Atlantic mackerel and Atlantic herring

Scomber scombrus, Clupea harengus

U.S. & Canada: Northwest Atlantic

Bottom trawls, Midwater trawls, Purse seines

Report ID 27861

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Seafood Watch Standard used in this assessment: Fisheries Standard v4

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About Seafood Watch

Monterey Bay Aquarium's Seafood Watch program evaluates the environmental sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Seafood Watch's science-based ratings are available at www.SeafoodWatch.org. Each rating is supported by a Seafood Watch assessment, in which the fishery or aquaculture operation is evaluated using the Seafood Watch standard.

Seafood Watch standards are built on our guiding principles, which outline the necessary environmental sustainability elements for fisheries and aquaculture operations. The guiding principles differ across standards, reflecting the different impacts of fisheries and aquaculture.

- Seafood rated Best Choice comes from sources that operate in a manner that's consistent with our guiding principles. The seafood is caught or farmed in ways that cause little or no harm to other wildlife or the environment.

- Seafood rated Good Alternative comes from sources that align with most of our guiding principles. However, one issue needs substantial improvement, or there's significant uncertainty about the impacts on wildlife or the environment.

- Seafood rated Avoid comes from sources that don't align with our guiding principles. The seafood is caught or farmed in ways that have a high risk of causing harm to wildlife or the environment. There's a critical conservation concern or many issues need substantial improvement.

Each assessment follows an eight-step process, which prioritizes rigor, impartiality, transparency and accessibility. They are conducted by Seafood Watch scientists, in collaboration with scientific, government, industry and conservation experts and are open for public comment prior to publication. Conditions in wild capture fisheries and aquaculture operations can change over time; as such assessments and ratings are updated regularly to reflect current practice.

More information on Seafood Watch guiding principles, standards, assessments and ratings are available at www.SeafoodWatch.org.

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished[1] or farmed, that can maintain or increase production in the long term without jeopardizing the structure or function of affected ecosystems.

The following guiding principles illustrate the qualities that fisheries must possess to be considered sustainable by the Seafood Watch program (these are explained further in the Seafood Watch Standard for Fisheries):

- Follow the principles of ecosystem-based fisheries management.
- Ensure all affected stocks are healthy and abundant.
- Fish all affected stocks at sustainable levels.
- Minimize bycatch.
- Have no more than a negligible impact on any threatened, endangered, or protected species.
- Managed to sustain the long-term productivity of all affected species.
- Avoid negative impacts on the structure, function, or associated biota of aquatic habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.

These guiding principles are operationalized in the four criteria in this standard.Each criterion includes:

- Factors to evaluate and score
- Guidelines for integrating these factors to produce a numerical score and rating

Once a rating has been assigned to each criterion, Seafood Watch develops an overall recommendation. Criteria ratings and the overall recommendation are color coded to correspond to the categories on the Seafood Watch pocket guides and online guide:

Best Choice/Green: Buy first; they're well managed and caught or farmed responsibly.

Good Alternative/Yellow: Buy, but be aware there are concerns with how they're caught, farmed or managed.

Avoid/Red: Take a pass on these for now; they're caught or farmed in ways that harm other marine life or the environment.

[1] "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates

Summary

This report assesses Atlantic mackerel (*Scomber scombrus*) caught in the United States and Canada (northwest Atlantic stock) and U.S.-caught Atlantic herring (*Clupea harengus*). Because of temporal and spatial overlap between the U.S. Atlantic mackerel and Atlantic herring fisheries, as well as the gear type being used in the fisheries, these species are often caught together. Gears evaluated in the Atlantic mackerel fisheries include midwater trawls and bottom trawls for the United States and purse seines for Canada. The bottom trawl fishery accounted for 66% of U.S. commercial catch of mackerel in 2019, while midwater trawls accounted for 17% (but most landings in the last decade have been from midwater trawling). In Canada, 46% of the commercial catch of Atlantic mackerel was caught by purse seine in 2019. Although Atlantic mackerel is landed using other gears, such as gillnets, jiggers, hand lines, and traps, the gears evaluated in this report represent a majority of landings; in Canada, catch of mackerel with gillnets and trap nets is primarily for bait for other fisheries. The Atlantic herring analysis covers U.S. Atlantic herring caught with midwater trawls, bottom trawls, and purse seines because these gears account for >95% of the U.S. herring catch. The Canadian Atlantic herring fisheries are not considered in this report; the Marine Stewardship Council (MSC) certifications for three Canadian Atlantic herring fisheries were either suspended or withdrawn in 2018 and 2019.

Atlantic mackerel in the Northwest Atlantic comprises northern and southern contingents. The northern contingent spawns in the southern Gulf of St. Lawrence; the southern contingent historically spawned mostly in the Mid-Atlantic and southern New England waters, but the majority of spawning has shifted into southern New England and the Gulf of Maine in recent decades. The two spawning contingents overlap seasonally (in winter and offshore) in U.S. shelf waters. The U.S. stock assessment combines information from both spawning contingents into a single stock status, while the Canadian assessment only considers the northern spawning contingent. According to both stock assessments, Atlantic mackerel is overfished and there is uncertainty in the terminal year estimate for fishing mortality. Overfishing was not occurring on the stock in 2022 for the first time in 35 years. U.S. Atlantic herring is overfished, but fishing levels on the targeted Gulf of Maine/Georges Bank stock have been below sustainable levels since 2019.

In the U.S. Atlantic mackerel bottom trawl fishery, there are concerns with bycatch of depleted species such as American shad, Atlantic herring, and river herring—catch of river herring is a concern in the U.S. midwater trawl fishery targeting Atlantic herring and Atlantic mackerel. The bottom trawl fishery also incidentally catches Risso's dolphin and short-beaked common dolphin, but the impact to these species is not considered a high concern. There are no bycatch concerns in the Canadian purse seine fishery for Atlantic mackerel or in the U.S. purse seine fishery for Atlantic herring.

A revised rebuilding plan for U.S. Atlantic mackerel was recently approved (February 2023) and has a 61% probability of rebuilding the stock within 10 years. The species is regularly assessed in the United States and Canada, and Canadian and U.S. fishery scientists collaborate on information sharing, but there is a need for improved coordinated management between the two countries. Atlantic herring is regularly assessed, and management is based on conservative policies that account for the ecological role of this important forage species. The U.S. has precautionary strategies to minimize the impacts to bycatch species, there is evidence that these strategies are successful, and bycatch mitigation measures are considered highly effective for all U.S. fisheries in this report. There are no known concerns with bycatch in the Canadian mackerel fishery, but there is insufficient information to assess the effectiveness of bycatch mitigation measures.

The impacts on habitats and ecosystem are of highest concern for bottom trawl, which contacts the seafloor and results in habitat degradation; purse seine gear generally does not touch the seafloor, while midwater trawl only occasionally contacts the seafloor. The Atlantic herring fishery is managed with precautionary policies intended to protect the ecological role of Atlantic herring, and with temporal and spatial management to protect spawning areas and prevent localized depletion. The Atlantic herring harvest control rule aligns with the standards set forth in the Lenfest report, but management targets are slightly less conservative: the harvest control allows for a maximum F of 80% of F_{MSY} and for fishing down to 10% of $B_{0,}$ which is higher than the 75% of F_{MSY} and lower than the 30% of B_0 recommended by Lenfest. But the Atlantic mackerel fishery lacks a conservative, ecological harvest control rule that is consistent with the Lenfest recommendations, with buffers to account for the needs of dependent predators, resulting in a high concern score for ecosystem-based fisheries management for all fisheries catching Atlantic mackerel.

Final Seafood Recommendations

SPECIES | FISHERY	C 1 TARGET SPECIES	C 2 OTHER SPECIES	C 3 MANAGEMENT	C 4 HABITAT	OVERALL	VOLUME (MT) YEAR
Atlantic herring | Northwest Atlantic | United States | Midwater trawls | Atlantic herring fishery	2.236	1.732	3.000	2.449	**Avoid (2.310)**	3,003 (MT) 2021
Atlantic herring | Northwest Atlantic | United States | Purse seines | Atlantic herring fishery	2.236	5.000	3.000	3.464	**Good Alternative (3.283)**	1,920 (MT) 2021
Atlantic herring | Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic herring fishery	2.236	1.732	3.000	2.000	**Avoid (2.196)**	210
Atlantic mackerel | Northwest Atlantic | Canada | Purse seines	1.732	5.000	3.000	2.828	**Avoid (2.928)**	4,326 (MT) 2021
Atlantic mackerel | Northwest Atlantic | United States | Midwater trawls | Atlantic mackerel fishery	1.732	2.236	3.000	2.449	**Avoid (2.310)**	4,150 (MT) 2021
Atlantic mackerel | Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery	1.732	2.236	3.000	2.000	**Avoid (2.196)**	730 (MT) 2021

The average annual production of U.S. Atlantic herring from 2015-2020 was 24,998 t by midwater trawl, 15,964 t by purse seine, and 2,884 t by bottom trawls (NEFMC 2022). Total landings declined to less than 10,000 t in 2020 and 2021. The total Atlantic herring catch in 2021 was 5,268 t (ASMFC 2022c). The volume for each gear in 2021 is based on the relative proportion of landings from each gear from 2015-2020, and should be considered an estimate.

The volume for the Canadian mackerel fishery in 2021 is total commercial production, but the seine fishery has landed the majority of the catch in the commercial fishery in recent years (DFO 2022). There commercial mackerel fishery was closed in 2022 or 2023.

Summary

There is temporal and spatial overlap between the U.S. Atlantic mackerel and Atlantic herring fisheries, and the two species are often caught concurrently. Although the Atlantic mackerel and Atlantic herring bottom and midwater trawl fisheries are separated in this report, the scoring is identical for Criteria 3 and 4 because management effectiveness is scored against all the main targeted and retained species/stocks. Because there are no other main species in the Canadian and U.S. purse seine fisheries, those fisheries are scored differently.

Atlantic mackerel caught in the United States with midwater trawls and bottom trawls and in Canada with purse seines receives a Red rating. Likewise, Atlantic herring caught in the U.S. with midwater trawls and bottom trawls receives a Red rating. A driving factor for these is the status of Atlantic mackerel, which is rated in Criterion 1 in the mackerel fisheries and Criterion 2 in the herring trawl fisheries. Atlantic mackerel

is overfished and there is uncertainty in the terminal-year estimate for fishing mortality. The other driving factor is ecosystem-based fisheries management, which is scored a high concern, because targeted and retained stocks are forage species and conservative ecological harvest control rules consistent with the Lenfest Forage Fish Task Force recommendations are not used for at least 70% of the main species/stocks.

Atlantic herring caught in the U.S. with purse seines is rated Yellow. The distinction between this fishery and the others above is based on two important factors. First, Criterion 2 is scored Green because there are no other main species. Second, the Atlantic herring harvest control rule aligns with the standards set forth in the Lenfest Forage Fish Task Force. The Yellow rating is driven by a high concern score for abundance and a moderately effective score for Factor 3.1.

Scoring Guide

Scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact.

Final Score = geometric mean of the four Scores (Criterion 1, Criterion 2, Criterion 3, Criterion 4).

Best Choice/Green = Final Score >3.2, and no Red Criteria, and no Critical scores

Good Alternative/Yellow = Final score >2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern2, and no more than one Red Criterion, and no Critical scores

Avoid/Red = Final Score ≤2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

[2] Because effective management is an essential component of sustainable fisheries, Seafood Watch issues an Avoid recommendation for any fishery scored as a Very High Concern for either factor under Management (Criterion 3).

Introduction

Scope of the analysis and ensuing recommendation

This analysis encompasses Atlantic mackerel (*Scomber scombrus*) caught in the United States and Canada North Atlantic Ocean (northwest Atlantic stock) and U.S.-caught Atlantic herring (*Clupea harengus*). Gears evaluated in the Atlantic mackerel fisheries include midwater trawls and bottom trawls for the United States and purse seines for Canada. Although Atlantic mackerel is landed using other gears, such as gillnets, jiggers, hand lines, and traps, the gears evaluated in this report represent a majority of landings; in Canada, catch of mackerel with gillnets and trap nets is primarily for bait for other fisheries. Fisheries and Oceans Canada (DFO) closed the commercial fishery for Atlantic mackerel in 2022 and 2023 to promote rebuilding of the stock. The Atlantic herring analysis covers U.S. Atlantic herring caught with midwater trawl, bottom trawl, and purse seines. The Canadian Atlantic herring fisheries are not considered in this report; the Marine Stewardship Council (MSC) certifications for three Canadian Atlantic herring fisheries were either suspended or withdrawn in 2018 and 2019.

Species Overview

Atlantic Mackerel

Atlantic mackerel is a schooling species found along the coasts of the North Atlantic Ocean. There are two distinct populations of Atlantic mackerel that do not mix: one in the Northeast Atlantic (around Europe) and the other in the Northwest Atlantic (around the northern United States and Canada); the latter also has northern and southern contingents. The northern contingent spawns in the southern Gulf of St. Lawrence (Figure 1), but the two contingents overlap in U.S. waters in winter months (Arai et al. 2021); though the southern contingent historically spawned mostly in the Mid-Atlantic and southern New England, spawning has shifted into southern New England and the Gulf of Maine in recent decades (Richardson et al. 2020). There is also evidence of some mixing of the southern contingent in Canadian waters (DFO 2021a). The Northeast Fisheries Science Center (NEFSC) assesses the entire population (NEFMC 2018) and DFO assesses just the northern contingent (DFO 2021a). The southern contingent has historically appeared in April off the mid-Atlantic (Virginia, Maryland, and Delaware) between the Chesapeake and Delaware Bays, and moves northward to New England, the Gulf of Maine, and into Canadian waters for the summer (Sette 1950). In December, the southern contingent moves offshore to overwinter between Cape Hatteras, U.S. and Sable Island, Nova Scotia. The maximum observed size and age are 42 cm and 20 years, respectively (Overholtz 2006). Sexual maturity generally occurs between 1 and 3 years old.

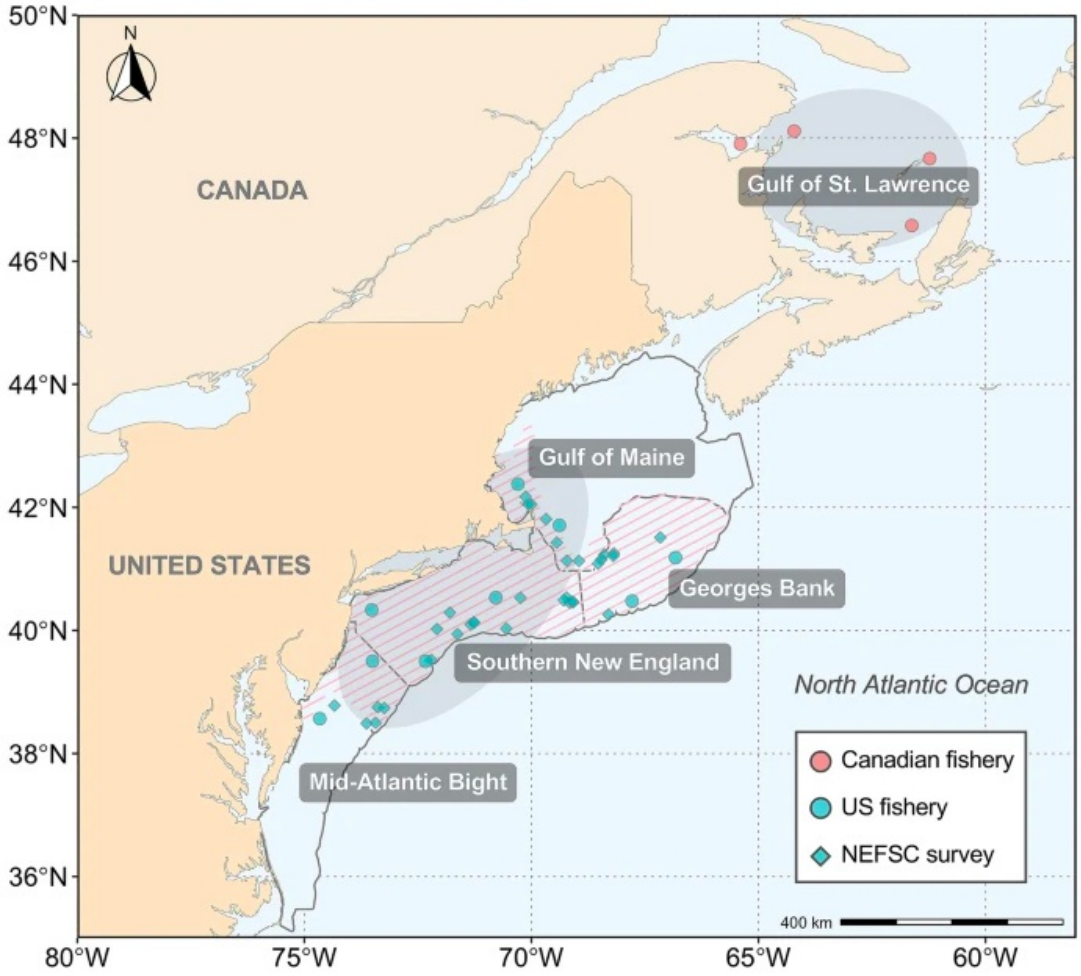


Figure 1: Northwest Atlantic mackerel spawning sites and fishery locations. Shaded ellipses in the Gulf of St. Lawrence and U.S. continental shelf depict principal spawning sites for the northern and southern contingents. Hatched areas in the U.S. continental shelf illustrate principal contingent mixing regions during winter (Arai et al. 2021).

The U.S. fishery is managed by the Mid-Atlantic Fishery Management Council (MAFMC) within the Mackerel, Squid, and Butterfish (MSB) Fishery Management Plan (FMP). The first fisheries management plan was implemented for Atlantic mackerel in 1978, and management was combined with squid and butterfish in 1983. The MAFMC recognizes substantial uncertainty on the status of this stock because of the species' dependence on environmental variables, including depth, salinity, temperature, chlorophyll, and zooplankton (NEFSC 2018d). Annual quotas are based on MAFMC recommendations to the National Marine Fisheries Service (NFMS) of the National Oceanic and Atmospheric Administration (NOAA). The MAFMC's recommendations cannot exceed the stock-wide acceptable biological catches (ABCs) determined by its Scientific and Statistical Committee (SSC). The SSC's ABCs account for stock status and scientific uncertainty, to avoid overfishing. The MAFMC subtracts expected Canadian catch and management uncertainty to prevent catches from exceeding the total ABC (MAFMC 2016b). The Canadian fishery is managed by DFO under an Integrated Fisheries Management Plan (IFMP) for Northwest Atlantic Fisheries Organization [NAFO] Subareas 3 and 4. Management under this plan began in 2007 (DFO 2007).

According to the U.S. stock-wide assessment, mackerel biomass and catch peaked in the early 1970s from

strong recruitment and lower fishing mortality (F), and has generally been declining since then owing to a combination of less recruitment and overfishing, though it is unclear if or how these causes may be intertwined. The Canadian assessment only addresses the northern contingent, and shows that component of the population peaking in the mid-1980s and declining since then for reasons similar to those of the U.S. stock-wide assessment (NEFSC 2018)(DFO 2019a).

Atlantic Herring

Atlantic herring inhabits waters from 0 to 400 meters (m) on the continental shelf, but is usually found from 11 to 200 m (NEFMC 2014b). Herring prefers cold waters from 5 to 9 degrees Celsius (°C) during spawning season, but throughout adulthood it is found in waters from 0 to 20 °C inshore and 2.5 to 10.5 °C on the continental shelf (NEFMC 2014b). Herring spawns once annually and can spawn along the coast of Maine, in Nova Scotia, the Gulf of St. Lawrence, or even as far offshore as Georges Bank. It matures at ages 2–4 and can live 15–18 years. The Atlantic herring fishery is known to target fish starting at age 3, up to age 12 (NMFS 2005). Herring is a synchronous spawner and produces 55,000 to 210,000 eggs once a year by depositing them on the seafloor (NMFS 2005). Herring eggs are preyed upon by many fish species including cod, haddock, red hake, sand lance, and winter flounder, and egg mortality is high (NMFS 2005). Herring is a plankton feeder and preys as a juvenile on a variety of pelagic zooplankton such as small copepods, and preys as an adult on chaetognaths, euphasiids, pteropods, and larger copepods (NMFS 2005). Herring feeds most often in spring and summer months, and often at dawn and dusk in the upper levels of the water column. It is also a major prey species for a variety of predators, including fish species such as cod, haddock, cunner, red hake, spiny dogfish, and bluefish; elasmobranchs such as thorny skate and dusky shark; marine mammals such as white-sided dolphin, harbor porpoise, and minke, fin, and humpback whales; and a variety of seabirds (NEFMC 2019b).

The Atlantic herring fishery has been operational since the early 1900s, and there are records of catch starting in 1960. Herring was first regulated through the International Commission for Northwest Atlantic Fisheries until 1976, when the U.S. passed the Magnuson-Stevens Fishery Conservation and Management Act. A herring fishery management plan was implemented in 1978, but withdrawn because catch quotas were not being enforced in state waters and foreign nationals were prohibited from landing any herring. Herring was managed in state waters through spawning closures until 2001, when a federal FMP was reinstated (NEFMC 2013a). The fishery is managed by four distinct management areas (Figure 2): Area 1A in the Gulf of Maine, Area 1B that extends from Cape Cod to the exclusive economic zone (EEZ) border, Area 3 south of Cape Cod to Georges Bank, and Area 2 inshore south of Nantucket (NEFMC 2013a). The fishery operates in Areas 1A, 1B, and 3 in the summer and in Areas 2 and 3 in the winter months (NEFMC 2013a). Atlantic herring is managed jointly in federal waters by the NMFS and New England Fishery Management Council (NEFMC), and in state waters by the Atlantic States Marine Fisheries Commission (ASMFC). Atlantic herring is managed jointly in state and federal waters under complementary management plans, which set quotas for all four management areas. The state and federal agencies jointly implement quotas, catch caps, and other management measures, but the NEMFC prohibits midwater trawling from June 1 to September 30 in federal waters, and the ASMFC operates by using spawning closures and a "days out" program, which limits the number of days per week that vessels can land herring in state waters (ASMFC 2021b).

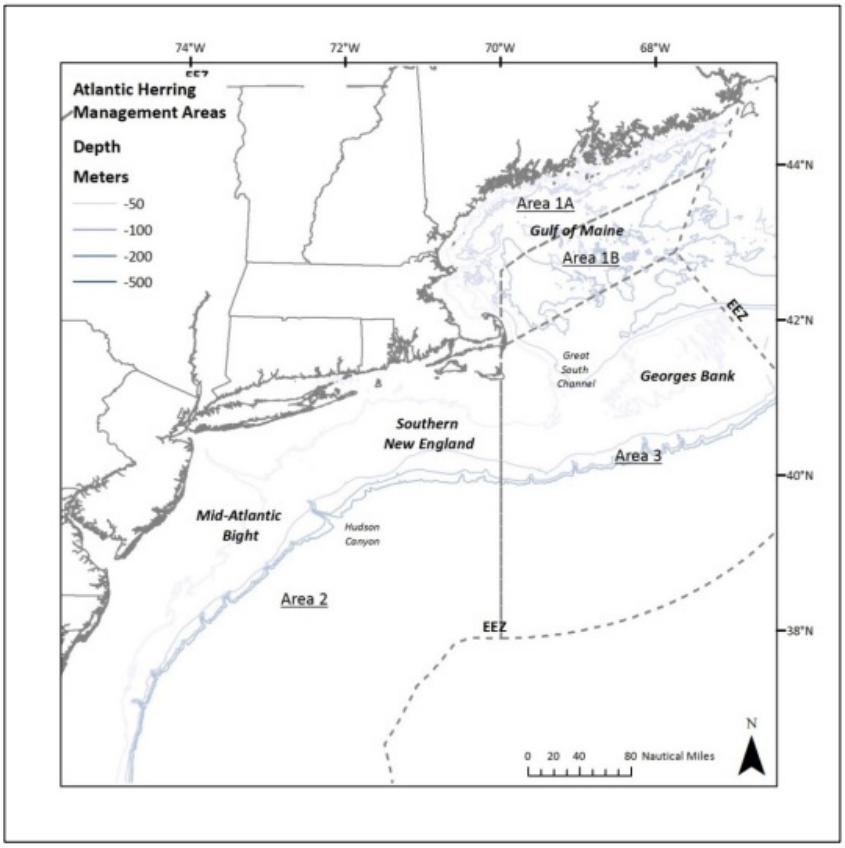


Figure 2: U.S. Atlantic herring management areas (NEFMC 2019b).

Atlantic herring in the U.S. is managed as a single Gulf of Maine/Georges Bank (GoM/GB) complex, because there is currently no ability to distinguish survey and fishery catches to stock of origin (NEFSC 2018c). The complex comprises three spawning stock components (Gulf of Maine, southwest Nova Scotia–Bay of Fundy, and Georges Bank) (NEFMC 2019b), and the degree of mixing between the GoM/BoF complex and the Scotian Shelf stock is unknown (NEFSC 2018). To account for multiple stock components within the Atlantic herring stock complex, NEFMC sets a total annual catch limit (ACL) that is divided and assigned as sub-ACLs in four management areas (NEFMC 2019b). The New Brunswick (NB) fixed-gear fishery also contributes to GoM/GB Atlantic herring mortality. Specifically, catch of juvenile Atlantic herring (ages 1 and 2) in the NB fishery is assumed to originate from the inshore Gulf of Maine herring stock complex component, while adult fish (age 3+) are from the SW Nova Scotian complex (NEFMC 2019b); however, the relative contribution of various spawning components to the NB fishery is unknown (DFO 2018b).

Production Statistics

In the 1960s and 1970s, foreign fleets dominated the Atlantic mackerel fishery, with annual catches of more than 400,000 mt (Figure 3) (DFO 2007). U.S. landings increased during 1985 to 1991 because of the start of a joint-venture fishery in the mid-Atlantic region (Overholtz 2006). Foreign fleets were eliminated from the U.S. Atlantic mackerel market in the early 1990s, thereby allowing only the United States and Canada to take part in this fishery since 1992 (MAFMC 1991).

U.S. commercial landings of Atlantic mackerel have been relatively low and variable in recent years, from 25,546 mt in 2006 to a low of 533 mt in 2011 (Figure 3), mirroring the declining trend in SSB (from 103,390 mt in 2007 to 42,862 mt in 2019 (NEFSC 2018d)(NOAA 2021b)). From 2012 to 2016, landings remained somewhat steady between 4,000 and 6,000 mt, and increased to nearly 7,000 mt in 2017 and 8,700 mt in 2018 (Figure 3). Landings for 2019 were 5,379 mt; 2018 and 2019 landings were likely lower than they would have been if not for the directed mackerel fishery being closed early for exceeding a bycatch cap for river herring and shad (NOAA 2021b).

In the U.S., bottom and midwater trawling account for a majority of the landings in the commercial fishery. Purse seine activity was low in the 2000s and does not currently appear in landings data. Atlantic mackerel also supports an important recreational fishery. The estimated average annual catch (landings plus discards) from the U.S. recreational fishery from 2010 to 2019 was 2,897 mt, or 20% of the total annual U.S. catch during that time; the relative proportion has been higher in recent years, with the recreational fishery accounting for 29% of the U.S. mackerel catch from 2017 to 2019 (NOAA 2021b).

In 2019, approximately 66% of the Atlantic mackerel landed domestically were caught with bottom otter trawls and 17% were caught with paired midwater trawls, which is considerably different than in 2018 (53% with bottom otter trawls and 25% with paired midwater trawls) (MAFMC 2020b)(MAFMC 2019d). The catch methods reported for the remaining proportion of Atlantic mackerel landed in 2019 and 2018, respectively, included bottom longline (<5%, 2%), handline (<5%, <2%), unknown (4%, 14%), single midwater trawl (<3%, <5%), and other (<2%) (MAFMC 2020b)(MAFMC 2019d).

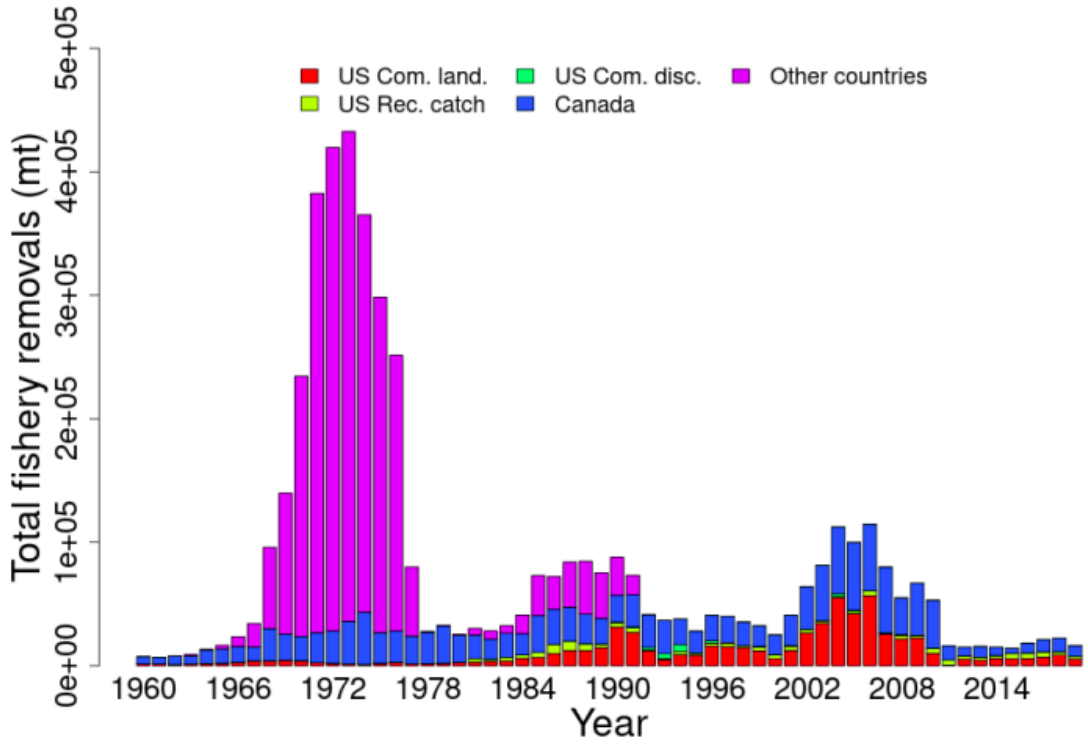


Figure 3: Total catch of northwest Atlantic mackerel between 1968 and 2019 by all sources. "US Rec. catch" represents United States recreational landings plus discards, "Canada" represents Canadian landings (discards are unavailable), and "Other countries" represents landings by all other countries (NOAA 2021b).

In the 1980s and 1990s, Canadian landings of Atlantic mackerel were relatively stable and averaged 22,000 mt per year (Figure 4). From 2000 to 2010, landings averaged 40,498 mt. The landings in 2005 resulted from an increase in fishing effort by large seiners in Newfoundland and the strong 1999 year class. Similar to U.S. production, landings in Canada have experienced a severe decline from a high of 54,809 mt in 2005 to a low of 4,272 mt in 2015, with slight increases to 8,057 mt in 2016, 9,786 mt in 2017, and 10,927 mt in 2018 (DFO 2021a). Canadian landings were restrained by quota closures in 2017 and 2018. The 2019 and 2020 Canadian quota was reduced to 8,000 mt, and DFO cut the commercial quota an additional 50% to 4,000 mt in 2021 (DFO 2021a). In March 2022, the Minister of Fisheries and Oceans Canada announced the closure of the Atlantic mackerel commercial and bait fisheries in Canada, which was extended through 2023. A large majority of landings occur in Newfoundland (DFO 2021a). Though records of landings from the Canadian bait fishery have improved in recent years, there is still considerable uncertainty in the amount of discards, bait, recreational catch, and the proportion of Canadian spawned mackerel caught in the U.S. winter mackerel fishery (DFO 2021a).

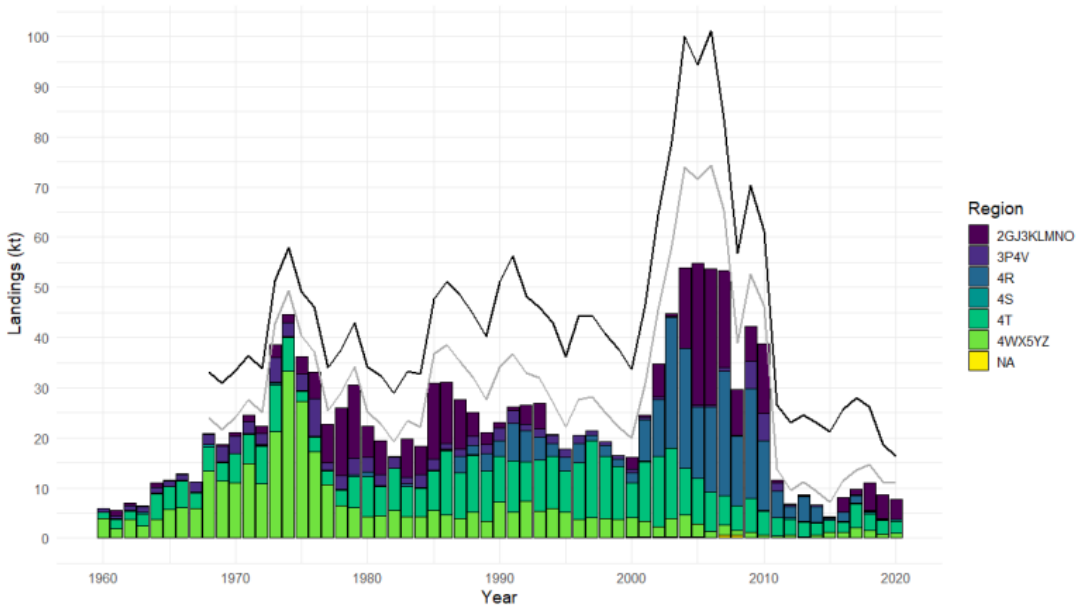


Figure 4: Atlantic mackerel landings (kt) within Canada's Exclusive Economic Zone by aggregated NAFO divisions. The grey and black lines represent the upper (black) and lower (grey) bounds in which total removals are estimated in the stock assessment model (1968–2020). These bounds are defined by total recorded landings as well as estimates of maximum unaccounted-for removals from all sources (e.g., recreational catch, unaccounted-for bait, discards, and 25% of U.S. landings for the lower bound and 50% of U.S. landings for the upper bound) (DFO 2021a).

Like mackerel, Atlantic herring landings have been variable through time, but historically low in recent years (Figure 5). Foreign fleets were mainly responsible for high landings in the 1960s, and the U.S. eventually prohibited foreign fishing for herring within the EEZ in 1982. Total commercial landings peaked in 1968 at 477,767 mt, averaged 78,164 mt in the 1980s, 113,358 mt in the 2000s, and declined to 7,865 mt in 2021 (Figure 5). The U.S. herring fishery targets the Gulf of Maine/Georges Bank (GoM/GB) stock. In 2022, the U.S. landed approximately 4,278 mt of Atlantic herring and, according to the preliminary estimates for the 2022 season, Massachusetts accounted for >55% of commercial landings of Atlantic herring, followed by Maine (>40% of commercial landings); all other states (NH, RI, CT, NY, and NJ) accounted for the remaining ˜5% of commercial landings (ASMFC 2022c). U.S. commercial landings of Atlantic herring from 2012 to 2014 were dominated by midwater trawl gear (67% of total), followed by purse seines (26%) and small mesh bottom trawl (7%) (Table 39 in (NEFMC 2019b)). Though midwater trawl gear still accounts for the majority of landings, the proportion of landings by gear has shifted in recent years (2015–19) as follows: midwater trawl (57%), purse seines (38%), and small mesh bottom trawl (5%) (Table 27 in (NEFMC 2021d)).

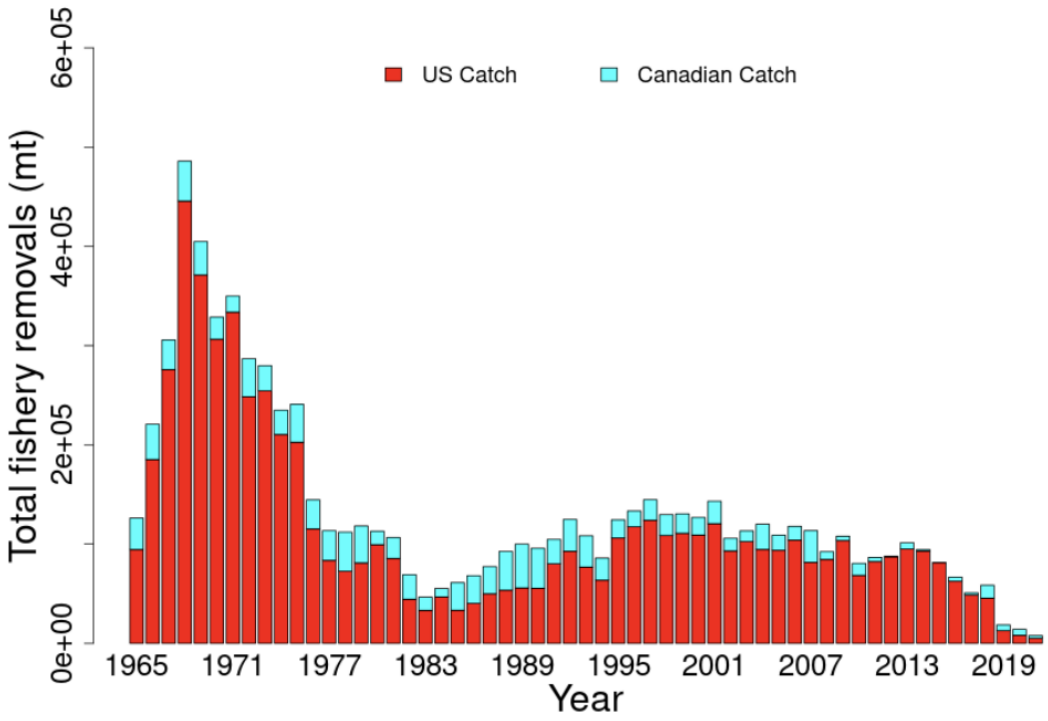


Figure 5: Commercial Atlantic herring landings from U.S. and Canadian fisheries from 1965 to 2021 (NEFMC 2023).

Importance to the US/North American market.

Atlantic herring and mackerel are important fisheries in the eastern United States and Canada; both species are targeted for human consumption and are important as bait in commercial and recreational fisheries (NMFS 2021c). Atlantic herring is primarily landed by the U.S. fleet (˜78% of total Atlantic herring harvest), and U.S. commercial fishery landings in 2020 were valued at $6.8 million (NMFS 2021c). The U.S. commercial mackerel fishery landed $5 million worth of mackerel in 2020, but landings and revenues from this fishery have declined considerably since 2004 (MAFMC 2020b). Unsurprisingly, these two forage species are also vital to the Canadian fishing industry. Since 2013, the total annual landed value of Atlantic mackerel in Canada has averaged CAD 7.4 million; the species also has essential social and cultural significance to First Nations communities in Eastern Canada. From 2016 to 2020, Canada exported an average of 827 mt of mackerel per year, with an annual value of CAD 2.16 million (DFO 2021d); the United States is considered a key export market (DFO 2020). Over the same period, Canada imported an average of 7,872 mt of mackerel each year, with an annual value of CAD 21.11 million (DFO 2021d).

Import and export data for Atlantic mackerel and Atlantic herring are combined with those for other species; thus, the import and export totals of these species are unknown. In 2019, the U.S. exported 16,854 mt of herring product with a combined value of $17.67 million—the majority of which was fresh/frozen product—and 3,958 mt of mackerel product (excluding Atka and horse mackerel) valued at $5.07 million, nearly all of which was exported as fresh/frozen (NMFS 2021c). In 2020, the U.S. imported 28,689 mt ($78.81 million) of mackerel product and 18,340 mt ($60.62 million) of herring product (Figure 6).

Canada provided the majority of herring product (52% by volume, 55% by value) imported to the United States, followed by Germany (9% by volume, 15% by value), Mexico (8% by volume, 5% by value), and Norway (5% by volume, 2% by value) (Figure 7). Norway exported the most mackerel product (24% by volume, 19% by value) to the United States in 2020, followed by China (17% by volume, 12% by value), Thailand (17% by volume, 22% by value), and Vietnam (10% by volume, 11% by value) (Figure 7).

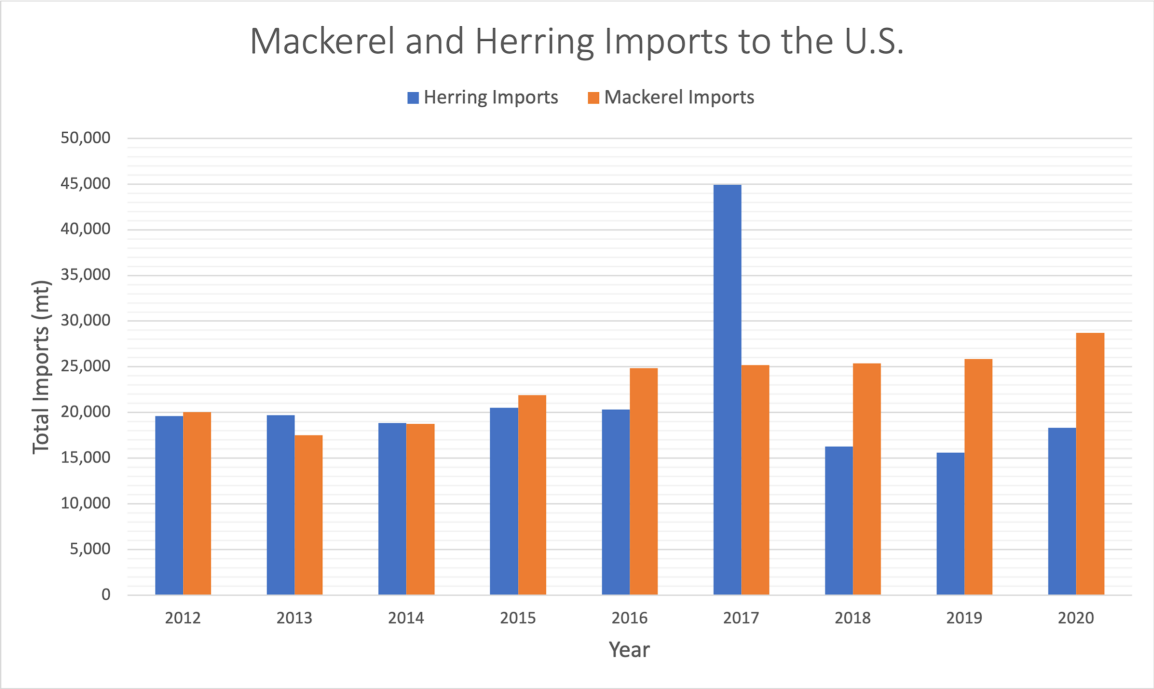
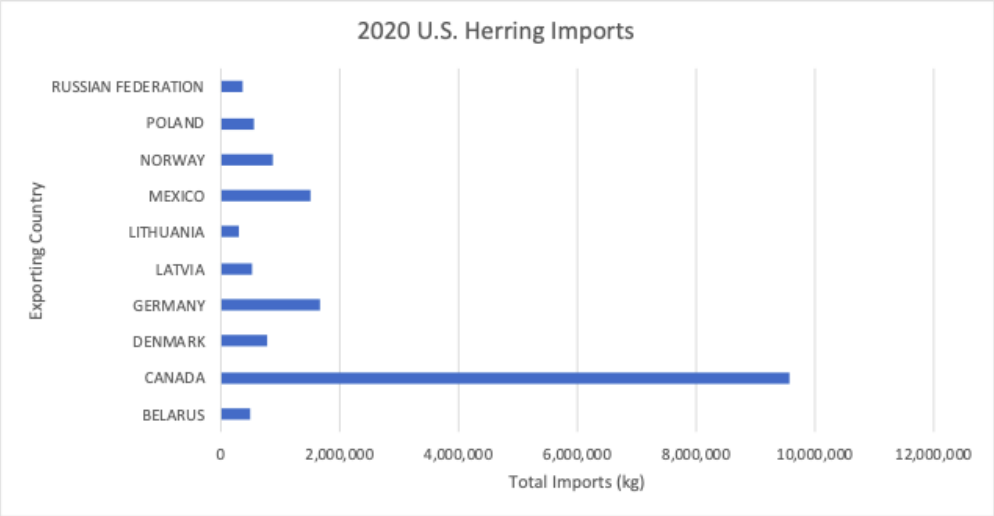


Figure 6: Imports of unspecified mackerel and herring species into the U.S., 2012–20 (NMFS 2021c).



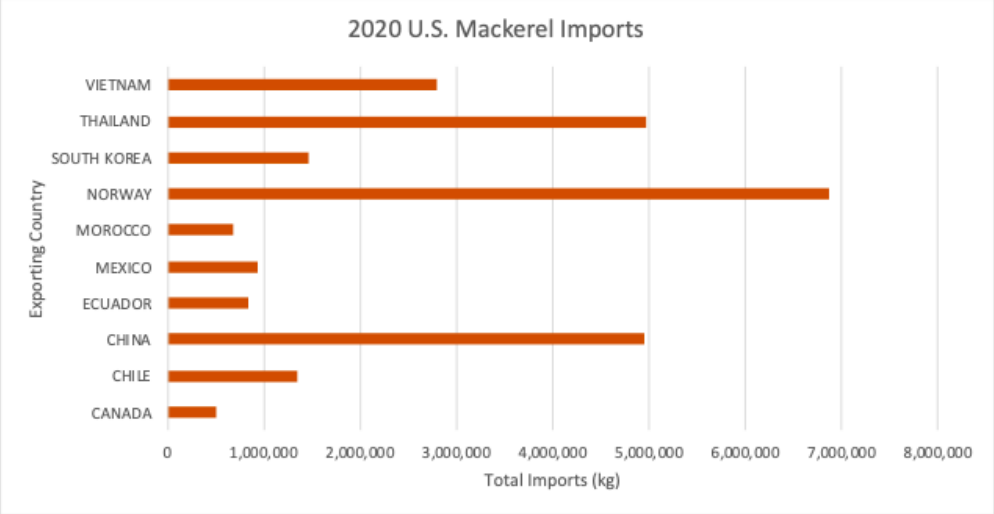


Figure 7: Imports of herring and mackerel into the U.S. in 2020 by exporting country (NMFS 2021c).

Common and market names.

Atlantic mackerel is also referred to as mackerel, Boston mackerel, common mackerel, tinker, and saba (in sushi). Common names for Atlantic herring include herring, sea herring, kipper, sild, common herring, Labrador herring, sardine, and sperling.

Primary product forms

Atlantic mackerel is sold fresh, frozen, smoked, or salted whole; as fillets, headed and gutted; as steaks; and canned. Fresh fish are primarily consumed in Canada and the United States, while frozen mackerel is sold worldwide (NEFSC 2018d). Mackerel is used as bait in the lobster fishery and fisheries for highly migratory species. Also, low-quality mackerel is used as food for captive animals in zoos and aquariums. Atlantic herring can be purchased fresh, frozen, pickled, smoked, preserved in oil, or salted. Herring is a critical bait source for the lobster and tuna fishing industries, and also used in blue crab, snow crab, and striped bass fisheries (ASMFC 2018).

Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Standard for Fisheries, available at www.seafoodwatch.org. The specific standard used is referenced on the title page of all Seafood Watch assessments.

Criterion 1: Impacts on the species under assessment

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. When abundance is unknown, abundance is scored based on the species' inherent vulnerability, which is calculated using a Productivity-Susceptibility Analysis. The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Factor 1.3 (Fishing Mortality) is Critical.

Guiding principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level*

Criterion 1 Summary

ATLANTIC HERRING			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Northwest Atlantic | United States | Midwater trawls | Atlantic herring fishery	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Northwest Atlantic | United States | Purse seines | Atlantic herring fishery	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic herring fishery	1.000: High Concern	5.000: Low Concern	Yellow (2.236)

ATLANTIC MACKEREL			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Northwest Atlantic | Canada | Purse seines	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Northwest Atlantic | United States | Midwater trawls | Atlantic mackerel fishery	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery	1.000: High Concern	3.000: Moderate Concern	Red (1.732)

This report covers the directed Atlantic mackerel fisheries in the U.S. and Canada, and the U.S. directed Atlantic herring fishery. The Northwest Atlantic mackerel population is divided into two spawning stocks, though mixing between the two occurs in both U.S. and Canadian waters (Arai et al. 2021). The MAFMC assesses the entire population and DFO assesses just the northern stock (Arai et al. 2021). Similarly, Atlantic herring consists of multiple stocks that overlap during part of the year. The Gulf of Maine/Georges Bank (GoM/GB) complex contains herring from three distinct spawning components: Gulf of Maine, southwest Nova Scotia–Bay of Fundy, and Georges Bank (NEFMC 2019b), and the U.S. manages these components as a single GoM/GB complex because there is currently no ability to distinguish survey and fishery catches to stock of origin (NEFSC 2018c). To account for multiple stock components within the Atlantic herring stock complex, NEFMC sets a total annual catch limit that is divided and assigned as sub-ACLs in four management areas (NEFMC 2019b). The U.S. uses an overfishing threshold of $F_{40\%}$ and an overfished threshold of ½ SSB_{MSY} proxy, which is calculated from 100-year projections at $F_{40\%}$ (NEFSC 2018)(NOAA 2022b). Canada uses an overfishing threshold of $F_{40\%}$ and an overfished threshold (i.e., limit reference point, or LRP) of 40% $SSB_{F40\%}$ (DFO 2021a).

Key forage species

Atlantic herring meet the criteria for a key forage species in the Gulf of Maine and Atlantic mackerel meet the criteria in the Northwest Atlantic waters off of Canada (see Appendix 3 for more information). These two stocks are scored against the Seafood Watch forage species criteria, for which scoring of abundance and fishing mortality is more conservative than for species that do not meet the criteria. Specifically, Atlantic herring is managed with a harvest control rule that accounts for the year-to-year variation in biomass estimates such that the allowable biological catch (ABC) can be modified annually based on variation in projected biomass, fishing mortality is capped at 80% of F_{MSY} and fishing levels are further restricted when biomass is low.

Due to the seasonal migration of theses stocks, the application of the Seafood Watch forage species guidance is nuanced. For example, Atlantic herring is considered a key forage species in the Gulf of Maine, but not the Canadian Atlantic. So, while the Scotian Shelf stock is not considered a key forage species during a portion of the year (i.e. when it inhabits Canadian waters), the stock does fill a key forage role during other parts of the year (i.e. when it inhabits the Gulf of Maine). Therefore, Seafood Watch considers both stocks of Atlantic herring as key forage stocks. Similarly, although Atlantic mackerel is not considered a key forage species in the Gulf of Maine, the U.S. fishery catches mackerel from the northern spawning contingent when the two stocks intermix in winter (Arai et al. 2021). Since mackerel is a key forage species

in the Canadian Northwest Atlantic (Table A1), the northern spawning stock is also scored against the Seafood Watch forage species criteria. In summary, any stock that fulfills a key forage species role in any portion of its range is scored against the forage species criteria, regardless of where the stock is caught.

Species	Fishery	Criterion	Affected Stock(s)
Atlantic mackerel	U.S. Atlantic Mackerel Fishery	C1: Target species	Northern and southern contingents
	Canada Atlantic Mackerel Fishery	C1: Target species	Northern contingent
	U.S. Atlantic Herring Fishery	C2: Bycatch species	Northern and southern contingents
Atlantic herring	U.S. Atlantic Herring Fishery	C1: Target species	Gulf of Maine/Georges Bank (GoM/GB) complex and Scotian Shelf complex
	U.S. Atlantic Mackerel Fishery	C2: Bycatch species	Gulf of Maine/Georges Bank (GoM/GB) complex and Scotian Shelf complex

Criterion 1 Assessments

SCORING GUIDELINES

Factor 1.1 - Abundance
Goal: Stock abundance and size structure of native species is maintained at a level that does not impair recruitment or productivity.

- *5 (Very Low Concern) — Strong evidence exists that the population is above an appropriate target abundance level (given the species' ecological role), or near virgin biomass.*
- *3.67 (Low Concern) — Population may be below target abundance level, but is at least 75% of the target level, OR data-limited assessments suggest population is healthy and species is not highly vulnerable.*
- *2.33 (Moderate Concern) — Population is not overfished but may be below 75% of the target abundance level, OR abundance is unknown and the species is not highly vulnerable.*
- *1 (High Concern) — Population is considered overfished/depleted, a species of concern, threatened or endangered, OR abundance is unknown and species is highly vulnerable.*

Factor 1.2 - Fishing Mortality
Goal: Fishing mortality is appropriate for current state of the stock.

- *5 (Low Concern) — Probable (>50%) that fishing mortality from all sources is at or below a sustainable level, given the species ecological role, OR fishery does not target species and fishing mortality is low enough to not adversely affect its population.*
- *3 (Moderate Concern) — Fishing mortality is fluctuating around sustainable levels, OR fishing mortality relative to a sustainable level is uncertain.*
- *1 (High Concern) — Probable that fishing mortality from all source is above a sustainable level.*

Atlantic herring

Factor 1.1 - Abundance

Northwest Atlantic | United States | Midwater trawls | Atlantic herring fishery
Northwest Atlantic | United States | Purse seines | Atlantic herring fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic herring fishery

High Concern

The most recent stock assessment update report for the U.S. Atlantic herring fishery was published in 2022; the update is a management track assessment to the existing benchmark assessment that used an age-structured model.

Atlantic herring is managed with a target reference point (TRP) of spawning stock biomass at maximum sustainable yield (SSB_{MSY}), which is based on a proxy overfishing threshold of $F_{40\%}$ (NEFSC 2018b). According to the 2022 update, SSB has continued to decline and is now below the updated SSB_{MSY} proxy through 2020, with a slight increase in 2021 (NOAA 2022b) (Figure 8). The stock is 30% of the TRP (56.566/185,750 = 0.29) and 61% of the LRP (½ SSB_{MSY} = 92,875) (NOAA 2022b). Because Atlantic herring is below limit levels, a high concern score is awarded.

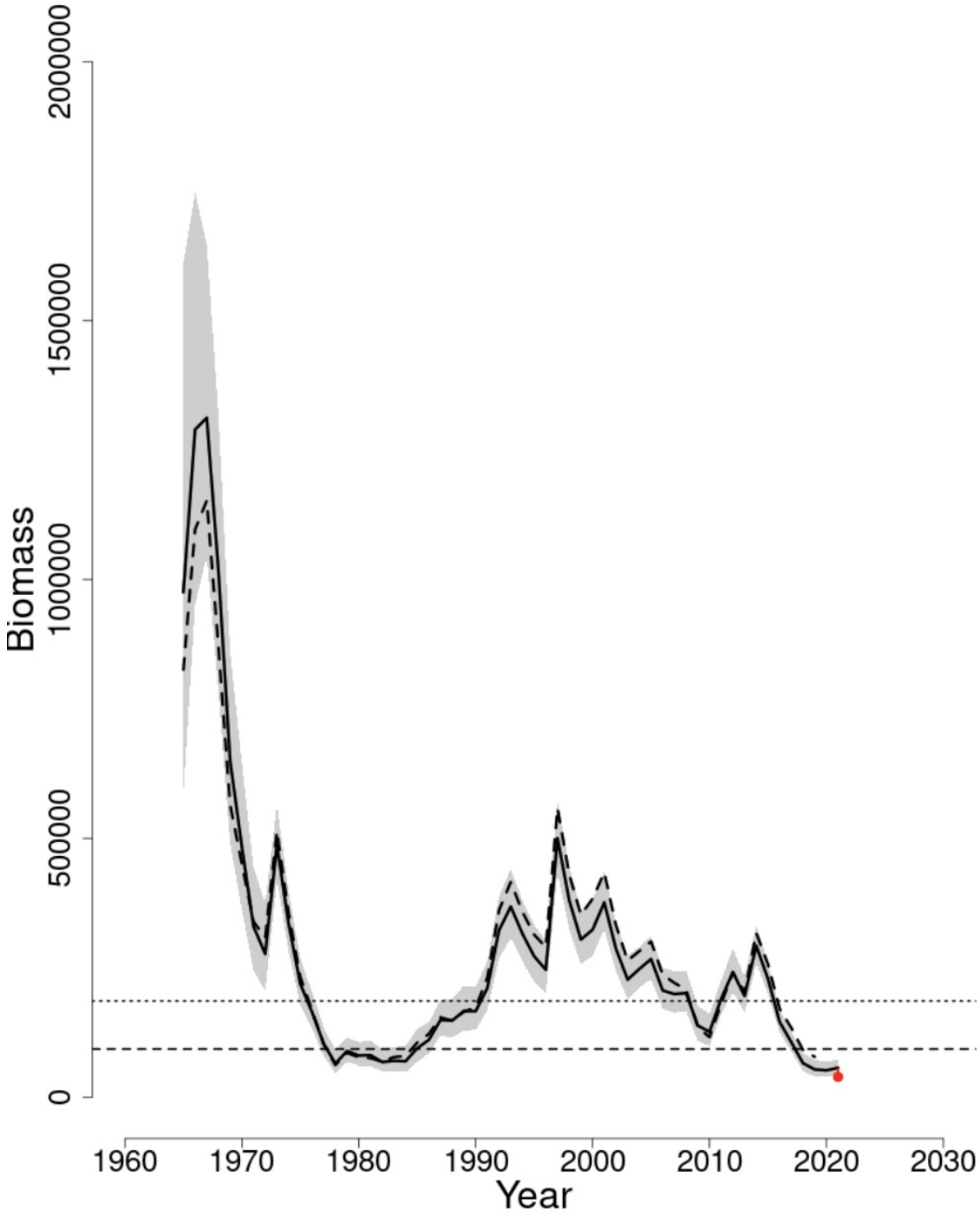


Figure 8: Trends in spawning stock biomass of Atlantic herring between 1965 and 2021 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ (0.5 SSB_{MSY} proxy; horizontal dashed line) as well as SSB_{Target} (SSB_{MSY} proxy; horizontal dotted line) based on the 2022 assessment. The approximate 90% confidence intervals are shown (ASMFC 2022b).

Factor 1.2 - Fishing Mortality

Northwest Atlantic | United States | Midwater trawls | Atlantic herring fishery
Northwest Atlantic | United States | Purse seines | Atlantic herring fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic herring fishery

Low Concern

The 2022 Atlantic herring assessment update estimated average annual fishing mortality for ages 7–8 Atlantic herring ($F_{7–8}$) from 2019 to 2021 to be 0.22, which is estimated to be 44% of the overfishing threshold proxy ($F_{MSY\ proxy}$ = 0.5) (Figure 9), and the GoM/GB stock complex is not considered to be undergoing overfishing (NOAA 2022b)(ASMFC 2022b).

To score a low concern for forage fish fisheries, the Seafood Watch Standard for Fisheries requires that fishing mortality be set low enough to prevent collapse during periods of low productivity, and a robust Management Strategy Evaluation (MSE) can be used to determine if fishing mortality is set appropriately (see details in Justification). NEFMC sets catch limits well under the overfishing limit (OFL) and the acceptable biological catch (ABC) to account for variability around estimates of recruitment, management uncertainty, and Canadian catches. For 2021, the U.S. catch limit is 4,815 mt, or 21% and 51% of the OFL and ABC, respectively. It is probable that fishing mortality from all sources is below a sustainable level that is appropriate for this species. Therefore, this factor is scored a low concern.

Justification:

U.S. Stock Assessment

Using $F_{7–8}$, the 2018 assessment showed a range of F from 0.13 to 1.04 from 1965 to 2017. The 2022 assessment update estimates MSY using a proxy overfishing threshold of $F_{40\%}$ and $F_{MSY\ proxy}$ = 0.5. Fishing levels were above the MSY proxy in 2018 and below it from 2019 to 2021 (NOAA 2022b).

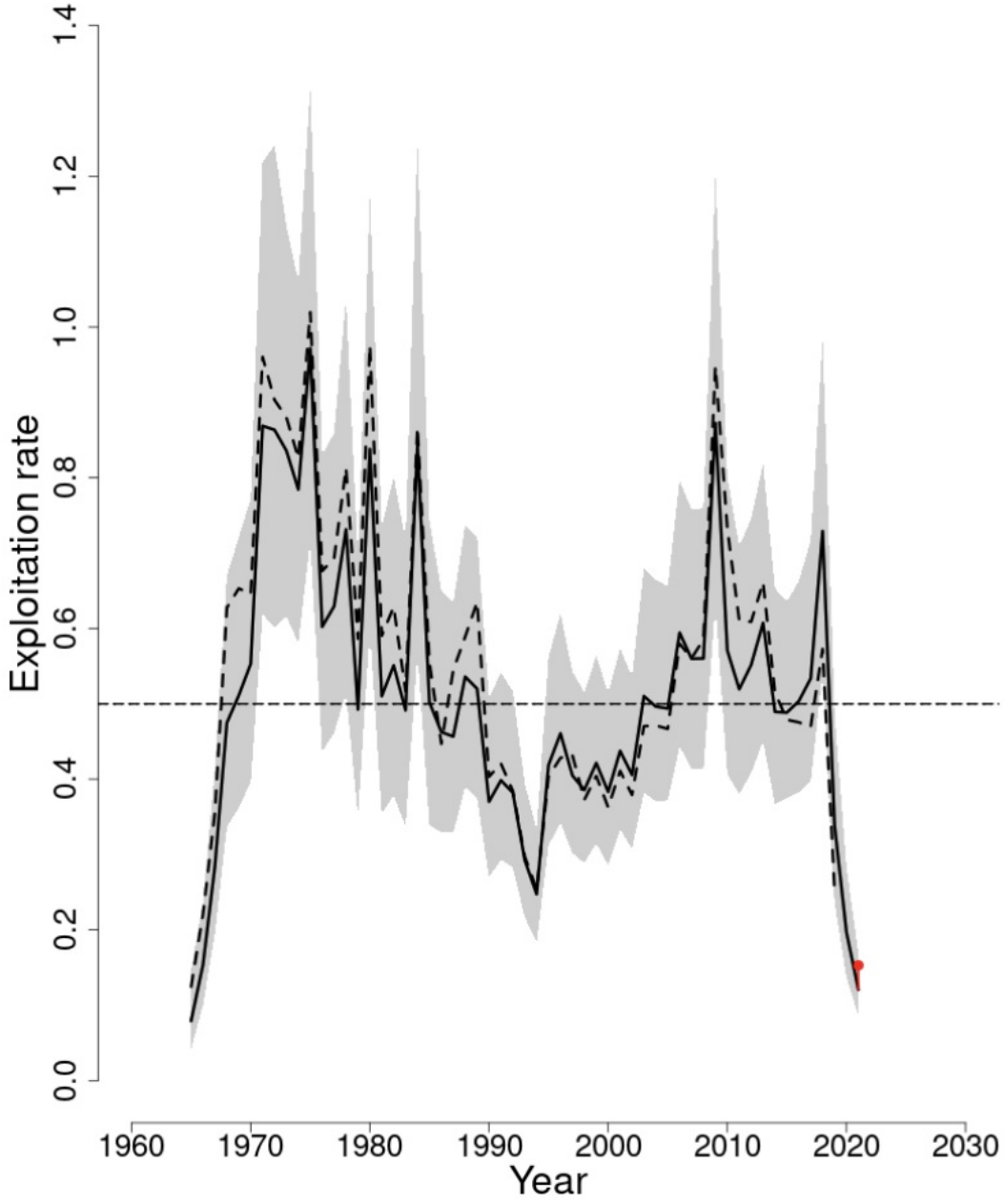


Figure 9: Trends in the average fishing mortality rate for ages 7–8, which are fully selected by the mobile fleet (F), between 1965 and 2021 from the current (solid line) and previous (dashed line) assessment and the corresponding F (F= 0.5; horizontal dashed line). The approximate 90% confidence intervals are shown (NOAA 2022b).

Management Strategy Evaluation

There is a process that accounts for the fluctuating nature of this forage species: although the ABC is set for a 3-year period, it can be adjusted each year based on variation in projected estimates of biomass. During the evaluation of proposed harvest control rules (HCR) under Amendment 8 to the

Atlantic Herring FMP, NEFMC ran eight operating models (OMs) to evaluate uncertainties in herring recruitment, natural mortality, growth, and assessment error/bias (NEFMC 2019b). According to Siple et al. (2018), it is important to evaluate HCR performance with these uncertainties, because inaccurate estimates of natural mortality and virgin biomass (B_0) can lead to long-term declines in mean biomass and catches. Ultimately, NEFMC selected Alternative 4b "because it explicitly accounts for the role of Atlantic herring as forage in the ecosystem by limiting fishing mortality at 80% of F_{MSY} and it has a low risk of overfishing based on the impacts analysis" (NEFMC 2019b). The specifics of Alternative 4b and the ensuing HCR are described in Factors 3.1 and 4.3 of this report. Under the selected HCR, the ratio of SSB/SSB_0 was stable across all operating models, ranging from 0.20 to 0.47; to prevent collapse, NEFMC set ABC to zero when $SSB/SSB_{MSY} = 0.10$ (NEFMC 2019b) and the HCR based on Alternative 4b was implemented in 2021 {Federal Registrar 2021}. Under all OMs, SSB/SSB_0 remained above 0.20, providing evidence that the HCR will help prevent collapse during periods of low productivity.

Scotian Shelf Stock

The GoM/GB complex consists of several spawning aggregations, but because stock origin cannot be determined in catches, the stock assessment combines data from all areas into a single assessment of the entire complex (NEFSC 2018b). According to a tagging study by the Maine Department of Marine Resources, there is an appreciable intermixing of GoM/GB complex with the Nova Scotian complex, and "[t]he results of [the] study call into question the long-standing assumption that the U.S. coastal complex does not intermix to any measurable extent with the NS stock" (MDMR 2006) (Kanwit and Libby 2009). The degree of mixing from the Nova Scotian stock is considered a source of uncertainty in the U.S. stock assessment, but catches from the Scotian Shelf were not considered in the GoM/GB stock assessment (NEFMC 2020). There is a Canadian total allowable catch (TAC) of 12,000 mt for the Scotian Shelf complex, but there is no basis for evaluating the TAC because there is no recent information on stock status (DFO 2018b).

Atlantic mackerel

Factor 1.1 - Abundance

Northwest Atlantic | Canada | Purse seines
Northwest Atlantic | United States | Midwater trawls | Atlantic mackerel fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery

High Concern

Recent U.S. and Canadian assessments of Atlantic mackerel state that biomass is near historic lows (DFO 2023)(NOAA 2021b). The 2021 U.S. management track assessment report (and 2023 draft management track assessment report) confirms that Atlantic mackerel continues to be overfished (Figure 10) (NOAA 2021b)(NOAA 2023a), and the 2023 Canadian stock assessment shows the stock to be in the Critical Zone (Figure 11) (DFO 2023). Because the Atlantic mackerel stock is currently overfished, abundance is deemed a high concern.

Justification:
Stock assessments of northwest Atlantic mackerel assume one population with two spawning contingents. The northern contingent primarily spawns in the southern Gulf of St. Lawrence and the southern contingent spawns in the Mid-Atlantic Bight, southern New England, and the western Gulf of Maine. The spawning contingents mix during winter (NEFSC 2018). The most recent peer-reviewed and accepted analytical assessment for U.S. Atlantic mackerel was conducted by the NEFSC in 2023 (NOAA 2023a); DFO published its updated stock assessment in 2023 (DFO 2023). The U.S. stock assessment addresses the concerns that came out of the first joint United States/Canadian stock report in 2010 by the Transboundary Resource Assessment Committee (TRAC), which were centered around uncertainty in abundance trends (TRAC 2010). In August 2018, the MAFMC approved a rebuilding plan that includes slight increases in commercial quotas over 5 years (MAFMC 2018); the final rebuilding plan was approved by NOAA in October 2019 (84 FR 58053). Because rebuilding objectives were not expected to be met by 2023, NOAA approved a revised rebuilding plan in February 2023 (88 FR 6665). The MAFMC requested an emergency closure of directed fishing in late 2023 based on the 2023 assessment, and even lower quotas are expected for 2024–25, given the lack of rebuilding observed through 2022 (MAFMC 2023b).

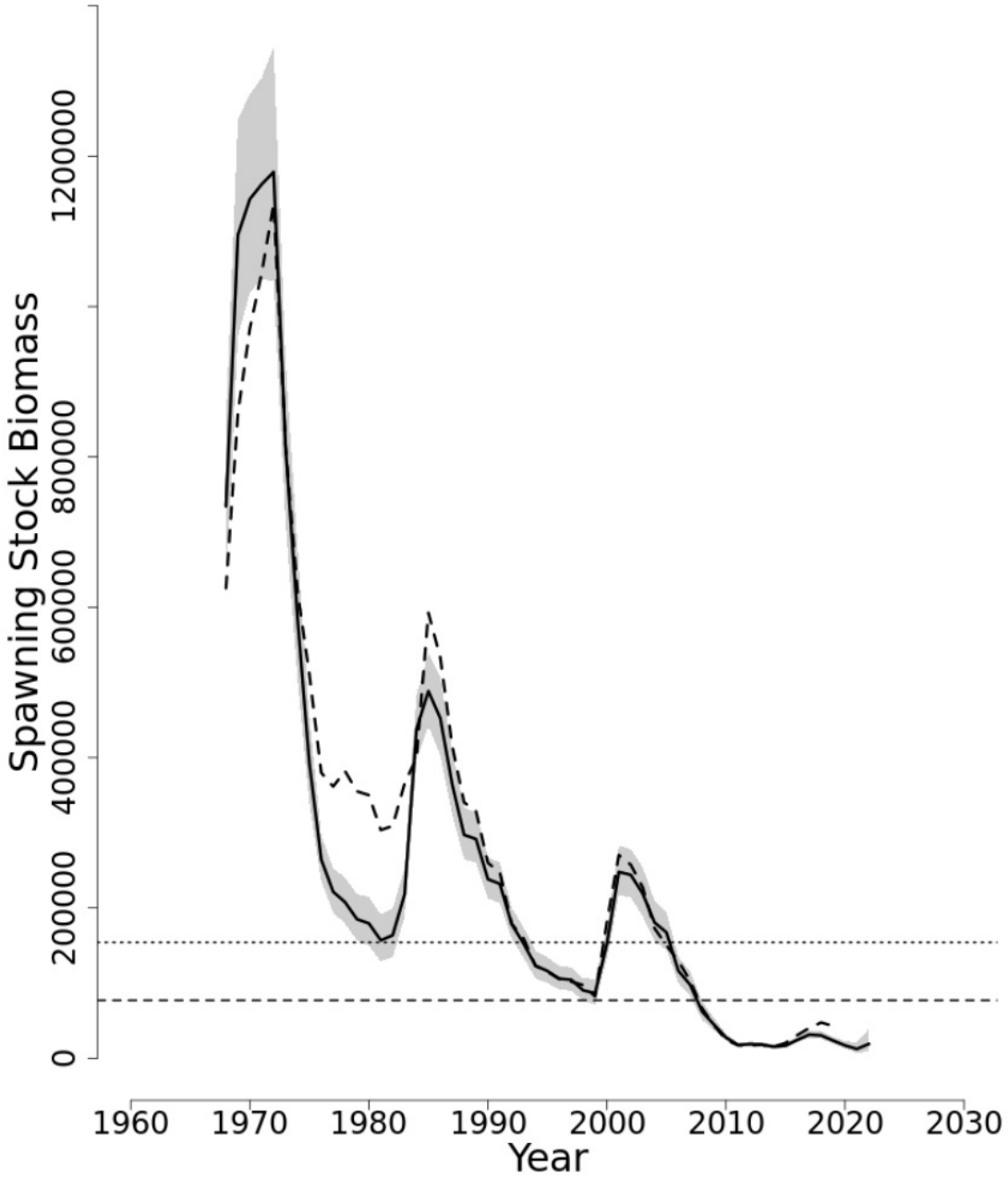


Figure 10: Trends in spawning stock biomass (mt) of northwest Atlantic mackerel between 1968 and 2022 from the current (solid line) and previous (dashed line) assessment and the corresponding $SSB_{Threshold}$ (0.5 $SSB_{MSY\ proxy}$; horizontal dashed line) as well as SSB_{Target} ($SSB_{MSY\ proxy}$; horizontal dotted line) based on the 2023 assessment. The approximate 90% lognormal confidence intervals are shown (NOAA 2023a).

The previous DFO stock assessment states that SSB has been in decline since the mid-2000s, reached historic lows in 2015 and 2016, and remained very low through 2018 (DFO 2019a). Abundance reached a historical low in 2015 and 2016 (59% of the 103,000 t limit reference point

[LRP]), but increased in 2017 and 2018 (73% and 77% of LRP, respectively) as a result of the average-sized 2015 year-class recruiting in 2016 (DFO 2019a). But the 2022 stock assessment states that SSB declined further through 2021 and 2022 (Figure 11), and reached its lowest value ever estimated (40% of the LRP) (DFO 2023).

Since 2000, the age structure of the Atlantic mackerel fishery has contracted, fish older than 7 years have disappeared (DFO 2017a), and "rebuilding the stock will require rebuilding the age structure of the stock which has been eroded by overexploitation" (DFO 2021a). Recruitment has also declined: in the last decade of the historical series (2009 to 2018), there were only two years of near-average age-1 recruitment (2009 and 2016); age-1 recruitment in 2017 and 2018 were at all-time lows (DFO 2019a), and there were no signs of notable recruitment events in recent years.

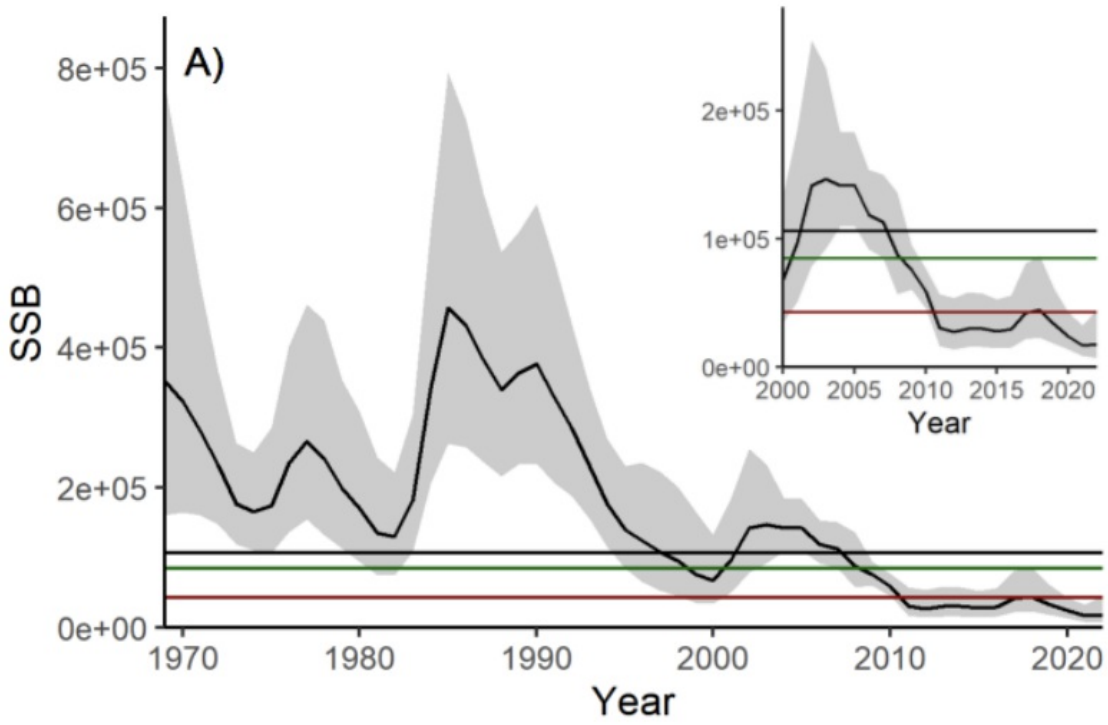


Figure 11: Model output: (A) Spawning stock biomass (kg) in June with a zoom for 2000–22 and horizontal lines indicating the target reference point ($SSB_{F40\%}$; black), the upper stock reference point (80% $SSB_{F40\%}$; green) and the limit reference point (40% $SSB_{F40\%}$; red) (DFO 2023).

Factor 1.2 - Fishing Mortality

Northwest Atlantic | Canada | Purse seines

Moderate Concern

The most recent peer-reviewed DFO and NEFSC stock assessments recommend $F_{40\%}$ as a proxy for F_{MSY} (DFO 2021a)(NEFSC 2018). The northern contingent of Atlantic mackerel was reassessed by DFO in 2022, a year in which the commercial fishery was closed. The updated stock assessment found that the fully selected exploitation rate (fish aged 5–10+) in 2022 was 0.42 (95% CI: 0.15–

1.20), which is below the target ($F_{40\%}$ = 0.68) (DFO 2023). The U.S. fishery catch is presumed to be 20–80% northern contingent mackerel, bycatch in Canadian fisheries was estimated at 55 t in 2022, and there remains considerable uncertainty in total removals (DFO 2023). Because the stock is not undergoing overfishing, but there is considerable uncertainty, this factor is scored a moderate concern.

Justification:
According to DFO's 2021 assessment, the mean fishing mortality of fully exploited mackerel has been above the F_{MSY} proxy since 1998, and the exploitation rate remained above this reference level despite a decrease in total catch (Figure 12). Fishing mortality only dropped below target levels in 2022 because the Canadian commercial fishery was closed (DFO 2023). The exploitation rate on fish aged 5–10+ (0.75) in 2020 was above the exploitation rate at $F_{40\%}$ (0.51). In 2020, $F_{5–10}$ was 1.3 and F over all ages was 0.97, the latter of which "… is considered relatively high given that most fish in the population were 1 to 5 years old and some were not fully selected by the fishery yet" (DFO 2021a).

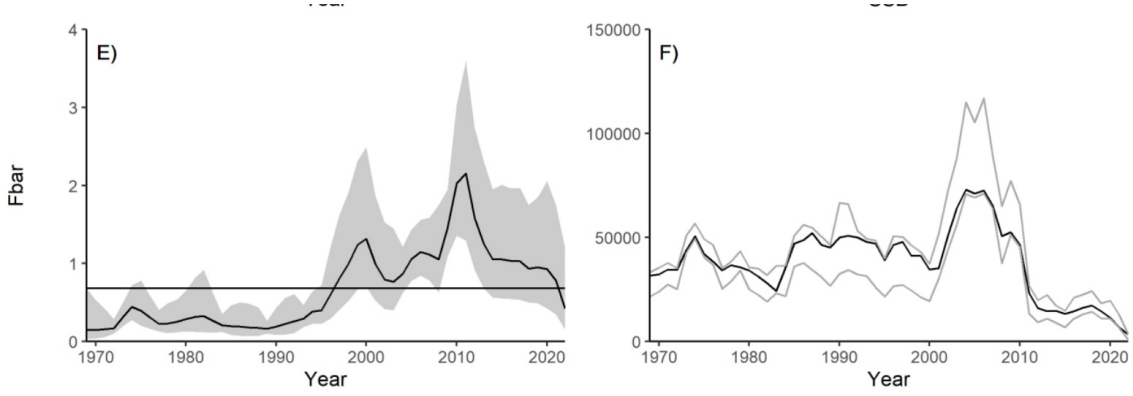


Figure 12: Fishing mortality F (averaged over the fully selected age classes 5–10) with indication of F (F = 0.68) (left) estimated catch (black) between the predetermined bounds (right) (DFO 2023).

Northwest Atlantic | United States | Midwater trawls | Atlantic mackerel fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery

Moderate Concern
The most recent peer-reviewed DFO and NEFSC stock assessments recommend $F_{40\%}$ as proxy for F_{MSY} (DFO 2023)(NOAA 2021b). Both assessments indicate that fishing mortality has exceeded sustainable levels for many years (Figures 12 and 13). The 2023 Canadian stock assessment notes that F dropped below below the reference level in 2022 due to the closure of the Canadian commercial fishery (DFO 2023). NOAA–NMFS considers the Atlantic mackerel stock overfished and currently undergoing overfishing (NMFS 2023). The NOAA 2021 management track assessment report—which is used for the official status determination—concluded that the stock continued to undergo overfishing (F_{2019} = 208% of $F_{MSY\ proxy}$) (NOAA 2021b). The 2023 management track assessment report notes that F_{2022} was 86% of the $F_{MSY\ proxy}$, likely because of the closure of the Canadian commercial fishery, and overfishing was not occurring for the first time in 35 years (NOAA

2023a). Like any terminal-year estimate, there is extra uncertainty in the status of 2022 Atlantic mackerel fishing mortality, especially given the long history of overfishing and the potential for retrospective upward adjustments to fishing morality. Therefore, fishing mortality is deemed a moderate concern.

Justification:
The 2017 NEFSC stock assessment estimated fishing morality (F) from 1968 to 2016. In the early portion of this time series, F peaked in 1976 just below 0.80, declined to around 0.10 in 1978, then remained near or below 0.40 until 1996. From 1996 to 2016, F remained over $F_{40\%}$ in all but three years (2001 to 2003), drastically increasing to approximately five times $F_{40\%}$ in 2010 before declining to 0.47 in 2016 (NEFSC 2018). The 2021 management track assessment report estimated that F in 2019 was 0.46, which is more than double the $F_{MSY\ proxy}$ of 0.22, while the 2023 *draft* report estimated F_{2022} to be 0.18, which was below the $F_{MSY\ proxy}$ of 0.21.

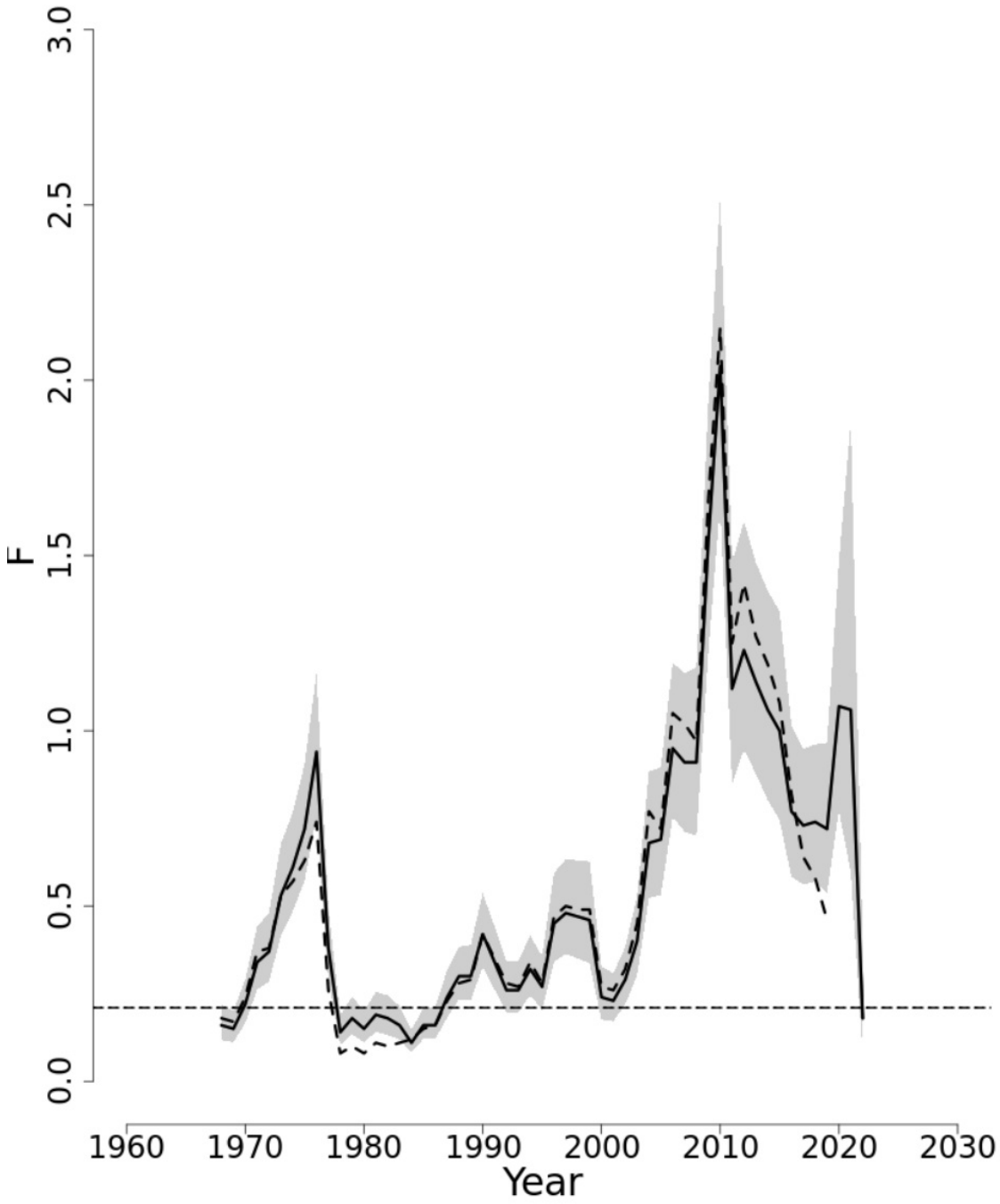


Figure 13: Trends in the fully selected fishing mortality (F) of northwest Atlantic mackerel between 1968 and 2022 from the current (solid line) and previous (dashed line) assessment and the corresponding $F_{Threshold}$ ($F_{MSY\ proxy}$ = 0.21; horizontal dashed line). The approximate 90% lognormal confidence intervals are shown (NOAA 2023a).

According to DFO's 2021 assessment, the mean fishing mortality of fully exploited mackerel has

been above the F_{MSY} proxy since 1998, and the exploitation rate remained above this reference level despite a decrease in total catch (Figure 13). The exploitation rate on fish aged 5–10+ (74%) in 2020 was above the exploitation rate at $F_{40\%}$ (51%). In 2020, $F_{5–10}$ was 1.3 and F over all ages was 0.97, the latter of which "… is considered relatively high given that most fish in the population were 1 to 5 years old and some were not fully selected by the fishery yet" (DFO 2021a). In 2022, the exploitation rate was 0.42, which was below the reference level (Figure 14), but this result is highly uncertain due to uncertainty in total removals (DFO 2023).

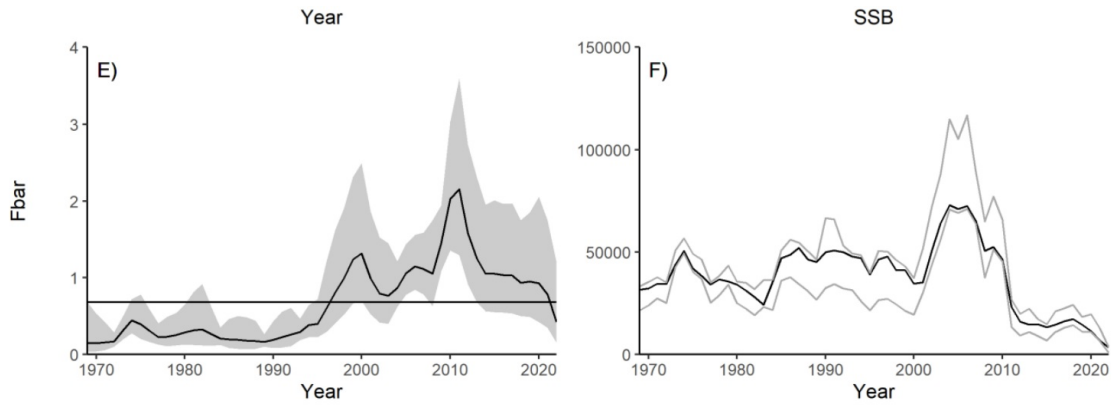


Figure 14: Model output from the 2023 Atlantic mackerel stock assessment: (E) Fishing mortality $F_{5–10}$ (averaged over the fully selected age classes 5–10); (F) estimated catch (black) between the predetermined bounds (grey) (DFO 2023).

Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated under Criterion 2. Seafood Watch defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing. Species are evaluated using the same guidelines as in Criterion 1. When information on other species caught in the fishery is unavailable, the fishery's potential impacts on other species is scored according to the Unknown Bycatch Matrices, which are based on a synthesis of peer-reviewed literature and expert opinion on the bycatch impacts of each gear type. The fishery is also scored for the amount of non-retained catch (discards) and bait use relative to the retained catch. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard/bait score. The Criterion 2 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Factor 2.3 (Fishing Mortality) is Crtitical

Guiding principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level.*
- *Minimize bycatch.*

Criterion 2 Summary

Criterion 2 score(s) overview

This table(s) provides an overview of the Criterion 2 subscore, discards+bait modifier, and final Criterion 2 score for each fishery. A separate table is provided for each species/stock that we want an overall rating for.

ATLANTIC HERRING			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Northwest Atlantic | United States | Midwater trawls | Atlantic herring fishery	1.732	1.000: < 100%	Red (1.732)
Northwest Atlantic | United States | Purse seines | Atlantic herring fishery	5.000	1.000: < 100%	Green (5.000)
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic herring fishery	1.732	1.000: < 100%	Red (1.732)

ATLANTIC MACKEREL			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Northwest Atlantic | Canada | Purse seines	5.000	1.000: < 100%	Green (5.000)
Northwest Atlantic | United States | Midwater trawls | Atlantic mackerel fishery	2.236	1.000: < 100%	Yellow (2.236)
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery	2.236	1.000: < 100%	Yellow (2.236)

Criterion 2 main assessed species/stocks table(s)

This table(s) provides a list of all species/stocks included in this assessment for each 'fishery' (as defined by a region/method combination). The text following this table(s) provides an explanation of the reasons the listed species were selected for inclusion in the assessment.

NORTHWEST ATLANTIC | CANADA | PURSE SEINES			
SUB SCORE: 5.000	DISCARD RATE: 1.000	**SCORE: 5.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Atlantic mackerel	1.000: High Concern	3.000: Moderate Concern	Red (1.732)

NORTHWEST ATLANTIC | UNITED STATES | MIDWATER TRAWLS | ATLANTIC HERRING FISHERY			
SUB SCORE: 1.732	DISCARD RATE: 1.000	**SCORE: 1.732**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Atlantic mackerel	1.000:	3.000:	Red (1.732)
American shad	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Atlantic herring	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
River herring	1.000: High Concern	5.000: Low Concern	Yellow (2.236)

NORTHWEST ATLANTIC | UNITED STATES | MIDWATER TRAWLS | ATLANTIC MACKEREL FISHERY			
SUB SCORE: 2.236	DISCARD RATE: 1.000	**SCORE: 2.236**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Atlantic mackerel	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
American shad	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Atlantic herring	1.000:	5.000:	Yellow (2.236)
River herring	1.000: High Concern	5.000: Low Concern	Yellow (2.236)

NORTHWEST ATLANTIC | UNITED STATES | PURSE SEINES | ATLANTIC HERRING FISHERY			
SUB SCORE: 5.000	DISCARD RATE: 1.000	**SCORE: 5.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Atlantic herring	1.000: High Concern	5.000: Low Concern	Yellow (2.236)

NORTHWEST ATLANTIC | UNITED STATES | SMALL MESH BOTTOM TRAWLS | ATLANTIC HERRING FISHERY			
SUB SCORE: 1.732	DISCARD RATE: 1.000	**SCORE: 1.732**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Atlantic mackerel	1.000:	3.000:	Red (1.732)
American shad	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Atlantic herring	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
River herring	1.000: High Concern	5.000: Low Concern	Yellow (2.236)

NORTHWEST ATLANTIC | UNITED STATES | SMALL MESH BOTTOM TRAWLS | ATLANTIC MACKEREL FISHERY			
SUB SCORE: 2.236	DISCARD RATE: 1.000	**SCORE: 2.236**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Atlantic mackerel	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
American shad	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Atlantic herring	1.000:	5.000:	Yellow (2.236)
River herring	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Risso's dolphin	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
Short-beaked common dolphin	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)

Because of temporal and spatial overlap between the Atlantic mackerel and Atlantic herring fisheries, as well as the gear type being used in the fisheries, these species are often caught together (NEFMC 2023). NMFS observer program data from 2011 to 2013 show that the amount of Atlantic mackerel caught during observed trips is almost the same as Atlantic herring (Table 7 in (MAFMC 2015)). It is unclear which of the two species these trips were targeting (MAFMC 2015). Recent observer data from 2018 to 2022 show that this pattern has remained consistent (see Tables 1–6 in (NEFMC 2023c)). Regardless of whether the trip is directed at herring or mackerel, the catch of each is landed and counted against both respective fisheries' quotas (Harrington et al. 2005). The U.S. Atlantic herring purse seine fishery catches quite low numbers of Atlantic mackerel (see Tables 9–11 in (NEFMC 2019b) and Tables 7–9 in (NEFMC 2023c)), and there are no other "main" species included in the fishery.

In the Canadian Atlantic mackerel fishery, herring is the only species that may be retained as bycatch. The quantity of herring must not exceed 10% of the weight of mackerel that is caught and retained during a trip, except for licenses that permit landings of herring specific to gear and area caught (DFO 2007). But, only minor quantities of herring have been caught as bycatch in the mackerel fishery over the past two decades, and Atlantic herring landings in the mackerel fishery are usually <1% of all Atlantic herring landings (pers. comm., Elisabeth Van Beveren, DFO 2021). Therefore, there are no other "main" species included in the Canadian purse seine fishery.

River Herring and Shad Bycatch (U.S.)

There are multiple species of concern that are incidentally caught in the Atlantic mackerel trawl fishery (bottom and midwater), including American shad, blueback herring, and alewife (MAFMC 2019)(NEFMC 2022)(NEFMC 2023). Although the midwater trawl fishery is considered to have quite low bycatch (<5%), some of the species that are incidentally caught and discarded in this fishery are of conservation concern, and bycatch may be a substantial source of mortality for blueback herring and alewife (MAFMC 2015) (MAFMC 2019). River herring, which include blueback herring (*Alosa aestivalis*) and alewife (*Alosa pseudoharengus*), have been declared "Species of Special Concern" because of drastic declines in stocks, which are attributed to the blockage of spawning rivers, overfishing, and habitat degradation (ASMFC 2016)(ASMFC 2017). A previous voluntary river herring bycatch avoidance program and continuing bycatch caps appear to have resulted in reduced interactions in the midwater trawl fishery for mackerel and herring

(MAFMC 2019b). Though river herring makes up a small percentage of catch in the Atlantic mackerel fishery (0.8%), the impact of this on the species is unknown, and the magnitude of bycatch is somewhat uncertain, given the short time series of bycatch data, underreporting, and a lack of observer coverage (NMFS 2019b). Because estimates of total biomass, fishing mortality rates, and reference points have not been determined for river herring, it is possible that catch in the Atlantic mackerel fishery exceeds 5% of a sustainable level (ASMFC 2017). Therefore, blueback herring and alewife are included in this assessment together, as "river herring."

American shad (*Alosa sapidissima*) and hickory shad (*A. mediocris*) are also encountered by the U.S. fisheries under assessment. Both species are grouped together as "shad," but American shad is more often caught as bycatch (ASMFC 2021f). Though statuses and trends vary by river system, the coast-wide metapopulation of American shad is depleted (ASMFC 2020b), and a sustainable level of mortality has not been identified for most American shad stocks (ASMFC 2020b). Because American shad is a depleted species and a sustainable level of mortality is unknown for most stocks, American shad is included as a "main" species in this report.

Although the Atlantic herring fishery has gear- and area-specific estimates of river herring and shad bycatch, estimates of bycatch in other fisheries (e.g., mackerel) are grouped by gear, though some gears (e.g., gillnets and bottom trawls) are further stratified by mesh size (ASMFC 2021f). Catch estimates are based on specific fishing fleets defined by a combination of factors, but catch estimates cannot be attributed to a specific fishery because species are managed through multiple fishery management plans (ASMFC 2021f). The MAFMC considers shads a primary nontarget species of concern for the mackerel fishery (MAFMC 2018b). Therefore, we conservatively include American shad as a main species in all trawl fisheries.

There are catch caps in place for river herring and shad (RH/S) in both the Atlantic mackerel and Atlantic herring fisheries. The mackerel fishery was closed early in 2018 and 2019 because the catch of RH/S met the cap, but did not close in 2020 or 2021 under the modified cap. Caps are not biologically based, but aim to provide an incentive to avoid these species (ASMFC 2020b)(NEFMC 2023). The available information on bycatch of RH/S varies by state, and the estimates in Table 1 may not capture all bycatch removals occurring in state waters (ASMFC 2021d).

Table 1: Commercial harvest and bycatch of RH/S in Atlantic herring and mackerel fisheries from 2018 to 2021. Bycatch in the Atlantic herring fishery is from midwater and bottom trawls combined; bycatch in Atlantic mackerel fisheries is from all gears. The proportion of bycatch in the fisheries under assessment relative to the total commercial harvest of RH/S is shown in parentheses.

	2018	**2019**	**2020**	**2021**
Bycatch in Atlantic herring fishery[1]	234.5 mt (18%)	179.3 mt (11%)	41.6 mt (4%)	0.8 mt
Bycatch in Atlantic mackerel fishery[1]	109.2 mt (9%)	91.5 mt (6%)	23.1 mt (2%)	3.4 mt
Total commercial harvest[2]	1,282.9 mt	1,650.8 mt	1,154.7 mt	NA

[1] Reported in the RH/S bycatch monitoring reports (NOAA 2021).

[2] Reported in the Annual Review of the Interstate FMP for Shad and River Herring; total harvest is the sum of American shad, hickory shad, and river herring (ASMFC 2022c).

Marine Mammal Bycatch (U.S.)

Cetaceans and pinnipeds are found in the same waters where the U.S. Atlantic mackerel fishery operates and are at risk of entanglement in midwater and/or bottom trawling gear. Interactions with trawling gear have resulted in serious injury or mortality, though not necessarily attributed to the Atlantic mackerel fishery (MAFMC 2015). Atlantic mackerel is part of the following NOAA List of Fisheries (LOF): Northeast midwater trawl, Mid-Atlantic midwater trawl, and Mid-Atlantic bottom trawl.

A number of marine mammals have been observed caught in the trawl fisheries assessed in this report (Table 2); the fisheries are listed in the 2023 LOF as Category II, which is defined as "annual mortality and serious injury of a stock in a given fishery is greater than 1 percent and less than 50 percent of the PBR level (i.e., occasional incidental mortality and serious injury of marine mammals)" (LOF 2023). According to the 2023 LOF, the potential biological removal (PBR) has not been exceeded for any of these populations, but mortality and serious injuries caused by the Mid-Atlantic bottom trawl fishery account for "greater than 1 percent and less than 50 percent of the stock's PBR" for three Western North Atlantic stocks, including offshore bottlenose dolphin, common dolphin, and Risso's dolphin; for the Northeast bottom-trawl fishery, the stocks include offshore bottlenose dolphin, common dolphin, gray seal, long-finned pilot whale, Risso's dolphin, and white-sided dolphin.

Only common dolphin and Risso's dolphin (shaded gray in Table 2) are include as "main" species in this report because mortality from the Mid-Atlantic bottom trawl fishery is greater than 5% of a sustainable level (i.e., PBR). No other fisheries in this report account for more than 5% of a sustainable level of PBR.

Table 2: Marine mammal incidental catch in the Mid-Atlantic bottom trawl and midwater trawl fisheries (calculated from marine mammal stock assessments) (Hayes et al. 2022).

Fishery	Species/Population	Potential biological removal (U.S. populations)	Est. total fishing mortalities	Est. catch in fishery
Mid-Atlantic bottom trawl	Bottlenose dolphin, WNA offshore	519	28	7.2
	Common dolphin, WNA	1,452	390	281
	Gray seal, WNA	1,458	*1,169	26
	*Harbor seal, WNA	1,729	334	4.1
	Risso's dolphin, WNA	301	34	24
Northeast bottom trawl	Bottlenose dolphin, WNA offshore	519	28	11.5
	Common dolphin, WNA	1,452	390	15
	Gray seal, WNA	1,458	*1,169	20
	Harbor porpoise, GME/BF	851	163	2.2
	*Harbor seal, WNA	1,729	334	2.7
	Harp seal, WNA	426,000	86	1.1
	Long-finned pilot whale, WNA	306	9	6.9
	Risso's dolphin, WNA	301	34	3.4
	White-sided dolphin, WNA	544	27	27
Northeast midwater trawl (including pair trawl)	Common dolphin, WNA	1,452	390	0
	Gray seal, WNA	1,458	*1,169	0.2

	*Harbor seal, WNA	1,729	334	0.6
	Long-finned pilot whale, WNA	306	9	0.6
Mid-Atlantic midwater trawl (including pair trawl)	Bottlenose dolphin, WNA offshore	519	28	0
	*Harbor seal, WNA	1,729	334	0
Gulf of Maine purse seine	*Harbor seal, WNA	1,729	334	0
	**Gray seal, WNA	1,458	*1,169	0

* Another 2,350 gray seals were killed annually in Canada as "nuisance animals" between 2015 and 2019.
** The Gulf of Maine Atlantic Herring Purse Seine Fishery is a Category III fishery; a total of eight gray seals were captured and released alive from 2014 to 2018. Zero harbor seals were captured over the same period.

Canadian Mackerel Fishery Bycatch

DFO has limited data on fishery interactions with marine mammals. Over the period from 2008 to 2014, DFO relates that 800 incidents of marine mammal strandings and human interactions were reported, including "a third of all incidents attributable to fishing operations or collisions with vessels. In 65% of all incidents, the animal was reported dead, and in 80% of those incidents involving mortalities, the cause of death was unknown" (Themelis et al. 2016). The DFO further breaks down interactions by fishery types (pot/trap, fixed/trap, nets, and unknown). Atlantic mackerel and herring are included in the "fixed/trap" gear type, but this designation likely reflects the trap net/weir fishery, which is not assessed in this report. From 2008 to 2014, "nets" (seine and gillnet) accounted for the following percentage of total interactions with fishing gear: humpback whale (13%), minke whale (19%), sperm whale (33%), northern bottlenose whale (100%), unspecified whale (12%), and harbor porpoise (3%) (Themelis et al. 2016). The estimates from the 2015 report are based on opportunistic sightings and reported interactions, and may not include all incidents (Themelis et al. 2016). Marine mammals in the Northwest Atlantic unassociated purse seine fisheries score 3.5 in the Seafood Watch unknown bycatch matrix (UBM), so they are not assessed in the Canadian mackerel purse seine fishery.

Criterion 2 Assessment

SCORING GUIDELINES

Factor 2.1 - Abundance
(same as Factor 1.1 above)

Factor 2.2 - Fishing Mortality
(same as Factor 1.2 above)

Factor 2.3 - Modifying Factor: Discards and Bait Use
Goal: Fishery optimizes the utilization of marine and freshwater resources by minimizing post-harvest loss. For fisheries that use bait, bait is used efficiently.

Scoring Guidelines: The discard rate is the sum of all dead discards (i.e. non-retained catch) plus bait use divided by the total retained catch.

Ratio of bait + discards/landings	Factor 2.3 score
<100%	1
>=100	0.75

American shad

Factor 2.1 - Abundance

Northwest Atlantic | United States | Midwater trawls | Atlantic herring fishery
Northwest Atlantic | United States | Midwater trawls | Atlantic mackerel fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery
Atlantic stock | Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic herring fishery

High Concern

The coast-wide stock assessment conducted by the ASMFC in 2020 found that American shad stocks are depleted (ASMFC 2020). There are differing regional trends in the abundance of system-specific stocks, but the coast-wide metapopulation is depleted based on the decline of landings since the 1950s; 21 stocks have unknown adult abundance levels, 2 are depleted, and 1 is not overfished (Figure 15). Stocks showing positive adult abundance trends from 2005 to 2017 include Merrimack, Pawcatuck, Cape Fear, and St. Johns (ASMFC 2020). The decline in shad stocks is likely due to overfishing, pollution, and habitat loss from dam construction {NEFMC 2013}, and it is not possible to separate the impacts of each factor (ASMFC 2020). The 2020 stock assessment found that, although there is some improvement, shad stocks are still in decline throughout their range (ASMFC 2020). Because the coast-wide stock remains depleted, a score of high concern is awarded.

Summary of American Shad Stock & Habitat Conditions				
System	Historic Riverine Habitat Currently Unobstructed	Abundance Trends (2005-2017)	Adult Status*	
			Total Mortality Rate	Abundance
Merrymeeting Bay	50.02%	YOY: No trend Adults: No data	Unknown	Unknown
Merrimack	17.83%	YOY: No data Adults: Increasing trend	Unknown	Unknown
Pawcatuck	19.21%	YOY: No data Adults: Increasing trend	Unknown	Unknown
Connecticut	45.19%	YOY: No trend Adults: Conflicting trends between indices (1 increasing, 1 no trend)	Unsustainable	Unknown
Hudson	89.24%	YOY: No trend Adults: No trend	Sustainable	Depleted
Delaware	72.05%	YOY: No trends (2 indices) Adults: Conflicting trends between indices (1 increasing, 1 no trend)	Unsustainable	Unknown
Nanticoke	100%	YOY: Declining trend Adults: No trends (2 indices)	Unknown	Unknown
Susquehanna & Upper Chesapeake	4.38%	YOY: No trend Adults: No trends (2 indices)	Unknown	Unknown
Patuxent	100%	YOY: No data Adults: No trend	Unknown	Unknown
Potomac	90.02%	YOY: No trend Adults: No trends (2 indices)	Unsustainable	Unknown
Rappahannock	95.98%	YOY: Increasing trend Adults: No trends (2 indices)	Sustainable	Unknown
York	87.42%	YOY: Conflicting trends between indices (1 increasing, 2 no trends) Adults: No trend	Sustainable	Unknown
James	72.77%	YOY: No trend Adults: No trends (2 indices)	Unknown	Unknown
Albemarle Sound	58.92%	YOY: Increasing trend Adults: Conflicting trends between indices (2 no trends, 1 increasing)	Sustainable	Not overfished
Tar-Pamlico	75.68%	YOY: No data Adults: No trend	Unknown	Unknown
Neuse	90.05%	YOY: No data Adults: Conflicting trends between indices (1 increasing, 1 no trend)	Sustainable	Unknown
Cape Fear	46.59%	YOY: No data Adults: Increasing trends (2 indices)	Unknown	Unknown
Winyah Bay	73.13%	YOY: No data Adults: Conflicting trends (1 increasing, 2 no trend)	Unknown	Unknown
Santee-Cooper	20.95%	YOY: No data Adults: Conflicting trends between indices (1 increasing, 2 no trend)	Unknown	Unknown
ACE Basin	82.28%	YOY: No data Adults: No trend	Unknown	Unknown
Savannah	59.19%	YOY: No data Adults: No trends (2 indices)	Unknown	Unknown
Altamaha	82.24%	YOY: No data Adults: Conflicting trends between indices (1 increasing, 1 no trend)	Unknown	Unknown
St Johns	90.04%	YOY: No trend Adults: Increasing trend	Unknown	Unknown
Coastwide	55.42%	YOY: NA Adult: Conflicting trends between indices	Unknown	Depleted

Figure 15: American shad stock summary and habitat conditions (ASMFC 2020).

Factor 2.2 - Fishing Mortality

Northwest Atlantic | United States | Midwater trawls | Atlantic herring fishery
Northwest Atlantic | United States | Midwater trawls | Atlantic mackerel fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery
Atlantic stock | Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic herring fishery

Low Concern

American shad mortality rates are assessed against total mortality (Z) reference points under a modified Thompson Bell spawning biomass per recruit (SBPR) model, with the threshold level being set at $Z_{40\%}$ (ASMFC 2020b). Overfishing status is not provided because fishing mortality cannot be separated from other sources of mortality (ASMFC 2021f). Therefore, stock statuses are presented in terms of "sustainable" and "unsustainable" (ASMFC 2021f).

Of the eight stocks with known statuses, five are experiencing sustainable mortality rates, and three are undergoing unsustainable mortality rates (Figure 15). There are 11 stocks that have unknown mortality statuses; data-limited assessments suggest that 2 other stocks are experiencing unsustainable mortality rates, while mortality is sustainable for 1 stock (Figure 15). According to the stock assessment, "it is important to note that maintaining sustainable adult mortality will not result in favorable abundance status if juvenile mortality is unsustainable. Unfortunately, data are not being collected in any system to determine juvenile mortality status and, without these determinations, a significant uncertainty remains in assessment advice for the management of American shad" (ASMFC 2020b).

According to the Draft Environmental Assessment (EA) to Mackerel Rebuilding Framework, American shad accounted for ≈0.04% of the observed catch (includes only species with at least 500 lb. of observed catch) in the Atlantic mackerel fishery from 2015 to 2017 (MAFMC 2018). Because there were a low number of observed trips, extrapolations could not be made, but the relative proportion of observed catch rates of American shad is similar to those in previous EIS analyses (e.g., (MAFMC 2015)). Bycatch of RH/S in Atlantic mackerel and herring fisheries, combined, declined in recent years; the decline has coincided with lower catches of the target species; bycatch of RH/S in these fisheries totaled 64.7 mt and 4.2 t in 2020 and 2021, respectively, down from 271 mt in 2019 (NOAA 2021). The total commercial harvest of American shad in 2020 was 184.7 mt (ASMFC 2022c). Because bycatch in Atlantic mackerel and herring fisheries is not a substantial contributor to fishing mortality (i.e., <5% of total fishing mortality), a low concern score is awarded.

Summary of American Shad Stock & Habitat Conditions				
System	Historic Riverine Habitat Currently Unobstructed	Abundance Trends (2005-2017)	Adult Status*	
			Total Mortality Rate	Abundance
Merrymeeting Bay	50.02%	YOY: No trend Adults: No data	Unknown	Unknown
Merrimack	17.83%	YOY: No data Adults: Increasing trend	Unknown	Unknown
Pawcatuck	19.21%	YOY: No data Adults: Increasing trend	Unknown	Unknown
Connecticut	45.19%	YOY: No trend Adults: Conflicting trends between indices (1 increasing, 1 no trend)	Unsustainable	Unknown
Hudson	89.24%	YOY: No trend Adults: No trend	Sustainable	Depleted
Delaware	72.05%	YOY: No trends (2 indices) Adults: Conflicting trends between indices (1 increasing, 1 no trend)	Unsustainable	Unknown
Nanticoke	100%	YOY: Declining trend Adults: No trends (2 indices)	Unknown	Unknown
Susquehanna & Upper Chesapeake	4.38%	YOY: No trend Adults: No trends (2 indices)	Unknown	Unknown
Patuxent	100%	YOY: No data Adults: No trend	Unknown	Unknown
Potomac	90.02%	YOY: No trend Adults: No trends (2 indices)	Unsustainable	Unknown
Rappahannock	95.98%	YOY: Increasing trend Adults: No trends (2 indices)	Sustainable	Unknown
York	87.42%	YOY: Conflicting trends between indices (1 increasing, 2 no trends) Adults: No trend	Sustainable	Unknown
James	72.77%	YOY: No trend Adults: No trends (2 indices)	Unknown	Unknown
Albemarle Sound	58.92%	YOY: Increasing trend Adults: Conflicting trends between indices (2 no trends, 1 increasing)	Sustainable	Not overfished
Tar-Pamlico	75.68%	YOY: No data Adults: No trend	Unknown	Unknown
Neuse	90.05%	YOY: No data Adults: Conflicting trends between indices (1 increasing, 1 no trend)	Sustainable	Unknown
Cape Fear	46.59%	YOY: No data Adults: Increasing trends (2 indices)	Unknown	Unknown
Winyah Bay	73.13%	YOY: No data Adults: Conflicting trends (1 increasing, 2 no trend)	Unknown	Unknown
Santee-Cooper	20.95%	YOY: No data Adults: Conflicting trends between indices (1 increasing, 2 no trend)	Unknown	Unknown
ACE Basin	82.28%	YOY: No data Adults: No trend	Unknown	Unknown
Savannah	59.19%	YOY: No data Adults: No trends (2 indices)	Unknown	Unknown
Altamaha	82.24%	YOY: No data Adults: Conflicting trends between indices (1 increasing, 1 no trend)	Unknown	Unknown
St Johns	90.04%	YOY: No trend Adults: Increasing trend	Unknown	Unknown
Coastwide	55.42%	YOY: NA Adult: Conflicting trends between indices	Unknown	Depleted

Figure 15: American shad stock summary and habitat conditions (ASMFC 2020).

American shad landed as bycatch in 2019 accounted for approximately 48% of total commercial landings of the species; directed fisheries accounted for the remainder of commercial landings, with South Carolina, North Carolina, and Georgia landing the majority (81%) of *directed* landings of American shad (ASMFC 2021f). Bycatch of American shad is known to occur in New York, Virginia, and New England states, but bycatch in state waters is unquantified (ASMFC 2020b). Incidental catch in marine fisheries varies substantially, but because of insufficient genetic information, stock-specific incidental catch cannot be determined (ASMFC 2020b). From 2010 to 2017, bycatch of American shad averaged 64 mt annually, with 65% occurring in New England; on average, small-

mesh bottom trawls account for 34% of total annual shad bycatch (ASMFC 2020b). In 2017, the small-mesh bottom trawl fishery caught 26.83 mt of American shad (ASMFC 2020b).

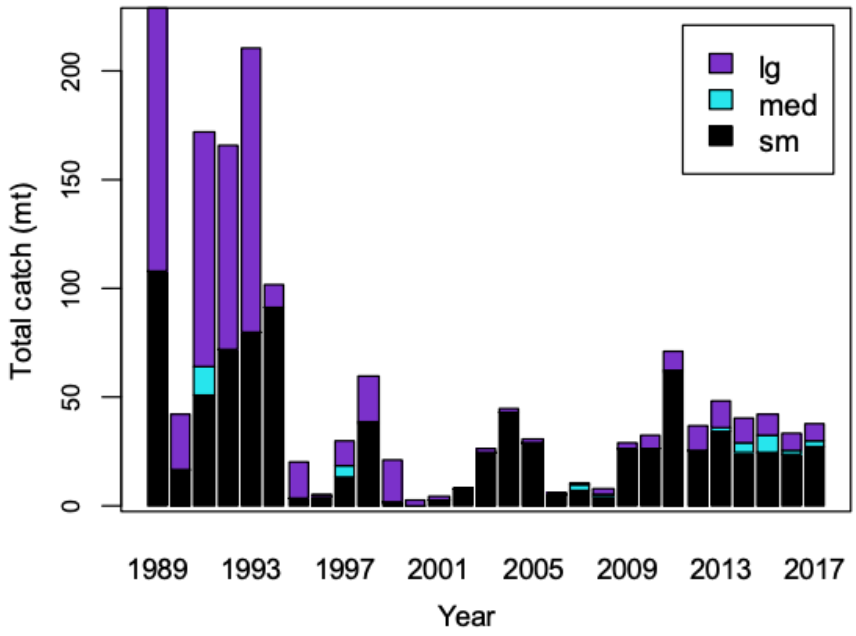


Figure 16: American shad total (retained plus discarded) annual incidental bottom trawl catch (metric tons) by mesh category from 1989 to 2017 (ASMFC 2020b).

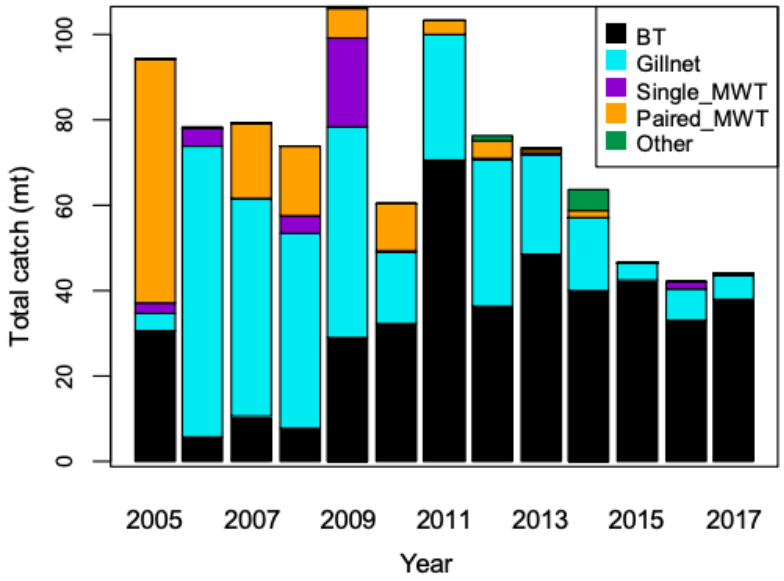


Figure 17: American shad total (retained plus discarded) annual incidental catch (metric tons) for the four gears with the largest catches from 2005 to 2017 (ASMFC 2020b).

Atlantic herring

Factor 2.3 - Discard Rate/Landings

Northwest Atlantic | United States | Midwater trawls | Atlantic herring fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic herring fishery

< 100%

From 2005 to 2015, the discard rate for the directed midwater trawl Atlantic mackerel fishery was 4.1%, and for the bottom trawl fishery was 11.2%. From 2014 to 2016, the discard rates in the Atlantic herring midwater trawl and bottom trawl fisheries were 1% and 3%, respectively (NEFMC 2019b). Discards in the New England purse seine fisheries are less than 0.01% of landings (Benaka et al. 2019). Discard rates in Atlantic herring and mackerel fisheries tend to be extremely low, and nontarget species, particularly haddock and river herring/shad, are typically retained {NEFSC 2019b}. Bait is not used in the Atlantic mackerel or herring fishery. Therefore, no modifying factor for discards and bait use is necessary in this fishery.

Justification:

From 1997 to 2000, when the Atlantic mackerel fishery was dominated by bottom otter trawling, 10 observed trips showed a bycatch to landings rate of 6%. From 2001 to 2006, with the shift to predominantly midwater trawling, observed trips showed a decline in the bycatch rate to

approximately 2.5% (MAFMC 2008). In recent years, overall catch of Atlantic mackerel has declined and it is likely that much of the catch is incidentally landed with the Atlantic herring fishery (MAFMC 2015). From 2011 to 2013, an average of four mackerel trips were observed per year, with approximately 16% of the total landings being observed (MAFMC 2015). During these trips, 94% of hauls were observed (49 total) to have a bycatch rate of 1% (MAFMC 2015). The purse seine fishery has even lower observer coverage rates, with an average of 3.84% from 2012 to 2016 {NEFSC 2019b}.

Overall, the quantity of nonlanded bycatch in the Atlantic mackerel fishery appears to be low, but because of limited observer coverage and the high-volume nature of the fishery, bycatch estimates and inferences regarding trends in bycatch rates should be viewed with caution.

Northwest Atlantic | United States | Purse seines | Atlantic herring fishery

< 100%

Multiple gear types are used to land Atlantic mackerel in Canada, though purse seine is dominant and the only gear type evaluated in this report. Although purse seine is a relatively selective gear type, other gear types (such as gillnets, weirs, and automatic jiggers) are not as selective. Purse seine selectivity allows for reduced bycatch (Chuenpagdee et al. 2003). To reduce overall bycatch, the season may be delayed if it is determined that there is potential for significant bycatch, which can be determined by "test" fisheries (DFO 2007). As with the United States fishery, bait is not used. Though observer data are limited, it is expected that the gear used in this fishery has quite low bycatch. Likewise, the U.S. Atlantic herring purse seine fishery has quite low levels of bycatch and even lower levels of discarding (see Factor 3.2) {NEFSC 2019b}(Benaka et al. 2019). Therefore, no modifying factor is necessary, because the ratio of bait (zero) and discards to landings is highly likely to be less than 100%.

Atlantic mackerel

Factor 2.3 - Discard Rate/Landings

Northwest Atlantic | Canada | Purse seines

< 100%

Multiple gear types are used to land Atlantic mackerel in Canada, though purse seine is dominant and the only gear type evaluated in this report. Although purse seine is a relatively selective gear type, other gear types (such as gillnets, weirs, and automatic jiggers) are not as selective. Purse seine selectivity allows for reduced bycatch (Chuenpagdee et al. 2003). To reduce overall bycatch, the season may be delayed if it is determined that there is potential for significant bycatch, which can be determined by "test" fisheries (DFO 2007). As with the United States fishery, bait is not used. Though observer data are limited, it is expected that the gear used in this fishery has quite low bycatch. Likewise, the U.S. Atlantic herring purse seine fishery has quite low levels of bycatch and even lower levels of discarding (see Factor 3.2) {NEFSC 2019b}(Benaka et al. 2019). Therefore, no modifying factor is necessary, because the ratio of bait (zero) and discards to landings is highly likely to be less than 100%.

Northwest Atlantic | United States | Midwater trawls | Atlantic mackerel fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery

< 100%

From 2005 to 2015, the discard rate for the directed midwater trawl Atlantic mackerel fishery was 4.1%, and for the bottom trawl fishery was 11.2%. From 2014 to 2016, the discard rates in the Atlantic herring midwater trawl and bottom trawl fisheries were 1% and 3%, respectively (NEFMC 2019b). Discards in the New England purse seine fisheries are less than 0.01% of landings (Benaka et al. 2019). Discard rates in Atlantic herring and mackerel fisheries tend to be extremely low, and nontarget species, particularly haddock and river herring/shad, are typically retained {NEFSC 2019b}. Bait is not used in the Atlantic mackerel or herring fishery. Therefore, no modifying factor for discards and bait use is necessary in this fishery.

Justification:

From 1997 to 2000, when the Atlantic mackerel fishery was dominated by bottom otter trawling, 10 observed trips showed a bycatch to landings rate of 6%. From 2001 to 2006, with the shift to predominantly midwater trawling, observed trips showed a decline in the bycatch rate to approximately 2.5% (MAFMC 2008). In recent years, overall catch of Atlantic mackerel has declined and it is likely that much of the catch is incidentally landed with the Atlantic herring fishery (MAFMC 2015). From 2011 to 2013, an average of four mackerel trips were observed per year, with approximately 16% of the total landings being observed (MAFMC 2015). During these trips, 94% of hauls were observed (49 total) to have a bycatch rate of 1% (MAFMC 2015). The purse seine fishery has even lower observer coverage rates, with an average of 3.84% from 2012 to 2016 {NEFSC 2019b}.

Overall, the quantity of nonlanded bycatch in the Atlantic mackerel fishery appears to be low, but because of limited observer coverage and the high-volume nature of the fishery, bycatch estimates and inferences regarding trends in bycatch rates should be viewed with caution.

Risso's dolphin

Factor 2.1 - Abundance

Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery

Moderate Concern

The best abundance estimate for Risso's dolphin in the Northwestern Atlantic is the sum of the estimates from the 2016 surveys: 35,215 (CV = 0.19), with a minimum population estimate of 30,051 (Hayes et al. 2022). This estimate is larger than previous (2011) estimates because the survey area was expanded by 1.3 million km^2 from 2011 to 2016 (Hayes et al. 2020). The status of this stock relative to the optimum sustainable population (OSP) in the U.S. Atlantic EEZ is unknown, and there are insufficient data to determine population trends (Hayes et al. 2022).

Risso's dolphin is assessed as "Least Concern" by the International Union for the Conservation of Nature (IUCN) (Kiszka and Braulik 2018), it is not listed as "Threatened" or "Endangered" under the Endangered Species Act, the Western North Atlantic stock is not considered strategic under the Marine Mammal Protection Act (Hayes et al. 2020), and status and trend analysis are unknown. Therefore, abundance is scored a moderate concern.

Factor 2.2 - Fishing Mortality

Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery

Low Concern

The potential biological removal (PBR) for this population is 301 (Hayes et al. 2022). The average annual fishery-related mortality from all fisheries from 2015 to 2019 was 35, of which 25 were attributed to the Mid-Atlantic bottom trawl fishery (Hayes et al. 2022). Because cumulative fishing mortality does not exceed PBR and the Mid-Atlantic bottom trawl fishery does not exceed 50% of PBR for Risso's dolphin, fishing mortality for Risso's dolphin is considered a low concern.

River herring

Factor 2.1 - Abundance

Northwest Atlantic | United States | Midwater trawls | Atlantic mackerel fishery
Northwest Atlantic | United States | Midwater trawls | Atlantic herring fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic herring fishery

High Concern

River herring is a collective term for alewife and blueback herring. These species are assessed together in the U.S. as "river herring." The most recent stock assessment determined that river herring remain depleted at near historic lows on a coast-wide basis (ASMFC 2017). Therefore, abundance is scored a high concern.

Justification:

River herring abundance has declined because of a number of factors, including dam construction, habitat quality decline, and fishing efforts, though the relative contribution to the decline for each factor has not been determined (ASMFC 2017). For these reasons, river herring are considered "depleted" rather than "overfished." In addition to finding that river herring remain depleted on a coast-wide basis, the 2017 stock assessment states that "[r]ecent trends in abundance data sets were variable, but generally showed no trend or, to a lesser degree, increasing trends" (ASMFC 2017). The assessment considered 54 in-river stocks of river herring for which data were available. Over the 10 most recent years of data, trends were as follows: 16 stocks increasing, 2 decreasing, 8 stable, 10 with no discernible trend/high variability, and 18 without sufficient data to assess recent trends, including 1 with no returning fish. These trends indicated that "coast-wide meta-complex of

river herring stocks on the U.S. Atlantic coast remains depleted to near historic lows. A depleted status indicates that there was evidence for declines in abundance due to a number of factors, but the relative importance of these factors in reducing river herring stocks could not be determined." Therefore, management could not determine overfished or overfishing status for the "coast-wide stock complex, as estimates of total biomass, fishing mortality rates and corresponding reference points could not be developed" (ASMFC 2017).

Factor 2.2 - Fishing Mortality

Northwest Atlantic | United States | Midwater trawls | Atlantic mackerel fishery
Northwest Atlantic | United States | Midwater trawls | Atlantic herring fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic herring fishery

Low Concern
The most recent stock assessment (2017) was not able to estimate fishing mortality from the available data. Although the assessment included total mortality estimates, management was not able to quantify which proportion was due to fishing mortality or other causes. According to the assessment, "[t]he fate of river-specific stocks during marine migrations is still largely unknown as is the stock composition of river herring in bycatch of ocean fisheries. Among-system differences and uncertainty in the marine life stages of river herring combined with the great variation in the amount, types, and quality of data collected by different agencies limited the types of assessment methods used during the benchmark assessment and, subsequently, updated for this assessment" (ASMFC 2017).

Fishing mortality relative to sustainable levels is unknown. But, bycatch of RH/S in Atlantic mackerel and herring fisheries, combined, declined in recent years. The decline has coincided with lower catches of the target species; bycatch of RH/S in these fisheries totaled 64.7 mt and 4.2 t in 2020 and 2021, respectively, down from 271 mt in 2019 (NOAA 2021). The total catch of river herring in 2020 was 928.3 mt (ASMFC 2022c). Because bycatch in Atlantic mackerel and herring fisheries is not a substantial contributor to fishing mortality (i.e., <5% of total fishing mortality), a low concern score is awarded.

Justification:
River herring are caught by fisheries targeting Atlantic herring, squid, and mackerel; the magnitude of incidental catch is highly uncertain; and additional analyses are needed to determine how river herring bycatch in these fisheries compares to total bycatch across all fisheries (NMFS 2019b). A majority of river herring bycatch is caught in midwater trawls (62%) and small mesh bottom trawls (37%) (ASMFC 2017). River herring bycatch in Atlantic mackerel and Atlantic herring fisheries is reported with bycatch of shad as "RH/S" (river herring and shad). In 2020, 23.1 mt and 41.6 mt of RH/S were caught in Atlantic mackerel and Atlantic herring fisheries, respectively. In the Atlantic herring-directed fishery in 2020, 39.5 mt of RH/S were caught by midwater trawls and 2.1 mt from bottom trawls (NOAA 2021); however, the annual catch by fishery/gear/region varies considerably (see quota reports from (NOAA 2021)).

The bycatch of river herring species (i.e., alewife and blueback herring) was estimated in the 2019 NMFS Status Review Report (Figures 18 and 19) (NMFS 2019b).

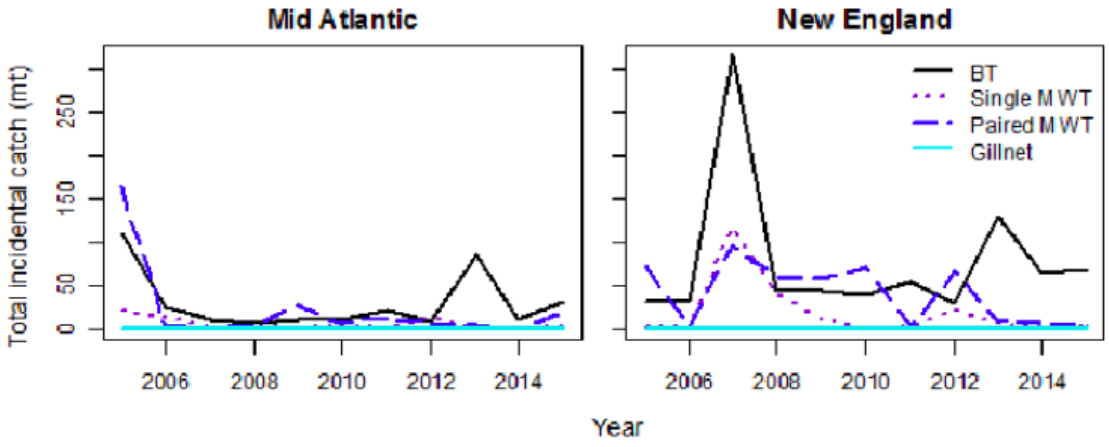


Figure 18: Alewife total annual incidental catch (mt) by region for the four gears with the largest catches from 2005 to 2015. Midwater trawl estimates are only included beginning in 2005 (NMFS 2019b).

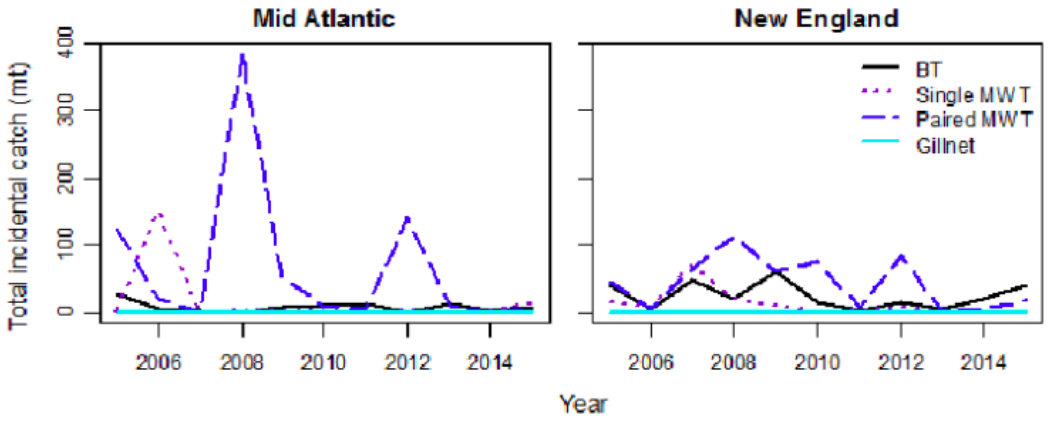


Figure 19: Blueback herring total annual incidental catch (mt) by region for the four gears with the largest catches from 2005 to 2015. Midwater trawl estimates are only included beginning in 2005 (NMFS 2019b).

The directed mackerel fishery has a cap on the amount of river herring and shad (RH/S) it can catch; the cap was initially set at a 20,000 lb. trip limit, once 82 mt of RH/S have been projected to be caught in the fishery (MAFMC 2019), but the cap is regularly adjusted to 0.74% of the annual Atlantic mackerel domestic annual harvest (DAH). The mackerel fishery closed early in 2018 and 2019 because the catch of RH/S met the cap, but did not close in 2020 (NOAA 2021). The cap is not biologically based, but aims to provide an incentive to avoid these species (ASMFC 2020b). For 2021, the following RH/S caps were in place for directed Atlantic herring fisheries: Gulf of Maine midwater trawl, 76.7 mt; the Cape Cod midwater trawl, 32.4 mt; the Southern New England

midwater trawl, 129.6 mt; and the Southern New England bottom trawl, 122.3 mt (NOAA 2021).

Short-beaked common dolphin

Factor 2.1 - Abundance

Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery

Moderate Concern

The current best abundance estimate for the Western North Atlantic stock of common dolphin is 172,947 (CV = 0.21), with a minimum population size of 145,216 (Hayes et al. 2022). The status of common dolphin relative to the optimum sustainable population (OSP) in the U.S. Atlantic EEZ is unknown, and population trends have not been investigated (Hayes et al. 2022). Common dolphin is assessed as "Least Concern" by the International Union for the Conservation of Nature (IUCN) (Braulik et al. 2021), it is not listed as "Threatened" or "Endangered" under the Endangered Species Act, the Western North Atlantic stock is not considered strategic under the Marine Mammal Protection Act (Hayes et al. 2022), and status and trend analysis are unknown. Therefore, abundance is scored a moderate concern.

Factor 2.2 - Fishing Mortality

Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery

Low Concern

The potential biological removal (PBR) for this population is 1,452 (Hayes et al. 2022). Average annual fishery-related mortality from all fisheries from 2015 to 2019 was 390, of which 281 were attributed to the Mid-Atlantic bottom trawl fishery (Hayes et al. 2022). Because cumulative fishing mortality does not exceed PBR and the Mid-Atlantic bottom trawl fishery does not exceed 50% of PBR for Western North Atlantic common dolphin, fishing mortality is considered a low concern.

Factor 2.3 - Discard Rate/Landings

Northwest Atlantic | United States | Midwater trawls | Atlantic herring fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic herring fishery
Northwest Atlantic | United States | Midwater trawls | Atlantic mackerel fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery

< 100%

From 2005 to 2015, the discard rate for the directed midwater trawl Atlantic mackerel fishery was 4.1%, and for the bottom trawl fishery was 11.2%. From 2014 to 2016, the discard rates in the Atlantic herring midwater trawl and bottom trawl fisheries were 1% and 3%, respectively (NEFMC

2019b). Discards in the New England purse seine fisheries are less than 0.01% of landings (Benaka et al. 2019). Discard rates in Atlantic herring and mackerel fisheries tend to be extremely low, and nontarget species, particularly haddock and river herring/shad, are typically retained {NEFSC 2019b}. Bait is not used in the Atlantic mackerel or herring fishery. Therefore, no modifying factor for discards and bait use is necessary in this fishery.

Justification:
From 1997 to 2000, when the Atlantic mackerel fishery was dominated by bottom otter trawling, 10 observed trips showed a bycatch to landings rate of 6%. From 2001 to 2006, with the shift to predominantly midwater trawling, observed trips showed a decline in the bycatch rate to approximately 2.5% (MAFMC 2008). In recent years, overall catch of Atlantic mackerel has declined and it is likely that much of the catch is incidentally landed with the Atlantic herring fishery (MAFMC 2015). From 2011 to 2013, an average of four mackerel trips were observed per year, with approximately 16% of the total landings being observed (MAFMC 2015). During these trips, 94% of hauls were observed (49 total) to have a bycatch rate of 1% (MAFMC 2015). The purse seine fishery has even lower observer coverage rates, with an average of 3.84% from 2012 to 2016 {NEFSC 2019b}.

Overall, the quantity of nonlanded bycatch in the Atlantic mackerel fishery appears to be low, but because of limited observer coverage and the high-volume nature of the fishery, bycatch estimates and inferences regarding trends in bycatch rates should be viewed with caution.

Northwest Atlantic | United States | Purse seines | Atlantic herring fishery
Northwest Atlantic | Canada | Purse seines

< 100%
Multiple gear types are used to land Atlantic mackerel in Canada, though purse seine is dominant and the only gear type evaluated in this report. Although purse seine is a relatively selective gear type, other gear types (such as gillnets, weirs, and automatic jiggers) are not as selective. Purse seine selectivity allows for reduced bycatch (Chuenpagdee et al. 2003). To reduce overall bycatch, the season may be delayed if it is determined that there is potential for significant bycatch, which can be determined by "test" fisheries (DFO 2007). As with the United States fishery, bait is not used. Though observer data are limited, it is expected that the gear used in this fishery has quite low bycatch. Likewise, the U.S. Atlantic herring purse seine fishery has quite low levels of bycatch and even lower levels of discarding (see Factor 3.2) {NEFSC 2019b}(Benaka et al. 2019). Therefore, no modifying factor is necessary, because the ratio of bait (zero) and discards to landings is highly likely to be less than 100%.

Criterion 3: Management Effectiveness

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

- *5 (Very Low Concern) — Meets the standards of 'highly effective' for all five factors considered.*
- *4 (Low Concern) — Meets the standards of 'highly effective' for 'management strategy and implementation' and at least 'moderately effective' for all other factors.*
- *3 (Moderate Concern) — Meets the standards for at least 'moderately effective' for all five factors.*
- *2 (High Concern) — At a minimum, meets standards for 'moderately effective' for Management Strategy and Implementation and Bycatch Strategy, but at least one other factor is rated 'ineffective.'*
- *1 (Very High Concern) — Management Strategy and Implementation and/or Bycatch Management are 'ineffective.'*
- *0 (Critical) — Management Strategy and Implementation is 'critical'.*

The Criterion 3 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Management Strategy and Implementation is Critical.

Guiding principle

- The fishery is managed to sustain the long-term productivity of all impacted species.

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

Criterion 3 Summary

FISHERY	MANAGEMENT STRATEGY	BYCATCH STRATEGY	DATA COLLECTION AND ANALYSIS	ENFORCEMENT	INCLUSION	SCORE
Northwest Atlantic | Canada | Purse seines	Moderately Effective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Northwest Atlantic | United States | Midwater trawls | Atlantic herring fishery	Moderately Effective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Northwest Atlantic | United States | Midwater trawls | Atlantic mackerel fishery	Moderately Effective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**

Northwest Atlantic | United States | Purse seines | Atlantic herring fishery	Moderately Effective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic herring fishery	Moderately Effective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery	Moderately Effective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**

Factor 3.1 for the U.S. and Canada Atlantic mackerel fisheries is scored under the same rationale because both countries catch fish from the same stock. But the supporting information ("Explanation" and "Justification" sections) is separate for each country for two reasons:

1. Management measures differ significantly by country, and lumping all management strategies into one scoring explanation may cause confusion.
2. Factor 3.1 is scored for all retained species, but the retained catch and management of retained species are different between the two countries. In the United States, herring and mackerel are both targeted by the same gear type and often caught together, so management of Atlantic herring is also discussed for the U.S. mackerel fishery. The U.S. fishery incidentally encounters and retains river herring and shad; strategies for managing this catch (e.g., setting TACs) are considered in Factor 3.1, while strategies for preventing catch of these species (and nonretained species) are accounted for in Factor 3.2. There is limited information on bycatch in the Canadian mackerel fishery.

Given the second reason, the U.S. midwater and bottom trawl fisheries for Atlantic herring are scored identically to the U.S. Atlantic mackerel fishery. But, Factor 3.1 for the U.S. purse seine fishery for Atlantic herring has no other "main" species, so it is scored differently.

The United States and Canada collaborate on Atlantic mackerel research, share knowledge and information (DFO 2022), and there are feedback loops between the two countries to determine catch levels. The U.S. manages Atlantic mackerel as a single stock with two spawning contingents: one primarily in the southern Gulf of St. Lawrence ("northern spawning contingent") and the other in the Mid-Atlantic Bight, Southern New England, and the western Gulf of Maine ("southern spawning contingent"). The uncertainty in contingent-specific removals by the U.S. fishery significantly affects the efficiency of management measures, and the difficulty in separating the contingents into two stocks may lead to one contingent having a higher risk of overexploitation (Bourret et al. 2023). Under Canada's Rebuilding Plan, rebuilding is not expected to occur within the timeframe of the Plan (by 2030), even without commercial fishing (DFO 2020). DFO notes that the inability to rebuild the Atlantic mackerel stock by 2030 is "in large part because the U.S. manages the stock independently and could continue to take an important fraction of the stock even in the absence of a Canadian commercial fishery" (DFO 2020).

Canada manages only the northern spawning contingent. Managements in the United States and Canada do not always set TACs appropriately because of undeclared catch in Canada. For example, the MAFMC determined the total allowable biological catch (ABC) for the entire stock in the United States and Canada for 2016 to 2018 to be 19,898 mt (81 FR 3768). After an estimated Canadian catch, the U.S. ABC was set at 11,009 mt. But management in Canada estimated the catch to be much higher: about 16,000 t, including unreported catch (DFO 2018).

Similarly, the U.S. herring fishery catches the same stock that is fished in the New Brunswick (NB) weir fishery. To account for this catch, NMFS subtracts the 10-year average catch from the NB fishery from the ABC to produce the annual catch limit (ACL). The U.S. may allocate 1,000 mt from the management uncertainty buffer if NMFS determines that the NB fishery lands less than the specified amount (64.5% of the uncertainty buffer) through October 1 (NEFMC 2023). But there has been discrepancy between NB landings and the amount allocated under the uncertainty buffer (i.e., the final NB landings were higher than the preliminary landings reported through October 1). This has resulted in the uncertainty buffer being exceeded by the U.S. fishery in 2018, 2020, and 2021 (i.e., Area 1A sub-ACL exceeded) (ASFMC 2022c) (NEFMC 2023), and the U.S. fishery exceed the ACL for the entire stock complex by 4% in 2021 (ASFMC 2022c). The recent overages of the Area 1A sub-ACL (and the stock-wide ACL overage in 2021) highlight the need for improved management coordination between the United States and Canada.

Criterion 3 Assessment

SCORING GUIDELINES

Factor 3.1 - Management Strategy and Implementation

Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? Do manages follow scientific advice?To achieve a highly effective rating, there must be appropriately defined management goals, precautionary policies that are based on scientific advice, and evidence that the measures in place have been successful at maintaining/rebuilding species.

Factor 3.2 - Bycatch Strategy

Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and when applicable, to minimize ghost fishing? How successful are these management measures? To achieve a Highly Effective rating, the fishery must have no or low bycatch, or if there are bycatch or ghost fishing concerns, there must be effective measures in place to minimize impacts.

Factor 3.3 - Scientific Research and Monitoring

Considerations: How much and what types of data are collected to evaluate the fishery's impact on the species? Is there adequate monitoring of bycatch? To achieve a Highly Effective rating, regular, robust population assessments must be conducted for target or retained species, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are met.

Factor 3.4 - Enforcement of Management Regulations

Considerations: Do fishermen comply with regulations, and how is this monitored? To achieve a Highly Effective rating, there must be regular enforcement of regulations and verification of compliance.

Factor 3.5 - Stakeholder Inclusion

Considerations: Are stakeholders involved/included in the decision-making process? Stakeholders are individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A Highly Effective rating is given if the management process is transparent, if high participation by all stakeholders is encouraged, and if there a mechanism to effectively address user conflicts.

Factor 3.1 - Management Strategy And Implementation

Northwest Atlantic | Canada | Purse seines

Moderately Effective

Atlantic mackerel in Canada has been managed by DFO under the IFMP for Atlantic Mackerel since 2007 (DFO 2007), and an update to the IFMP was under development (as of November 2021). Because of Atlantic mackerel's "Critical Zone" status, DFO developed a Rebuilding Plan in 2020 (DFO 2020) and evaluated the Rebuilding Plan under a Management Strategy Evaluation (MSE) framework (Van Beveren et al. 2020). The Rebuilding Plan is not legally binding and can be modified at any time under the Minister of Fisheries and Oceans' discretionary powers provided in the Fisheries Act (DFO 2020). DFO manages Atlantic mackerel under the Precautionary Approach Framework, which identifies a limit reference point (LRP) of 40% of SSB_{REF}, where REF is the fishing mortality reference point $F_{40\%}$ as a proxy for F_{MSY}; the upper stock reference (USR), or target reference point, is set at 80% of SSB_{REF} (DFO 2020). Catch limits (i.e., TACs) are informed by stock assessments for the northern contingent only, but no formal harvest control rules (HCRs) have been implemented for Atlantic mackerel (Van Beveren et al. 2020).

Managers have implemented several measures to promote Atlantic mackerel rebuilding (see Justification). Though DFO has a rebuilding plan in place for Atlantic mackerel, there is a low probability that the stock will rebuild within a reasonable timeframe, and no formal HCRs have been established. A new rebuilding plan is in development (DFO 2022). The most recent TAC was projected to allow SSB to increase in 2023 compared to 2021. Specifically, if the 2021 TAC of 4,000 t was maintained through 2023, DFO projections estimate that there is 64–79% probability (depending on recruitment scenario) that Atlantic mackerel $SSB_{2023} > SSB_{2021}$ (DFO 2021a). But the 2021 TAC decision applies only for a single year, so the projections should be interpreted cautiously until HCRs have been established. In March 2022, DFO announced the complete closure of the commercial and bait fisheries for Atlantic mackerel for the season (Palmeter 2022). Under a scenario in which there is no commercial or recreational fishery in Canada, and the United States removes up to 3,639 t (2023 TAC), the rebuilding time for the northern contingent is 7–9 years (DFO 2023). Although a revised rebuilding plan has not been published, DFO has implemented interim measures that are expected to promote rebuilding of the northern contingent of Atlantic mackerel.

The stock is expected to rebuild within a reasonable timeframe if the U.S. catch is below its TAC, but the fishery is not managed with a HCR that includes conservative buffers appropriate for this forage species, which precludes a highly effective score. Specifically, although interim rebuilding measures have recently been implemented, there is no permanent HCR that addresses the fluctuations in biomass and allows mackerel to recover from periods of low productivity. There is a need for a coordinated management strategy between the United States and Canada. Because the emergency closure of the Canadian fishery will promote rebuilding and there is evidence that measures are effective (i.e., the fishing mortality rate was below the reference level in 2022 (DFO 2023)), but there is a need for a formal HCR and improved coordinated management, this factor is scored moderately effective.

Justification:
Atlantic Mackerel Management

Sources of uncertainty in the catch included unaccounted-for removals from all sources (e.g., recreational catch, unaccounted-for bait, discards, and U.S. landings of northern contingent fish caught in the U.S. winter fishery) (DFO 2021a). Management gradually decreased TAC from 36,000 mt in 2013 to 8,000 mt in 2014 and 2015, but then increased the TAC to 10,000 mt in 2017 and 2018, before returning it to 8,000 mt in 2019 and 2020 (DFO 2021a). During the last assessment, there was agreement that the Canadian unaccounted-for catches would likely steadily decrease as a result of recent management measures aiming to improve catch monitoring (DFO 2021a). From 1987 to 2015, Atlantic mackerel TACs were not reached, indicating that the TACs were not restrictive (DFO 2017a)(DFO 2019a); however, the TACs were exceeded in 2016 (by 0.7%), 2018 (by 9.6%), and 2019 (by 7.8%) (DFO 2021a).

In the 2017 stock assessment, scientists estimated unreported catches at around 6,000 mt per year for 2011 to 2016 and provided a range of catch limits (reported plus unreported), with corresponding estimates on rebuilding the population (DFO 2017a). They referred to the previous year's TAC of 8,000 t (referred to as "status quo") and estimated that this catch limit would "result in an 81% probability of an increase in biomass and a 30% probability of reaching the LRP by 2019, assuming unreported catches are around 6,000 t in 2017 and 2018" (DFO 2017a). Management then set the TAC at 10,000 t (DFO 2017b), which, assuming 6,000 mt of unreported catches, would lead to a 77% probability of biomass increasing in 2019 and a 26% probability of reaching the LRP that year (with zero catches, 2019 SSB > 2016 SSB = 95%, 2019 SSB > LRP = 56%) (DFO 2017a). The TAC was reached for the first time in 2016 and was again reached in 2017 (DFO 2019a). The TAC was surpassed by 964 mt and 623 mt in 2018 and 2019, respectively (DFO 2021a). The mean fishing mortality of fully exploited mackerel (ages 5 to 10) has been greater than the reference level ($F_{40\%}$) since 1998, and the stock reached its lowest level (SSB_{2020} = 63% of the LRP) over the history of the time series (DFO 2021a).

The 2021 assessment provided updated projections based on two recruitment scenarios: 1) assumptions of the Beverton-Holt stock-recruitment relationship as estimated for the whole time series, and 2) using the mean recruitment over the past 10 years (DFO 2021a). Under the updated projections with two different recruitment scenarios, DFO states that: "…the probability of reaching the LRP by 2023 is 33% or 41% at the current TAC of 8,000 t. Under the same scenario, the probability of SSB in 2023 being greater than SSB in 2021 is 46% or 66%. Finally, with respect to the LRP, SSB in 2023 is projected to be at 0.46 or 0.60 of that value for a TAC of 8,000 t. Depending on the TAC (0–10,000 t) and recruitment projection, the probability of the SSB exiting the Critical Zone by 2023 varies from 29% (TAC = 10,000 t) to 58% (TAC = 0 t). These projections also indicate that the probability of SSB in 2023 being greater than SSB in 2021 varies from 39% (TAC = 10,000 t) to 92% (TAC = 0 t)" (DFO 2021a).

Rebuilding Plan

In 2018, DFO began an update of assessment model projections in support of development of a rebuilding plan and an MSE via the Atlantic Mackerel Rebuilding Plan Working Group. Specifically, the group "was requested to provide projections of total catch rates or F values that would 1)

increase the Atlantic Mackerel SSB out of the Critical Zone in a) 5, b) 10, and c) 15 years, with 75% probability, and 2) double the spawning stock biomass of Atlantic Mackerel in 10 years" (DFO 2018). A probability of 75% was chosen to reflect the desire for a "high probability" (DFO 2018). The short-term goal under the rebuilding plan is to limit the probability of SSB decline from one year to the next, while the long-term goal is to rebuild the stock above the LRP (DFO 2020). Rebuilding goals are related to the LRP, as opposed to TRPs that support maximum sustainable yield, as is the case in the U.S. (NOAA Fisheries 2017).

According to DFO's MSE, under the operating model (OM) that simulated an HCR of no fishing (F = 0), it would take anywhere from 3 to 7 years for the stock to rebuild (Van Beveren et al. 2020), and DFO established a goal of rebuilding above the LRP within 10 years (by 2030) (DFO 2020). Therefore, DFO uses a reasonable timeframe (number of years it would take the stock to rebuild without fishing, plus one generation [as described in (Restrepo et al. 1998)]). But, none of the true management procedures (HCRs 3–11) were able to meet Objective 1: rebuild Atlantic mackerel SSB above the LRP with a 75% probability within a reasonable timeframe (Van Beveren et al. 2020), and the stock is unlikely to rebuild if the catches remain near recent levels (DFO 2020). Because the short-term objectives of the rebuilding plan were not met, the objectives in the existing rebuilding plan will be re-evaluated and incorporated into a revised rebuilding plan (DFO 2022).

New Management Measures for Atlantic Mackerel

As part of the Rebuilding Plan, DFO adopted a number of management measures, including a 20% TAC reduction in 2019, improved catch monitoring and reporting, and measures to protect spawners (DFO 2020). DFO reduced the TAC another 50% in 2021 to 4,000 mt. Other management measures meant to promote rebuilding include a temporary freeze on new commercial mackerel licenses, an increase in the minimum fish size to L50 (the length that allows a minimum of 50% of the fish to spawn at least once before being fished), a later opening date for the commercial fishery in the southern Gulf of St. Lawrence to limit removal before spawning in a key spawning area, and improved monitoring and reporting (DFO 2020). DFO also implemented new recreational fishery management measures and limited the bait fishery to 2,000 pounds of mackerel per day (DFO 2020). In March 2022, the Minister of Fisheries and Oceans Canada announced the closure of the Atlantic mackerel commercial and bait fisheries in Canada (Palmeter 2022) and the closure was extended to 2023.

Before 2021, the recreational fishery for Atlantic mackerel was essentially unregulated and it was not uncommon for recreational vessels to land >500 pounds of mackerel; this created a potential commercial-scale fishery to continue fishing after the commercial fishery closed (DFO 2020). Effective May 26, 2021, the recreational fishery now has the following restrictions: fishery closure from January 1 to March 31 (although this is a period that is not traditionally fished recreationally (Canada Gazette 2021)), a daily limit of 20 fish per person, an increase in the minimum size to 26.8 cm for both commercial and recreational fishing, and a limit of 5 fishing lines with a maximum of 6 hooks per line (DFO 2021b).

Northwest Atlantic | United States | Midwater trawls | Atlantic herring fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic herring fishery
Northwest Atlantic | United States | Midwater trawls | Atlantic mackerel fishery Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery

Moderately Effective
Atlantic Mackerel

The United States and Canada manage Atlantic mackerel independently, but there is regular collaboration between scientists from both countries (Bourret et al. 2023). The U.S. FMP requires that the expected Canadian catch be deducted from the U.S. total allowable catch (TAC), so there is some de facto alignment. But, in some years, TACs for each country have been set to a level that exceeds scientific recommendations, indicating a breakdown in collaborative management, and there is a need for a coordinated management strategy between the two countries. More specifically, researchers recommend using genetic information to determine the proportion of each spawning contingent in U.S. landings and then managing the two spawning contingents separately (Bourret et al. 2023). Such measures could reduce overfishing (Bourret et al. 2023). A U.S. rebuilding plan for Atlantic mackerel was implemented in 2019, but the stock is not expected to rebuild under the original timeframe (by 2023) because of poor recruitment and the failure of recruitment to translate into older biomass. The MAFMC made in-season adjustments to reduce the potential harvest in 2021 while managers developed a revised rebuilding program (86 FR 57376). MAFMC approved a revised rebuilding plan in June 2022 (MAFMC 2022), and the revised rebuilding Amendment was approved by NOAA in February 2023 (88 FR 6665). In response to the 2023 assessment, the MAFMC requested emergency action in August 2023 to close the fishery while lower 2024–25 quotas are developed. There is evidence that the HCR addresses the fluctuations in biomass and productivity and accounts for scientific uncertainty (see Justification), but the HCR does not include conservative buffers for this forage fish species (see Factor 4.3).

Atlantic Herring

A rebuilding plan for Atlantic herring was approved under Framework Adjustment 9 in July 2022, following the recommendations made by NEFMC (87 FR 42962). NEFMC voted to use the ABC control rule developed under Amendment 8 to guide rebuilding (NEFMC 2021). Management of Atlantic herring meets some of the criteria for a highly effective score: the fishery is managed with appropriate reference points, precautionary policies are in place, and HCRs are responsive to changes in stock productivity and include conservative buffers. The stock is overfished, there are HCRs used to guide rebuilding, and the stock is expected to rebuild by 2026 (the first year that the probability of rebuilding is ≥50%) (NEFMC 2021)(87 FR 42962) and has a 65% probability of rebuilding within the 10-year timeframe (NEFMC 2023). The rebuilding timeline was pushed back to 2028, based on updated projections (88 FR 17397).

Atlantic herring from the Scotian Shelf stock overlaps with the GoM/GB stock, but fishing mortality on this stock is unknown, catch from this stock is unaccounted for in the United States stock assessment (NEFMC 2020), and there is no basis for evaluating the Canadian TAC for the Scotian Shelf stock (DFO 2018b). This highlights the need for cooperative management of Atlantic herring between the United States and Canada, because catch of this stock in the U.S. fishery introduces

uncertainty in the management effectiveness of all retained Atlantic herring stocks.

River Herring and Shad

The main strategy for managing catches of river herring and shad is the implementation of a catch cap (i.e., quota) for each area; caps in the Atlantic herring and mackerel fisheries have been in place since 2014 (ASMFC 2020b). Caps in the Atlantic mackerel fishery are not biologically based, because the data are not available to allow such a determination; rather, they are the median of actual river herring and shad catches by the Atlantic mackerel fishery from 2005 to 2012 (84 FR 58053). The cap is designed to "provide a strong incentive for the industry to avoid river herring and shad, and will help to minimize encounters with these species" (79 FR 10029). Catches of river herring and shad in Atlantic mackerel and herring fisheries in 2020 reached the lowest levels since caps were implemented in 2014 (ASMFC 2021c). But, it is difficult to say how effective they are in ensuring that the catch is at a sustainable level when the available data do not allow such a determination.

Summary of Score

Management measures are in place that are expected to be effective for more than 70% of the fishery's main targeted and retained species/stocks, but uncertainty remains. Such measures include buffers in TACs to account for uncertainty, up-to-date stock assessments that allow managers to determine if stocks are healthy, and strategies for rebuilding depleted stocks. Rebuilding of U.S. Atlantic mackerel within a reasonable timeframe is uncertain, based on repeated failures of projected biomass to materialize. The uncertainty in contingent-specific removals by the U.S. fishery affects the efficiency of management measures for both contingents. In addition, the existing HCR does not include a conservative buffer to account for the forage role of Atlantic mackerel in Canadian waters. GoM/GB Atlantic herring is managed with precautionary policies in the face of uncertainty and a rebuilding plan was recently approved, but the effectiveness of management of the Scotian Shelf stock is unknown. The amount of incidental catch of river herring and shad has declined in recent years, likely the result of lower Atlantic herring quotas and fewer trips targeting Atlantic herring (Figures 14-19 in (NEFMC 2023)), but the fishery's impact to individual stocks remains unknown. New measures for mackerel and herring (see Justification) have not been in place long enough to evaluate effectiveness. For these reasons, this factor is scored moderately effective.

Justification:
The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), commonly referred to as the Magnuson-Stevens Act (MSA), as currently revised, governs the management of American fisheries within the 200-mile Exclusive Economic Zone (EEZ) (MSA was most recently fully reauthorized in 2007 with amendments as recently as 2019). The managements of the Atlantic mackerel and Atlantic herring fisheries are covered under the MSA. Section 301 states that national standards for fisheries conservation and management shall be set by regional management councils. Section 302 establishes these councils. Section 304 requires the councils to create management plans complete with annual reports on the status of their governed fisheries and official determinations of stock status based on scientific evidence. Among many provisions, the MSA requires overfishing to end immediately and for rebuilding plans to be implemented within 2 years (NOAA 1996).

Atlantic Mackerel Management

The primary management tool for U.S. management is to close the directed commercial fishery based on a quota that accounts for Canadian landings, U.S. discards, U.S. recreational catch, and incidental commercial landings that may occur after the directed fishery is closed. The MAFMC sets aside catch for recreational catch (private and chartered boats and shore catch). In addition, the directed fishery is closed in a stepped fashion to ensure that overages do not occur. Although management of the Atlantic mackerel fishery appears to comply with scientific recommendations when setting the ABC and catch quotas, there were years when total catch could have exceeded total ABC if the expected Canadian catch was misspecified and the full U.S. catch occurred (but overages have not actually occurred). The current TAC system includes buffers for uncertainty, as demonstrated in the Framework Adjustment 13. For the 2019 season, the total ABC was 92% of the overfishing limit (OFL), and the U.S. TAC was set with a 3% management uncertainty buffer and a deduction based on the recent average Canadian catch (84 FR 58053). In the past decade, amendments aimed to improve management by implementing limited access (Amendment 11) and implementing annual catch limits, targets, and accountability measures (Amendment 13) (MAFMC 2016b). The Atlantic mackerel FMP has been amended a number of times to better limit access to the fishery and implement annual catch limits, targets, and accountability measures (MAFMC 2016b). Despite these efforts, it is determined that the Atlantic mackerel fishery has been overfished and that overfishing was occurring (NEFSC 2018), and the stock was not expected to rebuild by 2023 (86 FR 57376). Managers did recommend modifications to the 2020 harvest specifications as a result of the Canadian assessment, thus indicating that managers are willing to modify the plan further based on new scientific information. Likewise, managers responded with measures meant to reduce total fishing mortality as a result of the management track assessment review (which indicated that Atlantic mackerel was overfished and undergoing overfishing) (86 FR 57376). On June 14, 2022, MAFMC announced approval of a revised rebuilding plan for Atlantic mackerel (MAFMC 2022). MAFMC selected Alternative 4, which is predicted to have a 61% probability of rebuilding mackerel in 10 years, under a constant F of 0.12 (MAFMC 2022b). Because of uncertainty around Canadian landings and recreational catch deductions, final quota would need to be determined at the time of final action (MAFMC 2022b). MAFMC also recommended the first ever recreational possession limit in federal waters of 20 mackerel per person for 2023 (MAFMC 2022). These recommendations were adopted by NOAA under a formal rebuilding plan (88 FR 6665). Given the results of the 2023 assessment, the MAFMC requested emergency action to close directed fishing for the remainder of 2023 and until lower quotas are implemented for 2024–25 to increase the probability of rebuilding despite the failure of recent assessments' projection to materialize into biomass increases.

Timeline of recent management measures for Atlantic mackerel:

- **October 2019:** Rebuilding plan published with the following specifications for domestic annual harvest (DAH) for the 2019–21 fishing years: 17,371 mt, 20,557 mt, and 21,517 mt, respectively (84 FR 58053).
- **July 2021:** DAH set at 17,312 mt for 2021 and 2022 {86 FR 38586}. Management Track Assessment shows overfished and overfishing, triggering a new rebuilding plan requirement (NOAA 2021b).
- **October 2021:** A temporary rule reduces 5,000-lb. possession limit for remainder of the

year (86 FR 57376).

- **January 2022:** A temporary rule reduces the DAH to 4,963 mt (87 FR 1700).
- **June 2022:** The MAFMC selects Alternative 4, which would set the 2023 DAH at 1,002 to 3,587 mt, depending on the Canadian catch and recreational catch options (MAFMC 2022b).
- **July 2022:** Under a temporary rule extension, NOAA sets the 2022 interim Atlantic mackerel specifications to set the DAH at 4,963 mt (87 FR 40139).
- **February 2023:** NOAA approves a revised rebuilding plan with a commercial quota of 3,639 mt (ABC = 8,094 mt), a modified fisheries closure approach with different thresholds based on the time of year, and a recreational possession limit of 20 fish (88 FR 6665).
- **August 2023:** Council requests emergency closure of directed commercial mackerel fishing for the remainder of 2023 and until lower quotas are determined for 2024–25 (MAFMC 2023a).

Atlantic Herring Management

Atlantic herring is managed in a state and federal partnership by the NEFMC and the Atlantic States Marine Fisheries Commission. The Council and the Commission set fishing limits that are then divided into management areas. There are three permit categories in the limited access fishery and two permit categories in the open access fishery (ASMFC 2020c). The fishery is organized by three management areas and two sub-areas, each of which has its own ACL and gear/closure provisions (see details following and in Table 3). Directed fisheries within individual management areas are closed when 92% of the area-specific ACL is reached, and the stock-wide fishery closes when 95% of the ACL is projected to be reached (ASMFC 2021b). The NEFSC is responsive to changes in the stock, as evidenced by an in-season action to reduce catch limits in response to poor recruitment estimates in 2018 {ASMFC 2019}. As part of the recommended rebuilding program, the NEFSC voted to establish a new ABC rule that caps fishing mortality at 80% of F_{MSY} and allows for fishing mortality rates to decline linearly when biomass is low (NEFMC 2021). Harvest specifications were recently determined for 2023–25 under Framework 9—values were revised from the default values under Framework 8 (88 FR 17397).

Though variable, recruitment estimates have remained at low levels from 2013 to 2019; recruitment reached a low in 2016, at 175 mt (maximum recruitment is estimated at 14,035 mt) (NEFSC 2018) and remained low in 2018 (NEFMC 2020). Natural mortality rates have been adjusted in the models in each of the recent stock assessments (2012, 2015, 2018, 2020) to resolve retrospective patterns.

The ACL was set at 4,814 mt for the 2021 season and is divided by management area as follows: Area 1A = 1,391 mt (an increase of 218 mt from the initial specification because of a 5% carryover from the 2019 ACL), Area 1B = 207 mt, Area 2 = 1,338 mt, and Area 3 = 1,877 mt. In Area 1A, 30 mt are set aside for fixed-gear fisheries, and a buffer of 8% closes the fishery when 92% of the sub-ACL is reached; therefore, the total sub-area ACL for 2021 is 1,453 mt (ASMFC 2021b). Managers released a draft Addendum III in 2020 to allow more flexibility for quota allocation under low quota scenarios in Area 1A. Addendum III was drafted in response to short and infrequent harvesting opportunities and is intended to manage landings more efficiently and to avoid continual closures. The 2023 ACL was revised from 4,098 mt under Framework 8 to 12,429 mt under Framework 9. This increase was due to changes in the 2022 assessment relative to the 2020 assessment; specifically, the MSY reference points were revised, SSB_{MSY} decreased, and the ratio of

$SSB:SSB_{MSY}$ increased, resulting in a higher ABC and ACL (88 FR 17397).

Under Amendment 8, midwater trawling was prohibited in the inshore Gulf of Maine (Area 1A) from June 1 to September 30; the closure was extended from 4 weeks to 6 weeks under Addendum II in 2019 (ASMFC 2021b). But the measure was revoked following a lawsuit from the midwater trawl industry in which the "court ruled that this measure was arbitrary and capricious and violated the Administrative Procedure Act based on a conclusion that the available scientific information did not sufficiently support that localized depletion was occurring" (88 FR 17397). Addendum II in Amendment 8 was approved by managers in response to low recruitment and spawning stock levels. Under Addendum II, the fishery will be closed when a lower percentage of the population is spawning, and reclosed if the trigger level (20% or more of the sampled herring have not yet spawned) is reached.

There are three inshore spawning areas for Atlantic herring. The default spawning closure begins August 28 or September 23 (depending on spawning area), and a monitoring system is used to track reproductive maturity so that seasonal closures are aligned with the onset of Atlantic herring spawning (ASMFC 2021b).

Table 3: Atlantic herring permit categories. Adopted from (ASMFC 2020c).

	Category	Description	Landings 2014–2018 (permit[s])
Limited Access	A	Limited access in all management areas.	54,918.9 mt (A, BC)
	B	Limited access in Areas 2 and 3 only.	
	C	Limited access in all management areas, with a 25 mt (55,000 lb) Atlantic herring catch limit per trip and one landing per calendar day.	681.5 mt (C)
Open Access	D	Open access in all management areas, with a 3 mt (6,600 lb) Atlantic herring catch limit per trip and one landing per calendar day.	49.0 mt (D, DE, E)
	E	Open access in Areas 2 and 3 only, with a 9 mt (20,000 lb) Atlantic herring catch limit per trip and landing per calendar day.	

Strategies for Managing Catch of Other Species

Combined caps for river herring and shad are set for the mackerel fishery (236 mt in 2014, 89 mt in 2015, 82 mt in 2016 to 2019, and 129 mt in 2020–21) and the herring fishery (312 mt in 2014 to 2015, and 361 mt in 2016 to 2021), and the fisheries are closed once the caps are reached. The mackerel fishery was closed early in 2019 when the cap was reached, with 75% less mackerel catch than expected that year (84 FR 58053). Framework Adjustment 13 to the mackerel plan modifies the caps upward, to 89 mt for 2019 to 2021, with a further increase authorized if the fishery can land 10,000 mt of mackerel without hitting the 89 mt cap each year. Caps are reviewed annually and can be revised based on new information (84 FR 58053). Years in which the estimated catch exceeded a sub-ACL are highlighted in orange in Table 4; years in which the entire fishery exceeded the total ACL are highlighted in red.

Table 4: River herring and shad (RH/S) catch and cap in U.S. Atlantic mackerel and herring fisheries.

Year	Mackerel fishery catch	Mackerel fishery quota	Herring fishery catch	Herring fishery quota
2014	6.42 mt	236 mt	27.1	312 mt
2015	12.87 mt	89 mt	176.5*	312 mt
2016	12.88 mt	82 mt	107.7	361 mt
2017	39.2 mt	82 mt	92.7	361 mt
2018	109.2 mt	82 mt	234.5 mt**	361 mt
2019	91.5 mt	82 mt	179.3 mt*	361 mt
2020	23.1 mt	129 mt	41.6 mt	361 mt
2021	3.4 mt	129 mt	0.8 mt	361 mt
2022	6.8 mt	129 mt	5.7 mt	361 mt
2023	105.9 mt (through July 24, 2023)	129 mt	73.8 mt (through July 24, 2023)	361 mt

* Southern New England bottom trawl fishery exceeded the sub-ACL.

** Cape Cod midwater trawl and southern New England midwater trawl fisheries exceeded respective sub-ACLs.

Northwest Atlantic | United States | Purse seines | Atlantic herring fishery

Moderately Effective

The Atlantic Herring FMP has been amended a number of times to better limit access to the fishery and implement annual catch limits, targets, and accountability measures (ASMFC 2021b) (see Appendices for a list of recent FMP changes). Despite these efforts, Atlantic herring is overfished (NEFMC 2020). A rebuilding plan for Atlantic herring was approved under Framework Adjustment 9 in July 2022, following the recommendations made by NEFMC (87 FR 42962). NEFMC voted to use the ABC control rule developed under Amendment 8 to guide rebuilding (NEFMC 2021). There are HCRs used to guide rebuilding, and the stock is expected to rebuild by 2026 (the first year that the probability of rebuilding is ≥50%) (NEFMC 2021)(87 FR 42962) and has a 65% probability of rebuilding within the 10-year timeframe (NEFMC 2023). The rebuilding timeline was pushed back to 2028, based on updated projections (88 FR 17397).

Management of U.S. Atlantic herring (i.e., the GoM/GB stock) meets some of the criteria for a highly effective score: the fishery is managed with appropriate reference points, precautionary policies are in place, and HCRs are responsive to changes in stock productivity and include conservative buffers. Atlantic herring is managed with consideration for its role in the ecosystem such that fishing mortality is capped at 80% of F_{MSY} and declines linearly when biomass is low (NEFMC 2021). The HCR includes a buffer for management uncertainty and it is adjusted to allow the stock to recover from periods of low productivity.

Atlantic herring from the Scotian Shelf stock overlaps with the GoM/GB stock, but fishing mortality on this stock is unknown, catch from this stock is unaccounted for in the United States stock assessment (NEFMC 2020), and there is no basis for evaluating the Canadian TAC for the Scotian

Shelf stock (DFO 2018b). This highlights the need for cooperative management of Atlantic herring between the United States and Canada. Because catch of this stock in the U.S. fishery introduces uncertainty in the management effectiveness of all retained stocks, this factor is scored moderately effective.

Justification:
The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), commonly referred to as the Magnuson-Stevens Act (MSA), as currently revised, governs the management of American fisheries within the 200-mile Exclusive Economic Zone (EEZ) (MSA most recently fully reauthorized in 2007 with amendments as recently as 2019). The management of the Atlantic mackerel and Atlantic herring fisheries are covered under the MSA. Section 301 states that national standards for fisheries conservation and management shall be set by regional management councils. Section 302 establishes these councils. Section 304 requires the councils to create management plans complete with annual reports on the status of their governed fisheries, and official determinations of stock status based on scientific evidence. Among many provisions, the MSA requires overfishing to end immediately and for rebuilding plans to be implemented within 2 years (NOAA 1996).

Atlantic herring is managed in a state and federal partnership by the NEFSC and the ASMFC. There are three permit categories in the limited access fishery and two permit categories in the open access fishery (Table 5) (ASMFC 2020c). The fishery is organized by three management areas and two sub-areas, each of which has its own ACL and gear/closure provisions.

Table 5: Atlantic herring permit categories. Adopted from (ASMFC 2020c).

	Category	Description	Landings 2014–2018 (permit[s])
Limited Access	A	Limited access in all management areas.	54,919 mt (A, BC)
	B	Limited access in Areas 2 and 3 only.	
	C	Limited access in all management areas, with a 25 mt (55,000 lb) Atlantic herring catch limit per trip and one landing per calendar day.	682 mt (C)
Open Access	D	Open access in all management areas, with a 3 mt (6,600 lb) Atlantic herring catch limit per trip and one landing per calendar day.	49 mt (D, DE, E)
	E	Open access in Areas 2 and 3 only, with a 9 mt (20,000 lb) Atlantic herring catch limit per trip and landing per calendar day.	

Directed fisheries within individual management areas are closed when 92% of the area-specific ACL is reached, and the stock-wide fishery closes when 95% of the ACL is projected to be reached (ASMFC 2021b). The ACL was set at 4,814 mt for the 2021 season and is divided by management area as follows: Area 1A = 1,391 mt (an increase of 218 mt from the initial specification because of a 5% carryover from the 2019 ACL), Area 1B = 207 mt, Area 2 = 1,338 mt, and Area 3 = 1,877 mt. In Area 1A, 30 mt are set aside for fixed gear fisheries, and a buffer of 8% closes the fishery when 92% of the sub-ACL is reached; therefore, the total sub-area ACL for 2021 is 1,453 mt (ASMFC 2021b). Managers released a draft Addendum III in 2020 to allow more flexibility for quota allocation under low quota scenarios in Area 1A. Addendum III was drafted in response to short and infrequent harvesting opportunities and is intended to manage landings more efficiently and to avoid continual closures. The 2023 ACL was revised from 4,098 mt under Framework 8 to 12,429 mt under Framework 9. This increase was due to changes in the 2022 assessment relative to the

2020 assessment; specifically, the MSY reference points were revised, SSB_{MSY} decreased, and the ratio of SSB:SSB_{MSY} increased, resulting in a higher ABC and ACL (88 FR 17397).

As part of the recommended rebuilding program, for 2022, the NEFMC voted to use the newly established ABC rule that caps fishing mortality at 80% of F_{MSY} and allows for fishing mortality rates to decline linearly when biomass is low (NEFMC 2021)(87 FR 42962). NEFMC selected the Alternative 3A, which would set $F_{REBUILD}$ at 66% of F_{MSY} (F = 0.358), or the fishing mortality rate that is projected to rebuild by 2028 with a probability =50% under a low recruitment scenario (NEFMC 2021c). But, specifications related to rebuilding would not be implemented until 2023, and NEFMC did not include recommendations on how to adjust F if there is a future change in reference points, assessment model parameters, and/or fishery projection assumptions (NEFMC 2021c). NOAA approved the rebuilding plan in July 2022 (87 FR 42962). The main components of the rebuilding include: a HCR that sets the ABC at 80% of F_{MSY} or its proxy when the stock biomass is above $0.5B_{MSY}$; when biomass falls below $0.5B_{MSY}$, F declines linearly to 0 at $0.1B_{MSY}$. The rebuilding plan also outlines new accountability measures that are triggered with the ACL or Management Area sub-ACL is exceeded. Harvest specifications were recently determined for 2023–25 under Framework 9—values were revised from the default values under Framework 8 (88 FR 17397).

The ASMFC implements additional management measures in state waters to protect the herring stock, including seasonal closed areas for spawning and a "days out" program that controls fishing effort by limiting the number of days per week that herring can be landed in a particular state—which is used to provide a constant supply to the market (ASMFC 2021b). Under Amendment 8, midwater trawling was prohibited in the inshore Gulf of Maine (Area 1A) from June 1 to September 30; the closure was extended from 4 weeks to 6 weeks under Addendum II in 2019 (ASMFC 2021b). But the measure was revoked following a lawsuit from the midwater trawl industry in which the "court ruled that this measure was arbitrary and capricious and violated the Administrative Procedure Act based on a conclusion that the available scientific information did not sufficiently support that localized depletion was occurring" (88 FR 17397). Addendum II in Amendment 8 was approved by managers in response to low recruitment and spawning stock levels. Under Addendum II, the fishery will be closed when a lower percentage of the population is spawning, and re-closed if the trigger level (20% or more of the sampled herring have not yet spawned) is reached. There are three inshore spawning areas for Atlantic herring. The default spawning closure begins August 28 or September 23 (depending on spawning area) and a monitoring system is used to track reproductive maturity so that seasonal closures are aligned with the onset of Atlantic herring spawning (ASMFC 2021b).

Though variable, recruitment estimates have remained at low levels from 2013 to 2019; recruitment reached a low in 2016, at 175 mt (maximum recruitment was estimated at 14,035 mt) (NEFSC 2018) and remained low in 2018 (NEFMC 2020). Natural mortality rates have been adjusted in the models in each of the recent stock assessments (2012, 2015, 2018, 2020) to resolve retrospective patterns. A recent analysis of global herring stocks suggests that recruitment and biomass at high and low levels are strongly associated, and this association is a major determinant in collapse times and recovery (Trochta et al. 2020). Fewer years of strong recruitment and prolonged recruitment

failure were likely to occur in stocks that experienced larger maximum catch-to-biomass ratios, and "this connection could reflect that (a) recruitment failure precludes biomass recovery, which is exacerbated by increased exploitation, or that (b) this is the result of recruitment overfishing, as has been previously noted for herring stocks" (Trochta et al. 2020). Overall, the analysis suggests that median recruitment and variability in sea surface height anomalies and sea surface temperatures may best explain population recovery (Trochta et al. 2020).

Factor 3.2 - Bycatch Strategy

Northwest Atlantic | Canada | Purse seines

Highly effective

Purse seine is a selective gear that has low bycatch rates. But, even though DFO monitors the fishery through dockside monitoring, at-sea observers, hails of departures and arrivals, buyer hails and purchase slips, and the submission of logbooks (DFO 2020), details on bycatch rates from the directed Atlantic mackerel fishery are unavailable (pers. comm., A. Smith July 2019). Thus, bycatch in the Canada Atlantic mackerel fishery is unknown. Data from observers-at-sea programs and commercial landings do not show any marine mammals caught as bycatch (pers. comm., A. Smith July 2019). Purse seine harvesters use dip nets before hauling catch to determine fish size and bycatch composition; seiners also have access to herring and are permitted to retain up to 10% bycatch when fishing mackerel (pers. comm., DFO 2022). Because the fishery is highly selective and no species of concern are regularly caught, this factor is considered highly effective.

Northwest Atlantic | United States | Midwater trawls | Atlantic herring fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic herring fishery
Northwest Atlantic | United States | Midwater trawls | Atlantic mackerel fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery

Highly effective

Factor 3.2 is scored for strategies for preventing catch of these species (and nonretained species). The main bycatch concerns are alewife and blueback herring, grouped together for management purposes as river herring (see Criterion 2) and American shad and hickory shad, grouped together as shad. These species remain depleted across their range. Although catch management is addressed in Factor 3.1, it is worth noting that managers implemented the cap to create an incentive for fleets to avoid river herring and shad, and it appears that the cap has had the desired effect of encouraging avoidance behavior (MAFMC 2019)(NEFMC 2023).

Under the River Herring Bycatch Avoidance Program, officials in Massachusetts initiated a real-time communication system that identified river herring hotspots and notified vessels when RH/S bycatch is high. Though small-scale, the program enabled vessels to shift effort during times of high bycatch, and this change in fishing behavior contributed to decreased river herring and American shad bycatch (Bethoney et al. 2017). Under this program, the Massachusetts Division of Marine Fisheries issued two bycatch projections advisories, which led to low bycatch in Atlantic herring and

mackerel fisheries (ASMFC 2021c). But the program ended in March 2021. Other collaborations between fishers, managers, and researchers have aimed to use modeling to predict river herring bycatch, with the goal of incorporating forecasts into management measures (e.g., (Turner et al. 2017) and (Turner et al. 2016)); however, the applicability of current models remains limited (Turner et al. 2017). This program was discontinued due to a lack of funding.

Fishing mortality is not the only source of human-caused mortality on river herring and shad, which makes the task of managing those impacts all the more challenging. Improvements have been made to mitigate the impacts of the fishery, including placing a cap on river herring and shad and improving observer coverage (Amendment 14 in 2014 (79 FR 10029)), improving bycatch reporting and analysis (80 FR 37182), and addressing slippage or catch that is discarded before observers have had a chance to sample it (Framework 9 in 2015 (80 FR 28244)). But, for river herring, there is still no estimate of total mortality across all sources, an estimate of total mortality across all fisheries, or an estimate of total mortality in the mackerel and herring fisheries. There are also no estimates of a sustainable level of anthropogenic mortality.

Bottom trawl and midwater trawl fisheries in the Mid-Atlantic and Northeast region are listed as Category II fisheries (LOF 2021). The Atlantic Trawl Take Reduction Team was formed in 2006 to address incidental mortality and serious injury of long-finned pilot whale, short-finned pilot whale, common dolphin, and white-sided dolphin in these fisheries (NOAA 2008). The short-term goal was to reduce incidental mortality and serious injury to levels below the stock's potential biological removal (PBR), and the long-term goal was to reduce levels to 10% of PBR (NOAA 2008). According to the most recent stock assessments (see Criterion 2), only the common dolphin is currently experiencing incidental mortality and serious injury greater than 10% of PBR (Hayes et al. 2018). PBR is not exceeded for any marine mammal species caught in these fisheries, and none of the fisheries are Category I, which suggests that highly effective bycatch strategies are in place for marine mammals.

The Mid-Atlantic and Northeast trawl fisheries for Atlantic mackerel and herring have precautionary strategies and goals in place to minimize impacts on bycatch species, and there is evidence that these strategies are effective. Therefore, we deem bycatch management highly effective.

Justification:
Amendment 14 was implemented by the MAFMC in 2014 primarily to improve monitoring and control of river herring and shad incidental catch in the Atlantic mackerel fishery. Approved measures include: "revising vessel reporting requirements (vessel trip reporting frequency, pre-trip and pre-landing vessel notification requirements, and requirements for vessel monitoring systems); expanding vessel requirements to maximize observers' ability to sample catch at-sea; minimizing the discarding of unsampled catch; and a measure to allow the Council to set a cap on river herring and shad catch in the Atlantic mackerel fishery" (79 FR 10029). The cap is developed as part of the annual proposed rules for MSB specifications and was set at 236 mt for 2014, has been modified a number of times, and recently (2020–23) has been 120 mt.

Amendment 15 was implemented in 2015 to "improve and expand on the Standardized Bycatch Reporting Methodology" that was previously in place. The amendment is intended to implement "[a] new prioritization process for allocation of observers if agency funding is insufficient to achieve

target observer coverage levels; bycatch reporting and monitoring mechanisms; analytical techniques and allocation of at-sea fisheries observers; a precision-based performance standard for discard estimates; a review and reporting process; framework adjustment and annual specifications provisions; and provisions for industry-funded observers and observer set-aside programs" (80 FR 37182).

Framework 9 to the MSB FMP was implemented in 2015 to address slippage. The framework created consequences for slippage, depending on the reason why slippage occurred. As of September 11, 2015, "[i]f slippage occurs due to safety, mechanical failure, or excess catch of spiny dogfish, the vessel has to move and remain at least 15 nautical miles from the location of slippage; and [i]f slippage occurs for any other reason, the vessel must terminate its trip immediately and return to port. In addition, vessel operator must report a slippage event when it occurs on observed trips via the vessel monitoring system" (80 FR 28244).

Northwest Atlantic | United States | Purse seines | Atlantic herring fishery

Highly effective

The U.S. purse seine fishery for Atlantic herring has very low (<5%) bycatch, with no bycatch of species of concern. According to an analysis of U.S. bycatch data, New England purse seine fisheries targeting Atlantic herring, bluefin tuna, Atlantic menhaden, and other finfish had a bycatch ratio (bycatch/total catch) of <0.01 in 2014 (Table 3.4.1A in (Benaka et al. 2019)). Updated data from observed Atlantic herring trips from 2018 to 2023 showed similarly low bycatch rates (NEFMC 2023b). Therefore, Factor 3.2 is rated highly effective.

Factor 3.3 - Scientific Data Collection and Analysis

Northwest Atlantic | Canada | Purse seines

Moderately Effective

Atlantic mackerel data in Canada include a long time series and rich dataset, including an annual ichthyoplankton survey targeting mackerel eggs. Sampling effort has expanded in recent years in an effort to locate additional spawning aggregations (DFO 2019a). The DFO has an IFMP that is reviewed annually after the fishing season. Annual reviews may lead to changes in TAC levels. In addition to this evaluation, an Atlantic Mackerel Advisory Committee meets at least every year to review the IFMP and advance amendments as appropriate (DFO 2007). The most recent stock assessment was completed in 2021 and addresses stock status through 2020 (DFO 2021a). The DFO regularly updates the Atlantic mackerel stock assessment, which is peer-reviewed. In the 2021 assessment, DFO accounted for uncertainty in total fisheries removals, because landing statistics are known to be underestimated (Van Beveren et al. 2020), particularly landings in the recreational fishery (DFO 2021a). DFO advised that monitoring of all removals could be improved.

Although the at-sea observers are required in the mackerel fishery (DFO 2020), bycatch data collection and analysis is limited and we are unable to assess whether goals are being met for bycatch species such as Atlantic herring. Managers use regular peer-reviewed stock assessments to monitor the health of Atlantic mackerel, but limited bycatch monitoring precludes a highly effective

score. Therefore, this factor is scored moderately effective.

Northwest Atlantic | United States | Midwater trawls | Atlantic herring fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic herring fishery
Northwest Atlantic | United States | Midwater trawls | Atlantic mackerel fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery

Moderately Effective

Since the 1960s, the NEFSC has been conducting annual fishery-independent bottom trawl surveys in the spring to monitor the region's fishery resource (NEFSC 2019). These surveys provide four different types of information: data on the distribution and abundance of fish populations, the food habitat of fishes in the Gulf of Maine, predator-prey relationships, and fish growth and age-at-maturity trends (NOAA 2002). The recent mackerel and herring assessments made use of the ongoing bottom trawl surveys (NEFSC 2018)(NEFSC 2018b). The mackerel assessment also used the dedicated Canadian mackerel egg survey to create a stock-wide egg index for the first time (NEFSC 2018), and the herring assessment used the NMFS summer shrimp survey (NEFSC 2018b). For herring, the spring and fall surveys had three different time periods to account for changes in vessel and gear type (NEFSC 2018b). In addition, individual states conduct bottom trawl surveys to inform fisheries management. Fishery-dependent data that were used include catch at age data from NMFS vessel trip reports (VTR), which are sent from the vessel captain to NMFS on a weekly basis; North American Fisheries Organization (NAFO) reports; Maine Department of Marine Resources (DMR) data collections; and other state landings reports.

The 2018 mackerel assessment utilized fishery-independent and fishery-dependent information to estimate biomass and fishing mortality on a stock-wide basis. Its results seem to be more consistent with and explanatory of trends in landings. Future stock responses based on the projections from the new assessment will ultimately determine whether the new model constitutes an effective approach to assessing and predicting mackerel populations. The herring assessment also uses surveys, vessel trip reports, and biological data from commercial catch (NEFSC 2018b).

Observer coverage in the mackerel and herring fisheries has been relatively low in recent years (MAFMC 2020)(ASMFC 2018)(NMFS 2019b) and bycatch in state waters is largely unquantified (ASMFC 2020b), so caution should be used when extrapolating the limited available bycatch data to the entire directed Atlantic mackerel and herring fisheries. Catch data are provided by vessel trip reports and dealer reports. The Maine Department of Marine Resources (MDMR) conducts commercial portside catch sampling in purse seine and trawl trips for Atlantic herring (ASMFC 2021e). Overall coverage rates could improve in the Atlantic herring fishery under the 2020 NEFMC Industry-Funded Monitoring Omnibus Amendment that established a monitoring program to improve accuracy in catch estimates (85 FR 7414). The goal is to reach 50% monitoring coverage for vessels carrying Category A or B herring permits using midwater trawl, bottom trawl, and purse seine gear, but actual coverage will depend on the amount of funding available in a given year (85 FR 7414). Observer coverage rates in the Atlantic herring fishery in 2022 were 40% in midwater trawls, 1% in purse seines, and 9% in small-mesh bottom trawls (NEFMC 2023c).

Although the management process uses stock assessments to monitor the health, bycatch monitoring is not currently sufficient to meet the highly effective category. This factor is scored moderately effective.

Justification:
Observer coverage rates in 2015 were as follows: midwater trawl (4.7%), purse seine (2.5%), and small mesh bottom trawl (9.1%); this level of coverage may be more indicative of future coverage rates because of revisions made to the SBRM in April 2015 (NMFS and NEFMC 2018). Purse seine includes all purse seine gears, including those targeting tuna. Small mesh bottom trawl includes gear with cod-end mesh size <5.5 in., excluding scallop and shrimp trawls and bottom otter twin trawl (NMFS and NEFMC 2018).

Northwest Atlantic | United States | Purse seines | Atlantic herring fishery

Moderately Effective
A variety of fishery-dependent and -independent data are used in Atlantic herring stock assessments to determine the status of the stock (Wilberg et al. 2020). Since the 1960s, the NEFSC has been conducting annual fishery-independent bottom trawl surveys in the spring to monitor the region's fishery resources (NEFSC 2018b). These surveys provide four different types of information: data on the distribution and abundance of fish populations, the food habitat of fishes in the Gulf of Maine, predator-prey relationships, and fish growth and age-at-maturity trends. The spring and fall surveys had three different time periods to account for changes in vessel and gear type, and the 2018 assessment used the NMFS fall bottom trawl survey as an index of abundance of age 3+ herring (NEFSC 2018b). The following fishery-dependent data have been used in Atlantic herring stock assessments: catch at age data from NMFS vessel trip reports (VTR), which are sent from the vessel captain to NMFS on a weekly basis; North American Fisheries Organization (NAFO) reports; Maine Department of Marine Resources (DMR) data collections; and other state landings reports (NEFSC 2012b). Data on the Canadian weir fishery were provided by the Department of Fisheries and Oceans, Canada and were also used in assessments (NEFMC 2020).

Observer coverage in Atlantic herring fisheries has been relatively low in recent years (ASMFC 2018) (NMFS 2019b) and bycatch in state waters is largely unquantified (ASMFC 2020b), so caution should be used when extrapolating the limited available bycatch data to the entire Atlantic herring fishery. Catch data are provided by vessel trip reports and dealer reports. The Maine Department of Marine Resources (MDMR) conducts commercial portside catch sampling in purse seine and trawl trips for Atlantic herring (ASMFC 2021e). Overall coverage rates could improve in the Atlantic herring fishery under the 2020 NEFMC Industry-Funded Monitoring Omnibus Amendment that established a monitoring program to improve accuracy in catch estimates (85 FR 7414). The goal is to reach 50% monitoring coverage for vessels carrying Category A or B herring permits using midwater trawl, bottom trawl, and purse seine gear, but actual coverage will depend on the amount of funding available in a given year (85 FR 7414). Observer coverage rates in the Atlantic herring fishery in 2022 were 40% in midwater trawls, 1% in purse seines, and 9% in small-mesh bottom trawls (NEFMC 2023c).

Although the management process uses stock assessments to monitor the health, bycatch monitoring is not currently sufficient to meet the highly effective category. This factor is scored

moderately effective.

Justification:
Observer coverage rates in 2015 were as follows: midwater trawl (4.7%), purse seine (2.5%), and small mesh bottom trawl (9.1%); this level of coverage may be more indicative of future coverage rates because of revisions made to the SBRM in April 2015 (NMFS and NEFMC 2018). Purse seine includes all purse seine gears, including those targeting tuna. Small mesh bottom trawl includes gear with cod-end mesh size <5.5 in., excluding scallop and shrimp trawls and bottom otter twin trawl (NMFS and NEFMC 2018).

Factor 3.4 - Enforcement of and Compliance with Management Regulations

Northwest Atlantic | Canada | Purse seines

Highly effective
Canada has several programs and requirements in place to enforce fisheries regulations. Under the Fisheries Act, logbook keeping is mandatory. Logbooks must include information about catch and effort, and these data must be submitted as required by their license. DFO also has an at-sea observer program, dockside monitoring, and vessel monitoring systems, and the at-sea observer program is a component of the Atlantic mackerel fishery (DFO 2020). Though not reported relative to enforcement effort, the number of violations in recent years has increased from an average of 50 violations per year from 2015 to 2017, to 172 violations in 2018 and 104 violations in 2019 (DFO 2020). Approximately 42% of violations were related to registration/license issues and 15% were related to species/size limits (DFO 2020). Although the level of monitoring of the commercial mackerel fishery varies by DFO region, there have been improvements in recent years, including better reporting of landings (DFO 2020). Because the mackerel fishery is monitored at a capacity that is appropriate to the scale of the fishery, enforcement is deemed highly effective.

Northwest Atlantic | United States | Midwater trawls | Atlantic herring fishery
Northwest Atlantic | United States | Purse seines | Atlantic herring fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic herring fishery
Northwest Atlantic | United States | Midwater trawls | Atlantic mackerel fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery

Highly effective
There are three nearly simultaneous reporting mechanisms for the U.S. Atlantic mackerel fishery: 1) vessels with limited access permits, which produce most landings, must report landings electronically on a daily basis via vessel monitoring systems (VMS); 2) any vessel with any federal mackerel permits must complete vessel trip reports (VTR) before landing; and 3) those vessels must sell to federally permitted dealers, who must submit weekly electronic landings reports. This reporting system allows for timely monitoring and multiple opportunities for enforcement (GARFO 2017). Vessels in the Atlantic herring fishery must submit a VMS catch report the day after the trip (even if herring catch is zero), a pre-landing notification, and a weekly VTR (NMFS 2019). Beginning

in 2020, MAFMC and NEFMC began requiring commercial fishers to submit electronic VTRs, instead of paper copies. The NMFS Law Enforcement Office also monitors fishing violations and prevents the illegal, unregulated, and unreported (IUU) harvesting and trafficking of fish and wildlife (NMFS 2021b). In addition, the ASMFC has a Law Enforcement Committee that works with the Federal NOAA Fisheries Law Enforcement department and meets biannually to issue on the status of fisheries enforcement along the Atlantic coast (ASMFC 2021d). Because the fishery has regular enforcement of regulations and does not have a history of noncompliance, enforcement is deemed highly effective.

Factor 3.5 - Stakeholder Inclusion

Northwest Atlantic | Canada | Purse seines

Highly effective

Current and past consultations and reviews for regulatory changes to fisheries are clearly available on the DFO website (https://www.dfo-mpo.gc.ca/fisheries-peches/consultation/index-eng.html). Decisions are required to consider stakeholder comments and feedback. Because the public comment process is encouraged and clearly laid out by DFO, stakeholder inclusion is considered highly effective.

Northwest Atlantic | United States | Midwater trawls | Atlantic herring fishery
Northwest Atlantic | United States | Purse seines | Atlantic herring fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic herring fishery
Northwest Atlantic | United States | Midwater trawls | Atlantic mackerel fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery

Highly effective

All FMPs and new specifications for the Atlantic mackerel and herring fisheries are subject to public meetings and comments from stakeholders and the general public, based on provisions in the Magnuson-Stevens Act (MSA), the National Environmental Policy Act (NEPA), and the Administrative Procedures Act (APA), among other process statutes. Comments are included and addressed in FMP documents, meeting summaries, and/or proposed rules. The public comment process is encouraged and clearly laid out on the MAFMC website (http://www.mafmc.org/public-comment/) and the NEFMC website (https://www.nefmc.org/get-involved). For these reasons, stakeholder inclusion is considered highly effective.

Criterion 4: Impacts on the Habitat and Ecosystem

This Criterion assesses the impact of the fishery on seafloor habitats, and increases that base score if there are measures in place to mitigate any impacts. The fishery's overall impact on the ecosystem and food web and the use of ecosystem-based fisheries management (EBFM) principles is also evaluated. Ecosystem Based Fisheries Management aims to consider the interconnections among species and all natural and human stressors on the environment. The final score is the geometric mean of the impact of fishing gear on habitat score (factor 4.1 + factor 4.2) and the Ecosystem Based Fishery Management score. The Criterion 4 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Guiding principles

- Avoid negative impacts on the structure, function or associated biota of marine habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.
- Follow the principles of ecosystem-based fisheries management.

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

FISHERY	FISHING GEAR ON THE SUBSTRATE	MITIGATION OF GEAR IMPACTS	ECOSYSTEM-BASED FISHERIES MGMT	FORAGE SPECIES?	SCORE
Northwest Atlantic | Canada | Purse seines	Score: 4	Score: 0	High Concern	Yes	**Red (2.828)**
Northwest Atlantic | United States | Midwater trawls | Atlantic herring fishery	Score: 3	Score: 0	High Concern	Yes	**Red (2.449)**
Northwest Atlantic | United States | Midwater trawls | Atlantic mackerel fishery	Score: 3	Score: 0	High Concern	Yes	**Red (2.449)**
Northwest Atlantic | United States | Purse seines | Atlantic herring fishery	Score: 4	Score: 0	Moderate Concern	Yes	**Green (3.464)**
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic herring fishery	Score: 2	Score: 0	High Concern	Yes	**Red (2.000)**
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery	Score: 2	Score: 0	High Concern	Yes	**Red (2.000)**

Forage fish are noted for their functional role in the ecosystem through the transfer of energy to higher trophic levels and marine food webs (Pikitch et al. 2012). The Lenfest Forage Fish Task Force (LFFTF, or "Lenfest") recommendations from Pikitch et al. (2012) are used to guide the scoring of Factor 4.3. The targeted species in this report—and retained bycatch species (i.e., river herring and shad)—are recognized by the DFO, NEFMC, and MAFMC for their important roles as forage species (DFO 2020)(NEFMC 2015) (EBFM PDT 2015), but harvest control rules vary by species. Factor 4.3 is assessed for all targeted and retained species, except where the fishery is known to be a nonsubstantial contributor to a species' mortality. The Atlantic herring and mackerel fisheries are not substantial contributors to American shad or river herring fishing mortality. Therefore, the overall EBFM score for Atlantic mackerel and Atlantic herring trawl fisheries does not consider EBFM of the RH/S complex. The U.S. purse seine fishery for Atlantic herring is highly selective (there are no other main species), so the EBFM score only includes management of Atlantic herring. Lastly, because there is only one main species in the Canadian purse seine fishery, the EBFM score includes management of Atlantic mackerel.

Criterion 4 Assessment

SCORING GUIDELINES

Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate
Goal: The fishery does not adversely impact the physical structure of the ocean habitat, seafloor or associated biological communities.

- *5 - Fishing gear does not contact the bottom*
- *4 - Vertical line gear*
- *3 - Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Or bottom seine on resilient mud/sand habitats. Or midwater trawl that is known to contact bottom occasionally. Or purse seine known to commonly contact the bottom.*
- *2 - Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Or gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Or bottom seine except on mud/sand. Or there is known trampling of coral reef habitat.*
- *1 - Hydraulic clam dredge. Or dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)*
- *0 - Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl)*
  Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts
Goal: Damage to the seafloor is mitigated through protection of sensitive or vulnerable seafloor habitats, and limits on the spatial footprint of fishing on fishing effort.

- *+1 —>50% of the habitat is protected from fishing with the gear type. Or fishing intensity is very low/limited and for trawled fisheries, expansion of fishery's footprint is prohibited. Or gear is specifically modified to reduce damage to seafloor and modifications have been shown to be effective at reducing damage. Or there is an effective combination of 'moderate' mitigation measures.*
- *+0.5 —At least 20% of all representative habitats are protected from fishing with the gear type*

and for trawl fisheries, expansion of the fishery's footprint is prohibited. Or gear modification measures or other measures are in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing that are expected to be effective.

- *0 —No effective measures are in place to limit gear impacts on habitats or not applicable because gear used is benign and received a score of 5 in factor 4.1*

Factor 4.3 - Ecosystem-Based Fisheries Management

Goal: All stocks are maintained at levels that allow them to fulfill their ecological role and to maintain a functioning ecosystem and food web. Fishing activities should not seriously reduce ecosystem services provided by any retained species or result in harmful changes such as trophic cascades, phase shifts or reduction of genetic diversity. Even non-native species should be considered with respect to ecosystem impacts. If a fishery is managed in order to eradicate a non-native, the potential impacts of that strategy on native species in the ecosystem should be considered and rated below.

- *5 — Policies that have been shown to be effective are in place to protect species' ecological roles and ecosystem functioning (e.g. catch limits that ensure species' abundance is maintained at sufficient levels to provide food to predators) and effective spatial management is used to protect spawning and foraging areas, and prevent localized depletion. Or it has been scientifically demonstrated that fishing practices do not have negative ecological effects.*
- *4 — Policies are in place to protect species' ecological roles and ecosystem functioning but have not proven to be effective and at least some spatial management is used.*
- *3 — Policies are not in place to protect species' ecological roles and ecosystem functioning but detrimental food web impacts are not likely or policies in place may not be sufficient to protect species' ecological roles and ecosystem functioning.*
- *2 — Policies are not in place to protect species' ecological roles and ecosystem functioning and the likelihood of detrimental food impacts are likely (e.g. trophic cascades, alternate stable states, etc.), but conclusive scientific evidence is not available for this fishery.*
- *1 — Scientifically demonstrated trophic cascades, alternate stable states or other detrimental food web impact are resulting from this fishery.*

Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate

Northwest Atlantic | United States | Midwater trawls | Atlantic herring fishery
Northwest Atlantic | United States | Midwater trawls | Atlantic mackerel fishery

Score: 3

Most Atlantic mackerel in U.S. waters is currently landed by midwater trawls (58% on average since 2005) (NEFSC 2018) and approximately 25% of Atlantic herring is landed by midwater trawls (NEFMC 2019b). Reports have indicated that, in midwater herring trawls, the foot rope, the belly of the net, and/or the weights can occasionally come in contact with the seafloor (NMFS 2005b)(NEFSC 2006). There is substantial overlap between the midwater trawl fleet for mackerel and herring, to the extent that the permitting process for the Atlantic mackerel fishery has been altered to address the large amount of herring bycatch. It is unknown how frequently midwater trawls in the U.S. mackerel fishery contact the seafloor, but it is likely that bottom contact occurs, based on the fishery's similarity to the herring fishery. Midwater trawls that *occasionally* come into contact with the seafloor score 3 for Factor 4.1.

Northwest Atlantic | United States | Purse seines | Atlantic herring fishery
Northwest Atlantic | Canada | Purse seines

Score: 4

Purse seine gear is not designed to drag along the bottom (Chuenpagdee et al. 2003). The lead lines of purse seines may occasionally contact the seafloor when the net is first set, and when bottom contact occurs, it is likely to occur on flat sand and mud bottom (NMFS 2005b). Purse seine gears that *commonly* contact the bottom typically score 3, but because it has been demonstrated that these gears have minimal impact to seafloor habitats and that contact is occasional, rather than common, this factor is scored 4.

Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic herring fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery

Score: 2

Bottom trawl gear can cause many physical impacts to the habitat/substrate. This gear type is intended to contact the seafloor and results in habitat degradation, damage to sedimentary ecosystems, and decline or collapse of benthic biodiversity. Bottom trawling is considered a major threat to deep seafloor ecosystems (Pusceddu et al. 2014). Atlantic mackerel is found throughout the water column and is not associated with mud and sand (NMFS 1999). The Atlantic mackerel fishery mostly operates in areas of sand/silt/clay, with some potential impacts to areas of gravel or bedrock (MAFMC 2016c). Adult Atlantic herring are capable of inhabiting depths up to 300 m, but seldom migrate below 100 m (NEFMC 2018). Bottom trawls operating over mud and sand and shallow gravel score 2 for Factor 4.1.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Northwest Atlantic | Canada | Purse seines

Score: 0

Purse seine gear have minimal contact with the seafloor and thus have quite low impacts (NEFMC 2022). There are several marine protected areas (MPAs) that are closed to mobile gear in Canada, including the Laurentian Channel (11,580 km^2), St. Anns Bank (4,364 km^2), The Gully (2,363 km^2), Gilbert Bay (60 km^2), and Musquash Estuary, Basin Head, and Eastport (each <10 km^2) (DFO 2023b). Canada's territorial waters in the Atlantic cover over 1 million km^2 (Wallace 2007) and it is unlikely that a substantial proportion of all representative habitats are protected from all bottom contact. Because the fishery has little impact on the bottom, there are no ongoing efforts to make any gear modifications or to employ other measures to further reduce the fishery impact on bottom habitat. Therefore, these fisheries receive 0 for mitigation of gear impacts.

Northwest Atlantic | United States | Midwater trawls | Atlantic herring fishery
Northwest Atlantic | United States | Purse seines | Atlantic herring fishery
Northwest Atlantic | United States | Midwater trawls | Atlantic mackerel fishery

Score: 0

As discussed in the mitigation of gear impacts for the bottom trawl fishery, bottom trawl fishing is restricted in areas where effort overlaps with prime coral habitat (MAFMC 2016c). Midwater trawl gear and purse seine gear have minimal contact with the seafloor and thus have quite low impacts (NEFMC 2022). Amendment 16 does not include midwater trawls or purse seines, although it strictly prohibits contact with the seafloor in managed areas (MAFMC 2016c). Because the fishery has little impact on the bottom, there are no ongoing efforts to make any gear modifications or to employ other measures to further reduce the fishery impact on bottom habitat. Therefore, these fisheries receive 0 for mitigation of gear impacts.

Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic herring fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery

Score: 0

In an effort to reduce damage to essential fish habitat (EFH), Amendment 9 of the Atlantic MSB FMP prohibited bottom trawling in Lydonia Canyon and Oceanographer Canyon to prevent expansion of bottom trawling into this area (MAFMC 2008). In addition, Amendment 16 (Deep Sea Coral Amendment) to the MSB FMP protects deep-sea coral habitat from commercial fishing efforts (Figure 21). The area of protection includes 65% of coral in the region [MAFMC broad coral zones, in number (a) and percent, relative to the total number of records in the MAFMC region] (MAFMC 2016c)(81 FR 90246). Amendment 16 aims to protect deep-sea corals by restricting fishing in areas where effort overlaps with prime coral habitat and by restricting expansion of fishing effort into areas where corals are known or likely to be present (MAFMC 2016c). This amendment limits fishing effort, fishing intensity, and the spatial footprint of damage caused from fishing, and these

limitations are expected to be effective.

Amendment 1 (2009) to the tilefish FMP extended these protections. The amendment implements an IFQ program for the commercial fishery, establishes new reporting requirements, addresses recreational fishing issues, and establishes a ban on the use of bottom-tending mobile gear (including the otter trawls) within four deepwater canyons: Lydonia, Oceanographer, Veatch, and Norfolk Canyons (NMFS 2009). There are also a number of closures for the groundfish fishery in the Gulf of Maine (GoM) and Georges Bank (Figure 22). There are two groundfish closed areas (Western GoM Groundfish Closure, Cashes Ledge Groundfish Closure), eight applicable habitat management areas (HMAs), and two dedicated habitat research areas (Stellwagen DHRA and Georges Bank DHRA) in place to protect essential fish habitat (EFH) from the impacts of bottom trawling and set gillnets (see Figure 21) (GARFO 2018a)(GARFO 2018b). These areas are either closed year-round to all bottom-tending mobile gears, or closed to all fishing vessels, with certain exemptions (see details in Justification).

In addition, there are five GoM cod protection closures in which certain areas are closed to all fishing vessels, with handline (HL) and pelagic longline (LL) exemptions, during certain months (GARFO 2018a)(GARFO 2018b). There are also four seasonal closures affecting all fishing vessels with HL and LL exemptions: 1) Closed Area 1 North Seasonal Closure (1,937 km^2), closed from February 1 to April 15; 2) Winter Massachusetts Bay Spawning Protection Area (310 km^2), closed from November 1 to January 31; 3) Spring Massachusetts Bay Spawning Protection Area (46 km^2), closed from April 15–30; and 4) "Whaleback" GOM Cod Spawning Protection Area (114 km^2), closed from April 1 to June 30 (GARFO 2018a).

But because these spatial management measures do not affect all representative habitats (the criteria document requires a minimum of 20% complete protection for each representative habitat), this fishery received 0 for mitigation of gear impacts.

Justification:
The EFH provision of the Magnuson-Stevens Act establishes guidelines to 1) assist Regional Fishery Councils and the Secretary of Commerce to describe and identify EFH in FMPs; 2) identify adverse effects to EFH; and 3) identify actions that are necessary to conserve EFH (NMFS & NOAA 2002). This provision is meant to protect, conserve, and enhance EFH. Both the NMFS and the Councils are meant to coordinate to develop recommendations to federal and state agencies on actions that would adversely affect EFH. According to the final rule issued by the NMFS, which revises regulations pertaining to the EFH, Councils are meant to identify EFH in FMPs for each life stage of a managed fish species in a fishery management unit (NMFS & NOAA 2002). Furthermore, information on habitats that is required includes the spawning, breeding, feeding, and growth to maturity of managed fish species. Maps need to be provided with geographic boundaries to define the EFH of each species. In addition, Councils are meant to identify habitats of particular concern where EFH are vulnerable to degradation (NMFS & NOAA 2002). FMPs are also meant to include management strategies that reduce the negative impacts of fishing on EFH. But, in the Mid-Atlantic and New England region, the proportion of Council-designated EFH in federal waters that is effectively protected from bottom trawling is small (Figure 3 in (NDRC 2021)).

Amendment 16 created deep-sea coral protections that include: "a broad zone that starts at a depth contour of approximately 450 meters (m) and extends to the U.S. Exclusive Economic Zone (EEZ) boundary, and north and south to the boundaries of the Mid-Atlantic waters (as defined in the Magnuson-Stevens Act). In addition, the deep-sea coral protection area includes 15 discrete zones that outline deep-sea canyons on the continental shelf in Mid-Atlantic waters. The deep-sea coral area, including both broad and discrete zones, is one continuous area" (81 FR 90246). The Amendment also includes a vessel monitoring system requirement as an enforcement measure.

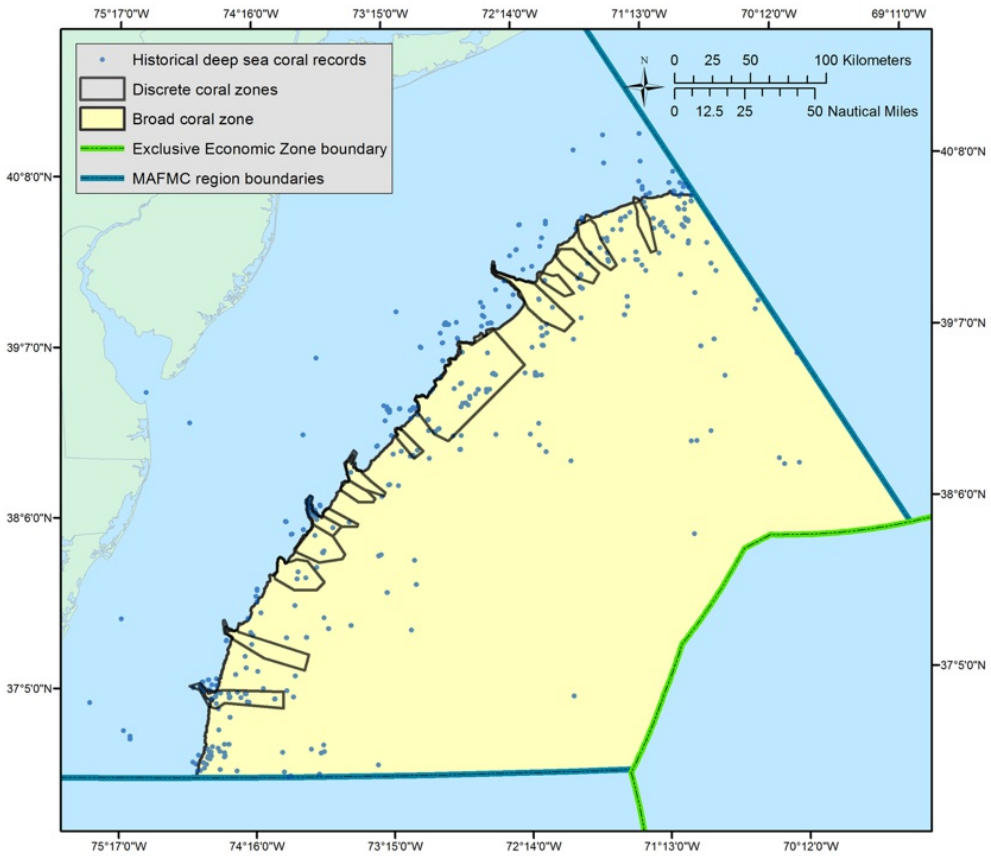


Figure 20: Approximation of deep-sea coral zones (MAFMC 2016c).

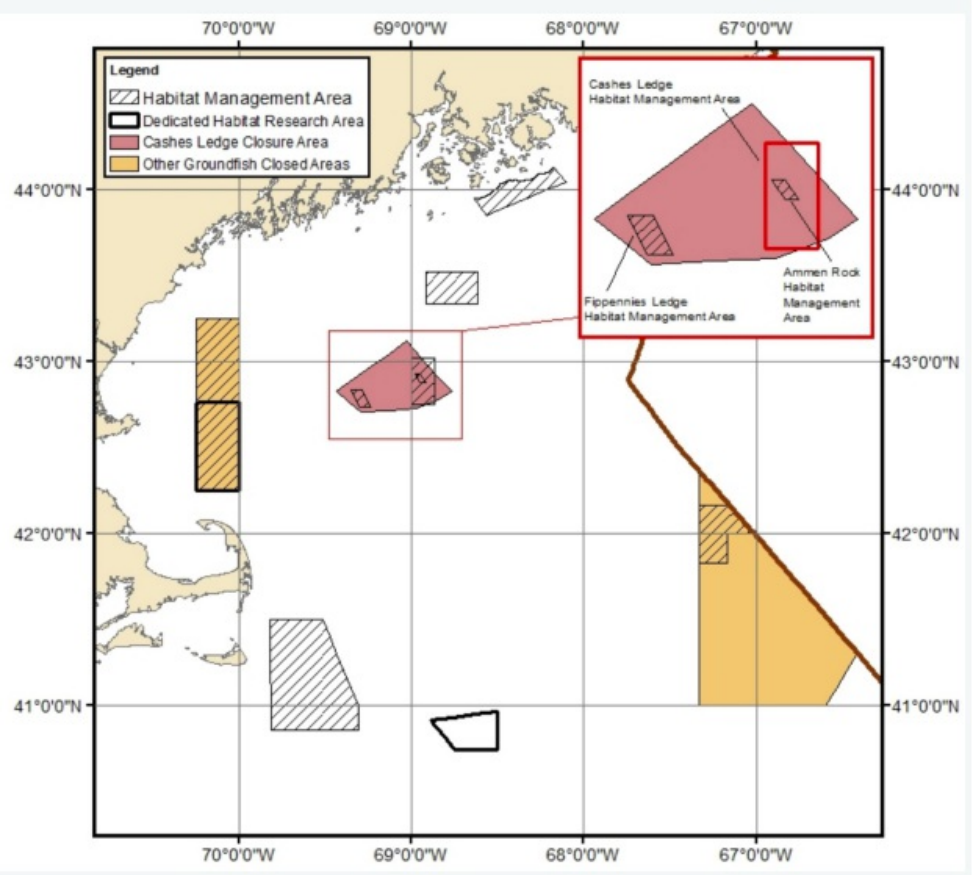


Figure 21: Year-round spatial closures in the Gulf of Maine and Georges Bank region that prohibit bottom trawling (GARFO 2018a).

Closed year-round to all fishing vessels, with exemptions: 1) Western GoM Groundfish Closure (3,030 km^2; HL and LL gears exempted), and the Stellwagen DHRA (large: 1,177 km^2, small: 670 km^2; HL and LL gears exempted); 2) Cashes Ledge Groundfish Closure Area (1,373 km^2; HL and LL gears exempted); 3) the Ammen Rock HMA (15 km^2; closed to all fishing, except lobster traps); and 4) Closed Area II (2,650 km^2; HL and LL gears exempted) {NEFMC 2016}(GARFO 2018a)(GARFO 2018b). Closed year-round to all bottom-tending mobile gears: 1) Western GoM Habitat Closure Area (2,272 km^2); 2) Cashes Ledge HMA (443 km^2); 3) Fippennies Ledge HMA (45 km^2); 4) Eastern Maine HMA (483 km^2); 5) Jeffrey's Bank HMA (499 km^2); 6) Georges Bank DHRA (584 km^2); 7) Closed Area II Habitat Closure Area (641 km^2, which is an HMA); and 8) two Great South Channel HMAs (2,301 km^2) {NEFMC 2016}(GARFO 2018a)(GARFO 2018b).

Closures to set gillnet and bottom trawl gear roughly equated to 9,810 km^2 in total closure area, not including seasonal closures, and 13,430 km^2 in total closure area including seasonal closures, where overlapping closures were accounted for {NEFMC 2016}(GARFO 2018a)(GARFO 2018b). GoM cod protection closures in May and June provided an additional 10,000 km^2 of closure area.

Factor 4.3 - Ecosystem-based Fisheries Management

Northwest Atlantic | Canada | Purse seines

High Concern

Atlantic mackerel is one of the main forage species in the Gulf of St. Lawrence and the Northwest Atlantic (Savenkoff et al. 2005)(DFO 2020), and the species meets the criteria for a key forage species in the Northwest Atlantic (Appendix 3). The primary predators of Atlantic mackerel in the Northeast U.S. continental shelf ecosystem fish community are spiny dogfish, white hake, northern silver hake, winter skate, and southern goosefish (Tyrrell et al. 2008), but predation estimates from other species (i.e., marine mammals, seabirds, and highly migratory species) are unavailable (NEFSC 2018d).

DFO has developed a policy for managing *new* forage fish fisheries with the objective of sustaining ecosystem integrity, and under this policy, DFO notes that "existing forage species fisheries are being reviewed against the principles of the new policy. Any adjustments that may be identified will be discussed through the fishery advisory processes" (DFO 2009b). But it is unclear how the policy and guidance has affected Atlantic mackerel, if it has at all. For example, the rebuilding strategies within the MSE do not consider the needs of dependent predators in any of the HCRs, nor is the ecological role of mackerel factored into management objectives (DFO 2020). Although DFO recently coordinated a workshop with the objectives stated as follows: "(1) Develop a fully operational Maritimes Ecosystem-Based Management (EBM) Framework to assess the cumulative impacts of fishing, and (2) Develop a common vision for a Maritimes ecosystem approach to management (EAM) Framework to assess the cumulative impacts of multiple activities," the Mackerel IFMP was excluded from the analysis because it has not been updated for over a decade (Daly et al. 2020).

Ecosystem considerations in the Canadian Atlantic mackerel fishery are limited to prey species. Assessments discuss mackerel condition and recruitment that are "largely explained by environmental variability," which is most likely driven by "variations in abundance, species composition and phenology" (DFO 2014). The IFMP lacks spatial management and other policies to protect ecosystem functioning and account for capture species' ecological roles. Like their U.S. counterparts, DFO manages Atlantic mackerel with an F_{MSY} proxy of $F_{40\%}$, despite more conservative reference points for forage species recommended by LFFTF; i.e., fishing mortality should not exceed 75% F_{MSY} in high information situations, or 50% F_{MSY} in more intermediate information situations (Pikitch et al. 2012).

The Canadian Atlantic mackerel fishery currently lacks a conservative HCR that is consistent with Lenfest recommendations, with buffers built in to account for the needs of dependent predators. In addition, the likelihood of trophic cascades, alternative stable states, or other detrimental food web impacts resulting from the fishery are high, but conclusive scientific evidence specifically related to the fishery is lacking. Therefore, ecosystem-based fisheries management is a high concern.

Northwest Atlantic | United States | Midwater trawls | Atlantic herring fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic herring fishery
Northwest Atlantic | United States | Midwater trawls | Atlantic mackerel fishery
Northwest Atlantic | United States | Small mesh bottom trawls | Atlantic mackerel fishery

High Concern

Atlantic herring is considered a species of exceptional importance to the Northwest Atlantic ecosystem because of its role as a forage fish. The Lenfest report recommends a buffer of 50% from F_{MSY} for fisheries with moderate data availability, to preserve forage fish in their natural environment (Pikitch et al. 2012). A 2015 report by the NEFMC's Ecosystem-Based Fisheries Management (EBFM) Committee provided six harvest control rules (including a Lenfest rule) to consider in setting Atlantic herring allowable biological catches (ABC). EBFM modeling suggests that higher biomass levels are maintained when biomass-based control rules are used (i.e., F is decreased as B declines) (EBFM PDT 2015).

The MAFMC recently implemented a policy to move from single-species focused management toward one focused on multispecies/ecosystem, and it created a nonregulatory Guidance Document to provide a framework to incorporate ecosystem considerations into management policies (MAFMC 2019c). The Guidance Document states, "It shall be the policy of the Council to support the maintenance of an adequate forage base in the Mid-Atlantic to ensure ecosystem productivity, structure and function and to support sustainable fishing communities" and "the Council could adopt biological reference points (overfishing levels or OFL) for forage stocks that are more conservative than the required MSA standard of F_{MSY}" (MAFMC 2019c). In addition, the Council has made multiple management decisions to protect habitat—both EFH and deep-sea coral habitat (81 FR 66245).

The Atlantic herring fishery is managed with precautionary policies intended to protect the ecological role of Atlantic herring, temporal and spatial management to protect spawning areas and prevent localized depletion, and a harvest control rule with built-in buffers to account for the needs of dependent predators. The HCR for Atlantic herring aligns with the principles of the standards set forth by the Lenfest Forage Fish Task Force, but management targets are slightly less conservative: the HCR allows for a maximum F of 80% F_{MSY} and for fishing down to 10% B_0 (84 FR 54094), which is higher than the 75% F_{MSY} and lower than the 30% B_0 recommended by Lenfest (Pikitch et al. 2012). The EBFM measures for Atlantic herring exceed the threshold for a high concern score, but fall short of a low concern score for this forage species. For Atlantic mackerel, some policies are in place and new management strategies are being developed to protect Atlantic mackerel's ecological role and ecosystem function, but management of this species does not currently meet the threshold for a moderate concern score.

The EBFM score is based on all the fishery's main targeted and retained species/stocks, which include the GoM/GB Atlantic herring stock complex and two Atlantic mackerel stocks (northern and southern spawning contingents). Atlantic herring in the Gulf of Maine is considered a key forage species, as is Atlantic mackerel in the Canadian Atlantic (Appendix 3). Of the three *targeted* stocks encountered by the U.S. fishery, only the Atlantic mackerel southern spawning contingent fails to

meet the criteria for a key forage species (Appendix 3). Therefore, Seafood Watch applies the forage species guidance to GoM/GB Atlantic herring and the Atlantic mackerel northern spawning contingent. Seafood Watch scores Factor 4.3 as high concern if a fishery is a substantial contributor to fishing mortality for forage fish species and the fishery lacks a conservative, ecological harvest control rule that is consistent with the Lenfest recommendations, with buffers built-in to account for the needs of dependent predators. Because Atlantic mackerel (northern spawning contingent) is not managed with an ecological harvest control rule that accounts for the needs of dependent predators, this factor is scored a high concern.

Justification:

Harvest Control Rules and Reference Points

Atlantic herring

In January, 2021, the NMFS published a final rule developed to account for the ecological role of Atlantic herring. Under this proposed rule, "when biomass is at or above 50 percent of the biomass associated with maximum sustainable yield (B_{MSY}) or its proxy, ABC is the catch associated with a maximum fishing mortality (F) of 80 percent of F_{MSY} or its proxy. When biomass falls below 50 percent of B_{MSY} or its proxy, F declines linearly to 0 at 10 percent of B_{MSY} or its proxy" (84 FR 54094). This rule follows the Lenfest recommendation that forage fish should be managed with "an upper limit to fishing mortality (MAX F), a lower limit to forage fish abundance below which targeting fishing ceases (B_{LIM}), and that fishing mortality be reduced as the lower abundance limit is approached" (Pikitch et al. 2012).

A 2015 report by the NEFMC's Ecosystem-Based Fisheries Management (EBFM) Committee provided six harvest control rules (including a Lenfest rule) to consider in setting Atlantic herring ABCs. EBFM modeling suggests that higher biomass levels are maintained when biomass-based control rules are used (i.e., F is decreased as B declines) (EBFM PDT 2015). NEFMC evaluated multiple alternatives to setting the ABC control rule under Amendment 8, before settling on Alternative 4b Revised (see Figure 22) (NEFMC 2019b). The final rule was selected to balance the goals of the FMP, and the Council "considered [it] a good compromise; it recognizes the important role of herring in the ecosystem, as forage for predators, as well as an important source of revenue for fishing communities in the Northeast including the directed herring fishery, the lobster fishery that uses herring as bait, as well as many other commercial and recreational businesses that focus on predators of herring" (NEFMC 2019b).

As noted previously, in January 2021, the NMFS published a final rule developed to account for the ecological role of Atlantic herring. Under this proposed rule, "when biomass is at or above 50 percent of the biomass associated with maximum sustainable yield (B_{MSY}) or its proxy, ABC is the catch associated with a maximum fishing mortality (F) of 80 percent of F_{MSY} or its proxy. When biomass falls below 50 percent of B_{MSY} or its proxy, F declines linearly to 0 at 10 percent of B_{MSY} or its proxy" (84 FR 54094). The original rule in the Draft Environmental Impact Statement (DEIS) set the maximum fishing rate to 70% of F_{MSY}, but this was increased to 80% of F_{MSY} in the Final EIS (FEIS) to allow for high fishing levels when the stock is not overfished (i.e., when SSB > 0.5

SSB_{MSY}) (p. 299 in (NEFMC 2019b)). Under the 2023–2025 Specifications, the fishing mortality reference point was set to 50% of F_{MSY}; the average F in 2021 was 31% of this threshold (NEFMC 2023).

Managers selected a biomass-based control rule under Amendment 8 to the Atlantic herring FMP, demonstrating a commitment to using harvest control rules that set a priority on maintaining biomass at the cost of high variability in yield (EBFM PDT 2015). The final rule was designed to manage "the fishery at long-term sustainable levels, taking forage for predators into account to support the ocean ecosystem, and providing a biologically sustainable harvest as a source of revenue for fishing communities and bait for the lobster fishery" {Federal Registrar 2021}. Under Amendment 8, Atlantic herring specifications (quotas) are set using a level that approximates to a 20% buffer from F_{MSY} to account for the ecosystem role of herring (NEFMC 2019b). So, while the full 50% buffer was not used, the Atlantic herring fishery is a data-rich fishery, and ecosystem characteristics were taken into consideration in the quota setting process. Siple et al. (2018) suggest that the effectiveness of control rules for anchovy-like species (which include herring) is greatly diminished if detection of declining biomass is delayed (especially related to collapse severity and duration). But, the application of the "hockey-stick" rule is more likely to result in reduced risk and severity of collapses, even when detection is delayed (Siple et al. 2018). The Atlantic herring fishery is currently managed with the hockey-stick rule that may improve ecological metrics, though at the long-term cost of catches and catch stability (Siple et al. 2018).

Atlantic mackerel

The MAFMC is making steps to move from single-species focused management toward one focused on multispecies/ecosystem. The approach the MAFMC has decided to take is transitional, working to implement policy in steps, and is referred to as an ecosystem approach to fisheries management (EAFM). Assessment and management frameworks will include environmental drivers, habitat and climate change, species interactions, and fleet interactions. The Council stated the needs for a guidance document to assist in the process through improved management decisions by incorporating biophysical and socioeconomic information on ecosystem climate conditions, climate change, habitat, and ecosystem interactions; maintaining adequate forage base and dynamics of ecosystem in management decisions; taking ecosystem into account when developing management measures; and coordinating across FMPs. This Guidance Document was approved by the MAFMC in August 2016 (MAFMC 2016d) and revised in 2019 (MAFMC 2019c).

In relation to mackerel, the document states the following: "Modifications to the existing risk policy to accommodate ecosystem level concerns for forage species could be accomplished by reducing the maximum tolerance for risk of overfishing. For example, forage species currently managed by the Council (Illex and longfin squid, butterfish, and mackerel) could be managed by maintaining the current OFL fishing mortality rate (F_{MSY} based or proxy) and reducing the maximum probability of overfishing to 35% (the default value chosen for atypical species) or some other level below the current maximum of 40%. In addition ... the Council could specify a control rule that reduces fishing mortality more aggressively as forage stock biomass declines (to address the concern that fishing tends to exacerbate environmentally driven declines in forage stocks)" (MAFMC 2016d). Though the Guidance Document provides a framework for managing forage species, the MAFMC has

yet to develop an optimal forage fish harvest policy (MAFMC 2019).

The Council's EAFM Guidance Document provides a framework for adopting conservative reference points for forage species, but an optimal forage fish harvest policy has not been established because "the science to evaluate the biological and socioeconomic tradeoffs of more precautionary management is lacking" and the Council has adopted a policy that would promote research to improve an understanding of these tradeoffs (MAFMC 2019). Therefore, Atlantic mackerel is currently managed with an F_{MSY} proxy of $F_{40\%}$, despite more conservative reference points for forage species recommended by LFFTF (MAFMC 2019c)(Pikitch et al. 2012).

Spatial Management

As mentioned under Factor 4.1, the MAFMC has made efforts to protect habitat through Amendment 9 and Amendment 16 to protect deep-sea coral habitat from commercial fishing efforts; several essential fish habitats (EFHs) areas within the New England and Mid-Atlantic regions are closed to bottom trawling (NOAA 2021c)(NOAA 2021d). There are annual spawning closures for the entire fishery. Three spawning areas (eastern Maine, western Maine, and Massachusetts/New Hampshire) are closed for 4 to 6 weeks in the fall and summer, with exact closure dates determined by spawning condition (ASMFC 2018). Additional spawning protections on Georges Bank are currently being considered under Framework Adjustment 7; however, the restriction would only apply to vessels on a declared Atlantic herring trip (NEFMC 2021b). Under Amendment 8 to the Atlantic Herring FMP, inshore waters (12 nautical miles from shore) from the United States–Canada border to the Rhode Island–Connecticut border were closed to midwater trawling, as are the inshore waters (20 nautical miles) off the east coast of Cape Cod {Federal Registrar 2021}. The NEFMC implemented this measure to minimize local depletion of Atlantic herring, help ensure that herring are available to predators, and reduce user group conflict; the closure may also have benefits to river herring and shad {Federal Registrar 2021}. But, the measure was recently overturned (88 FR 17397).

Northwest Atlantic | United States | Purse seines | Atlantic herring fishery

Moderate Concern

Atlantic herring is considered a species of exceptional importance to the northeast ecosystem because of its role as a forage fish. The Lenfest report recommends a buffer of 50% from F_{MSY} for fisheries with moderate data availability, to preserve forage fish in their natural environment (Pikitch et al. 2012). A 2015 report by the NEFMC's Ecosystem-Based Fisheries Management (EBFM) Committee provided six harvest control rules (including a Lenfest rule) to consider in setting Atlantic herring allowable biological catches (ABC). EBFM modeling suggests that higher biomass levels are maintained when biomass-based control rules are used (i.e., F is decreased as B declines) (EBFM PDT 2015).

The Atlantic herring fishery is managed with precautionary policies intended to protect the ecological role of Atlantic herring, temporal and spatial management to protect spawning areas and prevent localized depletion, and a harvest control rule with built-in buffers to account for the needs of dependent predators. The HCR for Atlantic herring aligns with the principles of the standards set forth by the Lenfest Forage Fish Task Force, but management targets are slightly less conservative:

the HCR allows for a maximum F of 80% F_{MSY} and for fishing down to 10% B_0 (84 FR 54094), which is higher than the 75% F_{MSY} and lower than the 30% B_0 recommended by Lenfest (Pikitch et al. 2012). The EBFM measures implemented under Amendment 8 exceed the threshold for a high concern score, but fall short of a low concern score for this forage species. Therefore, a moderate concern score is awarded.

Justification:

Harvest Control Rule and Reference Points

In January, 2021, the NMFS published a final rule developed to account for the ecological role of Atlantic herring. Under this proposed rule, "when biomass is at or above 50 percent of the biomass associated with maximum sustainable yield (B_{MSY}) or its proxy, ABC is the catch associated with a maximum fishing mortality (F) of 80 percent of F_{MSY} or its proxy. When biomass falls below 50 percent of B_{MSY} or its proxy, F declines linearly to 0 at 10 percent of B_{MSY} or its proxy" (84 FR 54094). This rule follows the Lenfest recommendation that forage fish should be managed with "an upper limit to fishing mortality (MAX F), a lower limit to forage fish abundance below which targeting fishing ceases (B_{LIM}), and that fishing mortality be reduced as the lower abundance limit is approached" (Pikitch et al. 2012).

A 2015 report by the NEFMC's Ecosystem-Based Fisheries Management (EBFM) Committee provided six harvest control rules (including a Lenfest rule) to consider in setting Atlantic herring ABCs. EBFM modeling suggests that higher biomass levels are maintained when biomass-based control rules are used (i.e., F is decreased as B declines) (EBFM PDT 2015). NEFMC evaluated multiple alternatives to setting the ABC control rule under Amendment 8, before settling on Alternative 4b Revised (Figure 22) (NEFMC 2019b). The final rule was selected to balance the goals of the FMP, and the Council "considered [it] a good compromise; it recognizes the important role of herring in the ecosystem, as forage for predators, as well as an important source of revenue for fishing communities in the Northeast including the directed herring fishery, the lobster fishery that uses herring as bait, as well as many other commercial and recreational businesses that focus on predators of herring" (NEFMC 2019b).

As noted previously, in January, 2021, the NMFS published a final rule developed to account for the ecological role of Atlantic herring. Under this proposed rule, "when biomass is at or above 50 percent of the biomass associated with maximum sustainable yield (B_{MSY}) or its proxy, ABC is the catch associated with a maximum fishing mortality (F) of 80 percent of F_{MSY} or its proxy. When biomass falls below 50 percent of B_{MSY} or its proxy, F declines linearly to 0 at 10 percent of B_{MSY} or its proxy" (84 FR 54094). The original rule in the Draft Environmental Impact Statement (DEIS) set the maximum fishing rate to 70% of F_{MSY}, but this was increased to 80% of F_{MSY} in the Final EIS (FEIS) to allow for high fishing levels when the stock is not overfished (i.e., when SSB > 0.5 SSB_{MSY}) (p. 299 in (NEFMC 2019b)). Under the 2023–2025 Specifications, the fishing mortality reference point was set to 50% F_{MSY}; the average F in 2021 was 31% of this threshold (NEFMC 2023).

Managers selected a biomass-based control rule under Amendment 8 to the Atlantic herring FMP, demonstrating a commitment to using harvest control rules that set a priority on maintaining biomass at the cost of high variability in yield (EBFM PDT 2015). The final rule was designed to manage "the fishery at long-term sustainable levels, taking forage for predators into account to support the ocean ecosystem, and providing a biologically sustainable harvest as a source of revenue for fishing communities and bait for the lobster fishery" {Federal Registrar 2021}. Under Amendment 8, Atlantic herring specifications (quotas) are set using a level that approximates to a 20% buffer from F_{MSY} to account for the ecosystem role of herring (NEFMC 2019b). So, while the full 50% buffer was not used, the Atlantic herring fishery is a data-rich fishery, and ecosystem characteristics were taken into consideration in the quota setting process. Siple et al. (2018) suggest that the effectiveness of control rules for anchovy-like species (which include herring) is greatly diminished if detection of declining biomass is delayed (especially related to collapse severity and duration). But the application of the "hockey-stick" rule is more likely to result in reduced risk and severity of collapses, even when detection is delayed (Siple et al. 2018). The Atlantic herring fishery is currently managed with the hockey-stick rule that may improve ecological metrics, though at the long-term cost of catches and catch stability (Siple et al. 2018).

	Upper Biomass Parameter	Lower Biomass Parameter	Max F (Proportion of Fmsy)
Alt1. No Action	N/A	N/A	N/A
Alt 1a. Strawman A	0.5	0.0	0.9
Alt 2. Strawman B	2.0	1.1	0.5
Alt 3. Parameters upfront	0.7	0.3	0.9
Alt 4a. MeetCriteria1	0.5	0.0	0.7
Alt 4b. MeetCriteria2	0.5	0.1	0.7
Alt 4c. MeetCriteria3	0.5	0.3	0.7
Alt 4d. MeetCriteria4	0.7	0.0	0.7
Alt 4e. MeetCriteria5	0.7	0.3	0.6
Alt 4f. MeetCriteria6	1.0	0.0	0.6
Alt 4b. Revised (Proposed)	**0.5**	**0.1**	**0.8**

Figure 22: Parameters for the ABC control rule alternatives under Amendment 8 to the Atlantic Herring FMP.

Spatial and Temporal Management

There are annual spawning closures for the entire fishery. Three spawning areas (eastern Maine, western Maine, and Massachusetts/New Hampshire) are closed for 4 to 6 weeks in the fall and summer, with exact closure dates determined by spawning condition (ASMFC 2018). Additional spawning protections on Georges Bank are currently being considered under Framework Adjustment 7; however, the restriction would only apply to vessels on a declared Atlantic herring trip (NEFMC 2021b). Under Amendment 8 to the Atlantic Herring FMP, inshore waters (12 nautical miles from

shore) from the United States–Canada border to the Rhode Island/Connecticut border were closed to midwater trawling, as were the inshore waters (20 nautical miles) off the east coast of Cape Cod {Federal Registrar 2021}. The NEFMC implemented this measure to minimize local depletion of Atlantic herring, help ensure that herring are available to predators, and reduce user group conflict; the closure may also have benefits to river herring and shad {Federal Registrar 2021}. But, the measure was recently overturned (88 FR 17397).

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Scientific review does not constitute an endorsement of the Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

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Appendix A: Updates to the Atlantic Mackerel and Atlantic Herring Report

Updates to the Atlantic Mackerel and Atlantic Herring Report

Overall Recommendations for Atlantic mackerel caught with all gears in all regions remained unchanged.

Overall Recommendations for Atlantic herring caught with midwater trawls in the U.S. were downgraded from a Yellow rating to a Red rating.

Overall Recommendations for Atlantic herring caught with purse seines in the U.S. were downgraded from a Green to a Yellow rating.

The Seafood Watch Atlantic Mackerel report was published in 2020 (SFW standard version F3) and the Atlantic Herring report was published in 2014 (SFW standard version F2). Seafood Watch merged these two reports into a single report in January 2024 (SFW standard version F4). Therefore, the following scoring changes are presented relative to the scoring in both reports.

Species (country)	Fishery (year of report)	Factor(s)	Previous score(s)	Updated score(s)
Atlantic mackerel (U.S.)	U.S. Atlantic herring (2014)	2.1 Abundance 2.2 Fishing mortality	Moderate concern Moderate concern	High concern Moderate concern
Atlantic herring (U.S.)	U.S. Atlantic herring (2014)	1.1 Abundance 1.2 Fishing mortality	Very low concern Very low concern	High concern Low concern
Atlantic herring (U.S.)	U.S. Atlantic mackerel (2020)	1.1 Abundance 1.2 Fishing mortality	Moderate concern High concern	
River herring (U.S.)	U.S. Atlantic mackerel (2020)	2.2 Fishing mortality	High concern	Low concern

Criterion 1

Atlantic herring relative to scoring in the 2014 Atlantic Herring report

- *Abundance* downgraded from very low concern to high concern, because the stock is overfished.

Criterion 2

Atlantic herring (Criterion 2) relative to scoring in the 2020 Atlantic Mackerel report

- Atlantic herring was removed as a C2 species from the Canadian Atlantic mackerel fishery because bycatch of Atlantic herring in purse seines is considered negligible.

Atlantic herring (Criterion 2) relative to scoring in the 2020 Atlantic Mackerel report

- *Fishing mortality* upgraded from high concern to low concern, because fishing mortality is below sustainable levels.

Atlantic mackerel (Criterion 2) relative to scoring in the 2014 Atlantic Herring report

- *Abundance* downgraded from moderate concern to high concern, because the stock is overfished.

Alewife was removed as a C2 species from the Atlantic herring fishery and is now included in the scoring of "river herring unspecified."

American shad was added as a C2 species in the U.S. Atlantic mackerel fisheries (bottom trawl and midwater trawl) because managers consider it a primary nontarget species of concern.

Haddock and long-finned pilot whale were removed as C2 species from the Atlantic herring fishery because neither species fits the criteria for a main species in the Atlantic herring fishery.

River herring caught in the U.S. Atlantic mackerel fisheries

- *Fishing mortality* upgraded from high concern to low concern because the fishery is not a substantial contributor to fishing mortality.

Criterion 3

C3.1 U.S. Atlantic herring midwater trawl and purse seine fisheries

- Management Strategy downgraded from highly effective to moderately effective, because there is uncertainty in the effectiveness of management measures for the Atlantic herring Scotian Shelf stock complex that is incidentally caught and retained in the fishery.

C3.2 U.S. Atlantic mackerel midwater trawl and bottom trawl fisheries

- Bycatch Mitigation upgraded from moderately effective to highly effective, because there are precautionary strategies and goals in place to minimize impacts on bycatch species and there is evidence that these strategies are effective.

Criterion 4

C4.3 U.S. Atlantic herring midwater trawl; U.S. Atlantic mackerel midwater trawl and bottom trawl fisheries

- EBFM downgraded from low concern to high concern, because at least 30% of the fishery's main targeted and retained species/stocks lack ecological HCRs that are consistent with the Lenfest recommendations.

Appendix B: Management Plan Updates

Management plan updates since Seafood Watch report publication

Atlantic mackerel FMP changes since the 2020 Seafood Watch report

- Omnibus Acceptable Biological Catch and Risk Policy Framework Adjustment (2020): "For stocks not subject to a rebuilding plan that have a ratio of biomass (B) to biomass at maximum sustainable yield (B_{MSY}) of 1.0 or lower, the maximum P* as informed by the overfishing limit (OFL) distribution will decrease linearly from a maximum value of 45 percent until the P* becomes zero at a B/B_{MSY} ratio of 0.10. For stocks with biomass that exceeds B_{MSY} and the B/B_{MSY} ratio is greater than 1.0, the P* will increase linearly from 45 percent to a maximum of 49 percent when the B/B_{MSY} ratio is equal to 1.5 or greater. Under the current risk policy, the maximum allowed P* is capped at 40 percent for stocks with a B/B_{MSY} ratio of 1.0 or higher, with this probability decreasing linearly until P* becomes zero at the B/B_{MSY} ratio of 0.10" {85 FR 81152 2020}.
- Omnibus Commercial Electronic Reporting Framework (2020): Commercial and for-hire fishing vessels are required to submit vessel trip reports electronically within 48 hours of the end of the trip.
- Amendment 23 (2023) established a revised rebuilding plan for Atlantic mackerel (88 FR 6665).

Atlantic herring FMP changes since the 2014 Seafood Watch report

- Amendment 3 (2016) implements a quota rollover of up to 10%, specifications are set for up to 3 years, sector-specific closures as management area catch approaches its respective sub-ACL, 2,000-lb. bycatch allowance continues when the directed fishery is closed, 3% research set-aside, 500 mt fixed gear set-aside in Area 1A, annual 4–6 week spawning closure for three defined spawning areas, prohibition for directed harvest for reduction ("directed mealing"), and prohibition of internal water processing in all state waters (ASMFC 2016b).
- Addendum I (2017) includes management measures intended to stabilize the rate of catch in the Area 1A fishery and distribute the seasonal quota throughout June–September (ASMFC 2021c).
- Addendum II (2019) initiates a closure in Area 1A when a lower percentage of the population is spawning, extends the closure from 4 weeks to 6, and recloses the fishery when 20% or more of the sampled herring are mature but have not yet spawned (ASMFC 2021c).
- Framework Adjustment 6 (2020) reduced the ACL in 2018 from 104,800 mt to 49,900 mt, and in 2019 from 49,900 mt to 15,065 mt. ACLs were reduced because Atlantic herring was approaching an overfished condition. The 2020–21 ACL was reduced further to 11,571 mt {85 FR 26874 2020}.
- Omnibus IFM Amendment (2020) established an industry-funded monitoring program to improve the accuracy of catch estimates of Atlantic herring, haddock, and river herring/shad.
- Framework Adjustment 9 includes Atlantic herring rebuilding measures and measures to potentially adjust accountability measures. A brief summary of proposed measures is available from the April 23, 2021 NEFMC press release. The final rule can be found at the Federal Registrar.

Appendix C: Forage Species Determination

Version 4 of the Seafood Watch Standard for Fisheries (Seafood Watch 2020) updated requirements around "forage species" as follows (Seafood Watch 2020a):

- Criterion 1: Acknowledges the high level of uncertainty associated with static reference points and lowers the score where B > B_{MSY} for forage species (relative to nonforage species). Specifically, static reference points with stationary parameters such as unfished biomass and B_0 are not considered to meet this requirement for forage species, because of those species' dynamic productivity that shifts in response to environmental conditions.
- Criterion 3: Requires adaptive and flexible management to account for environmental driven biomass and fluctuating populations (not just for forage species).
- Criterion 4: Requires a greater understanding of forage species' roles in the ecosystem to obtain a moderate concern rating or better. Addition of a critical score for when there is evidence of fisheries affecting the ecosystem; e.g., trophic cascades.

According to the glossary of Version 4 of the Seafood Watch Standard for Fisheries (Seafood Watch 2020):

"Forage species play an important role in food webs because they 1) exhibit high connectance to other organisms in the ecosystem, and 2) a large amount of energy is channeled through that species. Forage species typically exhibit highly variable productivity, such that there may be high uncertainty in their reference points, making it difficult to evaluate their stock status. The drivers of this variability in productivity may be environmental forcing and/or other factors. As a result of their importance in food webs, these stocks require management that is tailored to their specific life histories and ecological roles. Species that generally qualify as forage species include sandeels, sandlances, herrings, menhaden, pilchards, sardines, sprats, anchovies, krill, lanternfish, smelts, capelin, mackerels, silversides, sand smelts, Norway pout (adapted from MSC Fisheries Standard V2.01, p. 14). Other species or stocks may qualify if they meet the definition above."

In order to determine whether a species within a particular ecosystem is defined as a forage species, it must fulfill both the criteria in the glossary term: 1) exhibits high connectance and 2) serves as a channel for a large amount of energy. To identify a species' potential key role, a forthcoming white paper commissioned by Seafood Watch computed three indices using data and food webs applied to existing static ecosystem models. The connectance index and the SUpportive Role to Fishery ecosystems (SURF) index were calculated from mass-balanced models and an energy index from energy-balanced models. Excerpts from that study follow. The supporting data are available upon request.

Gulf of Maine

Dias et al. (2022) developed a food web model for the Gulf of Maine, which is in the Northwest Atlantic at the United States–Canada border, ranging from approximately 44° N. to 41° N. and 71° W. to 65° W. (Figure A1). The Gulf of Maine ecoregion comprises a total area of 79,128 km^2 that is enclosed to the west and north by the North American mainland and linked to the ocean to the southeast through one major channel (Figure A1). Important rivers include the Penobscot, Kennebec, and Androscoggin. The Gulf's waters are largely isolated from the ocean to the south by shoals and banks that restrict flows into and out of the Gulf. The three major basins within the Gulf are isolated from each other beneath the 650-foot (200-

m) isobath. The Gulf's cold waters, extreme tidal mixing, diverse bottom, and coastal kelp forests enable its biodiversity and high productivity. Both anadromous and oceanodromous forage fish species are of great importance to the ecosystem's food webs and fisheries' productivity (Dias et al. 2019). River herring [alewife (*Alosa pseudoharengus*) and blueback herring (*A. aestivalis*)] and American shad (*A. sapidissima*) dominate the anadromous forage fish pool. Dias et al. (2022) developed this food web model to assess how increasing river-to-ocean connectivity that resembled 19th-century conditions would potentially affect the ecosystem with data collection from 2000 (Dias et al. 2022).

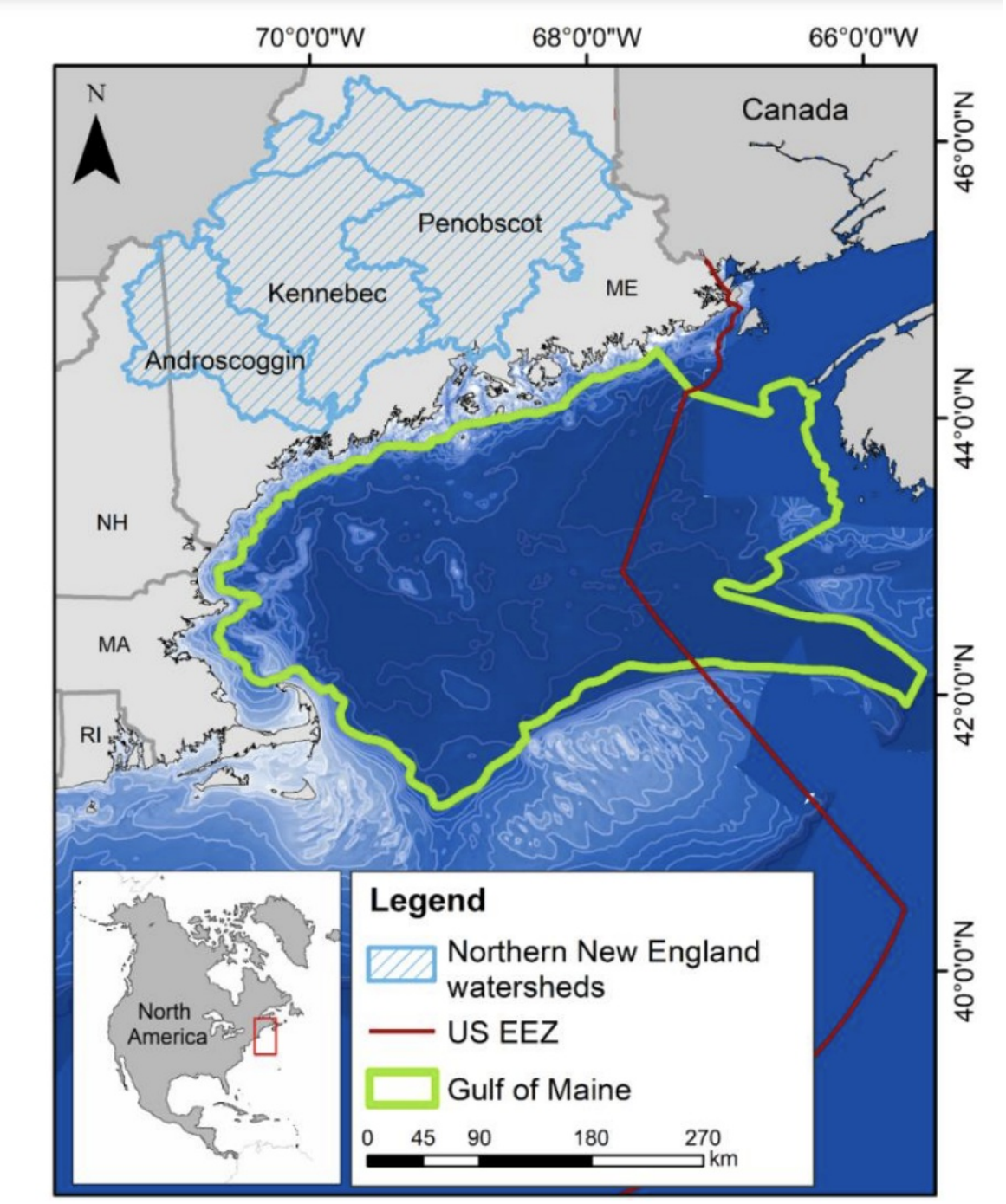

Figure A1. The model area of the Gulf of Maine (green outline) as considered in the food web model by Dias et al. (2022). Also shown is the region's bathymetry, the U.S. Exclusive Economic Zone (EEZ, red line), and the three Maine watersheds considered in the analysis (striped, blue). Imaged copied from (Dias et al. 2022).

Northern Gulf of St. Lawrence

Morisette et al. (2003) developed a food web model for the northern Gulf of St. Lawrence. This gulf is in the northwest Atlantic and semi-enclosed by the Canadian mainland in the north, west, and south, and by Newfoundland in the east (Figure A2). The total area of this gulf is about 200,000 km^2, ranging from approximately 51.4° N. to 47.4° N. and 67.3° W. to 56.9° W., with almost half this area exhibiting deep channels (Figure A2). Its waters are connected to the Atlantic Ocean by the Cabot Strait in the south and the Strait of Belle Isle in the north (Figure A2), through which it is supplied with relatively warm and cold water, respectively. Also, a vast amount of freshwater enters through several large rivers, including the St. Lawrence River. The modeled area covered a total area of 103,812 km^2, excluding the shallow water zone. The northern Gulf of St. Lawrence's ecosystem is characterized by phytoplankton, a low diversity of large zooplankton species, a relatively low abundance of fish (mainly cod, herring, and redfish), and a high abundance of juvenile fish [primarily capelin (*Mallotus villosus*)] (de Lafontaine et al., 1991). Morisette et al. (2003) developed this model to assess trophic flows of this ecosystem during the mid-1980s before the groundfish stock collapses. Diet data from this period relevant to the region were used for functional groups in the model where possible.

Northwest Atlantic—Canada

The model area as considered for the Northwest Atlantic Canadian model by Tam and Bundy (2019) comprises the southern part of the Labrador Shelf, the Northeast Newfoundland Shelf, and the Grand Bank, and stretched up to the 1000-m isobaths offshore (Figure A2). The area has a size of approximately 495,000 km^2 and includes most major commercial species. The authors developed this model to assess the general functioning of the ecosystem between 2013 and 2015 when the biomasses of major commercial species were relatively constant.

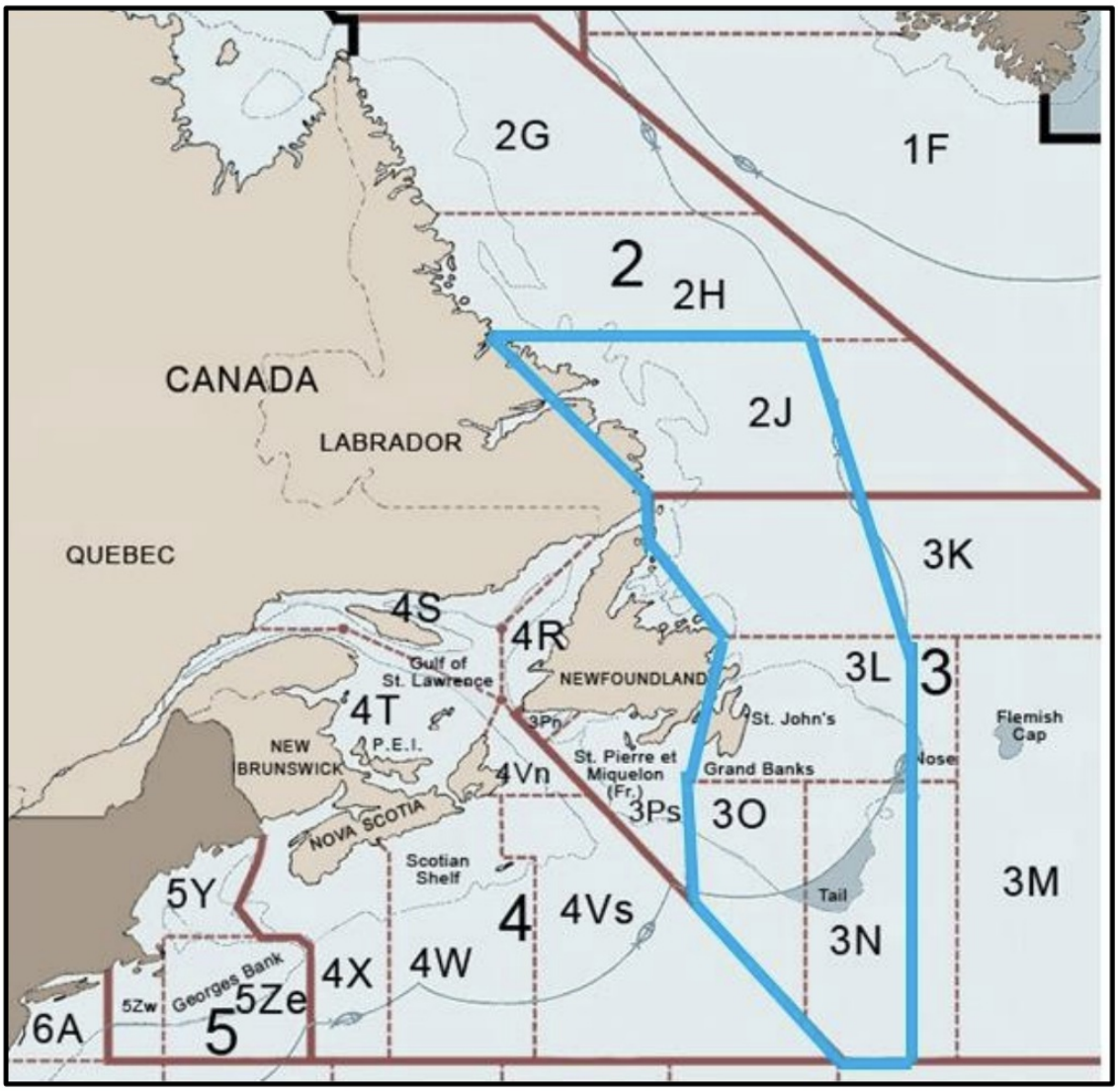

Figure A2. Model area of the model developed for the Northwest Atlantic—Canada as indicated by the solid blue line. Image copied from (Tam and Bundy 2019).

Results

Atlantic herring meets the criteria for a key forage species in the Gulf of Maine, and Atlantic mackerel meets the criteria in the Northwest Atlantic waters off Canada (Table A1). These two stocks are scored against the Seafood Watch forage species criteria. Because of the seasonal migration of these stocks, the application of the Seafood Watch forage species guidance is nuanced. For example, Atlantic herring is considered a key forage species in the Gulf of Maine, but not the in Canadian Atlantic. So, although the Scotian Shelf stock is not considered a key forage species during a portion of the year (i.e., when it inhabits Canadian waters), the stock does fill a key forage role during other parts of the year (i.e., when it inhabits the Gulf of Maine). Therefore, Seafood Watch considers both stocks of Atlantic herring as key forage stocks. Similarly, although Atlantic mackerel is not considered a key forage species in the Gulf of Maine, the U.S. fishery

catches mackerel from the northern spawning contingent when the two stocks intermix in the winter (Arai et al. 2021). Because mackerel is a key forage species in the Canadian Northwest Atlantic (Table A1), the northern spawning stock is also scored against the Seafood Watch forage species criteria. In summary, any stock that fulfills a key forage species role in any portion of its range is scored against the forage species criteria, regardless of where the stock is caught.

Table A1. Key forage species criteria results for Atlantic mackerel and Atlantic herring.

Ecosystem model	Model group name	Scientific name	Connectance*	SURF	Energy
Gulf of Maine	Atlantic herring	*Clupea harengus*	KEY	KEY	KEY
	Atlantic mackerel	*Scomber scombrus*	KEY		
Northwest Atlantic—Canada	Atlantic herring	*Clupea harengus*	KEY		
	Atlantic mackerel (included in group "other plantivores" with 12 other species)	*Scomber scombrus*	KEY	KEY	KEY

*The high occurrence of species' keyness according to the connectance index results because this index is affected by species aggregation in general, while SURF is mainly affected by aggregation of forage species (Plagányi and Essington 2014). The SURF index is used here to determine whether or not a species meets the connectance requirement.