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 undersea observations in terms of depths attainable, risk involved, time of immersion, temperature, mobility, and sensitivity to light and color, the underwater 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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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.

2. The fishing vessel, in contrast to the merchant ship, must maintain its position and, if possible, continue to fish, wherever fish are found just so long as wind and sea permit.
3. The fishing vessel must not only be highly seaworthy—stable, watertight and amply powered—she must also provide as steady a platform as possible from which to conduct fishing operations, and tolerable living conditions over a considerable period of time.
4. The fishing vessel must load cargo at sea; in all but a very few modern vessels of radical design, loading still requires the opening of hatches or scuttles for short periods whenever fish are taken aboard. If decks are flooded with hatches open, a dangerous volume of water can enter the fish holds and seriously reduce the vessel's stability and buoyancy.
5. Conditions of loading, displacement and trim alter continuously and often considerably through the exchange of fuel and ice for fish, and through occasional heavy icing of rigging and superstructure on winter voyages in high latitudes, with frequently adverse effect on stability.

The problem of seaworthiness from the common point of view of the fisherman and the fishing vessel is two-fold: on the one hand, the problem is to determine what are the limiting capabilities of the vessel in weather; on the other hand, what can be done to raise these limits. The solution of these problems will realize additional fishing time. Current research in the sea-keeping aspects of merchant ships indicates that it may soon be possible to define the upper limits of operational ability with respect to weather, and at the same time, current research in design features holds great promise for the extension of these limits.

What is really needed for the development of better fishing vessels is that the naval architect and shipbuilder be enabled to apply all of the knowledge now available to them to fishing vessel design and construction. The argument is not infrequently heard that the fishing vessel owner cannot afford the luxury of costly engineering advice. In reality, the best professional guidance is no luxury. The owner cannot risk the creation of his expensive vessel without the most skilled and experienced planning.

Expressed in simple terms, the vessel which is cheapest to build and operate and which can catch and deliver the most fish in the shortest time is the most profitable, assuming of course, that a satisfactory price is received. Now the overall efficiency of the fishing vessel is determined in part by the time which is spent in the actual operation of fishing, as distinguished from time spent on the outward and inward voyages, in shifting grounds, and in port. The time spent in fishing depends to a considerable extent on the degree of wind and weather in which the vessel can fish effectively. Hence improvements in seaworthiness which extend fishing capabilities are one way of increasing fishing efficiency as well as safety.

It is misleading to generalize and impossible to examine here the circumstances which are to be met in widely varying fishing activities. This paper will be confined to trawling and trawlers, which represent probably the most arduous fishing operation and the most seaworthy type of fishing vessel.

The trawling operation is performed at low speed—3 to 5 knots—though not necessarily at low power, since the added resistance of the trawl gear not infrequently requires full power to maintain the necessary trawling speed. When the trawl is hauled aboard, the vessel is brought broadside to wind and sea with little or no forward speed, and the gear is hoisted from a point well up the mainmast. This low speed while trawling introduces a factor which is, in fact, favorable to seaworthiness, since reduction in speed is nearly always helpful and often necessary when a ship is laboring excessively in a heavy sea. It explains why trawlers can often fish in comparative comfort in a seaway which would prevent anything approaching full speed operation. It is possible that the trawl net may have a steadying directional effect on the vessel's behavior not unlike the influence of a sea anchor. But as there is also a low limit of trawling speed below which the operation becomes ineffective, the objective is to extend the ability to trawl in heavy weather in order to gain fishing time. Likewise, of course, gains in ability to maintain speed on passage are desirable in a quite different speed range.

Hardy, Traung and Mökel say that the largest and most modern British and German trawlers—vessels of around 200 feet in length and 1,000 tons displacement with free running speeds of 11 to 13 knots—fish in winds up to Force 7 on the Beaufort scale (about 30 knots) and waves of about 20 feet in height from trough to crest in a fully developed seaway. They also report that the new German fisheries research vessel *ANTON DOHRN*—interestingly a steamer—which is fitted with a shelter deck, has fished in winds up to Force 8. These are most commendable performances, but they are a long way from being representative of smaller and older types which form the vast majority of trawlers at sea today. Each trawler is limited in ability to fish by some sea state which forbids maintenance of the speed necessary to tow the trawl gear.

A combination of factors determines the upper limit of speed in heavy weather; for the ship; size, the relation of displacement to length, hull form, and stability, for the sea; the relation of the length and period of the waves to the length and the natural periods of the motions of the ship. When these latter factors approach synchronism, the ship's behavior is most violent and its resistance most greatly increased. The problem is, what can be done to increase the safety and extend the upper limits of operational ability in both trawling and free running conditions?

Improvement of existing vessels is admittedly difficult. They are as they are, but some improvements may be effected. Stability characteristics may be accurately calculated and if advisable, ballast may be added or rearranged or even reduced. Loading and trim conditions may be improved and watertight integrity insured through well fitted hatches and other openings. But beyond these precautions, not much can be done to improve the seaworthiness and extend the operational limits of vessels already in service.

With the new design, there is much more latitude. For these small, "fat" vessels, V-type sections in the forebody, ample draft to insure good immersion of the propeller, and a moderate displacement-length ratio all have a favorable effect on seaworthiness and the ability to maintain speed in heavy weather. Ample freeboard and reserve buoyancy, particularly at the bow, are desirable. Sufficient transverse stability and easy rolling are somewhat conflicting requirements, but it may soon be possible and advantageous to incorporate such devices as anti-rolling tanks or adjustable fins which modify rolling without sacrifice of stability, which must, of course, be ample for all loading conditions.

Further than this, a rearrangement of conventional loading facilities which will improve watertight integrity is most desirable; systems which will obviate the necessity of open hatches at sea would contribute greatly toward increased safety. The problem of devising a subdivision of the hull of a trawler which would afford some protection in the event of flooding or underwater damage, and yet would not interfere with essential internal arrangements is admittedly difficult, and it may be that no real solution can be arrived at until the trawler evolves into something quite different from the accepted type. But the possibilities should be in every designer's thoughts, for the vast majority of these small ships are indeed "no compartment" vessels which lose stability and buoyancy very rapidly when damaged or flooded beyond the capacity of the pumps. Engine room flooding is almost always fatal to this class of vessels.

All in all, the seaworthiness of trawlers presents some unusual problems which tax the ingenuity of the naval architect and the skill and seamanship of the master alike. In general, it is impossible to resort to much greater size, since first cost and operating expenses rise rapidly with size and out of proportion to increased earning power. We must look, rather, to the mounting knowledge of the factors which make for seaworthiness and the extension of operational limits and apply this knowledge to the peculiar requirements of the trawler.

The innumerable small craft which venture many miles from shore and fish in what for them is very rough water indeed also present a problem. What can be done to improve the seaworthiness of these boats?

Their design and loading must provide for ample stability and buoyancy. Possibly the most vital requirement for safety is that water be prevented from getting below, and that accumulations of water on deck or in the cockpit be cleared as quickly as possible. For this, ample and reliable pumps are required for the first emergency; low bulwarks or shallow cockpits with generous freeing ports or scuppers for the second. But the small craft depends for safety much more on the skill of the operator than does the well found vessel, and it is amazing what severe conditions a well designed boat can weather if she is truly watertight and skillfully handled.

Considerations of safety and efficiency lead to the question of design and construction standards and regulations. For new vessels, standards of seaworthiness can be developed which, if adopted, will greatly reduce casualties at sea and improve performance. The problem in design and construction is no more obscure with the fishing vessels than with the merchant ship. But to evolve such standards requires recognition of their importance and acceptance of skilled professional guidance. The naval architect and marine engineer must be given the same freedom and responsibility they receive in all other branches of shipbuilding. And there is no possible question that reasonable standards and to some extent, sensible standardization, would be of benefit to all concerned with the fishing industry.

These suggestions must not be interpreted to mean that fishing vessels should necessarily be brought under the full jurisdiction of governmental regulatory bodies such as the United States Coast Guard. On the contrary, such an eventuality would place an undue burden on the government agency and could result in regulations which would be unsuited to the fishing industry. What is needed is a voluntary engineering house cleaning on the part of fishing vessel owners and the evolution of standards appropriate to the well being of the industry. There are, at last, some faint signs that a more realistic attitude toward these questions is emerging, and indeed it is most fervently to be hoped that this is so.

But there is one field in which government regulation is more than appropriate, and this is in the establishment of license requirements and standards for the deck officers and engineers on fishing vessels, for their abilities have direct bearing on the safety and performance of these vessels. The law which requires licensed officers above and below deck on almost non-existent steam fishing vessels seems to tolerate at great cost both unlicensed and often unqualified personnel on expensive and mechanically complex motor vessels. Again it is certain that the adoption of suitable license requirements would have a beneficial effect on the performance of fishing vessels, and on the cost of their insurance about which many complaints are heard.

The fishing industry should think hard and act wisely on these problems. A most significant step in the right direction was taken two years ago, when the meeting of the Gulf and Caribbean Fisheries Institute was joined with the first International Fishing Boat Congress here in Miami, at which technical and operational problems were presented and debated by designers, builders and operators together. It is to be hoped that that meeting was only the first of many to be devoted to this most important aspect of the fisheries.

It would be unimaginative to predict that present types of vessels will adequately serve the requirements for future fishing operations. Indeed it seems much more likely that as fishing is stepped up in intensity and complexity in many directions, the trend towards processing at sea will call for larger catches, longer voyages and bigger vessels. Nor is it certain that either ice or refrigeration will remain the best or most widely used methods of preservation of the catch on shipboard. But if the fishing vessel of the future becomes more and more a floating factory as well as a fishing ship, the combined operations will put an even greater premium on efficiency and safety. Such future vessels will call for somewhat elaborate facilities and operations approaching those of a shore based plant on the one hand, and a nearly continuously operated catcher on the other.

It would seem to the engineer that if the ocean fisheries are ever to approach their potential productive capacity, they must progress from the age old enterprise of hunting, even beyond the present and foreseeable stage in which detection of concentrations of fish becomes more and more positive. In effect, such progress would mean that some control could be exercised on the fish, and that, rather than relying on detection alone, the fish might be, in favorable locations and circumstances, attracted to the vicinity of the fishing vessel, and taken in quantity by methods radically different than heretofore. Successful methods of attraction and concentration, based on a wider knowledge of the habits and life cycles of desired species and of their ocean environment, could, it would seem, go far toward revolutionizing the fishing industry. If, as might also be conceived, sea food products should be developed which make use of a wide variety of species, something approaching mass fishing would be within reach.

What effects might be expected from such developments which would alter fishing vessel types and present new problems on the question of seaworthiness?

If the trend is to larger ships the problems of seaworthiness will be increased in importance, yet in a sense made easier. Increased size in itself will mean that the vessel will not be so continuously in relatively rough water; seas which to the conventional fishing vessel are large may become only moderate to bigger ships. Larger size will make the inclusion of anti-rolling devices far simpler. The question of suitable watertight subdivision will become at once more important and more feasible. Internal facilities may do away with the practice of placing propelling machinery as far aft as possible, and the machinery spaces will become less vulnerable. Continuous double bottoms may be fitted more readily, and low freeboard in the waist may not remain a requisite to fishing operations. If in the future nets and trawls are not lowered over the side or towed astern, it is expectable that the design can be developed with far greater regard to seaworthiness; if the catch is taken aboard other than through deck openings, one of the greatest hazards in heavy weather will be eliminated.

In summary, it would seem to be expected that problems of seaworthiness of the fishing vessel of the future will submit to better solutions than do those of our present day vessels. And our knowledge of the sea and of the responses of the ship is steadily increasing and will soon be applicable to a degree which was hardly foreseen until very recently.

The Occurrence and Taxonomic Relationships of the Atlantic Blue Marlin (Makaira Ampla) in the Pacific Ocean

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Abstract

Evidence is presented showing that the blue marlin of the Atlantic also occurs in the Pacific Ocean and may be pantropical in distribution. Such evidence includes direct comparisons of specimens from the western Atlantic and eastern Pacific and a study of the literature. Species separation of the blue marlin from the other Pacific species is also effected through direct comparison of specimens as well as a study of the literature. Relationships are established by means of a natural key.

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The Modified Tuna Long-Line In Bermuda Waters

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Bermuda, situated in mid-ocean 650 miles from the nearest land, offers many things which are not readily available off a main land coast. Foremost among these is the fact that really deep water is within a few miles of the shore, and from some of the small harbors it is less than four miles to waters 1,000 fathoms deep. With these conditions prevailing, it was decided that experimental fishing with the tuna long-line might possibly uncover information concerning an unexpected offshore fishery.