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BLUEFIN TUNA CONCENTRATION FOUND DURING A LONG-LINE EXPLORATION OF THE NORTHWESTERN ATLANTIC SLOPE^{1/}

By Frank J. Mather III* and Martin R. Bartlett*

ABSTRACT

Fourteen exploratory long-line sets (totaling 5,220 hooks) were made in November 1960 in or near the slope water between Cape Hatteras, North Carolina, and the Nova Scotia Banks. This area had not previously been explored for large pelagic fish in that season. Tunas caught included 355 bluefin tuna (*Thunnus thynnus*) and 33 of other species (23 albacore, *T. alalunga*, 3 yellowfin tuna, *T. albacares*, 1 blackfin tuna, *T. atlanticus*, and 6 big-eyed tuna, *T. obesus*). Other fish taken were 2 swordfish (*Xiphias gladius*), 1 opah (*Lampris regius*), 34 lancetfish (*Alepisaurus ferox* and *A. brevirostris*), and 133 sharks (44 blue shark *Prionace glauca*, 2 mako *Isurus oxyrinchus*, 75 porbeagle *Lamna nasus*, 8 silky shark, *Carcharhinus floridanus* (or sickle shark, *C. falciformis*), and 4 hammerhead shark *Sphyrna* sp. or spp.). Most of the bluefin tuna were taken at 4 localities along the 1,000-fathom curve from Hudson Canyon (39°16' N., 71°53' W.) to Lydonia Canyon (40°03' N., 67°37' W.). The catch rates of from 9 to 58 tuna per 100 hooks at those stations indicated an exceptionally dense concentration, while no more than 2 tuna were taken per 100 hooks at any of the other stations. Bathythermograms, surface salinities, and other environmental data were taken at each station.

INTRODUCTION

The objective of cruise 56 of R/V Crawford in November 1960, was to determine, by long-line fishing, the distribution of tuna and other large fish in the waters between the 100-fathom curve and the Gulf Stream, from Cape Hatteras to the Nova Scotia Banks. This information was needed for a continuing study of the biology of the larger pelagic fish of the western North Atlantic in general, and of the bluefin tuna (*Thunnus thynnus*) in particular. The trip also provided a continuation of the long-line exploration of that area by the M/V Delaware of the U. S. Bureau of Commercial Fisheries (Squire, in press).

The Delaware surveys have covered much of the northwestern Atlantic, usually including all or most of the above area and often extending much farther to the south and east, in mid-winter (Cruise 59-1, Anonymous 1959a), during the late winter, spring, and early summer (cruises 57-3, 57-5, 58-2, 59-6, and 60-6, Anonymous 1957a, 1957b, 1958b, 1959b, and 1960b), and also during the summer and early fall (cruises 57-8, 58-3, Anonymous 1958a and 1958c). No observations were



Fig. 1 - R/V Crawford at sea. The 125-foot former Coast Guard cutter (which made 8 transatlantic hydrographic sections during the International Geophysical Year and has been used mainly for hydrographic and productivity studies) by late 1961 had completed 2 major exploratory fishing cruises in the western North Atlantic.

* Woods Hole Oceanographic Institution, Woods Hole, Mass.

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made, however, between mid-October and mid-January. Those explorations showed that, from January well into June, bluefin tuna were present in the region mainly north of $36^{\circ}30' N$, and east of $70^{\circ} W$. Most of those taken were of medium size, weighing from 60 to 275 pounds, except in June, when several very large individuals were caught. During the summer and early fall, however, bluefin tuna catches were limited to a very few fish taken near the 1,000-fathom curve. This suggests strongly that in June and early July nearly all of them move on to the continental shelf between Cape Hatteras and Newfoundland, where they are found in numbers from mid-June to mid-October (Murray 1952, 1953, 1954, Squire 1959). The Delaware surveys showed, moreover, that yellowfin tuna (*T. albacares*) were present in the warmer waters of the area through much of the year, moving into the slope water as it warms up in the summer and out of it as it cools in the fall, and that the albacore (*T. alalunga*) and the big-eyed tuna (*T. obesus*) occurred in small numbers over much of the area through most of the year.

A similar program of exploratory long-line fishing by the M/V Oregon of the U. S. Bureau of Commercial Fisheries covered much of the Gulf of Mexico throughout the year (Bullis and Captiva 1955, Wathne 1959, and Anonymous 1960a). Those surveys and some commercial fishing (Harvey R. Bullis, Jr., personal communication) revealed the presence of giant bluefin tuna in the Gulf of Mexico from January into June, and in the northwestern Caribbean

(Bullis and Mather 1956) in April, but none were taken during the summer or fall. Likewise, extensive investigations of the inshore sport and commercial fisheries have produced very few positive records of the species for November or December.



Fig. 2 - Setting long-line fishing gear from R/V Crawford. The men handle the main and branch lines, tie the tubs of line together, attach the floats and float lines, and bait the hooks. A typical setting and recovery of a seven-mile line of 500 hooks commences at dawn and takes approximately ten hours.

Crawford Cruise 56 was designed to fill the seasonal gap in the Delaware program, and especially to determine the whereabouts of the bluefin tuna in November and to learn as much as possible about its migratory routes from its summer grounds on the continental shelf to its extensive wintering areas. Secondary objectives were to mark as many tunas as possible as part of a continuing gamefish tagging program (Mather 1960), and to obtain material for general biological studies, including meristics and morphometrics, length frequencies, seasonal variations of body proportions and gonad condition, and stomach contents.

In addition, we intended to gather as much environmental data as possible. The original plan called for a set of stations along the 1,000-fathom curve, another set just north of or in the Gulf Stream, and a third between the two.

METHODS AND EQUIPMENT

Fishing was conducted with standard 10-hook basket nylon long-line gear (Bullis and Captiva 1955) loaned to us, along with a hauler and other equipment, by the U. S. Bureau of Commercial Fisheries, Gloucester, Mass. Atlantic herring (*Clupea harengus harengus*), most of which was also furnished by the U. S. Bureau of Commercial Fisheries, was used almost exclusively for bait. Thirty to 50 baskets were usually set at each station, although at 2 only 20 and 17 baskets, respectively, were fished. Most of the float lines were from 10 to 18 fathoms long, allowing the hooks to fish from about 15 to 60 fathoms below the surface. On several sets, a few 30-fathom float lines were used, and they were attached at alternate rather than consecutive connections between baskets, permitting some hooks to fish at depths

perhaps exceeding 100 fathoms. The bait from each day's fishing was usually saved and used to chum the line on the following day. Plankton was gathered at the level of the shallower hooks by fastening a 1-meter No. 2 mesh ring net to the windward end of the line, suspended by a 15-fathom float line. This arrangement, which was first used by Francis Captiva of the U. S. Bureau of Commercial fisheries aboard the *Oregon*, not only collects plankton in an undamaged condition but also keeps the windward end of the line straight. Long-line fishing was supplemented by trolling feather and nylon lures on heavy hand lines during the daylight hours as circumstances permitted. In addition to the usual meteorological observations, bathythermograms and salinity samples were taken at least once at each end of the line, the water transparency was measured with a Secchi disk, and subsurface scattering layers were investigated with a precision graphical recorder.

OPERATIONS

Fourteen long-line sets (totaling 5,220 hooks) made between Cape Hatteras and the Nova Scotia Banks (fig. 3) produced 382 tuna and about 165 other fish (table 1). Over 200 of the tuna, mostly bluefin, were marked with dart tags (Mather 1960). The very heavy catches of bluefin tuna at stations 1 and 6 and the very poor results further south at stations 2-5, and

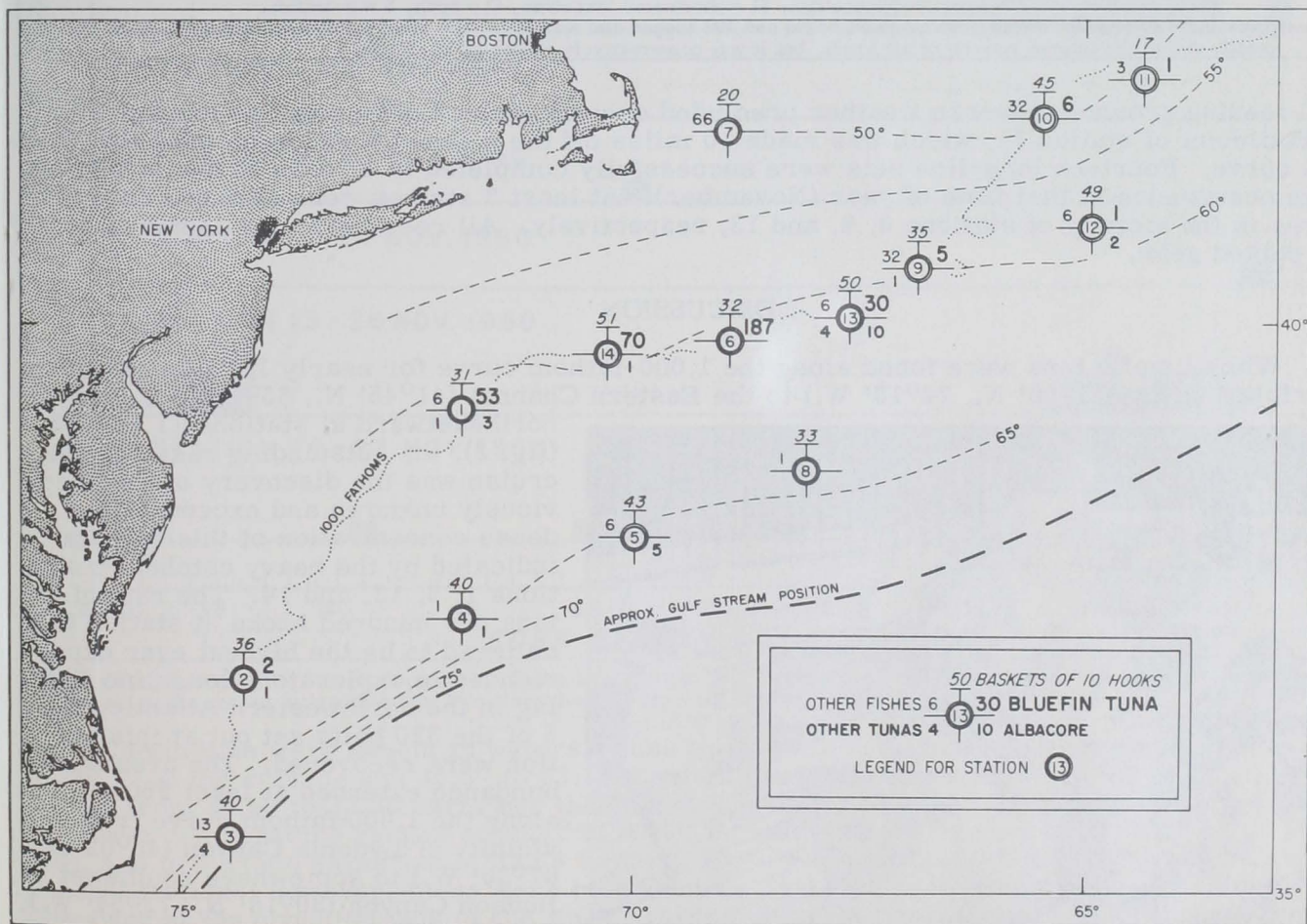


Fig. 3 - Locations of long-line stations occupied during R/V *Crawford* cruise 56, with the number of 10-hook baskets set and the catches of bluefin tuna, albacore, other tuna, and fish of other species for each. Isotherms (°F.) are based on the means of observation at stations only. More detailed environmental and other data are available at the Woods Hole Oceanographic Institution.

later, at station 8, led to a revision of the original plan. Some of the proposed offshore stations were omitted to permit a more extensive search along the 1,000-fathom curve, and also making a set in the northern end of Great South Channel (station 7) to determine whether the bluefin tuna had actually left this well known (Murray 1952, 1953, 1954) summer and early

Table 1 - Station Data and Catches for R/V Crawford Cruise 56, November 1960
(Temperatures, salinities and depths are mean values for each station. All fish brought alongside and identified are listed.)

Sta. No.	Date Nov.	Lat.	Long.	No. of Hooks	Bluefin Tuna	Other Tuna	Misc. Fish	Sharks	Temp.		Surf. Sal. ‰	Depth in Fathoms
									Surf.	180 Feet		
1	12	39°16'	71°53'	310	53	3A 1BE	2LL	2B 2H	62.0	60.6	34.55	1,000
2	13	36°56'	74°18'	360	2	1A			63.9	63.3	34.99	1,000
3	14	35°31'	74°27'	400		3YF 1BK		4B 8S 1H	75.1	74.4	36.22	1,200
4	15	37°28'	71°53'	400		1A	1SL		63.1	62.9	34.91	1,700
5	16	38°11'	69°59'	430		5A	3LL	2M 1H	66.0	64.6	35.28	1,940
6	17	39°52'	68°56'	320	@187				62.3	63.2	34.09	900
7	18	41°37'	68°58'	200				1B@65 P	50.7	49.2	34.35	80
8	21	38°45'	68°05'	330				1B	61.7	63.4	34.59	2,030
9	22	40°28'	66°51'	350	5	1BE	1LL	31B	58.7	59.7	34.31	1,000
10	23	41°43'	65°28'	450	6		IS 20LL	1B 10 P	49.1	45.5	32.40	1,000
11	24	42°03'	64°21'	170	1		2LL	1B	51.2	51.6	32.09	1,225
12	25	40°49'	64°57'	490	1	2A	3LL ISL	2B	57.7	61.6	34.26	2,095
13	26	40°03'	67°37'	500	30	10A 4BE	IS ILL 10	3B	62.0	62.4	35.03	1,200
14	27	39°45'	70°17'	510	70	1A			56.1	62.7	33.65	850
Totals				5,220	@355	23A 6BE 3YF 1BK	32LL 2SL 2S 10	44B 2M @75 P 8S 4H				

Abbreviations: Tuna - A = albacore, BE = big-eyed, BK = blackfin, YF = yellowfin.

Sharks - B = blue, H = hammerhead, M = mako, P = porbeagle, S = silky or sickle.

Misc. Fishes - LL = longnosed lancetfish, SL = shortnosed lancetfish, O = opah, S = swordfish.

@ - Approximate count. Sixty fish were taken on board and 102 tagged and released. The number lost alongside could not be counted exactly due to the intense activity of all hands, but it was conservatively estimated at 25 fish.

fall feeding ground. Adverse weather precluded operations on 2 days and also caused drastic curtailment of station 11, which was made 15 miles off the planned position on the 1,000-fathom curve. Fourteen long-line sets were successfully completed in 17 days at sea, a fortunate occurrence at that time of year (November). At least 3 strikes were obtained on trolled lures in the vicinity of stations 6, 9, and 13, respectively. All resulted in straightened hooks or parted gear.

DISCUSSION

While bluefin tuna were found along the 1,000-fathom curve for nearly 1,000 miles, from Norfolk Canyon (31°56' N., 74°18' W.) to the Eastern Channel (41°45' N., 65°25' W.), and



Fig. 4 - Hauling long-line gear on board R/V Crawford. The men at the rail tend the brake of the hauler and bring the branch lines through the roller removing baits and boating or tagging fish with the assistance of the men who haul and coil the float lines (right). The man at the hauler arranges the branch lines and hooks in the tub as the main line is coiled automatically, while his helper disconnects the lines, brings empty tubs, and removes the full ones.

northeastward at stations 11 and 12 (fig. 3), the outstanding result of the cruise was the discovery of the previously unknown and exceptionally dense concentration of this species indicated by the heavy catches at stations 1, 6, 13, and 14. The rate of 58 tuna per hundred hooks at station 6 is believed to be the highest ever experienced in exploratory long-line fishing in the northwestern Atlantic. Only 5 of the 320 baits set out at this station were recovered. The area of abundance extended at least 250 miles along the 1,000-fathom curve from the vicinity of Lydonia Canyon (40°02' N., 67°36' W.) to somewhere southwest of Hudson Canyon (39°16' N., 71°54' W.). The southwestern limit was poorly defined, as the next station in that direction was 180 miles away. The row of stations (3, 4, 5, and 8) further south yielded no bluefin, nor did station 7, inside of the 1,000-fathom curve. The northeastern limit of the thickly-popu-

lated area, as indicated by long-line catches, was fairly well established by the poor results at station 9, only 43 miles from Lydonia Canyon. The eastward extent of the species was not determined as some bluefin were taken at each of the 4 easternmost stations, 9-12. The duration of the concentration can only be estimated from the failure of the Delaware to catch bluefin in that general area in September and early October, and again in January and February.

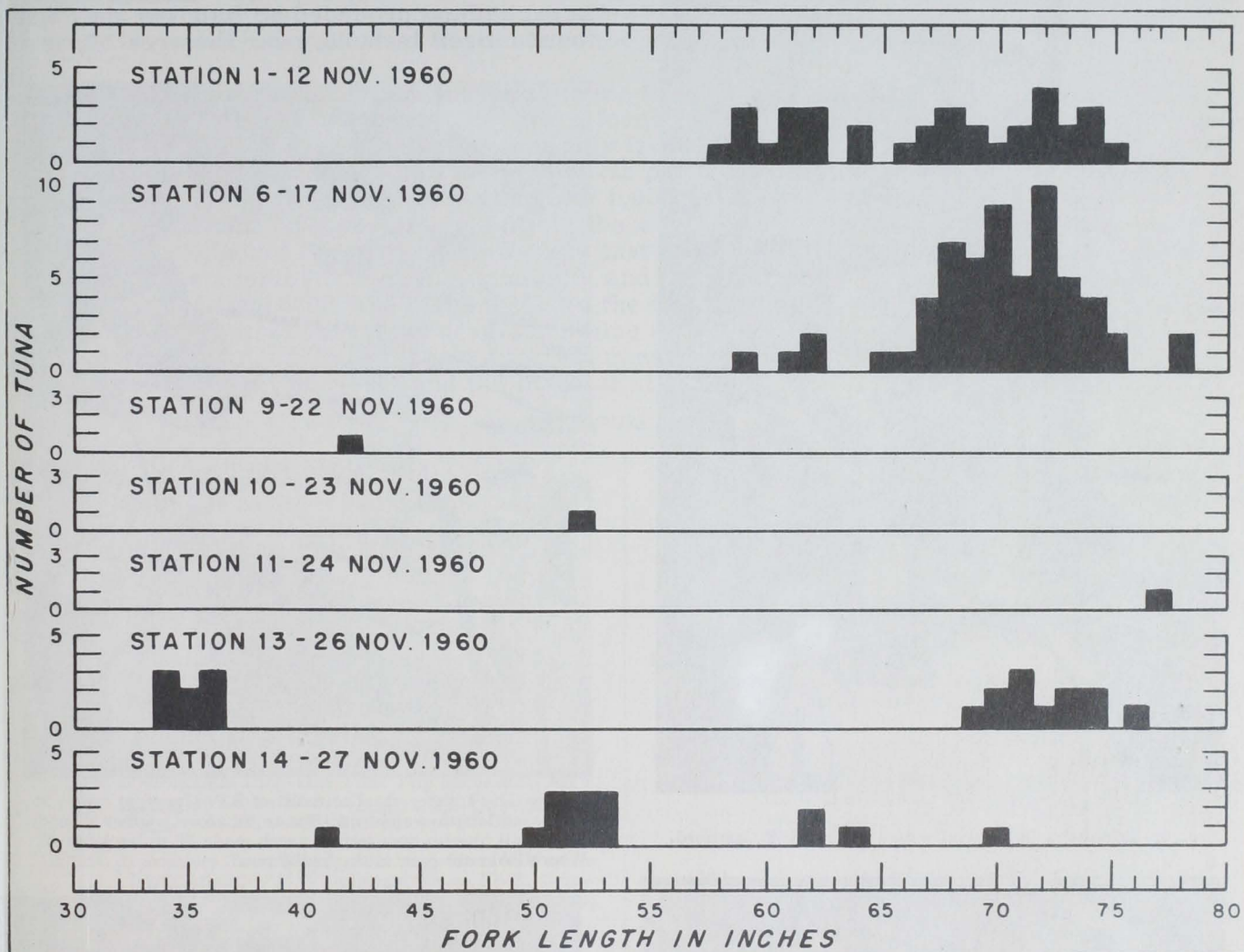


Fig. 5 - Length frequencies by 1-inch groups of bluefin tuna brought aboard R/V Crawford during cruise 56, by stations. Lengths were measured to the nearest inch with a tape laid along the body from tip of upper jaw to fork of tail.

Bluefin tuna were caught in waters whose average temperatures ranged from 49.1° to 63.9° F. at the surface and 45.5° to 63.4° F. at 180 feet. The average surface salinities varied from 32.90 to 35.30 parts per thousand. The larger catches, however, occurred in narrower temperature ranges of 56.1° to 62.3° F. at the surface and 60.6 to 63.2° F. at 180 feet, and in surface salinities of 33.65 to 35.30 parts per thousand. At two of the most successful stations, however, there were considerable differences between the temperatures observed at the opposite ends of the lines, and the bathythermograph slides also showed very complicated temperature structures. Furthermore, all 4 heavy catches were made at the entrances of canyons. It is possible that greater mixing of deep and surface waters occurs in those places, furnishing richer feeding grounds.

The dense schooling of this species may have been in preparation for migration to the offshore wintering grounds located during Delaware Cruise 59-1. The size composition of the bluefin tuna boated at the respective stations (fig. 5) suggests that the population was

changing. Those taken at stations 1 and 6 (12 and 17 November) were all over 57 inches long, but at stations 13 and 14 (November 26 and 27) in the same general area, many smaller ones were caught. A heavy concentration of this species was observed at about $38^{\circ}30'$ N. and $68^{\circ}30'$ W. in late May 1959 during Delaware cruise 59-6 (Anonymous 1959b). Fishing in the same area by the trawler Golden Eagle in early June produced no fish, but they were found closer inshore, near the area of the



Fig. 6 - Bringing a large bluefin tuna aboard R/V Crawford.



Fig. 7 - Part of a catch of medium bluefin tuna from the concentration discovered by R/V Crawford along the 1,000 fathom-curve off southern New England.



Fig. 8 - The author, chief scientist of R/V Crawford cruise 56, obtaining length-weight data for an albacore. Other albacore and small bluefin tuna from a catch made 80 miles south of Woods Hole are seen in the background.

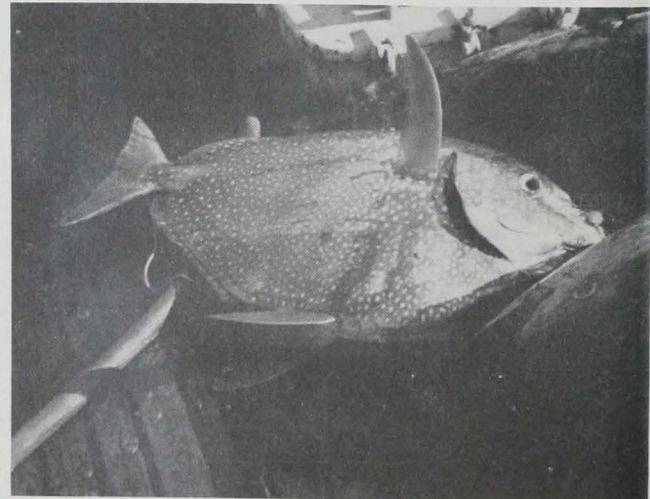


Fig. 9 - An opah or moonfish, a little known oceanic species taken during cruise 56 of the R/V Crawford.

Crawford catches (J. L. Squire, Jr., personal communication). Many of the bluefin tuna caught on the Delaware were tagged and one was recaptured off Provincetown, Mass., in August 1959 (Mather 1960). Those observations suggest that the medium bluefin tuna tend to concentrate in waters, just north of the Gulf Stream in the spring preparatory to moving inshore to their summering grounds, and again along the 1,000-fathom curve in the fall preparatory to moving offshore to their wintering grounds. The trolling strikes and surface sightings indicate that those tuna sometimes feed on the surface along the 1,000-fathom curve during November as well as at the depth of the long-line hooks.

Albacore were extensively but much more thinly distributed (fig. 3), the catch rate never exceeding 2 fish per 100 hooks. They were found in waters whose mean temperatures varied from 56.1° to 66.0° F. at the surface but only from 60.6° to 64.6° F. at 180 feet, and where surface salinities averaged 33.65 to 35.28 parts per thousand. Big-eyed tuna were even less abundant, being found occasionally along the 1,000-fathom line in waters of about 60° F. Yellowfin and blackfin tuna were found only in the warm Gulf Stream water, and the failure to catch any istiophorid fish suggests strongly that they had also left the slope water, where they have been taken during the spring, summer, and early fall, due to its lower temperature. The catches of swordfish are of interest, in the absence of any quantity of data for November, as are the concentrations of porbeagle and blue sharks encountered, and the unusual number of lancetfish taken. Although sharks were numerous at some stations, only 2 of the tuna taken were mutilated, 1 at station 1 and the other at station 14.

LITERATURE CITED

- BULLIS, HARVEY R., Jr., and CAPTIVA, F. J.
1955. Preliminary Report on Exploratory Long-Line Fishing for Tuna in the Gulf of Mexico and the Caribbean Sea. Commercial Fisheries Review, vol. 17, no. 10 (October), pp. 1-20. (Also Separate No. 416.)
- _____, and MATHER, F. J., III.
1956. Tunas of the Genus Thunnus of the Northern Caribbean. American Museum Novitates, no. 1765, pp. 1-12.
- COMMERCIAL FISHERIES, U. S. BUREAU OF
1957a. Excellent Catch of Tuna Made South of Nantucket, M/V Delaware Cruise 57-3. Commercial Fisheries Review, vol. 19, no. 5 (May), pp. 28-29.
- 1957b. Experimental Long-Line Tuna Trip Successful, M/V Delaware Cruise 57-5. Commercial Fisheries Review, vol. 19, no. 8 (August), pp. 27-29.
- 1958a. Exploratory Tuna Fishing with Long-Lines in Western North Atlantic, M/V Delaware Cruise 57-8. Commercial Fisheries Review, vol. 20, no. 1 (January), pp. 38-39.
- 1958b. Tuna Fishing Explorations in Western North Atlantic Continued, M/V Delaware Cruise 58-2. Commercial Fisheries Review, vol. 20, no. 7 (July), pp. 35-36.
- 1958c. Tuna Fishing Explorations Continued in Western North Atlantic, M/V Delaware Cruises 58-3 and 58-4. Commercial Fisheries Review, vol. 20, no. 9 (September), pp. 47-48.
- 1959a. Commercial Stocks of Tuna Found in Western North Atlantic, M/V Delaware Cruise 59-1. Commercial Fisheries Review, vol. 21, no. 4 (April), pp. 46-47.
- 1959b. Good Catches of Tuna Taken on Edge of Gulf Stream South-by-East of Nantucket, M/V Delaware Cruise 59-6. Commercial Fisheries Review, vol. 21, no. 7 (July), pp. 40-41.
- 1960a. Tuna Distribution in South-Eastern Caribbean Sea and Occurrence of Royal-Red Shrimp off Trinidad Explored, M/V Oregon Cruise 66. Commercial Fisheries Review, vol. 22, no. 7 (July), pp. 30-31.
- 1960b. Area Between Georges Bank and Cape Hatteras Explored for Tuna Stocks, M/V Delaware Cruise 60-6. Commercial Fisheries Review, vol. 22, no. 7 (July), pp. 34-35.
- MATHER, FRANK J., III.
1960. Recaptures of Tuna, Marlin and Sailfish Tagged in the Western North Atlantic. Copeia, no. 2, pp. 149-151.
- MURRAY, J. J.
1952. Report on 1951 Exploratory Bluefin-Tuna Fishing in the Gulf of Maine. Commercial Fisheries Review, vol. 14, no. 3 (March), pp. 1-19. (Also Separate No. 309.)
1953. Gulf of Maine Bluefin Tuna Explorations - 1952. Commercial Fisheries Review, vol. 15, no. 7 (July), pp. 1-17. (Also Separate No. 353.)
1954. Gulf of Maine Bluefin Tuna Explorations - 1953. Commercial Fisheries Review, vol. 16, no. 7 (July), pp. 10-19. (Also Separate No. 374.)
- SQUIRE, JAMES L., Jr.
1959. New England Commercial Bluefin Tuna Purse Seining - 1958 Season. Commercial Fisheries Review, vol. 21, no. 2 (February), pp. 1-5. (Also Separate No. 538.)
- In Oceanic Tuna Distribution in the Northwest Atlantic. press. Fisheries Bulletin.
- WATHNE, FREDERICK.
1959. Summary Report of Exploratory Long-Line Fishing for Tuna in Gulf of Mexico and Caribbean Sea, 1954-1957. Commercial Fisheries Review, vol. 21, no. 4 (April), pp. 1-26. (Also Separate No. 545.)

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