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## SHRIMP EXPLORATIONS OFF SOUTHEASTERN COAST OF THE UNITED STATES (1956-1958)

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### SUMMARY

New deep-water royal-red shrimp grounds were discovered off the Florida east coast during the 1956-1958 explorations of vessels chartered by the U. S. Bureau of Commercial Fisheries. The trawling investigations were conducted from Cape Hatteras, N. C., to Dry Tortugas, Fla. Commercial catches of royal-red shrimp have ranged as high as 800 pounds (heads-off) per fishing day. These shrimp, of a size desired by industry, have been found most consistently in depths of 180 to 220 fathoms between St. Augustine and Cape Canaveral, Fla.

Other possible commercial fishery resources of rock shrimp, scallops and flounder also were located.

The experience of both industry and the Bureau in operating conventionally-powered shrimp trawlers in the swift current of the Gulf Stream indicated that these vessels are presently underpowered for this work.



Fig. 1 - M/V Pelican 70-foot steel shrimp vessel used during early part of explorations for royal-red shrimp along the South Atlantic coast.

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## BACKGROUND

Between 1940 and 1955 there were several limited exploratory shrimp trawling operations along the southeastern Atlantic coast of the United States. All but one of these surveys were quite restricted in both area and depth coverage, and the total exploratory effort during this time left broad gaps in the seasonal picture. The general interest of the shrimp industry in more complete seasonal coverage, including broader depth ranges, led to an allocation of funds provided by the Saltonstall-Kennedy Act, for additional exploration between Cape Hatteras and Key West. This report presents the exploratory results obtained by the Pelican and Combat, U. S. Bureau of Commercial Fisheries chartered vessels, which operated continuously in this area from February 1956 through October 1957. Two additional cruises to the

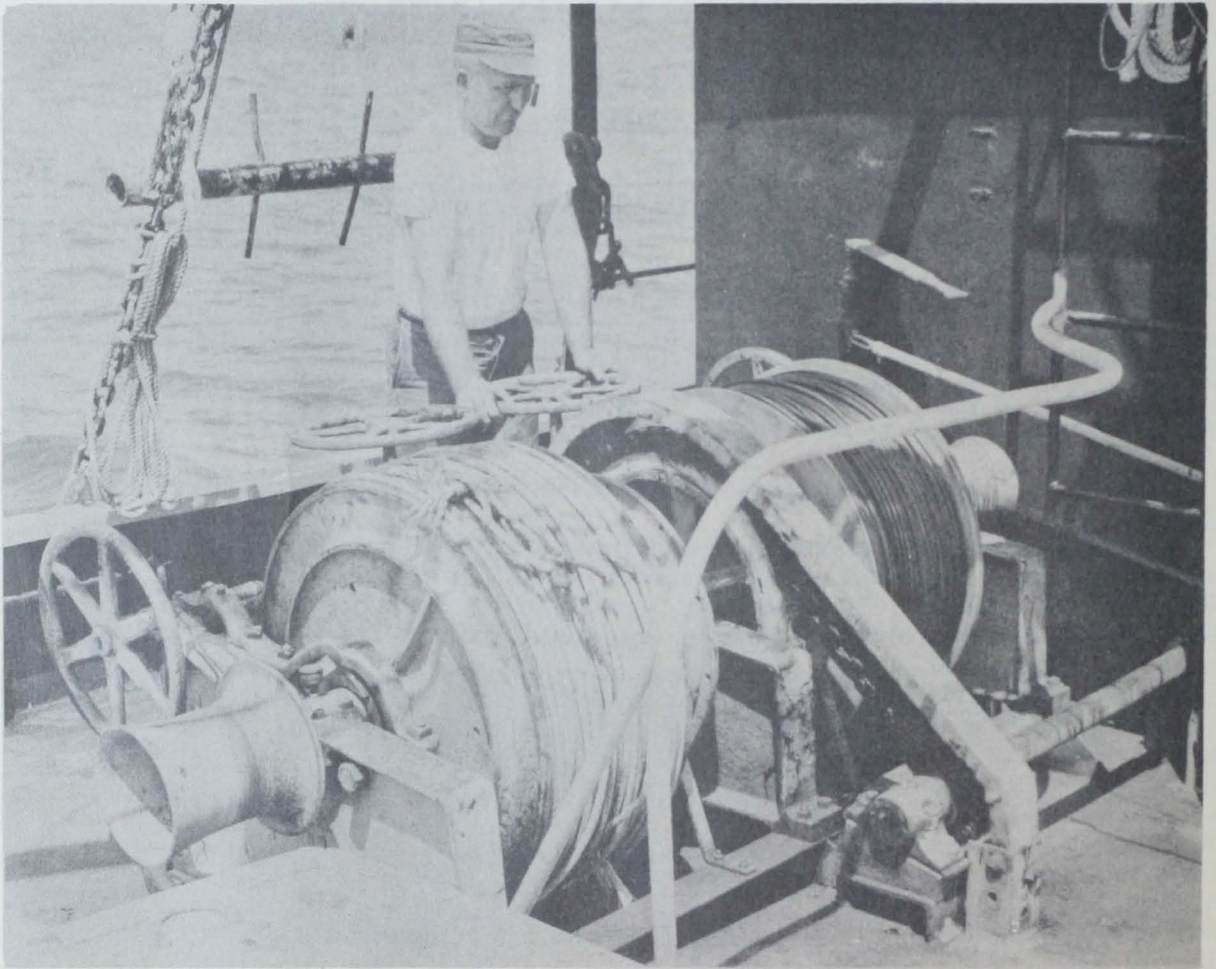


Fig. 2 - Trawling winch used on the Pelican for deep-water shrimp exploration.

area were made in November 1957, and June 1958 by the Bureau's chartered vessel Silver Bay. These were scheduled primarily to develop improved gear and fishing techniques for operating in the strong Florida current.

In programming this work, considerable time was spent in re-evaluating previous explorations, primarily to obtain leads for future fishing trials. A total of some 901 exploratory drags made by the Bureau's vessels Pelican and Albatross III, the University of North Carolina work with the Reliance, the operations of the T-19 by the Bears Bluff Laboratory, and the cooperative Fish and Wildlife Service-Gibbs Corporation work on the Antillas, showed that with the exception of a few scattered



brown-grooved shrimp (*Penaeus aztecus*), no commercial species were found beyond their known and expected depth ranges. The deepest of any of these drags was 130 fathoms and the only species of shrimp that showed any new potential was the rock shrimp, *Eusicyonia brevirostris*.

#### OPERATIONAL PROGRAM AND CRUISE ITINERARY

With the exception of some trawling along the South Carolina coast during the summer and fall of 1955 by the Bears Bluff Laboratory, all previous exploratory fishing along the southeast Atlantic coast had been carried out during the months of January to June. Since this relatively large amount of effort, which had been confined to the Continental Shelf (inside 100 fathoms), had failed to turn up new shrimp fishing areas, and since the present program was to start in late February or March, deep-water exploratory coverage was given primary emphasis. Depth-temperature and bottom-type data that had been collected by the Service's Theodore M. Gill between Cape Canaveral and Cape Hatteras showed similar conditions, in many areas within the 150-250 fathom range, to those in the royal-red shrimp grounds off Dry Tortugas. Special effort was programmed to determine the presence of royal-red shrimp (*Hymenopenaeus robustus*) off the Atlantic coast.

Cruise Itineraries Completed During the Bureau of Commercial Fisheries 1956-58 South Atlantic Fisheries Explorations			
Vessel	Dates	Areas of Coverage	Depth Ranges Fathoms
Pelican	Mar. 1-29, 1956	St. Augustine to Cape Canaveral	5-235
Pelican	Apr. 5-10, 1956	St. Augustine to Ft. Pierce	21-212
Pelican	Apr. 23-28, 1956	St. Augustine to Savannah	13-250
Pelican	May 1-22, 1956	St. Augustine	160-242
Pelican	June 8-14, 1956	St. Augustine to Ft. Pierce	153-250
Pelican	June 20-27, 1956	Georgetown, S. C., to St. Augustine	167-252
Combat	July 27-31, 1956	St. Augustine to Ft. Pierce	175-250
Combat	Aug. 6-10, 1956	St. Augustine to Ft. Pierce	170-210
Combat	Aug. 16-22, 1956	Jacksonville to St. Augustine	16-190
Combat	Aug. 30-Sept. 4, 1956	Jacksonville to Cape Canaveral	13-190
Combat	Sept. 13-19, 1956	St. Augustine to Ft. Pierce	150-215
Combat	Oct. 2-4, 1956	St. Augustine	170-200
Combat	Oct. 18-21, 1956	St. Augustine to Daytona Beach	180-230
Combat	Oct. 31-Nov. 19, 1956	Brunswick to Cape Hatteras	18-250
Combat	Dec. 5-6, 1956	Daytona Beach	180-220
Combat	Jan. 8-16, 1957	St. Augustine to New Smyrna	17-230
Combat	Jan. 28-Feb. 6, 1957	New Smyrna to Stuart and northern edge of Little Bahama Bank	175-250
Combat	Feb. 27-Mar. 16, 1957	Miami to Dry Tortugas	185-230
Combat	Apr. 17-30, 1957	Cape Fear to Cape Canaveral	13-250
Combat	May 29-June 3, 1957	St. Augustine to Cape Canaveral	18-225
Combat	June 12-27, 1957	Charleston to Cape Hatteras	21-225
Combat	July 17-30, 1957	St. Augustine to Key West and along western edge of Bahamas	40-565
Combat	Aug. 13-20, 1957	Jacksonville to Ormond Beach	20-230
Combat	Sept. 12-13, 1957	St. Augustine to Daytona Beach	180-210
Combat	Oct. 2-10, 1957	Brunswick to Charleston	6-100
Silver Bay	Nov. 20-30, 1957	South of Cape Canaveral to St. Augustine	6-250
Silver Bay	Dec. 2-4, 1957	North and South of Cape Canaveral	6-210
Silver Bay	June 8-23, 1958	Jupiter Inlet to Jacksonville	4-590
Silver Bay	June 24-28, 1958	Delray Beach to Florida Straits	10-15

In March 1957, explorations were started with the Pelican from Jacksonville, Fla. Program and operational supervision was carried out by the Bureau's Gulf Fisheries Exploration and Gear Research Office, Pascagoula, Miss. Then followed exploration by the vessels Combat and Silver Bay (see insert). In addition to these cruises, the Bureau's vessel George M. Bowers carried out shallow-water trawling for supplementary information during January-March 1956 between Jacksonville, Fla., and Cape Fear, N. C.

During the course of the exploratory work, periodic cruise reports were issued covering the current operations.



## DESCRIPTION OF VESSELS USED IN EXPLORATORY TRAWLING

During the program, three vessels were chartered by the Bureau for exploratory trawling: the M/V Pelican,<sup>1</sup> M/V Combat, and M/V Silver Bay. Two of these vessels were engaged in commercial shrimp trawling and one in groundfish trawling at the time they were chartered. The Pelican was used in the first phases of the work (February through June 1956). In July 1956, the Combat was obtained and continued through October 1957. The study was concluded with the December 1957 and June 1958 cruises of the Silver Bay.

M/V "PELICAN": The Pelican is a steel-constructed (70 feet long with a beam of 20 feet) conventional design offshore shrimp trawler (fig. 1). It was built in Tampa, Fla., in 1953, and was powered with a Diesel engine developing 170 hp. at 1600 r.p.m. The rigging was for conventional shrimp trawling, and a number of changes were required for the contemplated deep-water work.

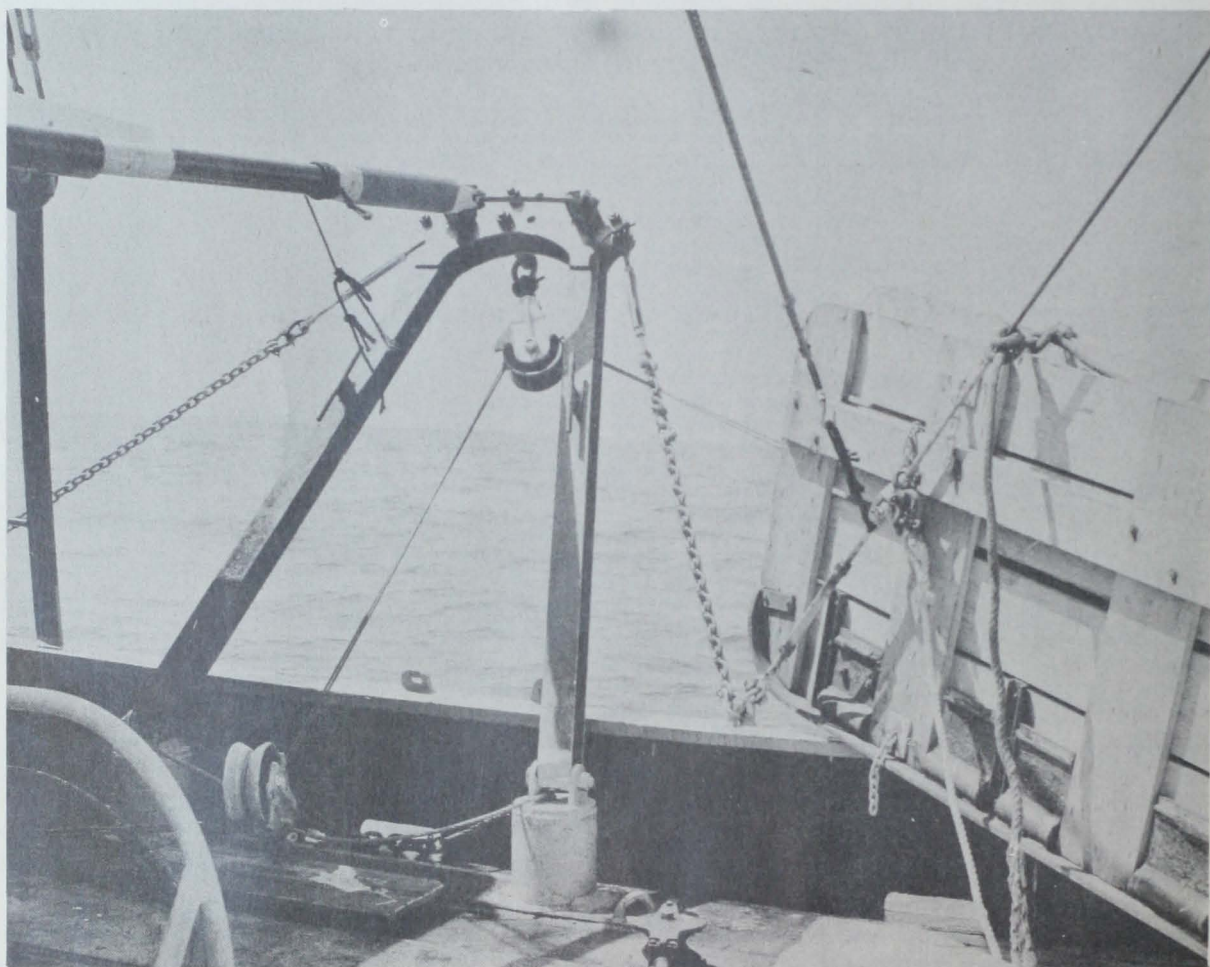


Fig. 3 - Gallows frame arrangement on M/V Pelican.

The smaller winch was replaced with a two-drum winch, with a capacity of 840 fathoms of  $\frac{3}{8}$ -inch diameter wire rope per drum (fig. 2). The new winch was mounted fore and aft, about 5-feet to port from the centerline, and was powered by a main engine take-off. One of the drums held 750 to 800 fathoms of  $\frac{3}{8}$ -inch diameter wire rope for towing the 40-foot exploratory nets, and 650 fathoms of  $\frac{1}{2}$ -inch diameter wire rope for larger trawls was carried on the other drum. An A-frame gallows

<sup>1</sup>Not the same M/V Pelican used in the earlier surveys in the Gulf of Mexico and along the South Atlantic Coast (Anderson 1956).



was mounted on the starboard side (about amidships) directly opposite the winch (fig. 3).

The wire-rope trawling cable was rove through a 9-inch x 4-inch hanging bollard blocks secured to the deck by a pad-eye, and a second similar block hung from the gallows. A guide bar was used for level-winding the cable on the winch drum.

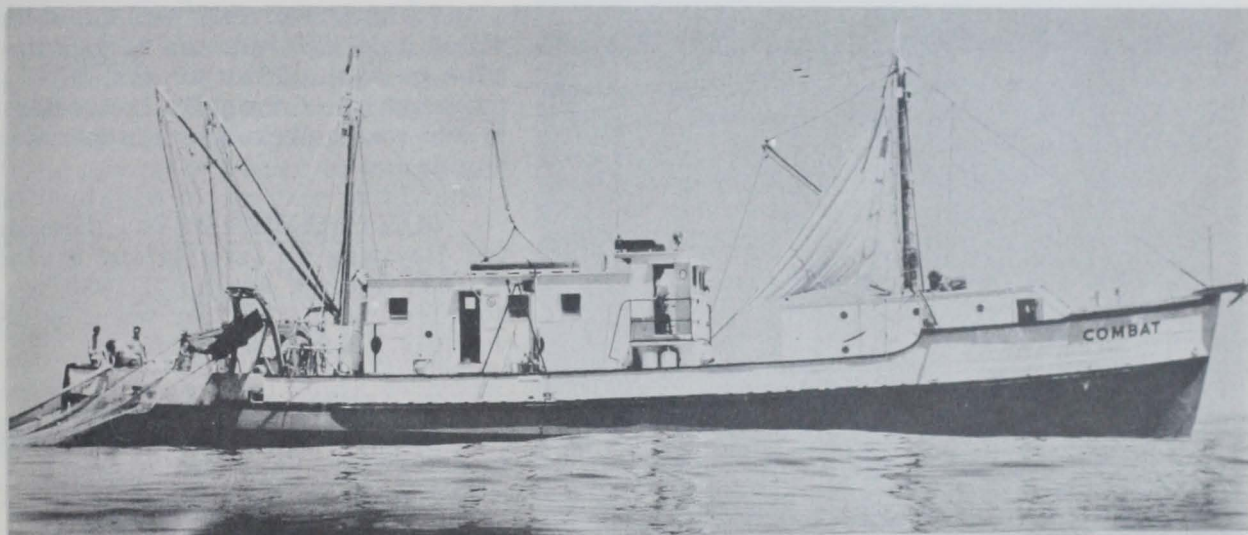


Fig. 4 - M/V Combat used during exploratory fishing program along South Atlantic Coast during 1956-57.

A chock was welded to the stern rail on the starboard side to hold the cable while trawling. The cost of these rigging changes including new equipment and wire rope was approximately \$3,500.

The vessel came equipped with loran, radiotelephone, and a shallow-water depth recorder. In addition, a recording depth-sounder with a range of 700 fathoms was installed.

M/V "COMBAT": The Combat, built in 1942, was converted from a United States Navy mine-sweeper (AMc) to a trawler in 1955 (fig. 4). The vessel was 97 feet long with a beam of 21.1 feet and a draft of 10.5 feet. The hull construction was of wood. The main engine supplied 585 hp., and the cruising speed was about 10.5 knots. The electrical system provided 110 and 32 volts; and latter was used

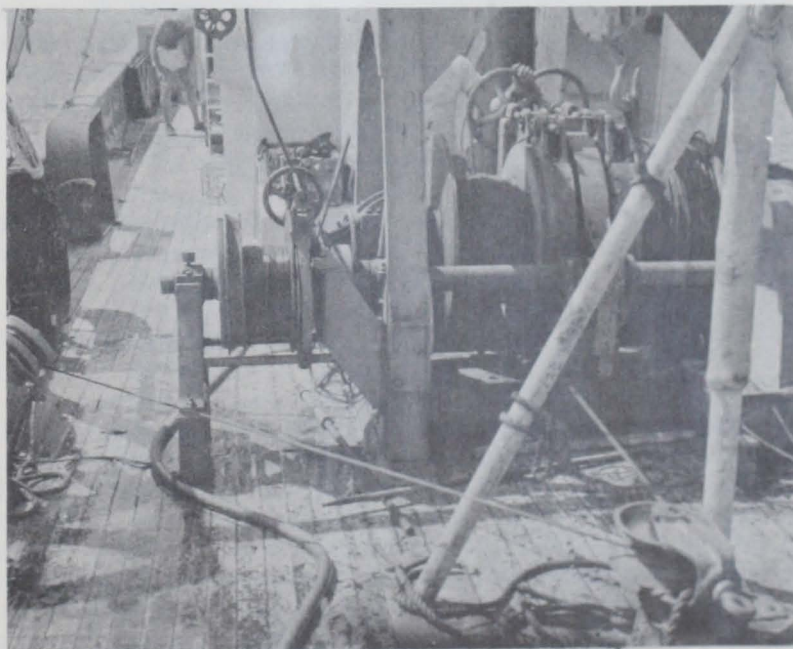


Fig. 5 - Afterdeck and winch arrangement, M/V Combat.

for the operation of electronic equipment. This included two radiotelephones, two loran sets, radiodirection finder, automatic pilot, and two depth-recorders which had ranges of 0-200 and 0-700 fathoms.



The vessel had accommodations for 11 men. The normal U. S. Bureau of Commercial Fisheries crew consisted of seven, including two scientific personnel.

A 20-foot x 28-foot holding room could hold up to 70,000 pounds of frozen fishery products at  $-15^{\circ}$  F. Two 10-hp. Diesels operated the compressors which refrigerated six banks of plates in the holding room.

The Combat had been rigged with stern davits and when desirable was capable of pulling two trawls simultaneously. A winch, which held 650 fathoms of  $\frac{1}{2}$ -inch wire on each of two drums, was mounted aft of the pilot house (fig. 5) and was powered by a separate engine.



Fig. 6 - M/V Silver Bay --a 96.4-foot New England-type side trawler used to terminate royal-red shrimp explorations along the South Atlantic Coast.

or starboard sides. Loran equipment is provided in addition to depth-recorder, radio, telephone, radar, and automatic pilot.

Accommodations are available for 16 men. Water and fuel capacity limit continuous operation to about 20 days. The main hold is not refrigerated and ice must be carried to preserve any catch.

#### GEAR AND METHODS

Since the greatest amount of trawl coverage was carried on the royal-red shrimp range, certain unique factors had to be considered in the operations. Depth and current were perhaps the most outstanding in this category. Generally speaking, fishing in depths of 150-230 fathoms was readily accomplished with only minor adaptations to conventional inshore shrimping gear. The use of a single towing cable with a bridle (25-35 fathoms in length) was the most distinct departure from methods in general use in the established fishery. During limited trials the Combat used two cables; however, these attempts were inconclusive in determining whether or not increased efficiency of the net resulted. Aluminum alloy floats were used in lieu of the more conventional plastic type which were crushed by the pressures encountered at over 150 fathoms. The amount of cable needed to fish successfully in these depths followed the 3 to 1 ratio, that is, for trawling in depths of 200 fathoms about 600 fathoms of cable were put out (in addition to the bridle).

Current fluctuations encountered throughout the area posed the most difficult obstacle in gear operation. It was by no means unusual to encounter surface cur-

M/V "SILVER BAY": The Silver Bay was utilized during the fall of 1957 and the spring of 1958 to supplement the earlier work by the vessels Pelican and Combat.

The Silver Bay, built in 1946, is a steel-constructed New England-type trawler, 96.4 feet in length with a beam of 22.6 feet and a draft of 12 feet (fig. 6). The main engine develops 562 hp. at 350 r.p.m.

Vessel equipment includes a large winch, which holds 650 fathoms of  $\frac{11}{16}$ -inch wire rope. The trawl is shot from a gallows rig which consists of gallows frames mounted fore and aft. Fishing may be carried on from either the port



rents exceeding 3 knots. Towing the trawl with the current or "fair tide" was not considered satisfactory, since steerage way was difficult or impossible to maintain, resulting in an inability to hold the proper depth range. In general, the 170 hp. of the Pelican was insufficient for counter-current trawling, and most of the work done with this vessel was down-current. Unless the current speed was considered negligible, all fishing in the royal-red shrimp range with the Combat was done counter-current (fig. 7). With this as a consideration, it becomes necessary to stress the importance of providing adequate power to any vessel designed to operate within the range of the Florida current.

Attempts to drag with the current were sometimes further hampered by blocking of the depth-recorder. At times the forward motion of the vessel would be less than the speed of the current, and the agitated water or propeller wash, being carried past the depth-recorder transducer on the bottom of the hull, caused interference that made accurate bottom recordings difficult or impossible to obtain.

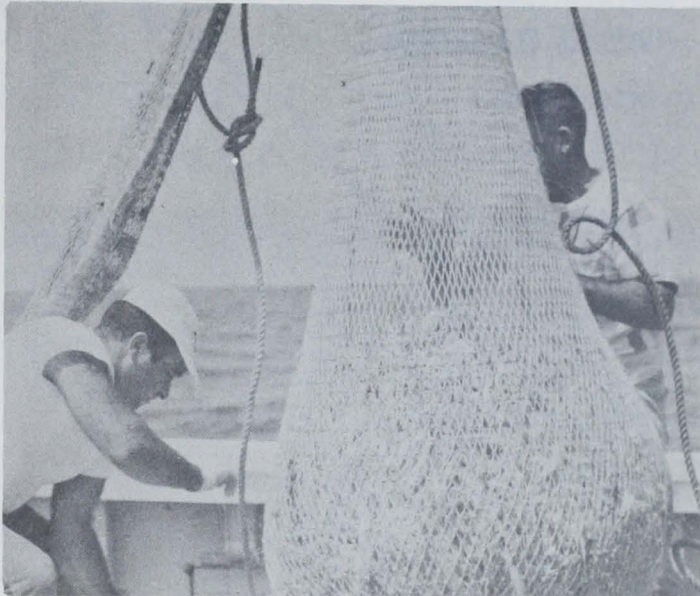


Fig. 7 - Large bag of royal-red shrimp coming aboard the M/V Combat.

When setting the gear, the net was put over, the brake was released from the winch drum, and the vessel proceeded in the general direction of the drag at about three-quarter speed. When the desired amount of cable was put out, the forward motion of the vessel was reduced to a minimum, giving the trawl about 10-15 minutes to reach bottom. After a loran fix was taken, the vessel speed was increased to the point at which the net would be moving over the bottom at approximately 3 knots.

With few exceptions standard 40-foot flat trawls, constructed of 21-thread cotton webbing with 2-inch and  $2\frac{1}{4}$ -inch stretched mesh, were used for this exploratory work. Occasionally, 55-foot and 65-foot balloon-type trawls were used. For the most part, either  $5\frac{1}{2}$ -foot northern-type bracket doors, or 5-foot chain-type doors were used in conjunction with 40- to 65-foot trawls. The chain doors performed well when constructed with extra-heavy runners; the bracket doors were used as received from the manufacturer and proved to be entirely satisfactory. The bridle of  $\frac{3}{8}$ -inch wire rope was attached to the trawling cable by a  $\frac{1}{2}$ -inch chain swivel.

The depth-recorder used aboard both the Pelican and Combat provided a continuous tracing of the bottom in depths down to 700 fathoms. Whenever practicable, any area not previously trawled would be recorder-surveyed for the purpose of locating bottom obstacles which might be a hazard to fishing gear. Once the bottom had been surveyed, 1- to 3-hour (fishing time) trial drags were made. Whenever possible drags would be carried on for at least two hours. It took 45 minutes to retrieve the trawl from depths of 200 fathoms.

#### AREA COVERED INCLUDING PHYSICAL ASPECTS

Bottom topography between Cape Hatteras and the Florida Keys displays considerable variation in both form and consistency. Off southern Florida the distance from shore to the 100-fathom curve (the edge of the Continental Shelf) is at many points less than 10 miles. At Cape Hatteras the 100-fathom curve is about 10 miles

offshore and the 1,000-fathom curve is less than 30 miles from the beach. Between north Florida and Cape Lookout the distance from shore to 100 fathoms varies from

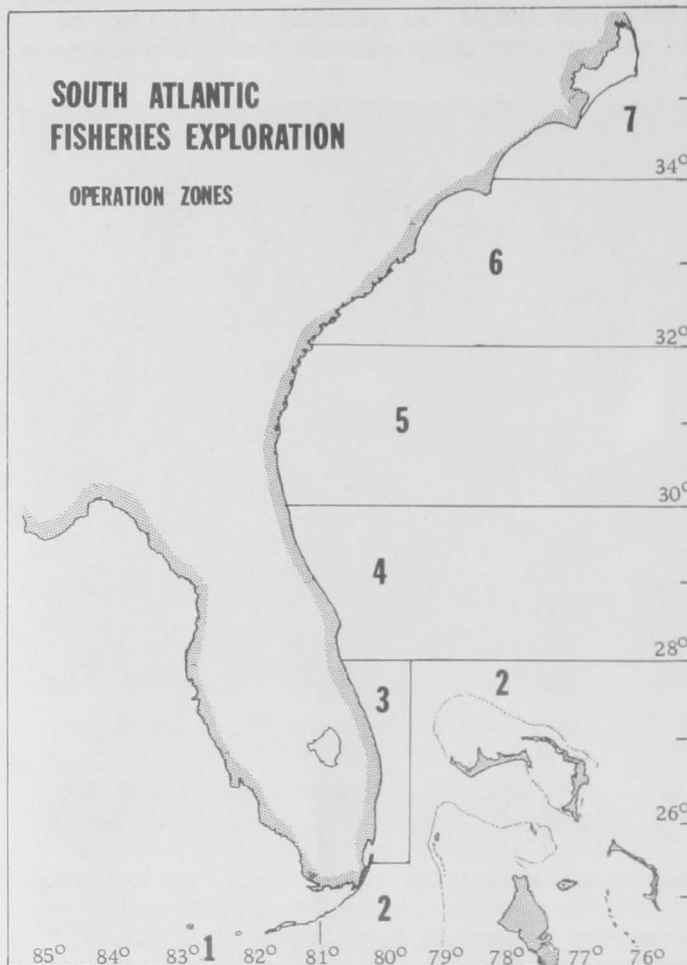


Fig. 8 - Geographic limits of zones discussed and covered by the exploratory fishing described in this article.

liot Key and the eastern portion of the Florida Straits adjacent to the Bahama Banks. This section is strongly affected by the action of the Florida Current, which greatly hampers trawling operations throughout its range. For example, east of Fowey Rocks the average surface velocity exceeds 3 knots, and it is not unusual to experience surface velocities in excess of 5 knots. For the most part, the Continental Shelf in this area is relatively narrow and the slope from 100-250 fathoms is steep and rugged, with numerous jagged limestone and coral peaks interfering with trawling operations (fig. 10). A third set of factors existing here which tend to confuse exploratory efforts are the contrasting temperatures and bottom conditions encountered along the east and west sides of the Florida Straits. The temperatures adjacent to the Bahama-Cay Sal Bank areas ranged

about 30 to 70 miles, and much of this shelf area is composed primarily of coarse sand. Throughout the entire area, the Florida Current (a portion of the Gulf Stream system) closely parallels the edge of the Continental Shelf.

For the purpose of discussion, the coast from Cape Hatteras to Key Largo has arbitrarily been divided into sections (fig. 8). A total of 672 trawl stations were attempted between February 1956 and July 1958. More than two-thirds of these were made in depths over 150 fathoms. Of the remainder, most were made in depths of 50 fathoms or less.

**AREA 1: KEY WEST-DRY TORTUGAS:** This section of the Gulf of Mexico was explored for royal-red shrimp potential by the Bureau's M/V Oregon prior to the work now under discussion. Early in 1957 the Combat carried on additional exploratory work within the royal-red shrimp range (fig. 9). The nature of the bottom, and the currents are discussed in detail by Bullis (1956).

**AREA 2: FLORIDA STRAITS-BAHAMA BANKS:** This sub-division includes the Florida Keys east of 81° W. longitude, as far north as El-



Fig. 9 - Catch of exploratory drag being emptied on stern deck M/V Combat.



from 6° to 14° F. warmer than in comparable depths (200-300 fathoms) along the western edge of the Florida Current. The bottom adjacent to the Bahama Banks in depths of 200-300 fathoms is typically composed of white calcareous mud with occasional patches of coral. By contrast, the bottom conditions encountered at the same depths in close proximity to the Florida coast consist primarily of green mud similar in general appearance to the bottom found in these depths along the Continental Slope further north.

AREA 3: SOUTHEASTERN FLORIDA COAST: This small subdivision embraces the waters adjacent to the southeastern coast of Florida. It extends southward from Malabar (latitude 28°00' N.) to a point just south of Fowey Rocks (latitude 25°30' N.).

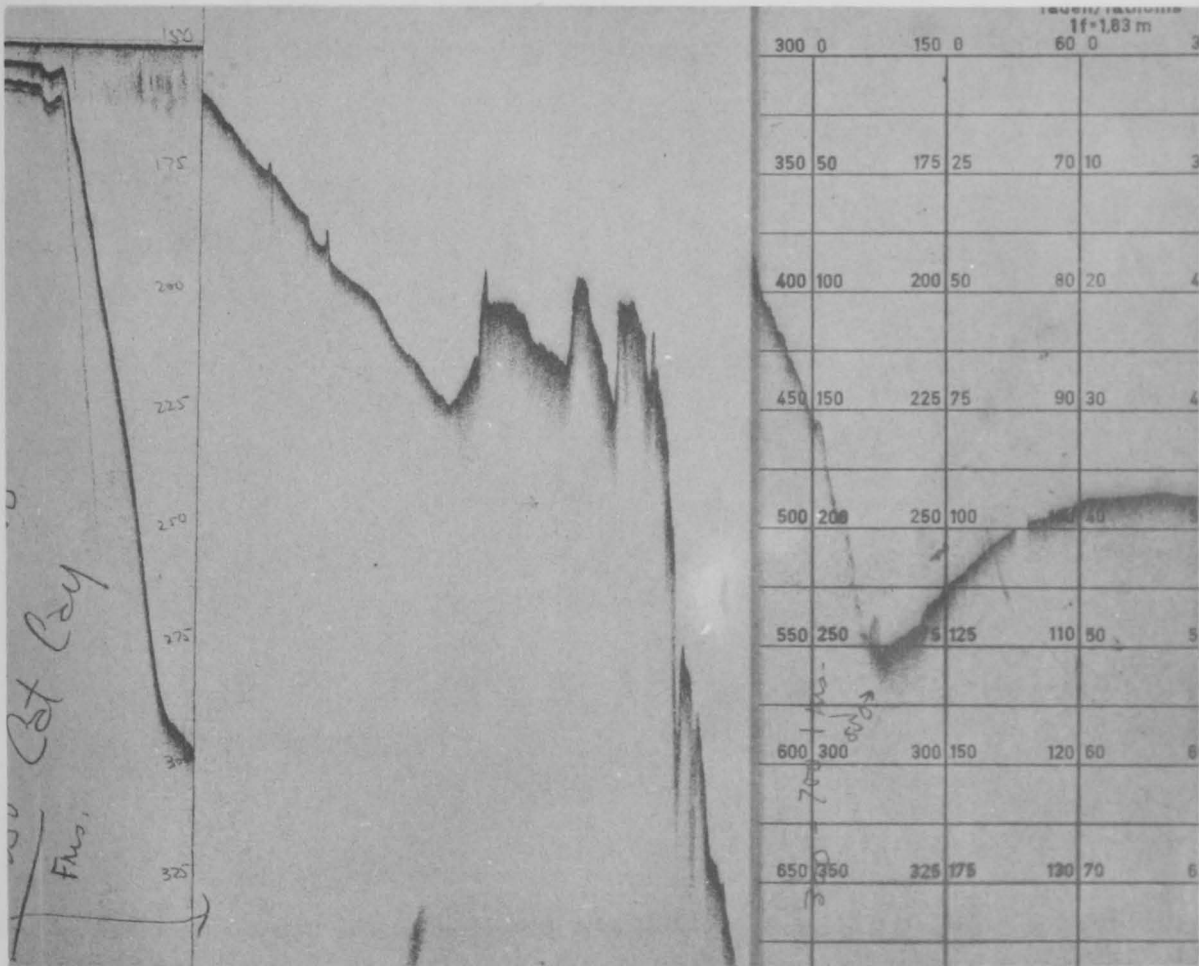


Fig. 10 - Depth-recording made sailing across Straits of Florida from Miami eastward. Middle portion of tracing illustrates the drop-off from 150 to 350 fathoms.

Throughout this area, particularly unfavorable trawling conditions persist. The Florida current reaches its maximum velocities within these boundaries. The Continental Shelf is extremely narrow. Concentrations of live coral and jagged limestone formations are the outstanding bottom characteristics (fig. 11).

Although occasional attempts were made to trawl in this area, most of these resulted in heavy gear damage. In addition to the effect of the currents and the poor trawling circumstances found here, unusually heavy convergence of shipping activity further complicates efforts to fish in these waters.



AREA 4: ST. AUGUSTINE-CAPE CANAVERAL: This portion received by far the greatest amount of coverage. Of the 672 trawl stations made between Cape Hatteras and the Florida Keys, 405 were made between latitudes  $30^{\circ}$  N. and  $28^{\circ}$  N.

150 Fathoms and Greater: A total of 340 trawl stations were occupied in this segment, and of these, 302 were made between  $29^{\circ}$  N. latitude and  $30^{\circ}$  N. latitude. With the exception of a small patch of rough bottom between  $29^{\circ}55'$  N. and  $30^{\circ}$  N., the bottom is relatively free of trawling hazards. For the most part, the bottom between

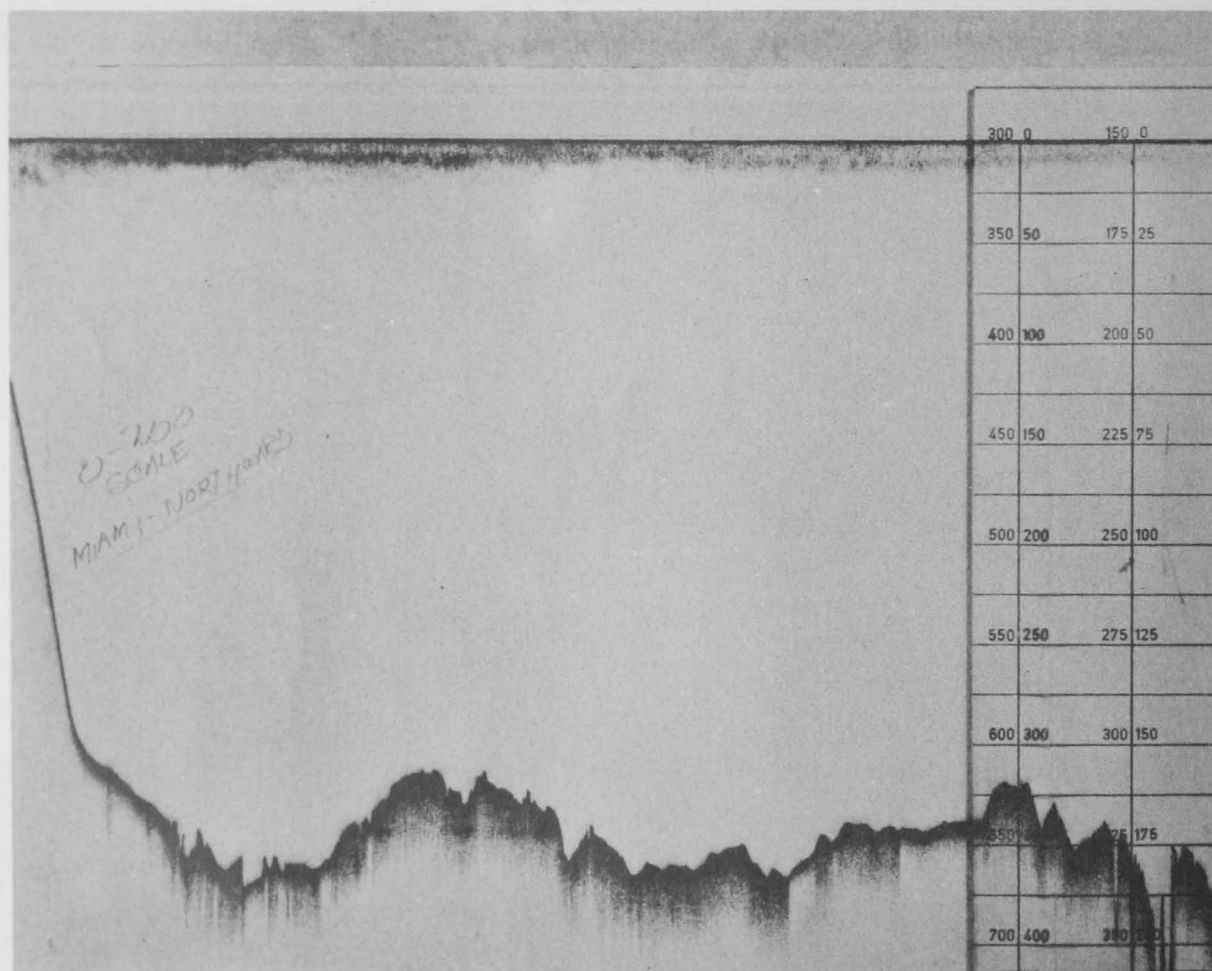


Fig. 11 - Depth-recording made in royal-red shrimp range east of Miami Beach, Fla. This type of bottom is not trawlable with conventional shrimp trawls.

150 and 250 fathoms consists of green mud and provides excellent trawling bottom (figs. 12 and 13). On occasion, the trawl would bog; however, in most cases when this occurred, it was observed that the vessel speed had been allowed to fall below the desired trawling rate of 3-knots ground speed.

An important factor at this location is the variable nature of the current speed and the flow here, on occasions, reaches velocities of at least 3 knots. A constant surveillance of its effect on trawling speed is required. Hourly checks were made by loran fix to insure a trawling speed of 2.5-3 knots over the bottom. When the vessel speed was observed to vary significantly from these speeds, a suitable allowance was made by increasing or decreasing the engine acceleration.

Variations in the force, direction, and relative position of the current have been observed to occur in short periods of time. No correlation is obvious between the local weather and the actions of the current.



In addition to the effect of the current on vessel speed, a second factor was apparent. Whenever the direction of the wind is from a northerly point, and if its velocity reaches a speed in excess of 20 knots, an unusually difficult sea is built up against the north or northeast flow of the surface waters. Since strong northerly winds are common between September and May, the resultant sea conditions frequently force curtailment of fishing operations until the wind moderates.

In June 1958, the Silver Bay made 13 drags beyond the 300-fathom curve (out to depths of 590 fathoms) and found that this depth range is practically untrawlable with conventional shrimp gear. Extensive patches of the deep-sea coral (Lophelia proliifera) predominate and contact with these invariably resulted in gear loss or extensive damage.



Fig. 12 - East-West transect from 160-260 fathoms at southern edge of royal-red shrimp grounds off east coast of Florida.

Coverage in Less than 150 Fathoms: Relatively good trawling coverage was given to areas inside the 150-fathom curve. In particular, the shelf waters adjacent to Cape Canaveral and east of the St. John's River entrance received considerable attention. Much of the shelf, inside 20 fathoms there, consists of sand with occasional impairment to trawling by isolated limestone outcroppings and concentrations of sea fans. Between the 20- and 100-fathom curves, much of the bottom is dominated by rugged coral formations and sponge which make trawling difficult or impossible with conventional gear.

AREA 5: SAVANNAH, GA.-ST. AUGUSTINE, FLA.: This zone received considerable effort, and it is particularly interesting to note that much of the shelf between



latitudes  $32^{\circ}$  N. and  $30^{\circ}$  N. displays a typical "tropical" fauna. Although many of the fishes and invertebrates generally considered to be tropical occur further to the north, it is at about the latitude of northern Florida where such forms as the massive loggerhead sponges and many of the reef fishes are relatively common.

150 Fathoms and Greater: The offshore area between Savannah, Ga., and St. Augustine, Fla., is characterized by extremely irregular bottom. Attempts to drag on the Continental Slope here were often interrupted by severe rises or depressions which made it compulsory to haul back the gear to prevent damage. Occasional samples of the bottom brought up in the trawl consisted of smooth limestone rock, known to the fishermen as "slab rock." Twenty-three drags were attempted at depths

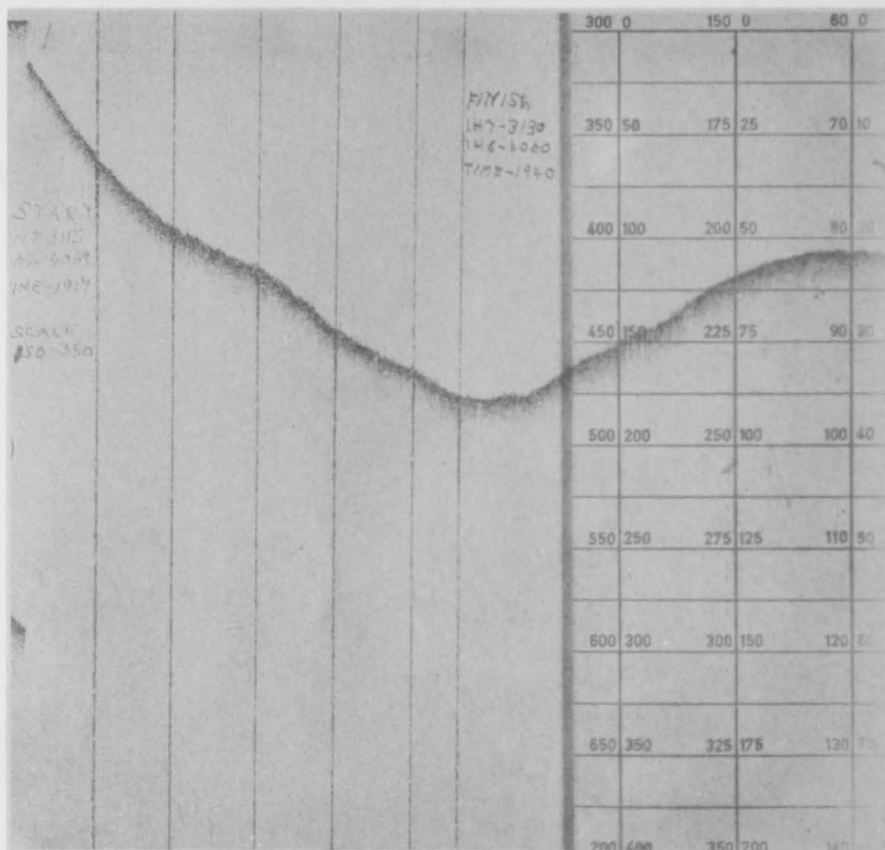


Fig. 13 - East-west transect from 160-240 fathoms at northern limit of royal-red shrimp grounds off east coast of Florida.

of the United States. From a point at the latitude of Georgetown, S. C., the distance, in an easterly direction to the 100-fathom curve is over 100 miles.

150 Fathoms and Greater: At a point in the vicinity of latitude  $33^{\circ}$  N., the distance between the 150-fathom and 250-fathom curves reaches a width of about 20 miles. This distance is the greatest between these depth ranges for any point along the entire region from Cape Hatteras to South Florida. For the most part, the bottom between 150 and 250 fathoms in this subdivision is composed of mud and sand and trawling is usually possible. A total of 31 drags was made at depths greater than 150 fathoms in this section (fig. 14). Six of these resulted in serious gear damage.

Less than 150 Fathoms: The shelf along here is gradual and composed chiefly of sand and shell. Intermittent ridges of dead shell (mostly *Pecten gibbus*) and occasional mud patches characterize the depths from 20-50 fathoms. In the vicinity of the 50-fathom curve sporadic rocky spots interfered with trawling. Between 11

of 150 fathoms or greater. Due to the limited amount of trawlable bottom, however, most were of short duration.

Less than 150 Fathoms: Sixty-two drags were made, most of these between 25 and 40 fathoms. There are large portions of trawlable bottom in this section. It is, for the most part, composed of sand and shell. There are also sporadic patches of coral, sponge, and sea-fan communities which often cause net damage.

#### AREA 6: CAPE FEAR-SAVANNAH, GA:

In this division, the Continental Shelf reaches its greatest breadth along the southeastern seaboard



and 150 fathoms a total of 20 trawl drags was made. The coverage accomplished by these is not truly representative of this portion of the shelf.

AREA 7: NORTH CAROLINA CAPES: Two exploratory cruises by the Combat were carried out in this section. One of these was made during the fall of 1956 and the other during June 1957.

150 Fathoms and Greater: The nature of the Continental Slope between Cape Hatteras and Cape Fear hampered trawling operations. The slope between these points is steep and occasionally rocky resulting in considerable loss of gear. The bottom types along this portion are variable with alternating stretches of sand, mud, coral and gravel mixed with large rocks. Although there is some good trawling bottom (fig. 15), it is not extensive.

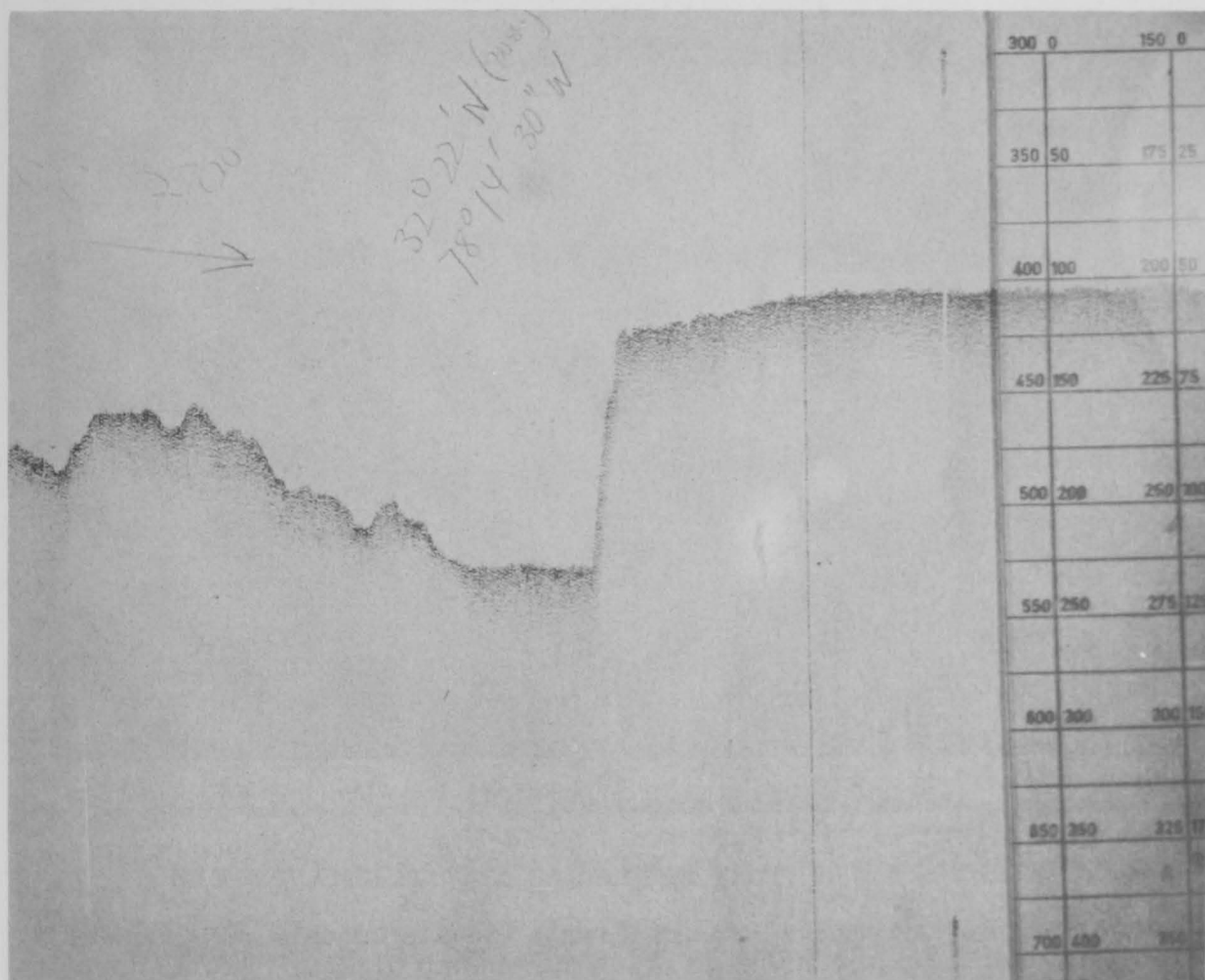


Fig. 14 - Depth-recording of bottom east of Beaufort, S. C. (150-350 fathom scale).

Although the northerly flow of the Gulf Stream system is less pronounced north of Cape Fear as compared with the area to the south, current did influence trawling operations in deep water as far north as Cape Hatteras.

Less than 150 Fathoms: Forty-two drags were attempted in depths of less than 150 fathoms. All trawling in these depths was carried on between Cape Lookout and Cape Hatteras. In this vicinity the slope of the shelf is gradual between 25 and 40 fathoms. Trawling conditions are relatively good out to the 40-fathom curve. Most of the bottom in this range consists of sand with some shell and only occasional

patches of hard bottom. By contrast, from about the 40-fathom depth contour seaward, the slope of the bottom increases sharply and is characterized by sometimes rugged bottom, showing little prospect of trawling with conventional shrimp fishing gear. No coverage was attempted to the south and west of Cape Lookout inside 150 fathoms. Some of this has been covered by other programs (Buller 1951; Institute of Fisheries Research 1951).

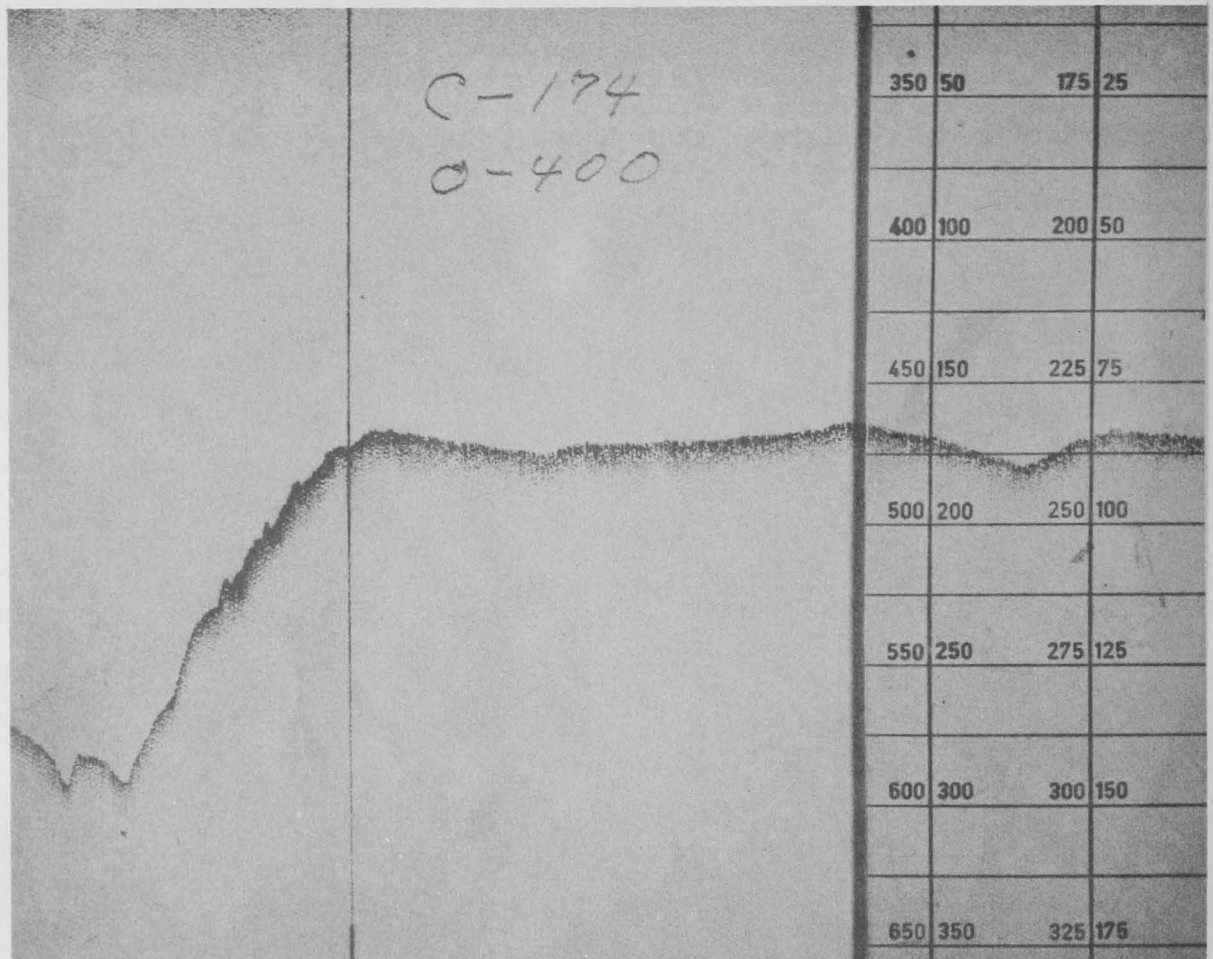


Fig. 15 - Depth-recording of bottom in the vicinity of Cape Hatteras, N. C.; vertical line indicates start of drag C-174 which was made at 175 fathoms. (0-400 fathom scale.)

#### FISHING RESULTS BY EXPLORATORY FISHING VESSELS

The first attempts by the Pelican to trawl in 180-235 fathoms were successful in finding promising concentrations of royal-red shrimp (fig. 16). From March 2 to June 14, 1956, a total of 55 exploratory stations were made in 150 to 250 fathoms from Cape Canaveral to St. Augustine, delimiting what appeared to be grounds of commercial potential. In May and June, 25 drags in this area produced 2,700 pounds of royal-red shrimp, with the most productive drags in the 175-212 fathom range off St. Augustine where 3 drags of 4 to 5 hours duration caught 1,020 pounds of heads-on shrimp.

The work of the Combat, starting in July, was directed to more precisely define the area, to obtain seasonal catch information, and to explore to the north and south for possible new royal-red shrimp fishing grounds. Of the 19 trips made by the Combat, 15 were devoted either in part or entirely to work in the St. Augustine to Cape Canaveral area, chiefly between 29° N. and 30° N. latitude.



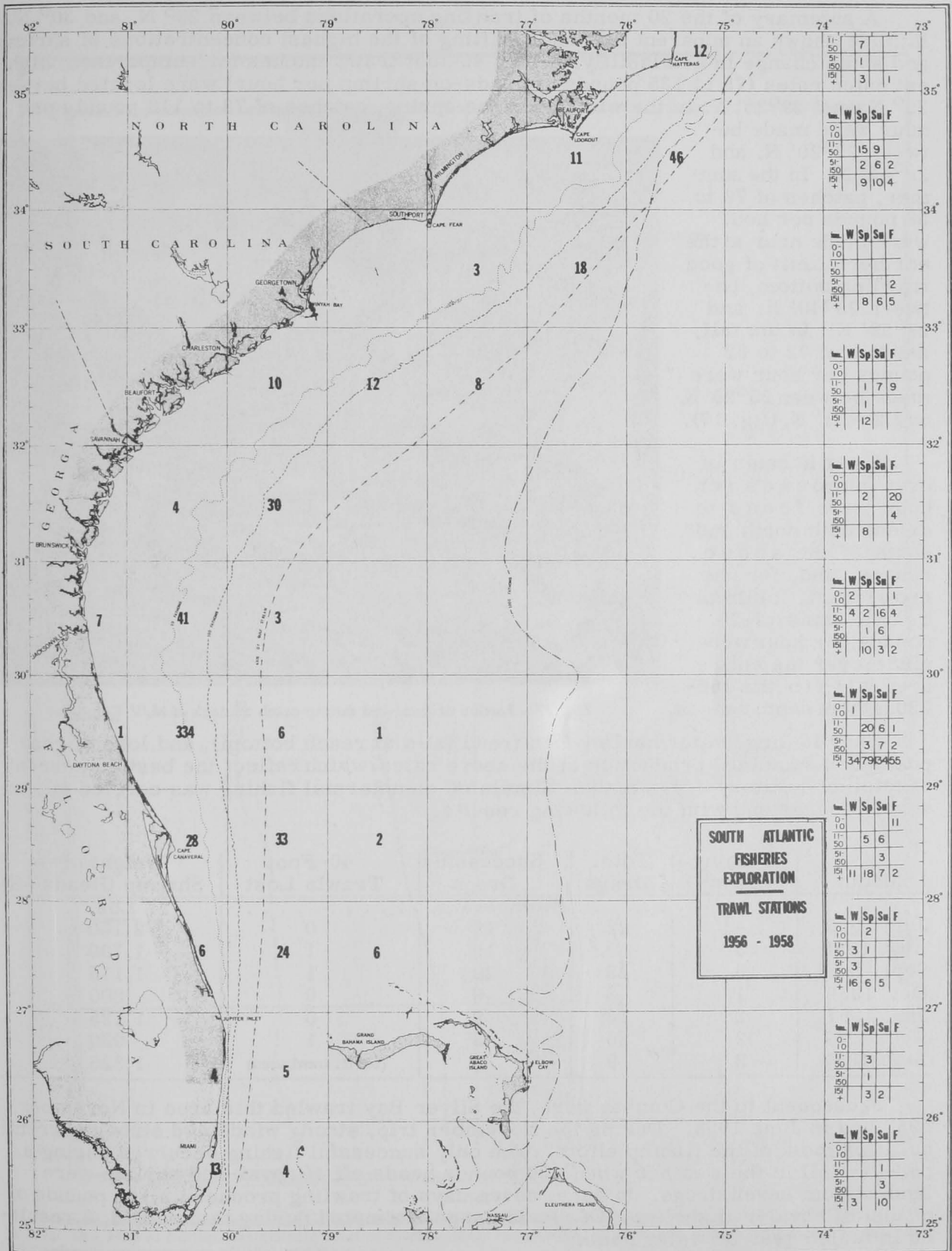


Fig. 16 - Geographic distribution of trawl stations made by the vessels *Pelican*, *Combat*, and *Silver Bay*, from 1956-1958. Numbers within latitude and longitude quadrangles represent the total number of drags made in each quadrangle. Figures on extreme right designate the total drags by season and depth for each degree of latitude.

A summary of the 20 months of trawling operations between 29° N. and 30° N. latitude shows an apparent seasonal shifting of the highest concentrations of shrimp, and some change in availability. Using 40-foot trawl catches for comparison, highest catch rates (75 to 135 pounds of heads-on shrimp per hour) were located between 29° N. and 29°20' N. in the winter. In the spring, catches of 72 to 118 pounds per hour were made between 29°20' N. and 29°45' N. In the summer, catches of 78 to 98 pounds per hour were made near at the northern limit of good trawling bottom, between 29°40' N. and 29°58' N. In the fall, catches of 72 to 82 pounds per hour were made between 29°20' N. and 29°35' N. (fig. 17).

Catch rates of over 50 pounds per hour were found to extend both north and south of the above ranges, and, for the most part, minimal catch rates of 20 pounds per hour were made over the entire area within the 160-220 fathom depth ranges.



Fig. 17 - Portion of royal-red shrimp catch on deck of M/V Combat.

Gear fouling, water hauls (when trawl fails to reach bottom), and loss of gear precluded sustained production at the above rates, which reflect the best 25 percent of total exploratory drags made. Simulated commercial fishing was carried out on several occasions with the following results:

Month	Fishing Days	Total Drags	Successful Drags	40-Foot Trawls Lost	Weight of Shrimp (Heads off)
			(Number)		Lbs.
July 1956	4 $\frac{1}{4}$	22	16	0	2,100
Aug. 1956	5	19	16	1	1,700
Sept. 1956	5	25	20	1	1,175
Oct. 1956	1	8	6	0	800
Jan. 1957	2	10	9	0	1,125
Feb. 1957	2	10	9	1	930
Aug. 1957	2	9	9	(65-ft. trawl used)	1,325

Subsequent to the Combat work, the Silver Bay trawled this area in November 1957 and in June 1958. During the November trip, strong winds and strong current nullified most of the fishing effort. The only successful fishing occurred during a two-day lull in the weather when 530 pounds heads-off of royal-red shrimp were landed from seven drags. In June, seven days of trawling produced 2,143 pounds of heads-off royal-red shrimp. Of the 35 drags attempted during this period, 9 resulted in fouled gear or water hauls.

Considerable time was usually spent at the beginning of each trip in locating the best fishing depths and areas. Daily and drag-by-drag fluctuations in the catch rate



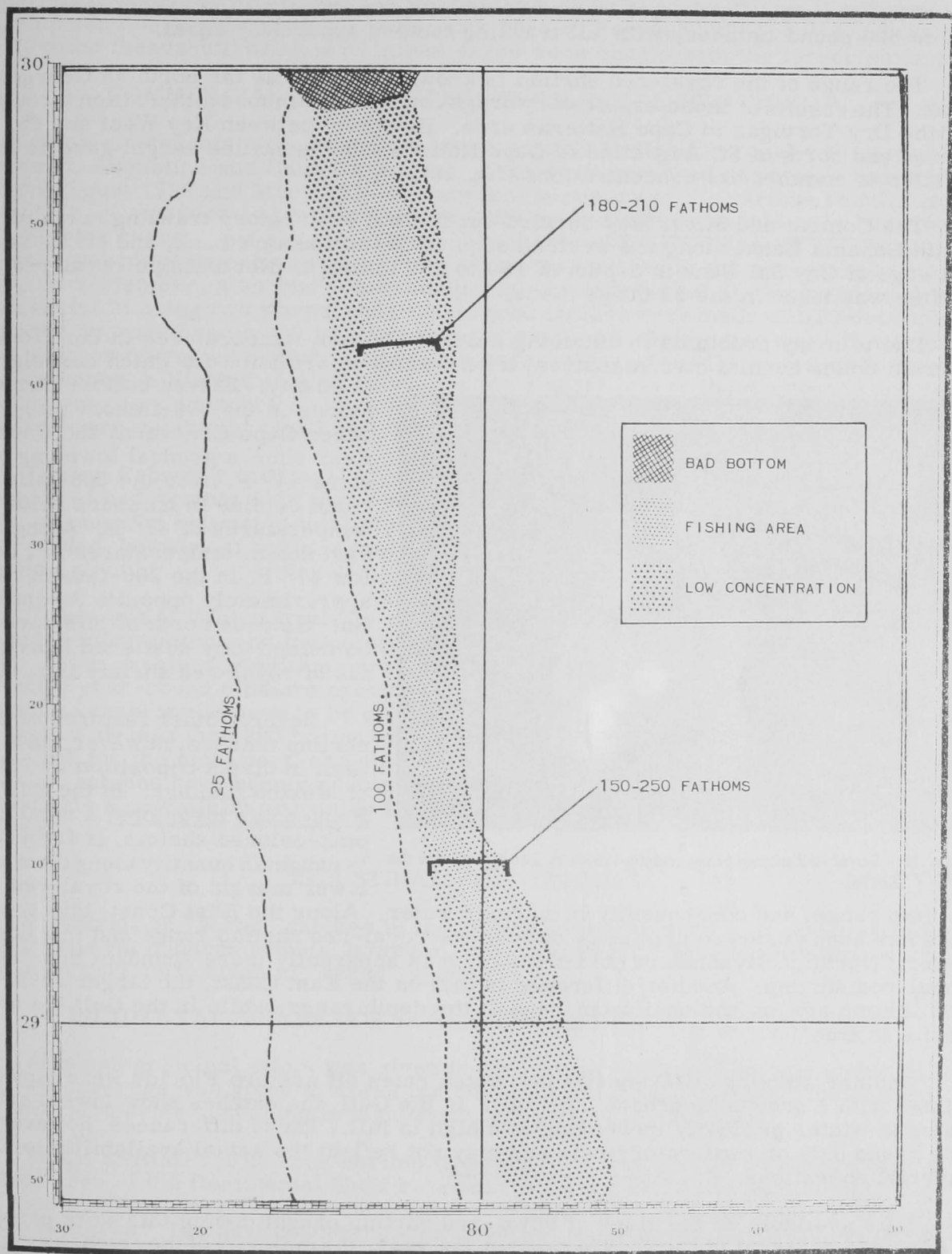


Fig. 18 - Map of fishing area off east coast of Florida where best catches of royal-red shrimp were taken. Shading refers to concentration of royal-red shrimp.

are still unexplained, and may be attributed to variation in gear operation or behavior of the shrimp. Catches of 10 pounds or less are frequently interspersed with 300 to 500-pound catches, with all trawling factors apparently equal.

The range of the royal-red shrimp is known to extend as far north as Georges Bank. The results of these exploratory drags confirm continuous distribution throughout the Dry Tortugas to Cape Hatteras area. However, between Key West and Ft. Pierce and north of St. Augustine to Cape Hatteras the quantities caught gave no indication of commercial concentrations (fig. 18).

The Combat and Silver Bay carried out limited exploratory trawling north of Little Bahama Bank, along the western edge of Grand Bahama Bank, and off the northern edge of Cay Sal Bank in depths of 180 to 590 fathoms. Not a single royal-red shrimp was taken in the 29 drags made.

Due to many problems in obtaining accurate bottom temperatures in the Florida Current under normal circumstances, temperature information for catch correlation is scanty. Eleven bottom temperatures in the 200-fathom range between Cape Canaveral and Cape Fear show a gradual lowering of some  $4\frac{1}{2}^{\circ}$  F. over the 300-mile rapid decline in numbers below temperatures of  $47^{\circ}$  F. Along the east coast, temperatures fall below  $47^{\circ}$  F. in the 200-fathom range approximately opposite Savannah, Ga. Catches north of this have contained only scattered individuals of royal-red shrimp (fig. 19).



Fig. 19 - Royal-red shrimp being weighed prior to freezing aboard the M/V Combat.

Several other features of the shrimp catches, however, have been in direct opposition to Gulf of Mexico findings. In the Gulf, Penaeopsis megalops, a smaller pink-colored shrimp, is frequently caught in quantity along the shallower margin of the royal-red shrimp range, and consequently in warmer water. Along the East Coast, this species has been observed primarily outside the royal-red shrimp range and in colder water. North of Savannah in colder water, it is apparently more abundant than the royal-red shrimp. Another difference is that on the East Coast, the larger royal-red shrimp are on the shallower edge of the depth range, while in the Gulf the opposite is true.

Another striking difference is that catch rates off eastern Florida were high in winter with a gradual decrease until fall. In the Gulf, the catches show lowest catch rates in winter gradually increasing to a high in fall. These differences, however, are based only on exploratory data and may not reflect the actual availability to commercial operations.

Data available on the sizes of royal-red shrimp caught during this work present a confused seasonal picture. Throughout the year, the majority of the catches ranged between 16 to 20 and 31 to 35 count heads-off, with an average count of 25 per pound. However, the differences in sizes between the sexes was very striking, with the males usually less than half the size of the females. An average count for the entire catch would then be materially affected by the sex ratio within the shrimp catch. In the St.



Augustine area, the females ranged between 15 and 25 count and made up over half the catch by total weight. The males ranged from 35 to 50 count. Signs of very small shrimp were obtained during the September 1956 to February 1957 period, when 50 to 70 count (heads-off) catches of mixed sexes were caught with the larger shrimp.

#### COMMERCIAL FISHING EFFORTS ON ROYAL-RED SHRIMP

Some six vessels have attempted to commercially fish for royal-red shrimp between St. Augustine and Cape Canaveral. This work occurred at various times between August 1956 and May 1957. A complete summary of the various results is not available. Considerable trouble was encountered in trawling in this area because of the Florida current and sea conditions. The first vessel experienced severe fouling of gear and trawling cables while trying to use two cables in the conventional manner. In September, a second vessel made four short trips off St. Augustine and was successful in using two warps, and several good catches were made with 80-foot trawls. Catches averaged some 400 to 500 pounds of heads-off shrimp per day. However, bad weather disrupted operations and this vessel discontinued deep-water fishing. In November, a North Carolina trawler made a short trip to these grounds and reported very large catches of 50 to 60 count royal-red shrimp. Catches of large shrimp were relatively small and fishing was discontinued.

During February to May 1957, from 1 to 5 vessels were in operation. Frequent periods of bad weather kept these vessels in port more than 50 percent of the time and, although an estimated total of over 40,000 pounds of heads-off royal-red shrimp was landed, because of various factors all deep-water shrimp fishing was discontinued.

These initial fishing trials by commercial vessels provided several pieces of valuable information, and indicated several points of importance for any future effort. First, weather conditions prevalent along the eastern Florida coast prevent efficient year-round offshore operation with the conventional shrimp trawler. A suitable vessel would have to be able to work safely in fairly heavy seas. In addition, vessels with less than 200 horsepower experience difficulty in towing counter-current, and for the most part, are able to do so only during periods of slack current. Finally, catches have been variable but a sufficient number of good trips were made to indicate a potentially profitable fishery if continuous fishing effort can be maintained.

#### INDUSTRIAL FISH CATCHES

Industrial or "scrap" catches in the 200-fathom area varied in amount from a few to several hundred pounds; however, large catches of royal-red shrimp were for the most part quite clean of "scrap" species.

#### INCIDENTAL SPECIES OF POSSIBLE COMMERCIAL IMPORTANCE

Although principal effort was given to evaluating royal-red shrimp potential, limited coverage was given to areas inside the range of this species. Indications of several species appearing in significant amounts were observed.

**ROCK SHRIMP:** The rock shrimp (*Eusicyonia brevirostris*) was taken over a wide area of the Continental Shelf between the depths of 10 and 80 fathoms. Significant amounts were taken from several locations between Cape Canaveral and Cape Hatteras. The best concentrations observed were in the 22-45-fathom depth range. Off North Florida in 22 and 23 fathoms, good catches of this species were made. One drag (C-101) there produced 150 pounds of rock shrimp after one hour's fishing time.

Farther to the north, up to 40 pounds per hour were taken in 25 fathoms southeast of Cape Lookout, N. C.

Considerable information regarding the distribution of rock shrimp was obtained in earlier work by Anderson (1956) and current explorations being carried on by the vessel T-19 operating out of the Bears Bluff Laboratory at Wadmalaw Island, S. C.

**SCALLOPS:** The scallop (Pecten gibbus) was taken in varying amounts between Cape Canaveral and the Georgia coast in depths from 20-30 fathoms. On several occasions over two bushels were taken in short drags with a conventional shrimp trawl. A one-hour drag (C-160) off the Florida-Georgia border in 21 fathoms resulted in a catch of 165 pounds of scallops up to 2 inches in diameter.

**FLOUNDER:** Occasional catches of the flounder (Paralichthys squamilentus) at depths of 60-90 fathoms offer the possibility that further exploration at these depths might uncover concentrations of this species. This flatfish, which is similar to the summer flounder (P. dentatus), reaches a size of over three pounds.

**OTHER SPECIES:** Intermittent large catches of several species of fish were made while using shrimp trawls. Among species sometimes taken in good numbers along the edge of the Continental Shelf were spot (Leiostomus), croaker (Micropogon), butterfish (Poronotus), hake (Urophycis), and whiting (Merluccius). Approximately 3,000 pounds of spot were taken in one tow off Georgia in 75 fathoms, during early October 1957.

#### APPENDIX

Complete fishing logs with detailed station records are not included here, but are available upon request as an appendix to the reprint of this article. Write for Separate No. 551, which contains the fishing logs of the vessels which participated in the Bureau's 1956-58 South Atlantic fisheries explorations.

#### LITERATURE CITED

- ANDERSON, WILLIAM W.  
1956. January to April Distribution of the Common Shrimp on the South Atlantic Continental Shelf. U. S. Fish and Wildlife Service, Special Scientific Report - Fisheries No. 171.
- BROAD, CARTER  
1950. Results of Shrimp Research in North Carolina. Proceedings of the Gulf and Caribbean Fisheries Institute, Third Annual Session, pp. 27-35.  
1951. Survey of Marine Fisheries of North Carolina. Part II. Biology and Natural History of the Economic Species, The Shrimps in North Carolina. The University of North Carolina Press, Chapel Hill, N. C., pp. 191-204.
- BULLER, RAYMOND J.  
1951. A Survey of Southern Coastal Waters. U. S. Fish and Wildlife Service, Special Scientific Report - Fisheries No. 58.
- BULLIS, HARVEY R., Jr.  
1951. Gulf of Mexico Shrimp Trawl Designs. U. S. Fish and Wildlife Service, Fishery Leaflet 394.  
1956a. Preliminary Results of Deep-Water Exploration for Shrimp in the Gulf of Mexico by the M/V Oregon (1950-1956). Commercial Fisheries Review, vol. 18, no. 12 (December). (Also Separate No. 460.)  
1956b. Royal-Red Shrimp - A New South Atlantic Resource. Proceedings of the Gulf and Caribbean Fisheries Institute, Ninth Annual Session, pp. 56-60.
- INSTITUTE OF FISHERIES RESEARCH  
1951. The Shrimp Survey in North Carolina Waters. The University of North Carolina, Institute of Fisheries Research, Morehead City, N. C.
- LUNZ, ROBERT G.  
1957. Notes on Rock Shrimp (Sicyonia brevirostris) (Stimpson) from Exploratory Trawling off the South Carolina Coast. Contribution from Bears Bluff Laboratories No. 25; Bears Bluff Laboratories, Wadmalaw Island, S. C., pp. 1-10.
- SPRINGER, STEWART and BULLIS, H. R., Jr.  
1952. Exploratory Shrimp Fishing in the Gulf of Mexico, 1950-51. U. S. Fish and Wildlife Service, Fishery Leaflet 406.  
1954. Exploratory Shrimp Fishing in the Gulf of Mexico. Summary Report for 1952-54. Commercial Fisheries Review, vol. 16, no. 10 (October). (Also Separate No. 380.)
- TAYLOR, FRANCIS B.  
1956. 39 Fathoms Southeast, North Edisto Sea Buoy off South Carolina. Contribution from Bears Bluff Laboratories, No. 20, Bears Bluff Laboratories, Wadmalaw Island, S. C., p. 15.

