PAIR TRAWLING FOR HERRING IN NEW ENGLAND

by Robert E. Taber
with James W. McLeod

Marine Advisory Service
Sea Grant

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Marine Bulletin Series Number 9

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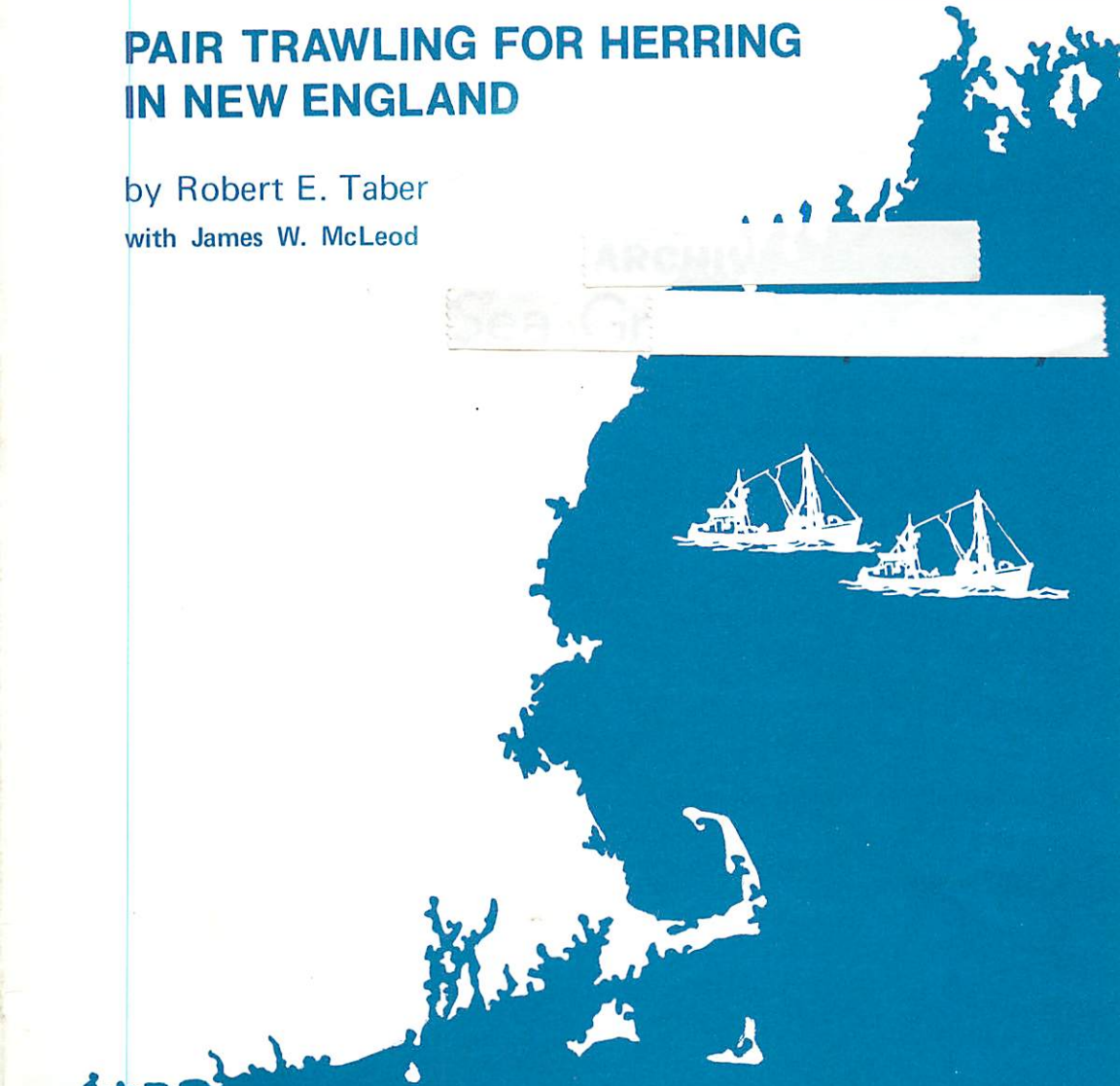

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MIDWATER PAIR TRAWLING

Pair trawling with the Larsen trawl has a history dating back to the late 1940s when experiments were first carried out in Ireland (Dublin). At that time, drift nets were used predominantly to catch herring. During the mid-1950s Scottish ring net boats began working out of Dunmore and Donegal, with great success. These soon gave way to the Scandinavian "vinge" trawls. Through the decade up to the late 1960s, both wing trawls and two-boat midwater trawls became mainstays of the Irish herring industry, and now pair trawling is the predominant method there.

But other methods are available to the herring industry, and the technology is advancing rapidly. In both the United Kingdom and Scandinavia, purse seines, ring nets, bottom wing trawls, and midwater pair trawls are all being used successfully; but either purse seines or the midwater pair trawls have proved most outstanding, depending on the area in question.

The local situation (in New England and eastern Canada) has varied. Canadian vessels have experienced notable success with the single-boat midwater trawl, using vessels with horsepower ranging from 800 to 1500-plus. Purse seiners operate from both Nova Scotia and Maine for Gulf of Maine stocks; but other herring fishing methods, successful in both Ireland and Canada, have been introduced to New England fishermen during the past several years with only varying degrees of success. During the middle and late 1960s both single-boat midwater trawls and bottom wing trawls were tried; the wing trawl became standard for the southern New England herring fishery. However, single-boat midwater trawling for herring in New England has not demonstrated economic success due to several reasons to be discussed later in the text. Nevertheless, whenever large shoals of herring are seen off bottom, interest in midwater trawling grows, and it seems to grow in proportion to the amount of fish seen.

Pair trawling has been seen as a promising possibility in midwater and, consequently, pair trawls have been tried on several occasions in Rhode Island waters and in the Gulf of Maine since 1969. During February and March of 1972, four vessels were notably successful in pair trawling out of Point Judith, Rhode Island. This report is based on their experience. The notes of James McLeod of Killybegs, Ireland, who was retained as a consultant, follow the main text.

Pair Trawling at Point Judith

During the fall of 1971 several fishermen from Point Judith, Rhode Island, showed interest in trying midwater trawling for herring during the winter. They initiated both single-boat and pair trawling efforts with the help of the University of Rhode Island Marine Advisory Service (MAS), a Sea Grant program. The MAS, however, played only a supporting role and did not underwrite any operational expenses. Substantial credit is due to the fishermen, both skippers and crews, for the information resulting from their efforts. Special thanks are due to David Roebuck and the crew of the *Karen Sue,* who were not able to realize a viable economic return from their single-boat venture.

The major emphasis in this report is on the rigging and operation of the four vessels doing the midwater pair trawling; each pair of vessels handled the gear differently, and, as will be noted, each method had its advantages and disadvantages. Comparisons with single-boat operations were made and will be mentioned where deemed important.

The Stern Trawling Pair

The first vessels to rig for pair trawling were the *Ocean State,* a 79-foot stern drum trawler with 420 horsepower, owned by Harold Loftes, and the *Susan and Lori,* a 60-foot stern drum trawler with 330 horsepower, owned by Peter Sprague. Consultant James McLeod assisted with the rigging and actual fishing operations.

The trawl used by the *Ocean State* and the *Susan and Lori* was an eight-fathom Larsen trawl with 12-inch wings and first section (see Appendix A, Figure 1). This trawl was smaller than the capabilities of the vessels allowed, and caution was required not to tow it too hard.

It is standard practice in Ireland for each vessel to have several gears, thus enabling the boat not hauling to shoot his trawl and get ready for towing while the hauling vessel is taking the fish aboard. This also sets the pattern for who is the skipper for the tow and, thus, which boat guides on the other. However, only one trawl was available for each pair of vessels and the *Ocean State* handled the gear for the pair. The *Susan and Lori* was used solely for towing power on the starboard side.

On the *Ocean State,* the net drum was used for all hauling and shooting in exactly the same manner as for bottom fishing. Twenty-fathom top and bottom legs of 3/8-inch wire rope were used with hookups from the drum and tow wires serving the same function they do on a normal stern drum operation. Because each boat used both tow wires, there were two hookups on each side of the drum instead of the usual single hookup.

The method of operation proceeded as follows. The trawl was shot by paying it and the 20-fathom legs over the stern off the drum. With the arrangement shown (Figure 2) where both of the *Ocean State's* tow wires lead from the port

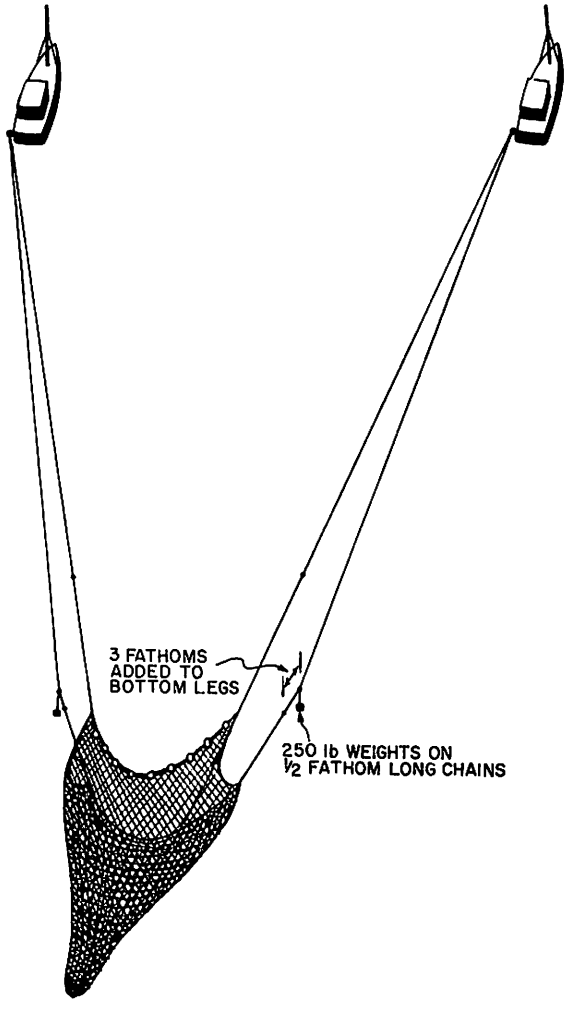


FIGURE 1. Pair trawling towing arrangement.

gallows and take the port side of the trawl, the hookups on the end of the tow wires were connected to the top and bottom legs of the trawl. The bottom tow wire had a 250-pound weight attached and a three-fathom length added to it to maintain the differential shown in Figure 1. The drum was unwound, allowing the strain from the port side of the trawl to be taken on the tow wires which, in turn, allowed the drum idlers to slack and be disconnected from the legs.

On the starboard side, the legs were tied off to the starboard gallows with a heavy nylon line made fast with a slipknot, and the drum idlers disconnected. The *Ocean State* then sent to the *Susan and Lori* a messenger that was connected to a 7/8-inch nylon heaving line. The end of the heaving line had two hookups that were connected to the legs. Upon signal, the *Susan and Lori* began hauling

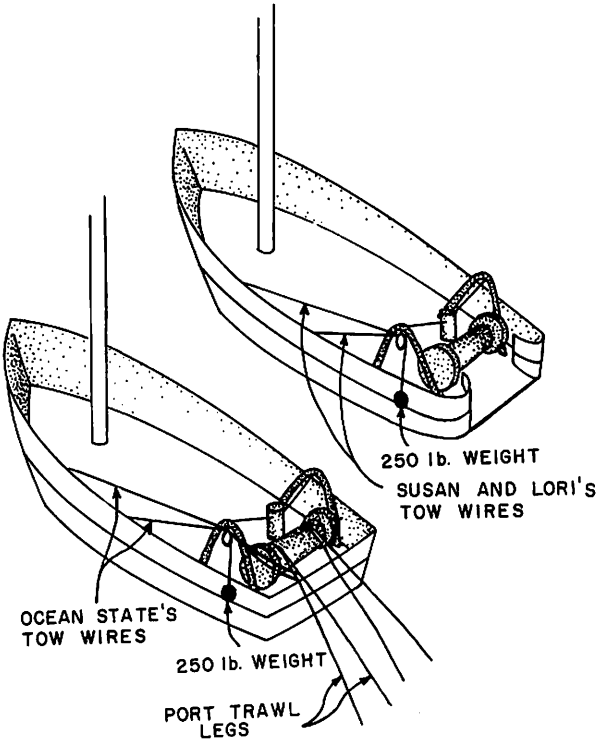


FIGURE 2. Stern trawling pair during the shooting of the trawl.

the starboard legs over with the heaving line on her winch and the *Ocean State* let the line go from her starboard gallows, which had been holding the starboard legs after coming off the drum.

The heaving line was hauled through a block attached near the *Susan and Lori's* port gallows from which her tow wires led. This brought the starboard legs to the tow wires and allowed the quick release hooks, similar to pelican hooks, (see Appendix A, Figure 4) on the tow wires to be connected to the legs. Again, a three-fathom length was added to the bottom tow wire aft of the 250-pound lead weight that the *Susan and Lori* had for the starboard side of the trawl. With the tow wires hooked to the legs, the heaving line was then slacked and removed, and the trawl was set to the desired depth by using a warp length-to-depth ratio of seven to one.

For hauling, the reverse operation took place with some differences. The starboard legs of the trawl were passed back to the *Ocean State* by the heaving line connected to the messenger. With only about a boat-length between vessels this was done quickly by use of the quick release hooks on the *Susan and Lori's* tow wires. With the heaving line on the winch of the *Ocean State* taking a moderate strain, the release hooks were let go and the legs hauled to the *Ocean State* for hookup with the drum idlers, and the normal hauling operation ensued.

The legs were wound on the drum and the choker line taken in, thus choking off the escape of herring from the extension and easing the strain on the face of the trawl as it was wound onto the drum. The choker, leading overhead from the boom, was used to bring the fish alongside for splitting. After the herring were out of the trawl, it was either shot over immediately or hauled aboard depending upon the scouting efforts made by the *Susan and Lori* during the *Ocean State's* hauling period.

The Side Trawling Pair

With the potential for pair trawling demonstrated by the *Ocean State* and the *Susan and Lori,* a second pair of vessels joined together for pair trawling. They were the *Jane Lorraine,* a 59-foot wooden, eastern port-rigged side trawler with 220 horsepower owned by Leon (Buddy) Champlin, and the *E. Carl Rice, Jr.,* a 70-foot wooden, eastern starboard-rigged side trawler with 170 horsepower owned by Joseph Whaley, Jr. Both Champlin and Whaley were encouraged and guided by the suggestions of Loftes. An eight-fathom Larsen trawl also was used by this second pair, but it had considerably more drag than the first trawl used, due to the eight-inch mesh used in the wings and first sections and the twine of heavier thread.

The rigging and hauling were markedly different due to vessel layout. The trawl was handled almost exclusively by the *E. Carl Rice, Jr.,* which was the larger vessel but, more importantly, the shallower in draft, which caused it to drift off from the net while shooting much more readily than the *Jane Lorraine.* However, the trawl could be (and was) passed back and forth from the two boats quite handily. Like the *Susan and Lori,* the *Jane Lorraine* took the starboard position, but for the most part all similarities stopped there. The *E. Carl Rice, Jr.* handled the trawl, both weights, and the tow wires, an operation that worked smoothly and efficiently. For both tow wires and legs, 3/8-inch wire rope was used with a two-fathom differential added to the bottom legs. (Comments on the adjustment of the differential are in Appendix A.)

The shooting and hauling operation proceeded almost identically to that of a side trawler fishing by itself. The *E. Carl Rice, Jr.* set the trawl from the starboard side (being starboard-rigged with gallows fore and aft). The trawl was drifted out, the legs were payed out as the vessel proceeded in a gentle circle to starboard, and the weights were attached as the end of the bottom legs passed the fore and aft gallows blocks. The vessel headed in the direction of the tow at about half-throttle and ran out the tow wires to 75 fathoms. A single tow wire was used for each side of the trawl from the 75-fathom point on.

With the 75 fathoms of wire plus the 20-fathom legs out, and the *E. Carl Rice, Jr.* maintaining a constant heading, the *Jane Lorraine* came alongside and passed over the end of her tow wire with a hookup via a messenger. The hookup was connected to the end of the 75-fathom tow wires and the strain was taken by the *Jane Lorraine* as it steamed ahead and hauled the end of the 75-fathom

tow wires and the single wire from the *E. Carl Rice, Jr.,* which was still hooked in over to a block on the port side of the stern of the *Jane Lorraine.* With the wire slacked from the *E. Carl Rice, Jr.,* and the end of the 75-fathom, 3/8-inch tow wires over to the *Jane Lorraine,* the *E. Carl Rice, Jr.'s* wire was unhooked and hauled back on board the *E. Carl Rice, Jr.* The vessels then spread apart to half the warp length out and began the tow. If more wire was needed to allow the trawl to go deeper, each vessel let out the appropriate amount of wire, which consisted of a single 1/2-inch wire per boat.

To haul, the reverse procedure was followed by the *E. Carl Rice, Jr.* She sent her tow wire from the forward gallows over on a messenger and had it hooked onto the end of the 75-fathom, 3/8-inch wires. The *E. Carl Rice, Jr.* then hauled over the tow wires, including the single wire from the *Jane Lorraine;* and the *Jane Lorraine's* wire was slacked, disconnected from 75-fathom wires, and returned to her. From that point on the hauling proceeded in the usual side trawler fashion with the exception of removing the weights when the legs came up to the gallows.

While the hauling proceeded, the *Jane Lorraine* scouted and set up the starting point and heading for the following tow in an operation similar to that of the *Ocean State* and the *Susan and Lori.*

General Remarks

The following discussion is intended to be general, but will dwell on some of the variables to be considered in midwater trawling for herring. Many fishermen have adopted what was a successful operation in some distant port with considerable enthusiasm and high expectations only to find their operation capitalized in an area unfamiliar to them and unable to earn a financial return for reasons not completely understood. The results of previous efforts now indicate, however, some grounds for understanding their lack of success: *the conditions of the fishing grounds and the size and horsepower of the vessel fishing are, perhaps, the most important considerations in determining what type of pelagic trawling technique is suitable.*

From the experience gained from midwater trawling for herring at Point Judith and eastern Canada, the following observations are offered. In general, the minimum horsepower acceptable for a single-boat operation is approximately 600. However, under special conditions, it may be as low as 350 and as high as 800. On the other hand, in pair trawling the minimum horsepower for each vessel is approximately 150. The prime variables that determine the minimum acceptable horsepower are net design, water depth, and whether the herring are spawning.

In relation to net design, the introduction of large-mesh trawls has greatly increased the fishing effectiveness of trawls of comparable size that formerly used small mesh. (Six- to eight-inch mesh in the wings and first section is considered small while 24- to 36-inch mesh and greater is considered large.) The

purpose of the large mesh is to reduce the total drag of the trawl as well as the pressure wave immediately ahead of the trawl.

Water depth is extremely important due to the effect of vessel noise on herring. It is generally felt that the vessel will significantly affect herring as it passes over, down to a depth of 30 fathoms. When fishing at night, deck lights or spotlights will also drive the herring away from the source.

Finally, the fisherman must consider the condition of the herring. When the herring are ready to spawn or are spawning, they become comparatively lethargic and easier to catch. Hence, in considering the following examples in light of these observations, definite conclusions can be drawn on the advantages and disadvantages of pair trawling versus single-boat trawling.

The fishing grounds in the vicinity of Point Judith vary in depth from 10 to 30 fathoms with the vessels fishing there ranging in horsepower from 170 to 420. During the period from January through March, 1972, both single-boat and pair midwater trawling took place. The single-boat operation started first with a vessel of 330 horsepower using a No. 5 Canadian diamond trawl with eight-inch mesh in the wings and first section. An acoustically-linked headrope transducer was also used in order to monitor and control the position of the trawl. Knowing the position of the trawl is a must for midwater trawling in order (1) to set the trawl at a depth where the highest concentration of fish is observed and (2) to keep the trawl off the bottom as it is not designed for bottom fishing. Fishing on the bottom distorts the trawl's shape, destroying its effectiveness as well as presenting the more serious possibility of tearing it up or losing it.

If effort alone were the key to success, David Roebuck and the crew of the *Karen Sue* would certainly have been successful in their single-boat operation. However, during their six weeks of effort, landings averaged only about 50,000 pounds per week, a level too low for the operation to sustain itself. Two observations, which may account for the lack of success, were made during this period. One, vessel noise affected the herring to such an extent that for the most part they were driven approximately five fathoms deeper when the vessel passed over. Efforts were made to compensate for this without success by undershooting the shoal as observed on the ship's recorder, but it is theorized that the herring were driven in a five-fathom radius as well, which would take them out of the path of the trawl. A second observation, made with the headrope transducer, indicated that the herring tended to bunch up in the mouth of the trawl. Good marks of herring indicated they were going under the headline and into the trawl, but it also indicated they were coming out on occasion. Moreover, when the vessel slowed down to engage the power takeoff and haul back, a substantial number of fish were observed by the netsounder apparently swimming out of the trawl.

It was thought that this situation could be remedied by making a trawl with 16-inch mesh wings and first sections to reduce the drag and pressure field immediately ahead of the trawl so that the herring would be well into the trawl before "feeling" the situation. However, the modified No. 5 Canadian diamond trawl with 16-inch 40-thread mesh in the wings and first section was found even

more difficult to tow. If a trawl were used that was specifically designed for a vessel of this horsepower, and if it used 24- or 36-inch mesh of relatively fine thread, the operation might have been more successful. At any rate, for the conditions in the vicinity of Point Judith, pair trawling is much more effective than single-boat midwater trawling.

Pair trawling started during the last days of January when the *Ocean State* and the *Susan and Lori* paired up with the guidance of James W. McLeod. Except for a few handling problems and the special problem of the crew becoming accustomed to working together, physically and mentally, the capability of pair trawling was established in a few days of fishing (see Appendix B).

Pair trawling, then, may be as much as eight times more effective than single-boat midwater operations in a framework such as Point Judith. There are several reasons. For depths of less than 30 fathoms, there is a net "herding" effect toward the path of the trawl due to the vessel noise on either side and ahead of the trawl's path. Because no doors are used, the vessels' power may be utilized more effectively in towing the trawl, and the size of the opening of the trawl is greater. Moreover, the capitalization required for each vessel is only for trawl and tow wires because the trawl fishes very close to the seven to one warp-to-depth ratio. The trawl's position may be easily checked with a warp angle indicator (Appendix A), and the warp length-to-depth ratio stays constant regardless of wind and tide. Finally, during actual fishing operations the trawl can be turned into the fish if one boat shows marks and the other does not. The vessel that sees the mark will turn to that side (if it is the starboard boat, it will turn to starboard) until it lines up with the tow wires; then the other boat will guide on it, maintaining one-half the warp length distance between boats.

To summarize, there are advantages and disadvantages of pair trawling compared to single-boat midwater trawling.

Advantages:

1. The vessels' noise herds the herring toward the path of the trawl for water depths to 30 fathoms.
2. Vessel power is used more efficiently because doors are not required. (There is ample evidence indicating the drag on midwater trawl doors varies between 10 and 40 percent of the total drag.)
3. The actual mouth opening of the trawl is larger for pair trawlers.
4. Capitalization per vessel is generally about half that required for a single-boat operation.
5. Searching and fishing modes are more effective.

Disadvantages:

1. The two skippers must coordinate their efforts constantly and, in effect, act as a single unit. (This point cannot be overemphasized; it is a requirement for a successful venture.)
2. In general, the depth of the trawl cannot be controlled by the vessels' RPM, but is regulated almost exclusively by the amount of tow warp used.

COMMENTS □ James W. McLeod

The Gear Used (Net: 4 x 150 x 150 mm nylon trawl)

The number of floats used (34 x 8-inch) appeared satisfactory, although they would probably be more so if rearranged somewhat in longer tubes of netting with an intermediate tying between each pair of globes to make them stow better on the net reel. In the cod end, a larger float than the two 8-inch globes could be used—a polyethylene buoy 50 - 60 inches in circumference—to keep the bag up; this could be very important when shooting or hauling over rough bottom, particularly in shallow water. This buoy would drop out when the first lift of fish is taken onboard and could be removed until the net is being prepared for resetting. If preferred, the buoy could be attached and towed outside the cod end.

The weights, approximately 250 pounds each, and the additional chains at the lower wing ends and quarters appeared to work satisfactorily, but heavier wing-end weights could be used when fishing over clean ground or in deeper water, particularly during daylight. An additional small piece of chain could be fitted about halfway up each wing if desired.

The poly-plus rope to the lifting strap should be adequate but the split-film choker rope and strap might need to be heavier, particularly if heavy bags were being taken or a larger net being used. A rope equivalent to 2½-inch* nylon should meet almost any requirement although a rope of three-inch nylon has frequently been used by boats of 300-400 horsepower. Where a considerable number of splits have to be made when taking aboard a bag of fish, it is advisable to have an alternative rope or wire available because constant use of the bull rope can cause excessive wear that might, in turn, cause a heavy bag to be easily lost.

When setting the net, it would probably be quite easy for the boat doing the job to stop completely when passing the ends as the vessel should be straight downwind. Moreover, the legs would have less tendency to roll around one another if there were no strain on them. While the use of a net reel makes it desirable to have the legs approximately even in length, it might be better to have the lower legs one to two feet longer than the upper ones. This difference would, of course, have to be taken into account when arranging the three-fathom differential between the lower and upper legs.

When passing the ends back, it might be better to take the towing strain off the gear completely as twisting of the legs could create quite a problem. Good communication between the net reel and the wheelhouse would facilitate this part of the work and would also make it much safer. With a heavy bag of fish, care has to be taken not to tow ahead too quickly, if at all, because the choker

*All rope sizes in this section indicate circumference rather than diameter.

rope might fail to take the strain while the net is being reeled in.

The need to prepare to cope with a heavy bag must be stressed. A sound, used automobile tire hung by a chain from the gallows would make an excellent spring; and a rope tailing attached to the tire, coupled with the use of a soft strap, would give a speedy means to secure the bag. If the choker rope or tailing were taken back to the tire it should be passed around it two or three times before securing the end; otherwise the knot might have to be cut.

The net should be checked occasionally in case it has become stretched in the top sheet, especially when the net is new, after some heavy bags of fish have been taken or when the net seems dull and is not giving results consistent with what is seen on the echometer or with the general run of the fishing. Some users prefer to turn the net over; others will use any of the four sides as the top. The shortest panel is put uppermost.

A piece of substantial, braided parachute cord should be woven in and out through the length of the bottom sheets and well secured to the middle of the sole-rope and the choker-guard. This line, which should be slightly slack, has been found to be one of the best means of recovering the bottom sheets in the event of their being torn out. Repairs to the net must be carefully done as the netting is under considerable tension during fishing, and careless or inaccurate work could easily lead to more serious damage. A tear, once started, can often end up as a wrecked net.

Locating Herring

While herring can vary in their behavior, they do tend to follow certain patterns; knowing these can help you fish for them. During daylight they may disappear altogether or show up in small and scattered spots on the seabed or at various depths in midwater. Near evening they will probably start to move toward the shore; and around dusk, to gather in dense spots and rise toward the surface. They may persist in these spots for some time but after an hour or two will start to scatter in the water and cover quite a large area. Eventually they may become so dispersed that they barely show in the echometer, and even long tows of two - three hours may not give any worthwhile return. Toward daylight they will probably again start to gather and may show in heavy concentrations, rise to the surface and "play" briefly just around dawn, then start to move offshore and disperse quickly toward the deeper water. Fish may show up much more readily around the period of neap tides or when the tides are "making," i.e., in the period between neap tides and the following springs. But they will tend to become much more scattered in strong tides and, even when good markings are seen, may be very difficult to catch. It is sometimes possible to get a good tow around slack water in these conditions. Strong moonlight will cause fish to go much deeper in the water, which can give the midwater trawl a great advantage over other methods of herring fishing provided the ground is clean or there is sufficient depth of water. But "fire" in the water will make them

extremely difficult or impossible to catch even when good markings are showing.

It is generally accepted that herring require a certain amount of nitrogen as part of their diet and that they obtain this by drinking fresh water; where a distinct "fresh" shows in the water, fish may be found concentrated along the edges, where rivers flow into the sea or where waterfalls pour from high banks after a heavy rainfall. In Norway it is said that the herring come in to drink the water from the melting snow, and in Scotland it is claimed that they will make a run for the fresh water after a breeze. Good markings are often seen off the Scottish and Irish coasts in the calm immediately following a storm, very often in an area sheltered from the heavy sea. In normal conditions the fish often head into inlets and bays during the night and return to the deeper water around dawn.

Off the New England coast, preliminary observations indicate that a somewhat different condition may prevail. After bad weather, the fish seem to break up into numerous small spots; a further study will have to determine whether or not the fish gather at night or if it would be practical to fish for herring in daylight using a large-mesh net with a wide mouth. Sea birds, by the way, circling or lying on the water or gathered on the shore can often help in locating fish during the day or, especially, in the early morning when they can be picked up by searchlight or may even show on the radar.

When pair-fishing, the two boats should try to stay in fairly close contact and search in unison. As herring can be a most elusive fish, a number of boats working in an area or information from other sources can greatly improve the general prospects.

Two other features should be mentioned. While the fish will very often continue to frequent a particular area for at least a part of the season, it does *not* follow that they will return to it in the next year, or in subsequent years. If fish begin to show up, too much time should not be spent in returning to have a look. Herring can react very quickly to fishing and develop evasive measures that in a few years can make them much more difficult to catch.

During the preliminary fishing off Point Judith in early February, 1972, only some of the anticipated types of markings were observed. During the day a few small spots were seen on the bottom, but they were mostly broken-up spots in midwater. Quite long tows were made on these, but only a few thousand pounds of fish were taken, a sufficient amount to indicate that the markings showed, in fact, clear herring, but not enough of them to be a commercial proposition in a low-priced market. Because the net in use was quite small, the amount taken was quite consistent with what one would anticipate. No sign was seen of the fish gathering toward dusk, but this is not to say that this does not happen as very little searching was carried out at that time of day. Moreover, even though it did not show at this particular time and season, it does not mean that it would not take place at another time or during another year. Sometimes herring fishing can be predominantly evening fishing; sometimes, early morning, around daybreak, with very little showing later in the day; sometimes, only in daylight (a most welcome arrangement); and sometimes it can last through the hours of darkness.

Off Point Judith at the time referred to, the fish seemed to spread out in a fairly even layer, quite high in the water (about four - five fathoms from the surface) and to remain there over rough ground of less than 20 fathoms all night. Around daylight they would head quickly down and into deeper water. No sign of morning "play" was observed which, again, was unusual.

The reason that so much emphasis is placed on this tendency to gather is that it makes it possible to take a large bag of herring in a very short tow. By the same token, it follows that it becomes necessary to set reasonably quickly and to tow the spot accurately as it is much easier to miss a concentrated spot than a wide spread of fish. When only one or two pairs of vessels are operating, the fish will probably stay put for a reasonable period, although the vessels should avoid steaming over them as much as possible. Where several pairs are working and some already towing, it is often better to wait a little while, dodge around quietly, and hope that the fish will re-group nearby in a short while. When searching, boats usually steam around at a moderate speed; when fish have been located, the speed should not be suddenly altered or, if possible, the boat turned suddenly because it is believed that the change of noise alerts the fish. When fish are located the position should be marked by any means available—landmarks, depth, distance offshore by radar, or even in daylight by a marker—and an assessment made of the best direction to tow. Towing across the tide makes it more difficult to come back accurately to the desired position; but by making sufficient allowance and heading up toward the tide, it is not too difficult.

When towing across the tide, one boat will appear to be ahead of the other, but relative to the actual course being made good, this is not so. Where one boat marks fish and the other does not, within a minute or two an alteration of course of, perhaps, two points can be made to bring the net towards the fish. If the second boat still does not mark, another two-point alteration can be made, but no more. An alternative method is to alter course until the warp is seen to be leading toward where the fish have been marked and to steady up on that course, possibly swinging a little past it and then coming back to it. If the second boat starts to mark fish just after the first alteration of course, it is probably better to steady back on to the original heading.

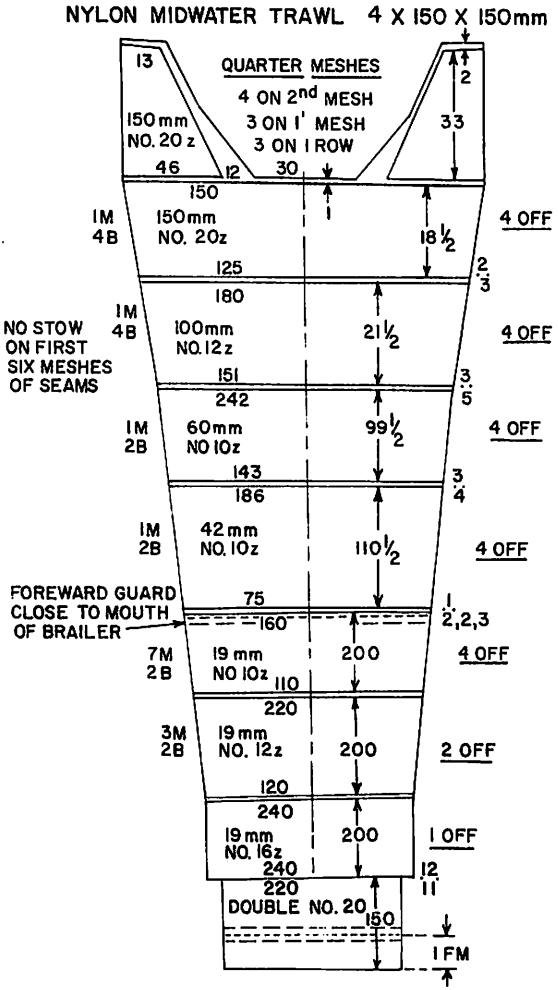
The assessment of a tow should also include considerations of the direction of the wind, the ease with which the setting and hauling can be carried out, a reasonable depth of water in which to shoot, an adequate depth or clear ground in which to haul, and the avoidance of any peaks or other dangers during the tow. This last item is of prime importance when the fish are lying close to ground of this nature. If the weights start to bump slightly, but a reserve of power is available, it may be possible to bring them up by increasing speed and, perhaps, by slacking back on the upper warp. But where the bumping is severe and the ground either too dangerous or unfamiliar, it is generally better to stop the boats and to lift the gear. This way the net may float up and avoid major damage even though a weight should happen to be stuck. In uncertain ground it is well to have somebody on deck watching the gear, but not leaning on the warp.

In the evening it is better to initially tow higher than the fish have been observed in the water because they are likely to be rising quite quickly and to run out more warp when towing if necessary. Moreover, if the fish show somewhat deeper than anticipated, it is advisable to wait for a few moments before making an adjustment because the edge of a good marking will often show deeper than the center. When tracking fish, it is very easy to run out more warp, but most difficult to heave it in. In the morning, especially after daybreak, it can be expected that the fish will be going down; and if other conditions permit, it is generally better to allow at least 25 fathoms more warp than the immediate markings indicate are needed.

At Point Judith during the night, where steady markings showed fairly consistently all night, it was found better to tow only the minimum amount of warp. This may have been due to the fish being relatively undisturbed by the boats, to the net traveling somewhat deeper than anticipated when using the standard seven-to-one formula, or to the relatively small-sized and fairly heavy warps (two-inch) being used. The standard diameter of warps on similar vessels in Western Europe would be 1¼-inch to 1½-inch for boats of up to 200 - 250 horsepower and 1¾-inch for boats of 400 horsepower. Especially where fish are high in the water and spread out, it is very likely that those between the boats will swim inward and downward when disturbed. For this reason it is quite usual to tow the extra 25 fathoms.

One final comment: for a variety of reasons, the markings seen on the echometer will not necessarily give a guide to the amount of fish that can be taken. On occasion a good bag can turn up when few markings were seen during the tow, or—more likely—practically nothing may be taken from an area of heavy markings. On dry paper particularly, heavy-looking markings may on later examination turn out to be powdery. Often the fish scope will give a better indication of their density. Again, the fish may be moving with the boats or across the line of tow and, where a tow turns out to be disappointing, it may be better the next time to tow in a different direction. With good markings a weak echometer may give the best indication of density, but this theory will lose out when long tows are being made on scattered fish.

APPENDIX A. Useful Information



APPENDIX FIGURE 1. Net plan used for midwater trawl.

Net Plans Used

This trawl is ideally suited for two 200/220 horsepower vessels; care must be exercised when using it on more powerful vessels. There are many trawls available to meet any given power requirements. They are made by the following concerns: (1) Boris Net Company Ltd., Fleetwood, Lancashire, England; (2) Bridport Gundry Ltd., Killybegs, County Donegal, Ireland; (3) I. C. Trawl Ltd., Howth, County Donegal, Ireland; (4) Apeldoornse Nettenfabriek von Zeppelin and Company, N. V., Apeldoorn, Holland.

Midwater pair trawls are constructed with great care because the dimensions of the panels are very critical. An error of a few inches on one or two panels can cause the net to fish extremely poorly. In general, it is not recommended that a fisherman make his first one or two trawls to "try out the idea." He should start off with a trawl that is known to be constructed correctly.

Import Duties

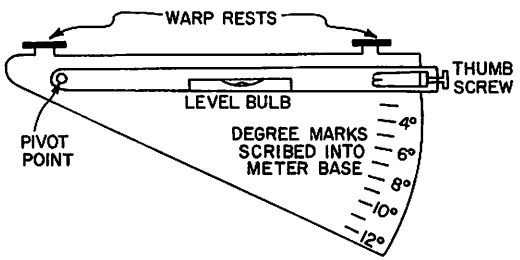
The import duties on commercial fishing gear are summarized below. By purchasing the trawl either incomplete or in separate sections, money may be saved.

Duties on commercial fishing gear (non-braided synthetic fiber):

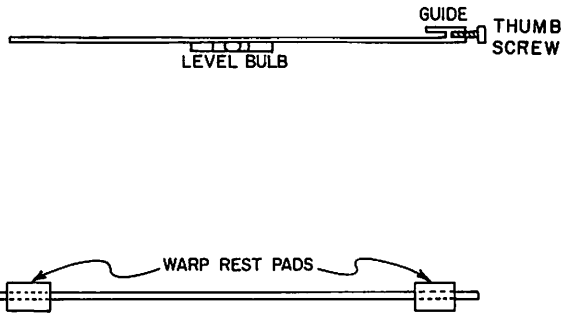
1. completed net: 32½ percent of the value plus 25 cents/pound of the total weight.
2. bulk twine and rope: 15 percent of the value plus 12½ cents/pound of the total weight.
3. combination wire rope or wrapped wire rope and cable (hanging lines): 7½ percent of the value.

Using the Warp Angle Meter

A warp angle meter is a simple, but necessary, device used to determine the fishing depth of the trawl. It may be constructed without difficulty of any noncorroding material such as stainless steel or brass sheet stock. The following drawing may be used as a plan; the only requirement that must be adhered to is placing the angle graduations correctly on the meter.



APPENDIX FIGURE 2. Front view of warp angle meter.



APPENDIX FIGURE 3. Top views of warp angle meter pivot arm (above) and base (below).

The angle meter is used in conjunction with the table below in the following manner. The warp rests are placed on the underside of the top warp and the arm moved to a horizontal position, as indicated by the centered bubble of the level bulb. The thumb screw is tightened and the meter removed and read. If, for example, the arm arrow indicates eight degrees and there are 100 fathoms of warp out, then the headline of the trawl is 14 fathoms below the surface. (Eight degrees provides approximately a seven-to-one ratio.)

Only the length of warp out is used to determine the fishing depth. Do not include the length of the legs. And, if the towing points on the vessels are more than a fathom above the surface, then one fathom should be subtracted from the calculated fishing depth.

Headline depth for various warp angles and tow warp lengths (rounded off to the nearest half-fathom).

Length of Tow Warp (fathoms)	Measured Warp Angle							
	5°	6°	7°	8°	9°	10°	11°	12°
25	2	2½	3	3½	4	4½	5	5
50	4½	5	6	7	8	8½	9½	10½
75	6½	8	9	10½	11½	13	14½	15½
100	8½	10½	12	14	15½	17½	19	21
120	11	13	15	17½	19½	21½	24	26
150	13	15½	18½	21	23½	26	28½	31
175	15½	18½	21½	24½	27½	30½	33½	36½

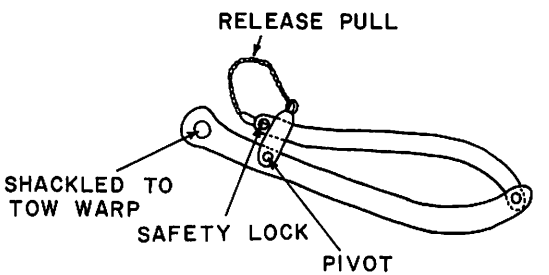
Adjusting the Differential Added to the Bottom Legs

In order to tow a pair trawl so that the face of the trawl is vertical, with no underhang or overhang, a length of wire must be added to the bottom legs. In general, a three-fathom length is used when fishing with approximately 100 fathoms of warp out. Should more warp be used, then the bottom tow wire on each side should be lengthened; conversely, if only 50-75 fathoms of warp are used, the bottom warps should be shortened. This may be easily accomplished by adjusting the individual tow warps on each vessel.

For example, if the trawl is to be fished rather shallow with only 50 fathoms of warp, then the differential should be decreased to only two fathoms. With a three-fathom length in the lower legs, the needed decrease may be made by having the top 50-fathom warp mark separated from the bottom 50-fathom warp mark by a fathom so that the top wire is out farther when the brakes are set on the winch.

Raising and Lowering the Trawl While Fishing

In general, a pair trawl does not respond in the same manner that a single-boat midwater trawl does; that is, increasing the vessels' RPM does not cause the trawl to raise significantly. However, it can be raised about a fathom if the two vessels close together significantly less than one-half the warp length. Conversely, the trawl will deepen slightly if the vessels separate more than half the warp length. It must be remembered, however, that any extreme separation of the vessels while towing will place the trawl under a tremendous strain for which it was not designed, and will create the very real possibility of stretching the trawl out of shape.



APPENDIX FIGURE 4. Quick-release trawling hook (for release under load).

APPENDIX B. Table on Herring Landings

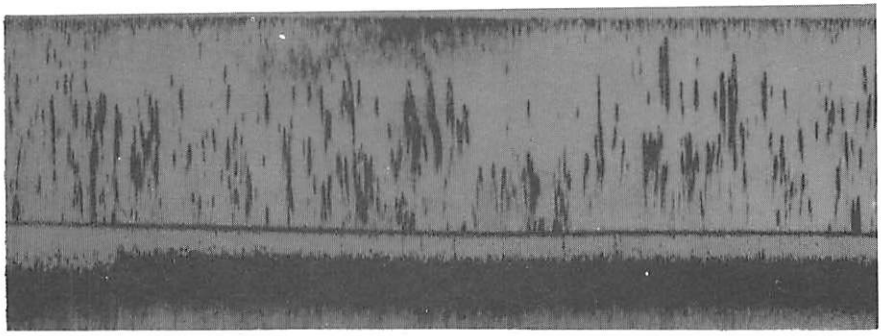
*Herring landings at Point Judith, Rhode Island, between January 31 and April 4, 1972 for (A)*Ocean State *and* Susan and Lori *and (B)* Jane Lorraine *and* E. Carl Rice, Jr. *(in thousands of pounds).*

	A	B		A	B
Jan. 31	5,270		March 2	72,100	
Feb. 2	7,010		March 5	187,200	
Feb. 6	16,000		March 7	52,480	
Feb. 7	62,140		March 10	166,340	7,780
Feb. 9	13,840		March 11	18,080	
Feb. 10	63,860		March 17	118,680	64,280
Feb. 11	63,340		March 19	43,500	110,280
Feb. 12	60,320		March 20	44,500	
Feb. 16	66,000		March 21		108,300
Feb. 18	82,840		March 22		16,500
Feb. 22	80,220		March 24	92,740	86,020
Feb. 24	154,040		March 25		24,840
Feb. 25	92,600		March 26	131,480	34,500
Feb. 26	72,000		March 28		40,520
Feb. 28	9,220		March 31		20,740
Feb. 29		23,200	April 4		30,680

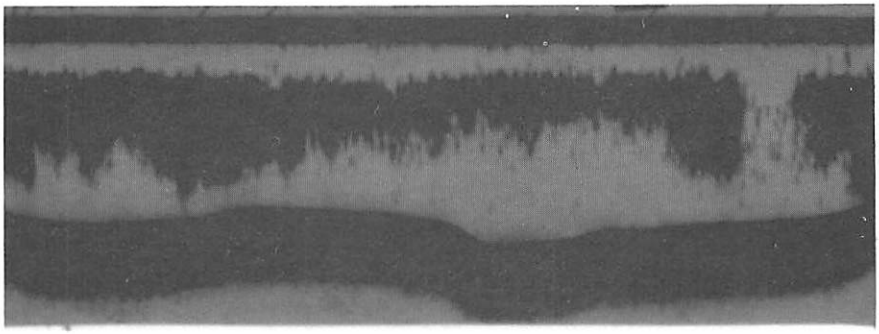
Totals for February and March	**Pair Trawls**	**All Boats**
February	840,630	1,249,060
March	1,440,860	1,481,120
Totals for December - March	2,286,760	6,693,660

APPENDIX C. Sample Recordings of Herring Shoals

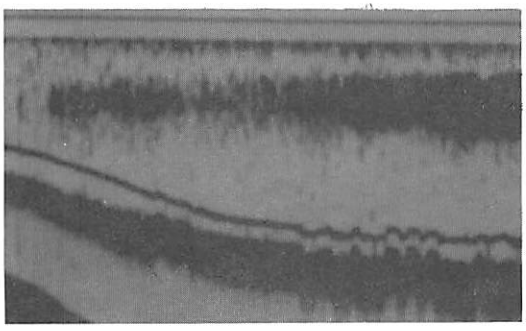
Recordings of herring shoals as observed while searching and fishing.



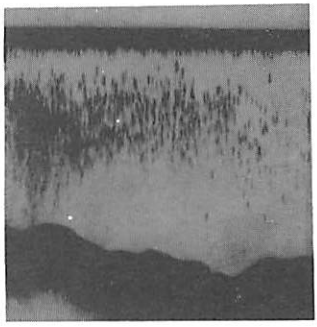
Daylight markings after a breeze. A few thousand pounds may be taken from a two-hour tow.



These markings look good, leading one to expect a heavy bag, but the sounder may *mark quite heavily on moderate soundings.*



Fish as recorded after dark.



Light scatter — poor prospects.

Would You Like Other Information?

Other publications for fishermen are available from the Marine Advisory Service, University of Rhode Island, Narragansett Bay Campus, Narragansett, Rhode Island 02882. In ordering publications for which there is a charge, please make your check payable to the University of Rhode Island.

Marine Leaflet 1	Cutting Web Tapers □ G. A. Motte
Marine Leaflet 2	Computing Horsepower Used in Trawling □ R. E. Taber
Marine Leaflet 3	The Dynamics of European Wing Trawls □ R. E. Taber
Marine Bulletin 7	Chartwork for Fishermen and Boat Operators □ G. A. Motte; $3.00
Marine Bulletin 8	How to Plan and Cut Nets □ A. E. Hillier
Publication P-3	Factors in Storage and Transport of the American Lobster □ T. L. Meade
Publication P-4	Long-lining for Swordfish □ Phillip Rhule
Publication P-10	Migrations and Growth of Deep-sea Lobsters □ R. A. Cooper and J. R. Uzmann
Publication P-15	Selecting a Radar Set for a Fishing Vessel □ G. A. Motte
Publication P-18	New FCC Marine Radio Regulations □ R. W. Merriam
Marine Memo 30	Fishing Cooperatives □ J. J. Napoli