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USE OF UNDERWATER TELEVISION IN FISHING-GEAR RESEARCH (PRELIMINARY REPORT)

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BACKGROUND

Direct observation of a midwater trawl net in operation was a joint field project conducted by the U. S. Fish and Wildlife Service and the U. S. Navy's Bureau of Ships in early November 1954. This was the first practical demonstration in this country of the application of underwater television as a research tool for experimental work in fishery methods and equipment. Dubbed operation "Fisheye" by participating members of the field party, the television broadcast in the clearer Gulf Stream waters off the east coast of Florida was carried out cooperatively by personnel from the Service's Coral Gables and and Pascagoula Stations and the Navy's Bureau of Ships, Washington, D.C. Representatives from the Navy Diving School, the Navy Photo Center, Geological Survey, and the University of Miami Marine Laboratory also participated.

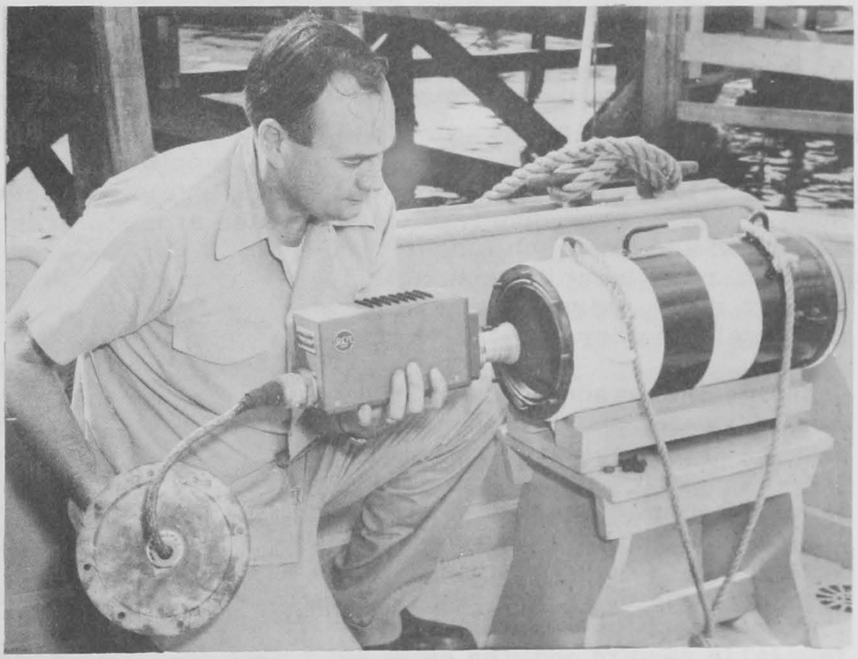

Fig. 1 - The RCA ITV-5 camera unit is inserted into the watertight housing. Camera lens is a Kodak 16 mm. Cine Ektar lens with wide angle adapter.

Research in the field of fishery methods and equipment has been hampered by the limited access to direct observation of fishing gear in operation. Advances in design and construction of nets, trawls, and other gear have come about largely as the result of trial and error, or have been based on scanty information obtainable from work with models, or by information supplied by the efforts of divers working with underwater cameras. With the advent of television into underwater research in other fields, recognition of the possibilities of the adaptation of the instrument as a means of securing direct observation of fishing gear and methods led to the assignment of such a project to the Service's Exploratory and Gear Development Station at Coral Gables, Fla. Here, in cooperation with other agencies at work in the field of underwater television at home and abroad, the gear research unit made preliminary investigations toward the adaptation of a standard vidicon television chain to underwater operation.

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EQUIPMENT AND METHODS

Over a period of two years many preliminary experiments were made to prepare the television chain for this initial demonstration, as well as to gather basic data useful in the development of television as a general gear research tool. Even though the sensitivity of the television camera is much greater than the human eye, many mechanical and technical modifications were necessary to utilize the maximum picture potential. Frequent complete check-overs and maintenance repairs resulted from the residual effects of salt air, dampness, and even short periods of inactivity. A separate generating set was installed aboard the Service's 57-foot research vessel Pompano to provide an adequate 110-volt a. c. power supply for the television chain. In addition to the sync-pulse generator built into the chain, an auxiliary unit was often necessary to stabilize picture quality under field conditions.

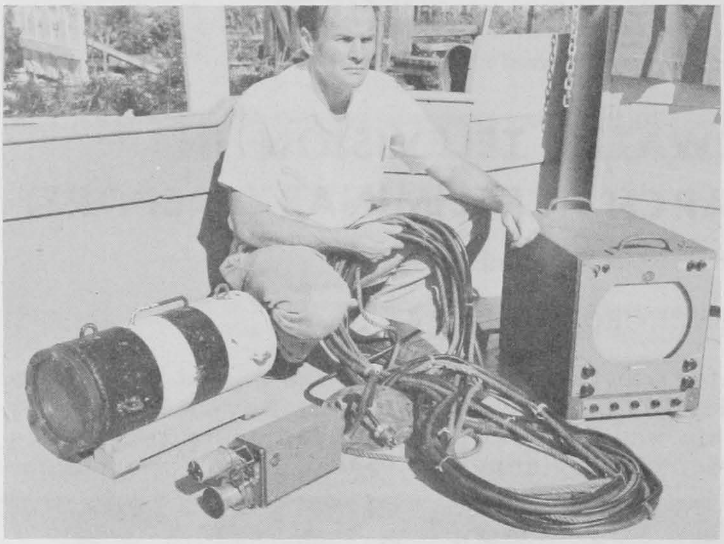

Fig. 2 - Complete TV chain used in these experiments. Left to right: watertight housing, TV camera, multiconductor cable, control monitor.

The television camera was housed in a watertight steel cylinder and connected by a flexible multiconductor cable to a remote control monitor aboard the research vessel. In this manner the camera becomes a sort of remote eye under the operator's control. Such a system can conceivably be operated at much greater depths than a diver can withstand and for much longer periods of time without the risk attendant to a diver operating an ordinary underwater camera.

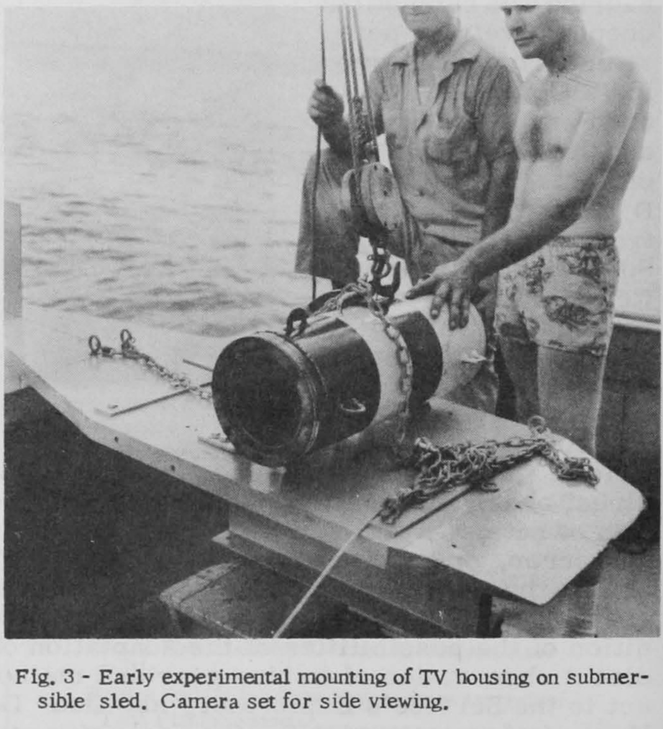

Fig. 3 - Early experimental mounting of TV housing on submersible sled. Camera set for side viewing.

By comparison of available data on underwater photography procedures and progressive experimental UW-TV operations, optimum and favorable conditions for the use of UW-TV in gear research were investigated. Considerations of the critical angle of sunlight and various surface conditions suggested more favorable results could be expected with a slight ripple on the water than in a flat calm. In the clearer waters such as those of the Gulf Stream off Florida, as much as 50 percent natural sunlight could be expected at depths to 25 feet. A period from 9:00 in the mornig to 3:00 in the afternoon, with favorable atmospheric and hydroscopic conditions, was found to be optimum for work with the vidicon television system. Effectiveness of the television camera may be sharply reduced by molecular diffusion of light or by suspensions of organic and inorganic matter in the water. This may be somewhat offset through the use of water contact lenses. At depths in excess of 30 to 40 feet, where color tends to go to shades of blue and green, white or yellow indicated the greatest persistence for visual observation of trolled lures, otter boards, and trawl nets. Due to the refraction of light, lens coverage was reduced by approximately 25 percent while the camera submerged. The use of a wide-angle lens afforded greater facility in viewing, with a minimum blurring of image, in most instances over limited distances.

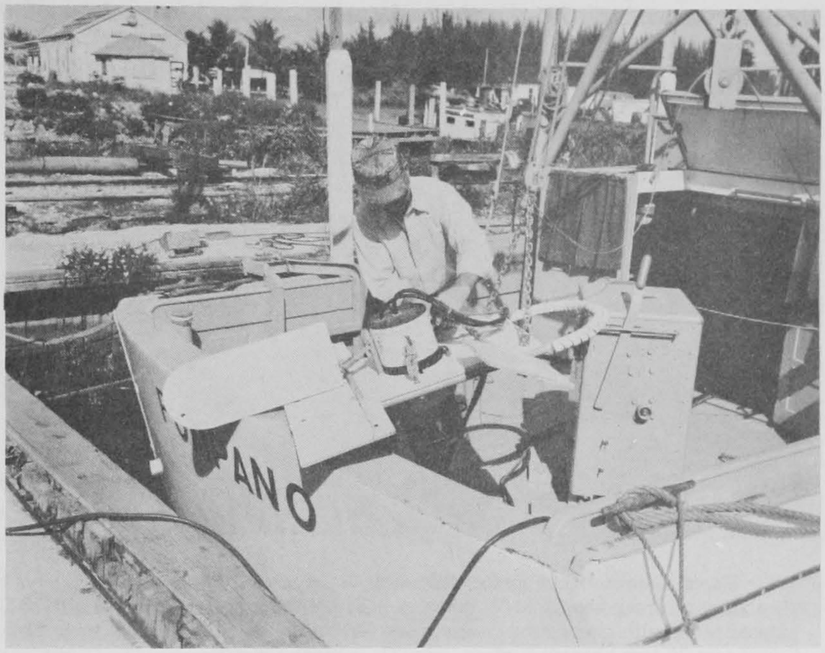

Fig. 4 - TV camera housing is adjusted on a submersible sled for downward viewing. Vertical and horizontal stabilizers can be preset.

Various methods of approach were investigated to find suitable simple mechanical appreca-tions of the existing equipment for the study of the particular problem mentioned above and for basic gear research as well. Early experiments were conducted by simply lowering the camera housing overside to depths of 40 feet. The addition of metal or wooden fins or rudders to the watertight housing allowed it to be towed at speeds up to 3 and 4 knots while submerged. By mounting the camera in a fixed position on a submersible sled with directional or stabilizing chains, a towed object could be viewed at comparable speeds. The speed of the vessel and the setting of vertical and horizontal stabilizers on the sled controlled the distance and attitude of the vessel to the camera, and the camera to the object. In this manner a towed net might be viewed from the front, the top, or laterally at different angles. An alternate simple arrangement for observation of trawl nets was affixing the camera housing to a trolley and lowering it down the length of the towing warp. By this means good front views were obtained of trolled lures, trawl nets, and otter boards at depths to 40 feet.

Fig. 5 - Camera housing mounted on sled for rear viewing.

EXPERIMENTAL RESULTS

During a joint cruise (November 1-15, 1954), the UW-TV equipment was used to observe and photographically record further tests of a modified Swedish "phantom" midwater trawl. The vidicon television chain was employed aboard the Pompano to observe laterally the action of the midwater trawl and accessories, while the trawl was towed by the Service's 100-foot exploratory fishing vessel Oregon. At the same time from the Oregon, an image orthicon camera in a special watertight housing affixed to an experimental submersible was used to view the trawl from the front. Good viewing was obtained at depths in excess of 60 feet, and at distances of more than 60 feet. Both moving picture and still photographs were made of the television observations. A limited amount of work with underwater artificial lighting to improve conditions for television observation was also carried out aboard the Pompano during this period. The use of standard diving lights with reflectors and photofloods afforded improved illumination to limited distances. Considerable variation has been found in individual reflector lamp ability to withstand pressures in workable ranges. Tests suggested that controlled artificial illumination should afford greater efficiency, but particular physical arrangements of lights and television camera are required for optimum results.

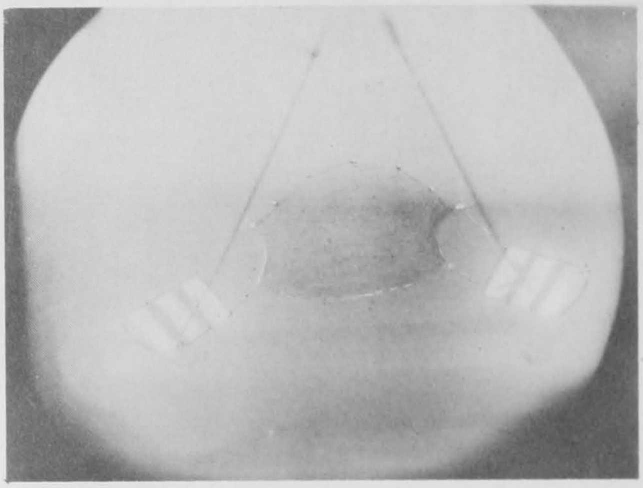

Fig. 6 - Front view of model 20-foot midwater trawl as seen on TV monitor screen aboard M/V Pompano. Trawl doors were painted white with alternating dark stripes for better viewing. Trawl was 20 feet beneath surface, with TV camera approximately 30 feet ahead of trawl mouth.

As a result of these experiments, it is indicated that an underwater television chain can successfully be utilized as a means of observing fishing gear in operation. While image orthicon television equipment is certainly desirable from the standpoint of greater sensitivity and definition, it remains a comparatively complex instrument. The picture quality of vidicon television equipment is somewhat less in comparison but should prove to be generally adequate for conditions of limited viewing distances wherever favorable illumination is provided.

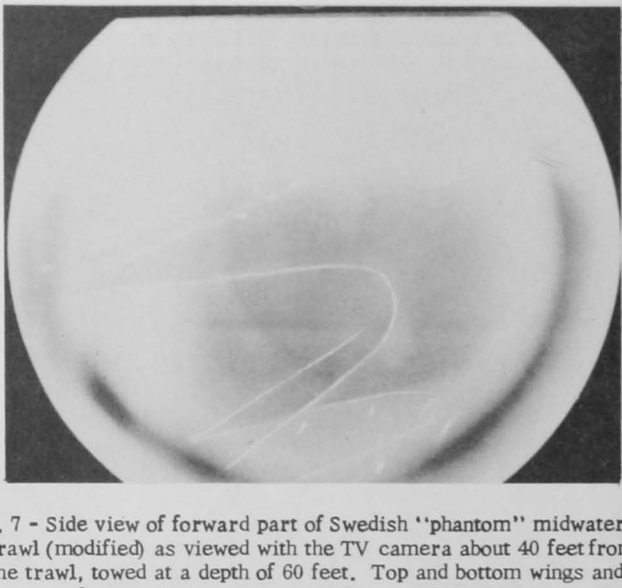

Fig. 7 - Side view of forward part of Swedish "phantom" midwater trawl (modified) as viewed with the TV camera about 40 feet from the trawl, towed at a depth of 60 feet. Top and bottom wings and amount of vertical net opening are shown. White objects attached to head and foot ropes are trawl floats and planes.

CONSIDERATIONS FOR FUTURE DEVELOPMENT AND USE

The size of any submersible television camera unit is of importance for ease in handling and maneuverability under field conditions. An extremely desirable feature for an underwater television vehicle would be some scanning facility for the camera in both azimuth and elevation. The ability of the unit to hover, to be placed on the bottom, or to be propelled at speeds in excess of 3 to 4 knots would also be of great value. The gear research unit at Coral Gables now has under construction a prototype of such a submersible television vehicle which will afford some scanning facility for the camera. An improved remote iris control is also being developed.

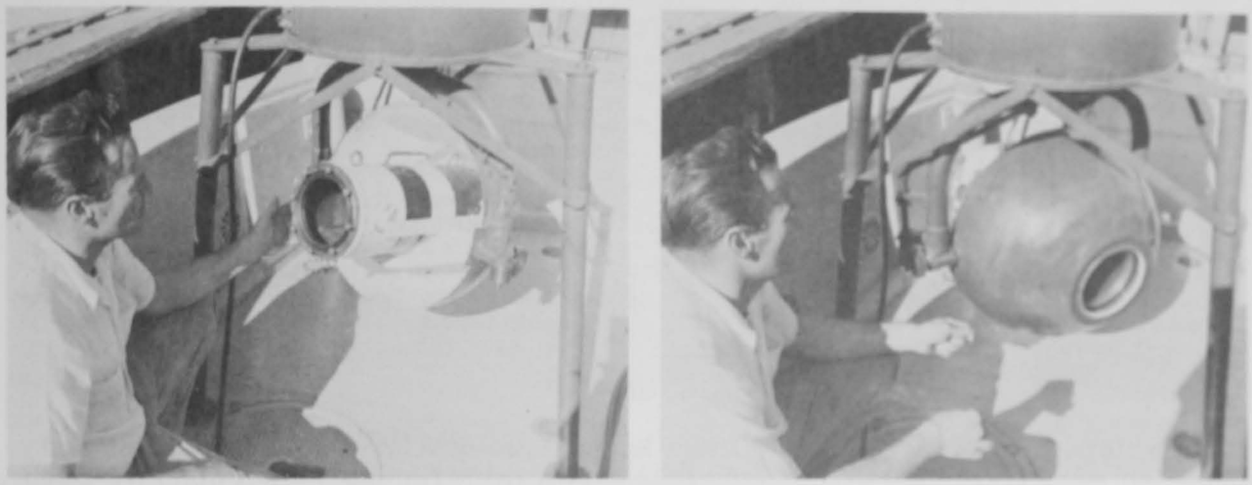

Fig. 8 - Experimental prototype tripod arrangement supporting remotely-controlled submersible power unit, with TV camera pressure cylinder mounted in a spherical free-flooding external housing capable of scanning 360° in azimuth and 90° in elevation. Left: rear view with half of spherical housing removed; right: front view.

The value of UW-TV as an aid to investigations in marine biology and in limnology has been shown. In addition to gear research work in the commercial fisheries, it may prove to be of assistance in the delineation and harvesting of clam beds and of oyster and scallop beds. Closer views might be obtained of bottom types, bottom formations, and of fishes in their natural habitat, which at present may be located only with difficulty by depth-sounding equipment. Water temperatures, current flow, turbidity, and other oceanographic data related to the fisheries might be directly monitored. One might reasonably expect that further experience will expand considerably the scope and variety of possible UW-TV observations. Within the limitations of the "closed" television system, the suitability of the equipment for a particular problem should rest principally on mechanical application.

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