DEVELOPMENT OF THE JOHN N. COBB PELAGIC TRAWL--A PROGRESS REPORT

By Richard L. McNeely*

ABSTRACT

A large single-boat pelagic trawl utilizing hydrofoil otter boards is under development by the U. S. Bureau of Commercial Fisheries Exploratory Fishing and Gear Research Base in Seattle, Wash. The general configuration of the huge gear is based on the theory that a large net traveling at relatively low speed through midwater or on the surface (fig. 1) would be more effective in capturing large, active fish than a small net towed at high speed. Construction details have primarily resulted from direct observation of experimental nets in action by SCUBA-equipped staff members. These observations have allowed a series of modifications to be performed, resulting in attainment of a favorable ratio of net size to horsepower requirements. A mouth opening of approximately 7,200 square feet and a towing speed of 2.5 knots using 350 horsepower has been accomplished.

INTRODUCTION

Commercial fishermen and marine scientists have in the past often considered improvements in the techniques of harvesting stocks of fish known to inhabit midwater. Their interest in mid-depth fishing was accelerated with the introduction of echo-sounding machines which, in addition to registering the depth of water under the vessel, indicated marine life at intermediate depths (Alverson and Powell 1955). In recent years a variety of mid-depth fishing trawls have been used experimentally in attempts to efficiently harvest pelagic fishes (Parrish 1959).

During early 1961, a program of one-boat midwater trawl development was undertaken by the Bureau's Seattle Exploratory Fishing and Gear Research Base, in cooperation with the

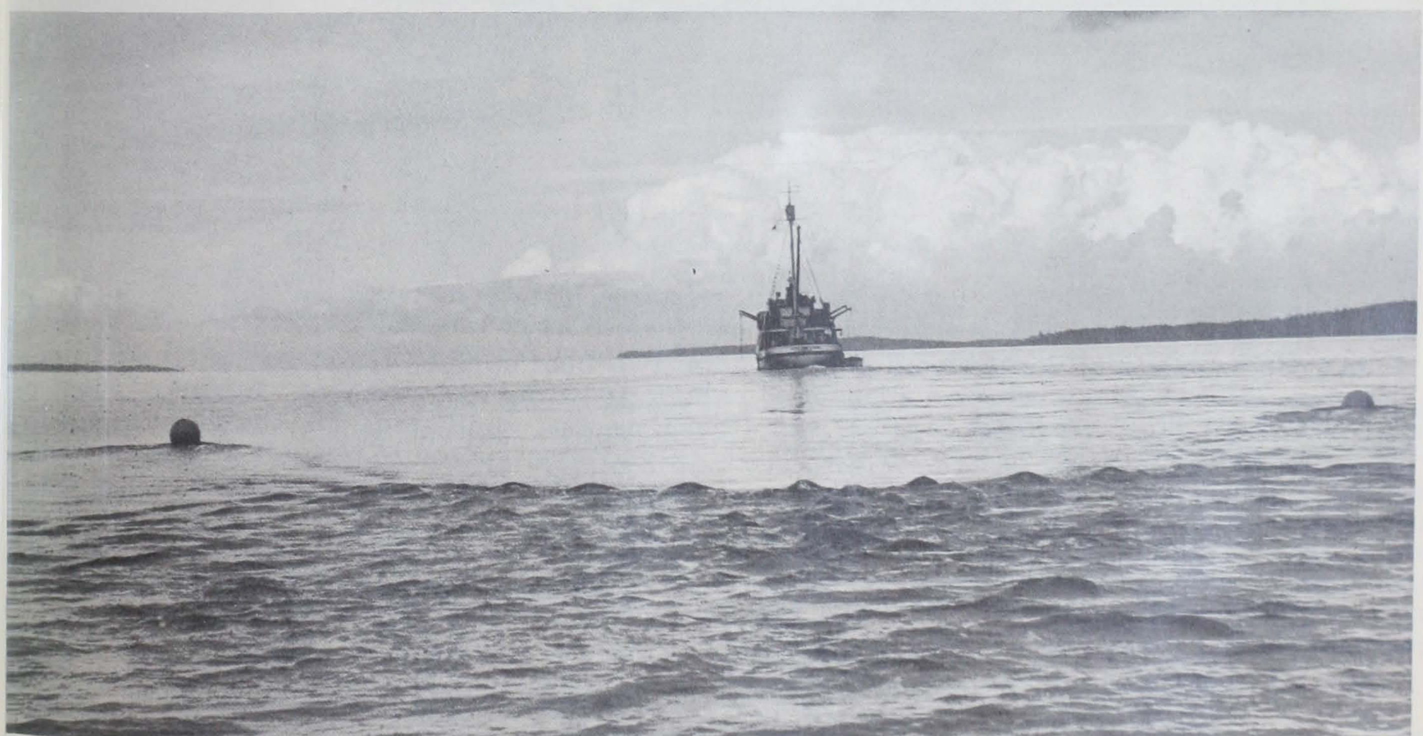

Fig. 1 - Float line of giant Cobb Pelagic Trawl skims surface 185 fathoms aft of the research vessel John N. Cobb.

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Bureau's Biological Laboratory at Seattle, Wash. A multipurpose gear was envisioned which would be both commercially acceptable by the fishing industry and useful as a pelagic fish sampling device.

DESIGN CONCEPTS: The initial concept of a gear capable of this dual operation was that it should be of sufficient size to utilize the maximum horsepower available (350 h.p.) in the Service's research vessel John N. Cobb. Prior experiments aboard the John N. Cobb with a British Columbia herring trawl (Barraclough and Johnson 1955), the Larsson "Phantom" Trawl (Larsson 1962), and other conventional midwater trawls designed and constructed by the Bureau indicated that fish could be captured at towing speeds less than two knots. Moreover, direct observations (using SCUBA) and televised observations (Sand 1959) of the reaction of fish to the approach of trawls show that most large pelagic fishes are capable of swimming speeds in excess of that necessary to avoid capture. Thus the capturing gear should be of sufficient size to entrap the fish before it becomes aware of the net. It was reasoned that a four-door otter board and bridle system (fig. 2) would be more effective in opening the mouth of the net than a conventional dual otter board system requiring unusually long bridles and unusually large doors.

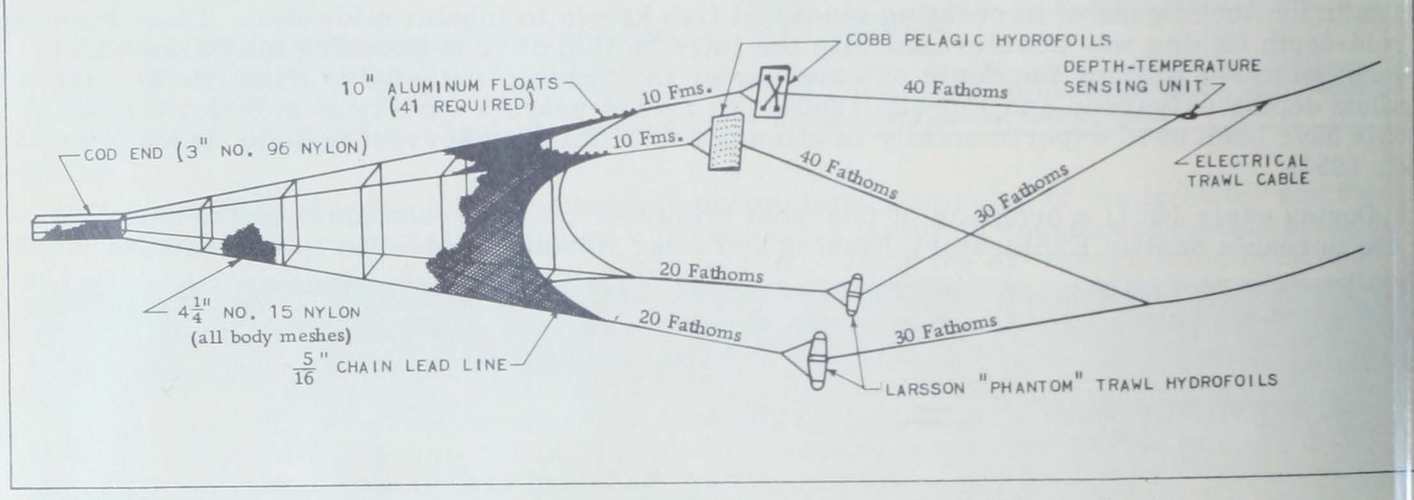


Fig. 2 - Otter board and bridle arrangement used to open the Cobb Pelagic Trawl.

GEAR DESIGN EXPERIMENTS

In 1960, a partially constructed experimental two-boat surface trawl was obtained from a commercial fisherman who had abandoned pelagic trawling experiments. In early 1961 assembly of the huge net to its original specifications was completed. During this same period a four-door otter-board system was designed and constructed to provide maximum opening and single-boat operation of the gear. A desired performance characteristic of high lift at low speeds of midwater otter boards appeared to be similar to aircraft wing sections used in the 1930's. Therefore, two experimental hydrofoil otter boards constructed of plywood and timbers were fitted with an appropriate bridle system to operate in conjunction with two patented "Phantom" trawl otter boards. The gear was then observed in action by SCUBA-equipped divers using a sea sled (fig. 3).

The net was found to have several defects which required extensive modifications to correct. The principal observed defect was excessive slack or "bagging" of webbing around the mouth of the net, apparently caused by the box-shaped wingless design of the net. Breastlines and footrope were found describing near semi-circular parabolic curves when viewed perpendicular to the longitudinal axis of the net. No provision for displacement of these sections from a straight line had been made. Subsequent to these findings, the net was disassembled, redesigned, and rebuilt with long tapering wings, hung in along the corner riblines 13.4 percent. Underwater observation of the redesigned net, named the Cobb Pelagic Trawl

Fig. 3 - SCUBA-equipped divers mounted on maneuverable sea sled prepare to examine experimental net in action.

(fig. 4), revealed a considerable improvement in performance. Most of the slack webbing had been eliminated, resulting in a more satisfactory ratio of net opening to number of meshes across the mouth. The immediate visible effect was a greater mouth opening and improvement of individual mesh openings which ranged in configuration from 60-degree diamonds to 90-degree squares. A more equalized distribution of load throughout the net was observed. Correction of an insufficient vertical opening was achieved by installation of $\frac{5}{16}$-inch chain for the lead line and increasing the number of floats on the headrope.

OTTER BOARDS: The attempt to provide horizontal spread of the net through use of large hydrofoil otter doors in conjunction with "Phantom" trawl otter boards has been successful. A measured opening of 80 feet horizontally and 90 feet vertically (7,200 sq. ft.) has been achieved during trials. The plywood doors which measure 8 feet 2 inches in height and 5 feet in length, have a blunt nose and proportionately thick chord section (fig. 5). It was necessary to provide sufficient holes on the back (curved) side of the doors to allow rapid flooding and spilling of water from each of the hollow compartments during setting and retrieving operations (fig. 6). A metal shoe was placed on the lower side of each door to provide weight for stabilization and to allow use of the doors in future bottom trawling or near bottom pelagic trawling experiments. Observed performance characteristics of the doors

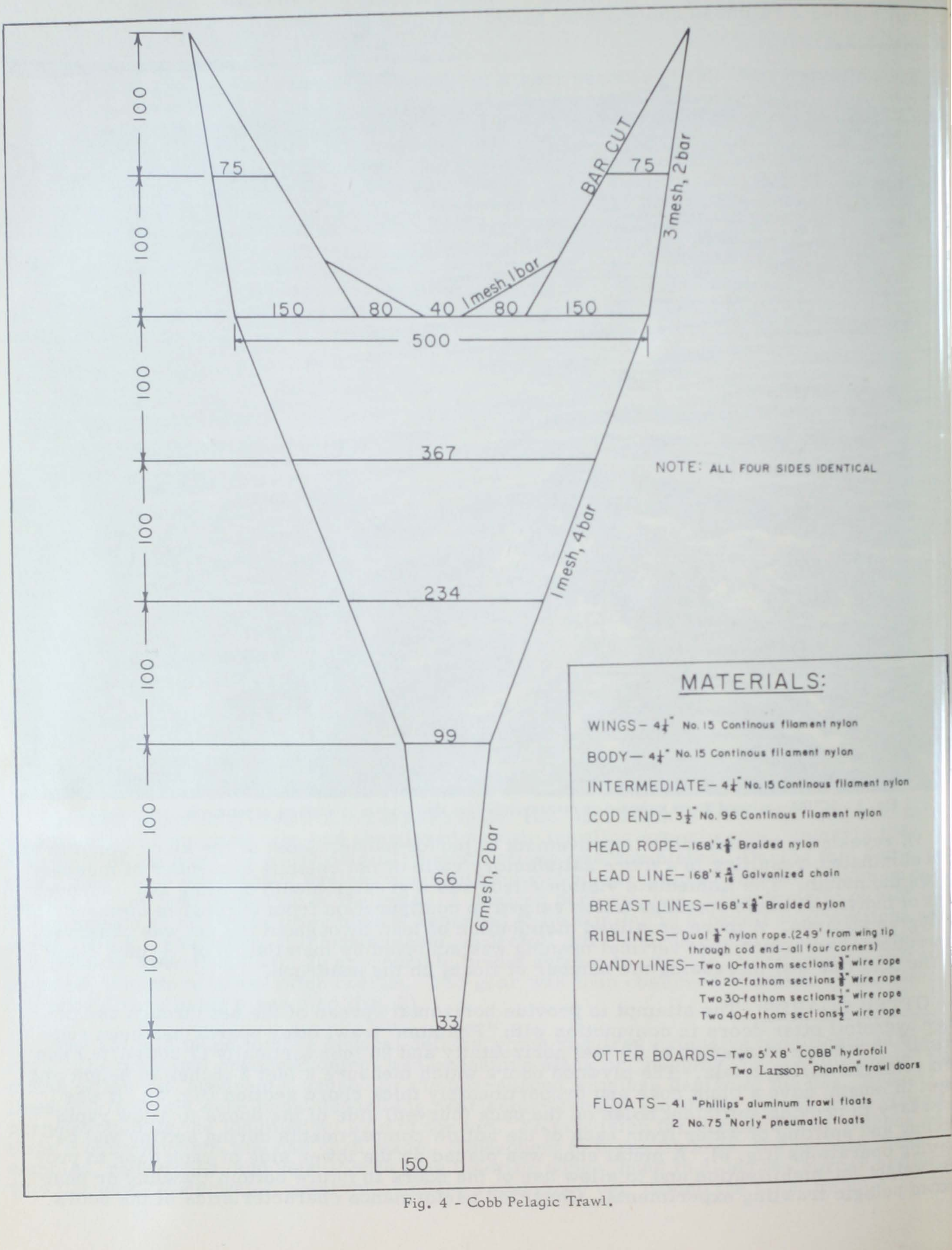


Fig. 4 - Cobb Pelagic Trawl.

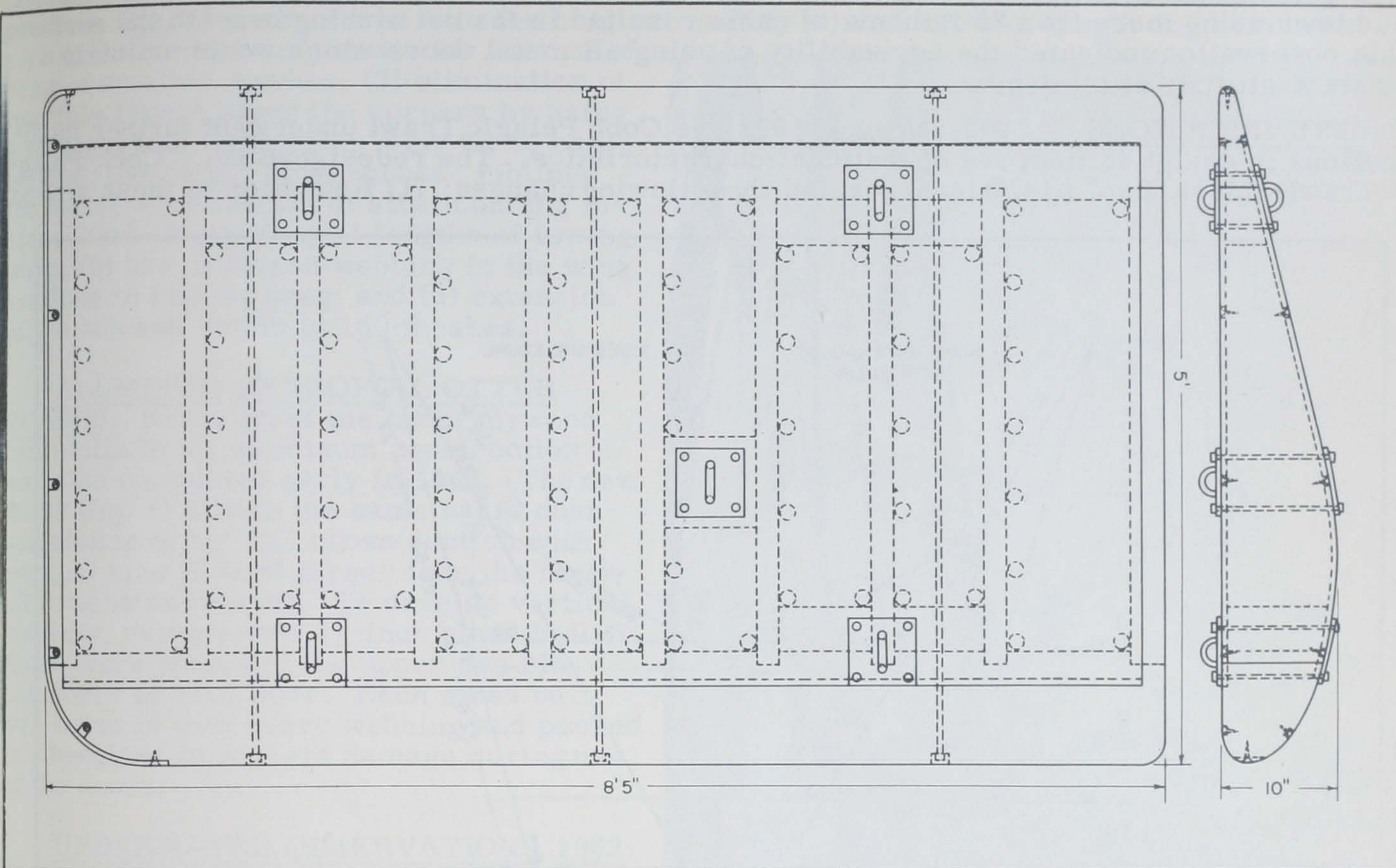


Fig. 5 - Prototype Cobb Pelagic Otter Board (1961).

showed them to be very stable, even when sets were made in cross currents. No tendency for the doors to cross was observed. Since both sides of the doors were covered with a plywood skin, no deflection vanes were needed to insure proper setting. The doors responded effectually to changes in bridle chain lengths which allowed manipulation of angle of attack for maximum spread. Changes in differential lengths of the trace chains at the rear of the doors provided control of rising or diving in the water. This function was useful during tests of the gear rigged to fish on the surface.

FOUR-DOOR HOOKUP: Use of Larsson "Phantom" trawl doors in conjunction with the larger plywood doors presented initial problems in hookup. The Larsson doors were later found easier to set and retrieve when placed ahead of the plywood doors. Positioning of the larger doors on the upper bridle section and the Larsson doors on the lower bridle section was found desirable since a part of the function of the upper doors in a four-door arrangement is to counteract their own weight and diving effect of the lower doors, thereby stabilizing the depth of the net.

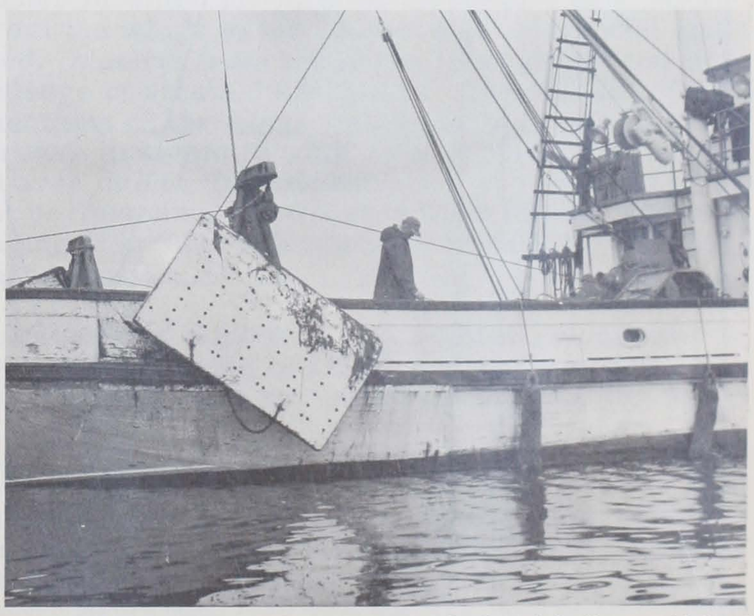


Fig. 6 - Numerous holes (drilled on curved side only) allow rapid flooding and drainage of inner compartments.

Use of the gear on the surface after use at depths of 150 to 200 fathoms resulted in a change in the attitude of the plywood doors due to their becoming water logged. Prior to mid-depth tows, surface tows could be made using 150 fathoms of cable. Following the mid-depth tows, attempted s face tows using more than 25 fathoms of cable resulted in the net sinking beneath the surfa This observation indicated the advisability of using all metal doors which would maintain a constant attitude at all depths.

MODIFICATIONS IN 1962: In early 1962, the Cobb Pelagic Trawl underwent further mo fications in design to improve operational characteristics. The redesigned net, "Cobb Pel ic Trawl--Mark Two" (fig. 7) incorporated the following changes: (1) Reduction of mesh size

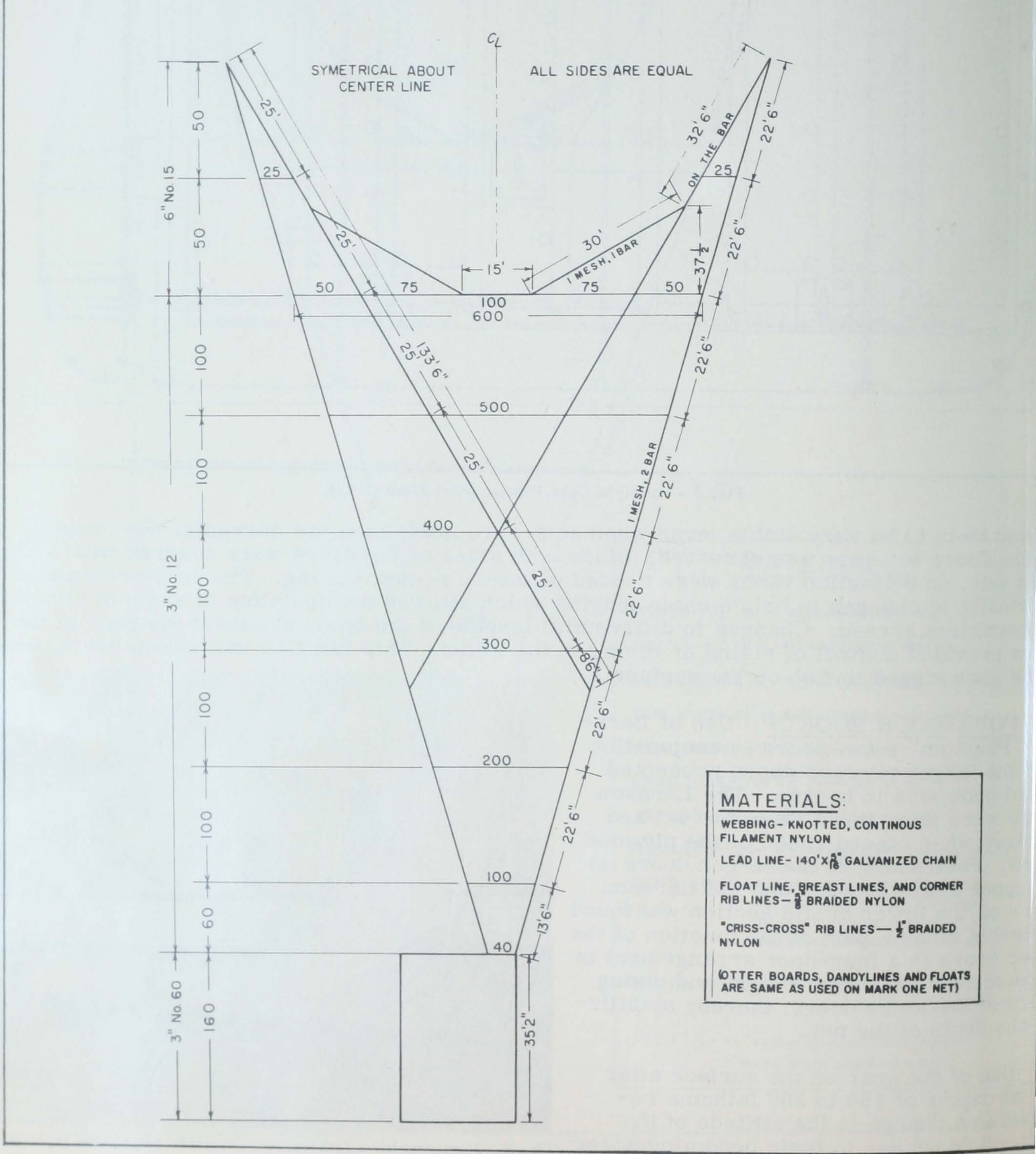


Fig. 7 - Cobb Pelagic Trawl--Mark Two (1962).

inches (stretched measure) in the body of the net to eliminate at least part of a serious gilling problem (fig. 8) encountered with the original model; (2) reduction of length and horizontal size of the net to compensate for increased drag of smaller meshes; (3) elimination of multiple tapers along the corners by using a straight-line taper from wing tip to bag; (4) installation of "criss-cross" riblines for better equalization of strain during instances involving unequal lengths of towing warp; (5) use of 6-inch webbing in the wing sections to reduce drag; and (6) extension of the cod-end length to 160 meshes.

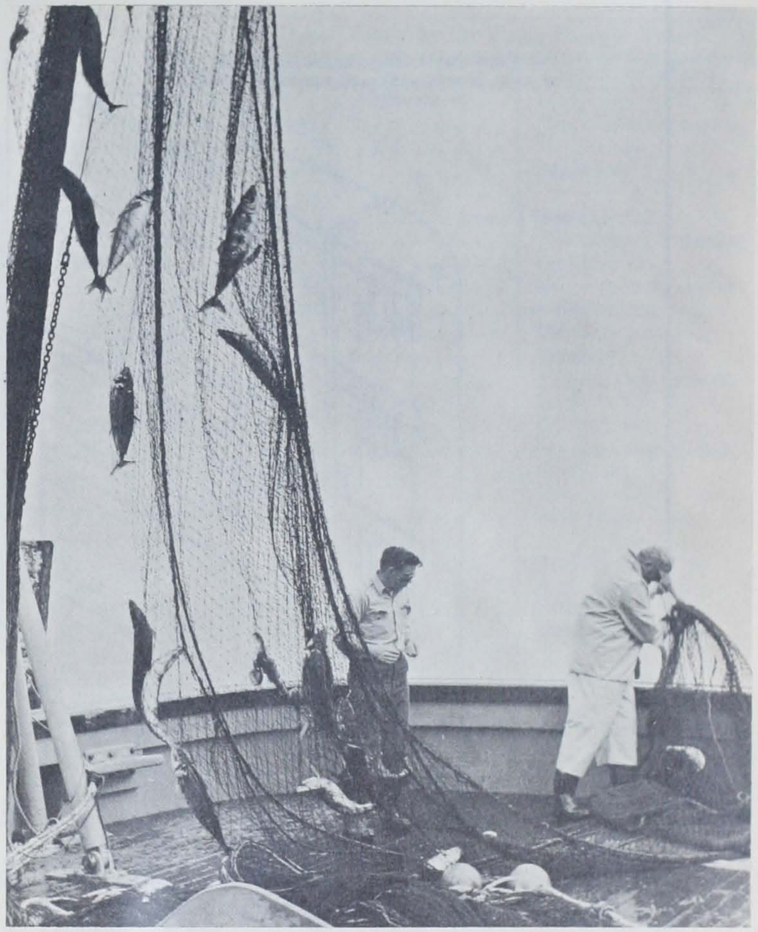


Fig. 8 - Mackerel and dogfish shark, gilled in intermediate section of trawl, suggest reduction in size of meshes.

ALUMINUM HYDROFOIL OTTER BOARDS: Redesign of the large plywood hydrofoils to all aluminum construction was also completed early in 1962. The new doors (fig. 9) utilize the same basic characteristics of air foil cross-section with vertical size (8 feet) larger than the fore-aft dimension (5 feet). To develop vertical stability, seventy-two $3\frac{1}{2}$-inch glass ball floats were placed in the upper two rib chambers of each door. Each glass ball was covered with heavy webbing and packed in fiberglass to prevent damage during use of the doors.

UNDERWATER OBSERVATIONS, 1962: Following construction of a new Mark II--Cobb Pelagic Trawl and modification of existing gear to Mark II design in early 1962, the trawl, equipped with aluminum hydrofoils and Larsson "Phantom" trawl doors, was again observed in action by SCUBA-equipped divers. With the exception of moderately excess strain noted in the wing tips, the net appeared to be fully expanded and exhibited the characteristics of a semi-elastic body being inflated by an internal force similar to the manner in which air inflates an airport wind sock. This condition extended throughout the net from the wings to the "bitter end" of the cod end. A near circular cross-section shape was noted. Meshes from the wings through the cod end were examined by sight and feel to gain knowledge of strain distribution. The amount of strain on individual meshes in all but the forward sections of the wings was found to be small even in areas adjacent to riblines. The slight increase in strain in wing meshes was attributed to a greater amount of stretch in ribline in this area due to the concentration of total load at the four wing tips. A further improvement in net performance is expected when corner riblines are rehung using an incremental hang-in ranging from approximately 15 percent at the wing tips to approximately 10 percent at the cod end junction.1/

Observations of the new aluminum hydrofoils from shipboard (fig. 10) and below water showed them to be very stable and responsive to adjustments in bridle and trace chains. Through manipulation of chain linkage it was possible to tow the net on the surface 185 fathoms behind the vessel.

MEASUREMENTS

NET SIZE MEASUREMENTS: Direct measurement of horizontal opening was accomplished using two auxiliary launches between which a tight line was suspended in the air over wing-tip mounted buoys. Wing-tip mounted buoys are shown in figure 1.

1/In other gear experiments conducted during 1961 and 1962 involving use of a giant, small-mesh fyke net to strain the total discharge of water from hydro-electric turbines, the author has found incremental hang-in to be a distinct advantage to counter distortion of meshes near the mouth of the net.

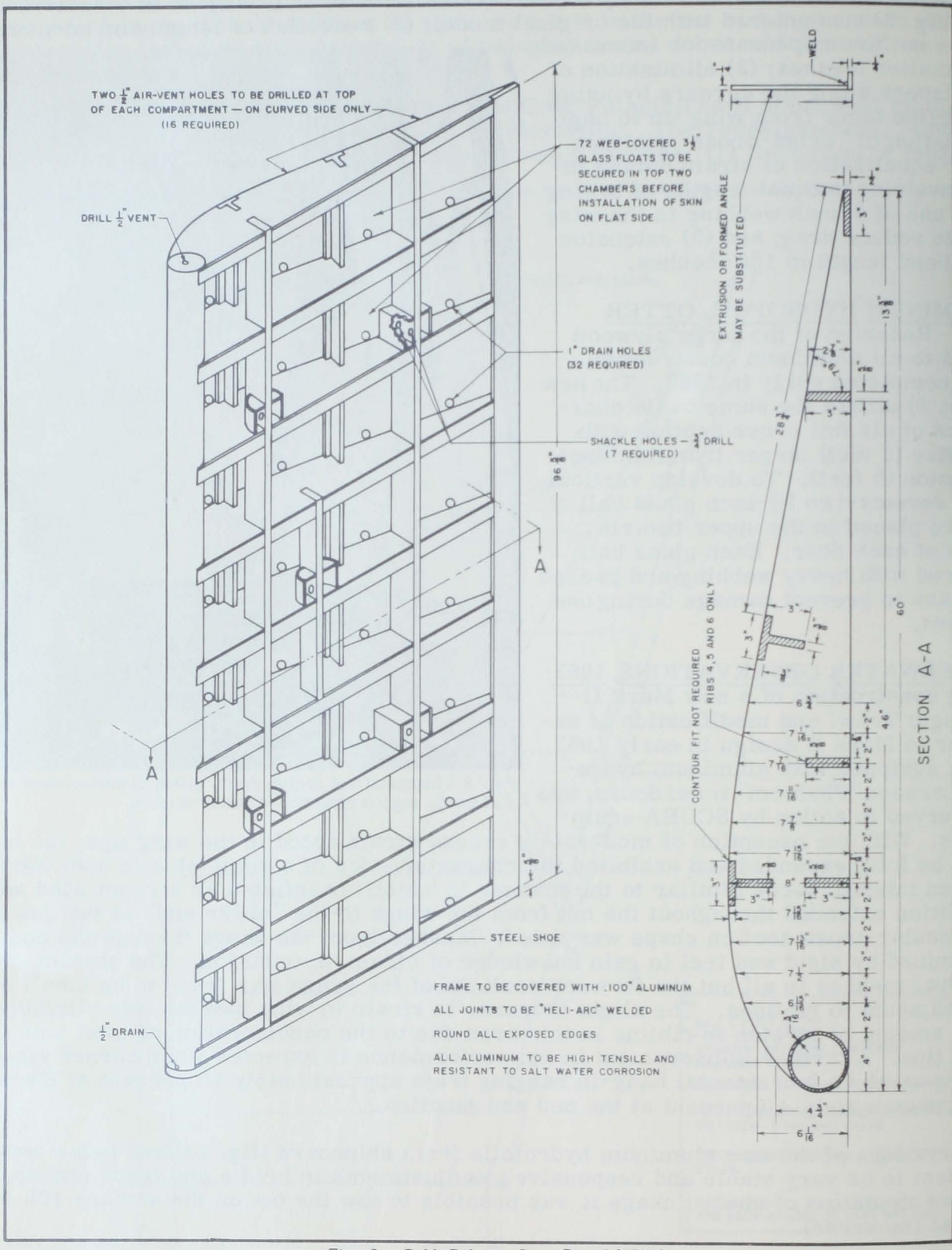


Fig. 9 - Cobb Pelagic Otter Board (1962).

Vertical opening measurements were accomplished by sea-sled mounted SCUBA dive descending alongside the net and observing the difference in depth-gauge readings.

SPEED MEASUREMENTS: An average towing speed of 2.5 knots was arrived at by us of radar and Loran to establish start and end positions of a series of trial drags, usually one hour duration.

NET DEPTH DETERMINATIONS: Indications of the depth of the net during experimentation and sea trials were accomplished through the use of an electrical Depth Telemeter (McNeely 1959) and conventional wire anglescope ratio calculations. Changes in net depth were normally made by regulation of the length of towing cable at the winch.

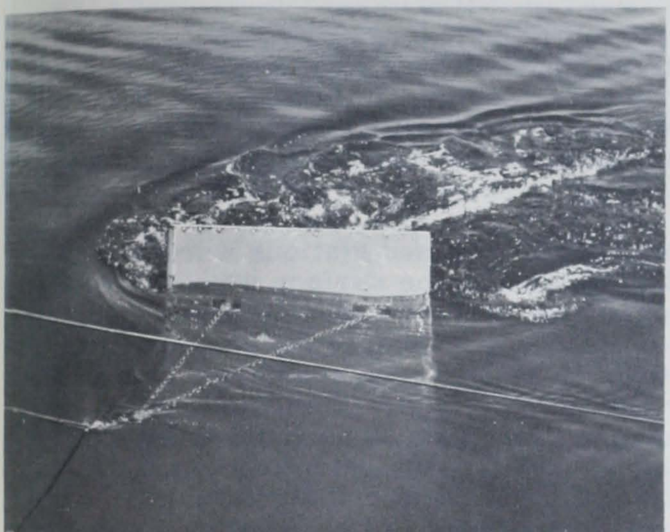


Fig. 10 - New aluminum otter board as seen from afterdeck of the John N. Cobb.

FISHING TRIALS

PRELIMINARY SEA TRIALS (1961): During July and August 1961, a Cobb Pelagic Trawl, made of $4\frac{1}{4}$-inch webbing and utilizing plywood hydrofoils in conjunction with Larsson "Phantom" trawl otter boards, was fished 25 times in offshore waters to determine operational characteristics. Most of the 25 tows were set "blind" (no indication of fish). Ten of the tows were made in the deep scattering layers (150 to 200 fathoms) 110 miles off the Washington coast to test the ability of the gear to descend to these depths. These tows produced small amounts of jellyfish, squid, lantern fish, and fanged viper fish. Other blind tows made in shallower depths (less than 50 fathoms) off the mouth of the Columbia River produced occasional silver salmon and up to 160 pounds each of hake and jack mackerel. Other species taken in small numbers include blue shark, herring, anchovy, English sole, turbot, and black rockfish.

Testing of the gear as a salmon sampling surface trawl yielded generally poor results. These drags, made on the Swiftsure Bank, and in Prince William Sound, Alaska, produced salmon in small numbers ranging from a single individual to 29 per drag. Large catches of dogfish shark taken on the Swiftsure Bank repeatedly damaged the net.

Partial List of Fishes Taken by the Cobb Pelagic Trawl

Scientific Name	Common Name
Aetobatus californicus	Whip ray
Alepocephalus tenebrosus	(No common name)
Anoplogaster sp.	-
Anoplopoma fimbria	Sablefish
Argentinidae	-
Argyropelecus lychnus	Hatchetfish
Bathylagus milleri	(No common name)
Brama raii	Pomfret
Caulolepis longidens	(No common name)
Ceratoscopelus townsendi	Lantern fish
Citharichthys sordidus	Mottled sandab
Clupea pallasii	Herring
Cyclothone microdon	Veiled anglemouth
Diaphus theta	Lantern fish
Diogenichthys atlanticus	Lantern fish
Electrona artica	Bigeye lantern fish
Engraulis mordax mordax	Anchovy
Gadus macrocephalus	True cod
Glyptocephalus zachirus	Rex sole
Gonostomatidae	-
Hydrolagus colliei	Ratfish
Hygophum sp.	Lantern fish
Hypomesus pretiosus	Surf smelt
Icichthys lockingtoni	Brown rudderfish
Idiacanthidae	-
Lampanyctus leucopsarum	Lantern fish
Lampanyctus ritteri	Lantern fish
Leuroglossus stilbius	(No common name)
Malacosteidae	-
Mallotus catervarius	Capelin
Melamphaes sp.	-
Merluccius productus	Hake
Microgadus proximus	Tom cod
Mola mola	Ocean sunfish
Notoscopelus resplendens	Lantern fish
Oncorhynchus keta	Chum salmon
Oncorhynchus kisutch	Silver salmon
Oncorhynchus tschawytscha	King salmon
Ophiodon elongatus	Ling cod
Palometa simillima	California pompano
Parophrys vetulus	English sole
Platichthys stellatus	Starry flounder
Pneumatophorus diego	California mackerel
Porichthys notatus	Midshipman
Prionaca glauca	Blue shark
Psettichthys melanostictus	Sand sole
Regalecidae	King of the Herrings
Roncador stearnsi	Spotfin croaker
Sarda chiliensis	Bonito
Sardinops sagax	Pacific sardine
Scomber japonicus	(No common name)
Sebastodes brevispinis	Silvergray rockfish
Sebastodes entomelas	Widow rockfish
Sebastodes flavidus	Yellow-tailed rock rockfish
Sebastodes goodei	Chili pepper
Sebastodes paucispinis	Bocaccio
Sebastodes ruberrimus	Turkey-red rockfish
Seriola dorsalis	Yellow tail
Squalus acanthias	Dogfish shark
Sphyraena argentea	Barracuda
Symbolophorus californiae	Lantern fish
Symphurus atricaudus	Tongue sole
Tactostoma macropus	Arrowfish
Tarandichthys sp.	-
Tarletonbeania crenularis	Lantern fish
Tetranarce californica	Electric ray
Trachurus symmetricus	Horse mackerel
Trachypterus rex-salmonorum	King of the Salmon
Theragra chalcogrammus	Whiting
Vinciguerria sp.	-

Catches of dogfish to 10,000 pounds were made. During one drag the entire cod end was lost and the intermediate section was severely chaffed. Jack mackerel and hake were also taken in amounts up to 200 pounds in the Swiftsure area. Although salmon did not appear to gill easily, dogfish, hake, and jack mackerel catches usually resulted in severe gilling. A reduction in mesh size from $4\frac{1}{4}$ inches (stretch measure) to 3 inches was therefore indicated for fish in this size group.

FISHING TRIALS IN 1962: In August 1962, the Cobb Pelagic Trawl--Mark II was used during an extensive survey to determine the relative abundance of all pelagic species of fish at predetermined stations off the coasts of California and Mexico. Following this work, tests of the gear were conducted in nearby waters off Mexico, California, Oregon, and Washington to determine its relative efficiency as a biological sampling tool and possible utility as commercial fishing equipment.

Results of Offshore Pelagic Survey: Forty-four predetermined stations were occupied during this phase of testing. Oblique tows from 220 fathoms to the surface were made at each station during daylight hours. At least one of each series of night tows was made on the surface. With the exception of one night surface tow in which 24 mackerel were taken, catch rates seldom exceeded five pounds per two-hour tow. However, echo-soundings taken at all stations along the track line, which extended over 600 miles offshore, indicated no fish concentrations were available. Scatter recordings were typical of those associated with the deep scattering layers. During part of the offshore survey simultaneous sampling was conducted by the Bureau's research vessel Black Douglass using plankton nets and stramin nets. A subsequent correlation (by cooperating scientists at the Bureau's La Jolla Biological Laboratory of catch rates made during these trials and catch rates made at other times by small, high-speed midwater trawls shows that small, fine mesh nets are as efficient as the Cobb Pelagic Trawl in taking zooplankton and small fishes such as stomatoids and myctophids. Catch rates and sizes of the larger fishes such as anchovy, hake, rockfish, bonito, sardine, mackerel, barracuda, and ribbon fishes (up to 6 feet in length) indicate that the large net was capable of sampling a wide spectrum of the large pelagic vertebrates. In most cases the larger fishes are rarely if ever taken in small, high-speed midwater nets.

Gear Efficiency Tests: Following the offshore pelagic survey, 16 surface tows and 11 mid-depth tows were made off the coasts of Mexico, California, Oregon, and Washington. Catch rates during the near-shore tests greatly exceeded catch rates offshore. Although a wide variety of species were taken (table), the largest catches consisted of 1,850 pounds of hake, 1,900 pounds of mixed sablefish and hake, 1,000 pounds of anchovy, and 600 pounds of ocean sunfish. Most of the larger catches were made at middepth.

CONCLUSIONS

Utility of the Cobb Pelagic Trawl for gross biological sampling[2/] was demonstrated during sea trials of the gear by the wide variety of fishes taken. Those sets made on schools of fish located by echo-sounding in depths greater than 30 fathoms usually produced fair amounts of fish. Attempts to capture surface-swimming schools usually resulted in poor catches.

It should be noted that the total number of drags made to date is small and has entailed many variables inherent in development of new gear. In view of this it would be presumptuous to attempt qualification of the gear in terms of average volume of fish taken.

Success of midwater trawling as a major commercial tool is dependent on the prior location of fishable stocks, use of gear capable of capturing commercial quantities of fish, and use of a system to determine vertical position of the net.

LITERATURE CITED

ALVERSON, D. L. and POWELL, D. E.
1955. The Open Ocean Challenges the Scientist and Dares the Fisherman, Pacific Fisherman, vol. 53, no. 11 (Oct.), pp. 25, 26, and 29, and vol. 53, no. 12 (Nov.), pp. 26-27.

BARRACLOUGH, W. E. and JOHNSON, W. W.
1955. Canadian Midwater Herring Trawl, World Fishing, vol. 4, no. 8 (August), pp. 20-24.

2/Towing at predetermined stations without prior echo-sounding or other observations to determine the presence of fish.

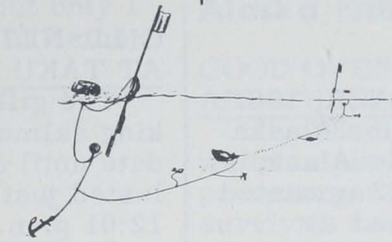
LITERATURE CITED (Contd.)

LARSSON, K. H.
1952. The "Phantom" Pelagic Trawl, Fishing News (9, Northington St., London), no. 2067 (November 29), pp. 7-9.

McNEELY, R. L.
1958. A Practical Depth Telemeter for Midwater Trawls, Commercial Fisheries Review, vol. 20, no. 9, pp. 1-10. (Sep. No. 522), and Modern Fishing Gear of the World, Fishing News (Books), Ltd., London, pp. 363-368.

PARRISH, B. B.
1959. Midwater Trawls and Their Operation, Modern Fishing Gear of the World, Fishing News (Books), Ltd., London, Section 9, pp. 333-343.

SAND, R. F.
1959. Midwater Trawl Design by Underwater Observation. Modern Fishing Gear of the World, Fishing News (Books), Ltd., London, Section 7, pp. 209-212.



MARINE ANIMAL SOUNDS DESCRIBED BY EXPERT

Fishes croak, grunt, cough, and drum, while barnacles slurp and black mussels crackle, in their daily underwater life in Chesapeake Bay and the lower Patuxent River, according to a famed acoustico-biologist of the Narragansett Marine Laboratory in Rhode Island. She described these sounds, played tape recordings, and showed a movie of noisy fish at a seminar given on December 10, 1962, at the Chesapeake Biological Laboratory of the Natural Resources Institute, University of Maryland.

The biologist reviewed her many years of pioneering investigations into the occurrence, character, and significance of underwater sounds produced by marine fishes, mammals, and invertebrates in many temperate and tropical waters of the world. The Institute's Director noted that up to now she has recorded sounds produced by about 300 species. These sounds are made in response to biological urges such as mating, defense, and feeding. She emphasized that many species have characteristic sounds that can be recognized.

During September 18-25, 1962, she recorded and analyzed the sounds of certain fishes in mid-Chesapeake Bay at the Solomons Laboratory. She found that the oyster toadfishes croaked, growled, and whistled, although the whistling calls were heretofore associated with spawning in spring. The weakfish, or gray sea trout, silver perch, and spot produced a very rapid, raspy croak with the aid of their air bladder. The Atlantic croaker makes a similar, almost drumming, sound at a slower rate. She recounted how croakers mystified personnel at defense installations at the entrance of Chesapeake Bay during the early critical months of World War II. The northern puffer, or swellfish, of the Bay squeaked, coughed, and made other noises by grinding their protruding teeth. The bizarre-looking striped burrfish also coughed, while the striped sea robin made a sound similar to that produced by scraping fingernails over a drum. The clucking of a sea robin matched the sounds produced by hens in a barnyard. She found that flounders were virtually mute.

The acoustico-biologist declared that she would investigate further sound production of fishes of Chesapeake Bay. Long supported by research grants from the Office of Naval Research, which has found her discoveries to be of strategic value, she plans to continue her field work with the aid of a U. S. Navy portable laboratory for recording underwater biological sounds. She hopes to produce charts that contain numerical data representing the probable level of animal sounds at many marine locations.