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REPORT ON 1951 EXPLORATORY BLUEFIN-TUNA FISHING IN THE GULF OF MAINE

By John J. Murray*

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PART I - COMMERCIAL ASPECTS OF THE NEW ENGLAND BLUEFIN-TUNA FISHERY

INTRODUCTION

The initial phase of the bluefin-tuna exploratory fishing operation was conducted in the Gulf of Maine during the summer and early fall of 1951 by the Exploratory Fishing and Gear Development Section, Branch of Commercial Fisheries, U. S. Fish and Wildlife Service. Additional explorations will follow the initial work reported herein.

Development of a Gulf of Maine commercial tuna fishery has long appeared as a definite possibility. It is known that bluefin tuna (Thunnus thynnus) are present in New England waters during certain seasons of the year, appearing annually in schools which have been observed between June and October over areas ranging from the waters southeast of Cape Cod to the shores of Nova Scotia in the north. Knowledge of the movements, abundance, and availability of these fish for commercial fishing operations is lacking.

Early in 1950, interest in the possibility of establishing a tuna-processing industry utilizing Maine sardine-canning plants during periods of normal off-season shutdowns led to an appropriation by Congress for the investigation of the commercial potentialities of bluefin tuna in the Gulf of Maine. Successful establishment of such a fishery would substantially contribute to year-round employment in the sardine industry now operating on a seasonal basis.

FIG. 1 - WESTERN EXPLORER LEAVING PORT FOR FISHING GROUNDS, AUGUST 1951.

* FISHERY METHODS AND EQUIPMENT SPECIALIST, EXPLORATORY FISHING AND GEAR DEVELOPMENT SECTION, BRANCH OF COMMERCIAL FISHERIES, U. S. FISH AND WILDLIFE SERVICE, COLLEGE PARK, MARYLAND.

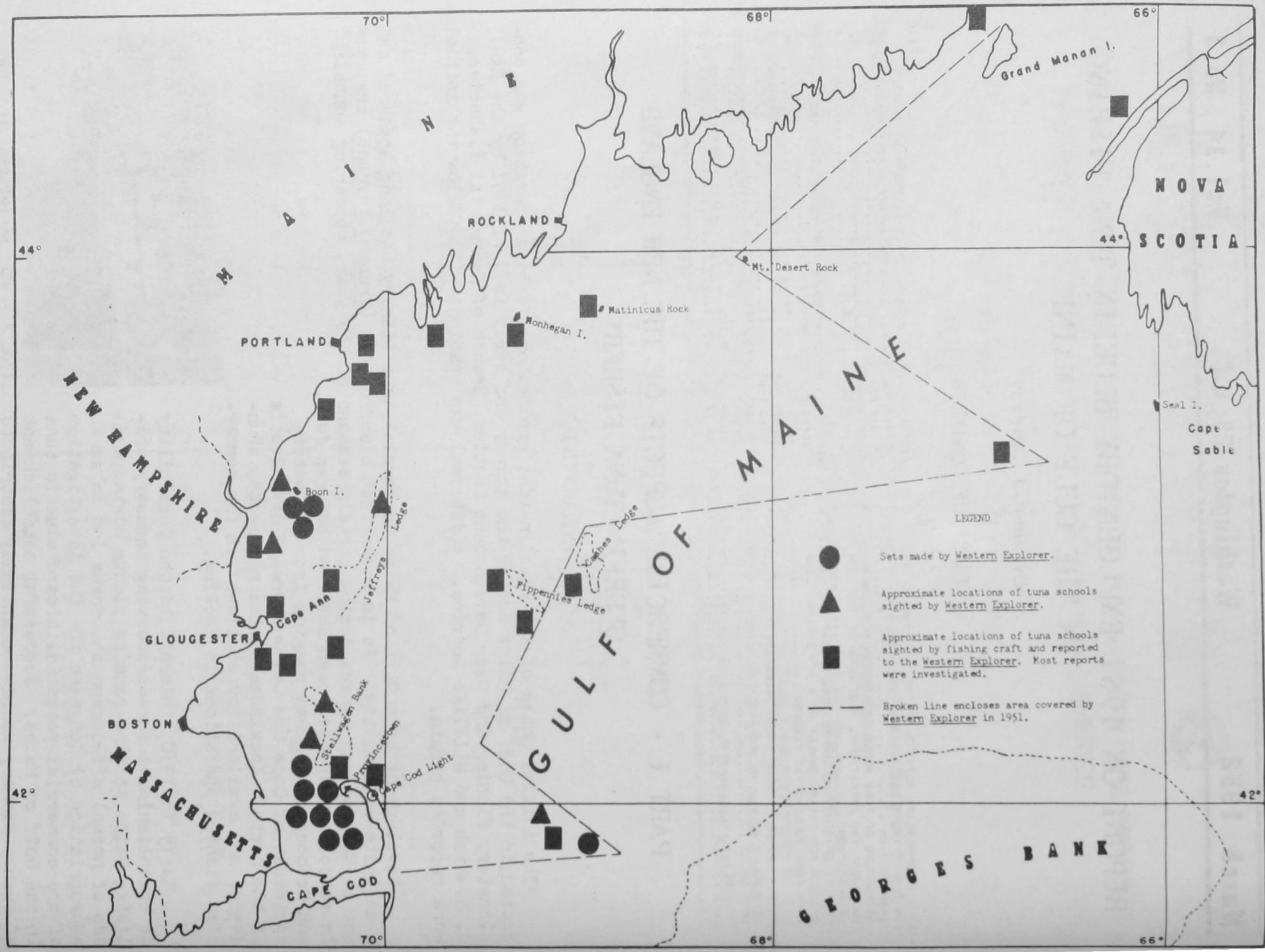

FIG. 3 - AREA OF BLUEFIN-TUNA EXPLORATORY FISHING OPERATION, SHOWING LOCATION OF SETS [illegible]

The principal objectives of the program are:

1. TO DETERMINE THE LOCATION, EXTENT, AND RANGE OF BLUEFIN-TUNA CONCENTRATIONS IN NEW ENGLAND COASTAL WATERS DURING THE SUMMER AND FALL SEASONS.
2. TO DETERMINE WHETHER THE BLUEFIN TUNA ARE CONSISTENTLY AVAILABLE IN SUFFICIENT QUANTITIES TO WARRANT EXPANDED COMMERCIAL FISHING OPERATIONS.
3. TO TEST VARIOUS FISHING METHODS AND EQUIPMENT AND TO DETERMINE THE MOST EFFICIENT METHODS FOR CAPTURING TUNA IN COMMERCIAL QUANTITIES.

In view of the proven effectiveness of purse seining in the capture of pelagic fish, especially successful in the Pacific Coast tuna fishery, this method was selected for use during the 1951 season. The M/V Western Explorer, which had engaged in some seining operations for bluefin tuna from the port of Gloucester, Mass., during 1938, was chartered for a four-month period.

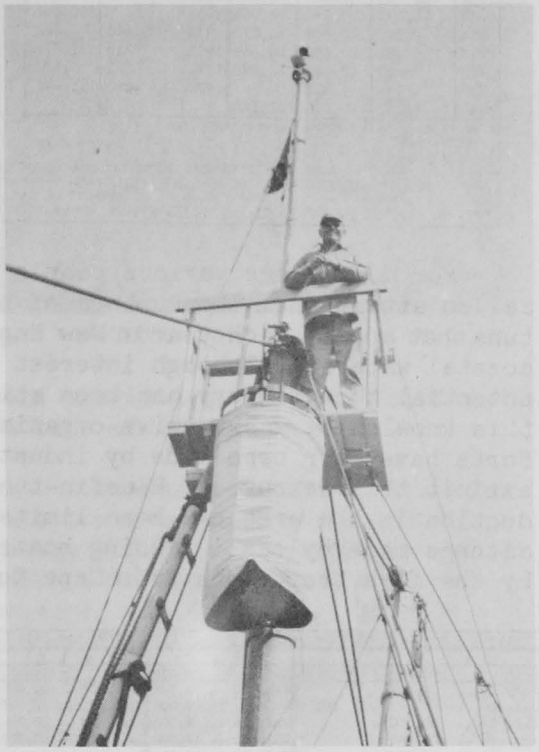

FIG. 3 - MASTHEAD MAN ON LOOKOUT FOR TUNA SCHOOLS.

A tuna purse seine measuring 330 fathoms in length and 33 fathoms in depth was shipped from California, and an experienced tuna-seining captain, Sam Braco, and three fishermen were hired for the operation. Additional experienced mackerel-seine fishermen were recruited in Massachusetts to complete a full crew of ten men.

The initial trip started on June 23 and operations were completed on October 3. During that period, eight trips were completed and 180,000 pounds of bluefin tuna were seined. The smallest catch was seined in the vicinity of Boon Island, Maine, on August 24 and comprised 41 large tuna with an average weight of 230 pounds each. The largest catch was made on September 17 in the waters approximately 60 miles southeast of Cape Cod Light, and totaled 120,000 pounds of tuna with an average weight of 33 pounds.

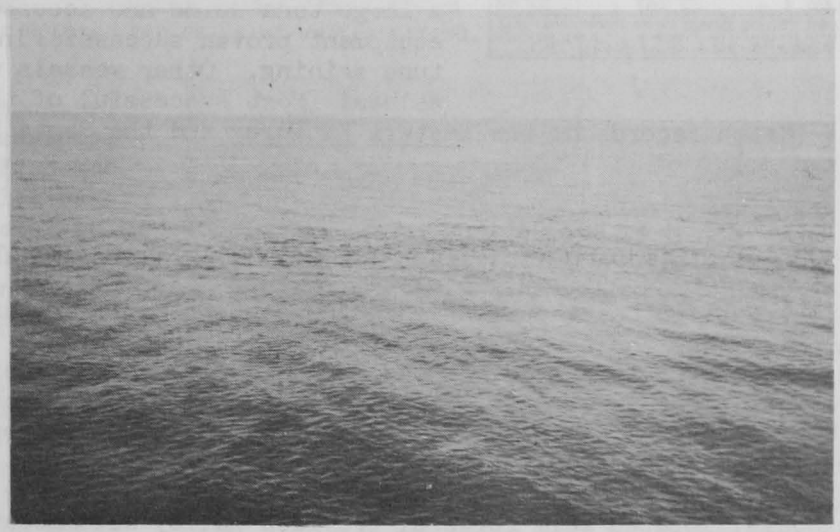

FIG. 4 - TUNA SCHOOL IN CAPE COD BAY, JULY 1951. (NOTE THAT SCHOOL CAN BE SEEN ALMOST IN CENTER OF PHOTOGRAPH.)

BACKGROUND OF TUNA PURSE SEINING IN NEW ENGLAND

Table 1 - U. S. Landings of Bluefin Tuna, 1930-1950

Year	Atlantic Coast	Pacific Coast	Total	Year	Atlantic Coast	Pacific Coast	Total
	(In Thousands of Pounds)				(In Thousands of Pounds)		
1950	3/	2/2,762	3/	1939	949	11,836	12,785
1949	2,738	4,390	7,128	1938	1,824	17,728	19,552
1948	2,997	6,529	9,526	1937	1,023	12,694	13,717
1947	1,087	20,838	21,925	1936	1/	18,925	
1946	1,184	22,032	23,216	1935	566	25,173	25,739
1945	1,374	20,594	21,968	1934	1/	18,358	
1944	829	20,344	21,173	1933	448	561	1,009
1943	481	10,178	10,659	1932	318	1,071	1,389
1942	827	12,845	13,672	1931	321	3,534	3,855
1941	1/	9,519		1930	422	21,921	22,343
1940	1,155	19,970	21,125				

1/NO FISHERY STATISTICAL SURVEY CONDUCTED.
2/PRELIMINARY.
3/NOT AVAILABLE.
SOURCES: 1930-38: BUREAU OF FISHERIES, U.S. DEPARTMENT OF COMMERCE, FISHERY INDUSTRIES OF THE UNITED STATES, ANNUAL REPORTS; 1939-49: FISH AND WILDLIFE SERVICE, U.S. DEPARTMENT OF THE INTERIOR, FISHERY STATISTICS OF THE UNITED STATES, ANNUAL REPORTS.

For many years various people have called attention to the numbers of bluefin tuna that appear each year in New England's coastal waters. Although interest in a potential tuna fishery has been stirred by this knowledge, no extensive organized efforts have ever been made by industry to exploit this resource. Bluefin-tuna production in the area has been limited to catches made by small fishing boats and by the fish traps located in Cape Cod Bay.

Table 2 - Bluefin-Tuna Landings by M/V Western Explorer at Gloucester, Massachusetts, 1938 1/

Date	Pounds
July 19	60,000
August 1	18,000
August 3	50,000
August 4	29,000
August 7	44,000
August 8	21,000
August 17	3,000
August 22	50,000
Total	275,000

1/TRIPS LANDED ON AUGUST 1 AND AUGUST 17 WERE FROM CAPE COD BAY. ALL OF THE OTHER CATCHES WERE MADE IN IPSWICH BAY. IN SEPTEMBER THE VESSEL TURNED TO MACKEREL FISHING, AND WAS SOLD TO CANADIAN INTERESTS IN JANUARY 1939 FOR EMPLOYMENT IN THE NEWFOUNDLAND HERRING FISHERY.
NOTE: FROM BOSTON DAILY FISHERY PRODUCTS REPORTS ISSUED BY THE MARKET NEWS SECTION OF THE SERVICE'S BRANCH OF COMMERCIAL FISHERIES. FIGURES ARE DAILY "HAILS" AND MAY VARY SLIGHTLY FROM ACTUAL WEIGH-OUTS.

Table 3 - Landings of Tuna by Santa Maria, 1938, 1939, and 1940

1938 Date	Pounds	or No. Fish	1939 Date	Pounds	1940 Date	Pounds
July 19 ..	14,000		July 10 ..	3,000	July 29 ..	100,000
July 30 ..		500	July 11 ..	4,000	Aug. 6 ..	13,500
Aug. 5 ..	35,000		July 14 ..	8,000	Aug. 21 ..	30,000
Aug. 6 ..	9,000		July 22 ..	19,000	Aug. 23 ..	23,000
Aug. 8 ..	21,000		July 27 ..	17,000		
Aug. 11 ..	18,000		Aug. 2 ..	14,000		
Aug. 15 ..		120	Aug. 3 ..	6,000		
Aug. 17 ..	65,000		Aug. 5 ..	25,000		
Aug. 22 ..	36,000		Aug. 6 ..	5,000		
Sept.15 ..	23,000		Aug. 8 ..	27,000		
Sept.21 ..	35,000		Aug. 9 ..	40,000		
			Aug. 12 ..	35,000		
			Aug. 18 ..	9,000		
Totals ...	256,000	& 620		212,000		166,000

NOTE: FROM BOSTON DAILY FISHERY PRODUCTS REPORTS ISSUED BY THE MARKET NEWS SECTION OF THE SERVICE'S BRANCH OF COMMERCIAL FISHERIES. FIGURES REPRESENT DAILY "HAILS" AND MAY VARY SLIGHTLY FROM THE ACTUAL WEIGH-OUTS.

Some steps by industry aimed at greater utilization of the fishery were undertaken from 1937 to 1941 when from two to five commercial fishing craft operated from the port of Gloucester and achieved fair success in capturing tuna by purse-seining methods. Included in this fleet during the 1938 season was the M/V Western Explorer, a Pacific Coast-type tuna purse seiner, equipped with a large tuna seine and accessory fishing equipment proven successful in Pacific Coast tuna seining. Other vessels used mackerel seines. Most successful of these was the Santa Maria. (Catch records of the Western Explorer and the Santa Maria are shown in tables 2 and 3.)

EQUIPMENT AND OPERATIONAL PROCEDURE OF THE 1951 EXPLORATIONS

The 75-foot Pacific Coast purse seine-type Western Explorer was equipped with a large tuna seine, set and hauled from a turntable on the stern. The vessel represented a distinct departure from the New England-type mackerel seiner. Full engine controls, a pilot wheel and compass located both in the pilothouse and outside on the bridge forward of the house, allowed the boat to be operated from this spot while cruising and setting for fish.

The deckhouse, located well forward, provided galley accommodations and berths for ten men on the main deck, while on the top deck a small cabin aft of

the pilothouse provided space for the captain's berth, a chart table, and radiotelephone. A depth indicator was part of the vessel's equipment, with the recording dial mounted in the wheelhouse. A small radio direction finder was also installed in the wheelhouse.

The ship was powered with a 200 horsepower Diesel engine, which also furnished the power for operation of the purse winch located midships aft of the deckhouse. The hold provided space for approximately 75 tons of iced fish.

FIG. 5 - SETTING SEINE FROM TURNTABLE (NOTE PURSE LINE IN LEFT-HAND CORNER.

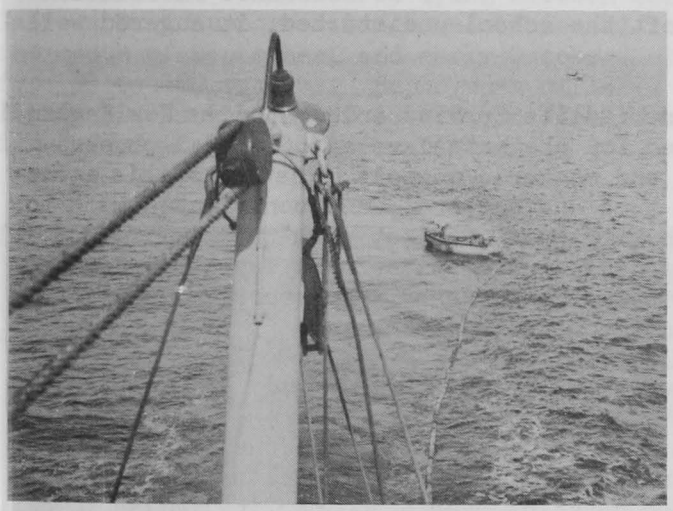

FIG. 6 - SKIFF HOLDING END OF SEINE WHILE SETTING.

A standard Pacific Coast-type tuna purse seine, measuring approximately 330 fathoms in length and 33 fathoms in depth, stretched-mesh measure, was employed. Details of the nets construction are included in the section entitled "Description of Tuna Purse Seine and Accessory Equipment."

Normally, tuna seiners carry 11 crew members, and the Western Explorer had facilities for this number of men. A captain and three fishermen were recruited from the Pacific Coast tuna fishery while the balance of the crew was recruited from Atlantic Coast mackerel fishermen. Personnel of the U. S. Fish and Wildlife Service were aboard the vessel on all trips and assisted the crew during seining operations.

FIG. 7 - SKIFF MAN MAKING FAST THE EXTENSION PURSE LINE TO END OF SEINE.

Program plans envisaged operations under conditions closely akin to current commercial practices of the New England mackerel-seining fleet.

FIG. 8 - PURSE RINGS AND LEAD LINE STRETCHED OUT ON DECK AFTER PURSING.

Reconnaissance cruises were carried out in Gulf of Maine waters from July to October. Spotting areas where tuna were found in commercial abundance, and tests on the effectiveness of a large tuna purse seine in capturing bluefin tuna schools were conducted. Before setting, the schools were circled slowly by the seine boat at a distance of 100 to 200 yards to determine the size of the school, direction and movement of the fish and inspection of water currents in relationship to the wind. If this maneuver left the school undisturbed, it augered well for a successful set.

An agreement between the Fish and Wildlife Service and many of the New England mackerel purse-seine operators provided for the mutual relay of visual observations regarding the locations of tuna and mackerel schools. Results of this agreement proved valuable in locating both tuna and mackerel, and contributed much to the success of the Western Explorer in keeping in contact with tuna concentrations. This phase of the program grew with each trip, necessitating a day-long radio watch to handle the calls coming from seiners, draggers, and sports fishermen from Cape Cod all along the coast and as far north as Nova Scotia.

RESULTS OF SCOUTING AND SEINING OPERATIONS

The Western Explorer left Boston for her initial trip on June 23 and completed eight trips before returning to Boston on October 3. The vessel spent 81 days at sea, steaming a total of 695 hours, and covering over 4,700 nautical miles in Gulf of Maine waters.

Bluefin-tuna schools were observed on all voyages. A total of 12 sets was made, eight of which yielded 180,000 pounds of bluefin tuna. These fish were landed at Gloucester, Massachusetts. In two of the unsuccessful sets, the schools were completely surrounded by the seine but the fish were lost because the lead line fouled on the bottom and the ship's main clutch failed to operate the purse winch.

Observations made during the season disclosed bluefin-tuna schools ranging over a wide area, extending from a point approximately 60 miles southeast of Cape

FIG. 9 - TUNA IN SEINE BEFORE BRAILING. POLE IS USED TO HOLD SEINE OPEN DURING PART OF THE OPERATION.

Cod Light to the waters around Boon Island, Maine--a distance of 110 nautical miles. Reports on tuna schools sighted by fishing craft operating in Gulf of Maine waters extended this range of occurrence to areas close to Nova Scotia shores--over 200 nautical miles east and south of the New England Coast.

Small-size fish comprised the great majority of the tuna captured and observed in the area. Only a small percentage (6 percent) of the total catch was composed of fish over 50 pounds live weight, with catches of fish in the 25- to 33-pound live-weight size range predominating. Visual observations of tuna schools and actual measurements of fish captured in coastal waters east and south of Cape Ann Light reveal that no large fish were found below this point. Conversely, no small fish were found in the coastal waters and north of Cape Ann. There appeared to be a distinct separation of the small- and large-size groups, roughly coinciding with the inshore waters northeast of a line extending east-south-east from Cape Ann Light. However, this generalization cannot be applied to offshore waters in view of reports received from creditable sources of tuna schools composed of small-size fish, observed north of Cape Ann Light on Fippennies Ledge, Cashes Ledge, and Jeffrey Bank. While bluefin tuna in varying degrees of volume were observed over a wide range during the program, sizable concentrations of schooling fish adaptable to commercial seining were located in four distinct areas.

The South Channel area lying between Cape Cod and the southwestern edge of Georges Bank supported large quantities of tuna during the latter part of August, the month of September, and early October. In this region, water depths range from 50 to 100 fathoms. Employment of large seines (measuring not less than 300 fathoms in length and 30 fathoms in depth) is indicated for best results in seining the large schools comparable in size to those observed here during September 1951.

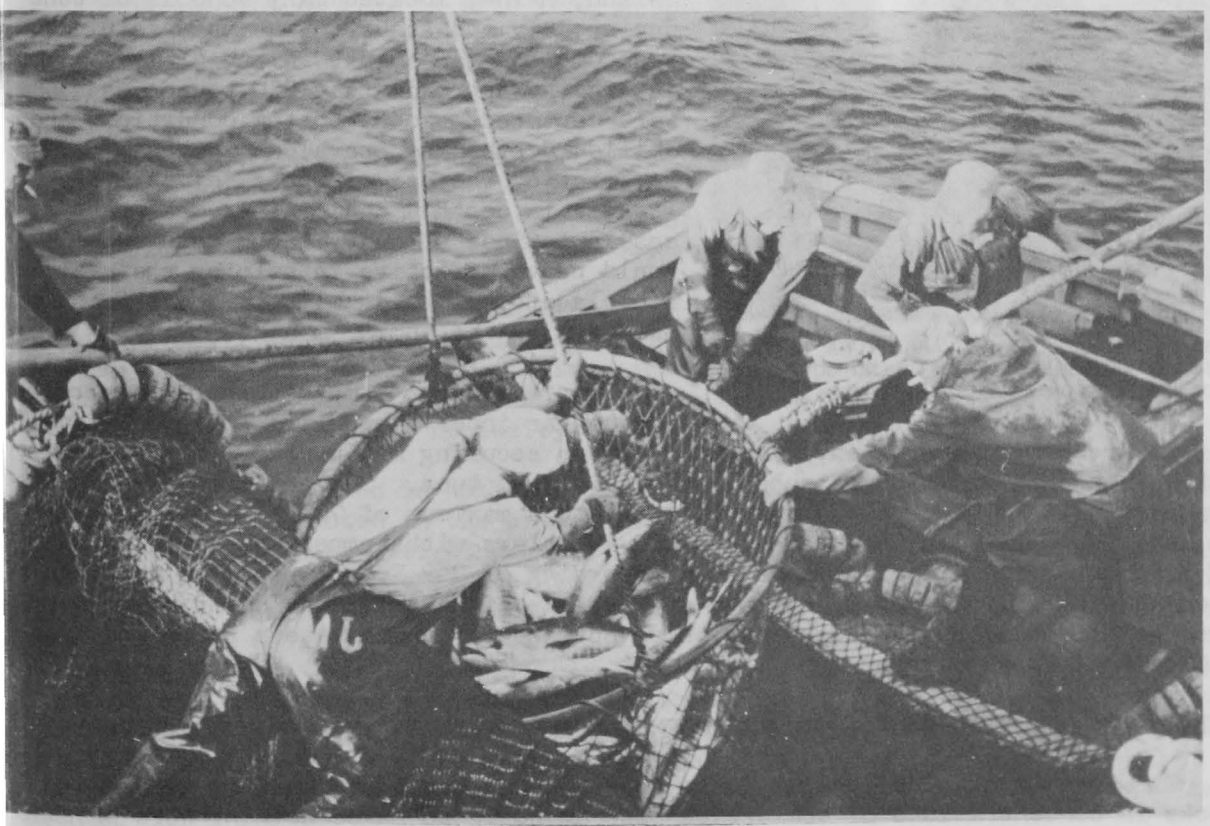

FIG. 10 - BRAILING TUNA FROM SEINE.

Varying amounts of small bluefin tuna were observed in the Cape Cod Bay region (comprising roughly the waters southeast of a line extending from Race Point Light northwesterly to the shore near Marshfield, Massachusetts) from late June until early September. The average schools observed contained between two and eight tons of 25- to 35-pound fish with occasional appearances of schools estimated to contain as high as 40 tons. Comparatively shallow depths (ranging from 8 to 28 fathoms) and heavy mud-bottom conditions preclude employment of deep, heavily leaded seines in this region. From observations gathered during the course of operations, it appears that a small seine not over 225 fathoms in length and 15 fathoms in depth is required for efficient operation in Cape Cod Bay.

FIG. 11 - DECKLOAD OF LARGE TUNA TAKEN OFF BOON ISLAND MAINE, BEING COVERED FOR PROTECTION FROM THE SUN.

Located near Cape Cod Bay and extending northeasterly towards Cape Ann for approximately 15 miles is the small fishing bank Stellwagen, but more generally known as Middle Bank. On five separate occasions schools of bluefin tuna were sighted near Stellwagen. Large bodies of bluefin tuna were sighted on the night of September 11 near the southern tip of the bank by the Gloucester mackerel-seining fleet. Generally smooth bottom and average depths of over 28 fathoms along the bank's perimeter indicate favorable conditions for tuna seining during periods of seasonal abundance.

Scouting operations in the waters between Isle of Shoals, New Hampshire and Boon Island, Maine, located many schools of tuna during July and August. One successful set was completed on August 24 and 41 large tuna (averaging approximately 230 pounds each) were captured. Rocky-bottom conditions and shallow depths are prevalent in this vicinity, restricting the use of purse seines over 20 fathoms in depth. Indications are that shallow seines of heavy large mesh twine would prove effective in seining the small schools of large-size bluefin found in this area during the summer months.

Surface water temperatures were recorded at regular intervals during the operations. Over 200 readings were taken, with emphasis on securing maximum coverage of waters in the immediate vicinity of school and individual tuna. Seasonal records exhibit a range of 22° F., from a minimum of 52° F. to a maximum of 74° F. Both schooling and individual bluefin tuna were observed in waters with temperatures as low as 58° F. and ranging upward to a maximum recording of 74° F. Temperature readings taken in waters lying north and east of the Isle of Shoals-Boon Island region were found to be consistently lower than those obtained from the waters south and east of Cape Ann, Massachusetts.

OUTLOOK FOR ESTABLISHMENT OF A NEW ENGLAND BLUEFIN TUNA PURSE-SEINE FISHERY

The results obtained during these operations demonstrate that bluefin-tuna stocks in concentrations of commercial size amenable to purse seining were present in Gulf of Maine waters from late June to early October.

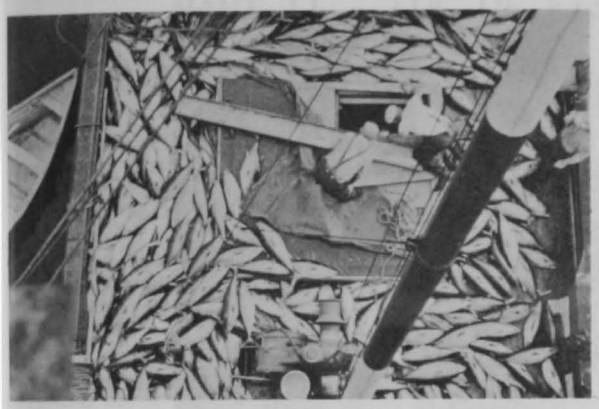

FIG. 12 - PREPARING TO STOW DECKLOAD OF BLUE-FIN TUNA IN VESSEL'S HOLD.

FIG. 13 - CREW REPILING NET ON TURNTABLE AFTER MAKING SET.

The success of the purse seiner employed in completing eight sets with an average haul of 22,500 pounds per set shows that the schools could be effectively fished. On 10 sets, out of a total of 12 made during the season, the schools were completely surrounded by the purse seine and subsequent loss of two of the encircled schools was due to failure of fishing equipment. Generally, the fish were fairly regular in their behavior and there was no difficulty in surrounding them with the seine.

Concentrations of tuna in volume attractive for seiners were found in four general areas--South Channel Region, Massachusetts Bay (Stellwagen Bank), Cape Cod Bay, Isle of Shoals-Boon Island region.

Tuna schools varying in size from an estimated 2 tons to 200 tons were observed from the Western Explorer within a radius of 60 miles from Cape Cod Light. Over 500 tons is a conservative estimate of the amount of fish observed in the schools sighted.

Conditions appear favorable for purse-seine operations in the South Channel area and around Stellwagen Bank where deep and heavy seines may be used without danger of fouling on the bottom. Large seine boats are indicated for use herein recognition of the size of the schools observed in the area in September 1951.

Cape Cod Bay presents possibilities during late June and July for a limited number of small seine boats employing shallow, lightly-leaded seines not over 225 fathoms in length. The length of time required to operate the gear and bail the catch would be limiting factors in production due to the prevalence of small schools noted here and the necessity for more sets per payload.

Conditions observed in waters northeast of Cape Ann, Massachusetts, differed sharply from those noted in the area south and east from this point. Small schools composed of large fish (weighing between 200 and 300 pounds) were found between the Isle of Shoals, New Hampshire, and Cape Neddick, Maine. With one or two exceptions, all schools were in shoal waters overlying rocky bottom. On two occasions, schools estimated to contain 10 tons of fish were sighted in deep water south-east of Boon Island. Invariably, the schools could be found on good fishing days surfacing north or south-west of the Island in depths varying from 7 to 15 fathoms. While seining in this area presents difficulties not found in southern Gulf-of-Maine waters, it appears that operations by persons familiar with local conditions, using shallow seines constructed of heavy twine with extra large meshes, could operate with reasonable success.

FIG. 14 - PREPARING TO UNLOAD TUNA CATCH IN PORT.

The difficulties attendant upon one boat in attempting to scout pelagic fish over an area approximating 20,000 square miles are obvious. While the Western Explorer was accorded excellent cooperation by the New England fishing fleet in spotting and reporting tuna schools, unquestionably a much greater measure of success would have been attained if additional tuna seiners had been active in the area.

A distinct advantage to tuna seiners operating in the Gulf of Maine is the relatively short distances between fishing grounds and landing ports. Within a distance of 100 nautical miles from areas where tuna schools were found, four major landing ports are located. Under such conditions, mechanically-refrigerated seiners, while desirable, are not a necessity and crushed ice affords a reliable and inexpensive means of preserving fish catches. After proper handling and adequate icing, bluefin tuna caught during the season were kept as long as seven days with little loss of quality. The fish were not gutted, and reports from boats who dressed their tuna catches, showed that this period could be safely extended for from three to four days without danger of spoilage.

Despite loss of many fishing days due to heavy fog and strong winds, it was not felt that weather conditions encountered during the season differed greatly from normal seasonal patterns. Weatherwise, purse seining differs from practically all other types of fishing in relation to conditions under which fishing operations may be prosecuted. Fairly calm weather is required for successful purse-seine operations. Operators in this fishery would be compensated for loss of fishing time regularly experienced each fishing season due to weather by heavy production during brief fishing periods.

While no attempt has been made here to evaluate any of the economic aspects for the successful establishment of a tuna industry in New England, experience gained from the limited work carried on in the area indicates that the basic raw material in the form of available stocks of bluefin tuna may be found in the coastal waters during the summer months.

PART II - LOG OF FISHING TRIPS (CONDENSED)

TRIP 1, JUNE 23-JULY 2

June 23: Cleared Boston harbor and set course for Cape Ann Light. Received reports that school tuna were sighted in Ipswich Bay on June 21 and on Cashe Ledge June 22. Masthead watch kept, but saw no tuna. Anchored in Ipswich Bay.

June 24-27: Scouted waters between Isle of Shoals, New Hampshire, and Monhegan Island, Maine. Weather unsettled with light fog and fresh easterly winds. No tuna schools sighted.

June 28: School containing about 5 tons of tuna sighted NW. of Boon Island, Maine. Fish 200- to 300-pound class, milling over rocky bottom in 12 to 16 fathoms of water. Weather favorable. Surface water temperature 58° F. Tuna remained at surface over 30 minutes swimming slowly. Water shallow and bottom too rocky for set.

June 29: Small school medium-large tuna sighted SE. of Boon Island in 18 fathoms over fairly smooth bottom. Made preparations to set, but school sounded. Sea calm with gentle winds. Surface temperature 57° F.

June 30: Large school of tuna estimated at 30 tons sighted in afternoon SE. of Boon Island in 38 fathoms. Fish sounded before set could be made. Same size school sighted 2 hours later in same general area. Set made but fish changed direction and escaped.

July 1: Small school of tuna sighted SW. of Boon Island over rocky bottom in 12 fathoms; too shallow to set.

July 2: Fresh NW. winds, rain, and fog. Too choppy to spot fish. Returned to Boston.

Summary of Trip: Six schools of tuna sighted within 2 miles of Boon Island, Maine. Four small schools over rocky bottom; too shallow to set. Two large schools in deeper water. Made 1 unsuccessful set. Vessel under way 94 hours, cruised about 600 nautical miles between Boston and Monhegan Island, Maine.

TRIP 2, JULY 7-15

July 7: After minor changes to gear and 2-day delay due to bad weather, left Boston. Set course for Cape Cod Bay after receiving reports from other trawlers that schools of tuna were seen there. Cruised 4 hours between Wood End-Race Point and Peaked Hill Bar Buoy. Saw many small schools of tuna. Fish small, average about 25 pounds. Largest school estimated about 2 tons. Tuna very erratic and not at surface long enough for set. Cruised north to Stellwagen Bank and sighted school estimated at 10 tons. Prepared to set but fish sounded. Ten small schools seen before dark, but too wild for seining.

July 8: Sighted many small schools, all wild and not at surface long enough to make a set.

July 9-10: Fresh south winds prevented scouting.

July 11: Scouted in the vicinity of Jeffreys Ledge, 15 miles NE. of Cape Ann Light. Small schools of tuna sighted but not at surface long enough for seining.

July 12: Proceeded to Cape Cod Bay. Fresh NW. wind precluded scouting.

July 13: Set made at 6:30 A.M.; caught 8 tons of tuna (from 25-35 pounds) off Wood End Light, Cape Cod Bay, in 18 fathoms. Made another set in afternoon on school of about 10 tons in about same location but shallower waters (15 fathoms). Lead line fouled in muddy bottom for 4 hours. Net ripped and all but 3 tons of tuna escaped. Anchored in Provincetown harbor to repair seine.

July 14: Set made in early morning on school of 10 tons in 13 fathoms about 3 miles off Truro shore, Cap Cod Bay. Lead line again fouled on muddy bottom. Seine ripped and tuna escaped.

July 15: Proceeded to Gloucester to discharge catch and to Boston to repair seine.

Summary of Trip: Twenty-two thousand and four hundred pounds of bluefin tuna caught in 2 sets. One other set unsuccessful due to fouling on mud bottom. Average weight of fish 30 pounds. Surface water temperatures ranged from 56° F. in Boon Island-Isle of Shoals area to 74° F. in Cape Cod Bay. Vessel under way 83 hours; covered about 600 nautical miles between Boon Island, Maine, and Cape Cod.

TRIP 3, JULY 25-31

July 25-26: Resumed operations in Cape Cod Bay after modifying seine for shallower waters. One web strip was removed reducing depth of seine from 33 to 27 fathoms. Approximately 1/3 of sinkers removed and replaced by 200 small, oval cedar floats to provide rolling motion to lead line. Fresh NE. and SW. winds hindered scouting.

July 27: Made set on school of about 5 tons of tuna in morning off Wood End Light in 18 fathoms. Complete miss as tuna changed course and evaded net. Made second set in afternoon and caught 7 tons of tuna (25-30 pounds) in 8 fathoms over smooth, sandy bottom.

July 28: Weather unfavorable for fishing.

July 29: Three schools of tuna sighted at noon off Wood End Light in 8 to 15 fathoms. Set made on largest school of about 40 tons, and fish surrounded perfectly. Main winch clutch broke down during pursing operations and lead line fouled in mud bottom, tearing net and allowing tuna to escape.

July 30-31: Proceeded to Gloucester to unload catch and to Boston to repair seine.

Summary of Trip: Three sets made in Cape Cod Bay. One caught 13,730 pounds tuna (25-30-pound class), one a complete miss, and one set on 40 tons lost because of mechanical breakdown. Surface

water temperatures ranged from 62° F. on Stellwagen Bank to 72° F. in Cape Cod Bay. Vessel under way 53 hours; steamed about 360 miles.

TRIP 4, AUGUST 4-14

August 4-5: Searched waters in vicinity of the Isle of Shoals and Boon Island. No tuna sighted. Radio reports indicated tuna schools still in Cape Cod Bay.

August 6: Cruised outside Cape Cod past Nauset Buoy and Chatham without sighting tuna. Small schools of tuna (20 to 30 fish) observed inside Race Point in late afternoon. Fish appeared to be chasing small bait fish. Too wild for seining.

August 7: Scouted waters outside Cape Cod without success. Sighted 6 schools off Wood End Light in afternoon and set on small school in 13 fathoms. Caught 5 tons, average weight 30 pounds.

August 8-9: Heavy fog prevented extensive scouting. Many small schools seen in Cape Cod Bay, but too small to warrant setting.

August 10: Fog cleared enough for one set off Barnstable Shore, Cape Cod Bay; 2 tons of tuna caught (30-pound average) in 13 fathoms.

August 11-14: Heavy fog impeded scouting. Proceeded to Gloucester to discharge catch.

Summary of Trip: Thirteen thousand and six hundred pounds tuna taken in 2 sets. Average weight about 30 pounds. Surface water temperatures ranged from 60° to 71° F. Vessel under way 68 hours covering about 450 nautical miles between Boon Island, Maine, and Chatham, Massachusetts.

TRIP 5, AUGUST 16-28

August 16-17: Scouted in vicinity of Fippennies Ledge, small fishing bank about 40 miles E. by S. of Eastern Point, Mass. Fresh winds and rough seas. No tuna sighted.

August 18-19: Set course for Monhegan Island, Maine, after receiving reports that tuna were seen there by small-boat fleet. Scouted vicinity of Boon Island en route. No tuna observed. Received report from trawler which sighted large schools of tuna about 56 miles S. by W. of Seal Island, Nova Scotia. Weather fair, so set course for Seal Island. Arrived in area of report after 20 hours steaming. Fresh NW. winds and choppy seas prevented effective scouting. Weather forecast unfavorable. Returned to Maine coast and anchored near Mt. Desert Light.

August 20-23: Scouted NE. along Maine coast toward Grand Manan Island. Strong tides in Grand Manan Channel. Surface water maximum temperature 54° F. Heavy fog encountered, no tuna sighted. Radio reports from fishing craft indicated school of tuna near Boon Island. Set return course and scouted areas around Matinicus and Monhegan Islands with no success.

August 24: Sighted small school of tuna in 30 fathoms about 2 miles SW. of Boon Island in morning. Made a set, but missed the school. Caught 5 tons of large tuna (230-pound average) in second set in 24 fathoms. Surface water temperature 61° F. Sighted at least 6 moderate-sized schools in afternoon SE. of Boon Island, swimming slowly but over rocky bottom too shallow to set (11-19 fathoms).

August 25-28: Scouted Isle of Shoals, Ipswich Bay, and Boon Island areas. Weather poor. No tuna sighted. Returned to Gloucester to discharge catch.

Summary of Trip: Nine thousand and twenty pounds tuna (average weight 230 pounds) caught in one set. One other set unsuccessful. Vessel under way 130 hours; covered about 1,000 nautical miles between Eastern Point, Mass., and Grand Manan Island, Canada.

TRIP 6, AUGUST 31-SEPTEMBER 15

August 31-September 5: Scouted offshore in vicinity of Fippennies Ledge. Failure of generator and air compressor forced return to port. Searched waters outside of Cape Cod Bay between Cape Cod Light and Chatham. Sighted only few scattered tuna. NW. winds and light fog hindered scouting. Weather colder and unsettled.

September 6-10: Searched Ipswich Bay and Isle of Shoals-Boon Island area. Small schools of tuna observed on 3 occasions. Fish moving rapidly and not at surface long enough for set. Weather unsettled.

September 11: Received radio reports from 2 Gloucester fishing vessels that large schools of tuna sighted off Race Point at 0200 September 10. Proceeded to area and kept night watch, but saw no tuna. Heavy fog prevented effective scouting.

September 12-15: Covered area near Boon Island and around Stellwagen Bank. No tuna seen. Weather very unsettled. Returned to port for repairs to generator.

Summary of Trip: Unfavorable weather combined with mechanical breakdowns caused loss of considerable fishing time. Vessel covered 850 nautical miles in 122 hours of sailing between Cape Porpoise, Maine, and Chatham, Mass. Surface water temperatures ranged from 61° F. near Boon Island on September 12 to 68° F. in Cape Cod Bay on September 3. No sets made. Few small scattered schools of tuna sighted for brief periods.

TRIP 7, SEPTEMBER 16-19

September 16: Set course for area approximately 60 miles SE. of Cape Cod Light, following reports from trawlers stating large schools of tuna there. Tuna feeding on scrap fish from trawl catch. Some vessels caught good amounts of tuna on hand lines baited with fresh herring. Catches of 15 tons and 13 tons by this method reported.

September 17: Arrived at position 56 miles SE. of Cape Cod Light in morning. Weather fair, slightly overcast sky, gentle southerly wind, calm sea, surface water temperature 68° F. Made set on large school of tuna estimated to contain over 200 tons. Necessary to cut school in half to avoid overloading seine. Trapped over 100 tons of tuna, but about 50 tons lost when cork line sank under heavy load and portion of net tore; 60 tons of tuna brailed in 4 splits. Fish averaged 33 pounds. During set, waters in vicinity "alive" with tuna; 10 large schools observed in course of 30 minutes.

September 18: Completed brailing and icing catch. Headed for port 15 hours after dropping skiff at beginning of set. Unloaded catch at Gloucester.

Summary of Trip: Sixty tons of tuna (average 33 pounds) caught in one set 56 miles SE. of Cape Cod Light. Vessel under way 32 hours; covered approximately 256 nautical miles.

TRIP 8, SEPTEMBER 23-OCTOBER 3

September 23: Set course for area 56 miles SE. of Cape Cod Light where large catch was made on Trip 7.

September 24: Many schools of tuna sighted in late afternoon. Schools estimated to contain 10-15 tons tuna in 25-50-pound class. Fish moving too fast and not staying at surface long enough for set. Weather unfavorable in evening. Proceeded to Provincetown for shelter.

September 25-29: Operations curtailed by extremely unfavorable weather. Strong NW. and SW. winds. Offshore operations impossible.

September 30-October 1: Searched waters offshore SE. of Cape Cod. No tuna sighted. Surface temperatures much colder, 52°-54° F. Weather unsettled, moderately choppy seas.

October 2: Received radio report of school tuna on Jeffreys Ledge, about 27 miles NE. of Eastern Point Light. Set course for that area.

October 3: Attempted scouting Jeffreys Ledge. Strong NE. wind and fog forced termination of operations. Docked at Boston in evening.

Summary of Trip: Worst weather of season encountered. Fresh to strong NW. and SW. winds and some fog. Weather unfavorable for purse seining on 7 out of 11 days. No sets made. School tuna sighted offshore from Cape Cod Light, but too wild for seining. Vessel under way 92 hours; covered about 600 nautical miles from 60 miles SE. of Cape Cod to Cape Ann, Mass.

Table 4 - Record of Sets, June 30 to October 17, 1951

Location	Date	Wind		Depth in Fathoms	Surface Water Temperature	Time of Set	Estimated Size of School (in tons)	Catch (in tons)	Remarks
		Direction	Force						
5 miles southeast of Boon Island, Maine	June 30	SE.	2	38	60° F.	1700	30	0	School changed course during set and escaped.
Off Wood End Light, Cape Cod Bay	July 13	NW.	2	18	74° F.	0630	8	8	Fish averaged 30 lbs. each.
Off Wood End Light, Cape Cod Bay	July 13	NW.	2	15	72° F.	1700	10	3	Seine hung up on mud bottom; lost most of school.
3 Miles Off Truro Shore, Cape Cod Bay	July 14	W.	2	13	72° F.	0800	10	0	Lost school when seine fouled on bottom and tore.
Off Wood End Light, Cape Cod Bay	July 27	NW.	2	18	68° F.	1000	5	0	Missed school.
Cape Cod Bay	July 27	NW.	2	8	72° F.	1500	7	7	Fish averaged 30 lbs. each.
Off Wood End Light, Cape Cod Bay	July 29	E.	2	12	71° F.	1200	40	0	Perfect set on large school; winch clutch broke while pursing; entire school lost.
Off Wood End Light, Cape Cod Bay	Aug. 7	E.	3	13	70° F.	1400	5	5	Fish averaged 30 lbs. each.
3 Miles Off Barnstable Shore, Cape Cod Bay	Aug. 10	N.	2	13	68° F.	1400	2	2	Fish averaged 30 lbs. each.
2 Miles SW. of Boon Island, Maine	Aug. 24	N.	2	30	60° F.	0930	5	0	Missed fish.
2 Miles SW. of Boon Island, Maine	Aug. 24	N.	2	24	61° F.	1215	5	5	Large tuna, averaged 230 pounds each.
56 Miles SE. ½ E. from Cape Cod Light	Sept.17	SSW.	2	80	68° F.	1030	200	60	Cut school in half and trapped an estimated 120 tons in seine. Lost 60 tons over cork line and through web failure. Fish averaged 33 lbs. each.

PART III - DESCRIPTION OF TUNA PURSE SEINE AND ACCESSORY EQUIPMENT

Purse seining is probably the most efficient and productive method currently employed for rapidly capturing large quantities of pelagic fishes. During 1947 the purse-seine fisheries in the states of Washington, Oregon, and California accounted for 57 percent of the total catch of fishery products in that region.[1]

Tuna fishermen have practically standardized on construction of tuna seines, using cotton-web strips 100 meshes deep of 4½ inches stretched-mesh size (No. 42- or 48-thread seine twine) for the main body of the net, and a strip 50 meshes deep of 8 inches stretched-mesh size (No. 60- to 96-thread seine twine) for the bottom or lead-line strip. Variation of the mesh size and thread size is normal procedure in hanging a seine, depending on the size and species of tuna for which the seine is to be used, and the size of the purse seiner employed.

When stretched out, a tuna purse seine has the appearance of a long shallow blanket of webbing, buoyed on top by corks or floats strung on a strong rope attached to the webbing and weighted on the bottom with a light rope strung with lead sinkers. Attached to the lead line by means of short ropes called "bridles" and suspended at regular intervals below the lead line are circular metal rings through which a strong wire cable or "purse line" is woven. Following setting and encirclement of the schooling tuna, the "purse line" is used to draw together the bottom of the seine, and successful completion of this operation leaves the fish catch safely impounded in the seine, with their only escape route being over the top of the cork line. With the aid of a power boom, simultaneously part of the seine is repiled on the turntable at the stern of the boat and the fish catch is concentrated in one section of the seine. The concentrated fish are brailed from the seine into the ship's hold with a dip net.

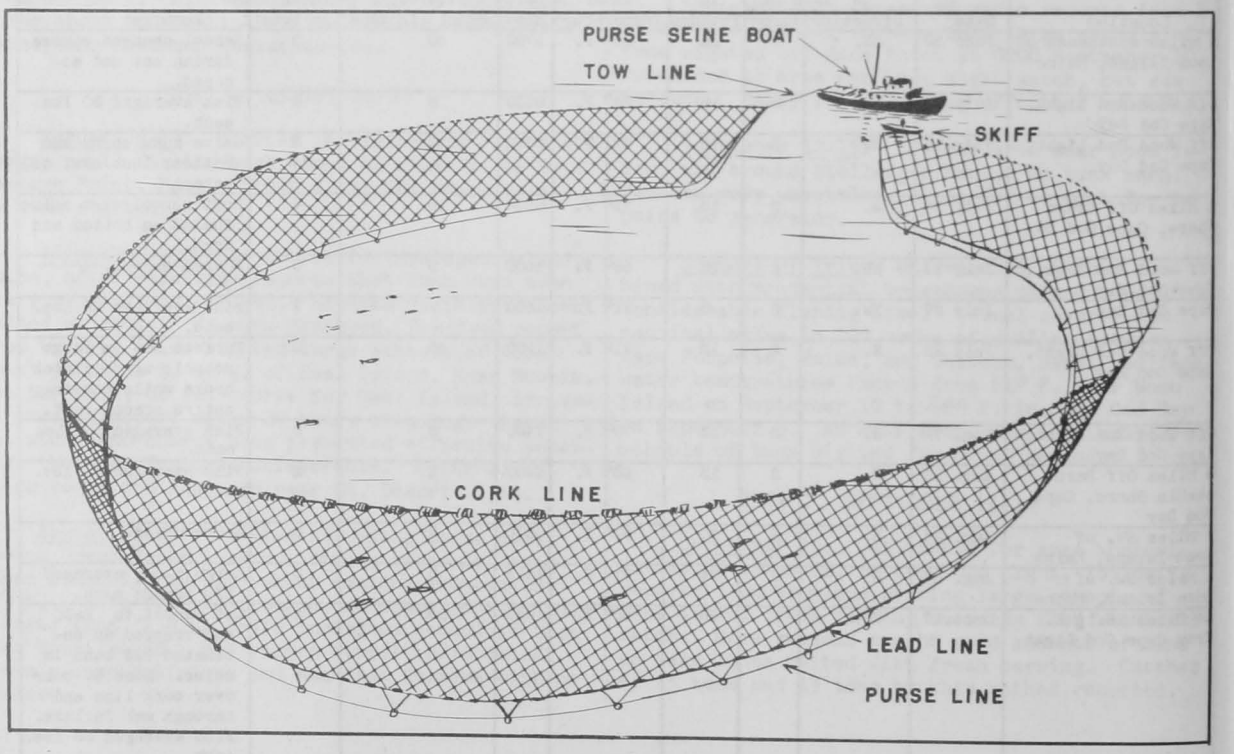

FIG. 15 - DIAGRAM OF PURSE SEINE WHEN SET.

1/ FISHERY STATISTICS OF THE UNITED STATES, STATISTICAL DIGEST NO. 21., U. S. FISH AND WILDLIFE SERVICE, 1947.

The tuna seine used by the Western Explorer was of the standard type used by the California tuna-seining fleet, and when hung ready for fishing the net had the following dimensions and components.

FIG. 16 - HANGING SEINE. LACING TOGETHER WEB STRIPS IN MIDDLE OF SEINE.

WEBBING

The body of the net consisted of five horizontal strips of cotton webbing approximately 330 fathoms in length, laced together forming a large rectangle. From the cork line down, the first four strips (each 100 meshes in depth) were of No. 42-thread medium-laid cotton seine twine, $4\frac{1}{2}$ inches stretched mesh. The lead-line strip (50 meshes in depth) was of No. 84-thread medium-laid cotton seine twine, 8 inches stretched-mesh. Before lacing the strips together, they were treated with net preservative to protect the webbing and retard deterioration. Depth of the seine was approximately 33 fathoms stretched-mesh measure after hanging operations were completed.

In accordance with accepted practice, the seine was hung with the cork line a trifle shorter than the webbing, and the lead line about ten percent shorter than the cork line. This was accomplished by measuring ten fathoms on the cork line and nine fathoms on the lead line. Then ten fathoms of $4\frac{1}{2}$-inch mesh was measured off along the selvage of the top web strip, stretching the netting taut, and adding 6 extra $4\frac{1}{2}$-inch meshes (stretched allowance) and dividing this slack evenly along the cork line. By tracing the straight mesh down across the web strips to the lead line strip selvage and fastening this point to the nine fathoms of lead-line rope, an extra fullness is obtained in order to insure a proper pursing operation. Thus the actual ten fathoms of lead-line webbing is secured to nine fathoms of rope.

Later in the season the depth of the seine was decreased approximately six fathoms by the removal of an entire web strip.

CORK LINE

The number of cork floats used to buoy the net is quite variable, depending on the size of the net, size of tuna to be fished, and current and tidal characteristics of the waters in which the seine is to be operated. Generally, there are from 14 to 20 corks to each fathom of cork line, following the basic principle that sufficient floats should be uniformly distributed along the entire cork line to assure that ample buoyancy is provided to keep the net afloat with the cork line at the water's surface. The seine used in this operation had approximately 16 corks to each fathom of cork line. The corks were disc-like in shape (6 inches in diameter and 2 inches thick) with a hole in the center for insertion of a manila rope $2\frac{1}{2}$ inches in circumference. The corks were usually spaced in three groups of four, each composing a "sausage" of twelve corks.

Corks were hung by picking up two $4\frac{1}{2}$-inch meshes of the top web strip with 21-thread fine manila and placing four corks directly above the two meshes, then

FIG. 17 - ARRANGEMENT OF CORKS ON CORK LINE.

passing the manila line under the corks and hitching it firmly to the cork line. This procedure was repeated for two more four-cork groups, thus completing a "sausage." Between "sausages" a space of 16 inches was left on the cork line.

LEAD LINE

The leads or sinkers were evenly distributed along a 21-thread manila rope attached to the bottom web section. The leads were oval shaped weighing four ounces each and provided with a 5/8-inch hole through the longitudinal axis for insertion of 21-thread manila rope. This heavily-weighted line insures that the net will sink quickly to the limit of its depth following setting of the seine and encirclement of the schooling fish. Leads were hung in groups of threes with approximately 38 leads to each fathom of lead line. Heavy-tarred seine twine was used for hanging, with each tie on the lead line about 7 inches apart and each 8-inch mesh picked up twice by the hanging twine. During actual fishing operations, it was found that the lead line was too heavy for efficient operation. Early in the season the seine was overhauled and from 14 to 16 leads removed from each fathom of lead line, and small cedar floats placed along the lead line at regular intervals. This arrangement proved helpful when working the seine in shallow water and on soft and muddy bottom.

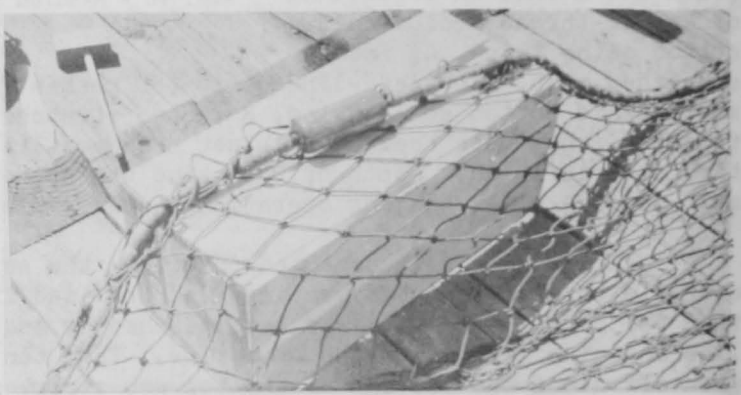

FIG. 18 - LEAD-LINE ARRANGEMENT, SHOWING LEADS AND TYPE OF CEDAR FLOAT USED TO LIGHTEN LEAD LINE WHEN USED ON MUDDY BOTTOM.

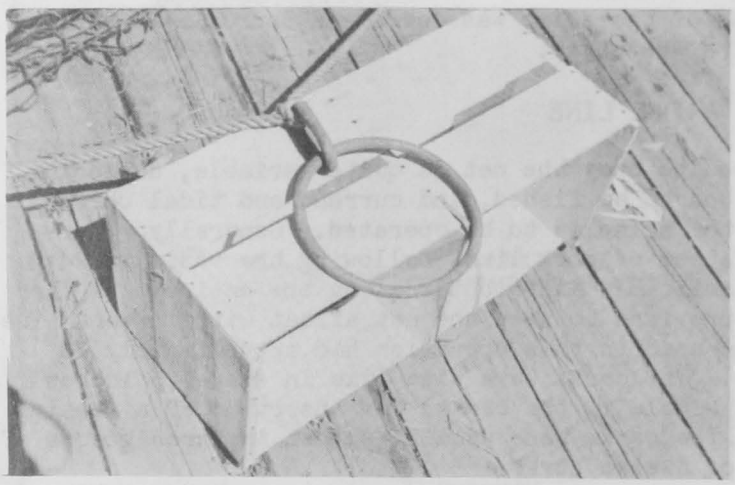

FIG. 19 - LEAD-LINE PURSE RING AND BRIDLE.

Galvanized-iron purse rings, measuring $9\frac{1}{2}$ inches outside diameter, $\frac{1}{2}$ inch thick, and fitted with a small closed loop were uniformly distributed along the entire length of the lead line. Each ring was fastened at the loop to the middle of a 15-foot long "bridle." The "bridles" were made from 18-thread manila rope and the ends were made fast to the lead line with several hitches of heavy-tarred seine twine. A distance of $12\frac{1}{2}$ feet was left between "bridle" ends on the lead line and the same distance was left between consecutive "bridle" lines. Seventy lead-line purse rings were used in hanging the seine.

PURSING ARRANGEMENT

The purse line of galvanized steel wire measured about 330 fathoms in length and was divided into three sections. The two end sections were approximately 115 fathoms long of 1/2-inch diameter wire, while the middle section was of 5/8-inch-diameter wire, 100 fathoms in length, joined to the end sections by means of swing links. This division of the cable facilitated handling and coiling the wire after pursing was completed and assured that the stronger middle section of the cable would be in a position to support the weight of the purse rings and lead line when hoisted inboard by the power boom.

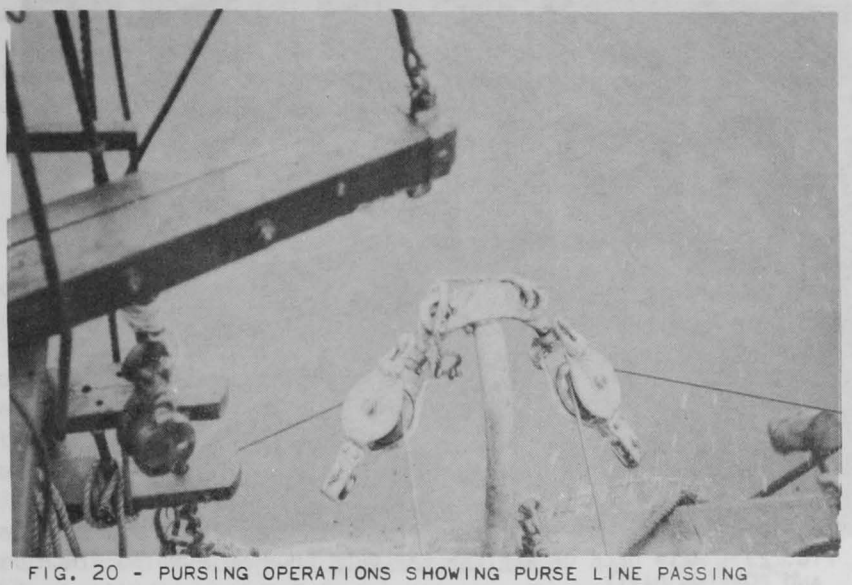

FIG. 20 - PURSING OPERATIONS SHOWING PURSE LINE PASSING THROUGH PURSE BLOCKS.

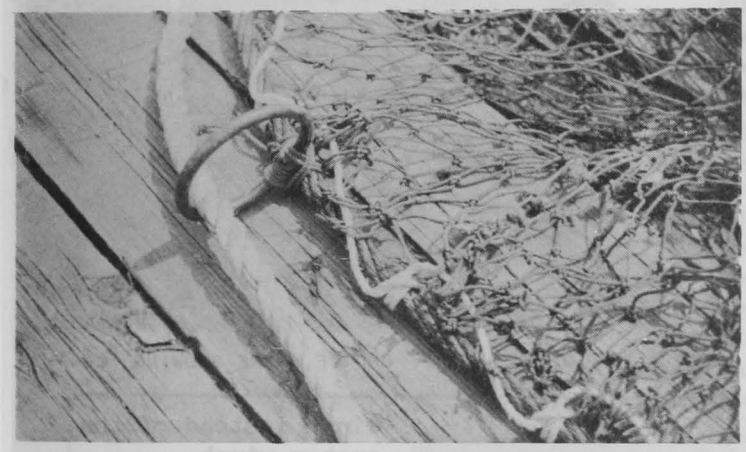

FIG. 21 - BREAST LINE AND BREAST RING.

BREAST LINES

During the haul it was necessary to lift the lead line up to the corks by pulling up the breast lines, the lower ends of which were fastened to the bottom of the net at a point about 1/2 to 1-1/2 fathoms from the lead line, while the top ends were tied loosely to the cork line. The breast lines were of 2 1/2-inch-circumference manila rope, while the breast rings were made from 7/16-inch galvanized iron and measured 4 inches inside diameter. The breast lines were passed through a series of metal rings fastened directly along the end of "up and down" lines on the extreme ends of the seine.

CORK LINE PURSING

Along the entire length of the cork line, approximately 80 bridle ropes were spaced about 4 fathoms apart. Each bridle was from 18 inches to 20 inches long, made from 18-thread manila rope with a 7/16-inch by 4-1/2 inches

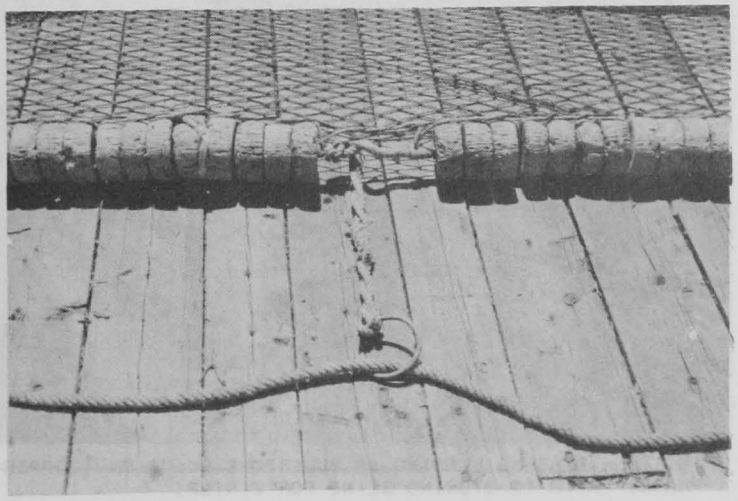

FIG. 22 - CORK PURSE LINE AND BRIDLE.

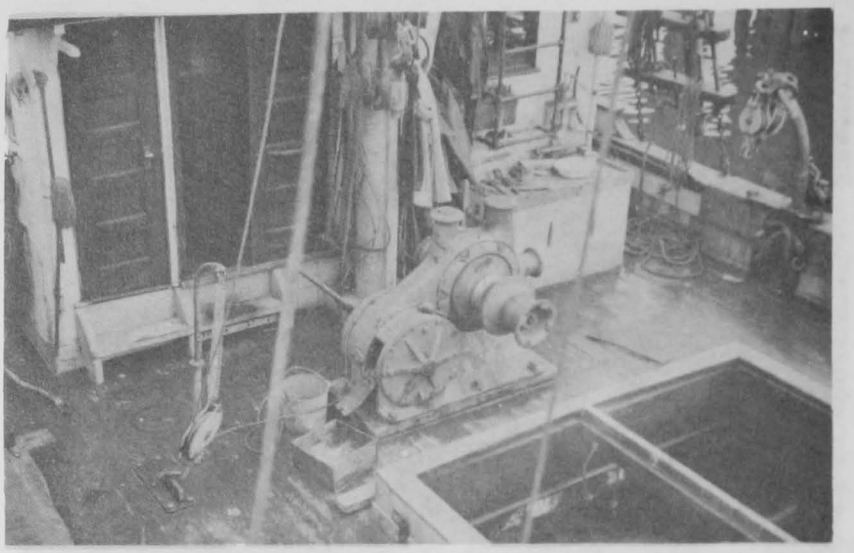

FIG. 23 - MAIN DECK OF WESTERN EXPLORER SHOWING PURSING WINCH AND PURSING DAVIT.

galvanized purse ring attached in the middle by means of a half hitch. The bridles are necessary in order to facilitate net operations. Upon completion of the setting of the net, the corks have a tendency to gather around the bow and stern of the boat, bunching up the net and impeding drying up operations. About 30 fathoms of 2-1/2-inch-circumference manila rope is a permanent fixture through approximately seven purse rings, covering a section of the net about 30 fathoms long. One end of the rope is fastened to the cork line while the other end is hitched loosely to the cork line in a spot within reach of the bow man who controls the pursing by means of the bow anchor winch.

When the corks gather around the boat, the loose end of the rope is pulled in and this procedure tends to keep the corks gathered at the bow of the boat and fastened securely. The same procedure is followed when the corks bunch around the stern of the boat, with the exception that the line is then pursed on the pursing winch instead of the anchor winch.

FIG. 24 - SKIFF END OF SEINE SHOWING "CANADIAN LINK."

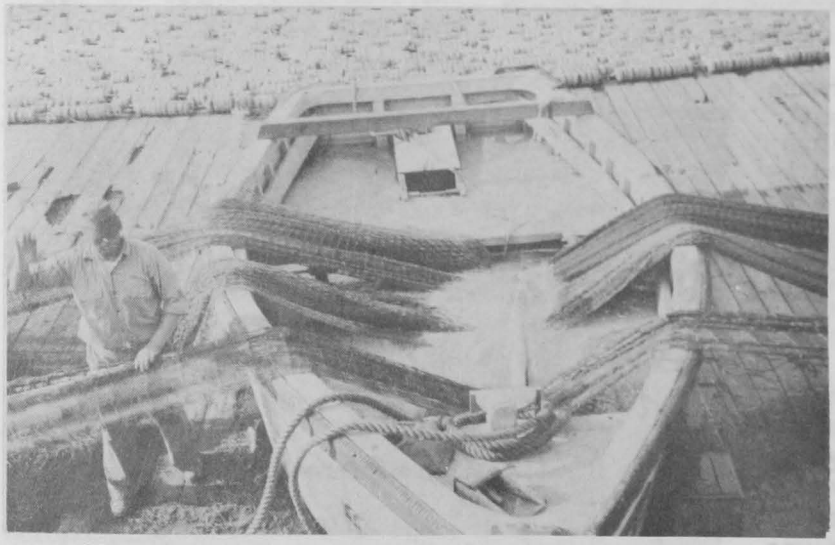

FIG. 25 - RINSING WEBBING IN BLUESTONE SOLUTION (COPPER SULPHATE) PRIOR TO STORING SEINE FOR WINTER.

An additional 30 fathoms of 1/2-inch wire is used upon completion of the setting to speed the transfer of the skiff end of the main purse line to the pursing winch. Before the circling maneuver of the seiner around the school fish is completed, one end of the wire attached to a light heaving line by a snap-hook arrangement is passed through the forward pursing davit outside the rigging and given to the bow man. When the seiner approaches

the skiff, the bow man throws the heaving line to the skiff man who secures the wire to a short pennant made fast to the cork line and signals to the winchman, who purses the wire on the winch and pulls the cork line up to the vessel's rail. Upon reaching the rail, the cork line is made fast to the main rigging, the main purse line is released from a device called a "Canadian Link," and both ends of the purse line are pursed simultaneously until the purse rings are safely up to the pursing davit.

SKIFF

The heavy, flat-bottom skiff used to assist in fishing operations is an important part of a purse seiner's equipment. In addition to its use in starting the seine off the turntable while setting the seine, the skiff is used to support the net during hauling and brailing operations and as a tow-off boat to swing the purse seiner away from the net in the event that the action of the wind or tide places the boat in a position making hauling operations difficult or impossible. Practically all the skiffs employed in the California tuna fishery are equipped with either gasoline or Diesel engines. The skiff furnished with the Western Explorer was not powered and in the interest of efficiency and ease of handling, a built-in well was constructed and a heavy-duty outboard motor was installed. This motor proved invaluable in the course of fishing operations. The skiff measured 22 feet in length with an 8-1/2-foot beam and was constructed of heavy timber (see figure 7).

ACKNOWLEGMENT

To the Captains and crew members of New England fishing craft for valuable assistance accorded the Western Explorer in reporting locations of tuna schools.

PACKAGED FISH--1951

Production of fresh and frozen packaged fish (fillets, steaks, and split butterfly) in the continental United States during 1951 totaled 205,486,068 pounds, valued at $59,487,098 to the processor. This represents an increase of 7 percent in quantity and 11 percent in value as compared with 1950. The principal items produced were ocean perch (rosefish) fillets, (75,023,366 pounds, valued at $18,732,729) and haddock fillets (50,830,527 pounds, valued at $14,545,679).

The total production of groundfish (cod, cusk, haddock, hake, pollock) and ocean perch (rosefish) fillets during 1951 amounted to 148,786,162 pounds, valued at $38,463,887. Imports of these fillets during the year amounted to 87,042,081 pounds.

It is estimated that 620,000,000 pounds of round fish were required to produce the 205,486,068 pounds of packaged fish produced in 1951.

--C.F.S. No. 735