Mackerel Rebuilding Version 2

Amendment to the

MACKEREL, SQUID, AND BUTTERFISH

FISHERY MANAGEMENT PLAN

Measures to Rebuild the Atlantic Mackerel Stock, Including 2023 Specifications and the River Herring and Shad (RH/S) Cap

Public Hearing Document

Atlantic Mackerel
Scomber scrombus

Prepared by the

Mid-Atlantic Fishery Management Council (Council) in collaboration with the

National Marine Fisheries Service (NMFS)

Council Address

Mid-Atlantic Fishery Management Council
800 North State Street, Suite 201
Dover, DE 19901

NMFS Address

NMFS Greater Atlantic Regional Fisheries Office
55 Great Republic Drive
Gloucester, MA 01930

Overview – Atlantic Mackerel Rebuilding Version 2

For details and commenting opportunities see https://www.mafmc.org/actions/atlantic-mackerel-rebuilding-amendment. Hearings are April 25, 2022 to May, 2, 2022. Comments are due May 9, 2022. Contact: Jason Didden – jdidden@mafmc.org – 302-397-1131.

PURPOSE: The 2021 peer-reviewed stock assessment found that Atlantic mackerel was still overfished and that overfishing was still occurring. In response, the Council is considering a new rebuilding plan for Atlantic mackerel.

This action contains five rebuilding alternatives (see table), all of which have been endorsed by the Council's Scientific and Statistical Committee (SSC) as being consistent with the best available science. This action will also set specifications for 2023.

Recruitment Assumptions	Rebuilding Alternative	10-Yr Rebuilding Probability
Poor recruitment for all 10 years	**ALTERNATIVE 1:** Eliminate most catch to rebuild as much as possible in 10 years.	57%
Recruitment starts low (similar to 2009+) and then increases toward long term (1975+) typical recruitment	**ALTERNATIVE 2:** Use a risk buffer from a fishing mortality rate of 0.14. Results in negligible U.S. total catch (commercial or recreational) for several years.	62%
	ALTERNATIVE 3: Use standard Council risk policy. Initially requires near zero U.S. commercial landings until 2025 (may increase discards) but accounts for Canadian catch and U.S. recreational catch.	52%
	ALTERNATIVE 4: Use a fishing mortality rate of 0.12. Depending on set asides for Canadian catch and U.S. recreational catch, could allow for about 1,000-3,600 metric tons (MT) of U.S. commercial landings initially (slow increase predicted).	61%
	ALTERNATIVE 5: Use a fishing mortality rate of 0.14. Depending on set asides for Canadian catch and U.S. recreational catch, could allow for about 2,300-4,900 MT of U.S. commercial landings initially (slow increase predicted).	53%

MEASURES: The action proposes closures and trip limits to hold the commercial fishery near the target catches. The action considers a 3-inch minimum mesh for directed trawling. The action would also set a 2023 river herring and shad cap for the commercial fishery. The action will clarify whether any possession of Atlantic mackerel in federal waters (beyond 3 miles and including bait) by commercial or for-hire vessels triggers federal permitting and electronic vessel trip report (VTR) requirements. Recreational bag/possession limits of 10 or 15 fish are possible, which might decrease recreational catch by 10%-30%.

1.0 EXECUTIVE SUMMARY AND TABLE OF CONTENTS

This action considers measures to rebuild the Atlantic mackerel (“mackerel” refers to Atlantic mackerel hereafter in this document) stock with an Amendment to the Mackerel, Squid, and Butterfish Fishery Management Plan (MSB FMP). This action includes 2023 mackerel specifications and related management measures, including the mackerel fishery’s river herring and shad (RH/S) cap. This action was originally going to set 2023-2024 specifications, but now proposes to only set 2023 specifications given a new Mackerel Management Track Assessment (MTA) is expected in 2023. If the assessment or subsequent specifications were delayed, then the 2023 specifications would roll-over into 2024 until new specifications were published. The MSB Monitoring Committee recommended this approach given the high degree of uncertainty that would have been involved in setting 2024 specifications based on 2019 data and then five years of projections. Setting 2024 specifications now would suggest too much stability for 2023/2024 (the initial rebuilding plan projections, which spanned only 3 years, were off by about a **factor of four**).

The purpose of this action is to rebuild the mackerel stock with appropriate measures so that Optimum Yield (OY) can be achieved on an ongoing basis. The action is needed because the recent 2021 Mackerel Management Track Assessment (MTA) found the mackerel stock to still be overfished, with overfishing still occurring through 2019 (NEFSC 2021). The 2021 Mackerel MTA determined that when implemented (11/29/2019), the original rebuilding plan (MAFMC 2019) was already out of date and did not provide a realistic rebuilding approach. The stock is estimated to have nearly tripled in size from 2014 to 2019 (from about 8% to 24% of rebuilt), but fully rebuilding on the original schedule (by 2023) appears impossible – the stock is now expected to be less than half rebuilt by 2023. This action incorporates the 2021 Mackerel MTA findings to continue rebuilding the mackerel stock.

Because none of the preferred alternatives are anticipated to be associated with significant impacts to the biological, social, economic, or physical environment, an Environmental Assessment (EA) documenting a "Finding of No Significant Impact" (FONSI) is planned, but this plan could change based on public comments or other analyses.

Summary of the Alternatives

The alternatives are based on rebuilding plans that all have at least a 50% chance of rebuilding mackerel within ten years, which is the maximum time typically allowed under the Magnuson–Stevens Fishery Conservation and Management Act (MSA). The alternatives focus on the probability of rebuilding by 2032 (ten years) due to the Scientific and Statistical Committee’s (SSC) July 2021 Meeting advice that “Preliminary rebuilding scenarios indicate long-term rebuilding will be required for this stock” and that higher rebuilding probabilities “are associated with shorter rebuilding time and greater catch stability” (MAFMC SSC 2021). Final rebuilding scenarios did not differ substantially from the preliminary analyses (MAFMC SSC 2022). Additional management measures are paired with each rebuilding plan.

Summary of Impacts

Target Species Impact Summary

The alternatives should allow the mackerel stock to rebuild within 10 years. Changes in mackerel fishing should not impact other FMP species due to low catch of those species in the mackerel fishery, and separate management measures control catch of those species. While Atlantic herring and mackerel are often caught together, separate management measures in the Atlantic herring fishery should ensure that overfishing does not occur on the Atlantic herring stock.

Non-Target Species Impact Summary

Non-target interactions are relatively low in the mackerel fishery, and all of the action alternatives would reduce catch from the status quo, thereby limiting effort. The RH/S cap should continue to limit interactions between the mackerel fishery and RH/S, which have been the primary non-target species of concern for the mackerel fishery.

Habitat Impact Summary

All of the alternatives would reduce catch from the status quo thereby limiting effort, so no additional negative habitat impacts would be expected.

Protected Resources Impact Summary

All of the alternatives would reduce catch from the status quo, thereby limiting effort, so no additional negative protected resource impacts would be expected.

Human Communities Impact Summary

Human communities may have negative impacts in the short term due to lower catches/revenues from mackerel during the beginning of the rebuilding period, but in the long term rebuilding should lead to higher catches/revenues.

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2.0 LIST OF COMMON ACRONYMS AND ABBREVIATIONS

ABC	**Acceptable Biological Catch**
ACL	**Annual Catch Limit**
ACT	**Annual Catch Target**
ASMFC	**Atlantic States Marine Fisheries Commission or Commission**
B	**Biomass**
CFR	**Code of Federal Regulations**
CPH	**Confirmation of Permit History**
CV	**coefficient of variation**
DAH	**Domestic Annual Harvest**
DAP	**Domestic Annual Processing**
EA	**Environmental Assessment**
EEZ	**Exclusive Economic Zone**
EFH	**Essential Fish Habitat**
EIS	**Environmental Impact Statement**
ESA	**Endangered Species Act of 1973**
F	**Fishing Mortality Rate**
FMAT	**Fishery Management Action Team**
FMP	**Fishery Management Plan**
FR	**Federal Register**
GB	**Georges Bank**
GOM	**Gulf of Maine**
M	**Natural Mortality Rate**
MAFMC	**Mid-Atlantic Fishery Management Council**
MMPA	**Marine Mammal Protection Act**
MSA	**Magnuson-Stevens Fishery Conservation and Management Act**
MSB	**Atlantic Mackerel, Squid, Butterfish**
MSY	**Maximum Sustainable Yield**
MT (or mt)	**Metric Tons (1 mt equals about 2,204.62 pounds)**
NE	**Northeast**
NEFMC	**New England Fishery Management Council**
NEFSC	**Northeast Fisheries Science Center**
NEPA	**National Environmental Policy Act**
NMFS	**National Marine Fisheries Service (NOAA Fisheries)**
NOAA	**National Oceanic and Atmospheric Administration**
OFL	**Overfishing Level**
OY	**Optimum Yield**
PBR	**Potential Biological Removal**
SNE	**Southern New England**
SSB	**Spawning Stock Biomass**
SSC	**Scientific and Statistical Committee**
U.S.	**United States**
VTR	**Vessel Trip Report**

Notes: "Mackerel" refers to "Atlantic mackerel" unless otherwise noted. Likewise “herring” alone refers to Atlantic herring.

3.0 LISTS OF TABLES, AND FIGURES

3.1 List of Tables

3.2 List of Figures

4.0 INTRODUCTION, BACKGROUND, AND PROCESS

4.1 Introduction and Background

Section 4.1 reviews several critical background topics including the 2021 Mackerel Management Track Assessment (MTA), the 2021 Canadian Mackerel Assessment, Current Management and Recent Catches, Rules on Rebuilding, the Council's Ecosystem Approach to Fisheries Management (EAFM), and the Council's P* Risk Policy.

The 2021 Mackerel Management Track Assessment (MTA) (NEFSC 2021)

Reference Points

"F" refers to fishing mortality, i.e. the rate at which fish die from fishing, expressed as the portion of the stock dying within a small amount of time. The rebuilding goal is based on F40% as the proxy for FMSY (MSY = "maximum sustainable yield") and was estimated to be F = 0.24[1], (dashed line in Figure 1) down from 0.26 in the previous mackerel assessment. Mackerel stock productivity has apparently declined. F40% was selected as a proxy for FMSY due to consistency with the Canadian reference point and ability to prevent stock collapse for stocks with similar life histories. F40% produces 40% of the "spawning stock biomass (SSB) per recruit" (equivalent to lifetime egg production) relative to that produced by an unfished stock. F in 2019 was estimated to be 0.46[2], so overfishing was occurring in 2019 and has been for 30 years (but 2019 was the lowest F in 15 years – see Figure 1). Past assessments (which used different methods and data) appear to have been overly optimistic about the stock's productivity, and too many fish were caught over a long period of time. The rebuilding biomass target is the SSB associated with the FMSY proxy or "SSBmsyproxy," and is estimated to be 181,090 MT. The 2019 spawning stock biomass (SSB) was estimated to be 42,862 metric tons (MT), or 24% of the SSB target so mackerel is "overfished" (below 50% of the target – see Figure 2). Once rebuilt, the MSYproxy (i.e. the proxy for maximum sustainable yield) is estimated to be 34,103 MT (total catch, U.S. plus Canada), which is lower than estimated in the previous assessment, reflecting the apparent reduced productivity of the stock.

[1] F = 0.24 equates to removing about 1/5 of the stock in a given year.
[2] F = 0.46 equates to removing slightly over 1/3 of the stock in a given year.

Projection Performance

Based on the recent 2021 Mackerel Management Track Assessment (MTA) (NEFSC 2021), the mackerel stock (measured by Spawning Stock Biomass - "SSB") will not rebuild as quickly as previously projected. The 2021 MTA found the mackerel stock to be overfished, with overfishing occurring through 2019 (NEFSC 2021) (see Figures 1 and 2 next pages). While the stock is estimated to have nearly tripled in size from 2014 to 2019 (from about 8% to 24% of rebuilt), rebuilding on the original schedule (by 2023) appears impossible – the stock is now expected to be less than half rebuilt by 2023. In addition, while both the 2018 and 2021 assessments concluded the stock reached a low point around 2011-2014 before starting to recover, the current assessment found that the stock was about 10% smaller at the low point. In the terminal year of the previous assessment (2016 – NEFSC 2018) the stock, while still recovering, is now estimated to have been 29% smaller in 2016 than originally estimated for that same year. While nearly all of the data in the 2021 assessment (data through 2019) represents the time period before the initial rebuilding plan took effect, the current assessment indicates we started rebuilding in 2019 at a stock size about 74% lower than anticipated (just 42,862 MT estimated in 2019 vs 162,796 MT projected). While not completely understood, factors contributing to this over-projection for 2019 include:

-starting from a lower low point in 2014 (retrospective pattern apparent but not strong enough to adjust for).
-summed 2014-2018 recruitment was 24% lower than anticipated (2017 year class lowest in time series).
-overfishing persisted.
-decreased maturity-at-age and SSB weight-at-age for some ages.

The scale of error observed in the previous three-year projection (2016 to 2019) provides some perspective for the four-year projection required to now set specifications for 2023 as the first year of the new rebuilding plan. This was part of the reason why the MSB Monitoring Committee recommended setting only a one year specification at this time, until the 2023 Mackerel MTA can be used to set 2024 specifications. The 2023 Mackerel MTA should include data through 2022, requiring only a two year projection for 2024 (2022 to 2024), versus the five-year projection that would be required to set 2024 specifications now (i.e. 2019 to 2024). While the lower recruitment inputs now being used in short term projections should help avoid as large of an over-projection, any potential improvement in projections will not be known until mid-2023 when then the 2023 Mackerel MTA is completed.

If 2022 catch happens to be lower than projected (e.g. due to recent Canadian closure), we could be slightly ahead of our final rebuilding projections, but given the general uncertainty and low stock size, lower 2022 catches are not expected to drastically change the rebuilding trajectories.

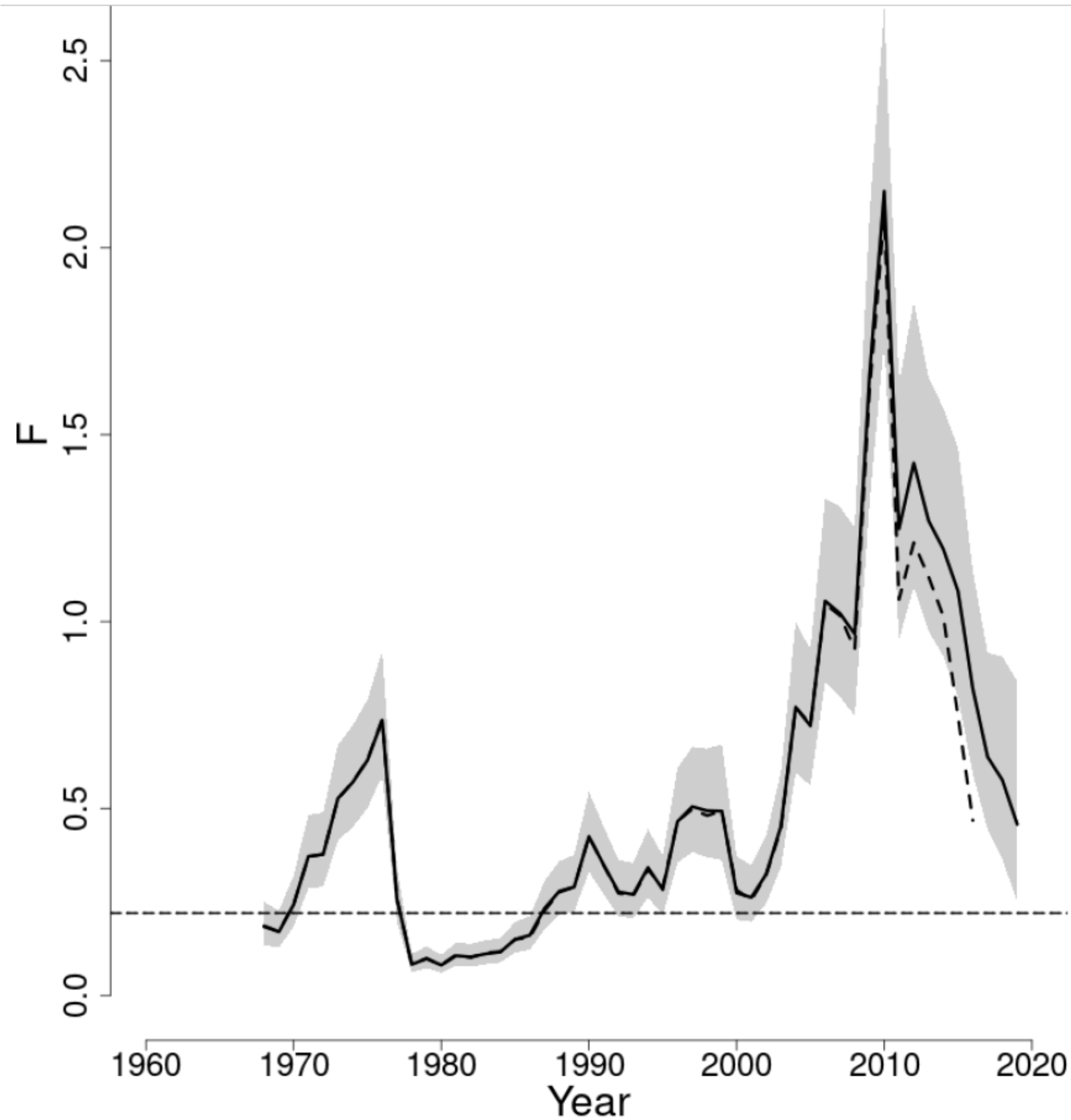

Figure 1. Trends in the fully selected fishing mortality (F) of northwest Atlantic mackerel between 1968 and 2019 from the current (solid line) and previous (dashed line) assessment and the corresponding FThreshold (FMSY proxy=0.22; horizontal dashed line). The approximate 90% lognormal confidence intervals are shown.

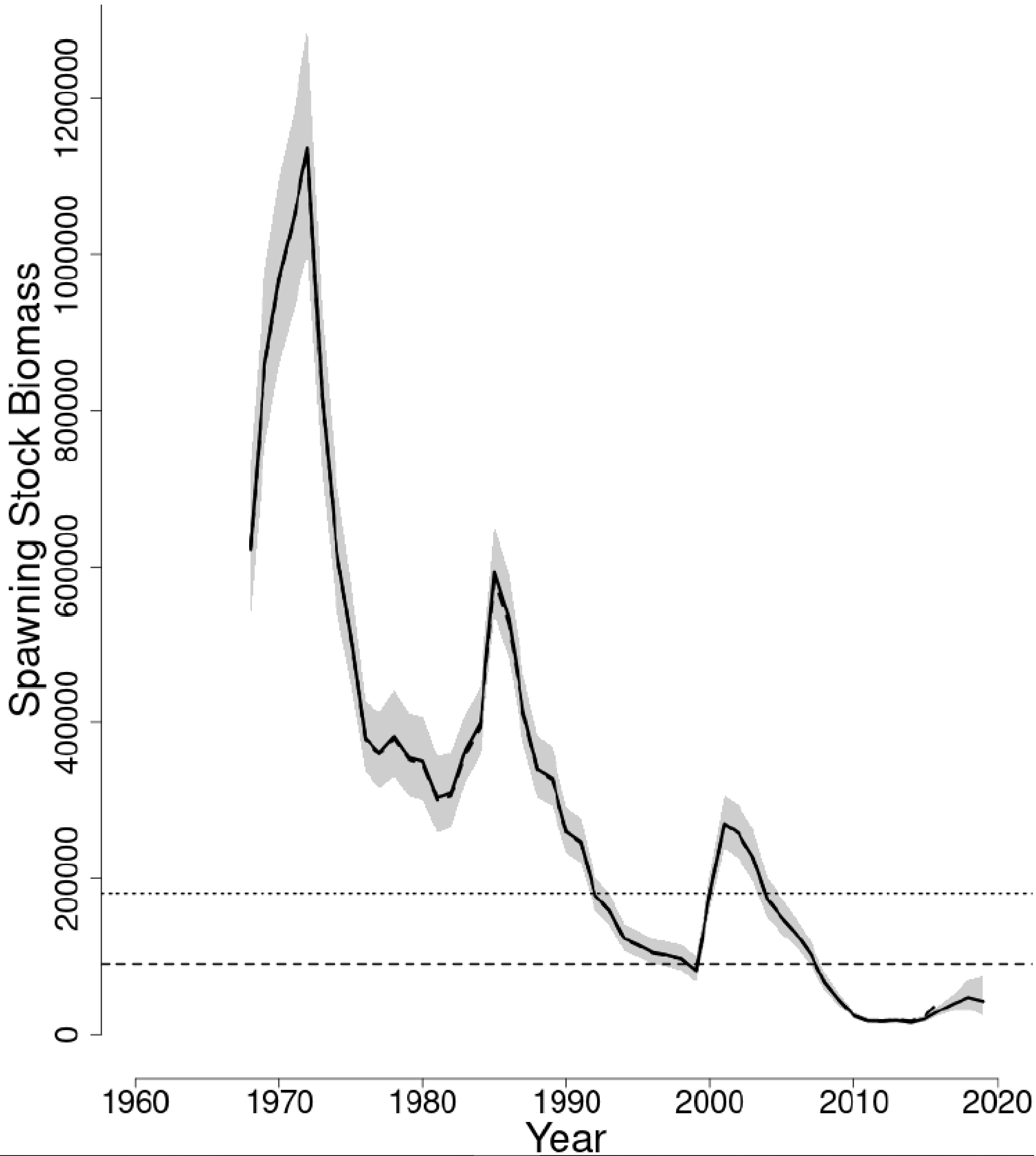

Figure 2. Trends in spawning stock biomass (MT) of northwest Atlantic mackerel between 1968 and 2019 from the 2021 MTA (solid line) and previous (dashed line, mostly the same) assessment and the corresponding SSBThreshold (1/2 SSBMSY proxy; horizontal dashed line) as well as SSBTarget (SSBMSY proxy; higher horizontal dotted line). The approximate 90% lognormal confidence intervals are shown.

The 2021 Canadian Mackerel Assessment and Recent Canadian Quotas

The Canadian stock assessment only assesses the northern mackerel contingent, unlike the stock-wide U.S. assessment. Excerpting from their summary and assessment:

- 2017-2020 Canadian landings occurred primarily in the Gulf of Saint Lawrence and off the northeast coast of Newfoundland.
- Recent genetic analyses confirmed previous studies that the Northwest Atlantic mackerel stock is distinct from the Northeast Atlantic (European) stock. These analyses also supported the previously established distinction between the northern and southern spawning contingents of our Northwest Atlantic stock. Genetic results showed some mixing of southern contingent mackerel in Canadian waters as well as northern contingent mackerel in U.S. waters.
- A fine-scale analysis of recruitment variability showed recruitment benefits from a spatial-temporal match between mackerel larvae and their preferred food as well as optimal population structure and dynamics (maternal condition, SSB, age-structure).
- The annual egg survey did not occur in 2020 due to restrictions incurred by Covid. The stock assessment model was still run (without a 2020 data point for the egg survey) to estimate stock status.
- The last notable recruitment event was in 2015. There has been no sign of any notable recruitment event in recent years. There are currently very few fish older than 5 years old (<1%) - The age structure of the population in 2020 was relatively evenly spread among individuals between 1 and 5 years, old with no single dominant cohort (the 2015 cohort represented about 7% of the SSB in 2020).
- The estimated fully selected exploitation rate (fish aged 5-10+) in 2020 was 74%, above the reference level of 51% (F40%). The fishery was concentrated on fish aged 2-5 (exploitation rate of 56%).
- The SSB in 2020 was the lowest ever estimated (58% of the Limit Reference Point - LRP). and has been in or near the Critical Zone for over 10 years. Rebuilding the stock will also require rebuilding the age structure of the stock which has been eroded by overexploitation.

The 2021 Canadian mackerel quota was set at 4,000 MT – landings at this level were estimated to have between a 2 in 3 chance and a 3 in 4 chance of facilitating at least some stock growth from 2021 to 2023. 2021 Canadian landings (preliminary) were 4,395 MT. Canada closed its fishery for 2022 so may have minimal landings in 2022. If Canada keeps its fishery closed for 2022 and 2023, their stock assessment indicates they have about a coin flip's chance (i.e. 50-50) of reaching at least 40% of their biomass target. With a 2023 Canadian assessment pending, 2023 Canadian landings are still challenging to predict. This action explores two options for deducting Canadian landings in 2023: Deducting their 2021 landings (4,395 MT) or half that amount (2,197 MT).

Current Management and Recent Catches

The commercial mackerel fishery is currently managed with an annual quota, in-season proactive accountability measures, and reactive accountability measures requiring paybacks if catches exceed the Annual Catch Limit (ACL). Canadian landings, U.S. recreational catch, and U.S. commercial discards are deducted off the total Acceptable Biological Catch (ABC) to derive the commercial quota. There are currently no recreational management measures. In 2022, based on an emergency rule by NMFS, total catch is expected to be 12,055 MT or less, with 4,395 MT deducted for assumed Canadian landings, 2,582 MT deducted for assumed recreational catch (the 2017-2021 average), and 115 MT deducted for assumed commercial discards (recent average). This leaves 4,963 MT for a commercial quota. When 90% of the quota is projected to be landed, trip limits of 40,000 pounds are implemented for Tier 1-3 directed permits and 5,000 pounds for incidental/open access permits[3]. When 100% of the quota is projected to be landed, a 5,000 pound trip limit is implemented for all permits for the rest of the fishing year to cover remaining incidental catches. The emergency rule will expire in early January 2023, at which point the previous specifications, with a much higher quota, would apply (see Alternatives Section below for details).

The 2022 emergency measures described above were designed to mirror 2021 catches while a new rebuilding plan is developed, but some differences exist due to projection approaches. 2021 catches are estimated to have been 12,220 MT, including 4,395 MT Canadian landings, 2,222 MT recreational catch, 127 MT commercial discards, and 5,476 MT commercial landings. See Section 6 for additional fishery descriptive information.

The mackerel fishery also operates under a river herring and shad catch cap (RH/S), which closes the directed mackerel fishery and implements a 20,000 pound trip limit for all permits once 129 MT of RH/S has been projected to be caught in the directed mackerel fishery. 129 MT was the amount of RH/S if the ratio of cap to all catch on mackerel trips (accounting for mostly Atlantic herring) was about 0.53% and the mackerel quota was 17,371 MT (or 0.74% applied to just the mackerel quota). Given the challenges with monitoring a very small cap, including potentially closing the fishery based on a few observed trips, the Council has kept the cap at 129 MT at the current lower mackerel quotas. This action proposes to either scale the RH/S cap with the mackerel quota or keep the RH/S cap at 129 MT if the mackerel quota is below 17,371 MT.

[3] When the fishery starts each year, the various commercial mackerel permit categories start with different trip limits. Tier 1 has an unlimited trip limit, Tier 2 has a 135,000 pound trip limit, and Tier 3 has a 100,000 pound trip limit.

Rules on Rebuilding

Section 304(e)(4) of the Magnuson–Stevens Fishery Conservation and Management Act (MSA) states:

> "For a fishery that is overfished, any fishery management plan, amendment, or proposed regulations…shall…specify a time period for rebuilding the fishery that shall--
>
> (i) be as short as possible, taking into account the status and biology of any overfished stocks of fish, the needs of fishing communities,…and the interaction of the overfished stock of fish within the marine ecosystem; and
>
> (ii) not exceed 10 years, except in cases where the biology of the stock of fish, other environmental conditions…dictate otherwise;
>
> …allocate both overfishing restrictions and recovery benefits fairly and equitably among sectors of the fishery…"

The Council's SSC advised the Council that "Preliminary rebuilding scenarios indicate long-term rebuilding will be required for this stock" and that higher rebuilding probabilities "are associated with shorter rebuilding time and greater catch stability." (MAFMC SSC 2021)

All options currently under consideration are projected to rebuild mackerel in 10 or less years so (ii) is addressed. Recreational catches have been relatively low in this fishery historically, but will be a higher percentage of total catch especially in the early part of the new rebuilding timeline, which is why recreational measures are being considered in this action.

The primary rebuilding considerations are to rebuild in a time period as short as possible, taking into account 1) the status and biology of any overfished stocks, 2) the needs of fishing communities, and 3) the interaction of mackerel within the marine ecosystem. Information on the status and biology of mackerel and interactions within the marine ecosystem (e.g. predation) is provided in Section 6.1.

Council's Ecosystem Approach to Fisheries Management (EAFM)

The alternatives in this document seek to rebuild mackerel to the SSBmsyproxy as defined in the recent mackerel MTA, i.e. to 181,090 MT of spawning stock biomass (SSB). The Council's Ecosystem Approach to Fisheries Management (EAFM) Guidance Document (https://www.mafmc.org/eafm) 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 FMSY." Acknowledging that the science to evaluate the biological and socioeconomic tradeoffs of more precautionary management is lacking, the Council has adopted a policy that it would promote data collection and development of analyses to get to the point where the Council could evaluate the relevant tradeoffs and "establish an optimal forage fish harvest policy."

Views vary on the precaution inherent in using the recommended F40% as a proxy for FMSY (and for the resulting SSBmsyproxy target). Clark 1993, Mace 1994, Gabriel and Mace 1999, and Legault and Brooks 2013 generally recommended F40% for typical stocks. Clark 2002 notes that for typical stocks, fishing at F40% would be expected to result in a target biomass that is 20%-35% of an unfished biomass. Pikitch et al 2012 recommended more conservative approaches for forage species to support predators, and this has spawned ongoing debate (e.g. Hilborn et al 2017 to the contrary). The Council's P* risk policy, by reducing catch to account for scientific uncertainty, should lead to biomass being maintained above the reference point target in the long run.

While not a complete picture of forage, the 2021 State of the Ecosystem reports for New England and the Mid-Atlantic indicate that for the Planktivore group that includes mackerel, long term (30-year) trends in the Mid-Atlantic Bight, Georges Bank, and Gulf of Maine are all either steady or increasing for both the Spring and Fall survey aggregate biomasses[4] (NEFSC 2022a, NEFSC 2022b). The 2018 mackerel assessment examined predator consumption and determined that the presence of mackerel in fish stomachs collected during the NEFSC bottom trawl surveys was generally low from 1973-2016, with spiny dogfish being responsible for 67% of all mackerel as prey occurrences in the NEFSC Food Habits Database. Mackerel were found in only 1% of sampled spiny dogfish however. Additional potentially important predators of mackerel are <u>not</u> sampled in the NEFSC trawl surveys, including highly migratory species, marine mammals, and seabirds. For the 17 analyzed mackerel predators from the NEFSC Food Habits Database, while mackerel did not appear to be an important contribution to their diet, there was a marked decline in consumption from 2000-2016, the terminal year of that analysis, matching the trend in mackerel abundance for that time period. The 2021 Mackerel MTA found that from 2014 to 2019 mackerel biomass had nearly tripled, so substantially more mackerel should already be available as forage by 2019. The mackerel assessment uses a constant natural mortality rate, so as mackerel biomass grows, more predation on mackerel is assumed to occur.

Council's P* Risk Policy

The Council's standard risk policy states that the Scientific and Statistical Committee (SSC) should provide Acceptable Biological Catches (ABCs) that are the lesser of rebuilding ABCs or standard risk policy (P*) ABCs. The P* risk policy requires higher confidence that overfishing will be avoided when biomass is lower, which results in lower catches. At the projected 2023 biomass, because it would only be 32% of rebuilt, the Council's risk policy requires an 85.5% confidence in avoiding overfishing in 2023. For a stock 100% rebuild, the P* risk policy requires a 55% chance of avoiding overfishing. Some alternatives being considered by the Council would

[4] Planktivore Group includes Atlantic mackerel, butterfish, Atlantic herring, alewife, American shad, blackbelly rosefsh, blueback herring, cusk, longhorn sculpin, lumpfsh, menhaden, northern sand lance, northern searobin, and unclassified sculpin.

result in a 2023 rebuilding catch higher than what would be the standard P*-adjusted ABC. In these cases, the alternatives note this fact, and represent a temporary adjustment of the Council's standard risk policy that apply to this particular decision – future decisions would need to re-evaluate any diversion from the Council's standard P* approach (Alternative 3 uses the current, unmodified P* risk policy). The risk policy adjustment would only apply to this instance of initiating rebuilding for mackerel to consider the effects of different rebuilding timelines and would not apply to management decisions regarding future ABCs once the stock is rebuilt.

<u>General SSC Input (MAFMC SSC 2022)</u>

Mackerel recruitment has been low in recent years and various assessments have debated the underlying causes. Environmental conditions may be resulting in low recruitment. Alternatively low recruitment may be due to reduced spawning stock biomass. If stock size is low due to long-term environmental conditions, then severe reductions in ABC are required to achieve the rebuilding target. Alternatively, if stock size is responsible, then increases in recruitment could occur in response to lower rates of fishing.

Owing to the varying starting conditions and random effects of time varying recruitment, the population trajectories under the rebuilding scenarios result in a broad distribution of values. Measures of central tendency (i.e., median) were used to describe the expected rebuild times, the probability of rebuilding by 2032 and the expected catch trajectories. It was noted that not all of the realizations would successfully rebuild, even under the most aggressive reductions in fishing mortality.

The SSC reviewed all alternatives and recommended the P* approach with the maximum fishing mortality threshold (MFMT) equal to the Fmsy proxy (Alternative 3). This alternative, (1) fulfills rebuilding plan requirements; (2) is the most responsive to new information on changes in stock status; (3) produces the highest rebuilding plan 10-year catch yield); (4) is fully consistent with the Council's P* risk policy; and (5) would avoid "break points" in catch limit advice, which would reduce year-to-year changes in the ABC.

Risks and scientific uncertainties pertain to the two classes of alternatives: Alternative 1, which considers projections on the basis of only recent recruitment (2009+) and the remainder (Alternatives 2-5) that use the recent recruitment period under the condition of SSB<0.5 SSBMSY, and use the entire recruitment series (1975+) when SSB≥0.5 SSBMSY (Alternatives 2-5). See details on the next page.

Alternative 1 - Risks:
• ABC/Catch levels are quite low indicating risk of a depleted industry and foregone catch once SSB recovers.
• At low to nil catch levels, fishery-dependent data will become unavailable to support stock assessment.
• High discard potential if recruitment recovers under low catch

Alternative 1 - Scientific Uncertainties:
• Predictions of which recruitment regime exists is highly uncertain owing to lack of understanding on how recruitment is controlled (i.e., role of SSB, the environment, and the food web).
• Recreational catch/unreported removals may exceed low ABCs under this Alternative; knowledge about catch will needs to become more precise at low ABCs.

Alternatives 2-5 - Risks:
• Stock may not recover without the low F specified in Alternative 1.
• The SSB trigger implies a sudden change in recruitment state, which is not supported by current understanding of what drives recruitment
• The two recruitment stanza approach applies uses an SSB trigger for which there is limited analytical support (SSC Chairman's September 22, 2021 Report to MAFMC)
• An immediate shift towards a higher recruitment regime is assumed at SSB≥0.5 SSBMSY, whereas an unknown lag may occur between increased SSB and recruitment.
• Because a stock-recruitment relationship is unknown for this stock, it is uncertain whether SSB changes will be driven by increased recruitment or vice versa. This approach implies a S-R relationship, which may be arbitrary given that it has not been parameterized in the assessment
• The approach of shifting recruitment regimes can have unexpected effects later on with respect to stock rebuilding. The threshold is sensitive to the timing of a pulse of strong recruitment and may not reflect longer-term SSB rebuilding.
• Approaches rely on a SSB-based boost to recruitment that has not been observed recently (since 2007).
• The lack of strong precedence of this approach (but see Brodziak et al. 2001) conveys risk in predicting its performance in rebuilding.

Alternatives 2-5 - Scientific Uncertainties:
• We do not know the form of the underlying stock-recruitment relationship.
• Knowledge about catch will needs to become more precise at low ABCs.
• The trigger SSB for using one or the other recruitment series is deterministic, without consideration of error.
• Uncertainty in small amplitude changes in SSB
• Uncertainty in long projections

4.2 Process

The Council initiated a framework adjustment action in 2021 upon receiving the 2021 Mackerel MTA results. This action was later converted into an amendment due to the potential consideration of recreational bag/possession limits and/or closures, which had not been previously considered in detail, and it was uncertain whether such measures could be considered via a framework adjustment action. Closures are not being considered in this action. The Council intends to take final action at its June 2022 meeting, after public hearings in late April 2022. An emergency rule currently limiting mackerel landings expires in early January 2023, necessitating rapid progress on this action to implement new measures before the emergency rule expires.

4.3 Purpose and Need

The purposes and needs addressed by this action are described in the table below.

Table 1. Purposes and Needs

Need	Corresponding Purpose
Prevent overfishing, rebuild the Atlantic mackerel stock, and achieve optimum yield in the mackerel fishery.	Implement measures to specify levels of catch of Atlantic mackerel consistent with the MSA and the objectives of the FMP, including ending overfishing and rebuilding the stock.
Achieve the Domestic Annual Harvest ("quota") allocation in the mackerel fishery without exceeding it or closing the fishery in a manner that creates avoidable discarding issues.	Implement in-season management measures, including management uncertainty buffers, triggers, and post-closure trip limits.
Minimize bycatch of river herring and shad in the mackerel fishery to the extent practicable.	Implement catch caps for river herring and shad.

4.4 Regulatory Authority

The MSA states that Fishery Management Plans (FMPs) shall "contain the conservation and management measures… necessary and appropriate for the conservation and management of the fishery to prevent overfishing and rebuild overfished stocks, and to protect, restore, and promote the long-term health and stability of the fishery." As discretionary provisions of Fishery Management Plans (FMPs), the MSA also allows restriction of fishing by gear/area/time/season. Seasonal management based on attainment of quotas has been previously incorporated into the MSB FMP and this action could modify the existing provisions regarding how the fishery closes due to attainment of the DAH or a portion of the DAH. The RH/S cap was previously implemented under the discretionary MSA provisions providing for conservation of non-target species.

The Council's risk policy was initially implemented via Amendment 13 to the MSB FMP (http://www.mafmc.org/msb/), which stated that the system would need to be "adaptive" and that "Flexibility is imperative and must allow for timely modifications given the dynamic nature of fisheries and the environment." Changing the desired probabilities of overfishing was contemplated as something that could be accomplished through even the annual specifications process. Major departures from the original risk policy were contemplated as needing to go through either an FMP framework adjustment or FMP amendment. Risk policy adjustments were explicitly provided for and anticipated by Amendment 13. See also implementing regulations at Title 50, Chapter VI, Part 648, Subpart B, §648.25(a)(1)(ii).

4.5 FMP History and Management Objectives

Management of the MSB fisheries began through the implementation of three separate FMPs (one each for mackerel, squid, and butterfish) in 1978. The plans were merged in 1983. Over time a wide variety of management issues have been addressed including stock rebuilding, habitat conservation, bycatch minimization, and limiting participation in the fisheries. The history of the plan and its amendments can be found at http://www.mafmc.org/fisheries/fmp/msb.

The MSA defines Optimum Yield (OY) generally as the amount of fish which A) "will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems"; B) "is prescribed as such on the basis of the maximum sustainable yield from the fishery, as reduced by any relevant economic, social, or ecological factor;" and C) "in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the maximum sustainable yield in such fishery." The Omnibus ACL/AM Amendment (Amendment 13 to the MSB FMP) defined OY specifically for mackerel as: "The long-term average amount of desired yield from a stock or fishery. OY cannot exceed MSY. For Atlantic Mackerel, OY is the quantity of catch that is less than or equal to the ABC in U.S. waters."

The management goals and objectives, as described in the current FMP are listed below.

1. Enhance the probability of successful (i.e., the historical average) recruitment to the fisheries.
2. Promote the growth of the U.S. commercial fishery, including the fishery for export.
3. Provide the greatest degree of freedom and flexibility to all harvesters of these resources consistent with the attainment of the other objectives of this FMP.
4. Provide marine recreational fishing opportunities, recognizing the contribution of recreational fishing to the national economy.
5. Increase understanding of the conditions of the stocks and fisheries.
6. Minimize harvesting conflicts among U.S. commercial, U.S. recreational, and foreign fishermen.

The Council recently updated the goals and objectives of the FMP through another action but that action has not yet been implemented:

The updated MSB FMP objectives will be:

Goal 1: Maintain sustainable MSB stocks.

> Objective 1.1: Prevent overfishing and maintain sustainable biomass levels that achieve optimum yield in the MSB fisheries.
>
> Objective 1.2: Consider and, to the extent practicable, account for the roles of MSB species/fisheries in the ecosystem.

Goal 2: Acknowledging the difficulty in quantifying all costs and benefits, achieve the greatest overall net benefit to the Nation, balancing the needs and priorities of different user groups and effects of management on fishing communities.

> Objective 2.1: Provide the greatest degree of freedom and flexibility to harvesters and processors (including shoreside infrastructure) of MSB resources consistent with attainment of the other objectives of this FMP, including minimizing additional restrictions.
>
> Objective 2.2: Allow opportunities for commercial and recreational MSB fishing, considering the opportunistic nature of the fisheries, changes in availability that may result from changes in climate and other factors, and the need for operational flexibility.
>
> Objective 2.3: Consider and strive to balance the social and economic needs of various sectors of the MSB fisheries (commercial including shoreside infrastructure and recreational) as well as other fisheries or concerns that may be ecologically linked to MSB fisheries.
>
> Objective 2.4: Investigate opportunities to access international/shared resources of MSB species.

Goal 3: Support science, monitoring, and data collection to enhance effective management of MSB fisheries.

> Objective 3.1: Improve data collection to better understand the status of MSB stocks, the role of MSB species in the ecosystem, and the biological, ecological, and socioeconomic impacts of management measures, including impacts to other fisheries.
>
> Objective 3.2: Promote opportunities for industry collaboration on research.
>
> Objective 3.3: Encourage research that may lead to practicable opportunities to further reduce bycatch in the MSB fisheries.

4.6 Management Unit and Geographic Scope

The management unit (fish stock definition) in the MSB FMP for Atlantic mackerel (*Scomber scombrus*) includes all mackerel under U.S. jurisdiction in the Northwest Atlantic, with a core fishery management area from Maine to North Carolina. The FMP also includes a deduction for mackerel caught by Canada - the U.S. assessment provides catch advice for the entire mackerel stock in the Northwest Atlantic (including Canadian waters), which is considered one unit stock.

5.0 WHAT ALTERNATIVES ARE CONSIDERED IN THIS DOCUMENT?

Notes: All of the rebuilding alternatives in this document utilize the peer reviewed and accepted 2021 Management Track Assessment (MTA) and associated projection methods. The Council's SSC also reviewed these specific projections in March 2022 and endorsed them as constituting the best available scientific information (for full report see https://www.mafmc.org/ssc-meetings/2022/march-15-16). All specifications will be reviewed and potentially revised annually and a MTA should be available in 2023 to set 2024-2025 specifications. The first alternative uses only 2009-2019 recruitments so it requires very low catches to rebuild. Options 2-5 utilize recruitment draws constrained to lower 2009-2019 estimates unless spawning stock biomass is above 50% of the target (then 1975-2019 recruitments, which the reference points are based on, are used). The SSC identified these two recruitment approaches as "defensible and supported by the data" at its September 2021 SSC Meeting (MAFMC SSC 2021b). The results of each rebuilding scenario are contingent on the assumed recruitment dynamics for the projection time period, which makes it difficult to compare Alternative 1 to the other alternatives. All alternatives assume less recruitment than the original mackerel rebuilding plan.

There will be Mackerel MTAs in 2023 and 2025 that both could result in revised rebuilding plans (they will be the new best available scientific information). Because the 2025 Mackerel MTA should consider catch through 2024, one way to compare across all alternatives in terms of relative probability of leading to stock growth by the 2025 Mackerel MTA is to just consider 2023-2024 combined catch. The higher the combined 2023 and 2024 combined catch, the relatively less likely stock growth will occur. The Action Alternatives 1-5 have been ordered from least to most 2023-2024 combined catch to facilitate comparison ("no-action" would result in the highest catch however, as described below). Conversely, the near-term socioeconomic effects would be most severe with Alternative 1 and least severe with Alternative 5. Longer term considerations are also discussed in the impacts section.

This action would only set specifications for 2023 given an MTA is expected in 2023, which should use data through 2022. Using the 2023 MTA to set 2024 specifications would only involve a two-year data lag from the 2023 MTA data (2022 to 2024). Using the 2021 MTA to set 2024 specifications would involve a five-year data lag (2019 to 2024). If the assessment or subsequent specifications were delayed, then the 2023 specifications would roll-over into 2024 until new specifications were published. The MSB Monitoring Committee recommended this approach given the high degree of uncertainty involved in setting 2024 specifications based on 2019 data. Setting 2024 specifications now is likely to convey more stability about 2023/2024 than warranted given the scale of changes observed in the 2021 Mackerel MTA versus the initial rebuilding plan projections.

NO ACTION ALTERNATIVE

For comparison purposes, "no action" would result in a return to the 2021/2022 published specifications for 2023 given the roll-over provisions in the regulations. Tied to the original rebuilding plan, these specifications would have a total catch of 29,184 MT, which would now result in overfishing in 2023 and fail to rebuild the mackerel stock in 10 years if maintained. While the stock is estimated to have nearly tripled in size from 2014 to 2019 (from about 8% of rebuilt to 24% of rebuilt), it has not increased enough to support the projected catch levels from the initial rebuilding plan. Due to the early January 2023 expiration of the current emergency rule, this is a rare case for MSB fisheries where no action does not equal status quo. The status quo catch (2022) is expected to be about 12,055 MT or less, but that would not be continued once the emergency rule expires in early January 2023. The no-action specifications that would re-commence in early January 2023 are detailed in the table below.

Table 2. No Action Specifications

Specification	Mackerel 2021-2022 (MT)
(a) Overfishing Limit (OFL)	Not available
(b) Acceptable Biological Catch (ABC)	29,184
(c) Canadian Deduction (10,000 MT)	10,000
(d) U.S. ABC = ACL (Canadian catch deducted)	19,184
(e) Recreational Allocation	1,270
(f) Commercial Allocation (rest of ACL)	17,914
(g) Management Uncertainty Buffer = 3%	537
(h) Commercial ACT (97% of allocation)	17,377
(i) DAH (0.37% set aside for discards)	17,312
(j) River Herring and Shad (RH/S) Cap	129

The mackerel fishery also operates under a river herring and shad catch cap (RH/S), which closes the directed mackerel fishery and implements a 20,000 pound trip limit for all permits once 129 MT of RH/S has been projected to be caught in the directed mackerel fishery. 129 MT was the amount of RH/S if the ratio of cap to all catch on mackerel trips (i.e. accounting for other species as well, mostly Atlantic herring) was about 0.53% and the mackerel quota was 17,371 MT (or 0.74% applied to just the mackerel quota). Given the challenges with monitoring a very small cap, including potentially closing the fishery based on a few observed trips, the Council has kept the cap at 129 MT at the current lower mackerel quotas.

5.1 ALTERNATIVE 1 – 10-year Rebuilding with Persistent Low Recruitment.

Alternative 1 assumes lower, post-2009 recruitment persists, which makes it nearly impossible to rebuild because the reference point "goal" rebuilding target is based on higher, typical recruitment (post-1975). The SSC identified this as one of two recruitment approaches that are "defensible and supported by the data" at its September 2021 SSC Meeting. With the low recruitment entering the population for the entire rebuilding period, only minimal catches allow rebuilding, based on a fishing mortality rate ("F") of 0.01. While one could argue this Alternative could be outright rejected given Canadian catches, incidental U.S. commercial catches, and state-waters recreational catches will easily exceed the proposed rebuilding catches, it illustrates the dependence on actually getting typical recruitment when trying to rebuild to a target that is based on typical recruitment. With the catches in this projection, and if lower recruitment persists, the probability of rebuilding by 2032 would be 57%, and the median probability is for rebuilding to occur in 2031. Because this probability is conditional on recruitment being similar to 2009+ recruitment, it is not directly comparable to the other alternatives, but because its catches are so low, Alternative 1 would have the highest overall probability of rebuilding regardless of the recruitments that actually end up occurring. This alternative would also have the highest probability of increasing stock size by the 2025 Mackerel MTA Because it leads to the lowest 2023-2024 catches.

The projected rebuilding period catches (which would be the Acceptable Biological Catches - ABCs) and biomasses under Alternative 1 are described in the table below.

Table 3. Rebuilding Alternative 1 ABCs and Biomass

	Catch (MT)	Biomass (MT)
2023	703	83,692
2024	865	101,492
2025	1,025	118,979
2026	1,169	133,914
2027	1,296	146,932
2028	1,406	158,172
2029	1,497	167,354
2030	1,574	175,260
2031	1,639	181,670
2032	1,692	187,093

In terms of setting specifications for 2023, Alternative 1 appears impracticable given the existing management framework. With a 2023 ABC of 703 MT, the U.S. ABC would be negative given just likely Canadian catches (see additional discussion regarding Canada catches in Alternatives 4 and 5). A complete EEZ closure would come closest to holding to the ABC.

5.2 ALTERNATIVE 2 – P* deduction applied to 50% Rebuilding Probability

Alternatives 2-5 utilize recruitment draws constrained to lower 2009-2019 estimates unless spawning stock biomass during the rebuilding period is above 50% of the target (then the higher 1975-2019 recruitments, which the rebuilding goal is based on, are used). The SSC identified this as one of two recruitment approaches that are "defensible and supported by the data" at its September 2021 SSC Meeting (see Alternative 1 for the other approach). Because the projection model selects the lower or higher recruitment stanza based on biomass in each year of each of 2000 runs, there is a transition toward higher median recruitment through the rebuilding period depending on the exact trajectory of each run.

Alternative 2 uses the Council's standard P* risk policy deduction applied to the 0.14 rebuilding F from Alternative 5, effectively treating a rebuilding F of 0.14 as an overfishing mortality rate (and then imposing a risk-policy deduction). The P* risk policy requires higher certainty in avoiding overfishing at lower biomasses. For example in 2023 the P* risk policy requires an 85.5% probability of not overfishing (or in this case of not exceeding F = 0.14) due to the low projected 2023 stock size, and catch is lowered accordingly. Higher certainty about avoiding exceeding even the rebuilding F means lower catches, which allows rebuilding by 2029 in this alternative. F starts at 0.04 and as biomass nears the rebuilding target, higher fishing mortality is allowed, but never rises above F = 0.13. The 10-year rebuilding probability for Alternative 2 given all 10 years of catches is 62.3% given the recruitments used. This alternative would also have the 2nd highest probability of increasing stock size by the 2025 Mackerel MTA because it leads to the 2nd lowest 2023-2024 catches.

The projected rebuilding period catches (which would be the Acceptable Biological Catches - ABCs) and biomasses under Alternative 3 are described in the table below.

Table 4. Rebuilding Alternative 2 ABCs and Biomass

	Catch (MT)	Biomass (MT)
2023	2,976	82,832
2024	4,168	98,752
2025	5,879	116,414
2026	8,127	134,870
2027	10,978	154,147
2028	14,519	172,753
2029	18,487	188,964
2030	21,394	202,302
2031	23,034	213,674
2032	24,459	222,817

In terms of setting specifications for 2023, Alternative 2 appears impracticable given the existing management framework. With a 2023 ABC of 2,976 MT, the U.S. ABC would be near zero, and the commercial quota would be negative given likely recreational catches (see additional discussion regarding Canada and recreational catches in Alternatives 4 and 5). A complete EEZ closure would come closest to holding to the ABC.

5.3 ALTERNATIVE 3 – P* approach with return to normal recruitment.

Alternatives 2-5 utilize recruitment draws constrained to lower 2009-2019 estimates unless spawning stock biomass during the rebuilding period is above 50% of the target (then the higher 1975-2019 recruitments, which the rebuilding goal is based on, are used). The SSC identified this as one of two recruitment approaches that are "defensible and supported by the data" at its September 2021 SSC Meeting (see Alternative 1 for the other approach). Because the projection model selects the lower or higher recruitment stanza based on biomass in each year of each of 2000 runs, there is a transition toward higher median recruitment through the rebuilding period depending on the exact trajectory of each run.

Alternative 3 uses the Council's standard P* risk policy as a rebuilding plan. The P* risk policy requires higher certainty in avoiding overfishing at lower biomasses. For example in 2023 the P* risk policy requires an 85.5% probability of not overfishing due to the low projected 2023 stock size, and catch is lowered accordingly. For a fully rebuilt stock, the risk policy requires a 55% probability of not overfishing, which causes the stock size to stabilize above the rebuilding target. Higher certainty about avoiding overfishing means lower catches (especially initially), which allows rebuilding by 2031 in this alternative. As biomass nears the rebuilding target, higher fishing mortality is allowed (slowing stock growth). The 10-year rebuilding probability given all 10 years of catches for Alternative 3 is 51.5% given the recruitments used. This alternative would also have the 3rd highest probability of increasing stock size by the 2025 Mackerel MTA because it leads to the 3rd lowest 2023-2024 catches.

The projected rebuilding period catches (which would be the Acceptable Biological Catches - ABCs) and biomasses under Alternative 3 are described in the table below.

Table 5. Rebuilding Alternative 3 ABCs and Biomass

	Catch (MT)	Biomass (MT)
2023	4,539	82,205
2024	6,207	96,378
2025	8,455	111,512
2026	11,245	126,811
2027	14,558	142,214
2028	18,391	156,433
2029	22,337	168,344
2030	25,981	177,517
2031	29,014	183,446
2032	30,564	186,886

As detailed above, this action would only set specifications for 2023 given a Mackerel MTA is expected in 2023, which can inform 2024-2025 specifications.

The SSC recommended the P* approach with the maximum fishing mortality threshold (MFMT) equal to the Fmsy proxy (Alternative 3). This alternative, (1) fulfills rebuilding plan requirements; (2) is the most responsive to new information on changes in stock status; (3) produces the highest rebuilding plan 10-year catch yield); (4) is fully consistent with the Council's P* risk policy; and (5) would avoid "break points" in catch limit advice, which would reduce year-to-year changes in the ABC.

The SSC also noted that this alternative provides lower initial catches (ABCs) than some other alternatives. In terms of setting specifications for 2023, Alternative 3 may be impracticable given the existing management framework and the needed Canadian and recreational deductions. Even if a relatively low deduction is made for Canada (2,197 MT as described below in Alternatives 4/5), the U.S. ABC would be 2,342 MT. With 2,195 MT being the smallest reduction for recreational catch recommended by the Monitoring Committee given the bag/possession limit options (see additional discussion regarding recreational deductions in Alternatives 4 and 5), there would be negligible catch for U.S. landings or discards. Discards could also increase if minimal retention is allowed. Accordingly, the P* approach does not appear practicable for 2023. However, at slightly higher stock sizes and ABCs the P* approach could be practicable, and is worth revisiting after the next Mackerel MTA. A complete EEZ commercial closure would come closest to holding to the ABC.

5.4 ALTERNATIVE 4 – 61% Rebuilding Probability in 10 Years

Alternatives 2-5 utilize recruitment draws constrained to lower 2009-2019 estimates unless spawning stock biomass during the rebuilding period is above 50% of the target (then the higher 1975-2019 recruitments, which the rebuilding goal is based on, are used). The SSC identified this as one of two recruitment approaches that are "defensible and supported by the data" at its September 2021 SSC Meeting (see Alternative 1 for the other approach). Because the projection model selects the lower or higher recruitment stanza based on biomass in each year of each of 2000 runs, there is a transition toward higher median recruitment through the rebuilding period depending on the exact trajectory of each run.

Alternative 4 uses an F of 0.12, which would be predicted to have a 61% probability of rebuilding the mackerel stock in 10 years given the recruitments used. The median rebuilt year is 2031. F stays the same for all 10 years, and as biomass increases, so does catch. This alternative would also have the 4th highest probability of increasing stock size by the 2025 Mackerel MTA Because it leads to the 4th lowest 2023-2024 catches.

The projected rebuilding period catches (which would be the Acceptable Biological Catches - ABCs) and biomasses under Alternative 4 are described in the table below.

Table 6. Rebuilding Alternative 4 ABCs and Biomass

	Catch (MT)	Biomass (MT)
2023	8,094	80,745
2024	9,274	91,738
2025	10,540	103,756
2026	11,906	116,857
2027	13,408	131,291
2028	15,004	146,553
2029	16,631	162,239
2030	18,261	177,731
2031	19,814	192,045
2032	21,215	204,796

As detailed above, this action would only set specifications for 2023 given a Mackerel MTA is expected in 2023, which can inform 2024-2025 specifications. Selecting this alternative would also modify the Council's risk policy for the purposes of beginning this rebuilding plan. The existing risk policy would otherwise cap the 2023 ABC at the standard P* catch calculation (4,539 MT).

The FMP accounts for Canadian landings, recreational catch, and commercial discards by deductions from the total ABC, with options described below.

Canadian Landings

Canada closed its fishery for 2022 so may have minimal landings in 2022. With a 2023 Canadian assessment pending, 2023 Canadian landings are still challenging to predict. This action explores two options for deducting Canadian landings in 2023: Deducting their 2021 landings (4,395 MT) or half that amount (2,197 MT). Given the uncertainty for 2023 and because under-specification of Canadian landings in 2023 would slow rebuilding, 2,197 MT is the lowest value considered.

Recreational Catch Restriction Alternatives

For 2022, 2,582 MT of recreational catch was deducted, the 2017-2021 average. 2017, with more catch than 2018-2021, was included to capture some of the historically-observed variability. Analysis of Marine Recreational Information Program (MRIP) and Vessel Trip Report (VTR) data suggest that replacing trips that caught higher numbers with the following bag/possession limits could result in the following harvest reductions, based on pooled available 2018-2021 MRIP/VTR data (2021 preliminary).

Table 7. Theoretical Bag Limit Reductions by Mode

	% Harvest Reduction		
Bag Limit	Private	Shore	For-Hire
10 fish	39%	27%	35%
15 fish	28%	19%	22%

Accounting for the proportion of each mode's harvest (77% private, 20% shore, 3% for hire), and that harvest is 83% of catch, then the calculated reductions in recreational catch would be (assuming that Maine, New Hampshire, and Massachusetts mirrored the Federal regulations):

Table 8. Theoretical Combined Bag Limit Reductions

	% Catch Reduction
Bag Limit	Combined
10 fish	30%
15 fish	22%

These bag limits appear to represent a reasonable range of initial restriction alternatives for the recreational sector for 2023. There have not been recreational limits for mackerel before, so angler responses may be difficult to predict. To avoid under-accounting for recreational catch the MSB Monitoring Committee recommended either maintaining 2022's 2,582 MT deduction for recreational catch, or only taking half credit for any calculated theoretical savings, which would result in deducting the amounts in the following table for recreational catch in each scenario. The "Recreational Deduction" is the amount of catch set-aside for anticipated recreational catch when commercial quotas are calculated:

Table 9. Theoretical Alternative Recreational Catch Deductions and Savings

	Recreational Deduction	
Bag Limit	Combined (MT)	Savings (MT)
10 fish	2,195	387
15 fish	2,298	284

The "Savings (MT)" column is the amount of fish less than the current 2,582 MT deduction each bag limit might entail. If less recreational catch is deducted, the commercial quota increases by the same amount.

The following specifications calculations assume that either the current approach of 2,582 MT of recreational catch is deducted (i.e. potential savings from recreational bag limits would not be assumed in 2023) or take the deductions from the above table. Staying with 2,582 MT could help account for the variability that can occur with recreational catch estimates – recreational catch (numbers of fish) has been stable from 2018-2021, but has varied substantially year to year in the past. It must be reiterated that these estimates are rough approximations given there is no history of bag limits in this fishery. Staff explored using a log regression to consider different increments given the apparent digit bias (at 5 and 10 fish increments) in the reported harvest data. While a log regression fit the data quite well, there did not appear reason to investigate further given there is already limited certainty about potential angler responses to a new bag limit for mackerel and subsequent effects on overall catch. Utilizing the digit bias could also simplify communications of regulations.

Commercial Discards

No changes are proposed to the averaging approach used by the NEFSC for 2022 projected catch – 115 MT is assumed for 2023 commercial mackerel discards.

Closure Approach

Averaging 2018-2021, the fishery landed 805 MT after April 1, and these were times when the directed limited access fishery was not active (range was 618 MT to 1,037 MT). As such, this time period should represent landings rates that could occur during a closure of the directed fishery. The proposed "first" closure approach is to buffer this performance by 10% and one month, so that before May 1 the directed fishery would close with 886 MT left in the quota, and from May 1 on, the directed fishery would close with 443 MT left in the quota. NMFS would also have the discretion to not close the fishery in November and December if performance suggests that a quota overage is unlikely. While it is possible that an early closure in January could result in more than 886 MT in additional landings, and it is possible that a closure in late April could result in unused quota remaining, this proposed system likely strikes a reasonable balance between achieving OY and regulatory simplicity. At this threshold for the "first" closure, additional trip limits would be implemented: 40,000 pounds for Tier 1-3 directed permits and 5,000 pounds for incidental/open access permits. There would be a final closure with 100 MT left in the quota where all permits were subject to a 5,000 pound trip limit to minimize any potential overages. With these trip limits any possible overages should be minimal, and would be deducted from subsequent years' quotas if an overall ACL overage occurs.

Specifications Summary

Based on the above proposed approaches to handle Canadian landings, recreational catch, commercial discards, and quota closures, the following specifications are possible for Alternative 4 – at the time of final action, the Council would need to identify the recommended Canadian landings and recreational catch deductions to determine the final quotas.

Table 10. Alternative 4 2023 Specifications Summary

Alternative 4 - 2023 Specifications (MT)						
ABC	8,094					
Canadian Catch Options	2,197			4,395		
Rec Catch Options (10, 15, na)	2,195	2,298	2,582	2,195	2,298	2,582
Commercial Discards	115	115	115	115	115	115
Commercial Quota	3,587	3,484	3,200	1,389	1,286	1,002
Before May 1 First Closure Threshold (-886 MT)	2,701	2,598	2,314	Insufficient quota for directed fishing - begin closed		
May 1/after First Closure Threshold (-443 MT)	3,144	3,041	2,757			
Final Closure Threshold (-100 MT)	3,487	3,384	3,934	1,289	1,186	902

"First" closure = 40,000 pound trip limit for Tier 1-3 directed permits and 5,000 pounds for incidental/open access permits. "Final" closure = 5,000 pounds for all permits.

For example following arrows to the left,, with an 8,094 ABC (=ACL), if 2,197 MT was deducted for Canada, 2,195 MT was deducted for recreational catch (10-fish bag limit), and 115 MT was deducted for commercial discards, the commercial quota would be 3,587 MT. At 2,701 MT before May 1 or 3,144 MT on/after May 1, the first closure trip limits would be implemented. At 3,487 MT the final closure trip limit of 5,000 pounds for all permits would be implemented.

Commercial Minimum Mesh Add-On Alternative

The Council has also requested inclusion of a 3-inch minimum mesh requirement that mirrors a similar requirement in the butterfish fishery. The regulatory wording would be: "Owners or operators of trawl vessels possessing more than 5,000 lb (2.27 mt) of mackerel harvested in or from the EEZ may only fish with nets having a minimum codend mesh of 3 inches (7.62 cm) diamond or square mesh, as measured by methods specified in § 648.80(f), applied throughout the codend for at least 100 continuous meshes forward of the terminus of the net, or for codends with less than 100 meshes, the minimum mesh size codend shall be a minimum of one-third of the net, measured from the terminus of the codend to the headrope.

Unfortunately there are not gear selectivity studies for Atlantic mackerel that allow quantitative analysis of this alternative. Casey et al 1992 examined an experimental midwater trawl codend of 60 mm polypropylene knotless square netting fished against a similar trawl fitted with a codend constructed from 40 mm knotted nylon mesh rigged in the conventional diamond configuration in the western English Channel. The size composition of the mackerel caught ranged from 18 to 37 cm (roughly almost age 1s to age 7s in our fishery) and a comparison of the length-frequency distributions indicated that there was no difference in the size composition, and hence selection, of fish taken by the two gears. Various studies on horse mackerel, a jack species of roughly similar size and shape of Atlantic mackerel have shown expected selectivity patterns. For example Campos and Fonseca 2003 saw small but significant effects on size selectivity across 65mm (2.6 inches) to 70mm (2.8 inches) and 80 mm (3.1 inches) meshes. The direct applicability to Atlantic mackerel would be uncertain, but the general literature on selectivity would support that some additional escapement of small mackerel should occur (e.g. https://www.conservationevidence.com/actions/2697#). Most Atlantic mackerel catch observations (raw data) in the observer data in the last 10 years occur from 48mm (1.9 inches) to 60mm (2.5 inches), with less then 10% of observations by weight occurring with mesh over 60mm (2.5 inches), making the observer data of limited use for exploring a mesh increase.

River Herring and Shad Cap

Sub-Option 1 (No-action / Status Quo for RH/S Cap)

Given the small 2023 directed fishery, the Council could simply retain the current 129 MT river herring and shad (RH/S) catch cap, which closes the directed mackerel fishery and implements a 20,000 pound trip limit for all permits once 129 MT of RH/S has been projected to be caught in the directed mackerel fishery. 129 MT was the amount of RH/S if the ratio of cap to all catch on mackerel trips was about 0.53% and the mackerel quota was 17,371 MT (or 0.74% applied to just the mackerel quota). Given the challenges with estimating and monitoring a very small cap, including potentially closing the fishery based on a few observed trips, the Council has kept the cap at 129 MT at the current lower mackerel quotas.

Sub-Option 2

The Council could also scale the RH/S cap with the quota selected in this Alternative, which would range the RH/S cap from 27 MT to 7 MT.

Permitting Option

There is some ambiguity in the current regulations regarding possession of Atlantic mackerel in federal waters (beyond 3 miles). If the prohibitions list is modified to include possession by commercial and for-hire vessels without an appropriate permit, any reporting loopholes would be closed, especially including possession of previously-caught or purchased Atlantic mackerel bait as triggering a permit requirement. Purchased Atlantic mackerel would not need to be reported, but all catch on all trips must be reported on vessel trip reports (VTRs) once in possession of a permit (regardless of the target species on a particular trip). This could add VTR reporting for a substantial number of vessels with Highly Migratory Species (HMS) permits (possibly 1,000-2,000 HMS for hire vessels and 1,000-2,000 HMS Atlantic Tunas General category vessels) if they wanted to possess mackerel in federal waters. The 1,000-2,000 vessel range is based on the total count of HMS permits and existing limited permit overlap.

5.5 ALTERNATIVE 5 – 53% Rebuilding Probability in 10 Years

Alternatives 2-5 utilize recruitment draws constrained to lower 2009-2019 estimates unless spawning stock biomass during the rebuilding period is above 50% of the target (then the higher 1975-2019 recruitments, which the rebuilding goal is based on, are used). The SSC identified this as one of two recruitment approaches that are "defensible and supported by the data" at its September 2021 SSC Meeting (see Alternative 1 for the other approach). Because the projection model selects the lower or higher recruitment stanza based on biomass in each year of each of 2000 runs, there is a transition toward higher median recruitment through the rebuilding period depending on the exact trajectory of each 2000 model runs.

Alternative 5 uses an F of 0.14, which would be predicted to have a 53.4 % probability of rebuilding the mackerel stock in 10 years given the recruitments used. The median rebuilt year is 2032. F stays the same for all 10 years, and as biomass increases, so does catch. Other than no action, this alternative would also have the lowest probability of increasing stock size by the 2025 Mackerel MTA Because it leads to the highest 2023-2024 catches.

The projected rebuilding period catches (which would be the Acceptable Biological Catches - ABCs) and biomasses under Alternative 5 are described in the table below.

Table 11. Rebuilding Alternative 5 ABCs and Biomass

	Catch (MT)	Biomass (MT)
2023	9,371	80,215
2024	10,591	89,949
2025	11,883	100,486
2026	13,252	111,737
2027	14,764	124,305
2028	16,365	137,457
2029	18,001	151,050
2030	19,665	164,694
2031	21,257	177,355
2032	22,672	188,731

As detailed above, this action would only set specifications for 2023 given a Mackerel MTA is expected in 2023, which can inform 2024-2025 specifications. Selecting this alternative would also modify the Council's risk policy for the purposes of beginning this rebuilding plan. The existing risk policy would otherwise cap the 2023 ABC at the standard P* catch calculation (4,539 MT).

The FMP accounts for Canadian landings, recreational catch, and commercial discards by deductions from the total ABC, with options described below.

Canadian Landings

Canada closed its fishery for 2022 so may have minimal landings in 2022. With a 2023 Canadian assessment pending, 2023 Canadian landings are still challenging to predict. This action explores two options for deducting Canadian landings in 2023: Deducting their 2021 landings (4,395 MT) or half that amount (2,197 MT). Given the uncertainty for 2023 and because under-specification of Canadian landings in 2023 would slow rebuilding, 2,197 MT is the lowest value considered.

Recreational Catch Restriction Alternatives

For 2022, 2,582 MT of recreational catch was deducted, the 2017-2021 average. 2017 was included to capture some of the historically-observed variability. Analysis of Marine Recreational Information Program (MRIP) and Vessel Trip Report (VTR) data suggest that replacing trips that caught higher numbers with the following bag/possession limits could result in the following harvest reductions, based on pooled available 2018-2021 MRIP/VTR data (2021 preliminary).

Table 12. Theoretical Bag Limit Reductions by Mode

	% Harvest Reduction		
Bag Limit	Private	Shore	For-Hire
10 fish	39%	27%	35%
15 fish	28%	19%	22%

Accounting for the proportion of each mode's harvest (77% private, 20% shore, 3% for hire), and that harvest is 83% of catch, then the calculated reductions in recreational catch would be (assumes that discards stayed similar and that Maine, New Hampshire, and Massachusetts mirrored the Federal regulations):

Table 13. Theoretical Combined Bag Limit Reductions

	% Catch Reduction
Bag Limit	Combined
10 fish	30%
15 fish	22%

These bag limits appear to represent a reasonable range of initial restriction alternatives for the recreational sector for 2023. There have not been recreational limits for mackerel before, so angler responses may be difficult to predict. To avoid under-accounting for recreational catch the MSB Monitoring Committee recommended either maintaining 2022's 2,582 MT deduction for recreational catch, or only taking half credit for any calculated theoretical savings, which would result in deducting the amounts in the following table for recreational catch in each scenario. The "Recreational Deduction" is the amount of catch set-aside for anticipated recreational catch when commercial quotas are calculated:

Table 14. Theoretical Alternative Recreational Catch Deductions and Savings

Bag Limit	Recreational Deduction Combined (MT)	Savings (MT)
10 fish	2,195	387
15 fish	2,298	284

The "Savings (MT)" column is the amount of fish less than the current 2,582 MT deduction each bag limit might entail. If less recreational catch is deducted, the commercial quota increases by the same amount.

The following specifications calculations assume that either the current approach of 2,582 MT of recreational catch is deducted (i.e. potential savings from recreational bag limits would not be assumed in 2023) or take the deductions from the above table. Staying with 2,582 MT could help account for the variability that can occur with recreational catch estimates – recreational catch (numbers of fish) has been stable from 2018-2021, but has varied substantially year to year in the past. It must be reiterated that these estimates are rough approximations given there is no history of bag limits in this fishery. Staff explored using a log regression to consider different increments given the apparent digit bias (at 5 and 10 fish increments) in the reported harvest data. While a log regression fit the data quite well, there did not appear reason to investigate further given there is already limited certainty about potential angler responses to a new bag limit for mackerel and subsequent effects on overall catch. Utilizing the digit bias could also simplify communications of regulations.

Commercial Discards

No changes are proposed to the averaging approach used by the NEFSC for 2022 projected catch – 115 MT is assumed for 2023 commercial mackerel discards.

Closure Approach

Averaging 2018-2021, the fishery landed 805 MT after April 1, and these were times when the directed limited access fishery was inactive (range was 618 MT to 1,037 MT). As such, this time period should represent landings rates that could occur during a closure of the directed fishery. The proposed "first" closure approach is to buffer this performance by 10% and one month, so that before May 1 the directed fishery would close with 886 MT left in the quota, and from May

1 on, the directed fishery would close with 443 MT left in the quota. NMFS would also have the discretion to not close the fishery in November and December if performance suggests that a quota overage is unlikely. While it is possible that an early closure in January could result in more than 886 MT in additional landings, and it is possible that a closure in late April could result in unused quota remaining, this proposed system likely strikes a reasonable balance between achieving OY and regulatory simplicity. At this threshold for the "first" closure, additional trip limits would be implemented: 40,000 pounds for Tier 1-3 directed permits and 5,000 pounds for incidental/open access permits. There would be a final closure with 100 MT left in the quota where all permits were subject to a 5,000 pound trip limit to minimize any potential overages. With these trip limits any possible overages should be minimal, and would be deducted from subsequent years' quotas if an overall ACL overage occurs.

Specifications Summary

Based on the above proposed approaches to handle Canadian landings, recreational catch, commercial discards, and quota closures, the following specifications are possible for Alternative 5 – at the time of final action, the Council would need to identify the recommended Canadian landings and recreational catch deductions to determine the final quotas.

Table 15. Alternative 5 2023 Specifications Summary

Alternative 5 - 2023 Specifications (MT)						
ABC	9,371					
Canadian Catch Options	2,197			4,395		
Rec Catch Options (10, 15, na)	2,195	2,298	2,582	2,195	2,298	2,582
Commercial Discards	115	115	115	115	115	115
Commercial Quota	4,864	4,761	4,477	2,666	2,563	2,279
Before May 1 First Closure Threshold (-886 MT)	3,978	3,875	3,591	1,780	1,677	1,393
May 1/after First Closure Threshold (-443 MT)	4,421	4,318	4,034	2,223	2,120	1,836
Final Closure Threshold (-100 MT)	4,764	4,661	4,377	2,566	2,463	2,179

"First" closure = 40,000 pound trip limit for Tier 1-3 directed permits and 5,000 pounds for incidental/open access permits. "Final" closure = 5,000 pounds for all permits.

For example following arrows to the left, with a 9,371 ABC (=ACL), if 2,197 MT was deducted for Canada, 2,195 MT was deducted for recreational catch (10-fish bag limit), and 115 MT was deducted for commercial discards, the commercial quota would be 4,864 MT. At 3,978 MT before May 1 or 4,421 MT on/after May 1, the first closure trip limits would be implemented. At 4,764 MT the final closure trip limit of 5,000 pounds for all permits would be implemented.

Commercial Minimum Mesh Add-On Alternative

The Council has also requested inclusion of a 3-inch minimum mesh requirement that mirrors a similar requirement in the butterfish fishery. The regulatory wording would be: "Owners or operators of trawl vessels possessing more than 5,000 lb (2.27 mt) of mackerel harvested in or from the EEZ may only fish with nets having a minimum codend mesh of 3 inches (7.62 cm) diamond or square mesh, as measured by methods specified in § 648.80(f), applied throughout the codend for at least 100 continuous meshes forward of the terminus of the net, or for codends with less than 100 meshes, the minimum mesh size codend shall be a minimum of one-third of the net, measured from the terminus of the codend to the headrope.

Unfortunately there are not gear selectivity studies for Atlantic mackerel that allow quantitative analysis of this alternative. Casey et al 1992 examined an experimental midwater trawl codend of 60 mm polypropylene knotless square netting fished against a similar trawl fitted with a codend constructed from 40 mm knotted nylon mesh rigged in the conventional diamond configuration in the western English Channel. The size composition of the mackerel caught ranged from 18 to 37 cm (roughly almost age 1s to age 7s in our fishery) and a comparison of the length-frequency distributions indicated that there was no difference in the size composition, and hence selection, of fish taken by the two gears. Various studies on horse mackerel, a jack species of roughly similar size and shape of Atlantic mackerel have shown expected selectivity patterns. For example Campos and Fonseca 2003 saw small but significant effects on size selectivity across 65mm (2.6 inches) to 70mm (2.8 inches) and 80 mm (3.1 inches) meshes. The direct applicability to Atlantic mackerel would be uncertain, but the general literature on selectivity would support that some additional escapement of small mackerel should occur (e.g. https://www.conservationevidence.com/actions/2697#). Most Atlantic mackerel catch observations (raw data) in the observer data in the last 10 years occur from 48mm (1.9 inches) to 60mm (2.5 inches), with less then 10% of observations by weight occurring with mesh over 60mm (2.5 inches), making the observer data of limited usefulness for exploring an increase to a 3-inch mesh.

River Herring and Shad Cap

Sub-Option 1 (No-action / Status Quo for RH/S Cap)

Given the small 2023 directed fishery, the Council could simply retain the current 129 MT river herring and shad (RH/S) catch cap, which closes the directed mackerel fishery and implements a 20,000 pound trip limit for all permits once 129 MT of RH/S has been projected to be caught in the directed mackerel fishery. 129 MT was the amount of RH/S if the ratio of cap to all catch on mackerel trips (accounting for mostly Atlantic herring) was about 0.53% and the mackerel quota was 17,371 MT (or 0.74% applied to just the mackerel quota). Given the challenges with estimating and monitoring a very small cap, including potentially closing the fishery based on a few observed trips, the Council has kept the cap at 129 MT at the current lower mackerel quotas.

Sub-Option 2

The Council could also scale the RH/S cap with the quota selected in this Alternative, which would range the RH/S cap from 36 MT to 17 MT.

Permitting Option

There is some ambiguity in the current regulations regarding possession of Atlantic mackerel in federal waters (beyond 3 miles). If the prohibitions list is modified to include possession by commercial and for-hire vessels without an appropriate permit, any reporting loopholes would be closed, especially including possession of previously-caught or purchased Atlantic mackerel bait as triggering a permit requirement. Purchased Atlantic mackerel would not need to be reported, but all catch on all trips must be reported on vessel trip reports (VTRs) once in possession of a permit (regardless of the target species on a particular trip). This could add VTR reporting for a substantial number of vessels with Highly Migratory Species (HMS) permits (possibly 1,000-2,000 HMS for hire vessels and 1,000-2,000 HMS Atlantic Tunas General category vessels) if they wanted to possess mackerel in federal waters. The 1,000-2,000 vessel range is based on the total count of HMS permits and existing limited permit overlap.

5.6 Considered but Rejected Alternatives

Given the extremely low catches required for even a 50% probability of rebuilding when lower recruitment is assumed for the whole rebuilding period (i.e. #1 above), higher probability options combined with the persistent low recruitment appeared redundant.

Even with the two phase recruitment scenario, achieving a 75% probability of rebuilding would require very low catches, and appeared redundant with remaining options that also required very low catches.

Given the unknown discard mortality, and potential enforcement issues related to chub mackerel mis-identification, minimum size options were “Considered but Rejected.”

6.0 DESCRIPTION OF THE AFFECTED ENVIRONMENT AND FISHERIES

6.1 Description of the Managed Resource and Non-Target Species

Mackerel

Unless otherwise indicated, the information in this section is taken from the mackerel EFH source document at http://www.nefsc.noaa.gov/nefsc/habitat/efh/ and the recent mackerel MTA.

Atlantic mackerel is a semi-pelagic/semi-demersal (may be found near the bottom or higher in the water column) schooling fish species primarily distributed between Labrador (Newfoundland, Canada) and North Carolina. Based on the work of Sette (1943, 1950) and confirmed in the recent assessment, the stock is considered to comprise two spawning contingents: a northern contingent spawning primarily in the southern Gulf of St. Lawrence and a southern contingent spawning in the Mid-Atlantic Bight, Southern New England and the western Gulf of Maine. The two contingents mix during winter months on the Northeast U.S. shelf; however, the degree of mixing and natal homing is unknown. Mackerel in the northwest Atlantic were modeled as one stock for the recent assessment. The Canadian fishery likely primarily catches the northern contingent while the U.S. fishery likely catches both contingents.

Mackerel spawning occurs during spring and summer and progresses from south to north as the surface waters warm. Atlantic mackerel are serial, or batch spawners. Eggs are pelagic. Post-larvae gradually transform from planktonic to swimming and schooling behavior at about 30-50 mm. Approximately 50% of fish are mature at age 2 and about 99% were mature at age 3 from 2007-2016 according to the 2018 Benchmark Assessment (NSFSC 2018).

Atlantic mackerel are opportunistic feeders that can ingest prey either by individual selection of organisms or by filter feeding.

A wide variety of fish and other animals are predators of mackerel. Predator food habits on the Northeast US Shelf have been systematically sampled during the NEFSC bottom trawl surveys since 1973. In the recent benchmark assessment, these food habits data were evaluated for the top 17 mackerel predators based on the percent occurrence of mackerel in predator diets (NEFSC 2018, Appendix A4). The presence of Atlantic mackerel in fish stomachs was generally low from 1973-2016. A total of 1,284 out of 619,637 stomachs (~0.2%) contained mackerel, including unidentified mackerel Scombridae and Scomber spp. Spiny dogfish was the most dominant mackerel predator sampled by the trawl surveys, but the frequency of occurrence for mackerel in spiny dogfish diets only average 1%.

Additional potentially important predators of mackerel are not sampled in the NEFSC trawl surveys, including highly migratory species, marine mammals, and seabirds. Consumption from these predators is more difficult to estimate due to incomplete information on population levels and annual diet information. Furthermore, predator food habits were not available for the months the northern contingent was outside of the area sampled by the NEFSC trawl survey. Given this incomplete sampling, the low occurrence of mackerel in predator stomachs, and the resulting interannual variability in consumption estimates, the final model did not incorporate predator diets as an index of abundance. The temporal trends in consumption were consistent with trends from the range-wide egg index as well as abundance estimates.

Additional life history information is detailed in the Essential Fish Habitat (EFH) document for the species, located at: http://www.nefsc.noaa.gov/nefsc/habitat/efh/.

The 2021 Mackerel MTA found mackerel continue to be overfished with overfishing occurring, as described previously.

Mackerel Non-Target Species

There have been very few recent observed directed mackerel trips due to the low directed effort toward mackerel in recent years. Various species will be caught incidentally to any mackerel fishing and will be impacted to some degree by the prosecution of the fishery. On the mackerel trips identified in this analysis, the 2017-2019 overall discard rate was 1%. For non-target species that are managed under their own FMP, incidental catch/discards are also considered as part of the management of that fishery. Data beyond 2019 was not analyzed due to potential Covid-19 impacts.

The primary database used to assess discarding is the NMFS Observer Program database, which includes data from trips that had trained observers onboard to document discards. One critical aspect of using this database to describe discards is to correctly define the trips that constitute a given directed fishery. A flexible criteria of what captains initially intend to target, how they may adjust targeting over the course of a trip, and what they actually catch would be ideal but is impracticable. The case with mackerel is further complicated by the small size of the fishery recently and the few observed trips. However from 2017-2019 there were on average 7 observed trips annually where mackerel accounted for at least 50% of retained catch, and those trips form the basis of the following analysis. These trips made 65 hauls of which 89% were observed. Hauls may be unobserved for a variety of reasons, for example transfer to another vessel without an observer, observer not on station, haul slipped (dumped) in the water before observing, etc.

The observed mackerel kept on these trips accounted for approximately 7% of the total mackerel landed (this is the overall coverage rate based on weight). While a very rough estimate, especially given non-accounting for spatial and temporal trends, one can use the information in the table immediately following and the fact that about 6,920 mt of mackerel were caught annually 2017-2019 to roughly estimate annual incidental catch and discards for the species in the table. Readers are strongly cautioned that while this is a reasonable approach for a quick, rough, and relative estimate given the available data, it is highly imprecise and does not follow the protocol used for official discard estimates. As a minimum threshold, only species estimated to be caught at a level more than 10,000 pounds per year are included (captures 95% of all discards). Species with a "*" are overfished, subject to overfishing, or otherwise considered depleted.

Table 16. Incidental Catch and Discards in the Mackerel Fishery

NE Fisheries Science Center Common Name	Pounds Observed Caught	Pounds Observed Discarded	Of all discards observed, percent that comes from given species	Percent of given species that was discarded	Pounds of given species caught per mt mackerel Kept	Pounds of given species discarded per mt mackerel Kept	Rough Annual Catch (pounds) based on 3-year (2017-2019) average of mackerel landings (6,920 mt)	Rough Annual Discards (pounds) based on 3-year (2017-2019) average of mackerel landings (6,920 mt)
MACKEREL, ATLANTIC *	3,207,485	585	1%	0%	2,205	0	15,258,755	2,785
HERRING, ATLANTIC *	626,320	4,639	9%	1%	431	3	2,979,549	22,068
HERRING, BLUEBACK *	28,805	9,570	19%	33%	20	7	137,031	45,529
FISH, NK	22,101	22,101	43%	100%	15	15	105,137	105,137
DOGFISH, SPINY	13,912	10,048	20%	72%	10	7	66,181	47,799
ALEWIFE *	7,580	1,793	3%	24%	5	1	36,061	8,531
HAKE, SILVER (WHITING	2,187	23	0%	1%	2	0	10,402	108

The observer program creates individual animal records for some fish species of interest, mostly larger pelagics and/or elasmobranchs, as well as tagged fish. There was only one such record for these trips, an unknown shark species.

6.2 Human Communities and Economic Environment

This section describes the performance of the mackerel fishery to allow the reader to understand the socio-economic importance of the mackerel fishery. The recent squid and butterfish specifications EA (MAFMC 2021) can be consulted for information on those species, but those fisheries are not expected to be impacted by this action. Recent Amendments to the MSB FMP contain additional information about the MSB fisheries, especially demographic information on ports that land MSB species. See Amendments 11 and 14 at http://www.mafmc.org/msb/ for more information or visit NMFS' communities page at: http://www.nefsc.noaa.gov/read/socialsci/community_profiles/. In general, the MSB fisheries saw high foreign landings in the 1970s followed by a domestication of the fishery, and domestic landings have been variable, but lower than the peak foreign landings. The current regulations for the MSB fisheries are summarized by NMFS at https://www.fisheries.noaa.gov/species/atlantic-mackerel#commercial, and detailed in the Federal Register at https://www.ecfr.gov/current/title-50/chapter-VI/part-648.

The most obvious way that human communities are affected by the MSB fisheries are from the revenues generated by the fisheries, and the jobs created. The affected communities include both individuals directly involved in harvesting and processing as well as indirect support services (e.g. vessel maintenance, insurance, ice, etc.). While the direct data points that are most available are landings and revenues, it is important to keep in mind that by contributing to the overall functioning of and employment in coastal communities, the MSB fisheries have indirect social impacts as well. Social impacts are strongly aligned with changes to fishing opportunities and while difficult to measure can include impacts to families from income changes/volatility, safety-at-sea (related to changes in fishery operations due to regulation changes), job satisfaction, and general frustration by individuals due to management's impacts especially if they perceive management actions to be unreasonable or ill-informed.

Descriptive information on the fisheries is included, and where possible, quantitative commercial fishery and economic information is presented. This section establishes a descriptive baseline for the fishery with which to compare actual and predicted future socio-economic changes that result from management actions.

Commercial Fishery Measures and Total Catches

There are four categories of mackerel permits. When the fishery starts each year, the various commercial mackerel permit categories start with different trip limits. Tier 1 has an unlimited trip limit, Tier 2 has a 135,000 pound trip limit, and Tier 3 has a 100,000 pound trip limit. An open access/incidental permit has a 20,000 pound trip limit. When 90% of the DAH is projected to be landed, trip limits of 40,000 pounds are implemented for Tier 1-3 directed permits and 5,000 pounds for incidental/open access permits. When 100% of the DAH is projected to be landed, a 5,000 pound trip limit would be implemented for all permits for the rest of the fishing year to cover remaining incidental catches.

Foreign catches dominated the fishery during the 1960s and 1970s, with total catch peaking at over 432,000 MT in 1973. Foreign catches declined and then were eliminated by the MSA, though there was also some joint venture activity from the mid-1980s through 1991. From 1992 through 2001, total catches (including Canada) averaged just under 36,000 MT before increasing to peaks over 112,000 MT in 2004 and 2006. Total catch then declined from 2011-2021 averaging just under 17,000 MT per year. It has been estimated by Canadian DFO staff that there could be between 2,000 and 5,000 metric tons of unreported historical catches per year[5] (not included in US assessments or catch accounting), which includes fishing mortality from various sources, notably recreational and some unreported commercial (including bait) harvests, discards, and other mortalities. Unreported Canadian commercial harvest may be lower in the most recent years due to stock concerns and additional focus on catch reporting.

[5] https://www.gazette.gc.ca/rp-pr/p2/2021/2021-05-26/html/sor-dors100-eng.html

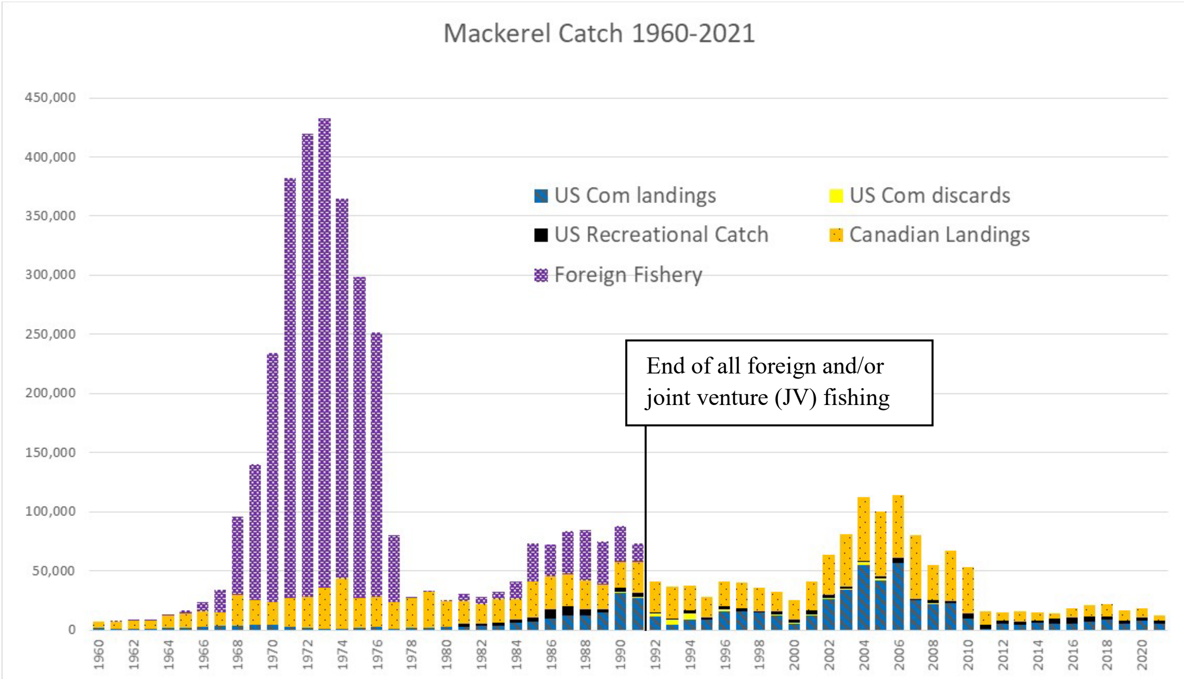

Figure 3. Recorded NW Atlantic mackerel catch (mt) 1960-2021.

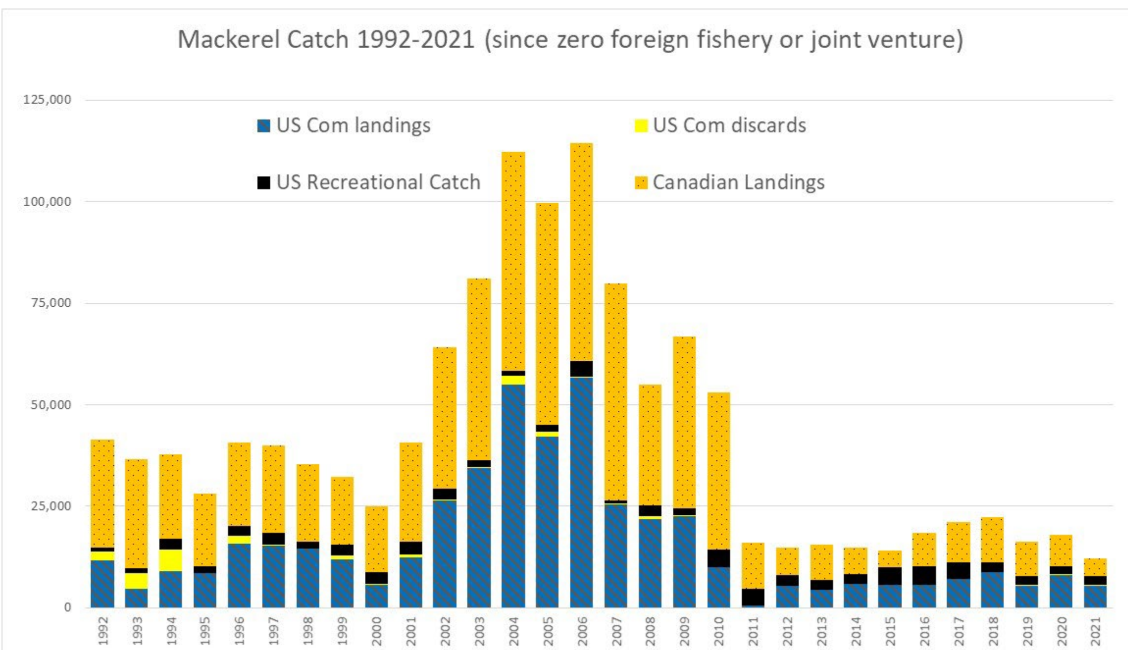

Figure 4. Recorded NW Atlantic mackerel catch (mt) 1992-2021.
(foreign fishery ended fully - note different scale and time period from Figure 3)

The figures below provides more detail on U.S. Commercial landings, ex-vessel revenues (in 2021 inflation-adjusted dollars), and prices per MT since 1996, when reporting was improved.

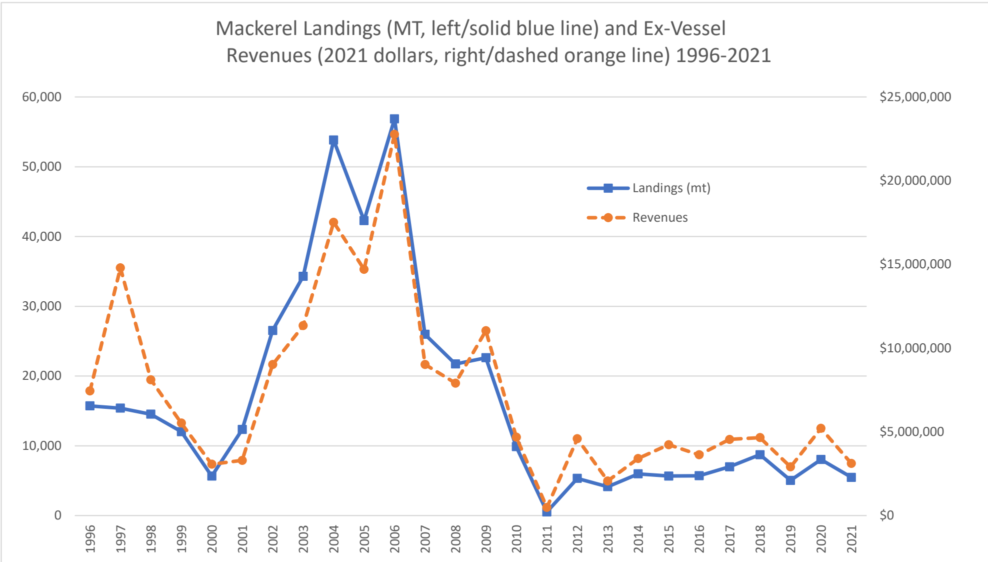

Figure 5. U.S. Commercial Landings and Ex-Vessel Revenues 1996-2021 Adjusted to 2021 Dollars Source: NMFS unpublished dealer data.

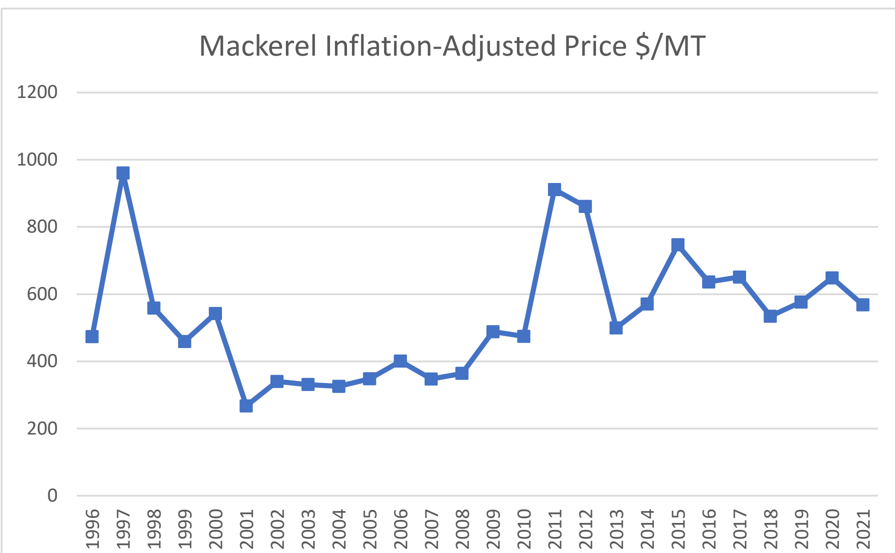

Figure 6. Ex-Vessel Mackerel Prices 1996-2021 Adjusted to 2021 Dollars Source: NMFS unpublished dealer data. [PRELIMINARY]

The mackerel fishery takes place in shelf waters as in the figures below. Landings were reported via dealer reports matched to a vessel trip report (VTR) when possible. From 2007-2011 80% of landings had location data, from 2012-2016 84% of landings had location information, and more recent years have also had a high percentage of landings with location information.

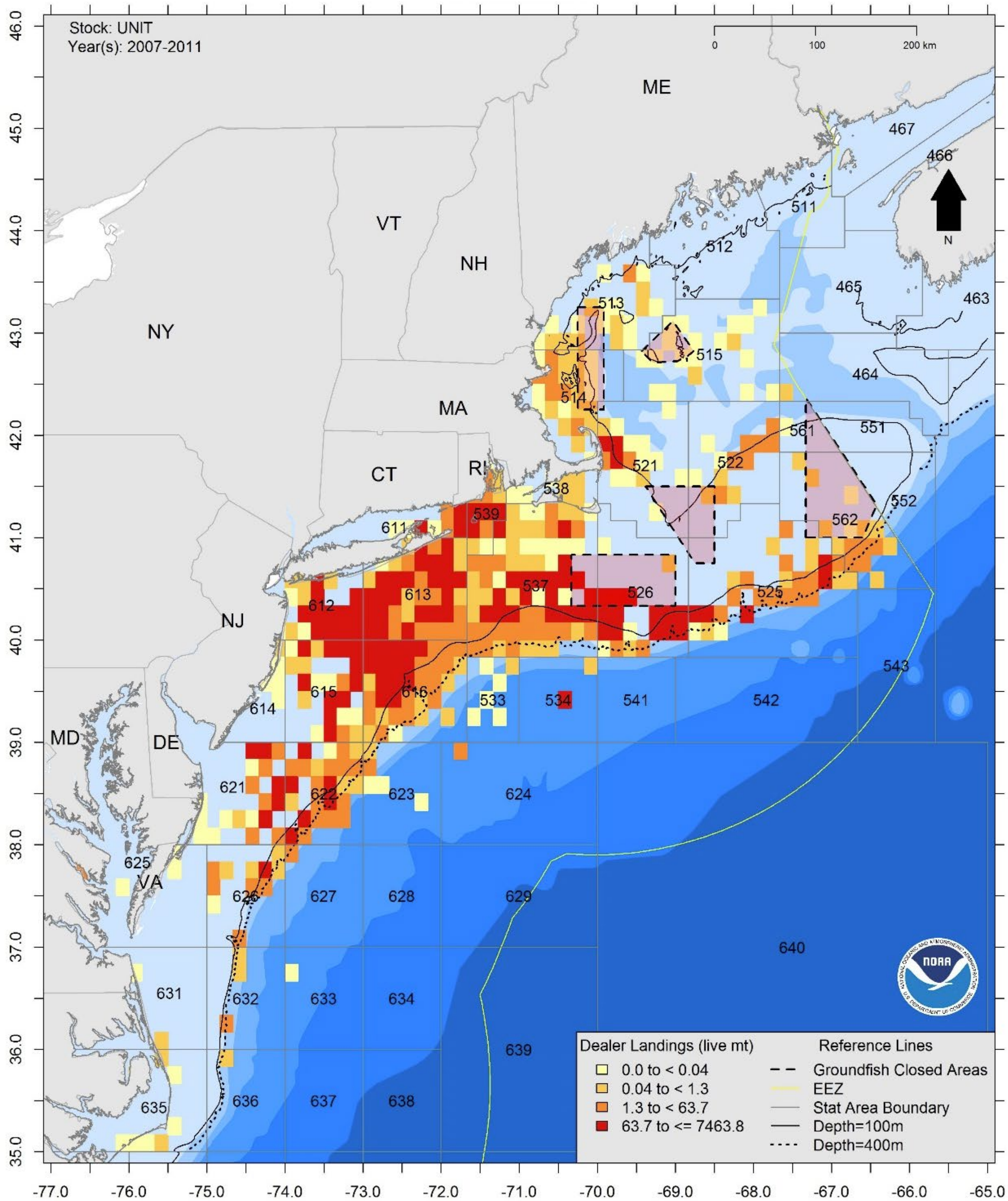

Figure 7. Spatial distribution of landings (mt) by ten-minute square, during 2007-2011.

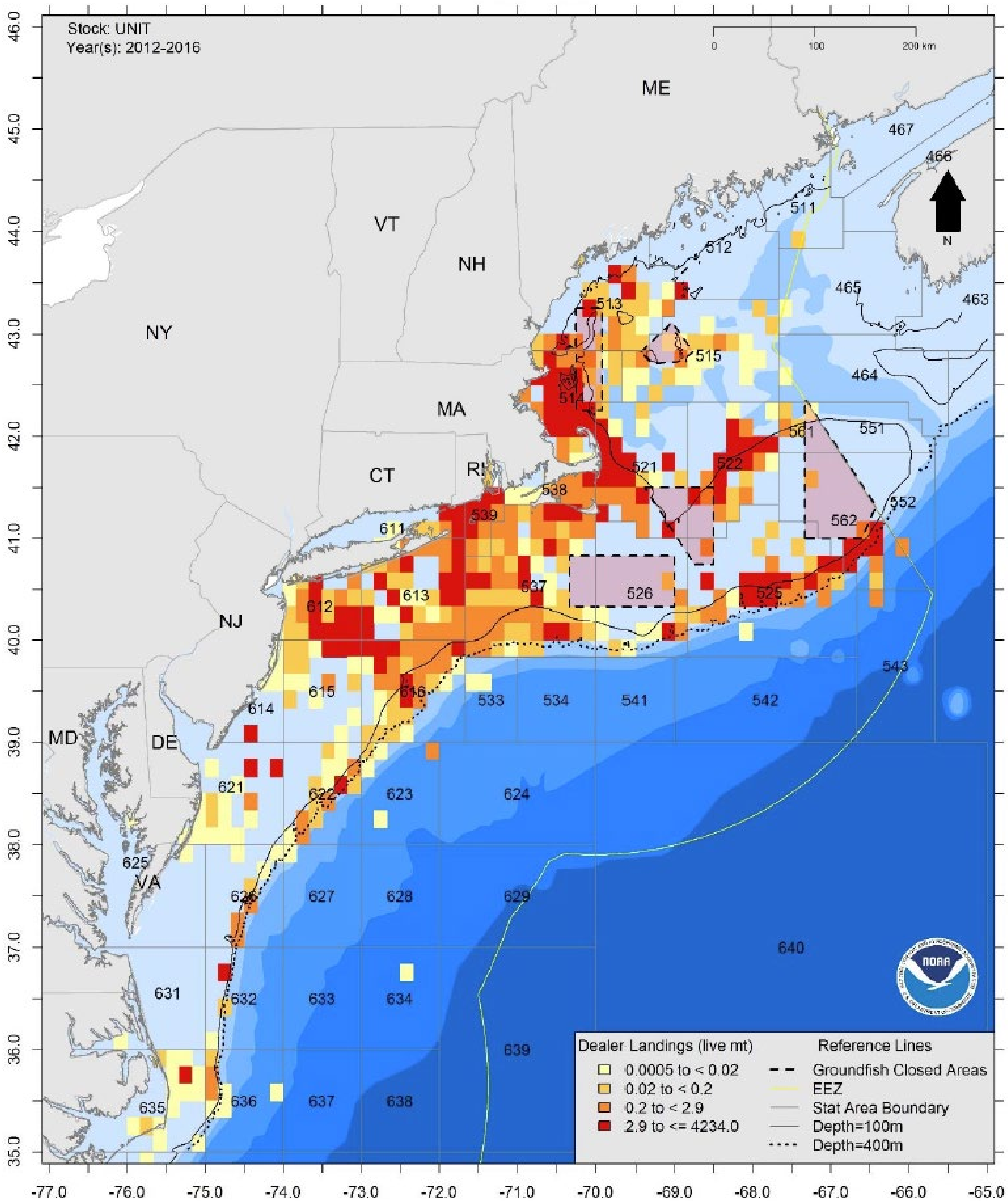

Figure 8. Spatial distribution of landings (mt) by ten-minute square, during 2012-2016.

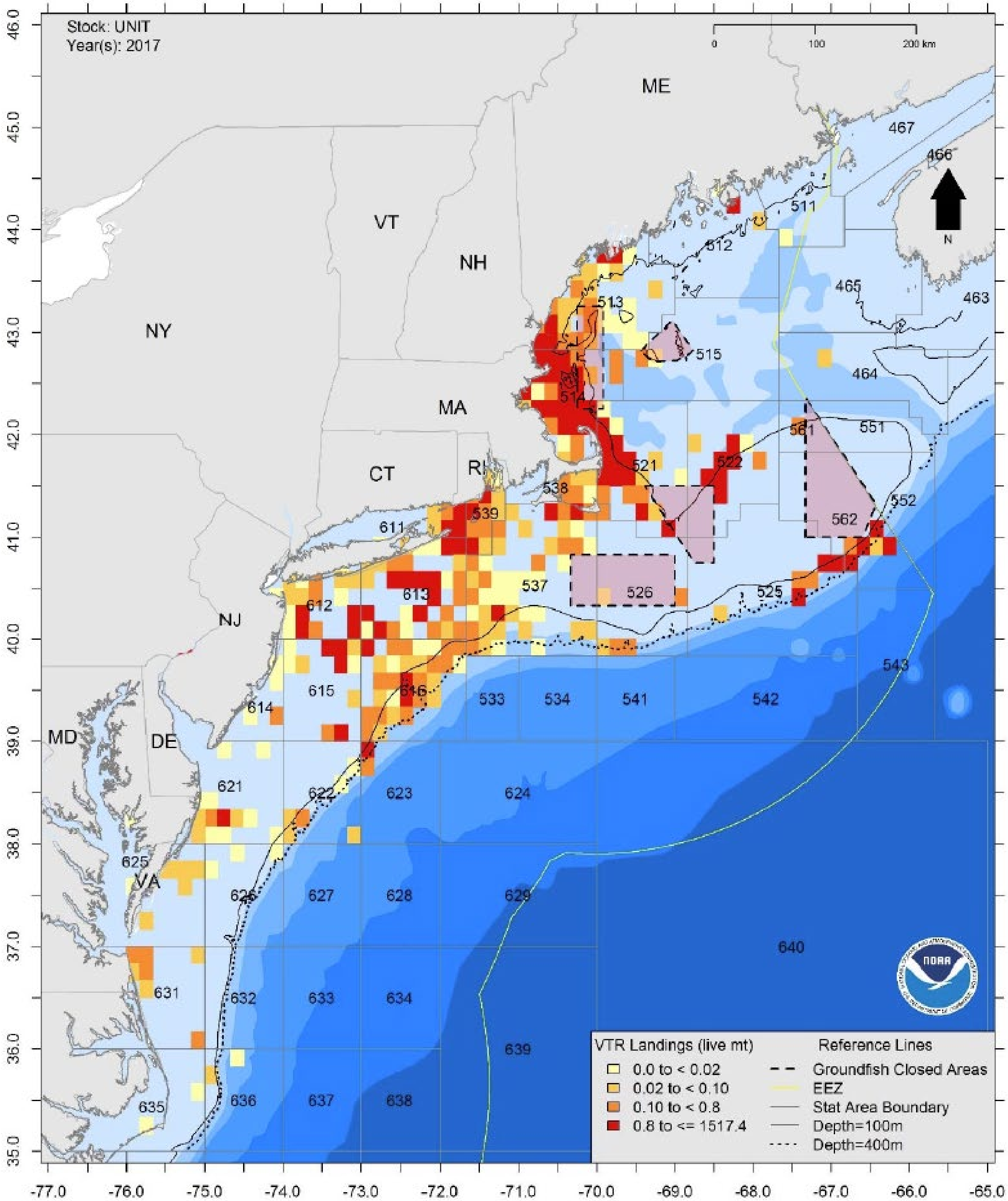

Figure 9. Approximate Primary 2018 Mackerel Catch Locations (from VTR data)

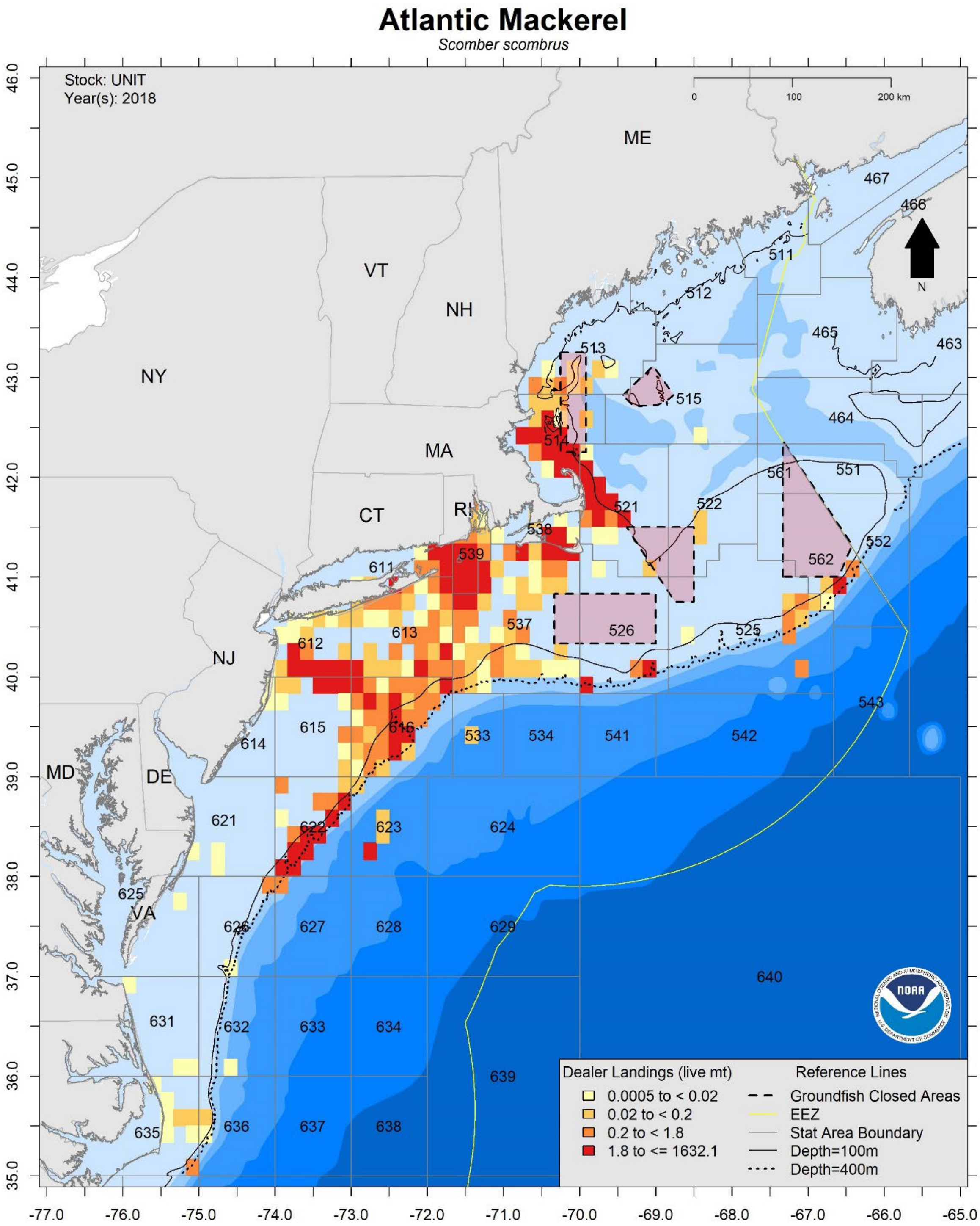

Figure 10. Approximate Primary 2018 Mackerel Catch Locations (from dealer and VTR data)

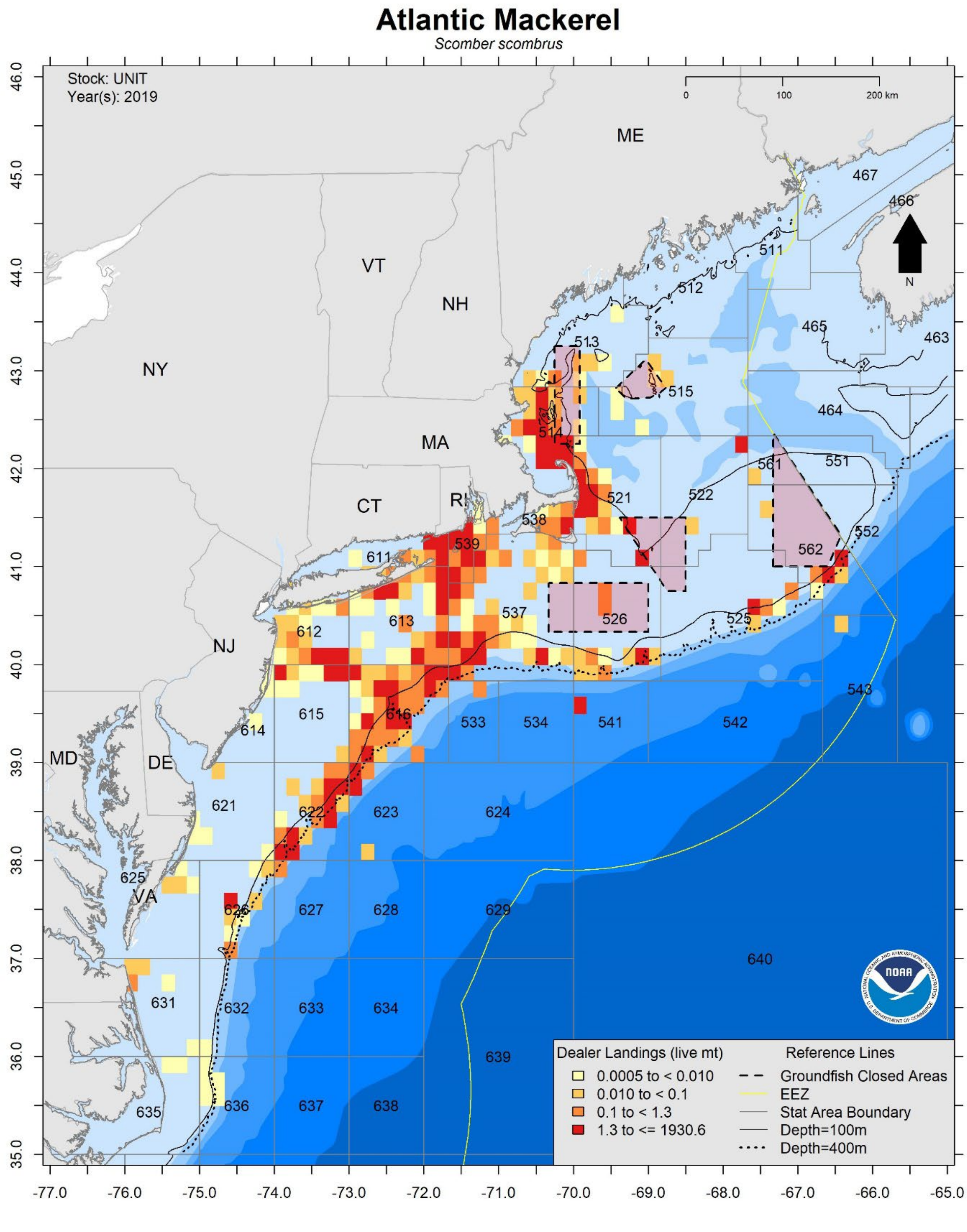

Figure 11. Approximate Primary 2019 Mackerel Catch Locations (from dealer and VTR data)

Updated maps are not available for 2020 and 2021, but the following tables bin mackerel landings by the same statistical areas noted on the figures above for 2020 and 2021, and the areas accounting for most 2020 and 2021 landings were not atypical. Area 514 is difficult to see on the above maps, but is just east of Massachusetts.

Table 17. Commercial mackerel landings by statistical area in 2020. Source: NMFS unpublished VTR data.

Stat Area	Metric Tons
613	2,900
521	1,164
612	1,152
616	806
615	738
514	705
Other/CI	580
Total	8,045

Table 18. Commercial mackerel landings by statistical area in 2021. Source: NMFS unpublished VTR data.

Stat Area	Metric Tons
522	2,023
521	1,854
612	992
514	450
Other/CI	332
Total	5,652

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In recent years (2017-2021) most mackerel landings have occurred in Massachusetts and New Jersey (see table below). There is more confidential information at the port level, but aggregate 2017-2021 landings and nominal revenues are also provided for major ports where possible.

Table 19. 2017-2021 Total Mackerel Landings by State

State	MT
MA	18,043
NJ	9,931
RI	3,979
ME	2,066
Other	254

Table 20. 2017-2021 Total Mackerel Landings by Port

PORT	MT
Cape May, NJ	9,849
Gloucester, MA	7,702
New Bedford, MA	7,108
Portland, ME	2,018
Point Judith, RI	1,703
Marshfield, MA	1,311
Chatham, MA	972
Other/CI	3,610

Table 21. 2017-2021 Total Mackerel Revenues by Port

Port	$ (Millions)
Cape May, NJ	4.3
Gloucester, MA	3.6
New Bedford, MA	3.5
Marshfield, MA	1.5
Portland, ME	1.3
Point Judith, RI	1.0
Chatham, MA	0.7
Other/CI	3.4

Table 22. Numbers of vessels that actively fished for mackerel, by landings (lbs) category, 1982-2021.

YEAR	Vessels 1 mil +	Vessels 100,000 - 1mil	Vessels 50,000 - 100,000	Vessels 10,000 - 50,000	Total
1982	0	10	10	43	63
1983	0	10	5	26	41
1984	0	11	14	29	54
1985	0	12	10	28	50
1986	1	10	5	37	53
1987	1	15	8	31	55
1988	2	20	8	40	70
1989	6	17	8	27	58
1990	6	16	7	39	68
1991	13	18	1	38	70
1992	9	17	13	48	87
1993	0	16	11	55	82
1994	2	27	14	44	87
1995	4	24	11	50	89
1996	7	45	15	53	120
1997	6	30	20	46	102
1998	9	16	6	39	70
1999	6	15	9	37	67
2000	5	3	0	26	34
2001	5	3	2	20	30
2002	12	3	1	22	38
2003	14	6	5	23	48
2004	18	6	1	14	39
2005	15	11	4	17	47
2006	20	12	5	10	47
2007	16	12	2	20	50
2008	15	5	1	17	38
2009	15	6	6	18	45
2010	10	9	2	14	35
2011	0	3	3	17	23
2012	3	9	1	9	22
2013	4	3	3	13	23
2014	6	5	1	13	25
2015	5	9	10	12	36
2016	3	16	7	26	52
2017	6	7	14	27	54
2018	8	6	3	24	41
2019	3	11	4	38	56
2020	7	9	1	10	27
2021	4	9	3	6	22

Recreational Fishery

The figure below describes total Atlantic mackerel recreational catch (numbers of fish) from 1981 to 2021 (2021 preliminary). Estimates before 2018 use calibration factors to account for substantial survey changes that were fully implemented in 2018, including the mail-based fishing effort survey and changes to the MRIP site-intercept survey (APAIS). Catch since 2018 has been relatively stable, but the time series includes substantial year to year variability.

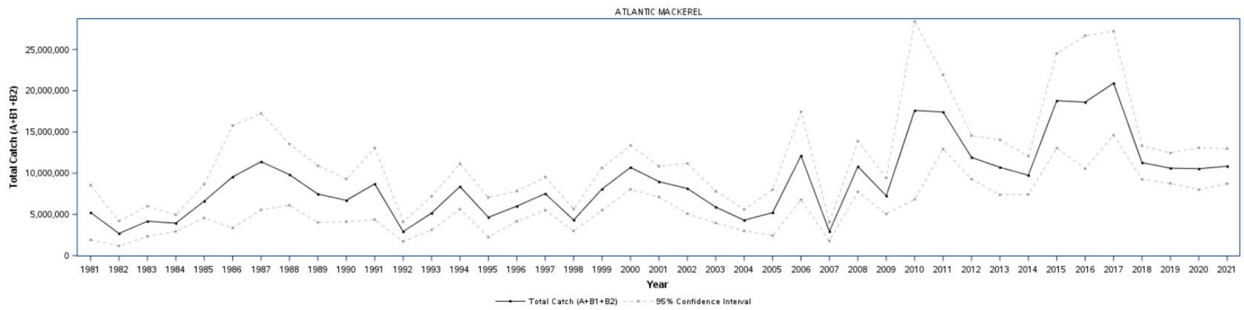

Figure 12. MRIP mackerel time series 1981-2021, total catch, numbers of fish.

The following more detailed discussion of recent catch focuses on data since 2018 to avoid any concerns about the effects of the calibration for pre-2018 data. Earlier discussions have highlighted that for-hire operators are not interviewed about trip catches but their anglers/customers could be, if they are at a site that is included on the MRIP site register. Anglers are to be asked about all fish caught and their disposition (available to be measured, harvested but not available, and/or released). PSE, or proportional standard error, expresses the standard error of an estimate as a percentage of the estimate and is a measure of precision.

Table 23. 2018-2021 MRIP Mackerel Estimates (#s) by Catch Type

Estimate Status	Year	Common Name	Observed Harvest (A)	PSE	Reported Harvest (B1)	PSE	Released Alive (B2)	PSE
FINAL	2018	ATLANTIC MACKEREL	2,330,587	23.3	7,164,214	11.3	1,782,338	19.9
FINAL	2019	ATLANTIC MACKEREL	2,646,784	16.3	5,913,593	12.6	2,041,877	18.8
FINAL	2020	ATLANTIC MACKEREL	3,136,063	19.6	6,439,192	17.6	964,581	15.2
PRELIMINARY	2021	ATLANTIC MACKEREL	705,745	18	8,663,790	12	1,473,430	19.5

Table 24. 2018-2021 MRIP Mackerel Estimates (#s) by State

Estimate Status	Year	State	Common Name	Total Catch (A+B1+B2)	PSE	** Contribution of Imputed Data to Total Catch Rate
FINAL	2018	CONNECTICUT	ATLANTIC MACKEREL	63	71.6	0%
FINAL	2018	MAINE	ATLANTIC MACKEREL	2,851,922	21	0%
FINAL	2018	MASSACHUSETTS	ATLANTIC MACKEREL	6,396,674	11.9	0%
FINAL	2018	NEW HAMPSHIRE	ATLANTIC MACKEREL	1,961,169	18.9	0%
FINAL	2018	RHODE ISLAND	ATLANTIC MACKEREL	21,119	71.5	0%
FINAL	2019	MAINE	ATLANTIC MACKEREL	3,275,535	20.8	0%
FINAL	2019	MASSACHUSETTS	ATLANTIC MACKEREL	5,647,588	10.5	0%
FINAL	2019	NEW HAMPSHIRE	ATLANTIC MACKEREL	1,637,111	16.9	0%
FINAL	2019	RHODE ISLAND	ATLANTIC MACKEREL	11,262	79.5	0%
FINAL	2020	CONNECTICUT	ATLANTIC MACKEREL	11,283	69.1	0%
FINAL	2020	MAINE	ATLANTIC MACKEREL	3,628,454	18.5	1%
FINAL	2020	MASSACHUSETTS	ATLANTIC MACKEREL	5,318,596	20.1	1%
FINAL	2020	NEW HAMPSHIRE	ATLANTIC MACKEREL	1,525,643	19.3	10%
FINAL	2020	RHODE ISLAND	ATLANTIC MACKEREL	1,420	62.5	77%
PRELIMINARY	2021	CONNECTICUT	ATLANTIC MACKEREL	1,311	92.3	0%
PRELIMINARY	2021	MAINE	ATLANTIC MACKEREL	3,913,997	17.6	1%
PRELIMINARY	2021	MASSACHUSETTS	ATLANTIC MACKEREL	5,384,078	14.5	0%
PRELIMINARY	2021	NEW HAMPSHIRE	ATLANTIC MACKEREL	1,317,292	13.1	0%
PRELIMINARY	2021	RHODE ISLAND	ATLANTIC MACKEREL	218,882	113	0%

PSE, or proportional standard error, expresses the standard error of an estimate as a percentage of the estimate and is a measure of precision. A PSE value greater than 50 indicates a very imprecise estimate and occurrences are highlighted in pink.

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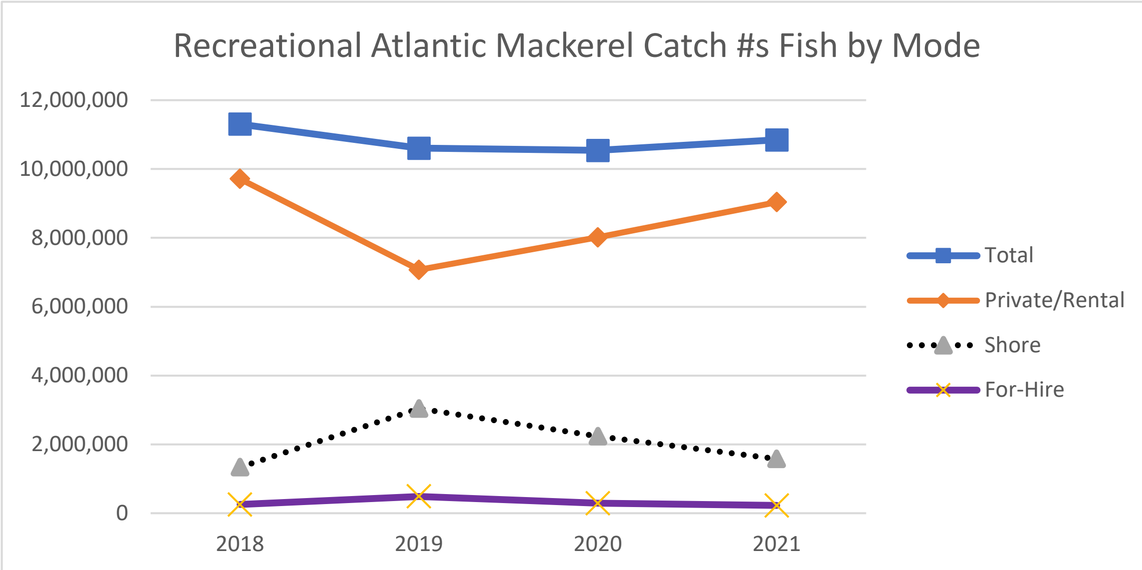

Figure 13. 2018-2021 MRIP Mackerel Estimates (#s) by Mode

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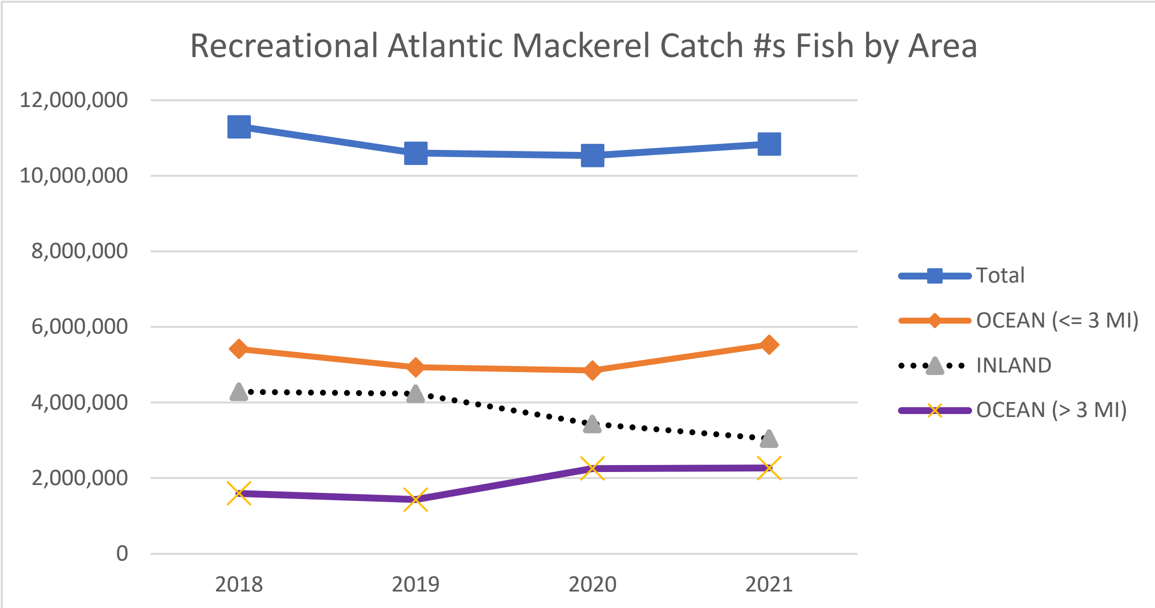

Figure 14. 2018-2021 MRIP Mackerel Estimates (#s) by Area

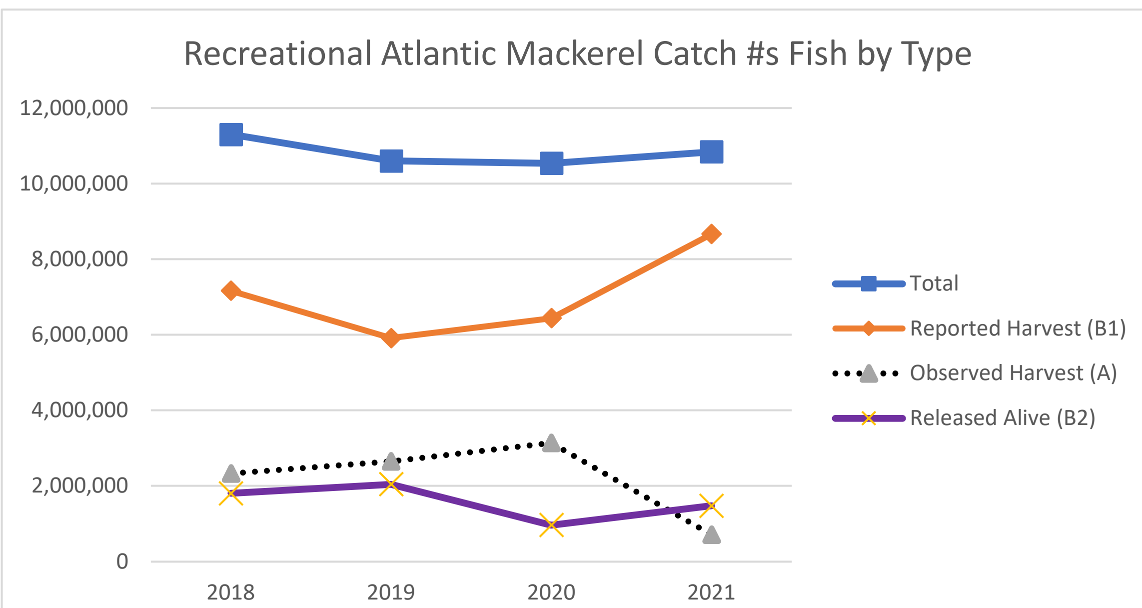

Figure 15. 2018-2021 MRIP Mackerel Estimates (#s) by Catch Type

6.4 Protected Species

Protected species are those afforded protections under the Endangered Species Act (ESA; species listed as threatened or endangered under the ESA) and/or the Marine Mammal Protection Act (MMPA). The Table below provides a list of protected species that occur in the affected environment of the MSB fisheries and the potential for the fishery to impact the species, specifically via interactions with MSB fishing gear (i.e., mid-water trawl and bottom trawl gear). The EA for this action will further describe interactions and impacts with these species, but all of the alternatives would decrease quotas compared to either no action (which would substantially increase quotas) or the status quo, so the action alternatives would not be likely to lead to increased effort or additional negative impacts on protected resources.

Table 25. Species Protected Under the ESA and/or MMPA that May Occur in the Affected Environment of the MSB FMP

Species	**Status**[2]	***Potential to interact with MSB fishing gear?***
Cetaceans		
North Atlantic right whale (Eubalaena glacialis)	***Endangered***	***No***
Humpback whale, West Indies DPS, (*Megaptera novaeangliae*)	Protected (MMPA)	No
Fin whale (Balaenoptera physalus)	***Endangered***	***No***
Sei whale (Balaenoptera borealis)	***Endangered***	***No***
Blue whale (Balaenoptera musculus)	***Endangered***	***No***
Sperm whale (Physeter macrocephalus	***Endangered***	***No***
Minke whale (*Balaenoptera acutorostrata*)	Protected (MMPA)	Yes
Pilot whale (Globicephala spp.)[3]	Protected (MMPA)	Yes
Pygmy sperm whale (*Kogia breviceps*)	Protected (MMPA)	No
Dwarf sperm whale (*Kogia sima*)	Protected (MMPA)	No
Risso's dolphin (*Grampus griseus*)	Protected (MMPA)	Yes

Species	**Status**[2]	***Potential to interact with MSB fishing gear?***
Atlantic white-sided dolphin (*Lagenorhynchus acutus*)	Protected (MMPA)	Yes
Short Beaked Common dolphin (*Delphinus delphis*)	Protected (MMPA)	Yes
Atlantic Spotted dolphin (*Stenella frontalis*)	Protected (MMPA)	No
Striped dolphin (*Stenella coeruleoalba*)	Protected (MMPA)	No
Beaked whales (*Ziphius and Mesoplodon spp*)[4]	Protected (MMPA)	No
Bottlenose dolphin (Tursiops truncatus)[5]	***Protected (MMPA)***	***Yes***
Harbor porpoise (*Phocoena phocoena*)	Protected (MMPA)	Yes
Pinnipeds		
Harbor seal (*Phoca vitulina*)	Protected (MMPA)	Yes
Gray seal (*Halichoerus grypus*)	Protected (MMPA)	Yes
Harp seal (*Phoca groenlandicus*)	Protected (MMPA)	Yes
Hooded seal (*Cystophora cristata*)	Protected (MMPA)	No
Sea Turtles		
Leatherback sea turtle (*Dermochelys coriacea*)	Endangered	Yes
Kemp's ridley sea turtle (*Lepidochelys kempii*)	Endangered	Yes
Green sea turtle, North Atlantic DPS (*Chelonia mydas*)	Threatened	Yes
Loggerhead sea turtle (*Caretta caretta*), Northwest Atlantic Ocean DPS	Threatened	Yes
Hawksbill sea turtle (*Eretmochelys imbricate*)	Endangered	No
Fish		
Atlantic salmon (*Salmo salar*)	Endangered	Yes
Atlantic sturgeon *(Acipenser oxyrinchus)*		

Species	**Status[2]**	***Potential to interact with MSB fishing gear?***
Gulf of Maine DPS	Threatened	Yes
New York Bight DPS, Chesapeake Bay DPS, Carolina DPS & South Atlantic DPS	Endangered	Yes
Cusk *(Brosme brosme)*	Candidate	Yes
Giant manta ray (*Manta birostris*)	Threatened	Yes
Critical Habitat		
Northwest Atlantic DPS of Loggerhead Sea Turtle	ESA (Protected)	No
North Atlantic Right Whale Critical Habitat	ESA (Protected)	No

Notes: Marine mammal species (cetaceans and pinnipeds) italicized and in bold are considered MMPA strategic stocks. Shaded rows indicate species who prefer continental shelf edge/slope waters (i.e., >200 meters).

[1] A strategic stock is defined under the MMPA as a marine mammal stock for which: (1) the level of direct human-caused mortality exceeds the potential biological removal level; (2) based on the best available scientific information, is declining and is likely to be listed as a threatened species under the ESA within the foreseeable future; and/or (3) is listed as a threatened or endangered species under the ESA, or is designated as depleted under the MMPA (Section 3 of the MMPA of 1972).

[2] Status is defined by whether the species is listed under the ESA as endangered (i.e. at risk of extinction) or threatened (i.e. at risk of endangerment), or protected under the MMPA. Marine mammals listed under the ESA are also protected under the MMPA. Candidate species are those species for which ESA listing may be warranted.

[3] There are 2 species of pilot whales: short finned (*G. melas melas*) and long finned (*G. macrorhynchus*). Due to the difficulties in identifying the species at sea, they are often referred to as *Globicephala spp*.

[4] There are multiple species of beaked whales in the Northwest Atlantic. They include the cuvier's (*Ziphius cavirostris*), blainville's (*Mesoplodon densirostris*), gervais' (*Mesoplodon europaeus*), sowerbys' (*Mesoplodon bidens*), and trues' (*Mesoplodon mirus*) beaked whales. Species of *Mesoplodon* are difficult to identify at sea, therefore, much of the available characterization for beaked whales is to the genus level only.

[5] This includes the Western North Atlantic Offshore, Northern Migratory Coastal, and Southern Migratory Coastal Stocks of Bottlenose Dolphins.

Cusk is a NMFS "candidate species" under the ESA. Candidate species are those petitioned species for which NMFS has determined that listing may be warranted under the ESA and those species for which NMFS has initiated an ESA status review through an announcement in the Federal Register. If a species is proposed for listing the conference provisions under Section 7 of the ESA apply (see 50 CFR 402.10); however, candidate species receive no substantive or procedural protection under the ESA. NMFS recommends that project proponents consider implementing conservation actions to limit the potential for adverse effects on candidate species from any proposed action. Additional information on cusk can be found at: https://www.fisheries.noaa.gov/endangered-species-conservation/candidate-species-under-endangered-species-act. .

7.0 Biological and Human Community Impacts

For habitat and non-target species impacts, the key determinant is not so much the catch itself but the amount and character of the related effort, and the impact of that effort on stock status and the quality/quantity of habitat (see Table 26). The table immediately below illustrates that the availability of the target species can drive effort as much as any quota change, and as effort changes so would impacts on habitat, protected resources, and non-target species. Since limits on catch do cap effort, measures that limit catch are considered a factor related to changes in effort.[6]

[6] National Oceanic and Atmospheric Administration Administrative Order 216-6A and the Companion Manual contains criteria for determining the significance of the impacts of a proposed action and it includes the possibility of introducing or spreading a nonindigenous species. This potential impact does not fit into the sections below so it is addressed in this introduction. There is no evidence or indication that these fisheries have ever resulted or would ever result in the introduction or spread of nonindigenous species.

Table 26. Changes in effort as a result of adjustments to quota and/or fish availability.

Change in quota	**Fish abundance/availability**		
	Decrease in availability	**No change in availability**	**Increase in availability**
Decrease in quota	Fishing effort may decrease, increase, or stay the same depending on a combination of factors[7].	Effort likely to decrease or stay the same. If per trip catch stays the same, the fishery will be closed earlier with fewer trips taken (reducing effort). However managers may reduce trip limits or adjust regulations that extend the fishing season (keeping effort the same).	Effort likely to decrease or stay the same. A lower quota plus higher catch per unit of effort (CPUE) from higher availability should decrease effort. However, managers may reduce trip limits or adjust regulations that extend the fishing season which may keep effort relatively even.
No change in quota	Effort may increase or decrease. Even with no change, fishermen may take more trips to catch the same amount of fish (increasing effort) or may stop targeting a stock of fish if availability is low enough to decrease profitability (decreasing effort).	Fishing effort may remain the same given the quota has not changed and availability is expected to be similar.	Effort should decrease. While the quota has not changed, fishermen should be able to take fewer trips to catch the same amount of fish (decreasing effort).
Increase in quota	Fishing effort likely to increase or stay the same. A higher quota plus lower catch per unit of effort from lower availability should increase effort. However, managers may increase trip limits or adjust regulations to allow more efficient fishing (keeping effort the same).	Effort likely to increase or stay the same. If per trip catch stays the same, the fishery will be closed later with more trips taken (increasing effort). However managers may increase trip limits or adjust regulations to allow more efficient fishing (keeping effort the same).	Fishing effort may decrease, increase, or stay the same depending on a combination of factors.

[7] Factors affecting fishing effort include other species abundance, availability of other opportunities, weather, climate, fish movements/availability, variable productivity, and market forces/price changes.

Environmental impacts are described both in terms of their direction (negative, positive, or no impact) and their magnitude (slight, moderate, or high). The table below summarizes the guidelines used for each VEC to determine the magnitude and direction of the impacts described in this section.

Table 27. General definitions for impacts and qualifiers relative to resource condition (i.e., baselines)

General Definitions				
VEC	**Resource Condition**	**Impact of Action**		
		Positive (+)	Negative (-)	No Impact (0)
Target and non-target Species	Overfished status defined by the MSA	Alternatives that maintain or are projected to result in a stock status above an overfished condition*	Alternatives that maintain or are projected to result in a stock status below an overfished condition*	Alternatives that do not impact stock / populations
ESA-listed protected species (endangered or threatened)	Populations at risk of extinction (endangered) or endangerment (threatened)	Alternatives that contain specific measures to ensure no interactions with protected species (i.e., no take)	Alternatives that result in interactions/take of listed species, including actions that reduce interactions	Alternatives that do not impact ESA listed species
MMPA protected species (not also ESA listed)	Stock health may vary but populations remain impacted	Alternatives that maintain takes below PBR and approaching the Zero Mortality Rate Goal	Alternatives that result in interactions with/take of marine mammals that could result in takes above PBR	Alternatives that do not impact MMPA protected species
Physical environment / habitat / EFH	Many habitats degraded from historical effort	Alternatives that improve the quality or quantity of habitat	Alternatives that degrade the quality/quantity or increase disturbance of habitat	Alternatives that do not impact habitat quality
Human communities (socioeconomic)	Highly variable but generally stable in recent years (see condition of the resources table for details)	Alternatives that increase revenue and social well-being of fishermen and/or communities	Alternatives that decrease revenue and social well-being of fishermen and/or communities	Alternatives that do not impact revenue and social well-being of fishermen and/or communities
	Impact Qualifiers			
A range of impact qualifiers is used to indicate any existing uncertainty	Negligible		To such a small degree to be indistinguishable from no impact	
	Slight (sl), as in slight positive or slight negative		To a lesser degree / minor	
	Moderate (M) positive or negative		To an average degree (i.e., more than "slight", but not "high")	
	High (H), as in high positive or high negative		To a substantial degree (not significant unless stated)	
	Significant (in the case of an EIS)		Affecting the resource condition to a great degree, see 40 CFR 1508.27.	
	Likely		Some degree of uncertainty associated with the impact	
*Actions that will substantially increase or decrease stock size, but do not change a stock status may have different impacts depending on the particular action and stock. Meaningful differences between alternatives may be illustrated by using another resource attribute aside from the MSA status, but this must be justified within the impact analysis.				

7.1 Managed Resource - Mackerel

Taking no action would lead to overfishing in 2023 and expected failure to rebuild due to the high catches that could be implemented without taking action and a reversion to previous specifications. This would be a high negative impact on mackerel, and highly negative compared to the action alternatives.

All of the action alternatives are predicted to rebuild mackerel within 10 years. Given the imprecision of 10-year projections, quantitatively comparing the relatively small changes in probability of rebuilding is likely to be uninformative and possibly misleading. The 4-fold error in the last 3-year projection estimate for 2019 SSB illustrates the degree of uncertainty. 2023 specifications alone require a 4-year projection from 2019, and projecting out to 2032 is really a 13-year projection (2019 to 2032). The probabilities of rebuilding are also dependent on the underlying recruitment assumptions, which makes comparing Alternative 1 to Alternatives 2-5 challenging in terms of the calculated probabilities, but the very low catches in Alternative 1 will create the highest probability of rebuilding in reality. Finally, the likely iterative nature of mackerel rebuilding with MTAs expected in 2023, 2025, 2027, and 2029 greatly complicates interpreting the probability of rebuilding. For example, if one were to lock in the projected catch trajectories for 10 years, Alternative 4 appears to have a higher probability of rebuilding (60.5%) than Alternative 3 (51.5%). However, the higher later catches in Alternative 3 that reduce its probability of rebuilding to near 50% would only occur if rebuilding is actually on track, and the initially lower catches of Alternative 3 mean that early rebuilding would be more likely with Alternative 3 than with Alternative 4. So while the overall rebuilding probability of Alternative 4 is calculated as higher with the full series of catches, Alternative 3 is in fact the more risk averse option (in terms of avoiding a failure to rebuild) due to the lower catches.

Accordingly, a simpler and probably better way to consider the impacts of the alternatives on mackerel is qualitatively based on allowed catches in years that would be considered in the 2025 Mackerel MTA, 2023 and 2024. The 2025 Mackerel MTA should consider catch through 2024, so one way to compare across all alternatives in terms of relative probability of leading to stock growth by the 2025 Mackerel MTA is to just consider 2023-2024 combined catch for each rebuilding path. The higher the combined 2023 and 2024 combined catch, the relatively less likely stock growth will occur. The Action Alternatives 1-5 have been ordered from least to most 2023- 2024 combined catch, so that is the same order from most likely stock rebuilding to least likely stock rebuilding by the 2025 MTA. Accordingly, that would also be the order of most to least positive impact on mackerel, though all are generally moderate in positive impacts given the predicted moderate stock growth predicted in the next few years.

7.2 Habitat/Protected Resources/Non-Target Species

The EA for this action will address these impacts in greater detail, but generally for these valued ecosystem components, there are relatively greater negative effects with more effort, and relatively less negative effects with less effort. Compared to no action, which would lead to substantially higher quotas, all of the action alternatives would be expected to have less negative effects. For 2023, the only year that this action proposes to set specifications, even Alternative 5, which would lead to the highest commercial quotas among the action alternatives, would also have quotas similar or less than the status quo, so negative impacts to Habitat/Protected Resources/Not Target Species would be expected to remain similar to or less than the status quo, and less than no action.

7.3 Socioeconomic Impacts

This action would primarily affect the mackerel fishery. As discussed above, the availability of the targeted species may drive effort (and catch and revenues) as much as any regulations.

Mackerel Commercial Fishery Current Condition:

Due to the year-to-year variation in catch and effort in the fishery, it is difficult to fully quantify human community impacts but the current fishery supports a number of vessels, as described in Section 6.3, and provides a variety of jobs related directly to fishing and also in associated support services. 22 vessels landed over 10,000 pounds of mackerel in 2021, with total mackerel landings valued at $3.1 million. From 2019-2021 mackerel ex-vessel revenues varied from $2.9-$5.2 million, averaging $3.7 million. The Council has received input from commercial tuna fishermen that commercial tuna fishing could be impacted by limitations on mackerel, but commercial vessels can get open access commercial incidental mackerel permits that would allow retention of up to 5,000 pounds of mackerel as bait (catch would need to be reported on Vessel Trip Reporting linked to that permit). Given the overfished status of mackerel and reduced productivity, the socioeconomic contributions of mackerel are reduced compared to historical levels.

Socioeconomic Mackerel Commercial Fishery Impacts:

Socioeconomic impacts related to commercial mackerel fishing are likely directly related to the quotas that are set. In the short run, the Alternatives sorted in order of 2023 quotas from most to least are No action, Alternative 5, Alternative 4, Alternative 3, Alternative 2, Alternative 1. Alternatives 1-3 would result in negative or near zero commercial quotas and do not appear practicable. All of the Alternatives would result in substantially lower quotas than no action, but the more relevant comparison is to the 2022 quota of 4,963 MT. Depending on Canadian and recreational deductions, Alternative 5 would result in a 2% to 54% reduction in quota. Depending on Canadian and recreational deductions, Alternative 4 would result in a 28% to 80%

reduction in quota. These ranges will be able to be refined at the time of final action. While no action would implement much higher quotas, it would not be a legal option given it would result in substantial overfishing. Over the 10 years in the rebuilding plan, total summed catches, in order of most to least would be Alternative 3, Alternative 5, Alternative 4, Alternative 2, Alternative 1. However, given the large error observed in the first iteration of projecting mackerel biomass even 3 years into the future, it is not clear what the meaningfulness of comparing summed 10-year catches would actually be. In the long run, rebuilding mackerel should result in high positive impacts due to achieving optimum yield, in a similar fashion among all the action alternatives.

Mackerel Recreational Fishery Current Condition:

Mackerel catch was relatively stable from 2019-2021, very close to the average of 10.7 million fish. The majority of fish are harvested, but are not made available to MRIP dockside interviewers – rather the majority of catch estimates result from "reported harvest" by interviewees. These fish may have been used for bait or the interviewee just doesn't want to show the fish to the MRIP interviewer. MRIP interviews are conducted with anglers by state staff, who also ask about fish that are discarded/released. These reported discards represented on average 14% of catch from 2019-2021. Almost all catch in recent years has been in Maine, New Hampshire, and Massachusetts. Private (and rental) boat catch is responsible for most catch, with about 20% from shore and a very small amount (5% or less) from the for-hire sector.

NMFS estimated the 2017 economic effects of recreational fishing in states including Maine, New Hampshire, and Massachusetts (Lovell et al 2020). The following describes their findings. Mackerel is not a frequent directed target, for example in 2021 only 5% of the 17.1 million marine fishing trips in New England targeted mackerel as a primary or secondary species, but mackerel has been reported as an important bait component for other fisheries, including striped bass and tuna.

Marine recreational fishing trips in Maine supported 714 full or part-time jobs, and contributed $75 million in sales, $27 million in income, and $45 million in gross domestic product (GDP) to the state's economy.

Table 28. Maine Marine Recreational Fishing Trips Economics

Fishing Mode	Expense ($1,000's)	# Jobs	Sales ($1,000's)	Income ($1,000's)	Value Added ($1,000's)
For-Hire	$2,863	52	$4,725	$1,644	$2,747
Private Boat	$15,322	138	$15,957	$5,353	$9,009
Shore	$40,223	524	$54,603	$20,012	$32,799
Total Trip	$58,408	714	$75,285	$27,009	$44,555

Marine recreational fishing trips in New Hampshire supported 378 full or part-time jobs, and contributed $37 million in sales, $15 million in income, and $25 million in gross domestic product (GDP) to the state's economy.

Table 29. New Hampshire Marine Recreational Fishing Trips Economics

Fishing Mode	Expense ($1,000's)	# Jobs	Sales ($1,000's)	Income ($1,000's)	Value Added ($1,000's)
For-Hire	$6,168	100	$9,393	$3,593	$5,680
Private Boat	$12,176	93	$9,555	$4,371	$6,376
Shore	$14,107	185	$18,166	$7,249	$12,569
Total Trip	$32,451	378	$37,114	$15,213	$24,625

Marine recreational fishing trips in Massachusetts supported 2,784 full or part-time jobs, and contributed $326 million in sales, $156 million in income, and $225 million in gross domestic product (GDP) to the state's economy.

Table 30. Massachusetts Marine Recreational Fishing Trips Economics

Fishing Mode	Expense ($1,000's)	# Jobs	Sales ($1,000's)	Income ($1,000's)	Value Added ($1,000's)
For-Hire	$30,563	463	$49,737	$19,342	$31,838
Private Boat	$181,933	1,118	$139,187	$68,344	$95,335
Shore	$100,756	1,203	$136,898	$68,646	$97,822
Total Trip	$313,252	2,784	$325,822	$156,332	$224,995

While there is some overlap with the above for-hire estimates, NMFS has also separately estimated the economic impacts of fishing for Highly Migratory Species (HMS) like tunas (Hutt and Silva 2019). These trips could be indirectly affected by limits on mackerel fishing due to use of mackerel as bait. Non-tournament HMS Angling Trips (Tournament trips were only estimated from Maine through Texas) in 2016 were estimated to have the following impacts:

Table 31. Total expenditures and economic contributions generated by New England non-tournament Atlantic HMS Angling trips, registered HMS tournament operations, and HMS tournament participating teams from Maine to Texas in 2016. Non-tournament trip expenditures are reported by region and nationally, while tournament-related expenditures are only reported nationally.

Type and Region	Total Expenditures	Employment (jobs)	Income	Value Added	Total Sales Output
Non-tournament Angling Trips					
New England	$5,172,293	37	$2,061,493	$3,056,170	$4,867,047
Tournament Angling[1]	$37,544,910	532	$26,153,290	$46,180,928	$84,671,666
Tournament Operation[2]	$20,170,466	295	$15,120,988	$26,099,884	$43,970,942

Recreational Impacts

There would be some reduction in the positive impacts the public currently derives from recreational mackerel fishing under the proposed bag limits. While it cannot be directly estimated what proportion of value would be lost if access to mackerel is limited (related to directed fishing or harvest for bait), the Council hopes to get additional public input on this issue. The Council has received input that a bag limit in the range of 10-15 fish per person should mitigate most of the potential negative effects of being limited in using mackerel for bait for the striped bass and/or tuna fisheries. In the short term, one would expect more negative effects from a 10 fish bag limit versus a 15 fish bag limit, and both would be more negative than the currently unrestricted fishery (i.e. no action). Given the expected catch reductions are moderate, one would expect the negative impacts to also be moderate. In the long term, there should be positive impacts as these restrictions contribute to mackerel rebuilding, allowing higher catches in the future.

8.0 LITERATURE CITED AND SELECTED BACKGROUND DOCUMENTS

Campos, Aida, and Paulo Fonseca. 2003. "Selectivity of Diamond and Square Mesh Cod Ends for Horse Mackerel (Trachurus trachurus), European Hake (Merluccius Merluccius) and Axillary Seabream (Pagellus Acarne) in the Shallow Groundfish Assemblage off the South-West Coast of Portugal". Scientia Marina 67 (2):249-60. https://doi.org/10.3989/scimar.2003.67n2249.

Casey J., Nicholson M.D. & Warnes S. (1992) Selectivity of square mesh codends of pelagic trawls for Atlantic mackerel (*Scomber scombrus* L.). *Fisheries Research*, 13, 267-279.

Clark, W. G. 1993. The effect of recruitment variability on the choice of a target level of spawning biomass per recruit. Pages 233–246 in G. Kruse, R. J. Marasco, C. Pautzke, and T. J. Quinn II, editors. Proceedings of the international symposium on management strategies for exploited fish populations. University of Alaska, Alaska Sea Grant College Program Report 93-02, Fairbanks.

Clark 2002. F35% Revisited Ten Years Later. North American Journal of Fisheries Management 22:251–257, 2002.

Gabriel, W. L., Mace, P. M. (1999). A review of biological reference points in the context of the precautionary approach. In Proceedings of the 5th annual NMFS National Stock Assessment Workshop. NOAA Tech Memo. NMFS-F/SPO-40.

Hilborn et al 2017. When does fishing forage species affect their predators? Fisheries Research. Volume 191, July 2017, Pages 211-221

Hutt and Silva 2019. Economic Contributions of Atlantic Highly Migratory Species Anglers and Tournaments, 2016. Available at https://repository.library.noaa.gov/

Legault and Brooks 2013. Can stock–recruitment points determine which spawning potential ratio is the best proxy for maximum sustainable yield reference points? ICES Journal of Marine Science, Volume 70, Issue 6, September 2013, Pages 1075–1080, https://doi.org/10.1093/icesjms/fst105

Lovell et al 2020. The Economic Contribution of Marine Angler Expenditures on Fishing Trips in the United States, 2017. NOAA Technical Memorandum NMFS-F/SPO-201. March 2020. Available at https://spo.nmfs.noaa.gov/sites/default/files/TM201.pdf.

Mace 1994. Relationships between Common Biological Reference Points Used as Thresholds and Targets of Fisheries Management Strategies. January 1994. Canadian Journal of Fisheries and Aquatic Sciences 51(1):110-122 DOI:10.1139/f94-013

MAFMC 2019. Framework 13 to MSB FMP - Mackerel Rebuilding. Available at https://www.mafmc.org/msb.

MAFMC 2021. MSB Specifications EA. Available at https://www.mafmc.org/supporting-documents.

MAFMC SSC 2021a. July 2021 Report of the MAFMC's SSC. Available at https://www.mafmc.org/ssc.

MAFMC SSC 2021b. September 2021 Report of the MAFMC's SSC. Available at https://www.mafmc.org/ssc.

MAFMC SSC 2022. March 2022 Report of the MAFMC's SSC. Available at https://www.mafmc.org/ssc.

NEFSC 2018. Atlantic Mackerel Benchmark Assessment. SAW 64. Available at https://apps-nefsc.fisheries.noaa.gov/rcb/publications/assessment-documents.html.

NEFSC 2021. Atlantic Mackerel Management Track Assessment. Available at https://apps-nefsc.fisheries.noaa.gov/saw/sasi/sasi_report_options.php.

NEFSC 2022a. Mid-Atlantic Bight State of the Ecosystem Report. Available at https://www.fisheries.noaa.gov/new-england-mid-atlantic/ecosystems/state-ecosystem-reports-northeast-us-shelf.

NEFSC 2022b. New England Shelf State of the Ecosystem Report. Available at https://www.fisheries.noaa.gov/new-england-mid-atlantic/ecosystems/state-ecosystem-reports-northeast-us-shelf.

Pikitch et al 2012. The global contribution of forage fish to marine Fisheries and Ecosystems. Fish and Fisheries. First published: 05 September 2012 https://doi.org/10.1111/faf.12004