Forecast for the 2021

Gulf and Atlantic Menhaden Purse-Seine Fisheries and Review of the 2020 Fishing Season

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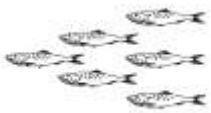
INTRODUCTION

The 2021 fishing year marks the forty-ninth year that the National Marine Fisheries Service has made quantitative forecasts of purse-seine landings of menhaden. The forecasts are based on a multiple regression equation that relates landings and fishing effort over the series of years. Landings forecasts are conditioned on estimates of expected fishing effort for the upcoming fishing year. Fishing effort estimates are vessel-specific and are derived from 1) industry input regarding the number of vessels that companies expect to be active during the upcoming fishing year, and 2) historical performance (catch and effort) of the vessels expected to participate in the fishery. In the Atlantic Menhaden fishery, actual purse-seine landings have differed an average of 13% from those forecasted for the forty year period, 1973-2012 (pre-TAC years; see page 4). Landings in the Gulf Menhaden fishery have differed from those forecasted by an average of 13% for the forty-eight year period, 1973-2020. In this forecast report, we review the 2020 Gulf and Atlantic Menhaden fishing seasons in terms of:

- landings and fleet size
- age composition of the catch
- status of the most recent forecast

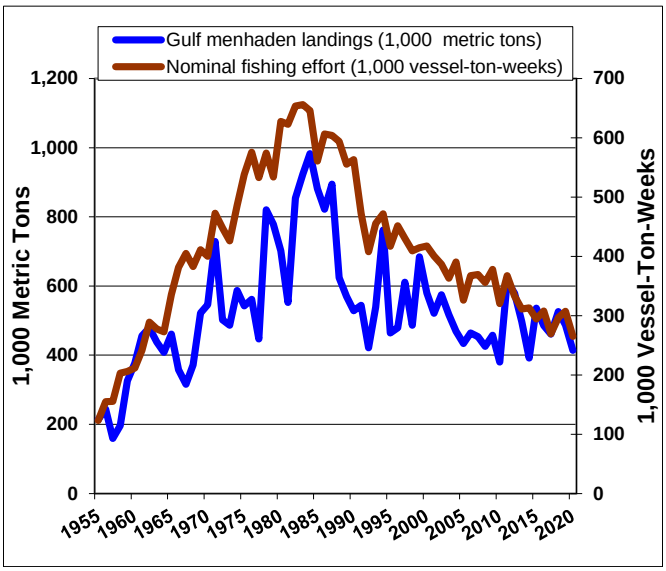
Finally, we will forecast estimated landings for the 2021 menhaden fishing season.



GULF MENHADEN FISHERY

Gulf Menhaden Landings, Fishing Conditions, and Vessel Participation in 2020

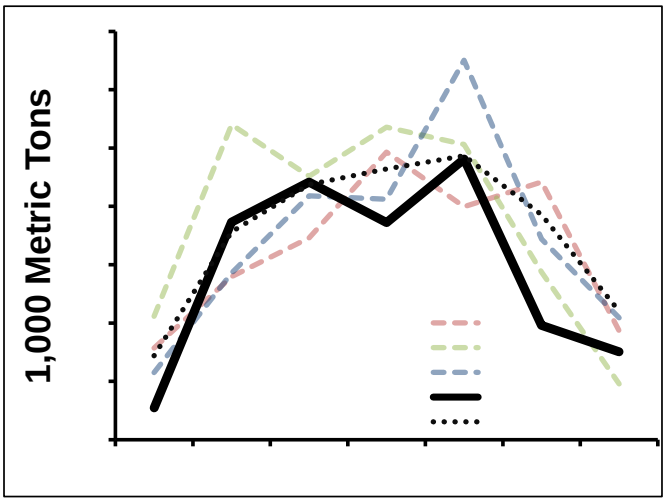
Final purse-seine landings of Gulf Menhaden for reduction in 2020 totaled 413,855 metric tons (mt; 1,361 million standard fish). This is a decrease of 15.0% from total landings in 2019 (486,980 mt), and 17.0% less than the previous 5-year mean (498,974 mt; Figure 1).



Winter 2019-2020 was warmer and wetter than usual along the plains that feed into the Mississippi River with temperatures above average for much of the region and season. Snowpack was close to average throughout January and February in the mountains that feed the Mississippi River Basin.

Throughout much of the southeastern region, temperatures were above average and precipitation higher than average for the winter. These conditions continued into the beginning of the fishing season in April.

The 2020 Gulf Menhaden fishing season opened on April 20th. Landings in April (10,919 mt) were well below both the 2019 landings (23,023 mt) and the 5-year average (28,817 mt). May landings (74,562 mt) increased to be higher than both the 2019 landings (57,179 mt) and slightly above the 5-year average (71,247 mt) for the month.



Tropical Storm Cristobal was the third named storm of the season, following two named pre-season storms. Cristobal departed the Yucatan Peninsula on June 5, heading north through the Gulf of Mexico and reducing fishing activity for the week of June 8. June landings (88,366 mt) were very close to both 2019 landings (83,601 mt) and the 5-year average for the month (87,478 mt).

Landings in July decreased slightly to 74,419 mt, below both 2019 (82,450 mt) and the five-year average (92,837 mt). Hurricane Hanna formed in the middle of the Gulf of Mexico on July 25th, keeping vessels docked while it moved steadily westward until it made landfall near South Padre Island, TX. Also in July the Louisiana Universities Marine Consortium's estimate of the Gulf of Mexico hypoxic zone was estimated to be relatively small this year, measuring 2,116 square miles. Making 2020's estimate of the hypoxic zone the third smallest in the 34 years it has been measured.

In August, Hurricanes Laura and Marco threatened the Gulf. Hurricane Marco progressed north and made landfall at the mouth of the Mississippi River on the 24th before dissipating. Tropical Storm Laura formed on the 20th before strengthening to a hurricane on the 21st. Now-Hurricane Laura then advanced across the Gulf of Mexico before turning north and making landfall in Cameron, LA as the strongest hurricane to make landfall in the state and causing extensive damage along its path. Landings for the month of August (96,213 mt) decreased from the 2019 landings for the same month (130,145 mt), and were similar to the 5-year average (97,384 mt).

Landings for September (39,225 mt) were the lowest since 2008, much lower than 2019 landings for the month (68,795 mt) and almost half of the 5-year average (77,122 mt). Landings in September were affected again by tropical cyclones. On September 10, Hurricane Sally moved into the Gulf of Mexico before making landfall in Alabama on the location and anniversary of Ivan's landfall in that state. After Sally dissipated, it was followed almost immediately by Tropical Storm Beta's formation in the western Gulf of Mexico and subsequent landfall in Texas. Although Tropical Storm Beta was relatively weak in terms of wind speed, it was fairly spread out along the Gulf Coast and impacting areas still recovering from earlier tropical cyclones.

October began with the formation of Hurricane Delta, the fourth hurricane of the season to make landfall in Louisiana, very close to Hurricane Laura's landfall only six weeks earlier. After Hurricane Zeta's presence disrupted fishing one last time for the season, Gulf Menhaden landings for October amounted to 30,152 mt, lower than the 2019 landings for the same time period (41,796 mt), as well as the 5-year average (44,088 mt) for the month. All plants cut out for the fishing season at the end of the month.

Age Composition of Gulf Menhaden in 2020

For the 2020 season, a combination of issues related to the 2018 ageing equipment failure and COVID-related complications have delayed the receipt and processing of Gulf Menhaden samples. The age estimation process with the new equipment has been validated and is in review for publication. A detailed examination of the age structure of the fishery will be conducted when age estimation of the samples submitted is complete later this year. Previous years' data are presented in Table 1 for reference.

Year	Age-0	Age-1	Age-2	Estimated total number of fish caught (billions)	Landings (1,000 metric tons)
2020	*	*	*	*	413.8
2019	<1%	46%	41%	*	487.0
2018	*	*	*	*	525.6
2017	1%	61%	30%	5.49	460.7
2016	<1%	47%	44%	4.95	485.8

Fishing Effort and Review of the 2020 Forecast for Gulf Menhaden

Nominal fishing effort for the Gulf Menhaden fishery during 2020 was estimated at 265,200 vessel ton weeks; this is 13.6% lower than nominal fishing effort in 2019 (307,100 vessel ton weeks).

In March 2020, we anticipated that nominal fishing effort during 2020 could amount to 290,400 vessel ton weeks with 33 vessels participating in the fishery. With this level of anticipated fishing effort, we forecasted 2020 Gulf Menhaden landings of 434,000 mt with 80% confidence levels of 316,000 and 552,000 mt. A "hindcast" using our forecast model and actual nominal fishing effort in 2020 produced a post-season forecast of 399,100 mt with 80% confidence levels of 280,700 and 517,500 mt. Actual landings of 413,855 mt were 4.6% lower than our forecast and 3.7% greater than our post-season estimate.

Forecast for the 2021 Gulf Menhaden Fishing Season

As in 2020, we expect three menhaden factories (Moss Point, MS, and Empire and Abbeville, LA) will process Gulf Menhaden for the season. Our best estimate is for 34 vessels: 29 regular steamers, as many as five run boats, and one bait boat participating. Based on average nominal fishing effort for recent years by the vessels expected to be active in 2021, we estimate that nominal fishing effort in 2021 may be about 294,800 vessel ton weeks; with this level of nominal fishing effort, 2021 Gulf Menhaden forecasted landings are 424,500 mt, with 80% confidence levels of 307,000 and 542,000 mt.

ATLANTIC MENHADEN FISHERY

Atlantic Menhaden Landings, Fishing Conditions, and Vessel Participation in 2020

Final 2020 landings of Atlantic Menhaden for reduction amounted to 124,604 mt (410 million standard fish; Fig. 3). This is 22.4% less than purse-seine landings for the 2012 season (160,627 mt), the last season before implementation of the coastwide total allowable catch (TAC). It is also 22.4% less than average landings for the years 2008-12 (160,524 mt). As has been the case since 2005, only one menhaden factory, the Omega Protein plant at Reedville, VA, operated on the Atlantic coast in 2020.

In December 2012, the Atlantic States Marine Fisheries Commission (ASMFC) approved Amendment 2 to the Fishery Management Plan for Atlantic Menhaden which established a TAC for the reduction and bait fisheries combined of 170,800 mt beginning in 2013. This TAC was subsequently raised to 187,880 mt in 2015, 200,000 mt for 2017, and 216,000 mt in 2018. The menhaden reduction

fishery was allocated about 151,400 mt of the TAC for 2020, prior to the set-aside.

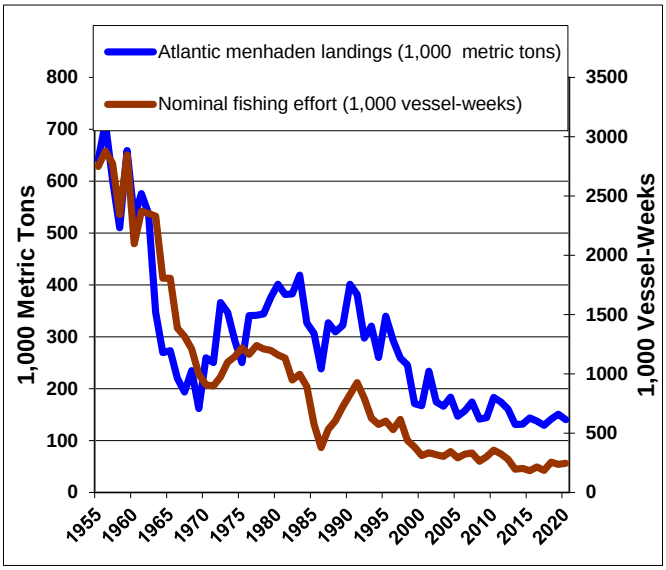
As in many recent years, menhaden were observed to be more abundant than usual in New England waters. Reported landings from New England states did not allow for unused set-aside quota to be reallocated to the reduction fishery in 2020.

The mid-Atlantic region also experienced an unusually active hurricane season. In the early season, Tropical Storm Arthur stayed offshore, but made rough conditions for the third week in May. Atlantic Menhaden landings for reduction during May 2020 were low (5,812 mt, Fig. 4), lower than both 2019 landings (22,367 mt) and the 5-year average (11,561 mt). Landings in June continued to be low, with 16,438 mt landed, lower than the 2019 landings for the same month (34,098 mt). June landings were lower than the 5-year average (30,194 mt) and the lowest for that month since 2013. In July, landings picked up, exceeding the 2019 value (25,057 mt), as well as the 5-year average (28,041 mt) and finishing the month with 29,091 mt landed. July was relatively free of tropical cyclone activity along the Mid-Atlantic States, with the exception of Tropical Storm Fay's passage from the Gulf of Mexico to the Atlantic Ocean on July 9th.

In August, landings declined (24,575 mt) to slightly below the 5-year average for that month (27,121 mt), similar to 2019 landings (24,333 mt). Hurricane Isaias formed at the end of July, disrupting fishing for the first week of August before moving north to Canada.

Hurricane Teddy moved along offshore, but created large ocean swells in mid-September; however, September landings (21,402 mt) were higher than the 5-year average (15,521 mt) and the 2019 landings for the same time period (18,500 mt). Since 2015, September landings have been increasing since a low in 2016. Landings in 2020 of 21,402 mt approached the average amounts landed prior to 2015.

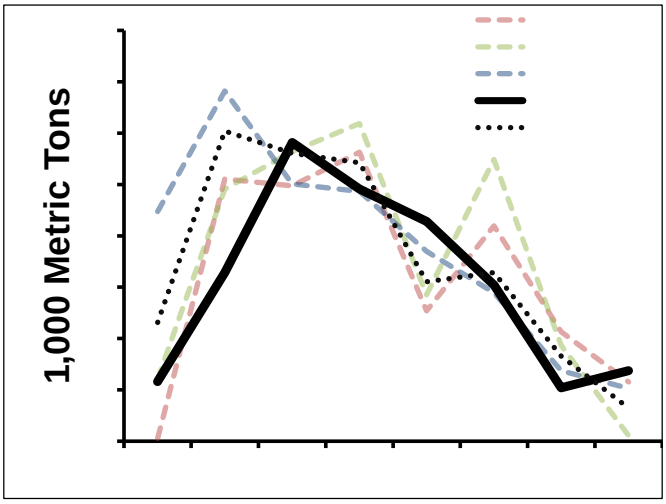
In October there were a number of off-shore tropical cyclones. While these did not directly strike the east coast, their effects were felt as rough seas and higher-than-usual winds. Landings continued to decrease to 15,206 mt, close to the 5-year average for that month (16,428 mt), but higher than the 2019 landings for the same time period (14,459 mt). The fishing season continued below average for the month of November with 5,199 mt of landings, lower than 2019 landings (6,857 mt) and the 5-year average (8,286 mt). December landings (6,881 mt) increased from November to above the five-year average (3,236 mt) and the 2019 landings (5,154 mt) before all reduction vessels cut out on December 11th.



The coastwide TAC for Atlantic Menhaden also included the bait fisheries. Bait allocations by state were allotted based on landings histories during 2009-11, but readjusted beginning with the 2018 season so that the minimum allocation to each state was 0.5% of the total TAC. The abundance of menhaden in northern waters meant that the portion of the quota reserved for such episodic events was not available for reallocation to the reduction fishery.

Maine's episodic event fishery closed July 2nd, allowing incidental take of menhaden up to a 6,000-pound limit. Massachusetts reduced their limit to 25,000 pounds upon reaching 85% of their allocation on June 29 and remained at that level for

the rest of the year. Rhode Island reduced their trip limit to 120,000 pounds on June 25th before closing the fishery on July 7th. New York and New Jersey's menhaden fisheries remained open all year.



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Fishing Effort in 2020 Atlantic Menhaden Season

Nominal fishing effort in 2020 was estimated at 245 vessel weeks, an increase of 4% over the 235 vessel weeks expended in 2019.

Year	Age-0	Age-1	Age-2	Age-3+
2020*	*	*	*	*
2019*	0%	58%	34%	7%
2018*	*	*	*	*
2017	0%	81%	17%	2%
2016	0%	26%	50%	24%

Forecast for the 2021 Atlantic Menhaden Fishing Season

Amendment 2 to the Fishery Management Plan for Atlantic Menhaden specified an annual coastwide TAC of about 129,900 mt for the purse-seine reduction fishery. This TAC was to be revisited every three years and was raised to 142,894 mt in 2015, 152,112 mt in 2017, and 151,400 in 2018. In Fall, 2020, the Atlantic Menhaden Management Board elected to reduce the Coastwide TAC to 194,400 mt, This action will result in approximately 137,635 mt available for reduction before the 1% set-aside. Landings are anticipated to be close to the TAC.

Combined 2020 Gulf and Atlantic Menhaden Landings

Combined landings by the Gulf and Atlantic Menhaden purse-seine fisheries for reduction during 2020 year amounted to 538,459 mt, or 1,772 million standard fish, or 1.19 billion pounds, a decrease of 15.6% from 2019 landings which amounted to 1.41 billion pounds.

1955	122.9	213.3	***1988***	594.1	623.7
1956	155.1	244.0	***1989***	555.3	569.6
1957	155.2	159.3	***1990***	563.1	528.3
1958	202.8	196.2	***1991***	472.3	544.3
1959	205.8	325.9	***1992***	408.0	421.4
1960	211.7	376.8	***1993***	455.2	539.2
1961	241.6	455.9	***1994***	472.0	761.6
1962	289.0	479.0	***1995***	417.0	463.9
1963	277.3	437.5	***1996***	451.7	479.4
1964	272.9	407.8	***1997***	430.2	611.2
1965	335.6	461.2	***1998***	409.3	486.2
1966	381.3	357.6	***1999***	414.5	684.3
1967	404.7	316.1	***2000***	417.6	579.3
1968	382.8	371.9	***2001***	400.6	521.3
1969	411.0	521.5	***2002***	386.7	574.5
1970	400.0	545.9	***2003***	363.2	517.1
1971	472.9	728.5	***2004***	390.5	468.7
1972	447.5	501.9	***2005***	326.0	433.8
1973	426.2	486.4	***2006***	367.2	464.4
1974	485.5	587.4	***2007***	369.2	453.8
1975	538.0	542.6	***2008***	355.8	425.4
1976	575.8	561.2	***2009***	377.8	457.5
1977	532.7	447.1	***2010***	320.3	379.7
1978	574.3	820.0	***2011***	367.2	613.3
1979	533.9	777.9	***2012***	332.7	578.4
1980	627.6	701.3	***2013***	332.5	497.5
1981	623.0	552.6	***2014***	312.9	391.9
1982	653.8	853.9	***2015***	294.2	535.7
	655.8	923.5	***2016***	307.7	484.8
1984	645.9	982.8	***2017***	301.3	460.7
1985	560.6	881.1	***2018***	296.7	525.6
1986	606.5	822.1	***2019***	307.1	487.0
1987	604.2	894.2	***2020***	265.1	413.8

1955	2748	641.4	***1988***	604	309.3
1956	2878	712.1	***1989***	725	322.0
1957	2775	602.8	***1990***	826	401.2
1958	2343	510.0	***1991***	926	381.4
1959	2847	659.1	***1992***	794	297.6
1960	2097	529.8	***1993***	626	320.6
1961	2371	575.9	***1994***	573	260.0
1962	2351	537.7	***1995***	600	339.9
1963	2331	346.9	***1996***	528	292.9
1964	1807	269.2	***1997***	616	259.1
1965	1805	273.4	***1998***	437	245.9
1966	1386	219.6	***1999***	382	171.2
1967	1316	193.5	***2000***	311	167.2
1968	1209	234.8	***2001***	334	233.7
1969	995	161.6	***2002***	318	174.0
1970	906	259.4	***2003***	302	166.1
1971	897	250.3	***2004***	345	183.4
1972	973	365.9	***2005***	291	146.9
1973	1099	346.9	***2006***	322	157.4
1974	1145	292.2	***2007***	333	174.5
1975	1218	250.2	***2008***	262	141.1
1976	1163	340.5	***2009***	300	143.8
1977	1239	341.1	***2010***	356	183.1
1978	1210	344.1	***2011***	324	174.0
1979	1198	375.7	***2012***	279	160.6
1980	1158	401.5	***2013***	196	131.0
1981	1133	381.3	***2014***	201	131.1
1982	948	382.4	***2015***	182	143.5
1983	995	418.6	***2016***	213	137.4
1984	892	326.3	***2017***	185	128.9
1985	577	306.7	***2018***	256	141.3
1986	377	238.0	***2019***	235	150.8
1987	531	327.0	***2020***	245	140.4