CORRELATION OF MIDWATER TRAWL CATCHES WITH ECHO RECORDINGS IN THE NORTHEASTERN PACIFIC

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SUMMARY

Midwater trawling experiments, utilizing a fish finder (the "Sea Scanar") equipped with a prototype recorder, were conducted during the spring of 1956 off the coasts of Washington and British Columbia. Catches of fish and other marine organisms were identified from 66 midwater tows made by the U. S. Bureau of Commercial Fisheries exploratory fishing vessel John N. Cobb. Trawl-fishing depths ranged from 10 to 213 fathoms over bottom depths of 15 to 950 fathoms. Catches varied widely, from no fish in a 60-minute tow to 5,500 pounds, mostly hake, in a 20-minute tow. Example of "Sea Scanar" recordings made during the tows show different types of traces for the various species caught, but with no fully consistent pattern. Traces of dense schools of hake are compared with others showing scattered patches of rockfish. Plankton forms, particularly euphausiids, were abundant and caused traces on the recorder which at first were mistaken for fish. With experience a fair degree of success was attained in identifying echoes and predicting species in the catch.

INTRODUCTION AND BACKGROUND

Midwater trawls capable of fishing at any depth from the surface to the bottom have been developed primarily within the last decade. They have been used successfully to capture herring in certain parts of the world, namely in Scandinavian and other European countries and in the inside waters of British Columbia (Barraclough and Johnson 1956). In addition to herring, other pelagic fish such as mackerel and anchovies are commonly caught with this type of gear (Glanville 1956). The Larsen two-boat midwater trawl is probably the best known of those now in use.

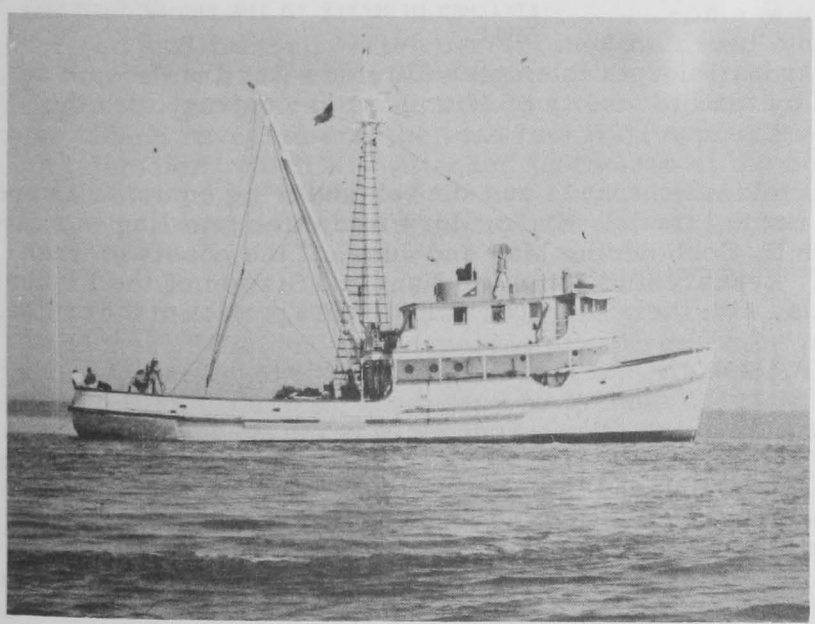

FIG. 1 - THE U. S. BUREAU OF COMMERCIAL FISHERIES EXPLORATORY FISHING VESSEL JOHN N. COBB MIDWATER TRAWLING OFF THE COAST OF WASHINGTON.

Two of the major problems faced by commercial fishermen and research workers using midwater trawls are: (1) locating and identifying schools of fish in midwater, and (2) positioning the net at the proper depth to catch the fish. Experience has shown that few if any

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fish are caught by "blind" towing, and for good hauls it is necessary to locate concentrations of known species of fish, determine their depth, and devise some accurate means of net positioning (Richardson 1957).

While midwater trawling thus far has been concerned primarily with the capture of herring, it has been proposed by some fishermen and researchers that other types of fish which spend part of their time off the bottom, such as rockfish and cod, might be available to midwater trawls when they are not available to bottom gear (Alverson and Powell 1955). To investigate this possibility, the Branch of Exploratory Fishing and Gear Research began developing gear and equipment several years ago. Objectives were to develop suitable one-boat midwater trawls and accessory equipment which could be used on the Bureau's exploratory fishing vessels in the northwestern Atlantic, northeastern Pacific, and Gulf of Mexico.

FIG. 2 - THE CUMBERSOME ACOUSTIC DEPTH TELEMETER UNIT, CENTER, HAS BEEN REPLACED BY THE SMALL ELECTRICAL DEVICE, UPPER LEFT, ATTACHED DIRECTLY TO THE END OF THE TRAWL CABLE.

Development and testing of the gear and equipment were undertaken at the gear research station located at Coral Gables, Fla. Underwater television was used for direct observation of midwater trawls in action (Sand 1955, and Sand and McNeely 1956). Inspecting and photographing the gear underwater was accomplished from a controllable two-man diving sled (Sand 1956). An acoustic depth telemeter for midwater trawl depth determination was constructed by the University of Miami under contract with the Bureau.

In the spring of 1956 two midwater trawls and the telemetering equipment were shipped to Seattle for actual fishing trials. Exploratory midwater trawling was carried out aboard the M/V John N. Cobb during May and June off the coasts of Washington and British Columbia. Researchers from the Nanaimo Station of the Fisheries Research Board of Canada, with their gear, participated in a portion of the cruise.

GEAR AND EQUIPMENT USED

A "Sea Scanar" equipped with a prototype recorder was the principal instrument used on the John N. Cobb for locating fish in midwater. Although a standard-type recording echo sounder was employed primarily for sounding the deeper bottom contours, it was also useful in confirming the location of the more dense fish schools located with the "Sea Scanar."

The acoustic telemeter for determining constant depth of the trawl gear consisted of (1) a sensing and transmitting unit which was attached to the port cable immediately ahead of the trawl door; (2) a hydrophone trailed on a boom just beneath the surface amidships for picking up the sonic depth signal; and (3) a receiving set on which the operator listened for and determined the signal frequency. Sound frequencies were then converted to corresponding depths using a prepared conversion table. (A complete description of this instrument is given by Stephens and Shea 1956.) Although accurate and quite dependable, the instrument was too large and complicated for practical adaptation to fishing vessels, and it has since been replaced by a simplified electrical depth telemeter (see fig. 2).

Three midwater trawls were used, all of nylon: the Canadian midwater herring trawl, and 40-foot and 50-foot square-opening trawls made at the Bureau's Coral Gables gear research station. The Canadian trawl had mesh sizes ranging from 5 inches in the wings to $1\frac{1}{4}$ inches in the cod end. (For a complete description of this net see Barraclough and Johnson 1956.)

The two trawls furnished by the Bureau were similar in design to the Canadian trawl, being made up of four equal sides and small wings on each corner. Mesh sizes were $4\frac{1}{2}$ inches (stretched measure) in the wings and body, and $3\frac{1}{2}$ inches in the cod end. Trawl doors, or otter boards, were of plywood, hydrofoil design, 4 x 6 feet, rigged with a conventional bridle arrangement and not fished at the ends of separate pennants as with the Canadian gear. The last nine feet of each cod end was lined with $1\frac{1}{4}$-inch cotton mesh to retain some of the small organisms which would normally pass through the larger mesh.

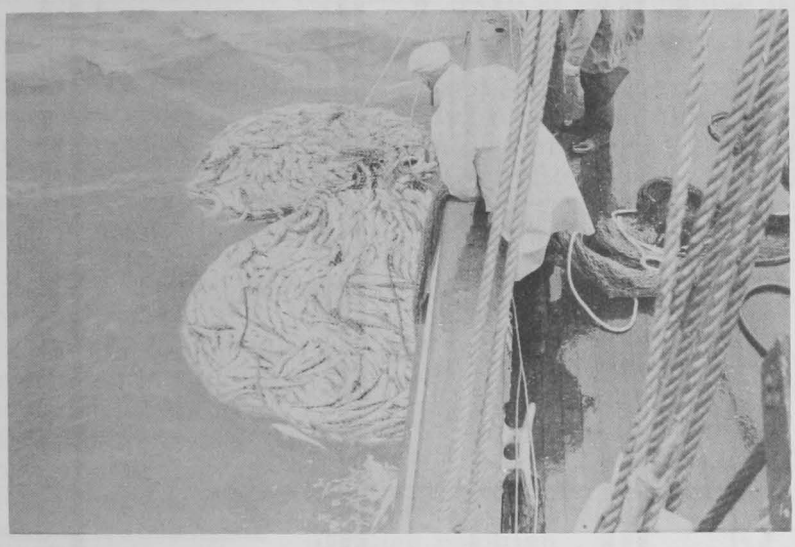

FIG. 3 - MIDWATER TRAWL CATCH, MOSTLY HAKE, ALONGSIDE THE JOHN N. COBB.

Before going offshore, the midwater gear was tested in inside waters and performed satisfactorily after certain modification. The hydrofoil doors were found to be extremely sensitive with a tendency to collapse when set in choppy seas, but this fault was partly remedied by adjustment of the chains. Sounding the net from a motor launch revealed that the lead line rode approximately 60 feet deeper than the depth telemeter, which was attached just ahead of the port door (with 40-fathom bridles between the doors and the net). Consequently, a correction factor of 60 feet was added to telemeter readings to determine lead-line depth during all tows.

FISHING RESULTS

Catches of fish and other marine organisms were identified from 66 midwater tows made in offshore waters between Grays Harbor, Wash., and Queen Charlotte Sound, British Columbia, from May 19 to June 21, 1956. The trawls were fished at depths ranging from 10 to 213 fathoms over bottom depths varying from 15 to 950 fathoms (Anonymous 1956). Sizable concentrations of fish at mid-depths were difficult to find during most of the cruise.

Fishing results fluctuated widely, from no fish in a 60-minute tow to 5,500 pounds, nearly all hake, in a 20-minute tow (see fig. 3). The wide variation in catches was not unexpected on this initial effort. Although numerous echo traces of fish in the North Sea have been identified (Hodgson 1950), it has been noted that the results do not have worldwide application and that intelligent interpretation of echo traces depends upon knowledge assembled locally (Hodgson and Fridriksson 1955). Except for inshore schooling herring, characteristic fish traces and reactions of fish to midwater trawls were unknown for the area in which the John N. Cobb operated.

In addition to the lack of identifiable echo traces from the area, this was the first attempt to utilize the "Sea Scanar" with a recorder for midwater trawling. Consequently there was no basis for interpretation of echoes received. As a result, many of the early tows made on likely-looking traces caught only plankton, jellyfish, small feed, or a few larger fish.

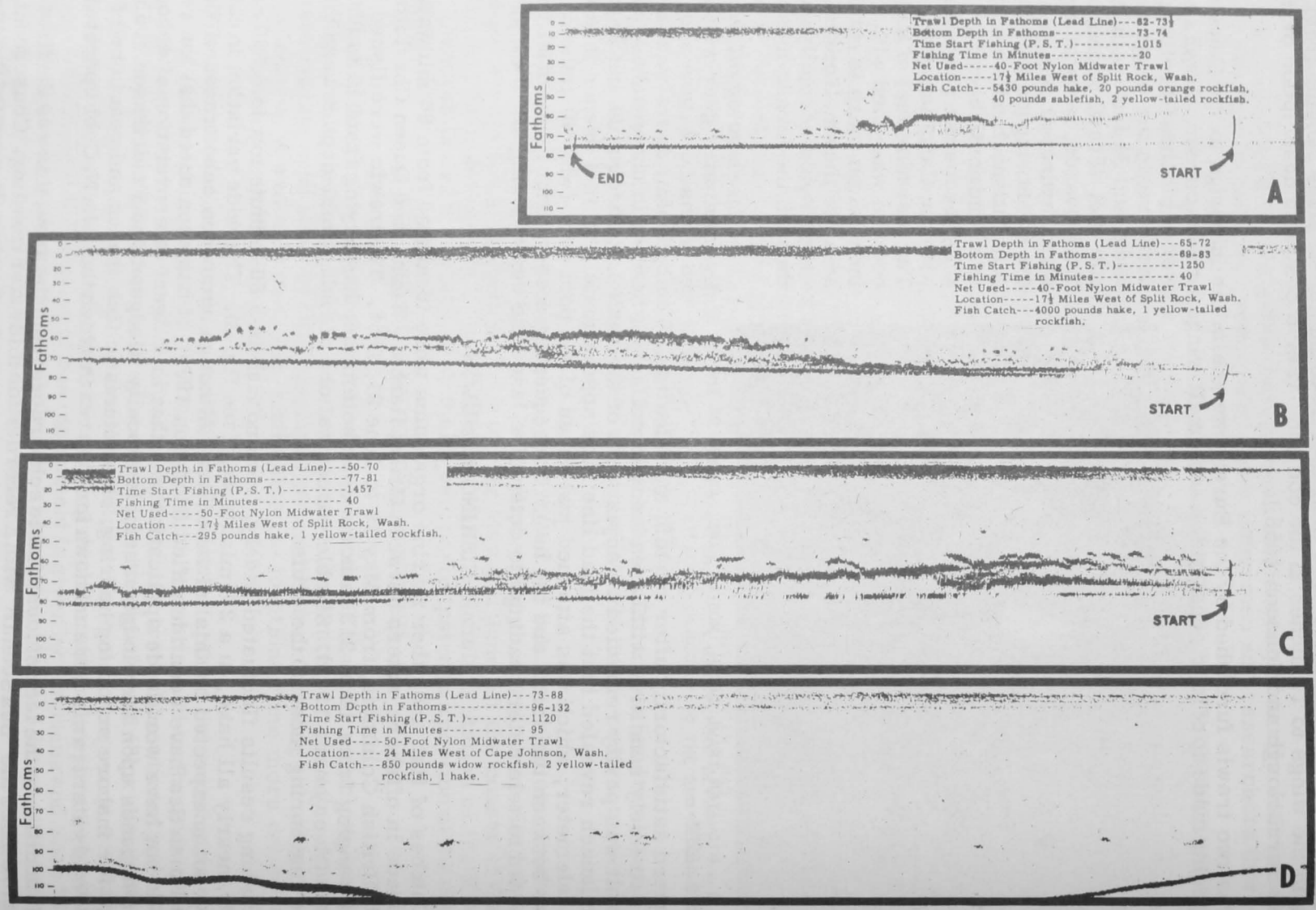

FIG. 4 - "SEA SCANAR" RECORDER TRACES MADE DURING PRODUCTIVE MIDWATER TOWS; MOSTLY HAKE AND ROCKFISH.

It was only after considerable sounding with the "Sea Scanar" and numerous tows with the midwater trawls that reasonably-sound opinions could be formed as to whether traces were caused by commercial-size fish, small feed fish, or by euphausiids or other plankton forms. Even then, sets were made on "doubtful" traces to gain additional knowledge on the organisms present in midwater in this area. Sets on "doubtful" traces usually produced no significant fish catches. The "Sea Scanar" proved to be extremely sensitive to plankton (euphausiids were abundant in most localities over the continental shelf), and it was often necessary to reduce sensitivity on the instrument to eliminate much of the plankton trace so that fish echoes could be distinguished.

There was an indication from the composition of some midwater catches that hake and rockfish may school together or in close proximity. Mixed catches sometimes occur in the North Sea midwater trawl fishery where catches of brisling also contain herring and mackerel (Glanville 1956). This degree of nonselectivity of midwater trawls probably will not create any greater problems in sorting the catch than is normally encountered on bottom trawlers.

INTERPRETATION OF "SEA SCANAR" TRACES

Examples of "Sea Scanar" recorder traces made during midwater tows are presented in figures 4, 5, and 6. In all cases the sounding angle was vertical (depth-sounding position) to show what was directly under the vessel. Figs. 4 and 5 contain traces made during tows which caught significant quantities of fish, while those in figure 6 were made on tows which caught none or only a few fish. The entire recordings are presented for the shorter tows, while only representative sections of the longer tows are shown.

LIST OF FISHES	
Yellow-tailed rockfish	*Sebastodes flavidus*
Orange rockfish	*Sebastodes pinniger*
Widow rockfish	*Sebastodes entomelas*
Pacific ocean perch	*Sebastodes alutus*
Hake	*Merluccius productus*
Sablefish	*Anoplopoma fimbria*
Arrow-toothed flounder	*Atheresthes stomias*
Dogfish	*Squalus suckleyi*
Pink shrimp	*Pandalus jordani*

Traces in figure 4A, B, and C are examples of dense schools of hake as proven by the midwater trawl catches. 4A resulted in the best catch in the least amount of fishing time--5,430 pounds of hake and 70 pounds of other species in 20 minutes. The catch rate differed because, as shown by the depth telemeter, the net in 4A was in the most dense part of the hake school at the start and through most of the tow; while in 4B the net was too shallow for the main body of the school near the start and too deep during the middle of the tow. As for 4C, the net was too shallow during most of the tow.

Since the net was known to be in the dense portion of the school in figure 4A, it was hauled soon after it appeared that the main body of fish had been passed, which was not the case in 4B and C. Even though the telemeter provided continuous accurate information on the depth of the trawl, it was not always possible to keep the trawl in the most dense portion of the schools, which varied in depth considerably. Regulation of trawl depth was accomplished by varying the length of towing warp or the speed of the vessel. After each adjustment a short period of time was required for the trawl to stabilize at the desired depth; but by then the position of the school may have changed, requiring further adjustment to raise or lower the trawl to the correct indicated depth for best results.

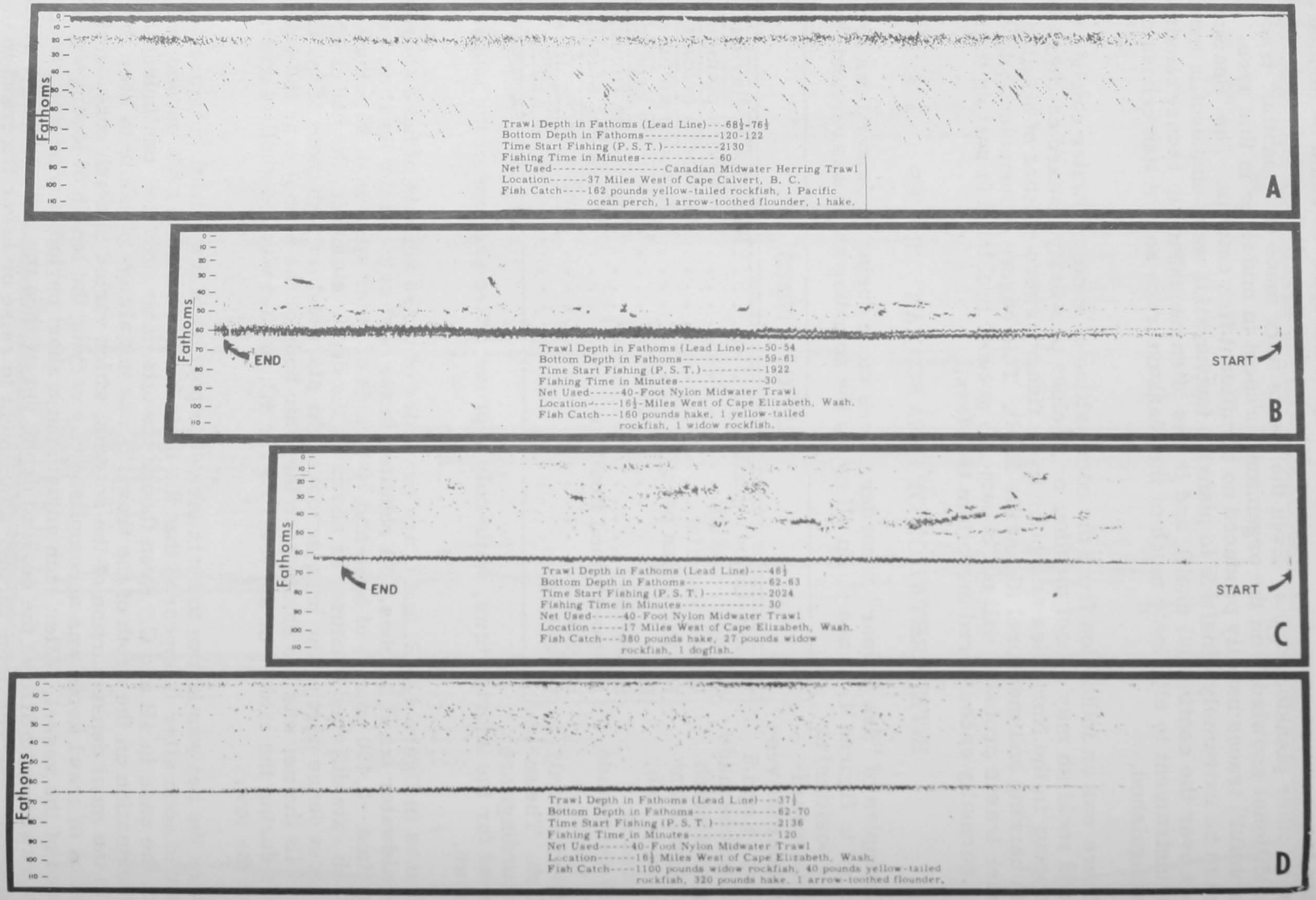

FIG. 5 - "SEA SCANAR" RECORDER TRACES MADE DURING PRODUCTIVE MIDWATER TOWS, MOSTLY HAKE AND ROCKFISH.

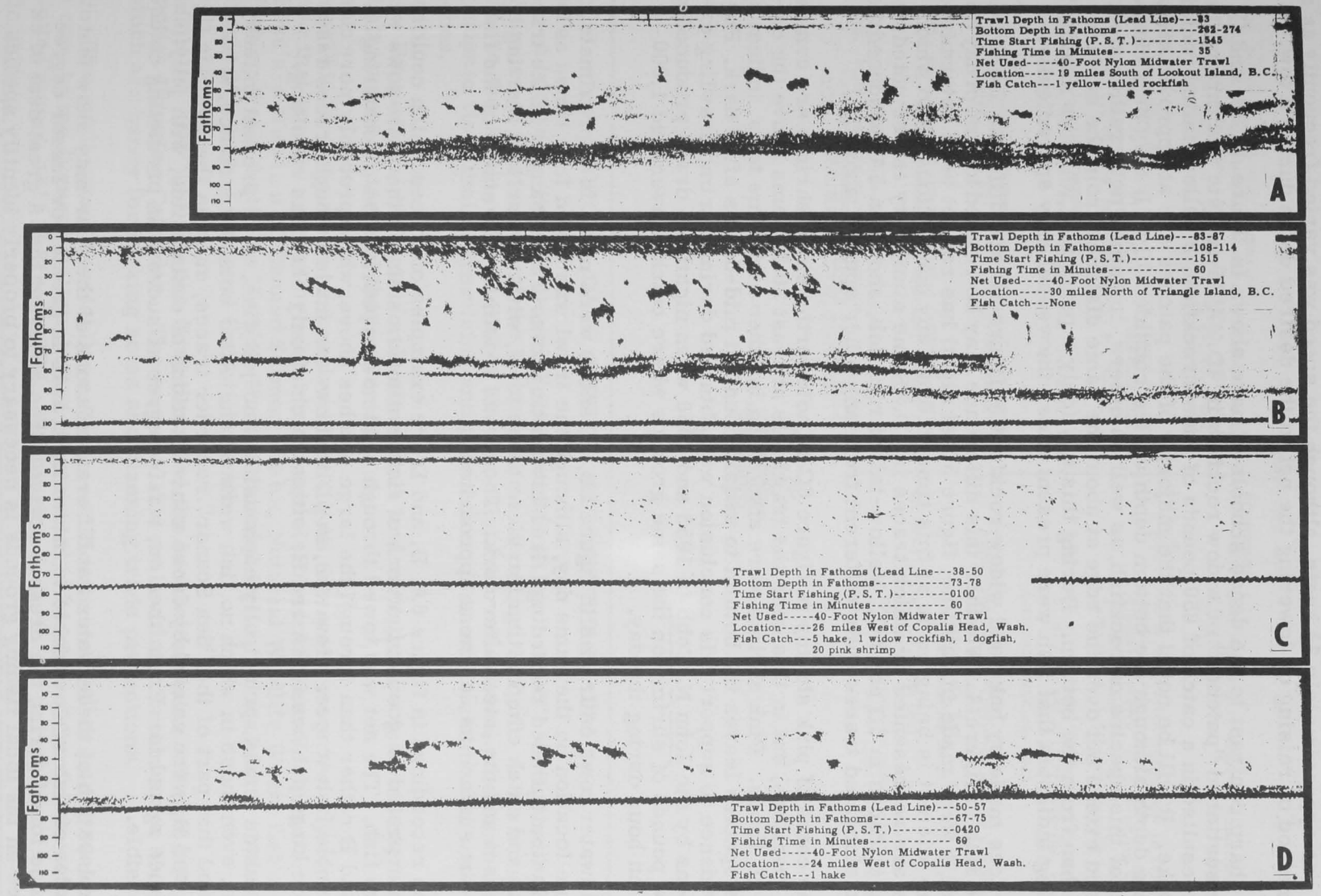

FIG. 6 - "SEA SCANAR" RECORDER TRACES, MADE DURING RELATIVELY UNPRODUCTIVE MIDWATER TOWS, BELIEVED TO HAVE BEEN CAUSED AT LEAST IN PART BY PLANKTON.

Calculated towing speed in figure 4A and C was from $3\frac{1}{2}$ to 4 knots. Speed in 4B was slightly slower because of wind conditions. Normal towing speed during the cruise was approximately $3\frac{1}{2}$ knots, although the speed was varied frequently as a quick method of raising or lowering the net to the desired depth during a tow.

In sharp contrast to the dense schools of hake shown in figure 4A, B, and C, are the scattered "patches" of widow rockfish in 4D. A 95-minute tow through these traces resulted in a catch of 850 pounds of widow rockfish, 2 yellow-tailed rockfish, and 1 hake. It will be noted that the majority of the patches are at approximately the same depth although the bottom depth varies considerably. It may be a characteristic of this species of rockfish, as well as others, to gather near rather steep edges and extend out over the edge at about the same distance from the surface rather than from the bottom. During this tow (only a portion of which is shown), the recording indicates that fish were present under the vessel only sporadically.

Traces made by hake and widow rockfish in figure 5D are different from traces of these fish in figure 4. Whether this difference may be related to time of day (tows in figure 4 were made in daytime, figure 5D at night) has not yet been determined. Also, no attempt is being made at this time to draw any conclusions as to which species are represented by which traces in 5D. Some similarity can be noted between the traces in 5D and 6C. Yellow-tailed rockfish, shown in 5A, produced distinctive elongated traces quite different from any other species shown.

The catch of pink shrimp in figure 6C is noteworthy since shrimp are common bottom dwellers, but in this case the trawl was at least 20 fathoms above the bottom at all times. Pink shrimp were also taken in other nighttime tows, indicating that the species leaves the bottom to swim around at mid-depths after dark. Further evidence to support this conclusion was obtained during shrimp trawling explorations by the John N. Cobb in 1955 and 1956 when nighttime drags produced only a few pounds of shrimp on the same grounds where catches averaged 1,000 pounds an hour during the day.

Midwater tows on traces in figure 5B, C, and D were made in approximately the same location on the same day, although the trawl was towed four times as long on the last-mentioned recording. It is interesting to note the changes in the trace patterns and catch composition for these three tows, with the earliest starting before sunset and the latest after dark. There was a definite movement of the fish toward the surface as darkness approached.

The recordings in figure 6A, B, and D are examples of traces which could have been interpreted as good indications of fish, but total catch for the three tows was only two fish. The net was towed through what now appears to be a scattering layer in 6A and B rather than through the large patches above, which probably more closely resemble fish traces. However, in 6D the tow was made through traces resembling the large patches in 6A and B, with a catch of only one hake resulting.

Plankton forms, principally euphausiids and jellyfish, were present in many catches, even those in which no fish were taken. After some experience, it was concluded that part of the "Sea Scanar" recorder traces, such as the layers in figure 6A and B, were caused by dense concentrations of euphausiids, with jellyfish sometimes mixed in. From then on, a fair degree of success in predicting catches was possible.

Exploration of these waters at different seasons of the year may show that other species of fish are available to midwater trawls in greater or lesser degree than those found during the present cruise. It is apparent that a great deal of experience on the local fishing grounds is necessary to properly identify species of fish from traces on the echo recorders, under different conditions and times of day. Suitable electronic fish-finding equipment, competently operated, and an accurate

trawl-depth indicating method are essential items for successful offshore midwater trawling exploration.

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SPECIAL DAYS, WEEKS, AND MONTHS IN 1958

A booklet--"Special Days, Weeks and Months in 1958"--compiled by the Chamber of Commerce of the United States, Washington, D. C., is now available to the public. The object of this booklet is to aid businessmen and civic groups to tie in their advertising and promotion plans with established observances.

Promotional material for businessmen and civic groups is available from the sponsors of most of these events.

This is quite a comprehensive listing as there are very few days in the year that are not marked by one or more special observances. Included among these are National Canned Salmon Week, National Wildlife Week, Let's Go Fishing Week, Let's Go Hunting Month, National Better Breakfast Month, Picnic Month, and National Sandwich Month.

Also, this year is the first time that the booklet contains a Trade Promotion Planning Calendar. The pages of this calendar contain large blocks which are handy for making notes and planning trade promotions.

The publication "Special Days, Weeks and Months in 1958" is sold at 50 cents a copy by the Domestic Distribution Department, Chamber of Commerce of the United States, 1615 H Street NW., Washington 6, D. C.