



## 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 Data Sources for Fishery Information Documents include unpublished National Marine Fisheries Service (NMFS) fisheries-independent surveys, commercial dealer reports, vessel trip reports (VTRs), permits, and Marine Recreational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.<sup>1</sup> Adults prefer temperatures of 15-20°C (about 60-70°F).<sup>1,2</sup> Some studies suggest that juveniles tend to be found closer inshore than adults.<sup>3,4</sup>

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

Atlantic chub mackerel spawn in several batches. Spawning areas likely occur from North Carolina through the Gulf of Mexico.<sup>8,9</sup> 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.<sup>3,9</sup>

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

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*).<sup>11</sup> The family Scombridae has been documented in the diets of some fish, marine mammals, sea birds, and sharks in the western North Atlantic.<sup>12,13</sup> 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<sup>14</sup> 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.<sup>15</sup> 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<sup>16</sup> and Cabo San Lucas.<sup>17</sup> 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.<sup>18</sup> 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.<sup>19</sup>

Large fluctuations in abundance have been reported around the world, including in the mid-Atlantic and New England.<sup>3, 20</sup> These fluctuations may be partly the result of environmental influences such as temperature and upwelling strength on recruitment.<sup>3</sup> 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.

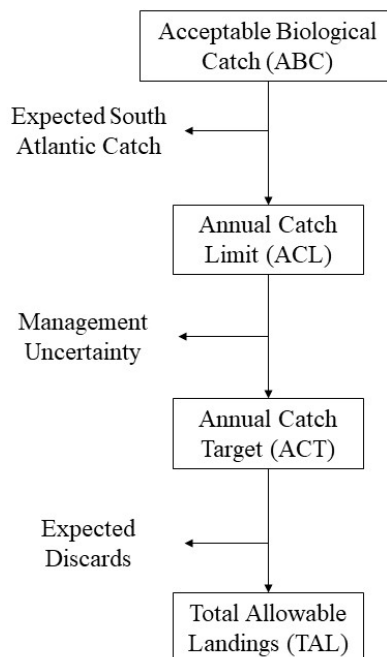
An increase in commercial landings during 2013-2015, as well as concerns about the potential role of chub mackerel as prey for tunas and marlins, prompted the Council to adopt an annual commercial landings limit and a commercial possession limit for chub mackerel as part of the Unmanaged Forage Omnibus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

2017 and were the first regulations for chub mackerel fisheries off the U.S. east coast.<sup>13</sup> 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.<sup>21</sup>

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 addition 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.<sup>22</sup> 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.<sup>22</sup>

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).<sup>22</sup>

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.<sup>23</sup>

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%).<sup>22</sup>

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).<sup>23</sup>

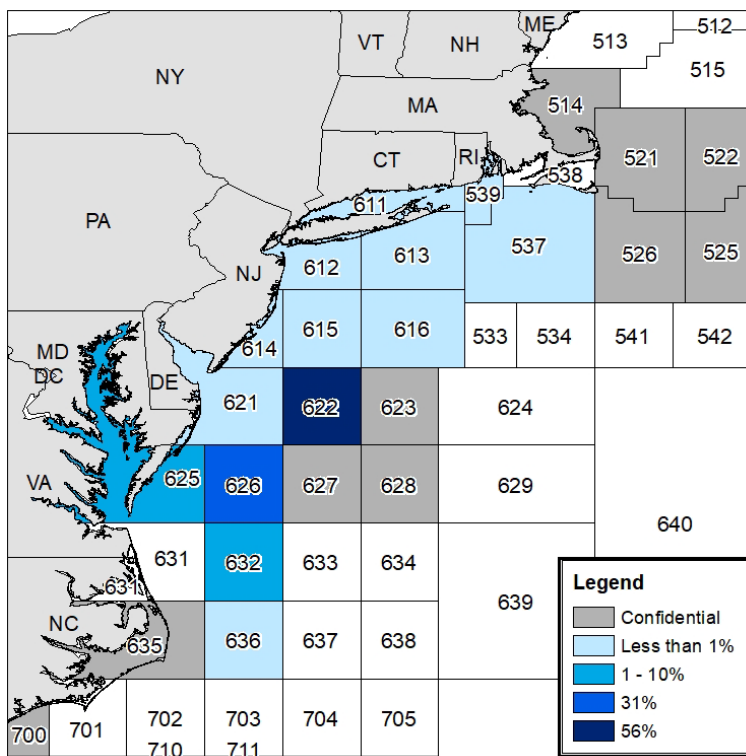
Public comments received during development of Amendment 21 suggest that most chub mackerel landed on the east coast are processed for use as human food, much of which is sent overseas, and lesser amounts are used as bait in other fisheries.

**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.<sup>22</sup>

<b>Year</b>	<b>Landings (pounds)</b>	<b>Ex-vessel value</b>	<b>Average price per pound</b>
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
<b>2000-2019 avg</b>	<b>508,601</b>	<b>\$115,499</b>	<b>\$0.49</b>

**Table 2.** Number of dealers by state which purchased any amount of chub mackerel, 2000-2019. "C" indicates confidential data.<sup>22</sup>

<b>State</b>	<b>Number of dealers</b>
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.<sup>23</sup>

### 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).<sup>24</sup>

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.<sup>25</sup> 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.<sup>26</sup>

**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.<sup>24</sup>

<b>Year</b>	<b>Recreational catch (# of fish)</b>	<b>Recreational harvest (# of fish)</b>	<b>Recreational harvest (pounds)</b>	<b>Avg. percent retained</b>
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.<sup>24</sup>

<b>Year</b>	<b>Party/charter</b>	<b>Private/rental boat</b>	<b>Shore</b>
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%
<b>Avg.</b>	<b>41%</b>	<b>45%</b>	<b>15%</b>

**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.<sup>24</sup>

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



**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.<sup>24</sup>

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

## References

- <sup>1</sup> Collette, B. B. and C. E. Nauen. 1983. FAO species catalogue. Vol. 2 Scombrids of the word: An annotated and illustrated catalogue of tunas, mackerels, bonitos, and related species known to date. Available at: <http://www.fao.org/docrep/009/ac478e/ac478e00.htm>
- <sup>2</sup> Perrotta, R. G., M. D. Viñas, D. R. Hernandez, and L. Tringali. 2001. Temperature conditions in the Argentine chub mackerel (*Scomber japonicus*) fishing ground: implications for fishery management. *Fisheries Oceanography*. 10(3):275-283.
- <sup>3</sup> Hernández, J. J. C. and A. T. S. Ortega. 2000. Synopsis of biological data on the chub mackerel (*Scomber japonicus* Houttuyn, 1782). FAO Fisheries Synopsis No. 157.
- <sup>4</sup> Castro, J. J. 1993. Feeding ecology of chub mackerel *Scomber japonicus* in the Canary Islands area. *South African Journal of Marine Science*. 13(1): 323-328.
- <sup>5</sup> Velasco, E. M., J. D. Arbol, J. Baro, and I. Sobrino. 2011. Age and growth of the Spanish chub mackerel *Scomber colias* off southern Spain: a comparison between samples from the NE Atlantic and the SW Mediterranean. *Revista de Biología Marina y Oceanografía*. 46(1):27-34.
- <sup>6</sup> Daley, T. T. and R. T. Leaf. 2019. Age and growth of Atlantic chub mackerel (*Scomber colias*) in the Northwest Atlantic. *Journal of Northwest Atlantic Fisheries Science*. 50: 1-12.
- <sup>7</sup> Carvalho, N., R. G. Perrotta, and E. Isidro. 2002. Age, growth and maturity in the chub mackerel (*Scomber japonicus* Houttuyn, 1782) from the Azores. *Arquipélago Life and Marine Sciences*. 19A: 93-99.
- <sup>8</sup> Houde, E. D., S. A. Berkeley, J. J. Klinovsky, and C.E. Dowd. 1976. Ichthyoplankton survey data report: summary of egg and larvae data used to determine abundance of clupeid fishes in the eastern Gulf of Mexico. University of Miami Sea Grant Technical Bulletin Number 32. Available at: <https://repository.library.noaa.gov/view/noaa/10888>
- Houde, E. D., J. C. Leak, C. E. Dowd, S. A. Berkeley, and W. J. Richards. 1979. Ichthyoplankton abundance and diversity in the eastern Gulf of Mexico - a report to the Bureau of Land Management prepared under contract number AA550-CT7-28. Available at: <https://www.boem.gov/ESPIS/3/4042.pdf>
- Berrien, P. L. 1978. Eggs and larvae of *Scomber scombrus* and *Scomber japonicus* in continental shelf waters between Massachusetts and Florida. *Fishery Bulletin*. 76(1):95-115.
- Richardson, D. E., J. K. Llopiz, C. M. Guignard, and R. K. Cowen. 2010. Larval assemblages of large and medium-sized pelagic species in the Straits of Florida. *Progress in Oceanography*. 86(2010):8-20.
- Southeast Area Monitoring and Assessment Program (SEAMAP) larval survey catches from 1983-2014.

- <sup>9</sup> Daley, T. 2018. Growth and reproduction of Atlantic chub mackerel (*Scomber colias*) in the Northwest Atlantic. Master's thesis. University of Southern Mississippi.
- <sup>10</sup> Castro, J. J. and A. S. Del Pino. 1995. Feeding preferences of *Scomber japonicus* in the Canary Islands area. *Scientia Marina*. 59(3-4):352-333.
- Sever, T. M., B. Bayhan, M. Bilecenoglu, and S. Mavili. 2006. Diet composition of the juvenile chub mackerel (*Scomber japonicus*) in the Aegean Sea (Izmir Bay, Turkey). *Journal of Applied Ichthyology*. 22(2006):145-148.
- <sup>11</sup> Paine, M. A., J. R. McDowell, and J. E. Graves. 2007. Specific identification of western Atlantic Ocean scombrids using mitochondrial DNA cytochrome C oxidase subunit I (COI) gene region sequences. *Bulletin of Marine Science*. 80(2):353-367.
- Personal communication with John Graves, Virginia Institute of Marine Science; Steve Poland, N.C. Division of Marine Fisheries, and Michelle Staudinger, University of Massachusetts Amherst.
- <sup>12</sup> Montevecchi, W. A. and Myers, R. A. 1997. Centurial and decadal oceanographic influences on changes in northern gannet populations and diets in the north-west Atlantic: implications for climate change. *ICES Journal of Marine Science*. 54: 608–614.
- Smith, L. A., J. S. Link, S. X. Cadrin, and D. L. Palka. 2015. Consumption by marine mammals on the Northeast U.S. continental shelf. *Ecological Applications*. 25(5):373-389.
- Staudinger, M.D., K. E. Mills, K. Stamieszkin, N. R. Record, C. A. Hudak, A. Allyn, A. Diamond, K. D. Friedland, W. Golet, Me. E. Henderson, C. M. Hernandez, T. G. Huntington, R. Ji, C. L. Johnson, D. S. Johnson, A. Jordaan, J. Kocik, Y. Li, M. Liebman, O. W. Nichols, D. Pendelton, R. A. Richards, T. Robben, A. C. Thomas, H. J. Walson, and K. Yakola. 2019. It's about time: a synthesis of changing phenology in the Gulf of Maine ecosystem. *Fisheries Oceanography*: 1-34. Available at: <https://doi.org/10.1111/fog.12429>
- Personal communication, Nancy Kohler, NEFSC.
- <sup>13</sup> Unmanaged Forage Omnibus Amendment. Available at: <http://www.mafmc.org/actions/unmanaged-forage>
- <sup>14</sup> Chub mackerel literature review available at: [http://www.mafmc.org/s/12\\_Chub\\_lit\\_review\\_July2018.pdf](http://www.mafmc.org/s/12_Chub_lit_review_July2018.pdf)
- <sup>15</sup> Manooch, C. S., D. L. Mason, and R. S. Nelson. 1984. Food and gastrointestinal parasites of dolphin *Coryphaena hippurus* collected along the southeastern and Gulf Coasts of the United States. *Bulletin of the Japanese Society of Scientific Fisheries*. 50(9):1151-1525.
- <sup>16</sup> Veiga, P., J. C. Xavier, C. A. Assis, and K. Erzini. 2011. Diet of the blue marlin, *Makaira nigricans*, off the south coast of Portugal. *Marine Biology Research*. 7:820-825.
- <sup>17</sup> Abitia-Cardenas, L. A., F. Galvan-Magaña, F. J. Gutierrez-Sanches, J. Rodriguez-Romero, B. Aguilar-Palomino, and A. Moehl-Hitz. 1999. Diet of blue marlin *Makaira mazara* off the coast of Cabo San Lucas, Baja California Sur, Mexico. *Fisheries Research*. 44(1999):95-100.
- <sup>18</sup> Alonso, H, J. P. Granadeiro, V. H. Paiva, A. S. Dias, J. A. Ramos, and P. Catry. 2012. Parent-offspring dietary segregation of Cory's shearwaters breeding in contrasting environments. *Marine Biology*. 159 (2012): 1197-1207.
- Alonso, H, J. P. Granadeiro, M. P. Dias, T. Catry, and P. Catry. 2018. Fine-scale tracking and diet information of a marine predator reveals the origin and contrasting spatial distribution of prey. *Progress in Oceanography*. 162 (2018): 1-12.
- Ambrose, S. T, P. W. Froneman, M. J. Smale, G. Cliff, and S. Plön. 2013. Winter diet shift of long-beaked common dolphins (*Delphinus capensis*) feeding in the sardine run off KwaZulu-Natal, South Africa. *Marine Biology*. 160 (2013): 1543-1561.
- Granaderio, J. P., L. R. Monterio, and R. W. Furness. 1998. Diet and feeding ecology of Cory's shearwater *Calonectris diomedea* in the Azores, north-east Atlantic. *Marine Ecology Progress Series*. 166 (1998): 267-276.

Marçalo, A., L. Nicolau, J. Giménez, M. Ferreira, J. Santos, H. Araújo, A. Silva, J. Vingada, and G. J. Pierce. 2018. Feeding ecology of the common dolphin (*Delphinus delphis*) in western Iberian waters: has the decline in sardine (*Sardina pilchardus*) affected dolphin diet? *Marine Biology*. 165 (2018): 44.

- <sup>19</sup> Report of the July 2018 SSC meeting. Available at: <http://www.mafmc.org/ssc>
- <sup>20</sup> Goode, G. B. 1884. The food fishes of the U.S. part 3: natural history of useful aquatic animals. In: *The Fisheries and Fishery Industries of the United States*. U.S. Government Printing Office. Washington, D.C. Available at: <http://celebrating200years.noaa.gov/rarebooks/fisheries/welcome.html>
- <sup>21</sup> More information on the Chub Mackerel Amendment (Amendment 21 to the MSB FMP) is available at: <https://www.mafmc.org/actions/chub-mackerel-amendment>.
- <sup>22</sup> Unpublished NMFS commercial fish dealer data (i.e., “DERS”), which include both state and federal dealer data).
- <sup>23</sup> Unpublished NEFSC commercial fish dealer data (including both state and federal dealer data) combined with vessel trip report data (i.e., “AA tables”).
- <sup>24</sup> Personal communication from the National Marine Fisheries Service, Fisheries Statistics Division. Accessed August 17, 2020. Available at: <https://www.st.nmfs.noaa.gov/recreational-fisheries/data-and-documentation/queries/index>
- <sup>25</sup> Digital copies of the small scombrid ID guide are available at: <https://www.mafmc.org/actions/chub-mackerel-amendment> (scroll down to “Related Resources”). Waterproof hard copies may be obtained by contacting Council staff at 302-674-2331 or [contact@mafmc.org](mailto:contact@mafmc.org).
- <sup>26</sup> Summary of November 9, 2017 webinar on chub mackerel in HMS diets. Available at: <http://www.mafmc.org/actions/chub-mackerel-amendment>