678
1991	24,914	597	25,511	26,961	3,540	1,098	31,599	15,714
1992	24,307	2,255	26,562	11,761	919	2,072	14,752	0
1993	26,158	690	26,848	4,662	1,231	3,902	9,795	0
1994	20,564	49	20,613	8,917	2,654	5,409	16,980	0
1995	17,627	62	17,689	8,468	1,697	54	10,219	0
1996	20,282	76	20,358	15,728	2,466	2,053	20,246	0
1997	21,294	116	21,410	15,403	2,857	229	18,489	0
1998	19,176	10	19,186	14,525	1,553	97	16,176	0
1999	16,526	12	16,538	12,031	2,832	771	15,634	0
2000	16,053	26	16,079	5,649	3,054	153	8,856	0
2001	24,336	11	24,347	12,340	3,300	718	16,358	0
2002	34,600	7	34,607	26,530	2,678	155	29,364	0
2003	44,463	9	44,472	34,298	1,870	264	36,433	0
2004	53,861	14	53,875	54,990	1,169	2,141	58,300	0
2005	54,764	0	54,764	42,209	1,694	1,083	44,985	0
2006	53,503	3	53,506	56,640	3,911	135	60,687	0
2007	53,223	0	53,223	25,546	761	159	26,467	0
2008	29,474	4	29,478	21,734	2,731	747	25,212	0
2009	42,205	0	42,205	22,634	1,768	126	24,529	0
2010	38,646	0	38,646	9,877	4,288	97	14,261	0
2011	11,485	0	11,485	533	4,040	38	4,610	0
2012	6,841	0	6,841	5,333	2,670	33	8,036	0
2013	8,674	0	8,674	4,372	2,406	20	6,798	0
2014	6,678	0	6,678	5,905	2,296	51	8,252	0
2015	4,272	1	4,273	5,616	4,274	13	9,904	0
2016	8,045	0	8,045	5,687	4,569	18	10,274	0
2017	9,749	3	9,752	6,975	4,161	83	11,219	0
2018	10,907	1	10,908	8,717	2,394	177	11,288	0
2019	8,750	0	8,750	5,379	2,117	200	7,696	0
2020	7,947	0	7,947	8,306	2,017	192	10,515	0
2021	4,505*	0	4,505*	5,752	2,168	133	8,053	0
2022	56*	0	56*	1,908	1,350*	44*	3,302*	0

*Preliminary numbers

Table S2. Recorded landings (t) of Atlantic mackerel by DFO region.

Year	Gulf	Maritimes	Newfoundland	Quebec
1985	6,125	6,265	14,883	2,179
1986	8,518	4,799	2,400	3,004
1987	9,611	5,233	9,902	2,753
1988	9,469	6,065	4,234	3,662
1989	9,686	4,814	1,911	2,252
1990	9,634	8,499	1,208	1,971
1991	14,451	7,270	834	3,256
1992	9,888	8,622	1,283	3,480
1993	6,996	6,718	9,683	3,175
1994	6,875	7,608	2,800	3,546
1995	4,831	6,574	2,953	3,382
1996	7,049	5,170	3,869	4,317
1997	9,590	4,762	1,188	5,769
1998	8,676	4,431	2,331	3,738
1999	5,462	4,550	1,445	5,104
2000	5,294	4,359	4,406	2,022
2001	9,123	3,113	8,981	3,212
2002	10,069	2,190	17,982	4,421
2003	9,727	3,737	26,675	4,597
2004	7,728	4,241	40,003	1,979
2005	8,238	2,691	42,660	1,221
2006	6,043	1,603	44,277	1,818
2007	4,685	2,357	44,602	1,750
2008	3,599	1,173	23,036	1,863
2009	4,562	1,116	34,237	2,316
2010	3,278	554	33,159	1,709
2011	2,417	409	7,337	1,345
2012	2,258	692	2,619	1,278
2013	1,648	403	5,169	1,453
2014	1,042	703	3,432	1,502
2015	1,226	1,172	701	1,182
2016	1,241	1,215	4,633	966
2017	3,726	2,057	2,653	1,347
2018	2,390	1,522	5,625	1,426
2019	2,170	912	4,814	859
2020	1,952	1,205	4,015	788
2021*	1,824	1,232	602	859
2022*	0.25	54.674	0.141	0.614

*Preliminary numbers

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