Mid-Atlantic Fishery Management Council
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Michael P. Luisi, Chairman | P. Weston Townsend, Vice Chairman
Christopher M. Moore, Ph.D., Executive Director

MEMORANDUM

Date: September 25, 2020

To: Chris Moore, Executive Director

From: Julia Beaty, staff

Subject: Review of 2021 Atlantic chub mackerel specifications

On October 7, 2020, the Mid-Atlantic Fishery Management Council (Council) will review the previously implemented 2021 specifications for Atlantic chub mackerel and discuss if revisions are necessary.

The following materials are provided behind this tab (unless otherwise noted) for the Council's consideration.

1) Summary of the September 16, 2020 Monitoring Committee webinar
2) September 2020 Scientific and Statistical Committee report (*behind Tab 10*)
3) September 2020 Advisory Panel Fishery Performance Report
4) Additional Advisory Panel member comments
5) Staff memo on 2021 specifications for Atlantic chub mackerel, dated September 2, 2020
6) 2020 Chub Mackerel Fishery Information Document
7) Characterization of the Atlantic Chub Mackerel Fishery and Stock - Dr. Robert Leaf, University of Southern Mississippi

Mackerel, Squid, Butterfish Monitoring Committee
September 16, 2020
Webinar Meeting Summary

Monitoring Committee Attendees: Julia Beaty (MAFMC staff), Doug Christel (GARFO), Daniel Hocking (GARFO), Aly Pitts (GARFO)

Additional Attendees: Russell Brown (NEFSC), Greg DiDomenico (Lund's Fisheries, AP member), Zoe Goozner (Pew Charitable Trusts), Peter Hughes (MAFMC member, MSB Committee Chair), Jeff Kaelin (Lund's Fisheries, AP member), Eric Reid (NEFMC liaison to MAFMC), Alissa Wilson.

Note: This document summarizes the Monitoring Committee's discussion during their September 16, 2020 webinar as well as additional follow up discussion on South Atlantic data which occurred over email after the meeting.

Meeting Objectives

- Review recent fishery information, Advisory Panel Fishery Performance Report, SSC recommendations, and staff recommendations.
- Review and if necessary, recommend revisions to the previously implemented catch and landings limit for 2021, as well as other management measures for 2021.

Summary of Monitoring Committee Discussion

The Monitoring Committee asked for clarification on why estimated chub mackerel harvest in South Carolina through Florida, as provided by the Atlantic Coastal Cooperative Statistics Program (ACCSP) in September 2020 and presented during this meeting, was so much higher than that considered through development of Amendment 21. For example, the Council previously agreed to remove 84,500 pounds of expected South Carolina through Florida catch from the ABC. This was calculated by increasing the highest annual commercial and recreational landings in South Carolina through Florida during 1998-2017 (i.e., 76,835 pounds in 2011, mostly from the recreational fishery) by about 10% to account for discards, which are poorly documented in this region. Updated data through 2019 presented during the Monitoring Committee meeting suggested that much higher commercial landings occurred in the South Atlantic than previously considered and that the peak year was 2001, not 2011. The Monitoring Committee expressed concern about this discrepancy and wanted to know more about why the data changed. Council staff explained that the ACCSP indicated that one or more states changed how the species was coded in the data they provided. One Monitoring Committee member said, at face value, it would appear that a change is necessary. However, without better understanding why the data changed, the Monitoring Committee did not feel that they could make an informed recommendation on if or how this part of the specifications should be revised for 2021.

After the Monitoring Committee meeting, it was determined that the data shown during the meeting included landings from all of Florida, rather than only the east coast of Florida. After

correcting for this error, the data were extremely similar to those considered during Amendment 21. ACCSP staff indicated that the minor changes that did occur were the result of landings which were previously assigned to the east coast of Florida being reassigned to the Gulf coast of Florida. The updated data show that 2011 remains the year with the highest commercial and recreational chub mackerel landings in the South Atlantic through 2019. The methodology used in Amendment 21 to estimate total catch based on assumptions about recreational harvest in weight and discards in both sectors results in 84,368 pounds of expected South Atlantic harvest based on the updated data. After reviewing this information over email after their meeting, the Monitoring Committee agreed that no change is warranted to the currently implemented value of 84,500 pounds of expected South Atlantic Catch in 2021.

One Monitoring Committee member said it seems appropriate to maintain the 10% discard assumption for South Atlantic catch which was justified through Amendment 21, given that no updated information on discards in the South Atlantic was provided.

The Monitoring Committee recommended no change to the currently implemented management uncertainty buffer between the annual catch limit (ACL) and annual catch target (ACT). They also recommended no change to the 6% buffer between the ACT and the total allowable landings limit (TAL) to account for expected discards. Although updated commercial discard data suggest discards as a percentage of total catch increased in recent years, this is likely because the fishery heavily targeted available *Illex* squid since 2017. Fishermen have indicated that they prefer not to retain both species due to reduction in product quality when stored together. Generally, the Monitoring Committee agreed that it is appropriate to maintain specifications which are largely based on the historic high for chub mackerel landings as the availability of *Illex* squid can change greatly from one year to the next. If *Illex* availability is low in 2021, chub mackerel fishing effort may return to 2013 levels. (See the Fishery Information Document and Fishery Performance Report for more information on the relationship between the chub mackerel and *Illex* squid fisheries.)

The Monitoring Committee recommended no changes to any of the other currently implemented specifications.

One Monitoring Committee member asked why recreational harvest from Maine through North Carolina increased in 2018 compared to previous years. The small scombrid identification guide developed by the Council and NOAA Fisheries was not distributed until 2019. Council staff indicated that the ACCSP added chub mackerel to their list of core species for trainings of MRIP intercept samplers from Maine through North Carolina; however, it was not known if this change impacted the 2018 data.

Summary of Input from Other Participants

One advisor noted that, although it was not summarized in the report provided to the Monitoring Committee,[1] additional age data beyond 2016-2017 has been collected through the ongoing collaboration between Lund's Fisheries, SeaFreeze, LLC., and Dr. Robert Leaf at the University of Southern Mississippi. He added that Lund's and SeaFreeze will continue providing samples for this effort in 2021.

[1]Available at: https://www.mafmc.org/s/e_Characterization-of-the-Atlantic-Chub-Mackerel-fishery-1.pdf

Another advisor asked which commercial fisheries and gear types in the South Atlantic are catching chub mackerel. Council staff was unable to provide information on this during the meeting.

One Council member noted that fixed gear such as floating traps can also catch chub mackerel and said it could be informative to examine catches in those gear types in New England.

One advisor said fishermen have indicated that *Illex* squid were available slightly later in the season in 2020 compared to past years. Larger squid were becoming available around the time the *Illex* fishery closed. He suggested that the Council consider a start date for the *Illex* fishery to help maximize catches and efficiency. He added that the *Illex* fishery was strong enough this year that no one targeted chub mackerel.

SSC Report is behind
Tab 10

Chub Mackerel Fishery Performance Report

September 2020

The Mid-Atlantic Fishery Management Council's (Council's) Mackerel, Squid, and Butterfish Advisory Panel (AP) met via webinar on September 3, 2020 to review the Fishery Information Document and develop the following Fishery Performance Report. The primary purpose of this report is to contextualize catch histories for the Scientific and Statistical Committee (SSC) by providing information about fishing effort, market trends, environmental changes, and other factors. A series of discussion questions listed below were posed to the AP to generate discussion of observations in the chub mackerel fishery. Please note: Advisor comments described below are not necessarily consensus or majority statements.

Advisory Panel members present: Eleanor Bochenek, Gregory DiDomenico, Joseph Gordon, Jeff Kaelin, Meghan Lapp, Pam Lyons Gromen, Gerry O'Neill.

Others present: Julia Beaty (Council staff), Doug Christel (GARFO staff), Jason Didden (Council staff), Gavin Fay (SSC member), Zoe Goozner (Pew Charitable Trusts), Peter Hughes (Council member), Zack Greenberg (Pew Charitable Trusts), Paul Rago (SSC Chair), Eric Reid (NEFMC member and liaison to MAFMC), Jamie SB, Alissa Wilson

Discussion questions:

1. What factors have influenced recent catch (markets/economy, environment, regulations, other factors)?
2. Are the current fishery regulations appropriate? How could they be improved?
3. What would you recommend as research priorities?
4. What else is important for the Council to know?

Impact of *Illex* Squid Fishery

Two advisors familiar with the targeted commercial chub mackerel fishery said the vessels responsible for most chub mackerel landings have been focusing on *Illex* squid for the past three years. Any commercial chub mackerel landings from these vessels in recent years were incidental. The levels of targeted fishing effort seen in 2013, when commercial landings reached their peak, have not occurred since. However, if *Illex* are not available in 2021, chub mackerel landings could return to that level.

One advisor said notable amounts of chub mackerel are likely not caught in other commercial fisheries because high horsepower is needed to catch this fast-swimming species and, in this

region, most of the high horsepower vessels are those that participate in the *Illex* squid fishery and the winter Atlantic mackerel fishery.

One advisor said 2020 has been a good year for *Illex* squid, but not an extremely good year. Landings were starting to slow down before the *Illex* fishery closed. There may be some incidental catch of chub mackerel this year, but landings will likely not be very high.

Environmental Conditions

Two advisors called chub mackerel an "emerging stock" due to changing climate conditions. They also said increased recreational catches could indicate increased availability.

One advisor noted that chub mackerel can be found close to shore. For example, schools of chub mackerel could be seen chasing white bait in point Judith Harbor this year and they were also caught in floating fish traps in Narraganset Bay. Therefore, the statement in the Fishery Information Document which says they are found to depths of 250-300 meters should be modified to reflect that they are also found close inshore.

One advisor said that chub mackerel catches may be low in years with high *Illex* catches because *Illex* may push chub mackerel into other areas.

Management Issues

Three advisors expressed support for an increase in the chub mackerel catch limits as the current catch limits are based on one year of targeted fishing effort (2013) and the stock will likely continue to expand in this region due to changing climate conditions. Therefore, an incremental increase in the catch limits could allow for expanded fishing opportunities. For example, one advisor said the harvest in 2013 mostly came from two statistical areas in the Mid-Atlantic, but availability in other areas could increase in the future. Another advisor agreed and said availability could increase in New England, for example.

One advisor asked if the Council could evaluate the ecological value of the protections for other forage species implemented through the Unmanaged Forage Omnibus Amendment and if this could be weighed against the impacts of a potential increase in the chub mackerel total allowable landings limit beyond 4.50 million pounds. This advisor added that ecological considerations always seem to result in additional cuts to commercial harvest.

One advisor said, with other forage species such as Atlantic herring, Atlantic mackerel, and butterfish either overfished or trending down, chub mackerel could be especially important for some predators. This advisor added that the management measures for individual species often do not look at the bigger picture and consider ecological implications.

Research Priorities

One advisor asked what research would be needed for the Council to consider allowing an expansion of the chub mackerel fisheries.

Several advisors asked about an ongoing study funded by the Council to evaluate the importance of chub mackerel in the diets of highly migratory species (HMS) such as tunas and marlins. One advisor asked if information on spatial and temporal variations in diet would be provided in the final report, adding that there can be discrete pulses of chub mackerel availability. Both the commercial fishery and predators take advantage of these pulses and this is important to evaluate. For example, chub mackerel may be important prey for certain predators in discrete times of year and locations.

Another advisor agreed and said that if the fishery is allowed to expand, it should be done carefully in a way that considers the impacts to the structure and function of the ecosystem. This may be difficult to evaluate given that the fishery largely takes place in deep, offshore areas. He added that if the HMS diet study does not indicate that chub mackerel are eaten by the species examined, then it would be important to determine which other species are chub mackerel predators.

Another advisor said chub mackerel are both prey and a voracious predators of other forage species. If the Council considers the impacts of chub mackerel harvest on the stock status of HMS, then serious consideration should also be given to HMS management and how it has contributed to HMS stock status. Any conclusions about the impacts of chub mackerel harvest on HMS stock status should be supported by peer reviewed evidence.

One advisor called attention to the length frequency information provided by commercial dealers[1] and said it would be helpful to know if the SSC thinks industry should continue to collect these data. This is the most comprehensive length frequency data currently available for chub mackerel. The chair of the SSC responded and said this is an important data source which could be used to look for evidence of recruitment pulses and could possibly also be used to evaluate mortality rates on the population if enough data were available.

Other Issues

One advisor said chub mackerel are valuable as bait and as human food. Most markets for human consumption are in Europe and Africa.

It was noted that although a few AP members present on the call are associated with companies that have participated in the commercial chub mackerel fishery, other AP members who have more on the water experience harvesting chub mackerel were not present.

[1] Available at: https://www.mafmc.org/s/e_Characterization-of-the-Atlantic-Chub-Mackerel-fishery-1.pdf

From:	Joseph Gordon
To:	Beaty, Julia
Cc:	Lyons Gromen, Pam; Zachary Greenberg; Zoe Goozner
Subject:	RE: Draft fishery performance report for your review by noon tomorrow
Date:	Friday, September 4, 2020 11:35:34 AM

Julia-

Thank you for your efforts and leading yesterday's discussion. I'm not replying all, but please consider including. For the FPR document, a few things—

Since we know that other forage species like Atlantic herring, Atlantic mackerel, and butterfish are either overfished or trending down, can that statement be moved into the 'management issues' section, instead of 'research priorities'.

It would be good to note that the current TAL of 4.5 million pounds is well above the 2000-2019 total landings average (522,390 pounds/year) for chub mackerel.

It's also worth mentioning that while chub mackerel are an extremely data poor forage species (requiring a precautionary approach to management per the Council's EAFM Guidance Document), there is price/pound, observer and VTR data from Amendment 21 detailing that while most chub mackerel catch is kept, that when discards do occur it's often due to a lack of market. Understandably, this data is several years old, but it could provide helpful context for future decision-making.

Lastly, I want to acknowledge that yesterday's AP call could have benefited from additional attendance from other AP members and others that have a more intimate knowledge of recreational fishing and the importance chub mackerel play in that activity. I look forward to next week's SSC discussion and thanks again for all your efforts!

Best,
Joseph

Best wishes,

Joseph

Joseph Gordon
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Conserving Marine Life in the U.S.

From: Beaty, Julia <jbeaty@mafmc.org>
Sent: Friday, September 4, 2020 10:14 AM

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Christopher M. Moore, Ph.D., Executive Director

MEMORANDUM

Date: September 2, 2020

To: Chris Moore, Executive Director

From: Julia Beaty, staff

Subject: 2021 specifications for Atlantic chub mackerel

Executive Summary

This memorandum includes information to assist the Mid-Atlantic Fishery Management Council's (Council's) Scientific and Statistical Committee (SSC) and Mackerel, Squid, and Butterfish (MSB) Monitoring Committee in reviewing and potentially revising the previously approved 2021 catch and landings limits for Atlantic chub mackerel (*Scomber colias*), as well as the other management measures which can be modified through the annual specifications process.

Additional information on fishery performance and past management measures can be found in the 2020 Chub Mackerel Fishery Information Document and the 2020 Chub Mackerel Fishery Performance Report developed by advisors.[1]

The Council approved 2020-2022 catch and landings limits for Atlantic chub mackerel in March 2019 based on the acceptable biological catch (ABC) recommendations of the Council's SSC. These previously approved catch and landings limits are shown in Table 1. They were implemented through Amendment 21 to the MSB Fishery Management Plan (FMP) and will become effective on September 3, 2020 (85 Federal Register 47103).

During their September 2020 meeting, the SSC will review their previously recommended 2021 ABC and consider if revisions are necessary. The Monitoring Committee will then meet to review and, if appropriate, recommend changes to the previously approved 2021 annual catch limit (ACL), annual catch target (ACT), and total allowable landings limit (TAL), and other management measures which can be modified through the annual specifications process.

The Council will meet in October 2020 to review the recommendations of the SSC and Monitoring Committee, as well as input from advisors. They will then consider revising their previously approved catch and landings limits for 2021, and any other management measures which can be modified through the annual specifications process.

[1] The Fishery Information Document is available at: https://www.mafmc.org/msb. The Advisory Panel Fishery Performance Report will be posted to the same page once available.

Pending additional input provided by advisors during their meeting on September 3rd, staff recommend no revisions to the previously approved 2021 specifications for chub mackerel at this point in time.

Table 1. Previously approved 2020-2021 catch and landings limits for Atlantic chub mackerel.

Measure	mil lb	mt	Basis
ABC	5.07	2,300	SSC recommendation
Expected SC-FL catch	0.08	38	A conservative estimate based on the highest annual SC-FL landings shown in commercial dealer and MRIP data (i.e., 76,835 pounds in 2011, mostly from the recreational fishery), increased by about 10% to account for discards, which are not well quantified.
ACL	4.99	2,262	ABC minus expected SC-FL catch.
ACT	4.79	2,171	ACL minus a 4% management uncertainty buffer.
Expected total dead discards, ME-NC	0.29	130	6% of ACT based on based on the commercial discard rate during 2003-2017 according to northeast observer data.
TAL	4.50	2,041	ACT minus expected total dead discards.

Recent Catch and Landings

After remaining below 0.5 million pounds per year for many years, commercial chub mackerel landings spiked to 5.25 million pounds in 2013, but decreased to pre-2013 levels by 2016. Recreational chub mackerel landings are variable and averaged 13,788 pounds per year during 2000-2019 (Table 2). In 2019, a total of 522,390 pounds of chub mackerel were landed by commercial and recreational fishermen from Maine through North Carolina.

The Marine Recreational Information Program (MRIP) provides estimates of recreational chub mackerel discards in numbers of fish. MRIP data suggest that an average of 9,102 chub mackerel were discarded per year during 2000-2019. As with recreational landings, recreational discards were variable.

Commercial and recreational discards in weight are typically provided by the NEFSC. Chub mackerel was formally added as a stock in the MSB FMP in 2020; therefore, this will be the first year that the NEFSC calculates chub mackerel discards in weight. This information will be included in a data update provided by the NEFSC. The data update was not available at the time of writing this memo and will be provided separately to the SSC and Monitoring Committee.

Additional information on commercial and recreational chub mackerel fisheries is available in the 2020 Chub Mackerel Fishery Information Document (available at https://www.mafmc.org/msb).

Table 2. Commercial and recreational chub mackerel landings, 2000-2019, from Maine through North Carolina. Landings in some years are combined to protect confidential data associated with fewer than three vessels and/or dealers.

Year	**Commercial landings** (pounds)	**Recreational landings** (pounds)	**Total landings** (pounds)
2000	16,246	6,991	23,237
2001	4,384	0	4,384
2002	471	0	471
2003	488,316	0	488,316
2004	126	0	126
2005	0	0	0
2006	0	0	0
2007-2009	21,039	0	21,039
2010-2011	192,301	355	192,656
2012	164,867	0	164,867
2013	5,249,686	0	5,249,686
2014	1,230,411	48,087	1,278,498
2015	2,108,337	0	2,108,337
2016	610,783	2,093	612,876
2017	2,202	14,831	17,033
2018	22,356	128,949	151,305
2019	60,498	74,462	134,960
2000-2019 avg	**508,601**	**13,788**	**522,390**

Stock Status and Biological Reference Points

The stock status of chub mackerel in the western Atlantic Ocean is unknown as there have been no quantitative assessments of this species in this region. In July 2018, the SSC assumed that biomass is currently at or above biomass at maximum sustainable yield, as described in more detail in the following section.

The Council requested a data update from the NEFSC with information on chub mackerel catches in fisheries-independent surveys through 2019. Once this document is available, it will be provided to the SSC and Monitoring Committee and posted to https://www.mafmc.org/ssc-meetings/2020/september-8-9.

Review of Prior SSC Recommendations

The SSC recommended the current chub mackerel ABC during their July 2018 meeting. They concluded that insufficient information exists to assess the status and trends of chub mackerel in the northwest Atlantic. They concluded that an overfishing limit could not be specified and recommended an ABC of 2,300 mt (5.07 million pounds) based on expert judgement. Their ABC recommendation is based loosely on the historic high for commercial and recreational landings (i.e., around 5.25 million pounds in 2013) and assumptions about discards. This level of ABC will prevent the fishery from achieving its historic high, but will allow landings to exceed those

in every other year over at least the past 20 years (Table 2). The SSC agreed that this level of catch is unlikely to result in overfishing given the general productivity of this species in fisheries throughout the world combined with the relatively low fishery capacity in U.S. Atlantic waters. Based on their recommendations, the ABC applies to total dead catch (i.e., commercial and recreational landings and dead discards) from Maine through the east coast of Florida.

The SSC determined the following to be the most significant sources of scientific uncertainty associated with the ABC:

- Stock size and productivity cannot be determined, there is no information to determine reference points for stock biomass levels, and little information exists to determine reference points for fishing mortality rates.
- There is no information on the source of recruits; it is unknown whether chub mackerel are episodic in the Mid-Atlantic, whether this is a range expansion with localized spawning, or neither.
- There is no information on predation mortality, or on the role of chub mackerel in predator diets.
- There is very high uncertainty in recreational landings and discards. Observer coverage on fisheries likely to catch chub mackerel may be low (*Illex* fleet, Mid-Atlantic small mesh bottom trawl).

Annual Catch Limit

The ACL for chub mackerel is derived by subtracting expected South Carolina through Florida catch from the ABC (Figure 1). When the Council adopted 2020-2022 specifications in March 2019, they approved a value of 84,500 pounds of expected catch from South Carolina through Florida. This represents about 2% of the ABC and is a conservative estimate based on the highest annual South Atlantic landings shown in commercial dealer and MRIP data through 2017 (i.e., 76,835 pounds in 2011), increased by about 10% to account for discards. Discards in SC-FL are highly uncertain.

The value of expected South Carolina through Florida catch used in the currently implemented chub mackerel specifications was calculated based on an examination of data through 2017. The Atlantic Coastal Cooperative Statistics Program provided updated South Carolina through Florida commercial landings data through 2019. These data reflect recent revisions to the data in earlier years. These revised data, as well as MRIP data, suggest that highest commercial and recreational landings in South Carolina through Florida over the past 20 years occurred in 2001 at 268,110 pounds. Average annual South Carolina through Florida landings were 89,885 pounds.

At this time, staff recommend no changes to the 2021 chub mackerel ACL of 4.99 million pounds (2,262 mt).

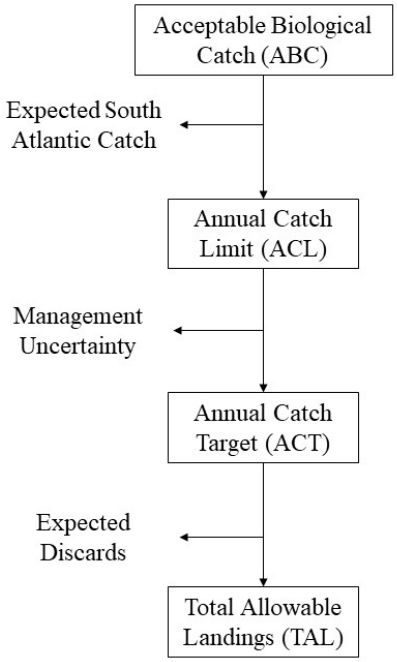

Figure 1. Flowchart summarizing chub mackerel catch and landings limits.

Annual Catch Target

As defined in the FMP, The ACT can be set less than or equal to the ACL to account for management uncertainty (Figure 1). Potentially relevant sources of management uncertainty for chub mackerel include misreporting due to challenges with species identification and under-reporting on VTRs due to misunderstanding of the requirement to report all catch on VTRs, including catch of unmanaged species and discarded catch. In addition, when setting the 2020-2022 specifications, the Council noted that there is some uncertainty regarding how the fishery will respond to the management measures implemented through Amendment 21. Several of the implemented management measures (e.g., ACL overage paybacks, recreational permit requirements) have never been used for chub mackerel off the U.S. east coast, though they have been used in many other fisheries.

The Council adopted a 4% management uncertainty buffer when they set the 2020-2022 specifications in March 2019. Considered in combination with the in-season commercial fishery closure regulations described on the next page, this was expected to be a reasonable buffer between the ACL and ACT to prevent ACL overages.

Council staff recommend no changes to the previously implemented ACT of 4.79 million pounds (2,171 mt) at this time.

Discards

Expected commercial and recreational discards in weight are subtracted from the ACT to derive the TAL (Figure 1). When setting 2020-2022 specifications in March 2019, the Council agreed to reduce the ACT by 6% to account for expected discards. This was based on the commercial discard rate during 2003-2017 according to northeast observer data (Table 3). The Council selected this as a preferred alternative because it is based on 15 years of data. It does not explicitly account for recreational data; however, based on information available at the time,

recreational chub mackerel discards were assumed to be generally very low compared to commercial discards, especially in years with targeted commercial fishing effort. The previously implemented catch and landings limits are based loosely on years with targeted commercial fishing effort. As previously stated, more information on commercial and recreational discards in weight will be provided in a forthcoming data update from the NEFSC. Pending additional information provided in that document, staff recommend no changes to the previously implemented 2021 TAL of 4.50 million pounds (2,041 mt) at this time.

Table 3. Percent of commercial chub mackerel catch that was discarded, based on northeast fisheries observer and northeast vessel trip report (VTR) data, 2003-2017. The associated number of trips is in parentheses.

Years	Observer Discard %	VTR Discard %
2003-2017 (15 years)	6% (217 trips)	3% (1,894 trips)
2008-2017 (10 years)	5% (199 trips)	3% (1,869 trips)
2013-2017 (5 years)	4% (156 trips)	3% (1,540 trips)
2013-2015 (top 3)	4% (95 trips)	3% (740 trips)
2013 (historic high)	3% (27 trips)	1% (120 trips)

Possession Limits

Under the currently implemented specifications, there is no commercial possession limit for chub mackerel until 90% of the TAL is projected to be landed. At that point, a 40,000 pound (18 mt) possession limit is in effect. Once 100% of the TAL is projected to be landed, commercially-permitted vessels are limited to a 10,000 pound (4.5 mt) possession limit. When setting 2020-2022 specifications, the Council agreed that the commercial fishery possession limits prior to in-season closure were unnecessary as the preferred in-season AMs were likely sufficient to constrain the fishery to prevent ACL overages.

According to stakeholder input provided during development of the Unmanaged Forage Omnibus Amendment, 40,000 pounds is approximately the amount of chub mackerel needed to fill a bait truck. Given the low value of chub mackerel (e.g., $0.49 per pound on average during 2000-2019), fishermen may not target chub mackerel when restricted to a 40,000 pound possession limit; however, they would have an incentive to land chub mackerel caught incidentally. A 40,000 pound possession limit could, therefore, discourage discards. The number of trips which landed more than 40,000 pounds of chub mackerel over the past 20 years is confidential as it is associated with fewer than three vessels and/or dealers.

Ten thousand pounds is approximately the average trip-level landings of chub mackerel based on northeast commercial fishery data for 1998-2017. A small number of vessels are responsible for most chub mackerel landings. If those vessels are excluded from the calculation, about 99% of the trips which landed chub mackerel during 1998-2017 landed less than 10,000 pounds. This analysis has not been updated through 2019; however, given that only 22,356 pounds in total were landed in the commercial fishery in 2018 and 60,498 pounds in 2019, it is assumed that there were few, if any, large commercial chub mackerel trips during 2018 and 2019.

As previously stated, unless modified, the 2021 TAL will be 4.50 million pounds (2,041 mt). Therefore, a commercial possession limit will be triggered once 4.05 million pounds (1,837 mt) of chub mackerel are projected to be landed by commercial and recreational fishermen. This level of landings has been reached only once over the past 20 years (i.e., in 2013, Table 2).

As described in more detail in the next section, there are currently no recreational possession limits for chub mackerel.

Council staff recommend no changes to the commercial or recreational chub mackerel possession limits at this time.

Other Management Measures

The Council did not develop recreational management measures such as possession limits, minimum fish sizes, and closed seasons for chub mackerel through Amendment 21. Recreational catch of chub mackerel appears to be low; however, the data are limited, making it difficult to develop effective recreational management measures. There are also concerns about potential misidentification as chub mackerel are similar in appearance to Atlantic mackerel. Chub mackerel may be misidentified at Atlantic mackerel and misreported in charter/party logbooks and as part of data collections for MRIP. There are no federal possession limits, minimum fish sizes, or season restrictions for recreational Atlantic mackerel fisheries.

Minimum fish size limits are typically used to reduce fishing mortality on immature fish; however, a minimum size limit for chub mackerel may provide little additional biological benefits considering current fishery selectivity. According to an analysis of observer data done for Amendment 21, about 88% of the chub mackerel caught in bottom otter trawls are at least 20 cm in length. As suggested in Daley and Leaf (2019)[2] and supported by comments from fishermen, it is possible that chub mackerel's fast swimming speed reduces the potential for capture of larger individuals. Several scientific studies have documented the length at maturity for chub mackerel in various regions. The length at maturity varies by study. Daley (2018)[3] examined chub mackerel caught in commercial fisheries in the Mid-Atlantic and Southern New England and found that 50% of females reached maturity at about 27 cm. According to observer data, about 73% of the chub mackerel caught in bottom trawls are at least 27 cm.

Given that chub mackerel are predominantly caught with bottom otter trawls off the U.S. east coast, it can be assumed that most discarded chub mackerel would not survive. Therefore, a minimum fish size likely would increase mortality on this species without notable benefits of protecting immature fish.

Most chub mackerel landed on the U.S. east coast over the past 20 years were caught on bottom trawl vessels which also participate in the *Illex* squid fishery. Regulations for that fishery specify gear requirements (see 50 CFR 648.23), including gear restrictions for specific regulated mesh areas (50 CFR 648.80). The Council did not see a need to develop additional gear restrictions for chub mackerel beyond what vessels are currently subject to in other fisheries.

At this point in time, Council staff do not recommend that the Council implement new chub mackerel management measures such as minimum fish sizes, closed seasons, or gear restrictions.

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Chub Mackerel Fishery Information Document

August 2020

This Fishery Information Document provides a brief overview of the biology, stock condition, management system, and fishery performance for Atlantic chub mackerel (*Scomber colias*) with an emphasis on 2019. Data Sources for Fishery Information Documents include unpublished National Marine Fisheries Service (NMFS) fisheries-independent surveys, commercial dealer reports, vessel trip reports (VTRs), permits, and Marine Recreational Information Program (MRIP) data and should be considered preliminary. For more resources, including previous Fishery Information Documents, please visit https://www.mafmc.org/msb.

Key Facts

- The Council developed the first management measures for Atlantic chub mackerel in U.S. waters. These measures became effective in 2017 and were modified in 2020.
- Stock status of chub mackerel in this region is unknown as there has been no quantitative stock assessment. The Council's Scientific and Statistical Committee assumes that stock biomass is currently at a sustainable level.
- After spiking at 5.25 million pounds in 2013, commercial chub mackerel landings returned to low levels. In 2019, commercial fishermen landed 60,498 pounds of chub mackerel from Maine through North Carolina.
- Data on recreational chub mackerel harvest are variable and likely imprecise. It is estimated that recreational fishermen from Maine through North Carolina harvested 13,788 pounds of chub mackerel in 2019.

Basic Biology

Atlantic chub mackerel are a schooling pelagic species. They migrate seasonally and can be found throughout U.S. Atlantic waters to depths of about 250-300 meters.[1] Adults prefer temperatures of 15-20°C (about 60-70°F).[1,2] Some studies suggest that juveniles tend to be found closer inshore than adults.[3,4]

Atlantic chub mackerel grow rapidly during the first year of life.[2,3,5,6] They can reach at least age 13.[7] Daley and Leaf (2019) found that most fish sampled from commercial fishery catches off the northeast U.S. were age 3.[6]

Atlantic chub mackerel spawn in several batches. Spawning areas likely occur from North Carolina through the Gulf of Mexico.[8,9] Daley (2018) suggested that chub mackerel reach maturity around age two in the Northwest Atlantic, though other studies from various locations have published a range of ages at maturity.[3,9]

Chub mackerel are opportunistic predators with a seasonally variable diet of small crustaceans (especially copepods), small fish, and squid.[1,10] Adults tend to consume larger prey and more fish prey than juveniles.[4]

Very few quantitative estimates of the contribution of chub mackerel to the diets of predator species in the western North Atlantic are available. This is likely due in part to the difficulty of visually distinguishing partially-digested chub mackerel from related species such as Atlantic mackerel (*Scomber scomber*), bullet mackerel (*Auxis rochei*), and frigate mackerel (*Auxis thazard*).[11] The family Scombridae has been documented in the diets of some fish, marine mammals, sea birds, and sharks in the western North Atlantic.[12,13] However, few studies identify chub mackerel to the species level in the diets of any predators. A thorough literature review conducted by Council and NMFS staff in 2018[14] identified only one study with quantitative data on the role of chub mackerel in the diets of any predators off the U.S. east coast. Manooch et al. (1984) found that chub mackerel made up 0.2% (by frequency of occurrence) of the diets of dolphinfish sampled off North Carolina through Texas.[15] Chub mackerel have been documented as prey for some predators in other parts of the world. For example, they are important prey for blue marlin at certain times of year off Portugal[16] and Cabo San Lucas.[17] They have also been documented as prey for Cory's shearwaters in the eastern North Atlantic, for long-beaked common dolphins off South Africa, and short-beaked common dolphins off the Iberian Peninsula.[18] It should be emphasized that diet composition of a predator species may vary by geography and can be flexible. Therefore, the importance of chub mackerel in the diets of predators in other parts of the world does not necessarily indicate its importance off the U.S. east coast. More diet information would be required to better establish this relationship.

In 2018, the Council funded a study with the goal of better delineating the role of chub mackerel in the diets of tunas and marlins, which were identified by stakeholders as predators of key interest. Final results from this study are expected to be available in 2021.

Status of the Stock

The stock status of chub mackerel in the western Atlantic Ocean is unknown as there have been no quantitative assessments of this species in this region. The Council's Scientific and Statistical Committee (SSC) assumes that biomass is currently at or above biomass at maximum sustainable yield.[19]

Large fluctuations in abundance have been reported around the world, including in the mid-Atlantic and New England.[3, 20] These fluctuations may be partly the result of environmental influences such as temperature and upwelling strength on recruitment.[3] Given that chub mackerel are a fully pelagic species, ocean processes likely influence their availability in any given area, as well as their recruitment.

Management System and Fishery Performance

Management

The Mid-Atlantic Fishery Management Council manages Atlantic chub mackerel fisheries in federal waters from Maine through North Carolina.

An increase in commercial landings during 2013-2015, as well as concerns about the potential role of chub mackerel as prey for tunas and marlins, prompted the Council to adopt an annual commercial landings limit and a commercial possession limit for chub mackerel as part of the Unmanaged Forage Omnibus Amendment. These measures were implemented in September

2017 and were the first regulations for chub mackerel fisheries off the U.S. east coast.[13] They were intended to be temporary measures and were replaced by longer-term measures developed through Amendment 21, which added chub mackerel as a stock in the Mackerel, Squid, and Butterfish (MSB) Fishery Management Plan (FMP). These new management measures will become effective September 3, 2020.[21]

The Council's SSC recommends annual acceptable biological catch (ABC) limits for chub mackerel. The Council must either approve the ABC recommended by the SSC or approve a lower ABC. Total catch (i.e., commercial and recreational landings and dead discards) from Maine through the east coast of Florida count against the ABC. Expected South Carolina through Florida catch is subtracted from the ABC to derive the annual catch limit (ACL). An annual catch target (ACT) is set less than or equal to the ACL to account for management uncertainty. Expected discards are subtracted from the ACT to derive a total allowable landings limit (TAL). The commercial and recreational fisheries do not have separate annual catch or landings limits (Figure 1).

Unless revised, the catch and landings limits for 2020-2022 include an ABC of 5.07 million pounds (2,300 mt), an ACL of 4.99 million pounds (2,262 mt), an ACT of 4.79 million pounds (2,171 mt), and a TAL of 4.50 million pounds (2,040 mt).

Although total catch from Maine through the east coast of Florida counts against the ABC, the ACL, ACT, and TAL apply to Maine through North Carolina. Based on past landings trends, the Council agreed that catch from South Carolina through Florida is immaterial to proper management. Therefore, commercial and recreational fisheries in South Carolina through Florida are not subject to the permit and possession limit requirements described on the next page.

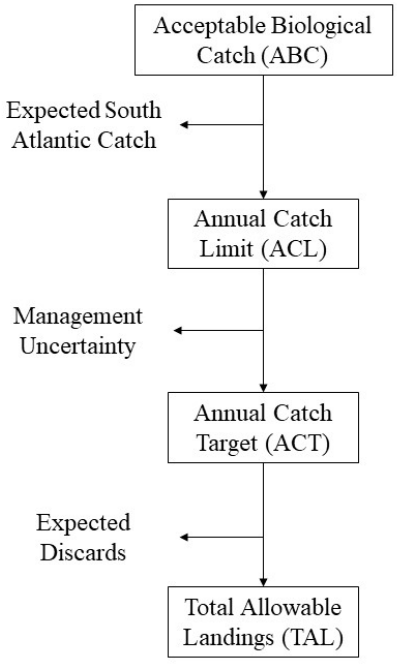

Figure 1. Flowchart summarizing chub mackerel catch and landings limits.

Commercial Fishery

In additional to the catch and landings limits described above, commercial chub mackerel management measures include a permit requirement and a possession limit after a certain level of landings is reached.

A commercial MSB fishing permit is required of vessels which retain chub mackerel for sale in federal waters from Maine through North Carolina. Ten permit types meet this requirement. There is no permit type specific to chub mackerel.

There is no commercial possession limit for chub mackerel until 90% of the TAL is projected to be landed. At that point, a 40,000 pound (18 mt) possession limit is in effect. Once 100% of the TAL is projected to be landed, commercially-permitted vessels are limited to a 10,000 pound (4.5 mt) possession limit.

After remaining below 0.5 million pounds per year for several years, commercial chub mackerel landings spiked to 5.25 million pounds in 2013, but decreased to pre-2013 levels by 2016 (Table 1). This temporary increase was the result of a small number of trawl vessels targeting chub mackerel.[22] These vessels also participate in the *Illex* squid fishery. Some fishermen have described chub mackerel as a "bailout" species which they sometimes target when they are not able to harvest *Illex* squid. Chub mackerel tend to be harvested in the same areas and times of year when *Illex* squid are harvested; however, fishermen have said they typically will not harvest both species at the same time because the quality of both species suffers when they are stored together.

According to public comments, a small number of vessels on the east coast are capable of harvesting chub mackerel in profitable quantities because vessels need to be large, fast, and have refrigerated sea water or freezing capabilities in order to harvest this fast-swimming, low-value, warm water species. Landings data seem to support these statements.

Fewer than 5 vessels accounted for more than 95% of chub mackerel landings over the last 20 years (2000-2019). The chub mackerel landings from these vessels were sold to fewer than three dealers; therefore, much of the data associated with these vessels and dealers are confidential.

During 2000-2019, at least 32 dealers across 6 states purchased chub mackerel. The majority of these dealers purchased low amounts of chub mackerel (i.e., less than 20,000 pounds total over the 20-year period) and did not purchase chub mackerel every year. New York, New Jersey, and Rhode Island had the highest number of dealers which purchased any amount of chub mackerel during 2000-2019 (Table 2). On average, 14 vessels per year, with a maximum of 31 vessels per year, landed chub mackerel from Maine through North Carolina.[22]

Like landings, the annual average ex-vessel price per pound varied during 2000-2019, averaging $0.49 per pound (adjusted to 2019 dollars). There appears to be a relationship between price and volume landed, though this relationship is neither linear nor consistent across time. In general, years with higher landings had lower average annual prices per pound, and vice versa (Table 1).[22]

About 96% of the chub mackerel landed by commercial fishermen from Maine through North Carolina from 2000 through 2019 were caught with bottom otter trawls.[23]

Nearly all commercial chub mackerel landings (>97%) from Maine through North Carolina over the past 20 years occurred during June-October. The highest proportion of landings occurred in

September (38%). June, July, August, and October contributed about equally to commercial landings (13-16%).[22]

Over 97% of commercial chub mackerel landings from 2000-2019 originated from statistical areas south of New York. Much of these landings came from statistical areas which overlap with the shelf break (Figure 2).[23]

Public comments received during development of Amendment 21 suggest that most chub mackerel landed on the east coast are processed for use as human food, much of which is sent overseas, and lesser amounts are used as bait in other fisheries.

Table 1. Commercial chub mackerel landings (in pounds) from Maine through North Carolina, ex-vessel value, and average price per pound. Ex-vessel value and price are inflation-adjusted to 2019 dollars using the Gross Domestic Product Price Deflator. Landings in some years are combined to protect confidential data representing fewer than three vessels and/or dealers.[22]

Year	Landings (pounds)	Ex-vessel value	Average price per pound
2000	16,246	$7,508	$0.46
2001	4,384	$6,109	$1.39
2002	471	$284	$0.60
2003	488,316	$33,245	$0.07
2004	126	$86	$0.68
2005	0	$0	--
2006	0	$0	--
2007-2009	21,039	$7,413	$0.65
2010-2011	192,301	$38,432	$0.43
2012	164,867	$70,627	$0.43
2013	5,249,686	$1,101,190	$0.21
2014	1,230,411	$362,202	$0.29
2015	2,108,337	$520,829	$0.25
2016	610,783	$107,858	$0.18
2017	2,202	$2,765	$1.26
2018	22,356	$11,585	$0.52
2019	60,498	$39,853	$0.66
2000-2019 avg	**508,601**	**$115,499**	**$0.49**

Table 2. Number of dealers by state which purchased any amount of chub mackerel, 2000-2019. "C" indicates confidential data.[22]

State	Number of dealers
MA	C
RI	9
CT	C
NY	14
NJ	9
VA	4

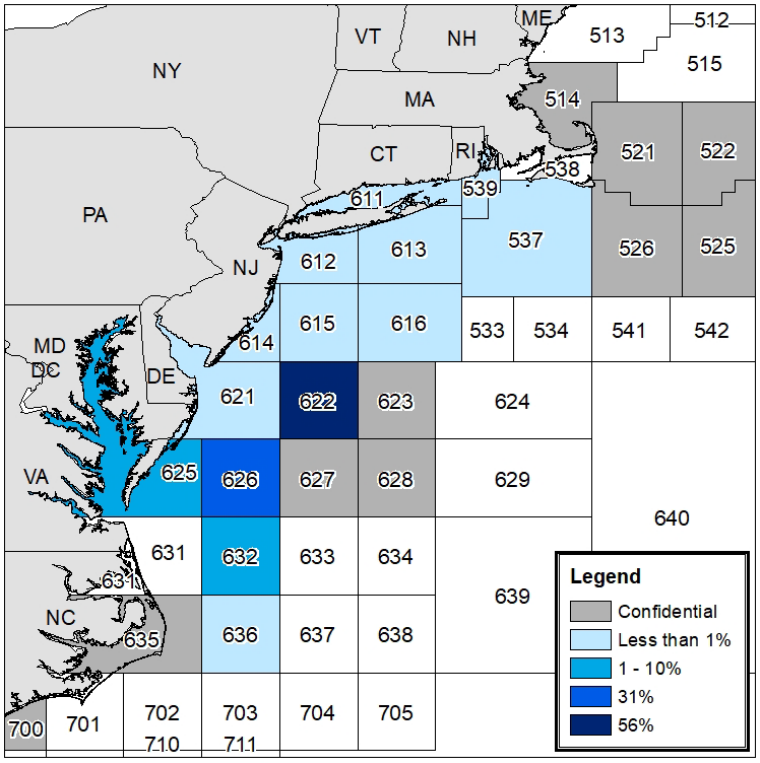

Figure 2. Percent of commercial chub mackerel landings by statistical area, 2000-2019 as shown in dealer and VTR data. Data associated with fewer than three vessels and/or dealers are confidential. Confidential landings collectively account for about 2% of the total.[23]

Recreational Fishery

Recreational catch and harvest data are available from MRIP. MRIP data show an average of 20,402 chub mackerel caught and 11,300 chub mackerel harvested per year from 2000 - 2019 from Maine through North Carolina. An average of 13,788 pounds of annual recreational harvest was estimated. In about half of those years, no recreational catch or harvest was estimated (Table 3). About 57% of the harvest (in numbers of fish) was caught in state waters, with the remaining 43% caught in federal waters. The proportion of harvest by mode varied considerably over the past 20 years, but averaged 45% from private and rental boats, 40% from party and charter boats, and 15% from shore (Table 4). Most of the recreational catch and harvest occurred in New York and New Jersey (Table 5). Most catch and harvest occurred during July and August (Table 6). [24]

Chub mackerel may be rarely encountered on recreational trips. There may also be instances of misreporting chub mackerel as Atlantic mackerel. This is an important consideration for MRIP and other data sets which incorporate self-reported data from fishermen (e.g., VTRs). To address this concern, the Council and partners at NMFS developed a species identification guide and distributed over 3,700 copies to commercial and recreational permit holders and other interested stakeholders.[25] In addition, in 2017 chub mackerel were added to the core list of species for trainings of MRIP field samplers from Maine through Virginia.

Through development of Amendment 21, the Council heard anecdotal descriptions of recreational chub mackerel harvest, including reports of catch on for-hire vessels out of New

York and New Jersey. There have also been reports of chub mackerel harvest for use as live bait on recreational trips out of Maryland and Virginia targeting white marlin, blue marlin, sailfish, spearfish, yellowfin tuna, bigeye tuna, and/or wahoo. According to public comments, this live bait fishery occurs on the edges of certain offshore canyons, especially Norfolk Canyon, where chub mackerel and their predators are concentrated in the late summer and early fall.[26]

Table 3. MRIP-estimated recreational catch and harvest of chub mackerel from Maine through North Carolina, 2000-2019 based on MRIP data downloaded August 17, 2020.[24]

Year	Recreational catch (# of fish)	Recreational harvest (# of fish)	Recreational harvest (pounds)	Avg. percent retained
2000	4,461	4,461	6,991	100%
2001	821	0	0	0%
2002	0	0	0	--
2003	0	0	0	--
2004	0	0	0	--
2005	0	0	0	--
2006	0	0	0	--
2007	0	0	0	--
2008	0	0	0	--
2009	0	0	0	--
2010	0	0	0	--
2011	1,613	1,613	355	100%
2012	15,569	0	0	0%
2013	0	0	0	--
2014	60,191	49,813	48,087	83%
2015	0	0	0	--
2016	2,575	2,087	2,093	81%
2017	26,061	13,310	14,831	51%
2018	157,471	104,830	128,949	67%
2019	139,282	49,892	74,462	36%
Avg.	20,402	11,300	13,788	57%

Table 4. Proportion of total chub mackerel harvest by recreational fishing mode in numbers of fish, 2000-2019, based on MRIP data downloaded August 17, 2020. "--" indicates a year with no data.[24]

Year	Party/charter	Private/rental boat	Shore
2000	0%	100%	0%
2001	--	--	--
2002	--	--	--
2003	--	--	--
2004	--	--	--
2005	--	--	--
2006	--	--	--
2007	--	--	--
2008	--	--	--
2009	--	--	--
2010	--	--	--
2011	0%	0%	100%
2012	--	--	--
2013	--	--	--
2014	100%	0%	0%
2015	--	--	--
2016	91%	9%	0%
2017	18%	82%	0%
2018	41%	56%	2%
2019	34%	66%	0%
Avg.	**41%**	**45%**	**15%**

Table 5. Proportion of total chub mackerel catch and harvest in numbers of fish by state, 2000-2019 based on MRIP data downloaded August 17, 2020.[24]

State	Recreational catch	Recreational harvest
ME	0%	0%
NH	3%	4%
MA	0%	0%
RI	4%	3%
CT	9%	10%
NY	46%	44%
NJ	39%	39%
DE	0%	0%
MD	0%	0%
VA	0%	0%
NC	0%	0%
Total	100%	100%

Table 6. Proportion of total chub mackerel catch and harvest in numbers of fish by wave, Maine through North Carolina, 2000-2019 based on MRIP data downloaded August 17, 2020. Note that only North Carolina conducts MRIP sampling during wave 1.[24]

Wave	Catch (numbers of fish)	Harvest (numbers of fish)
1 (Jan-Feb)	0%	0%
2 (Mar-Apr)	0%	0%
3 (May-Jun)	4%	6%
4 (Jul-Aug)	69%	76%
5 (Sep-Oct)	27%	18%
6 (Nov-Dec)	0%	0%
Total	100%	100%

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Characterization of the Atlantic Chub Mackerel fishery and stock, 2020 update

Robert Leaf

April 8, 2020

Introduction

The objective of the project "Characterization of the Atlantic Chub Mackerel fishery and stock" is a continued effort to work with industry partners (J. Kaelin, Lund's Fisheries and M. Lapp, SeaFreeze Ltd.) to characterize the age and length composition of Atlantic Chub Mackerel(ACM) in the commercial fishery. To our knowledge, the data collected here are the only available for understanding the fishery dynamics of Chub Mackerel in the United States. Our work focuses on collecting length-compositon information from the two primary companies that target the stock. Both companies harvest ACM and Illex squid, and ACM is considered a secondary target and one of opportunity.

The collection of fishery-dependent data was initiated in 2016 using funding provided by the Science Center for Marine Fisheries. SCeMFiS is a National Science Foundation Industry/University Cooperative Research Center (I/UCRC).

The intention of this work has been to understand inter-annual variations in age and length composition of ACM. In this report, we have integrated data collected this year with those collected by Leaf and from previous fishery-dependent sampling work (earlier than 2016) from the mid-Atlantic. SeaFreeze Ltd. has provided these data from random sampling of boxes of fish packed and frozen at sea. The intention of this effort is to contribute to a continued understanding of the length and age-composition of harvest and to expand the time series of annual length composition for inclusion into quantitative stock assessment.

Methods

In 2019 to 2020, working with industry partners, we have requested that both SeaFreeze and Lund's Fisheries collect a random subset of the catch of ACM and keep them frozen at their facility, labeled with the date of collection. Depending on the volume of samples, we have made trips to Lund's Fisheries in the late summer/early fall to collect and sample fish (determine length, weight, and collect otoliths and gonads) onsite. In other years, including in 2019, we have requested that frozen samples be shipped to the Gulf Coast Research Laboratory, Ocean Springs, MS. This year (2019) the fishery did not encounter ACM until late in the season (Table 1) and these samples were collected by SeaFreeze Ltd.

Table 1. Summary of sampling (month and year) performed by SeaFreeze Ltd. (2007 to 2015) and industry and academic cooperative partnership with Leaf's Laboratory at the Gulf Coast Research Laboratory and Lund's Fisheries and SeaFreeze Ltd. (2016 to 2019).

Year	Month Start	Month End	Number of Fish Examined
2007	7	7	107
2008	5	5	96
2010	9	9	122
2012	6	11	556
2013	7	10	1066
2014	6	11	1352
2015	6	12	906
2016	7	9	2841
2017	6	11	427
2018	6	8	66
2019	11	11	109

Table 2. Summary statistics of sampling performed by SeaFreeze Ltd. (2007 to 2015) and cooperative partnership with the Gulf Coast Research Laboratory at the Univerisity of Southern Mississippi and Lund's Fisheries and SeaFreeze Ltd. (2016 to 2019). Note that 2016 does include some fish collected in the northern Gulf of Mexico (from fishery-dependent sampling) and included to show the scope of the sampling work in that year.

Year	Minimum FL (cm)	Maximum FL (cm)	# Fish Measured	# Age Determined
2007	18.9	29.7	157	0
2008	18.9	25.2	96	0
2010	21.6	27.9	122	0
2011	25.2	28.8	95	0
2012	19.8	34.2	580	0
2013	18.9	31.5	1096	0
2014	19.8	32.4	1352	0
2015	18.9	33.3	906	0
2016	18.9	39.2	2888	328
2017	22.8	39.5	427	108
2018	31.5	35.9	66	0
2019	20.9	34.8	109	0

In 2016 to 2017 we focused our efforts on describing the length-at-age, weight-at-length, and maturity dynamics of Atlantic Chub Mackerel. These analysis have been published (Daley and Leaf, *J. Northw. Atl. Fish. Sci.*, 50: 1-12). In our most recent effort, in 2019, we continued to collect and characterize the length composition of Atlantic Chub Mackerel from the fishery.

Based on aggregated length-composition information, of all years, the length composition exhibits a slight bimodal pattern with peaks at 25 cm TL and another at 32 cm TL. There is considerable variation in the patterns of annual length composition encountered in the commercial fishery and in general length composition data from a single year do not exhibit a bimodal pattern, instead, the mean of the annual length composition distributions are generally unimodal and either centered or skewed to smaller lengths (e.g. years 2007, 2008, 2012, 2018) or centered or skewed to larger lengths (e.g. years 2007, 2008, 2012, 2014).

However, the harvested fish in 2019, provided to us from SeaFreeze Ltd., exhibited a bimodal pattern. One trip in particular resulted in the harvest of small ACM, with a mean FL of approximately 22 cm. Large individuals, 30 to 35 cm, were also harvested as they have been nearly every year, since 2012 (Table 2).

Based on the historical analysis of length composition, there is no relationship between the month of harvest and the mean length of the fish encountered.

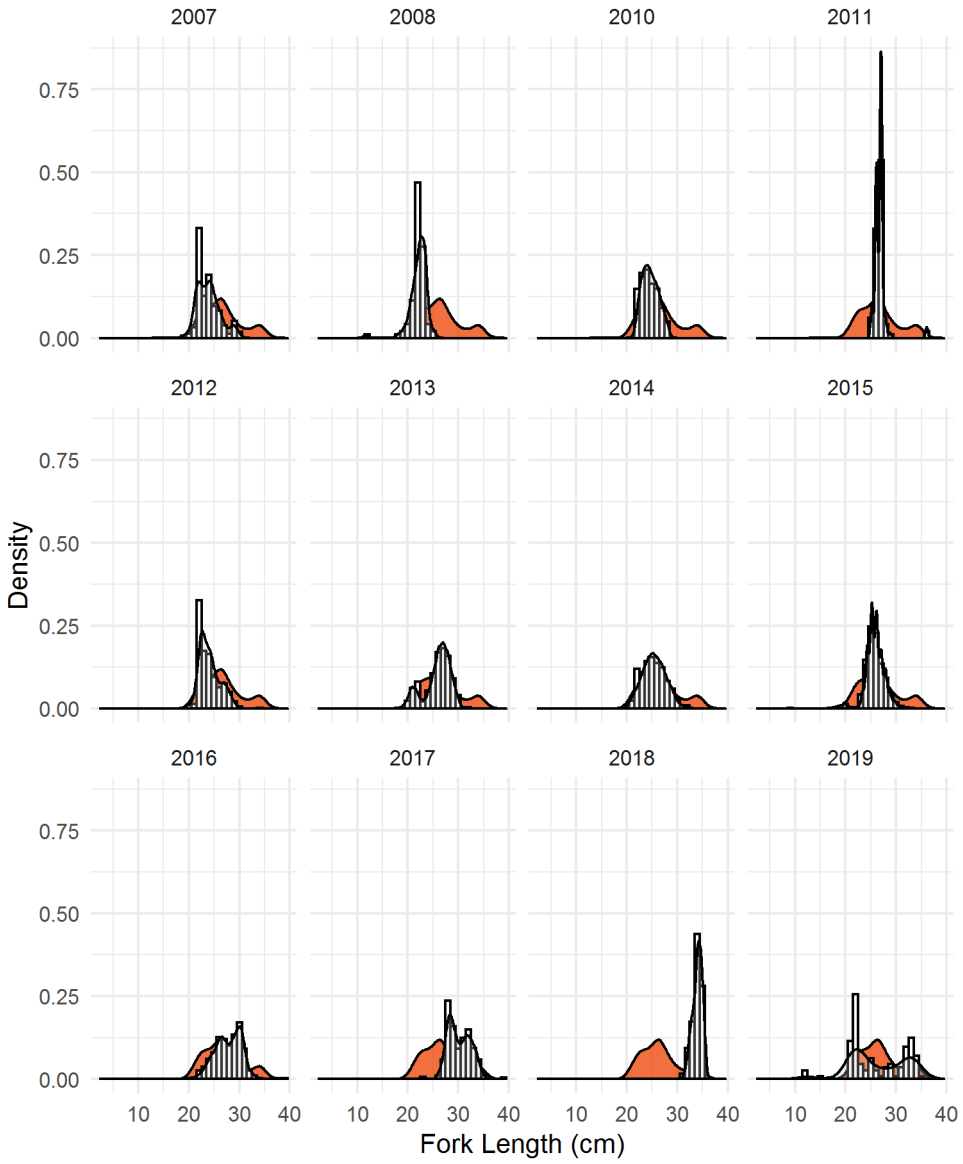

Figure 1: Length (Fork Length) composition collected from the commercial fishery. The orange polygons are the aggregated (all year) density polygons provided for comparison to the annual (panel specific) length compositions.

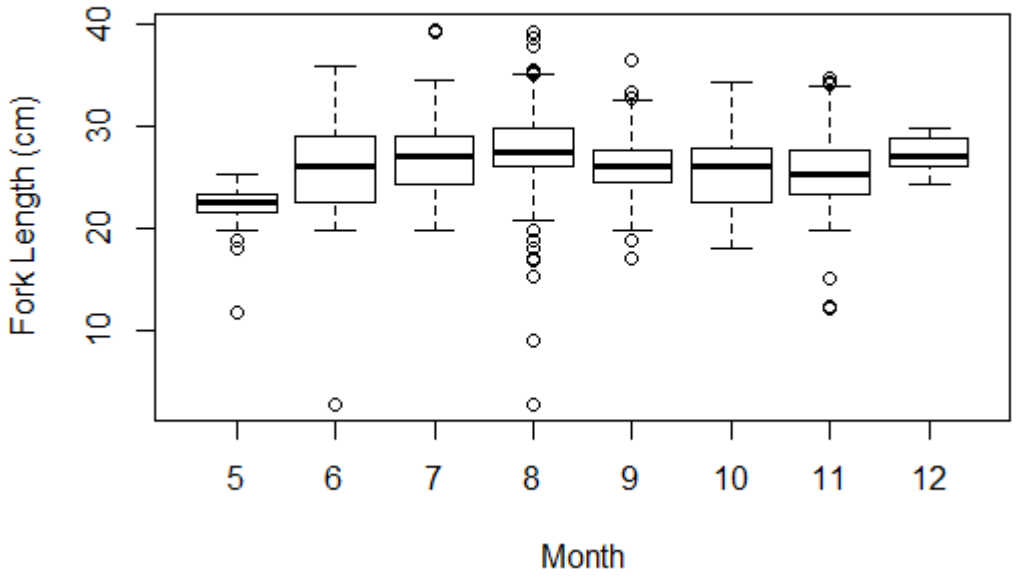

Figure 2: Boxplot of Fork length (cm) of collected Atlantic Chub Mackerel caught during the fishing season.