COLLECTING COASTAL PELAGIC FISHES WITH ARTIFICIAL LIGHT AND 5-METER LIFT NET

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The National Marine Fisheries Service (NMFS) Exploratory Fishing and Gear Research Base, Pascagoula, Mississippi, has used underwater lights and a large-diameter lift net to attract and capture live coastal pelagic fishes for experimental studies. The gear design and fishing methods evolved from our observations of the behavior of coastal pelagic fishes around underwater lights, and their responses to conventional lift nets. This article provides details for building and rigging the 5-meter (16.4 feet) diameter lift net--and the mounting platform used to position underwater lights and an echo sounder transducer over the net. The methods of fishing this gear and handling the live fish are described.

Artificial lights have been used to attract fish at night for capture with a great variety of fishing gear. Light-attraction techniques in the world sardine fishery were reviewed by von Brandt (1960). The Japanese have used hand-held dip nets and lift nets to capture light-attracted saury. Recent developments in Japanese night-light fishery were reported by Anonymous (1968). Borisov (1956) described equipment and fishing methods of the Soviet Caspian Sea fishery in which lift nets are used to harvest light-attracted sprat. Methods for collecting and keeping live clupeoids for experimentation were described by Verheijen (1956), who obtained his specimens from ring nets around night lights in the Mediterranean Sea. In Gulf of Mexico, Siebenaler (1953) collected various live tuna-bait fishes with an $8\frac{1}{2}$-foot square trap lift net and 150- or 300-watt light. Recently, personnel of the Exploratory Fishing Base at Pascagoula have used several types of high wattage lights and a 5-meter (16.4 feet) diameter lift net to capture numerous coastal pelagic species for experimental studies.

FISH BEHAVIOR & LIFT NET DESIGN

Prior to designing the light attraction and lift net shown in Figure 1, a variety of light sources and net designs were used at night-lighting stations in the Gulf of Mexico. Fish were attracted to almost every type and intensity of light used. A bright-point source light, with a well-defined intensity gradient, created a better organized or structured aggregation than did a dispersed field of light created by several sources. Maeda (1951) described the structure of the communities around fishing lights in Japan. Most coastal pelagic fishes attracted to artificial light in Gulf of Mexico also exhibited preferential spacing within light field, probably in relation to light intensity. Many of these fishes did not accumulate directly beneath light but occupied dimmer zones. Fish would move to center of light field when light was dimmed gradually.

To capture as many fish as possible from the dim light zones, the lift net was designed with the largest hoop that could be operated from research vessel's outrigger. The large opening improved catch because the hoop would often reach the level of the fish before they could detect it.

Fish in the path of a rising net escape by rapidly dispersing horizontally and/or sounding obliquely out of the path of the approaching net. Several features of the net may have reduced the fright stimulus produced

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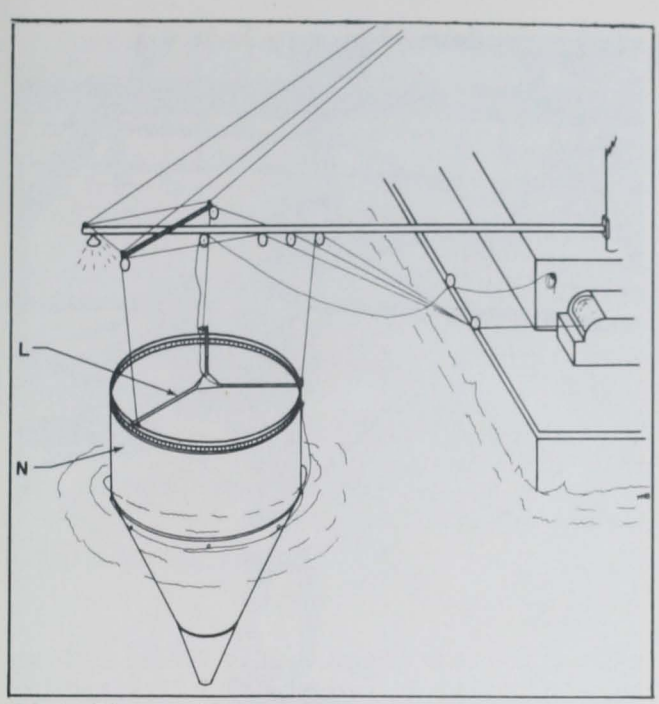

Fig. 1 - Diagram of design and rigging for the 5-meter lift net (N) and the underwater lamp and echo-sounder transducer mounting platform (L).

during fishing. The net was rigged with 3 separate lift lines because a bridle caused a fright response and the fish evaded capture. The 3 lift lines produced some vibrations during a lift, but they did not elicit fright reactions--and the fish were not much disturbed before visually detecting the net. The visual fright stimulus produced by the net's approach was reduced by making the top 10-foot section of webbing hang straight down from hoop before tapering to cod end. Although pressure wave that precedes rising net was not measured, the straight-side design also may have reduced this pressure wave, or lowered it to within the net opening.

LIFT NET HOOP DESIGN

The lift net hoop was made by rolling a 2- by 2- by $\frac{1}{4}$-inch angle iron and a 1-inch iron pipe to a 5-meter (16.4 feet) diameter circle and welding the iron pipe to the angle iron. The hoop was constructed in 2 equal parts bolted together with overlapping angle-iron stiffeners (Fig. 2). This construction permits hoop to be dismantled for easy storing.

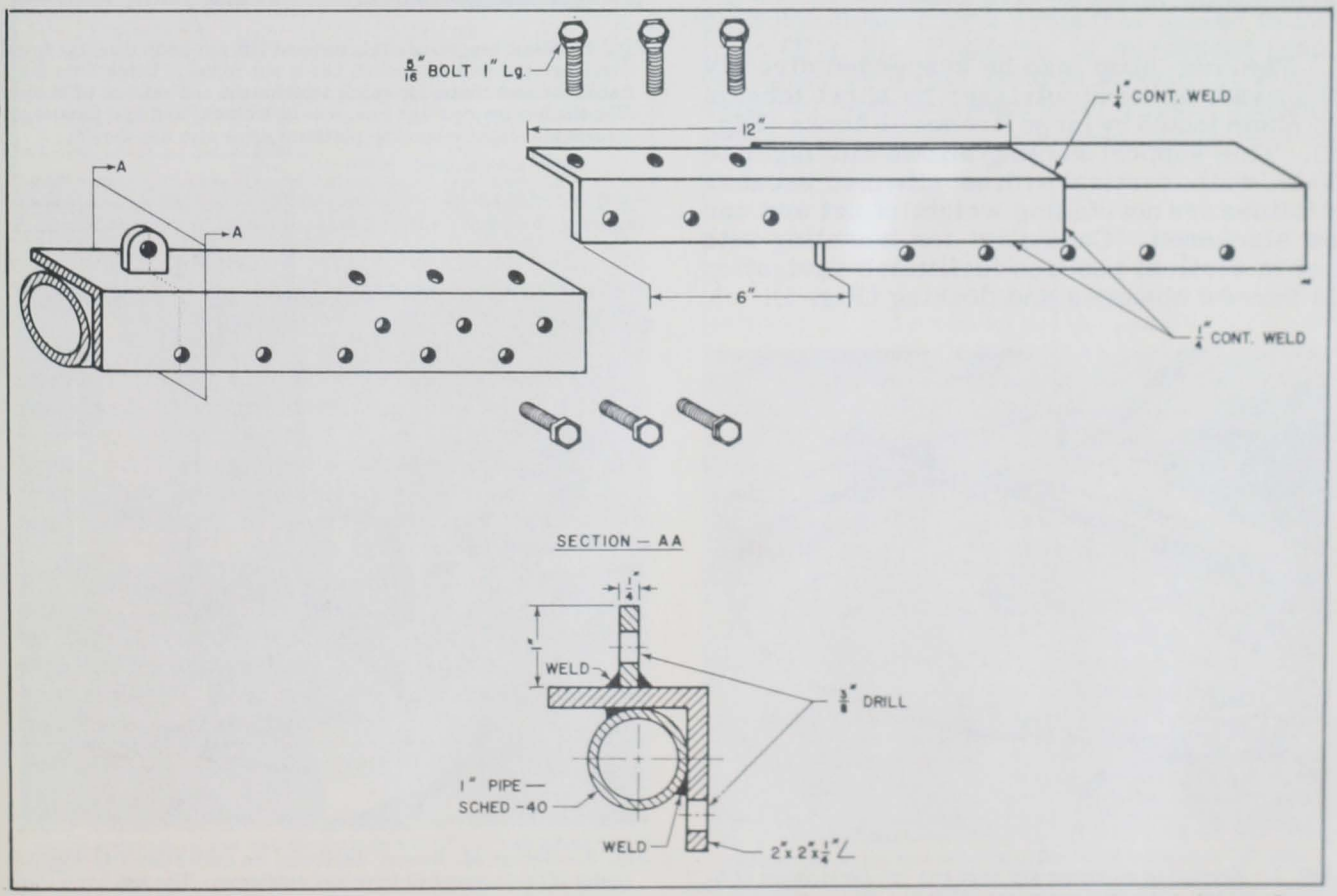

Fig. 2 - Design and construction of lift-net hoop frame. Upper diagram shows method of bolting together the hoop's two halves. Cross section of lift-net hoop frame (Section AA) shows details of angle iron and pipe frame, lift-line pad eyes, and net-attachment holes.

The hoop's lower flange was drilled with $\frac{3}{8}$-inch holes spaced at 3-inch centers for net attachment. Lift lines were attached to 3 pad eyes equally spaced on hoop's top flange.

LIFT NET RIGGING

Operation of a lift net with 3 separate lift lines, instead of a single line bridle, required special rigging to put a block directly above each lift point. The rigging's general layout is shown in Figures 1 and 3. A specially built yard arm was bolted across end of vessel's outrigger to space and support the blocks for the two outboard lift points. The inboard block was attached directly to outrigger. The yard arm is 15 feet long of 2-inch schedule 80 iron pipe; it is supported by guy wires leading to tip of outrigger and to top of main mast. The lift lines run from net hoop through series of 4-inch blocks that bring lines together and lead through a single 6-inch snatch block to vessel's main winch. The lift lines are attached at winch and wrapped together around drum. Lift lines are 75-fathom lengths of $\frac{5}{16}$-inch stainless-steel wire rope.

The net hoop can be suspended directly from yard arm and outrigger by short lengths of chain joined by large Brummel hooks (Fig. 4). This support rigging allows outrigger to be raised to vertical with net attached because lift lines are not holding weight of net and can be slackened. Capability for traveling with net in vertical position facilitates navigation in narrow channels and docking (Fig. 5).

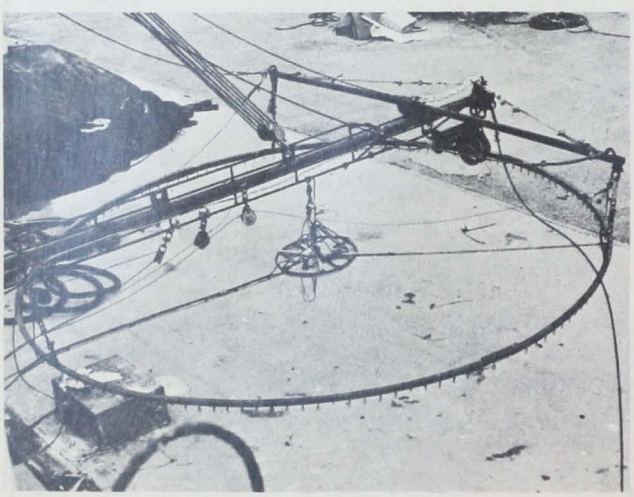

Fig. 3 - Rigging of outrigger and yard arm for deployment of 5-meter lift net. Details of net hoop and lift line rigging are shown with prototype model of underwater light mounting platform.

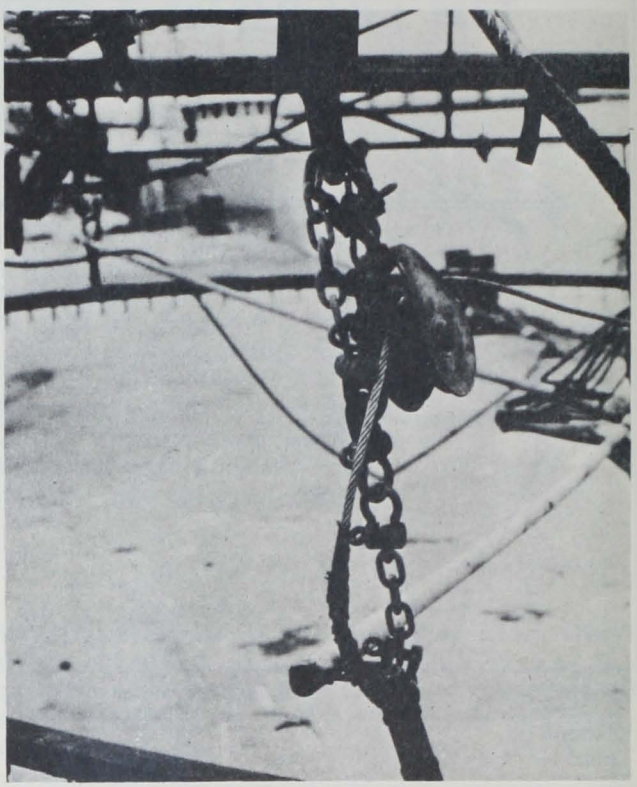

Fig. 4 - Short lengths of chain suspend lift net hoop directly from outrigger and yard arm when net is not in use. Large Brummel hooks connect chains for quick attachment and release of hoop. The slack-wire rope-lift line, a 4-inch block, and one prototype underwater light mounting platform arms also are shown.

Fig. 5 - George M. Bowers departing on collection trip with 5-meter lift net suspended from port outrigger. The net hoop was attached to outrigger and yard arm (see Fig. 4) permitting lift lines to be slackened and outrigger raised to clear dock.

NET DESIGN

The net was made of $\frac{1}{2}$-inch stretched-mesh knotless nylon webbing dyed dark green. It was strengthened at seams with nylon tape (Fig. 6). The opening was 5 meters (16.4 feet) in diameter. The top 10 feet of webbing were hung from hoop with a straight fall, whereas remaining section tapered to the cod end. The 28-foot total length provided sufficient slack for cod end to be hoisted aboard vessel for emptying. Rings for choker lines were sewn into net around cod end and in other appropriate areas. An iron weight was attached to cod end to sink webbing during fishing. Grommets were placed at 3-inch centers in band of dacron sewn around top of net. Small Brummel hooks attach net to hoop and permit quick installation and removal of webbing for storage out of the sun (Fig. 7).

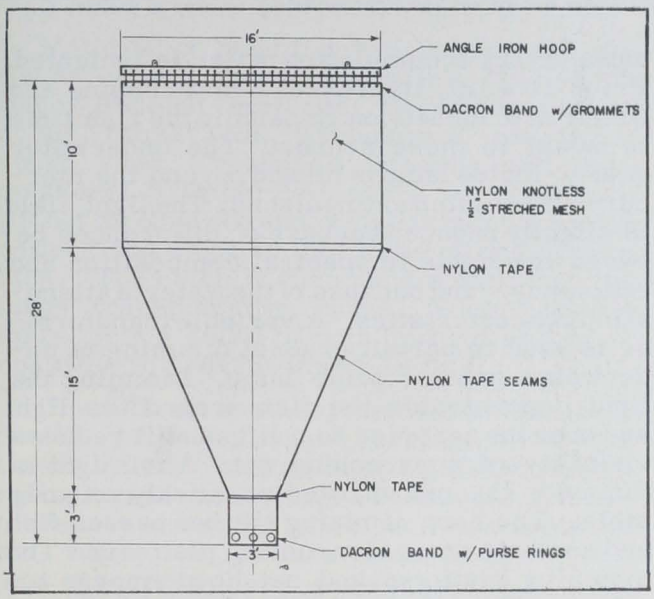

Fig. 6 - Diagram of lift net showing measurements and major design features.

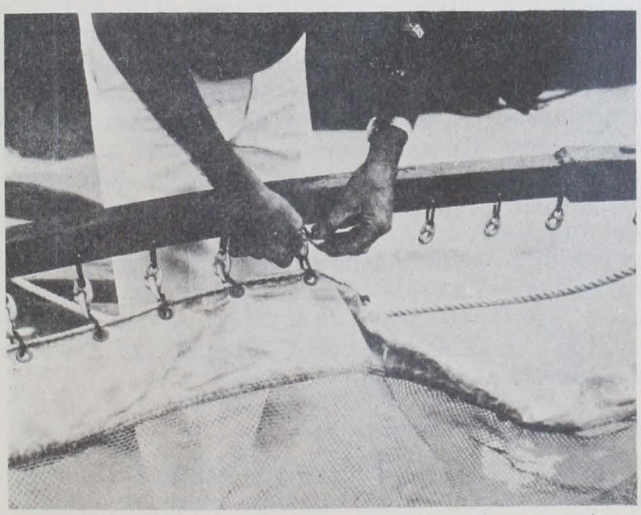

Fig. 7 - Small Brummel hooks attach the net to the hoop and quick removal of the net for storage out of the sun when not in use.

LIGHT SOURCES & UNDERWATER MOUNTING PLATFORM

The first light-attraction source was a 1,000-watt quartz-iodide lamp mounted on vessel's outrigger and directed downward above net. Although this lamp attracted fish successfully because of its mounting location, its light zone and attracting ability were considerably reduced by vessel's hull. Reflection from water surface also reduced lamp's efficiency, especially when seas were choppy.

Fish aggregations were monitored originally by an echo sounder using vessel's hull-mounted transducer. Transducer's location proved unsatisfactory for detecting fish near surface and directly over lift net.

Various arrangements for positioning an underwater light and echo-sounder transducer above lift net were evaluated before satisfactory design was developed. This design, described below, consists of a mounting platform braced by 3 arms that extend to lift lines (Fig. 8). Platform is suspended from outrigger by a line used to position it at any selected depth below surface. Figure 3 shows

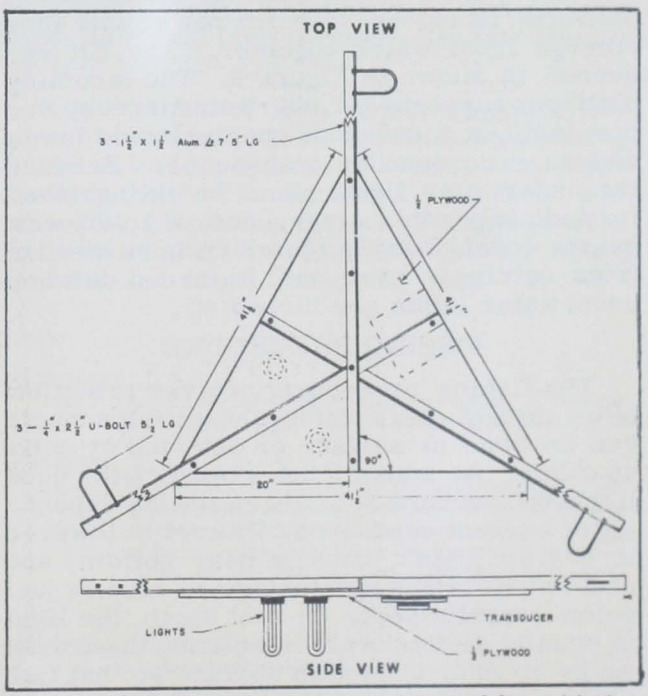

Fig. 8 - Design details of mounting platform used for positioning underwater lights and echo-sounder transducer over lift net.

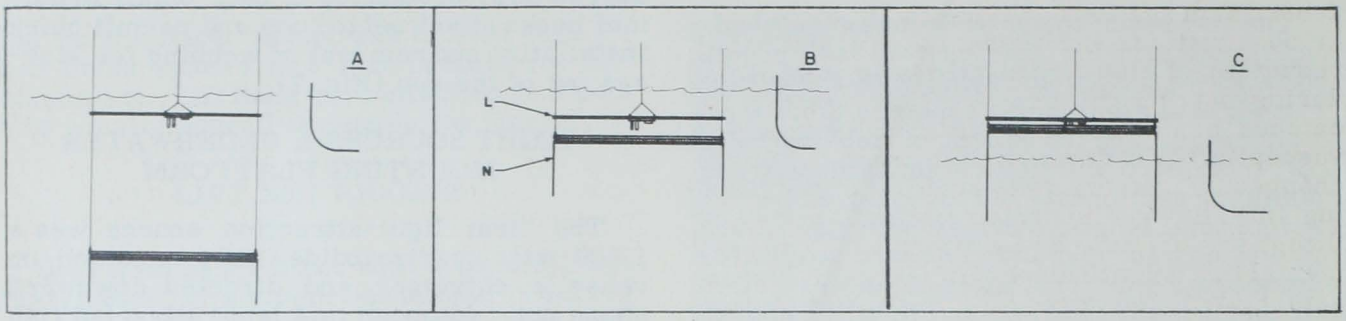

Fig. 9 - Diagram shows sequence of events during a net lift; A - Lift net and underwater light mounting platform in fishing position, B - During a lift, the lifting lines pass through hoops on mounting bracket as net moved upwards until net hoop reaches and contacts arms of mounting bracket, C - The net hoop and mounting bracket begin moving upward together, both emerging from water at same time. (N) Lift net. (L) Underwater light mounting platform. Fig. 1 shows the lift net and light mounting bracket in position C.

a prototype platform suspended over net hoop. Final mounting platform was constructed of $1\frac{1}{2}$- by $1\frac{1}{2}$- by $\frac{1}{4}$-inch aluminum angle. Mounting platform is centered over net by 3 arms that are attached loosely to lift cables by u-bolts, through which lift cables can move freely.

The arms prevent platform from flipping when vessel rolls. A widely spread bridle attached to arms also adds to stability. Vertical movement is dampened but not eliminated with this device. During a net lift, the lift lines move through u-bolts in arms of mounting platform, but the platform does not move until net hoop contacts tips of arms. From moment of contact, arms rest on net hoop and mounting platform is raised with lift net so that they emerge from water together. The lift sequence is shown in Figure 9. The mounting platform supports a 1,000-watt mercury vapor lamp, a 1,000-watt quartz-iodide lamp, and an echo-sounder transducer. Because the underwater lights must be extinguished immediately after emergence, a 1,000-watt quartz-iodide flood lamp, which is suspended from outrigger over net, is turned on when underwater lights are turned off.

FISHING PROCEDURE

The fishing procedure involves selection of an area of clear water where fish schools can be seen at surface or detected by echo sounder. At sunset, the vessel, with deck lights off, anchors or drifts on station depending on current conditions. The net is lowered to desired depth, usually near bottom, and underwater lamps are positioned usually just below vessel's keel. At keel depth, the light is equally visible in all directions; the transducer is near enough to surface so that fish accumulating beneath lights can be detected. The underwater mercury vapor lamp is turned on, and the echo sounder monitored until a satisfactory accumulation of fish is indicated. Prior to a lift, the vessel's main engine and winch are turned on to permit the fish time to adapt to these sounds. The underwater quartz-iodide lamp is turned on, and the mercury-vapor lamp extinguished. The light field is slightly reduced because of differences between the lights in spectral composition and efficiency--and because of the water's attenuation characteristics. A variable transformer is used to permit gradual dimming of underwater quartz-iodide lamp. Dimming the light concentrates the fish around the light and over the net prior to a lift, and it reduces visibility of approaching net. After light is dimmed, the net is lifted as quickly as possible. The hoop of rising lift net passes fish and contacts arms of mounting platform. The mounting platform and net hoop emerge together. The quartz-iodide lamp, suspended from outrigger, is then turned on, and the underwater light extinguished. The surface light retains the fish not captured in the general area for capture on following lifts. The surface lamp also provides light for handling catch without turning on deck lights. If two nets were fished, the alternate net and light would be deployed from the opposite outrigger at this time. After removal of the catch, the net and platform are lowered back to their respective positions, the underwater lamps are turned on, and the surface light is extinguished. The procedure described above is repeated until a sufficient quantity of fish is captured.

Other Best Catches Made

Best catches with the lift net and light attraction were made in the summer around dark of the moon in clear calm water. The most productive night times for fishing were in the early evening and predawn hours. The latter period usually produced larger and

denser aggregations. Visual and echo-sounder observations and lift net catches indicated reduction of fish aggregations in light field during midnight hours. Peak periods in catches could be caused either by increased susceptibility of fish to light attraction, or by changes in light-intensity preferences resulting in greater dispersion around light even though fish continue to be attracted. Experimental fishing with more efficient gear (purse seine) would be necessary to evaluate these hypotheses.

HANDLING TECHNIQUES FOR LIVE FISHES

Methods of handling live coastal pelagic fishes depend upon the species. The hardy fishes (scaled sardines, Harengula pensacolae; round scad, Decapterus punctatus; rough scad, Trachurus lathami; and chub mackerel, Scomber colias) are removed from lift net through cod end, which is quickly swung on deck and emptied into water-filled plastic tubs. The catch is then hand sorted into the large transportation tanks. When catch is large, only a small part is brought aboard at one time to prevent injury to fish.

The delicate species (Spanish sardine, Sardinella anchovia; round herring, Etrumeus teres; Atlantic thread herring, Opisthonema oglinum; and anchovies, Anchoa spp.) are removed by dumping catch back into mouth of net, where the fish are removed by dip net. The dip nets have small mesh ($\frac{1}{2}$-inch stretched mesh) knotless webbing, which causes less injury to fish than knotted netting. Sometimes, a plastic liner is used in dip net for extremely delicate species. The fish removed in small batches with the dip net either are placed in tubs for sorting, or are introduced directly into the transportation tanks if the catch consists mostly of the desired species.

On the stern of the 'George M. Bowers' are two portable 1,500-gallon rectangular fiberglass tanks for transporting live fish (Fig. 5). Each is divided into two compartments by a removable wood-and-fiberglass screen. The divider keeps several species separated; it also acts as a baffle by reducing water sloshing caused by vessel's roll. Fewer fish probably would be injured in cylindrical transportation tanks or tanks with rounded corners than in rectangular tanks.

During transport at sea, the tanks are supplied with a constant flow of fresh sea water and, though often crowded, the fish survive well. Upon entering harbors or other areas of doubtful water quality, the tanks are shifted from the flow-through system to the recirculating system powered by a small portable pump. Recirculation keeps fish alive for short periods, but survival time is prolonged when water is cool and the fish are not crowded.

Immediately upon return to the Base, the fish are removed from transportation tanks by dip net and transferred in water-filled plastic tubs to sea-water laboratory (Wickham, MS). In laboratory, the fish are placed either into holding tanks or into the large experimental pool. Temperature and salinity shock is minimized by gradually introducing the fish into the system.

The equipment and techniques described here have supplied the Exploratory Fishing and Gear Research Base at Pascagoula, Mississippi, with fish for controlled field and laboratory studies. These techniques also could be adapted to supply live bait for commercial and sport fisheries.

LITERATURE CITED

Anonymous
1968. Japan hopes new method will boost saury catch. Fish News Int., 7(11): 76, 78.

BORISOV, P. G.
1956. Experimental and commercial fishing in the USSR with the help of electric light. Contribution to Conseil Permanent International pour l'exploration de la mer, meeting Baltic-Belt Seas Committee, No. 4, 11 p.

von BRANDT, A.
1960. Fishing Methods in World Sardine Fisheries. In Proceedings of World Scientific Meeting on the Biology of Sardines and Related Species, Ed., Rosa, H., Jr. and Murphy, G., Rome, 1959, Vol. II, Subject synopsis No. 3: 563-623.

MAEDA, HIROSHI
1951. Analytical studies on marine lamp-communities. Publ. Seto Mar. Biol. Lab., 1(4): 195-213.

SIEBENALER, J. B.
1953. Trap lift net for catching tuna bait fishes. Commer. Fish. Rev., 15(8): 14-17. (Also Sep. No. 356)

VERHEIJEN, F. J.
1956. On a method for collecting and keeping clupeids for experimental purposes, together with some remarks on fishery with light-sources and a short description of free cupulae of the lateral line organ on the trunk of the sardine, Clupea pilchardus Walb. Pubbl, Sta. Zool. Napoli, 28: 225-240.

WICHKHAM, DONALD A.
Salt-water recirculation system and laboratory at the Exploratory Fishing and Gear Research Base, Pascagoula, Mississippi. Manuscript.