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Underwater Television in Commercial Fisheries Research

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THERE ARE NUMEROUS problems in fisheries investigations which might be better answered by direct visual underwater observations rather than by techniques of sampling and analyses. This is particularly true in research in fishery methods and equipments, long hampered by limited access to actual observations of gear in action. Traditionally, fishermen have tended to use proven types of gear. Advances in the design and construction of nets, trawls and other gears have come about largely as the result of trial and error, based upon catch returns. Information obtained by the use of models or divers working with underwater cameras has been helpful and at times rewarding. The operation of such equipment is often difficult and the data obtained cannot always be completely evaluated.

Perhaps the first successful use of underwater television was during the Bikini atom bomb tests by the United States Navy in 1947. Shortly afterward some experiments were carried out in Canada, in the United Kingdom, and in this country at Cornell University. Early in 1951, the British Admiralty using a standard television broadcast unit was able to locate and salvage a sunken submarine. In 1952 the Canadian Wildlife Service applied underwater television to limnological studies in British Columbia.

The initial success with television in marine research prompted the Fish and Wildlife Service to develop equipment for operating fishing gear. This work was assigned to the Service's Exploratory Gear Development Station at Coral Gables, Florida.

Preliminary investigations were conducted in cooperation with the Navy Bureau of Ships, The Marine Laboratory of the University of Miami and others, through the summer of 1954. This work helped to determine the optimum conditions for the use of underwater television. It was found that in clearer waters, such as those of the Gulf Stream, as much as 50% of natural sunlight could be expected at depths to 25 feet. Somewhat reduced lighting was found in northern latitudes.

By means of comparison of underwater television experiments, and available data on underwater photography, studies were made of atmospheric and surface conditions, the critical angle of sunlight, of the reflection and defraction of light, dispersion and absorption under water. At depths in excess of 30 to 40 feet where light tends to be restricted to hues of blue and green, white and yellow indicated the greatest persistence for observations of trolled lures, otter boards and trawl nets. To overcome the low light levels that prevail in greater depths, the camera and control monitor had to be modified to improve video and definition, so that the maximum picture potential of the chain might be utilized. A special remotely controlled lens aperture device was constructed for use with 16 mm, 25 mm and wide angle or wide angle adapter lenses. Contrary to claims that the sensitivity of the underwater television camera might be as much as one hundred times that of the human eye, a closer figure was found to be three to four times. Lack of light and shadows was found to produce flat, two-dimensional images. Motion of the camera in most instances tended to increase the effect of depth perception. Artificial light sources ranging from standard light bulbs to 1000 watt navy diving lamps also tended to improve depth perception. Under normal lighting conditions at depths of 70 to 80 feet when there is a minimum of light dispersion and scattering of light, the television cameras might have a range of 70 to 80 feet or more. If artificial lighting is used the back-scattering can reduce the effective range of the camera to 10 to 12 feet. Close up views of a few inches' range are also possible.

The camera vehicle has been developed from simple experiments using the camera suspended overside. It features a 360° scanning facility in azimuth and 90° in elevation, and the operation has an almost studio-like control of a view covering complete hemisphere. The basic unit consists of the following: A vidicon TV camera fitted with lens, remote controlled focus and iris assembly fitted into a water tight pressure housing. The pressure housing may be attached to the scanning unit. The image is transmitted to the viewing unit by co-axial and multi-conductor cable. The operator regulates all mechanical and electrical functions, synchronization of signals, quality of image, focusing, and lens aperture from the control and viewing unit. Here at the monitor screen photographic cameras may be used to permanently record the transmitted image. To obtain good results it is important to have a highly stable 110 volt 60 cycle source of alternating current.

In November of 1954, a joint experiment of the service vessels *Oregon* and *Pompano* in cooperation with the Navy Bureau of Ships, the Navy Photo Center, and The Marine Laboratory of the University of Miami featured the first practical demonstration of the use of underwater television in gear research with an experimental midwater trawl as viewing subject matter. Underwater television units were installed aboard the M/V *Oregon* and the *Pompano*. While under tow from the *Oregon* the trawl doors, cables and net openings were observed by means of an underwater television unit streamed astern between the *Oregon's* towing warps, and the *Pompano*, was employed in lateral observations. During the course of these tests excellent observations were obtained of the performance of the trawl, the doors, floats, leads, spread and opening of the trawl. It was revealed by the television camera that while this gear was apparently fishing as designed it would require some modification. Observations of the webbing at various points revealed evidence of unequal distribution of load to various sections of the net. At times, the trawl and doors as a whole seemed to rotate about a center line, and to have difficulty to maintain a stable fishing depth. Of particular interest were the television camera, observations which showed that the trawl did not act as an inflated bag containing a volume of water exerting a pressure on the twine in all directions. The trawl mouth appeared as a stable, wire cage-like at all test speeds. During most of the tests the cod end of the experimental trawl remained open. At times, however, fish were observed near the net. These fish were seen swimming away easily from the trawl mouth, not as if frightened but as if aware of it. Whether the color of the net and accessories had any effect on their behavior was not known.

The usefulness of underwater television was further demonstrated as a practical gear research tool in Key West, Florida, in January, February and March, 1955. In conjunction with underwater sound experiments carried on at several stations in the Key West shrimping grounds, the power suspension assembly was used with underwater lights. Submerged for periods of twelve to fourteen hours almost around the clock observations were possible. At the appearance of light, pink shrimp were observed to immediately bury in the sea bed. Many other interesting views of marine life were seen and some sound sources identified by means of the television. At one time sounds attributed to the pink shrimp were more properly associated with the Florida lobster.

During experiments with various types of shrimp traps, numerous species of fish and marine life were seen and permanent records made by photography at the monitor screen. Some of these offer sharp detail. It was noted that after a short time many species of fish observed seemed to be unconcerned with the artificial illumination or the television camera.

In March, 1955, the underwater television gear was used to observe a 40 foot flat trawl and a 70 foot balloon trawl under normal dragging operations at depths to 60 feet. With the television unit trained on one of the trawling cables, the warp was followed down to the net. With the remote control scanning facility and by careful positioning of the *Pompano* it was possible to view the shrimp nets from front, top, rear and several angles for extended periods of time. Good close-up views were afforded of twine, doors, floats and lead lines, and while it was shown that these two nets were apparently performing as designed and rigged, it was possible to make adjustments and corrections to improve their fishing ability. Disturbed clouds of coral dust on the bottom revealed no indications of back wash at the trawl mouth on these particular tests. It may be said that an important consideration in the performance of bottom trawls appears to be towing speed. The television cameras revealed that at times an excessive rate of speed resulted in leap-frogging of lead lines or that too slow a rate of speed allowed trawl cables to come at times in contact with the bottom resulting in smaller angle of doors and decrease in net opening.

Of particular interest was the test of the 70 foot balloon trawl, which had not performed satisfactorily. Observations with the television camera were made which revealed that the net was functioning as designed.

During these Key West investigations and while examining local Florida waters for suitable gear proving grounds, the television unit was found to be very useful in delineating bottom types and conditions. A good deal of the success of trawling operations is dependent on bottom conditions which may change or which may not be accurately defined in fishing charts.

Often difficulties are experienced by shellfish operators in locating and efficiently harvesting beds of clams or oysters in waters deeper than 50 feet. The television unit might be of considerable help here and perhaps even allow some forecast of production.

The underwater television gear might also be used for studies of long line gear, gill nets, traps, or other stationary fishing gear. The behavior of fish passing through the webbing or over it could be studied, and observed at all times.

The experience gained thus far seems to indicate an expanded scope and variety of the use of underwater television. How suited the equipment is for a particular operation depends principally upon mechanical applications within the limits of the closed television system. Refinements in television have been rapid and future equipment might even allow 3-dimensional or color television for under-sea use. In comparison with other forms of under-sea observations in terms of depths attainable, risk involved, time of immersion, temperature, mobility, and sensitivity to light and color, the under-water television unit has some definite advantages. The ability of the unit to hover, be placed on the bottom or to be moved through the water for extended periods of observation with no risk to a diver's life is an outstanding advantage.

In summary, it is felt that rather than a novel application, the use of underwater television has been rewarding in scientific studies of fishing gear, bottom surveying, and of the behavior of fishes and marine life. The equipment in its present form is suitable for a variety of research observations. Work is continuing on the development of the proto-type instrument toward a multi-purpose undersea television vehicle. It is felt that with its use, and that of associated visual aids, progress toward more efficient fishery methods and equipment may more rapidly come about and aid in improving the position of the commercial fishermen.

The Seagoing Requirements of Fishing Vessels

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READ BY HARDEN TAYLOR

THERE IS PERHAPS no service on the high seas in which the element of seaworthiness is more vital than in fishing. There are a variety of reasons, of which the following are most noteworthy:

1. The work of the offshore fishing vessel is carried on in the open ocean where even the largest—excepting whaling and a few other factory ships—is small when measured against the prevailing sea conditions. To put it a little differently, the sea is almost always rough for the small ship.