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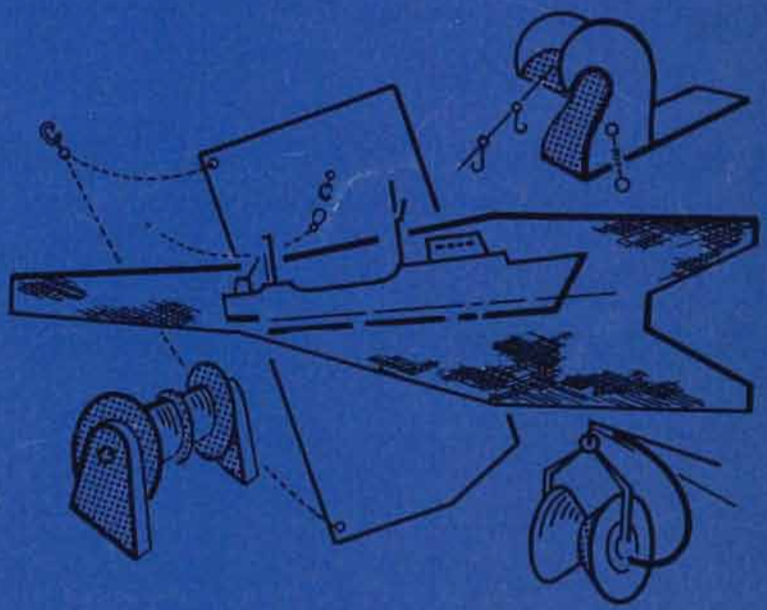
THE MANAGEMENT OF INNOVATION IN THE FIELD OF FISHING GEAR IN CANADA



Industrial Development Branch

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THE MANAGEMENT OF INNOVATION IN THE FIELD OF FISHING GEAR IN CANADA

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INTRODUCTION

The author was the first commercial fisherman to be employed by the Department of Fisheries, expressly for the purpose of carrying out the Development Service Program outlined in this paper. Since there was no precedent in the Canadian Public Service, he was classed as a non-professional and placed in a general technical officer category with the title "Fishing Gear Technologist".

This was an entirely new field of endeavour, for which very little information could be drawn from books or educational institutes. It was, in fact, only possible to acquire knowledge through personal experience and subsequently to develop a working system of managing innovation in fishing vessels, gear, machinery, electronics, equipment and operating techniques.

Beginning as a project leader, the author, because he talked their language, developed a rapport with both the fishing industry and associated industries. Such rapport is essential to the successful introduction of innovations and in developing fisheries for underexploited and unexploited stocks.

During the intervening years, the author's special interest in developing midwater trawling in Canada was never forgotten and work was continued to that end, even though it often had to be set aside to make way for other contemporary developments.

Eventual success, resulting in catches of herring never before achieved with midwater trawls, was finally realized and a growing fleet of

Atlantic midwater trawlers was subsequently established in Canada. However, the author is still not completely satisfied, and after 17 years continues to work on increasing the efficiency of midwater trawling.

It is certain that this fishing method will be finally proved in Canada to be as positive, productive and profitable as purse seining, for catching not only herring and other pelagic species, but also for high swimming demersal species.

While working for many years on the development of many types of fishing vessels and fishing gear, the author studied applicable sciences and principles and eventually became Chief of the Fishing Operations Division of the Industrial Development Branch.

The work resulted, through evolutionary processes, in successful methods of carrying out developmental work and of acquiring personnel and material, and did much to establish the Industrial Development Branch's identity with the industry in Canada.

FISHING VESSELS AND FISHING GEAR ARE AN INTEGRAL UNIT

The management of innovation in the field of fishing gear in Canada cannot be described in isolation, since it is integrated with the introduction of new vessels and equipment as well as of operational techniques. The introduction of new fishing gear requires a knowledge of the correct rigging of vessels in order to use the gear. Naturally, knowledge of operating fishing vessels is also essential in order to train skippers and crews in the use of new fishing gear, equipment and techniques.

Since 1959, when the author first joined the Canadian Department of Fisheries, now the Fisheries Service of the Department of the Environment, he has spent much time in rigging or converting vessels for new methods of fishing. This on many occasions necessitated major changes to the vessels, especially when they were designed for traditional methods of fishing or for other purposes. Such conversion work calls for a broad knowledge of fishing vessel shipyard work and includes structural changes, such as new masts and derricks, the installation of new deck machinery and electronics, new propellers and modifications to fish handling and fish holding systems.

Naturally, when converted vessels prove successful, most company owners build new vessels specifically for the new methods of fishing, and request the author to collaborate with the owners, skippers, naval architects and shipbuilders in the design. Our input is quite extensive and includes the establishment of requirements, such as over-all dimensions, cargo capacity, main and auxiliary engine power, electronics, power of deck machinery,

bridge layout, general arrangement, deck arrangement and fish handling systems.

Above all, we try to encourage the design of vessels capable of more than one method of fishing. As a result, we have been involved in the development of vessels which carry two types of gear and can change to the most suitable method while on the fishing grounds with a minimum loss of time. We also, of course, design gear such as bottom and midwater trawls specifically for individual vessels.

In summation, it can be said that the vessel and its gear are an integral unit and must always be considered together. A fishing vessel's primary function is to catch fish, and it has to be designed around one or a number of methods of fishing. Its secondary function is to stay on the fishing grounds, and to do so it must be seaworthy and seakindly enough to meet regional weather conditions. The third function is to carry fish in suitable quantities in prime condition.

The conversion work carried out by the author always involves the entire package (vessel, gear and equipment). It is interesting to note that while such projects usually involve joint federal-provincial and industry financing, on the other hand, new construction has been almost entirely financed by industry, but requests for technical advice continue to be made on an ever-increasing scale. Not only do we provide advice during the design stages, but we direct the rigging out of the new vessels and train the crews to construct and operate their gear.

FISHING VESSEL AND GEAR DEVELOPMENT IS A NEW TECHNOLOGY

There has always been some confusion as to what to call the type of work carried out by people in this field. We have chosen to call the type of work "Fishing Vessel and Gear Technology", and to describe people involved in such work as "Vessel and Gear Technologists".

Fishing vessel and gear technology is a new profession at the same evolutionary stage as aeronautical engineering was in 1908. It encompasses a thorough knowledge of many methods of commercial fishing, coupled with knowledge derived from many disciplines which have application to fishing vessels and gear. These include: shipbuilding, fishing gear construction, naval architecture, marine engineering, electrotechnology, refrigeration, hydraulics, oceanography, biology and economics, seamanship and navigation.

The prime requirements are comprehensive first-hand experience and knowledge in commercial fishing to which must be added the basic knowledge of related professions. The potential contributions by such professions to the development of fishing vessels and gear may not even be known as yet since these particular aspects are not taught by educational institutes. We are, in effect, talking about a new field of education. As a matter of fact, the only formally qualified professionals fully capable of applying their knowledge to fishing vessel and gear development are those who have had considerable experience in the fishing industry.

For many years, it has been wrongly assumed that a formally qualified professional in any related discipline, no matter how remote, is

capable of directing development work on fishing vessels and gear, regardless of whether or not he has actual practical experience in such development, or even in the total fishing operation.

In our view, the most effective people to direct and carry out such work are technically adaptable commercial fishermen. Those who have owned, operated and maintained fishing vessels are particularly suited, since necessity has forced them to learn as much as possible about the entire vessel. They are also likely to have served in every crew capacity on the way to becoming a skipper. Such men, whether employed by government or industry, can rapidly expand their technical knowledge and many become dedicated to doing so when they see how beneficial this can be to the fishing industry.

There may be exceptions: people in some parts of the world who became graduate professionals first and fishermen afterwards. Such people, who have acquired applicable knowledge in one of the related professions, are able to successfully direct fishing vessel and gear development as members of industry or government. However, these people can also be considered as experienced commercial fishermen, since they have acquired the necessary first-hand experience at sea. In case someone should assume that a graduate professional need only make an occasional commercial fishing trip to become thoroughly versed in fishing, I must emphasize that intensive and continuous first-hand experience in commercial fishing is essential in order to build up the necessary background.

Commercial fishing is an important profession and, since there are few educational institutes turning out graduate fishing officers, the only

ones qualified to be rated professionally are those who have gained knowledge and recognition through practice in the fishing industry. To acquire a worthwhile knowledge of the operation of fishing vessels and gear requires not less than 5 years of varied experience as a commercial fisherman. Even so, such experience may only cover one or two methods of fishing and an even longer period may be required before qualifying as a vessel and gear technologist. It must be stressed, however, that a commercial fisherman is far more adept and can learn new methods of fishing much quicker than a professional from another field.

The accomplishments of self-educated vessel and gear technologists have resulted in recognition of this new field, and industry has demanded that educational institutes turn out such people. Such institutes must, of necessity, seek advice from recognized fishing vessel and gear technologists in order to prepare adequate training programs.

THE BEGINNING - BOTTOM AND MIDWATER TRAWL DEVELOPMENT IN BRITISH COLUMBIA

In order to explain the management of innovation in the Canadian fishing industry, it seems logical to review the author's main projects individually and in sequence over the years.

The author began experimental development work on bottom and midwater trawls as a commercial fishing crewman and skipper with private fishing vessels out of Vancouver, British Columbia between 1947 and 1954.

Four Panel Trawls

The author's venture into trawl design began in 1945 when his late father, Henry W. Johnson, introduced him to the four panel bottom trawl of which he made a model to point out its advantages over the conventional two panel trawl. At the time the advantages were not apparent, but even if they were there was no opportunity for them to build and test a full size trawl, since they did not own a vessel with which to try it.

However, around that time a four panel trawl design from Seattle, Washington, U.S.A., was introduced to British Columbia by Captain Harley Brown aboard his 50-foot 110 h.p. trawler "Double Island". Captain Brown who was an extremely successful trawlerman, demonstrated the four panel trawl's superiority with his large catches.

Captain Nels Nelson with his 60-foot 105 h.p. "Combat" of which the author was a crewmember, obtained a similar trawl from Captain Brown in 1947. The trawl performed so well that the advantages previously pointed

out had to be reconsidered. The most dramatic of these was a greater vertical opening, which resulted in the "Combat" consistently making much better catches of, high swimming species such as dogfish and Pacific cod, than other trawlers using conventional two panel trawls. Another advantage was that the four panel trawl was designed to fish with less netting near the sea bed, consequently it was not as vulnerable to wear and damage.

In 1948, remembering the advantages of the "Combat's" four panel trawl, the author built a scaled down version for his father's fishing vessel, "Midway", which he skippered as a trawler during the winter months. In spite of the vessel being only 40-feet long and having only 45 h.p., the trawl fished as well as two panel trawls on much larger and more powerful trawlers. The most significant contribution to the trawl's success, of course, was that it had more vertical opening, while retaining the same spread as the conventional trawls. The use of very fine twines and larger meshes in the wings made it possible to tow the four panel "box trawl" as it was called, with limited power. As a matter of fact the original design used by the "Double Island" and "Combat" was larger than the standard two panel trawls, having both greater vertical opening and spread. It was possible to tow these trawls since a 6-inch mesh, large at that time, of fine cotton twine, number 18 thread, was used in the wings while $4\frac{1}{2}$-inch mesh of number 42 thread cotton twine was employed in the square and bellies. This early experience left a lasting impression.

Around 1950, the U.S. trade journal "Pacific Fisherman" published an article on Exploratory Fishing carried out by the Research Vessel "John

N. Cobb" operating out of the U.S. Bureau of Commercial Fisheries, Gear Research and Exploratory fishing base in Seattle, Washington. The article contained the drawings of a four panel trawl used by the "John N. Cobb" to explore new grounds where large catches of redfish were made. The trawl was called a Western Trawl because of its origin and popularity in the Pacific, while conventional two panel trawls were called Eastern trawls because of their origin in Europe and the fact that they were used almost exclusively by Atlantic coast fishermen.

In 1952, the author built his first version of the "Cobb" Western Trawl when he rigged out and skippered the 69 foot, 135 h. p. "San Juan No. 2" for stern trawling. The "Cobb" Western Trawl differed from the earlier box trawl used by the "Combat" in that it employed the same size of $4\frac{1}{2}$ inch mesh of 42 thread cotton in the wings and bellies and had shorter headrope and footrope lengths. Furthermore, all parts were made from 100 mesh deep sheet netting with both the wings and bellies being 100 meshes in length. It was very efficient and because it was simple to build and repair it became more popular than the "Combat" trawl, which although a better fishing net, was much larger and more complex.

By 1952, all four panel trawls in Canada were known as Western Trawls and there were many versions built and used by British Columbia trawler fishermen, although generally the traditional two panel "Eastern" trawl continued to be the most popular. However, there was no doubt, from comparison of fishing results, that the Western type was the most productive as far as catching round fish was concerned, and of course, it was also less subject to wear and damage.

There was one difference between the configurations of the Western and Eastern Trawls which caused some concern. The "Combat" type had four identical bellies, which made the assembled belly section take a conical form with the lower belly rising slightly off bottom at the footrope to well off bottom at the lengthening piece. It was thought that flat fish might not swim up the incline and would tend to bunch up in the lower belly, causing it to chafe through on the sea bed or that they might swim out while hauling.

In contrast, only the upper edge of the Cobb Trawl side panels were tapered, while the lower edge was straight, causing the lower belly to run parallel with the sea bed. It was thought that this would permit better passage of flat fish to the codend. Such was not the case in practice; the "Combat" net proved to be just as effective. In fact, the Cobb type chafed out its lower and side bellies much faster and when stones rolled into the trawl they hammered holes all the way to the codend which they usually broke through with a resultant loss of the catch. The type employing four equally tapered bellies was subsequently adopted, since stones which jumped the footrope either chafed or tore their way through the lower belly and seldom rolled down into the codend.

Most of the Western type trawls employed large wedges between the wings and square of the headrope and between the wings and belly of the footrope, which resulted in narrow bosoms of no more than two feet in width. Some of the trawls employed narrower wedges and very wide wings which overlapped on the square and lower belly, resulting in the same narrow bosom

section. It was thought that somehow the wedges and narrow bosom contributed to the trawl's success, but just how was never truly defined. However, it was observed that the wedges between the footrope and lower bellies were very susceptible to damage and were always requiring repairs. Experiments were made with narrower wedges and wider bosoms and it was found that the trawls fished every bit as well as the others, and that the repair work was decreased in the lower wedges. Such problems today seem insignificant but in 1950 such changes were viewed by fishermen as being very radical since they might adversely affect the trawl's efficiency.

Another important feature of the "Combat" trawl which the author employed in all his own Western trawl designs was the adjustable top laceage ropes along the wedge and wing seam. The rope was secured along the upper laceages of the square and bunt wings but was free along the wedge and wing laceage, being fastened at the wedge and wing intersection of the headrope. The rope was tightened sufficiently to take a good strain on the top laceages, after which the free section was seized to the laceage with three or four settings. What the adjustment line actually did was to compensate for the difference in hanging between the bunt wing foot rope and the square, which prevented the top belly and top edges of the side bellies from sagging back too much. It was observed that the trawl fished best with a certain length of adjustment rope and this observation definitely had an influence on future Western trawls designed by the author.

Headrope heights were easily substantiated by towing the trawls in shoal waters. At normal trawling speeds, about 3.5 knots, the bosom section

of the Western Trawls would always be on the surface in a depth of 3 fathoms. In contrast, the headropes of two piece trawls would not come to the surface. A two piece or Eastern type trawl could not achieve a great vertical opening because the spreading force of the otter boards was greater than the lift from the floats and the billowing effect from the internal water pressure. In contrast, the spreading power of the otter boards had little effect on the vertical opening of the four panel trawl because even though the top and bottom panels may have been stretched to their maximum widths, there was no effect on the side panels which had ample slack to allow the top of the trawl to rise.

It was also learned from the Western trawls that to achieve optimum opening at the bosom it was necessary to have a good opening at the wing ends. This meant that the wing ends had to be high, necessitating the use of long bridles to open the wing ends themselves. In other words, the bridles were merely an extension of the wings. Most Eastern type trawls lacked high wing ends: a detrimental factor which limited their vertical opening.

The headline slope that could be used in the design of trawls was estimated from the maximum headrope heights at which the headrope broke surface in shallow water. This slope, which was in the order of about 5:1 was retained in most of the author's trawl designs. Naturally, it followed that the bridles should have slightly less slope and a ratio of about 7:1 was adopted and used ever since.

Trawl design began on the basis of the working dimensions and material specification of various trawls and otter boards which could be

towed at a certain maximum speed by trawlers of known power. It then became a question of changing the trawl's geometry without significantly altering towing resistance, by distributing the netting in such a manner that the greater spread and lower vertical opening of the two panel was traded for the lesser spread but higher vertical opening of the four panel trawl. When the resistance of the new trawls increased too greatly, it was remedied by making the trawl parts from netting of finer twine.

After building trawls for several different vessels and also learning what other fishermen were doing, the author became fairly knowledgeable as to the size of trawls and doors which could be fished by vessels of given power. Mistakes which affected trawl performance were easily corrected through modifications made during a fishing voyage with little actual loss of fishing time. It always seemed easy to create a trawl that fished as well as others, but the difficulty lay in making one which would fish better.

Designing two panel trawls was not difficult, since the departure from convention was very minor. There was little problem in deriving the head to footrope hanging ratios, since most trawl makers employed a bar taper on the wing sections of the headrope and footrope and hung them the full natural length of the wings. This, together with hanging the bosom meshes in about 50 per cent, produced a trawl which fished satisfactorily.

It was not possible to do the same with a four panel trawl since full side meshes were employed in the footrope section of the wings while a very slow taper was employed on the headrope section. It was therefore necessary to employ a different design system. This consisted of drawing

scale side and plan views of the trawl to the envisioned working dimensions in rectangular form, after which the vertical and horizontal diagonals of the correctly open meshes were divided into the width and length of the trawl parts to estimate their dimensions in terms of numbers of meshes. Once the dimensions of the parts were known, it was a simple matter to calculate the tapers. However, one tried to retain the most popular simple tapers as much as possible. The correct length of the sloping headrope or other parts could be measured directly from the plans and the hanging ratios could then be easily calculated. Even though the dimensions were lifted from drawings of the parts in flat form and the trawl was, of course, circular or oval shape in cross section while fishing, the resultant trawl performance was not affected. At times however, allowances were made for curvatures of the panels by pure "guesstimate".

The author, on many occasions, demonstrated this simple method of designing trawls, especially to show fishermen that they did not require an extensive knowledge of mathematics and trigonometry to design their own trawls.

From 1950 to the end of 1959, the author continued to build improved Western trawls, the advantages of which continued to grow. The ideas that resulted were later employed in the series of Atlantic Western Trawls which the author designed after joining the federal Department of Fisheries.

THE DEVELOPMENT OF MIDWATER HERRING TRAWLING IN INDUSTRY

British Columbian fishermen first became interested in herring trawling in the mid-1940's, at which time it was generally believed that herring could only be caught in quantity by the home fleet of purse seiners.

Around 1964, however, two boats began making fair catches of herring with bottom trawls, which were of two piece construction and were made entirely of small mesh measuring one and one quarter to one and one half inches, stretched. The results were fair, but not spectacular and the herring were only captured in the middle of winter when they were ripe with spawn and rather inactive. Nevertheless, the author and other fishermen began thinking aobut developing a midwater trawl to catch herring all the year around.

Strangely enough, debates centered around positive depth control of proposed midwater trawl gear as this was felt to be the key to success. There were lengthy discussions on the various methods that might be developed for this purpose; however, no one ventured to build and test actual midwater trawl gear.

In 1948, the success of the Danish "Rovert Larsen", two boat midwater trawl, called the Atomic trawl, caught the interest of British Columbia trawler fishermen and many constructed and tested their own designs of midwater trawls, but caught little or no herring. Unfortunately, it was still assumed that depth control was the problem, and no one examined the actual trawls which, while cut in a different shape to attain more vertical

opening than bottom trawls, were still made entirely of small mesh netting.

Karl-Hugo Larsson, a Swedish engineer, subsequently designed a one boat herring midwater trawl called the "Phantom Trawl" which was spread by doors shaped like aircraft wings and opened vertically by hydro-dynamically shaped floats and depressors. The "Phantom Trawl" made good catches on Baltic herring, but was unsuccessful on the larger, faster swimming North Sea herring. On the other hand, the Larsson two boat trawl could catch both kinds.

It was thought, however, that the kites and depressors could open the British Columbia trawls properly and so the author, together with his father, built similar ones for use on a small midwater herring trawl for their small 40 foot 45 h. p. dragger "Midway". The gear was towed through massive schools, but all that could be caught was a bucket or two of herring.

The trawl was of four piece construction with very deep wings and again was made entirely of small mesh. If it had only been known that this was the big mistake, midwater trawling might have developed much faster in British Columbia. Unfortunately, in those days no detailed accounts and drawings of either the "Atomic" or "Phantom" trawls were available.

Feeling that something might be amiss with the trawl configuration, the author and his brother, Raymond Johnson, constructed a model of a midwater trawl and while towing it alongside a mooring float in Vancouver Harbour, they noted that the shape and opening was exactly what it had been designed for, but at the same time they were fortunate to see the reaction of small stickleback fish to the gear. It was observed that the otter boards would cut through the school and the fish between would remain quiet until

the mouth of the trawl approached. They would then swim rapidly ahead, maintaining depth until passing the doors after which a repeat performance would follow. In exasperation the trawl was towed for three hundred feet or more with repeat performances from the untiring fish until the trawl struck bottom in shoal water where the school escaped. No fish were seen being captured and it was surprising to find twenty or so of the tiny sticklebacks in the codend. Apparently, every time the trawl got near the school, one or more individuals were captured; however, the number caught was very low in relation to the large number in the path of the gear.

The lesson learned was that although the trawl had sufficient opening, its resistance was far too great, and it would be impossible to tow it fast enough to capture a good quantity of sticklebacks. Plainly drastic changes were needed to reduce trawl resistance and increase the water flow through the trawl. Poor water flow was recognized as a problem and thought to cause water stowage which created pressure waves which helped to frighten the fish just in front of the mouth of the trawl, somewhere between the wing tips and the bosom sections.

When the model findings were related to full size gear, almost insurmountable problems were visualized in ever achieving satisfactory water flow and sufficiently reduced resistance to attain efficient trawling speeds. The model was to scale in the over-all geometrical configuration, but the mesh size of the netting was not. When the model meshes were related to those used in a full size trawl, they would have been equal to a four inch mesh which was thought to be far too large to retain herring. To accomplish this and still retain the fish seemed a mystery and a mental block would not permit visualizing the use of larger meshes, since it was thought that these

would surely allow too great an escapement of herring. Some fishermen did suggest three inch meshes in the wings and bellies, but no one really wanted to test such a seemingly radical approach.

The first real progress in midwater trawling began when Mr. Anker Kjerside, a fisherman from Esbjerg, Denmark, came to Vancouver, British Columbia, after the war and in 1949 became a crewman on Captain Nels Nelson's "Combat", 60 foot, 105 h. p. Anker Kjerside had plans of the Robert Larsen two boat trawl and he convinced fishermen that the forward part of the trawl should be made of six inch meshes and that mesh sizes should decrease section by section to the codend which was of small enough mesh to retain the catch. To the unitiated, it did not seem possible to catch herring with such a trawl, but Anker Kjerside demonstrated its feasibility.

He constructed the first one boat midwater trawl from fine cotton salmon seine netting for the "Combat" and late in 1950, Captain Nelson caught enough herring with the trawl to be convinced of its efficiency and built a proper trawl to try pair trawling.

In the fall of 1951, the author rejoined the "Combat" and subsequently helped Anker Kjerside build British Columbia's first two boat Larsen trawl. Captain Nelson teamed up with Captain Ray Prince, Victoria, British Columbia, with his "Violet Prince", 69 foot, 115 h. p., and some moderately successful catches were made. However, the gear proved complicated to operate and Nels Nelson gave up the two boat trawl in favour of the one boat trawl which Anker Kjerside constructed.

The "Combat" subsequently made many successful catches in Gas Boat Passage in Northern British Columbia in late 1951 and early 1952. However,

the catches were made in extremely dense schools of herring. Success was short lived because in 1953 the same gear could not catch paying quantities from less dense schools, from which purse seiners were able to catch all they wanted. Captain Nelson gave up midwater trawling in 1953 and converted the "Combat" to a purse seiner.

The author's experiences in midwater trawling were imparted to Captain Alf Ritchie, M. V. "New Laurel" and Captain Frank Gale, M. V. "Carolina Maria", both of Prince Rupert, British Columbia, who built "Combat" type trawls and in the spring of 1953 made successful catches of herring on dense schools in Chismore Pass, south of Prince Rupert, British Columbia. In the fall of that year, the two trawlers were joined by four others with similar trawls and although purse seiners were doing well, the herring were not schooled densely enough for the trawlers to meet with continuing success, and as a result they gave it up.

Mr. Rupert Prince, brother of Ray Prince, subsequently took over command of the "Violet Prince". He also engaged in one boat midwater and bottom herring trawling and like the others achieved only limited success. However, Rupert believed that with sufficient time and money, a successful midwater trawl could be developed. As a result, he wrote to the Canadian government and funds were allocated for this purpose. This in turn resulted in the author being employed on a contract basis by the Fisheries Research Board of Canada where he developed the first really successful Canadian one boat midwater trawl.

The experience gained during periodic contractual employment with the Fisheries Research Board of Canada, at Nanaimo, British Columbia from 1954 to 1957 in developing midwater trawls, which included bypass twin codend midwater trawls, a high reaching bottom trawl and vee otter boards gave the author his first experience in managing such developments and introducing them to the fishing industry. However, before describing these experiences, it is also necessary to provide some background on the introduction of stern trawling in British Columbia, which definitely affected future work on vessel and gear development.

DEVELOPMENT OF STERN TRAWLING

The adoption of the American method of stern trawling by British Columbia trawlers not only improved the efficiency of bottom trawling, but also greatly contributed to the successful development of one boat midwater trawling on both the Pacific and the Atlantic Coasts of Canada.

The rigging of the first British Columbia fishing vessels for stern trawling was carried out by fishermen, and first-hand knowledge gained at this time enabled the author, on behalf of the federal government, to direct major conversions of fishing vessels, as well as create the deck, rigging and general arrangements for new fishing vessels.

When midwater trawling was first introduced, it was found that winches originally designed for bottom trawling now had insufficient power, since it became necessary to haul the trawl against the maximum propeller thrust. This resulted in many winch failures, and solving such problems led to a good basic knowledge of deck machinery and their working parameters. Such knowledge and experience proved later to be absolutely essential for converting vessels to new methods of fishing or for defining deck machinery requirements and laying out the fishing and deck arrangements of new vessels.

Until 1944, the few British Columbia vessels engaged in trawling employed a simple, low cost, but effective method of side trawling developed around 1919 by Captain Jack Shannon of Vancouver. The gear was towed from a single sheave block attached to the end of a wooden boom, located amidships.

The boom was hinged at the inboard end and lowered over the starboard rail so that the end would project outboard by six feet or more. The otter boards were attached to bridles of 50 to 100 fathoms. The vessel ends were spliced to single warp which ran through a single sheave towing block to a single drum trawl winch.

The trawl was attached to the otter boards by rope, combination rope, cable or chain sweeplines and since G-hooks, recessed links, Kelly's eyes and stoppers were not employed, the sweepline could not be disconnected from the otter boards so that they could be connected to the main bridles and wound onto the winch to bring the trawl up to the vessel.

Shooting was carried out by pawing out the trawl while the vessel slowly described a half or full circle, and after returning to the towing course, full speed was applied and the gear shot. After the correct length of warp was payed out the warp was then hoisted onto a stern roller and towing commenced. Shooting was simple, but hauling was difficult and dangerous since the sweeplines and trawl had to be fleeted by means of tackles from a boom. It was particularly dangerous when lifting rocks, mud or large quantities of non-floating species of fish. Another disadvantage was having to lay broadside to the weather, when hauling the warps as well as the trawl.

In contrast, fishermen on the Pacific Coast of the United States had practised stern trawling without ramps for as long as British Columbians had been trawling over the side.

Increased demand for fish during World War II caused many fishermen to convert their vessels to stern trawling on a year round or part-time basis.

Many U. S. vessels trawled off the coast of British Columbia and it was not uncommon to see 100 vessels in one area trawling for prime fish and also for dogfish, of which only the livers were saved for processing into oils.

British Columbian trawlermen fishing alongside the American boats soon realized the advantages of stern trawling, and eventually converted most of their fleet to the method.

The author was directly involved in rigging several boats for stern trawling as well as skippering them, and the experience gained was of untold value in later years in the development of stern trawling on the Atlantic Coast.

COMBINATION FISHING VESSELS AND SUITABLE DECK MACHINERY

The true development of trawling for groundfish on the Canadian West Coast really only began during the second World War and grew more slowly than purse seining because of the abundance and ready marketability of species caught by the latter method.

When trawling first started around the time of World War I, two types of vessels were in use, the halibut longliner and true trawlers brought from England with engine and superstructure aft, and the purse seiner with its superstructure and engine forward. As time passed, the latter was found more suitable for both methods and after 1928, the purse seiner type vessel became the combination fishing vessel. Experience in skippering both types of vessels was later to prove of value in Atlantic Coast stern trawler development work.

The combination fishing vessel quite naturally became a trawler, being especially suited to stern trawling.

Very few West Coast vessels engaged in year round trawling; rather they rigged out for at least one other method of fishing during a year's operation. Some would engage in trawling during the winter and halibut longlining during the summer. Others would purse seine salmon for a short period during the summer and herring during the winter, trawling groundfish for the remainder of the year.

This, of course, presented problems, since one set of fishing gear and deck machinery had to be replaced by another every time the vessel

changed its method of fishing. The removal and re-installation of trawling winches and equipment was especially bothersome, because the split winches originally used in stern trawling could not usually be left on deck since they were seldom compatible with other methods of fishing.

The deck machinery problem was solved when Haldor Dahl of Tacoma Boat Building, Tacoma, U.S.A. developed the combination trawl, seine and longline winch which eliminated the need to replace winches when changing from one method of fishing to another.

Around 1952, Dan Luketa of Seattle, Washington, U.S.A. introduced the trawl reel, thereby increasing the utility of powered reels which had long been in use in British Columbia to handle salmon gillnets. The reel was also developed around 1945 for handling purse seines. British Columbia trawlers quickly adopted trawl reels and this useful equipment was later introduced and developed still further on Canada's Atlantic Coast.

Rigging to handle large catches of trawl caught herring

One of the early problems that arose in British Columbia pioneer midwater trawling was the removal of large catches from the codend without loss of or damage to the gear.

Early in his pioneering experiments in midwater trawling, Captain Nels Nelson realized that the ordinary method of bagging groundfish might not be very satisfactory for removing a large catch of herring from a trawl. He reasoned that a codend full of herring would be of immense length and bagging would kink the net, killing the herring which would then sink, especially if they were ready to spawn. The rigging at the time was not sufficiently strong to raise them and the vessel could even have capsized.

Nels Nelson and his crew subsequently devised a method for keeping the herring alive and removing them by brailing as was practised by purse seiners. This involved bringing the codend alongside with its forward end choked aft and the aft end brought up to the bow. An opening called a zipper located in the forward part of the bag was then opened for brailing by lashing one edge to the bulwarks and the other edge to two poles, one hove away from the ship by a tackle from a boom protruding 20 feet or more forward of amidships and another attached to the main mast. This boom was equipped with tackles used to dry up the codend on the bow, forcing the herring aft for brailing.

The method proved very successful and many of the principles involved were retained and used years later to develop methods of emptying much larger trawl catches of herring by pumping as well as bagging.

REBUILDING FISHING VESSELS

Rebuilding older fishing vessels to modernize the, increase cargo capacity, provide better accomodation, more deck space or more freeboard, has long been a part of the heritage of British Columbian fishermen and boat builders.

Many of the present day wooden British Columbia fishing vessels were originally built in the late 1920s or earlier, and most have been rebuilt at least once or twice.

Rebuilding generally involved removing the older superstructure and the entire deck and raising the new deck to increase hull depth and freeboard as well as building larger and more commodious superstructures.

PROPULSION MACHINERY

Experience in an era which saw the transition from the naturally aspirated slow-turning heavy duty two cycle semi-diesel and the four cycle full diesel through the naturally aspirated medium and high speed diesels, to the present modern turbo-charged after-cooled medium and high speed diesel has proved of great benefit in the development of fishing vessels.

Operating the older types of engines required constant attention with regard to control of their lubrication, oil and water temperatures and; constant adjustment of governors and valve clearances as well as the carrying out annual overhauls. This experience provided an appreciation of the benefits of modern high speed diesels, eliminated many of the tasks and reduced the need for the constant attention involved in operating the older type of engines.

The compactness of the modern engine with its greater power to weight and space ratio and its capability of operating virtually unattended became an important consideration in advising on machinery and power for new fishing vessels and in re-engining older ones.

HYDRAULICS

Captain Nels Nelson pioneered not only midwater trawling, but also high pressure hydraulic trawl winches in British Columbia.

The winches which were designed and manufactured by the late John Swann of J. Swann and Sons Ltd., Machinists and Engineers, Vancouver, British Columbia, proved very successful and the entire British Columbia fishing fleet soon adopted hydraulically driven deck machinery.

MANAGEMENT OF THE FIRST GOVERNMENT PROJECT

In 1954, money was provided from the Industrial Development Vote of the Department of Fisheries to the Biological Station at Nanaimo, British Columbia, for the purpose of developing a better midwater trawl. (Fisheries Research Board of Canada, Bulletins 104 - "A New Midwater Trawl for Herring", and 123 - "Further Midwater Trawl Developments in British Columbia").

The author was hired on a contract basis to design and construct midwater trawls, train the crews of chartered commercial fishing vessels in the use of these trawls and prepare reports on the results in co-operation with Mr. W. E. Barraclough of the Nanaimo Biological Station.

Prior to the beginning of the project, Fisheries Research Board representatives and British Columbian fishermen formed a committee of which the author became a member, to advise on a development program.

Previous experiments carried out by fishermen at their own expense were reviewed and, since British Columbia midwater trawls to this date had caught herring only when they were densely schooled at night time, it was decided to attempt to develop a trawl which would produce profitable quantities of herring under any conditions. Two principal improvements appeared possible.

(a) much larger trawls, and

(b) some means of getting the otter boards much farther apart, as it was felt that they frightened the herring.

Research

The first step was to gather all the information possible on the behaviour of herring. At the time such knowledge was very limited; in fact, the author found that he had much more knowledge in that field from previous experiments in midwater trawling than was available from scientific and other journals.

The next step was to research all the trade journals for detailed information on Robert Larsen's two boat midwater trawl and Karl-Hugo Larsson's one boat "Phantom" midwater trawl, but such details were sadly lacking. However, it was known that the U.S. Bureau of Commercial Fisheries Gear Research and Exploratory Fishing Base in Seattle, Washington, U.S.A., had a "Phantom" trawl and was working on midwater trawl development. Therefore, a trip was made to the base where a meeting was held with people in charge of gear research to discuss midwater trawl development and view the "Phantom" trawl gear.

The most impressive part of the trawl was the aircraft wing type otter boards. However, it was also recalled that Captain Dave Moore of Prince Rupert had made a set for his midwater trawl experiments and that while they worked satisfactorily, they did not help to catch more herring than conventional doors.

A further trip was made to the Canadian Navy Base at Esquimalt, British Columbia, to investigate mine sweeping gear which might be used to spread and control the depth of midwater trawl gear. A navy officer kindly gave a lecture on the use of mine sweeping gear. However, the equipment did not seem to be suited for midwater trawling.

We then contacted the suppliers of nylon netting to learn the characteristics, costs and availability of the material, as it was relatively new at the time. Nylon had not at the time been used in midwater trawl anywhere in the world but the author felt it would be a superior material because it had greater strength, greater elasticity and lower water absorption than natural fibres such as cotton, for similar diameters. If nylon were used there would be a great reduction in the twine diameters, and this of course would reduce resistance so tremendously that a nylon trawl, much larger than the cotton ones previously used, could be towed with the same power.

Lastly, we studied all available trawlers to see which was the most suitable to carry out the project and it was thought that a commercial groundfish trawler between 60 and 70 feet in length with about 150 h. p. and rigged for stern trawling, would do the job. We knew such a vessel, "Sea Pride II", owned and operated by Captain Norman Sigmund, Vancouver, British Columbia, could probably be made available, as Captain Sigmund was very interested in midwater trawling. Preliminary talks with Captain Sigmund indicated he would charter his vessel for the project when the time came to carry out fishing trials.

Design and Model Testing

Much serious thought had to be put into designing the trawl to make it as large as possible with a vertical opening of five fathoms or more while being towed at better than three knots with a mere 150 h.p. It was found that by using nylon, reduction in the weight of netting would permit

the construction of a one boat trawl as large as the original "Combat" Larsen type two boat trawl, which could be towed by about 150 h. p. Accordingly, using the "Combat" trawl as a guide, the author designed a midwater trawl.

The otter boards caused some concern, since it would be virtually impossible to attach the warp and trawl sweeplines to conventional otter boards of the size required in the normal fashion and still obtain the great spread recommended by the committee. It was also apparent that even much larger doors would not provide such a spread.

Recalling that a school of herring, when a rope or cable is drawn through it, will open up only sufficiently to allow it to pass, after which they will again close up, it was reasoned that the herring would behave similarly towards the sweeplines and trawl warps. If the doors could be flown from long pennants attached at the junction of the trawl warps and sweeplines, they would be a great distance apart and only the sweeplines and warps would be left between.

Drawing on his knowledge of aircraft gained through being an aviation enthusiast, the author designed several types of midwater trawl doors which had hydro-oil sections, vertical and horizontal stabilizers and were balanced to run almost horizontal. Models of the doors were tested until they performed satisfactorily, after which a set of plans for the full-size doors was drawn up.

Normally heavy lead or iron weights attached to the lower sweeplines ahead of the wing tips had been used by most fishermen to open the

trawl. However, Dave Moore of Prince Rupert, British Columbia, had developed a simple depressor plate, and a larger set was designed for the new trawl in place of the weights.

Purchase of Materials

The author prepared all specifications for the trawl materials required and held costs within a strict budget. The otter boards were ordered from a shipyard in Vancouver.

Construction of the Trawl

When all materials for trawl construction arrived at a Vancouver fishing gear supplier, the latter permitted the use of a net loft for construction of the trawl.

Chartering the Trawler

A straight charter was negotiated for the "Sea Pride II" at a flat daily rate for a set period of two months. At that time, it was the policy of the Fisheries Research Board not to retain and sell the catch resulting from research work. The author pointed out that the project differed from any of their previous experiments and that the proper way to demonstrate the commercial potential of the new midwater trawl gear was to catch all the herring possible and to sell it for the prices received by fishermen. Apparently the mechanics of implementing the sale and disposing of the proceeds were very cumbersome to the accounting system, and therefore, the proposal to sell the catch was discarded.

Fishing Gear Trials

Before actual fishing trials got under way, the gear had to be tested and the "Sea Pride II" was taken out to deep water for such a purpose.

Some adjustments had to be made to the otter boards to get them to perform properly. The main purpose was to check the warp angles at various lengths of warp and trawling speeds and prepare a table of warp angles. Measurement of warp angles was at that time, the only method of ascertaining the depth of the gear, since net sounders had not yet been invented.

Fish Catching Trials

Captain Sigmund was directed to take the "Sea Pride II" to the nearest area where there was herring. The first tows which were made at night produced catches ranging from 20 to 30 tons. Work continued both day and night during January and February and the catches of herring were sluggish at that time of the year, and that a true test of gear effectiveness would have to be made late in the year when the fish would be more active. One major breakthrough was the successful daytime catches, which had never before been possible.

The Captain and crew were very pleased with the early results, but disliked having to use warp angles to measure trawl depth. They felt, since the herring were in areas with suitable trawling bottom, that the gear should be rigged behind standard trawl doors and fished as a semi-pelagic trawl during the daytime when herring were densely schooled close to the sea bed. They also felt, of course, that it was ridiculous not to retain the fish and sell them, rather than photograph and release them.

Direction to Captain of Vessel

Since this was an absolutely new method of fishing, a new operational technique had to be created, and it was necessary to give the captain continual direction in trawl depth control and removal of the catch. Even

though the catch was not retained, it was necessary to practise emptying the codend by brailing as the method required development.

Concluding Opinions

At the termination of the project, the Captain and crew were asked for their personal views. They said that they were pleased with the catches of herring that resulted, but had the following comments, some of which were mentioned previously:

(a) the catch should have been retained for sale;

(b) control of depth of the gear was too complex;

(c) the gear should be rigged for semi-pelagic trawling;

(d) experiments should be made in the autumn when the herring were known to be far more active;

(e) they could not afford to purchase similar gear and use it in commercial fishing. Therefore, more development work should be carried out to produce commercially usable gear.

Reporting

On conclusion of the vessel charter, Mr. Barraclough and the author set about preparing a report. The author drafted parts of the text and made all the drawings, while Mr. Barraclough did the major part of the writing. No other work was undertaken until the report, "Fisheries Research Board Bulletin 104" was finished. It was subsequently published and made available to anyone who was interested.

Recommendations

We felt that the results of the project were beyond expectations and recommended that further fishing trials be carried out in the fall of the year. New gear incorporating features recommended by the "Sea Pride's" Captain and crew, as well as our own recommendations should be constructed.

The results of the project and our recommendations resulted in the allocation of additional funds from the Industrial Development Vote of the federal Department of Fisheries for the purpose of continuing midwater trawl development.

Development of a Semi-Pelagic Trawl

In the fall of 1955, the "Sea Pride II" was again chartered and new midwater trawls were constructed which incorporated modifications recommended by project one.

The first test tows were again carried out in midwater and as before, successful catches were made showing that the wilder fall herring could be captured. However, when attempts were made to tow close to the sea bed, it was found to be virtually impossible to regulate the gear through use of warp angle measurement to prevent it from striking bottom. The trawl was not made to run on the sea bed and even though the bottom was suitable for trawling, the fine nylon netting was easily damaged.

Since the trials were being carried out in the Gulf Island region of the Gulf of Georgia, where the bottom is smooth and the herring are adjacent to the sea bed during the daytime, the trawl was rigged for semi-pelagic trawling. This consisted of attaching the trawl to standard bottom doors and making the top sweeplines longer than the bottom ones, so the

headrope would rise and the footrope would tow well-off bottom.

The gear was an immediate success and many good catches ranging from 10 to 40 tons were made during November, 1955. Vancouver trawlers which were working the area for groundfish immediately became interested and hand sketches and details of the gear were provided to them.

One of the trawls was loaned to Captain Frank Gale for use on his "Carolina Maria" and he immediately began to catch herring, although not as well as the "Sea Pride II", owing to a lack of power.

Since the "Sea Pride II" could not retain the catch for sale, some of it was given away to other trawlers, and this at least provided a fairly accurate measurement of the quantities caught.

Adoption of the Gear by Industry

As soon as the charter finished in December, 1955, Captain Sigmund rigged the "Sea Pride II" with similar gear and fished it semi-pelagically and in a five-week period, during December, 1955, and January, 1956, caught 622 tons of herring.

Others followed and in the fall of 1956 and 1957, there were about 19 trawlers catching herring using the midwater trawls semi-pelagically. However, the exception was the late Captain Alex Simms with his 45 foot 80 h. p. "Loretta B", who successfully and consistently caught herring in midwater. His son, Dick Simms, continued midwater trawling until quite recently.

The trawlers were not to enjoy herrring fishing for long, as the Gulf of Georgia had a 40,000 ton quota and the purse seiners had increased

their efforts, achieving the quota in three to four weeks. As there were few other suitable areas for semi-pelagic trawling where herring were found, most of the trawlers gave up herring fishing.

There can be no doubt that the lack of a net sounder to accurately tell the depth of the trawl and observe fish entering or going over or under the trawl was an important obstacle to the growth of midwater trawling for herring in British Columbia.

FURTHER DEVELOPMENTS IN MIDWATER TRAWLING IN CANADA

Following the success of the second project, further funds were made available and the author continued to be employed on an intermittent contract basis to carry out such work.

The purse seine was still the most effective method of catching herring and the efficiency of the midwater trawl had to be greatly improved before it could become a profitable method of fishing. Emphasis was placed on experiments to that end between 1956 and the end of 1957.

To improve the trawl itself, experiments were conducted to create a greater flow through the trawl since it was becoming quite apparent that the quantity of herring captured was in direct proportion to this factor.

Trawls with meshes from five to six inches in the forward sections and a reduction in the amount of smaller meshes in the after sections were tested and proved to be a little better than the original trawls. The use of much larger meshes should have been pursued.

In order to increase water flow, two trawls embodying the same principle as a high-speed plankton trawl (Gauld and Bagenal, 1951) were constructed. A free passage through the centre of the trawl was provided, one version employing a single codend with two leads from the codend while the other had twin codends. Neither net caught anymore herring than the original trawls.

A high speed trawl was also constructed on the theory that a small trawl towed at high speed could catch more than a large one towed slowly, but this was disproved in fishing trials.

To spread the trawl, the author designed a set of aluminium dual purpose "Vee" doors for both bottom and midwater herring trawling, which worked very well. Similar doors for bottom trawling groundfish and midwater herring trawling were used by the author in 1959 in commercial fishing operations.

To open the trawls vertically, the upper wing tip kites of various types were constructed and tested and while they improved the opening, they did not increase the catching power to any significant degree.

Diversification was introduced into the program when the author designed and constructed a new high-reaching four panel trawl for redfish. Unfortunately, only two or more tows were made with the trawl and while the catch was greater than that of commercial trawlers, it could hardly be termed a conclusive trial.

Gear Comparison Trials

In the spring of 1956, the Fisheries Research Board made arrangements for the author and Ed Barraclough to test the performance of the midwater trawls which were fished so successfully by the "Sea Pride II" with that of gear developed by the U. S. Bureau of Commercial Fisheries Exploratory and Gear Research Base's research vessel "John N. Cobb". It was also the intention to search for herring in open waters off the West Coast of Vancouver Island and exchange ideas.

The opportunity to learn how to operate sonar, since the "John N. Cobb" was equipped with Minneapolis Honeywell equipment, was very worthwhile. Sonar had not yet been taken up by the fishing industry.

No significant quantities of herring were caught, only a few small schools being found on the West Coast of Vancouver Island, but the exchange of views gave the author much information on what was going on in the U.S., and it was shown conclusively that the Canadian midwater trawls were more efficient.

Net Sonde and the Power Block

Early in 1957, the Fisheries Research Board chartered the 69 foot, 175 h. p. stern trawler "Aleutian Queen" to demonstrate midwater trawling to the Prince Rupert fishermen in Northern British Columbia, as well as to carry out more development work.

Meanwhile, Minneapolis Honeywell at Seattle, Washington, U.S.A., were working on the development of a net sounder which operated on the telemetry principle and the "Aleutian Queen" was dispatched in Janurary to Seattle, where she made tows to test a pilot model. The design engineers were satisfied from the tests that they could develop a satisfactory net sounder, but were unfortunately forced to abandon the development owing to the limited market for such equipment at that time.

By the end of 1957, midwater trawl development had come to an end, and the author returned to commercial fishing.

FROM THE PACIFIC TO THE ATLANTIC

In the summer of 1958, Dr. Leonce Chenard, Deputy Minister of Fisheries for New Brunswick, arranged through the newly formed Industrial Development Service of the Department of Fisheries for the author to try midwater herring trawling in the Gulf of St. Lawrence.

The midwater trawl gear used in the British Columbia experiments was shipped to Caraquet, New Brunswick, and was placed on Captain Martin Chiasson's 72 foot, 220 h. p. side trawler "Dorothy and Rosalie", which had been chartered for a period of two months.

The catches were small, but enough herring was caught to encourage the author to believe the project should be tried for a longer period in the coming year of 1959.

In April, 1959, the author returned to New Brunswick to carry out further midwater herring trawl experiments with the "Dorothy and Rosalie". A second trawler, the 48 foot, 165 h. p. "Chaleur 8", skippered by owner Fidel Savoy of Neguac, New Brunswick was also chartered and rigged for midwater herring trawling under the author's direction.

Teaching the crews to handle the gear was an easy task, but finding good quantities of herring was difficult and much exploratory fishing had to be carried out to locate herring and trace their movements. At that time, the stocks of herring in the Gulf of St. Lawrence were probably at their lowest.

The catch results were poor. However, much was learned about herring behaviour, school density, and seasonal migrations in the Gulf of

St. Lawrence.

On December 1, 1959, the author became a permanent employee of the recently formed Industrial Development Service of the federal Department of Fisheries. This had previously been a three-man organization, mainly involved in administering the funds of the Industrial Development Vote, but it was now expanding and acquiring a staff of engineers, and gear technologists to take an active part in development of the primary phases of the fishing industry.

THE LAKE ERIE SMELT TRAWLING PROJECT

The introduction of trawling to Lake Erie was the first project carried out in participation with industry and a provincial government.

Handling the project was a large task and many good ideas for the future grew from this experience.

By 1960 most of the premium species had declined in Lake Erie and the fishing industry was in a depressed state. However, the lake was full of smelt and yellow perch and while the perch could be caught easily with gillnets, the smelt could really only be caught economically with pound nets when they came in to spawn in the springtime.

Assessing the Resource

In order to select the most effective type of gear, it was necessary to obtain some idea of the distribution of the smelt, and the densities in which they schooled. This was obtained principally from echo sounder recordings made by fishermen which indicated that the schools were extremely heavy, despite the fact that they had been made by an older make of echo sounder which at its best would barely record the lake bed, let alone fish. Discussions with fishermen indicated that the schools were very lengthy and broad, that they were distributed fairly well along the entire length of the lake, but that they appeared in some areas only at certain times of the year.

It was also learned that the lake surface did not always freeze in the winter, due to wind action, and that it was possible to break through the shore ice from the harbours to the open water. However, gillnetting could not be carried out in the open waters because drifting ice would carry

away the mark buoys and also tear the nets.

Selecting the Most Suitable Fishing Gear

It was apparent that a midwater trawl rigged for semi-pelagic trawling and a high-reaching herring type bottom trawl would be suitable for catching the smelt in quantity. Everything was in favour of trawling; the water was seldom clear; smelt were slow swimmers compared to herring and also densely schooled.

Furthermore, the U.S. Bureau of Commercial Fisheries had already tried trawling on the U.S. side of the lake with a shrimp trawl, and had made some excellent catches, although a trawl fishery had not been established.

Selection of a Fishing Vessel

It was decided that a lake fishing vessel, termed a fishing tug, around 60 to 70 feet in length, could be rigged for trawling and that it would be required for experimental fishing for a period of at least four years, since experimental fishing might also have to be done in other lakes as well.

Naturally, many owners were willing to charter their tugs but this was not desirable since it was felt that it might be necessary to rebuild and modify to the point of rendering the tug useless for normal fishing operations.

The problem was resolved by Omstead Fisheries of Wheatley, Ontario, agreeing to purchase a 72 foot, 150 h. p. fishing tug selected by the department and modified as required. Omstead Fisheries paid for rigging and modifications and also paid the crew. In return, the federal Department of

Fisheries chartered the vessel and also permitted the owners to purchase and process the catch. They were, however, allowed to retain only 50 per cent of the landed value of the catch, with the other 50 per cent going to the department.

Selecting Equipment and Rigging Out

All fishing gear, equipment and machinery were selected by the department, special attention being paid to the selection of an efficient fish finding echo sounder; only echo sounders of very limited fish finding capability had been used in the lake fishing tugs up to that time.

Installation of deck machinery equipment and modifications to the vessel, which was renamed "Erie I" were directed by the author with the vessel's Captain Norman Omstead acting as supervisor.

Lake fishing tugs are completely decked in, and a great deal of thought had to be put into rigging the vessel for trawling while keeping the decked-in feature for the cold months of the year. The vessel was rigged for stern trawling and had the first hydraulically driven trawl reel used on the lakes.

Fishing Gear Construction and Crew Training

Since the crew of the vessel had never before worked on trawl gear, the materials were purchased rather than the complete trawl and the crew were trained to construct their own trawls.

Such training was absolutely essential. We sought to thoroughly familiarize the men with the gear, not merely so that they could carry out repairs, but also so that they could act as instructors to other interested fishermen.

The two types of trawls designed by the author were built. These were a midwater and a Western type bottom trawl.

Fishing Operations

It was decided that the vessel would operate on a commercial basis and because the captain was an experienced lake fisherman, there was no one better qualified to locate the smelt schools. Consequently, he was given a completely free hand as to where and when to fish. The only stipulation was that he had to shift to other ports along the lake when requested, to demonstrate the method.

Keeping an accurate log of the fishing statistics was also part of the Captain's duties, and as agreed, he turned data over to the scientists of the Ontario Department of Lands and Forests who were studying the resource.

The method used to ensure optimum production was to locate the largest stocks of smelt and then to concentrate on fishing as intensely as possible. As the schools of smelt shifted, the vessel would shift along with them. In this way, knowledge of the smelt schools and their movements was gained. It was felt that if the vessel proved profitable, others would soon follow its example and as they began exploiting the smelt stocks nearest to their home ports, a comprehensive knowledge of the smelt distribution and behaviour would be obtained.

Demonstrations and Exploration

Initial fishing trials in the West end of Lake Erie produced fair, but not large catches. The vessel was, therefore, dispatched to Port Dover in the Eastern end of the lake. Very large catches resulted and local

fishermen who accompanied the vessel immediately became in smelt trawling.

In the second year of operation, the vessel began making excellent catches also in the West end of the lake and the earnings were such that other fishermen wanted to go trawling.

Training Courses

Realizing that many men would have to be trained in trawl gear repair and construction, as well as in the operating technique, it was decided to establish a training program.

Omstead fisheries provided ample indoor space to run a construction course. As each vessel was to be rigged for trawling, the crew constructed their own trawl gear under the author's direction. It was interesting to note that crewmen were anxious to learn and that they willingly participated in the construction of trawls for vessels other than their own.

Rigging Out the Vessel

While the crew constructed their own gear their tug was rigged out for trawling under the author's direction, or that of Mr. Milo Reid, the mate of the "Erie I", who was found to have a special aptitude for such work.

Instruction in Fishing Techniques

By the time the vessel had all its deck machinery, echo sounder and equipment installed for trawling, the fishing gear was also finished and the vessel was ready to go fishing.

The mate of the "Erie I" then accompanied the vessel to act as an instructor. Because the vessel's skipper and mate had made a trip or two in advance on the "Erie I", it did not take them long to learn the techniques of trawling.

Project Results

As a result of the "Erie I's" pioneering efforts and the assistance given by the author through direct advice, a fleet was quickly rigged out for trawling. Omstead Fisheries found the production beyond their processing capabilities and had to place a catch quota on the trawlers.

When the company found that trawling could produce a steady supply of smelt, they increased their processing capacity and expanded the market for smelt.

At an initial cost of less than $200,000 to the Government of Canada, the fishing grew from landings of about 3,000,000 pounds of smelt in 1960, to a sustained average annual yield of 15,000,000.

EFFECT OF EXPERIENCE IN LAKE ERIE ON PROJECT MANAGEMENT

The Lake Erie project established a pattern for managing the introduction of fishing gear, equipment and vessels which has been followed, more or less closely, ever since.

Some important aspects are as follows:

(a) carry out the project on a commercial basis retaining the catch for sale thus giving the fishermen the necessary incentive which they would not have if they received a straight salary;

(b) use commercial fishing vessels of the type which can be expected to adopt the innovations for commercial operations. Research or other government vessels are usually not suitable;

(c) allow the captain a free hand in fishing where and when he chooses unless exploratory fishing or gear tests are being carried out. This gives him additional incentive to make a success of the project;

(d) when instructing the captain in new methods of fishing do so verbally and never take over actual control of the vessel unless requested to do so;

(e) when instructing the crew in gear handling, repairs or construction, participate directly if necessary;

(f) make sure the project is being carried out in co-operation with a processor who wants or needs the catch;

(g) from among the crews select potential future instructors who will be capable of helping out in a training program;

(h) create a training program to instruct fishermen in gear construction and fishing techniques to ensure growth and perpetuation of new methods;

(i) provide proper working drawings of the vessel modifications and gear.

GROWTH OF INDUSTRIAL DEVELOPMENT BRANCH ACTIVITIES

In 1960, just before the Lake Erie project began, the Industrial Development Branch began to expand its program of development by introducing other methods of fishing where there was obviously low production. For example, the Industrial Development Branch contacted Mr. William Dunn, a Lake Erie fisherman, and in co-operation with the Nova Scotia Department of Fisheries, introduced lake gillnetting techniques to the Atlantic Coast.

Lake fishermen were very advanced in gillnetting and although Atlantic inshore fishermen had used bottom gillnets to a very limited extent to catch cod, line fishing was still the principal method used.

William Dunn successfully introduced lake style gillnetting to the Atlantic Provinces, particularly Newfoundland. As a result, most of the Newfoundland inshore fleet now use gillnets for cod and similar species at times other than when engaged in the cod trap-net fishery.

The introduction of lake style gillnetting to the Canadian Atlantic was very successful, resulting in greatly increased earnings for inshore fishermen.

DEVELOPMENT AND INTRODUCTION OF THE ATLANTIC WESTERN TRAWLS

The Skagen trawl, introduced by the Acadia Fisheries of Nova Scotia in the early 1960s out-produced traditional two piece trawls, and remembering his own experience in the Pacific, the author felt that a four panel Western trawl could outperform the Skagen trawl.

In December of 1963, the author, with assistance from Booth Fisheries fishermen, constructed the original Model I four panel Atlantic Western Trawl. On the first voyage the trawl immediately showed it could catch more haddock, pollock and cod than other nets then used, but the weather was so bad that little fishing could be carried out.

Captain Barnes had great faith in the trawl and in 1964 used it extensively with excellent results. However, he recommended stronger materials and also suggested that part of the forward end of the lower wing be cut away to form a flying wing. In the summer of 1964, we tested the new Model I, incorporating these features, on flounder, and found that the trawl caught as many if not more than the two panel trawls.

Three other companies, noting the "Barbara B. Fletcher's" success in haddock fishing requested that the author build a Model I trawl for them. However, only one vessel, the stern trawler "Grand Monarch", used the trawl successfully.

The main reasons for the Newfoundland and trawlers discarding the A.W.T. at this time were the seemingly longer repair times required for the

larger trawl and the lack of understanding of the trawl construction on the part of the crewmen.

A similar fate was suffered by a smaller version called the Model II A.W.T. which was constructed for Booth Fisheries 60 foot 250 h. p. "Donna Louise", which fished the trawl successfully early in 1964.

Out of Nova Scotia

Brian Meagher, Deputy Minister of Fisheries, Nova Scotia, proposed that National Sea Products of Halifax try the Model I A.W.T. on one of their trawlers.

In September, 1964, the trawl was put aboard the company's 141 foot 660 h. p. "Cape Blomidon", commanded by Captain Charles Carter of Halifax. To his credit Charles Carter used only the Western trawl on the first trip as he felt that it would not otherwise receive a fair trial.

Fishing was poor and the trip only yielded 108,000 pounds of mixed haddock and cod, but on landing it was found that the catch compared very favourably with those of other boats. Noting that not a single belly had been lost, and repairs had been restricted to the wings in spite of 10 fasteners in a single day, Captain Carter concluded that the trawl had potential. He recommended that the headrope and footrope length be reduced to facilitate easier repairs and promised to try a modified trawl.

New Brunswick next

In the fall of 1964, using Captain Carter's recommendations, the author directed the construction of another Atlantic Western Trawl. This was Model Number III for the stern trawler "Donald Rheal", 93 feet, 490 h.p., of Shippegan, New Brunswick. Once again, the crew helped in the construction.

The trawl was an immediate success and so significantly increased the vessel's production that Captain Guignard continues to use the Model III Atlantic Western Trawl to this very day.

As a result of this success, the New Brunswick Department of Fisheries requested the author to construct a smaller version called the Model IIA for the 65 foot, 300 h. p. "Donald & Rena". This model, incorporating flying wings, also proved to be a very successful trawl, increasing the "Donald & Rena's" catch considerably over those of competitors using conventional trawls.

Introduction of trawl reel to the Atlantic

This was carried out by the author on the 93 foot, 660 h. p. seine trawler "Blue Waters" at Campobello in conjunction with the introduction of another Model III Atlantic Western Trawl; the total project was financed under a federal-provincial shared-cost arrangement.

Both the trawl and the reel proved to be very successful, resulting in some outstanding catches during the winter months.

Back to the "Cape Blomidon"

In June, 1965, an improved version of the Model III was built and tried out by Captain Charles Carter with the "Cape Blomidon".

This time, thanks to the patience of the mate James Trimm, in instructing the crew in making repairs and to his creation of prefabricated, easily replaceable sections, the Model III became a success.

The "Cape Blomidon" landings increased significantly while gear maintenance costs were reduced.

In 1966, when Captain Carter took charge of National Sea Products new stern ramp trawler "Cape Nelson" (154 foot, 1,100 h.p.) he chose the Model III Atlantic Western Trawl, subsequently outproducing sisterships which used small modified Granton trawls. The "Cape Nelson's" gear expenses were also consistently lower than those of a sistership fishing other types of trawls.

National Sea Products carefully studied Captain Carter's catch records and gear costs. For example, in 1968 he caught 6,800,000 pounds compared to 5,400,000 caught by the next best vessel, together with a reduction in gear costs from $50,000 to about $34,000. As a result, in 1969 the company installed the Atlantic Western Trawl Model III on their other nine stern ramp trawlers.

Following National's success, H.B. Nickerson & Sons of North Sydney also adopted the Model III on their most powerful stern ramp trawlers. On their less powerful vessels they used a modified version of the Model IIA with great success. The modified version was developed by Mr. Martin Picco, Nova Scotia Fisheries Training Centre, Lunenberg, Nova Scotia, who instructed the crews in constructing, repairing and fishing the trawl.

Provincial Department of Fisheries Instruction

After introducing and testing the Model III aboard the "Cape Blomidon" the author never again found it necessary either to go to sea to demonstrate the use and repair of the Western trawl, or to provide shore side instruction in construction. This service was undertaken by the Nova Scotia Department of Fisheries Training Centre at Lunenberg, headed by ex-fisherman, Martin Picco.

Mr. Picco has also studied midwater trawl construction and fishing techniques as an observer on some of the Industrial Development Branch mid-water trawl projects, so that he will be able to provide instruction in this field in the future.

The Atlantic Western Trawl returns to Newfoundland

On his appointment to the position of Regional Representative of Industrial Development Branch in Newfoundland, Mr. Rupert Prince reintroduced the Atlantic Western Trawl in that province, as he felt the original trials were not satisfactory.

In 1967, he put the Model IV Atlantic Western Trawl (originally designed for Quebec trawlers) aboard the 65 foot, 250 h. p. side trawler "Penny Worth" with excellent results. Booth Fisheries also put the Model IV on their "Donna Louise", one of the vessels on which the original Model II had been tested.

The Model IIA was next placed aboard three small stern trawlers, one 52 foot, 350 h.p. and two 65 foot, 350 h.p. and subsequently on a 65 foot, 350 h.p. side trawler "Margaret R".

However, the introduction of Model III on three large stern ramp trawlers, 144 feet to 155 feet, with 1,200 to 1,500 h.p., was not successful.

One of these Model III trawls was re-rigged with a lighter codend, laceage ropes and bobbins and was put aboard John Penny and Sons' 120 foot 660 h.p. side trawler "Penny Pride" which achieved outstanding success fishing redfish. Another Model III on the "Penny Pride's" sistership "Penny Fair" produced equally good results and the adoption of the Model III on Newfoundland's south coast subsequently accelerated.

Government participation

Financial support was provided through the federal-provincial cost-sharing program for the first trawl; however, once a model was accepted by industry, only technical assistance was provided by contracted fishing vessel and gear staff. Newfoundland's College of Fisheries is now providing training in the construction and use of the trawl.

Industrial Development Branch plan and design service

Excellent highly detailed plans of the Atlantic Western Trawls and other trawls are provided by the Industrial Development Branch's design and planning division, headed by Mr. Frank Dopplinger.

The plans of the trawls are up-dated from time to time to accommodate new rigging practices and are made available to all interested parties at no cost.

Future Atlantic Western Trawl Development

It is not possible to describe in this paper all the many experiments which took place; however, when time permits, the author's Division plans to develop larger Atlantic Western type trawls employing such features as large meshes in the wings and forebody.

It is not anticipated that any difficulty will be encountered in testing the trawl and because of the rapport the Industrial Development Branch has with industry, we feel confident that a Canadian trawler company will be willing to test it without charge, provided technical assistance is available.

DEVELOPMENT OF THE ATLANTIC COAST HERRING INDUSTRY

In 1960, the Industrial Development Branch was requested by the Newfoundland and Fisheries Development Authority to join them in assisting Dunphy Fisheries, the last major Newfoundland salt herring producers, because the company was not catching enough herring to keep them from going out of that fishery.

Dunphy's, located at Curling, Bay of Islands, had a single 72 foot, 330 h.p. Pacific type seiner called "Dunville" which, prior to 1959, been able to catch enough herring in Port Aux Port Bay to supply the needs of the plant. However, the herring had disappeared from the immediate area, where, because of the shoal waters and smooth bottom, herring had been easily purse seined for a number of years.

Herring had been found, in the meantime, off Bonne Bay to the north of the Bay of Islands in deep water, but the "Dunville" had been unable to catch them as they reportedly remained too deep for purse seining.

Dunphy's, hearing of midwater trawl developments in Europe, felt that if the "Dunville" were converted to that method it would be able to catch the deep swimming herring.

Where Experience Counts

Accordingly, the author met with Dunphy's Captain Sid Anderson of the "Dunville" to discuss their problems.

Captain Anderson's echo sounding charts showed extremely dense and large schools of herring but as reported, the "Dunville's" seine was too shallow to reach the schools. The vessel could not carry a deep enough

seine owing to the lack of deck space aft, and the seine in use was carried on an old-fashioned seine table. Furthermore, they were not equipped with a power skiff for towing off, or a power block for hauling the seine.

The author recommended modernization of the "Dunville", which would allow a deep seine to be carried and thus produce all the herring Dunphy's required. Midwater trawling had not advanced sufficiently to give such certainty.

Not being a purse seine specialist, the author arranged for the contracting of Captain Walter Steen, a Vancouver, British Columbia, herring seine skipper, to supervise the modernization of the "Dunville" and teach its captain and crew the latest techniques.

It was decided also to attempt midwater trawling for herring and the Newfoundland Fisheries Development Authority provided a 60 foot, 160 h.p. longliner called the "Cape Ballard" for this purpose.

The "Dunville's" seine table was removed, the deck was squared and bulwarks were built around it to carry a longer and deeper seine. A power block was also installed to handle the seine while a long range recording type sonar, the first of its type in Canada, was installed to locate the herring.

The "Dunville", needless to say, was an immediate success and caught more herring off Bonne Bay than Dunphy's had dreamed of.

The "Cape Ballard" was rigged for midwater trawling and equipped with the first net sounder in North America.

Unfortunately, the trawl winch was not powerful enough to haul the trawl against a fair propeller thrust and when the propeller thrust was reduced to allow the winch to haul, the herring would swim out of the trawl. As a result, the "Cape Ballard's" catches were small with the best single hauls yielding about 10 tons and the best day's fishing producing some 20 tons of herring, far below what the "Dunville" could do.

Exploratory Fishing

On returning to Vancouver, Walter Steen informed Ken Fraser, then Vice-President of B.C. Packers, of the herring resource around Newfoundland. B.C. Packers were about to move their groundfish trawling operation to a new plant in Harbour Breton on Newfoundland's south coast, and a meal plant for groundfish offal was to be installed. The company was willing to install equipment for processing herring also, provided herring could be found nearer to Harbour Breton.

The author's proposal to use the "Cape Ballard" to explore for herring off the south coast of Newfoundland was subsequently accepted. Midwater trawling was considered far more suitable for such work than purse seining, since a school of fish registered on the recorder could be sampled much quicker, no matter how deep it was. Sampling could also be carried out in rougher weather, a smaller crew could be used and the cost of repairing trawl damage was small compared to that for a purse seine.

Under command of Captain George Lace, English Harbour West, Newfoundland, with the author as project leader, the "Cape Ballard" began exploring for herring in St. Mary's Bay in March, 1963. Working westward,

every bay was searched but no significant recorder indications were seen until the vessel reached Cape la Hune, where some indications were noted. More schools were spotted near Ramea and finally large schools were discovered from La Poile Bay to Port Aux Basque.

The recordings were verified by sampling with the trawl, which despite modifications could only catch small quantities (today the problem can be pinpointed to insufficiently large meshes in the forebody), never exceeding two tons per haul. Nevertheless, the midwater trawl had served its purpose and the author was able to state that the herring potential was very large.

Subsequently, B.C. Packers equipped the plant for herring reduction. They also rigged their ex-whaler "Lavallee" at Vancouver for herring seining and sailed her around to Newfoundland. In order to stimulate what appeared to be a very promising new sector of the Atlantic fishing industry, the Industrial Development Branch chartered this vessel under command of Captain Kirk Anderson. Following some initial technical difficulties, large catches were made, thus establishing a large herring fishery on Newfoundland's south coast and encouraging development in the other provinces.

The cost to government for establishing this industry was less than $200,000. In 1961, the total Newfoundland herring catch was only 6,202 short tons (mostly processed for human consumption). It grew to a 1968 high of approximately 160,572 tons with a landed value of approximately $3,284,000, or a processed value of about $6,900,000.

The success of the Newfoundland herring fishery developments led to the establishment of similar herring fishing industries in Nova Scotia,

New Brunswick and Quebec where the author also made many decisions and recommendations which had a direct effect on the development.

The total Canadian landings in the Atlantic region subsequently increased from 97,000 short tons in 1961 to nearly 589,320 short tons in 1968 with a landed value of approximately $12,345,000 or a processed value of about $22,800,000.

EXPLORATORY FISHING AND FISHING VESSEL AND GEAR DEVELOPMENT ARE INTEGRATED

The establishment of the Newfoundland herring fishery bears out the importance of commercial exploratory fishing and it is evident that first-hand fishing experience is a prime requisite for assessment of the commercial potential of unexploited or underexploited fish stocks.

Commercial exploratory fishing and fishing vessel and gear development go together, because it is also necessary on most occasions to locate large fish stocks to effectively utilize improvements in catching capability, and similarly it is necessary to utilize the most efficient fishing methods to effectively carry out exploration for species with widely varying behavioural characteristics.

In the case of the expansion of the herring fishery, it can be seen that the improvements in fishing vessels, gear and operating techniques allowed Captain Steen and the author to carry out effective exploratory fishing operations which stimulated the interest of a fishing company and thus created a new industry.

THE NEED TO ACQUIRE ADDITIONAL KNOWLEDGE

The author found that projects were becoming more complex as the conversion of fishing vessels continued to expand, and it was necessary to acquire more knowledge in basic principles of electricity, hydraulic and mechanical engineering. Fortunately, Industrial Development had an excellent Engineering Division, headed by Mr. M.A . (Terry) Foley, which solved many of the author's technical problems and taught him how to solve others himself.

To further broaden the author's knowledge, in 1963, when the stern trawler boom was just getting underway, the Industrial Development Branch sent him to Great Britain as Canada's representative to the first Conference on Stern Trawling. He toured industry, viewing the newest stern trawlers, and also made a trip on the North Sea in one. The knowledge acquired, combined with that of small boat stern trawling, proved very beneficial in later work on deck and general arrangements, as well as on gear handling systems on Canadian stern trawlers.

INDUSTRY'S CONFIDENCE IN THE INDUSTRIAL DEVELOPMENT BRANCH CONTINUES TO GROW

Following the Newfoundland herring project, Nova Scotia's Deputy Minister of Fisheries, Mr. Brian Meagher, initiated the development of herring fishing in southern Nova Scotia, where a herring reduction plant was being built.

More herring fishing vessels were needed and since there were many side trawler type vessels in Nova Scotia, it was decided to investigate the possibility of converting some to purse seiners, as had been done in Iceland.

The author was asked to head such a project and in 1964, he and Mr. Olafur Egilsson, an Icelander working for the Nova Scotia Department of Fisheries, flew to Iceland to study the Icelandic method.

On returning to Canada, Captain Lawrence Doving, a purse seine fisherman of Vancouver, British Columbia, was engaged to convert the 92 foot wooden scalloper "Stuart and Lynne" to an Icelandic type seiner, with the addition of a Canadian power skiff.

It was a bold venture, as the "Stuart and Lynne", Captained by Carl Atkinson of Clariss Harbour Nova Scotia, was a side trawler type vessel and putting the seine up on the boat deck had never before been done in Canada.

The vessel went on to fish herring under Captain Atkinson very successfully and a number of similar vessels were subsequently rigged out in a similar manner.

FISHING VESSEL CONVERSIONS LEAD TO ADVISING ON NEW DESIGNS

The introduction of new methods of fishing leads to progressively increasing conversion work, such as converting side trawlers for stern mid-water trawling or herring purse seining. Such conversions require extensive work on the vessels.

Scalloper to Seiner Conversion

When converting the scalloper "Stuart and Lynne" to an Icelandic style seiner, bulwarks were built around the boat deck to contain the seine, and a trough was fitted to the bulwarks for the purse rings. A suitably braced hydraulic crane to support the power block was mounted on the boat deck. The fish hold was fitted with proper drains, in addition to a thwartship bulkead and fore and aft divisions. All the protective steel for scalloping was removed and the rails, decks and underwater part of the hull were faired to prevent the seine netting from catching. A sonar was sited and installed. A purse seine warping-head winch, an anchor winch and a running-line winch, as well as a fish pump and a larger bilge pump, were installed, together with the necessary hydraulic power package. The main mast and boom were modified for purse seining and an additional boom was added to handle the fish pumps. A suitable power skiff also had to be constructed.

Such work was directed by contracted fishermen, who had done similar work on their own vessel, under the direction of the author.

After rigging the vessel, which included selecting and ordering all necessary material, the contracted specialist then had to go out with

the vessel and train the captain and crew in the fishing technique. He then remedied all the small technical problems and when the captain and crew were able to operate the vessel satisfactorily, he was able to leave the vessel for the next project.

It can be seen that it is necessary to have a vast knowledge of the vessel's requirements, as well as a complete knowledge of the gear and fishing techniques.

Scalloping to Stern Midwater Trawler Conversion

In 1967, the author directed the conversion of the 101 foot, 750 h.p. scalloper "Lady Anna" to a stern midwater trawler, and its successful catches of herring and pollock launched midwater trawling on Canada's Atlantic Coast.

The project involved a fair amount of structural change, but the biggest problem was the development of new gear handling techniques. The "Lady Anna" was a typical side trawler, with engine and superstructure aft and only five feet of space between the aft end of the lower deck house and the stern bulwarks. Everyone was sure that the vessel could never operate as a stern trawler and so at the Captain's suggestions, the vessel was first rigged as a side trawler.

However, much work had to be done. All protective steel sheeting for scalloping was removed and the deck rails and underwater part of the hull were faired to prevent fouling of the netting; a net sounder, sonar and trawling log were installed, and the hold was prepared for handling herring. A submersible fish pump and larger bilge pump were installed, together with an appropriate hydraulic drive system. Rigging was modified

to accommodate a new method of handling the codend. As the front-end power take-off from the main engine was not suitable for midwater trawling, a new winch engine was installed.

While the vessel was being converted, the crew was trained in the construction of the vessel's trawl gear.

A week of fishing showed the side rig to be hopeless for handling the extremely long net. The vessel was, therefore, converted to tow the stern and immediately began to produce results. However, it was necessary to design a method for hauling the wings and fleeting the bellies. A roller had to be designed for the stern to set and haul the trawl properly.

As soon as the vessel began making good catches, the system of removing the catch was improved, both by bagging and pumping.

Concurrently, exploratory fishing had to be pursued in order to find stocks of herring to work on. In the end the "Lady Anna" was a smooth working rig that was without beauty, but performed so satisfactorily that it caught enough fish to spur further development.

The system of hauling the lengthy midwater trawl was developed from methods used to haul bottom trawls on stern trawlers overseas while the system for handling the codend to remove the catch was developed from the techniques employed aboard the "Combat" in British Columbia, while engaged in herring midwater trawling.

Such problems were tackled individually and discussed with the crew, who implemented the gear handling arrangements and refined them to working perfection.

Building up a "Team"

The "Lady Anna" project led to midwater trawling with the stern ramp trawlers "Brandal" and "J.B. Nickerson", and conversion of four other side trawlers to stern midwater trawling. It therefore became necessary to obtain assistance as the workload could not be handled alone.

Mr. Wilbert d'Entremont, mate of the "Lady Anna", was taken on contract since he showed special talent in directing the actual conversion work as well as being a competent net man and potential fishing instructor.

Mr. James Trimm, former mate and relieving captain of the "Cape Nelson" and "Cape Blomidon", who did much to make the Atlantic Western Trawl successful, was also engaged on contract. He proved exceptionally good at refining trawl construction and developing fishing techniques as well as at laying out the fishing deck, and is an enthusiastic instructor.

Through Wilbert d'Entremont, we contracted Mr. Gabriel d'Entremont, who had much experience in trawling and scalloping and who also proved to be a good instructor.

The three men are capable individually of taking charge of a project, or of functioning as a team on a single project, as they often do.

About a year ago, the author became Chief of the Operations Division and acquired a single permanent headquarter's staff member, Mr. George Imbeault, who is a vessel and gear technologist, as well as a certified machinist and electrician; he is particularly adept at solving mechanical and technical problems.

As the fishing industry's shipbuilders, consulting naval architects and engineers gained confidence in the author and his team, they requested

technical guidance with respect to the requirements for new fishing vessels.

In 1969, at the request of Mr. Ben Comeau of Comeau Sea Foods (Saulnierville, Nova Scotia) and of Hypro Sea Products (Souris, Prince Edward Island), we collaborated with the naval architects, Veatman and Endal Ltd., Halifax, Nova Scotia and the shipyard in the development of Canada's first two stern trawlers built especially for midwater trawling. The author recommended the deck arrangement, gear handling system, main engine power and deck machinery arrangement.

When the sister ships, "Lady Maria and "Lady Janice, (130 foot, 1,700 h.p.) were delivered, the team trained the Georgetown Shipyard, P.E.I. crews in operating them.

Not all the ideas provided by the author and his team are necessarily used; however, we had a fair input into the midwater trawl features of Canada's first two combination midwater trawl-purse seiners "Mattuna Mariner" and "Mattuna Maid", 115 foot, 110 h.p., built by Ferguson Marine Industries, Pictou, Nova Scotia, for the Mathews Brothers, Campobello, New Brunswick.

When the vessels were completed, the crews were instructed in midwater trawling techniques. The demand for such advisory work continues to grow and the foregoing are examples of such work. The advisory work usually centres around general arrangements, gear and fish handling systems, bridge layout, deck machinery specifications and arrangements, and other similar aspects which are not usually available from commercial naval architects or builders.

However, we do not engage in actual new advanced hull, machinery or electronic design work. Such work is generally carried out by our Vessels and Engineering Section in co-operation with industry.

EXPANSION OF INDUSTRIAL DEVELOPMENT BRANCH

In 1962, as the requests for technical assistance and exploration continued to grow, the Branch engaged Mr. Rupert Prince, a fishing captain and boat owner of long experience, from Victoria, British Columbia.

Rupert Prince had a wide experience of various fishing methods, such as longlining, trawling and crab fishing. He had also demonstrated a natural ability to promote worthwhile development projects.

Crab Fishing Development

Rupert had much faith in developing a crab fishery on Canada's Atlantic coast and managed to instigate exploratory fishing for rock crab, in co-operation with the New Brunswick Department of Fisheries, in the Gulf of St. Lawrence. Unfortunately, owing to the crabs being on the small side, they were difficult to process; furthermore they were most abundant on lobster grounds. Since lobster were also caught in the traps, the crab fishery was restricted to the lobster fishing season, controlled by law.

However, Rupert Prince's enthusiasm for the development of a crab fishery brushed of on Mr. Louis Deveau, Regional Representative for the Industrial Development Branch in Halifax. He found during a trip to Cape Breton in 1965 that incidentally caught spider crab, cooked by a fish plant, was a delicious product.

The crab were to be found in deeper water than lobsters and therefore fishing them with traps would not be a problem.

Mr. Deveau, in co-operation with Brian Meagher, Nova Scotia's Deputy Minister of Fisheries, obtained further samples which were processed and were found to have a good yield and taste.

A crab development project was launched, and Mr. Deveau was able to hire Mr. Hiram McAllister of Seattle, Washington, U.S.A. who had not only engaged in Dungness crab fishing, but had engaged in Alaska King Crab fishing and operated processing plants as well.

Mr. McAllister not only took care of the fishing aspect, but developed and taught the Atlantic coast operators how to process the crab. A thriving fishery developed for the crab, which had been dubbed Queen Crab by Mr. Deveau. As quite a number of plants were being set up in the Atlantic Provinces, it became necessary to bring Mr. Sam Simpson and his wife Jessie, who had retired from crab fishing and processing business in Masset, Queen Charlotte Islands, British Columbia to the Atlantic Coast to give further instruction in managing crab plants and in processing the product.

Rupert Prince, who in 1965 had become the Regional Representative in Newfoundland, and was located in St. John's, also introduced and developed a crab fishing and processing industry in Newfoundland, in co-operation with the Newfoundland Fisheries Development Authority and the industry.

CO-OPERATION WITH THE EXPLORATORY FISHING BRANCH

When the author is away from Headquarters, as he and his assistant, Mr. Imbeault, are a large percentage of the time, and when technical assistance is required, it is given by his colleague Mr. Jack Rycroft, Chief of the Exploratory Fishing Division. Similarly the author and Mr. Imbeault are also expected to help Mr. Rycroft and his staff in similar situations.

Mr. Rycroft, a former fisherman from the Isle of Man, who served seven years as captain of a fisheries research vessel on Lake Ontario, joined the Industrial Development Branch in 1965.

Because Mr. Rycroft speaks the fisherman's language, he is easily able to handle the author's office and similarly the author can handle Mr. Rycroft's projects and office in his absence.

The two divisions work in close co-operation and since Mr. Rycroft is a Scottish seine and pair seining specialist, he is generally involved in the development of those methods, even though his division is primarily engaged in exploratory fishing. He is also the branch consultant on all freshwater fisheries matters.

Similarly, the author often engages in exploratory fishing and since there naturally is an overlap, the two divisions must work together.

Work carried out by the Exploratory Fishing Division has been of great benefit, especially to the Atlantic Coast fisheries. Explorations for species such as queen crab, pink shrimp, and of course, herring have provided the basis for important new sectors of the industry.

In many instances these have been implemented through shared-cost arrangements with individual provinces, but when exploration is necessary in offshore areas, it is undertaken as a completely federal project.

SCOTTISH SEINE NETTING FOR GROUNDFISH

This technique was introduced in 1964 in order to allow small underpowered draggers and longliners to compete more effectively in the market for groundfish. Scottish seine netting is a very effective method of catching fish under certain circumstances. The towing power requirements are about half of those for similar size draggers. In 1965, a Scottish vessel was chartered for one year to demonstrate this method of fishing to Canadian fishermen and to explore Atlantic areas in terms of this gear. As a result of this project, quite a number of what would otherwise have been redundant vessels are now fishing very effectively on the North shore of New Brunswick, parts of Nova Scotia, Prince Edward Island, and Newfoundland.

There were some traditional Danish seiners already operating in Canada prior to 1964. However, the methods and gear used were only effective for catching limited quantities of flounders and similar flatfish. The Scottish techniques which were taught to the fishermen and the nets which were introduced allowed them to catch large quantities of other species such as cod, haddock, hake, etc.

The traditional Scottish seine net vessels have the wheelhouse aft and the working deck forward. Technologists of the Fishing Operations Division modified the gear handling technique for Canadian vessels with the wheelhouse forward. This proved very effective as the latter type of vessel is much better adapted for Canadian Atlantic conditions. There are now approximately 50 fishing vessels between 50 and 65 feet in Canada using this

fishing method. In some areas, these vessels regularly outfish draggers of comparable size.

CANADIAN PAIR-SEINING

There are literally thousands of inshore fishing vessels on both the East and West Coasts of Canada which are very limited in capability, due to the fact that they are designed to carry out a single, specific fishing method. The object of this experiment, therefore, was to develop a new, productive method of fishing which would allow such vessels to diversify their operations and by lengthening the operating season, increase the annual income of both vessels and crews. In addition, it was thought possible that such a venture could help to relieve the critical fishing pressure on stocks of valuable species such as lobster.

Towed gear, such as trawls and Scottish seine nets, is by far the most efficient method known for catching bottom oriented species such as cod, haddock, hake, and flatfish. However, one of the most serious limitations of Canadian inshore boats is the lack of the towing power necessary for trawling. The Scottish seine net, on the other hand, is much easier to tow, and it was therefore decided to combine the two methods by towing a net of this type between two inshore boats.

Prince Edward Island lobster boats were chosen to carry out the experiment in view of the enthusiasm and interest shown by the Prince Edward Island Department of Fisheries, and because, if successful, there could be great interest from fishermen in that province. Suitable grounds also exist close to the Prince Edward Island coast.

The original concept came from Captain James Thomson, a Scottish seine net skipper with many years' experience, who has been engaged on

contract by the Industrial Development Branch for varying periods during the past four years. Discussions took place in 1968 among the Prince Edward Island Department of Fisheries, the Industrial Development Branch and Captain Thomson, and it was decided to implement the project in 1969. Assuming the success of the projects, it was seen that the application of the fishing method would be widespread; therefore the total cost was borne by the Federal Department of Fisheries and Forestry.

Implementation

Implementation began in April, 1969, with an agreement to charter two Prince Edward Island lobster boats, the 39 foot 112 h.p. "Norman M" which is owned and operated by Captain Peter Arseneault, Abram's Village of Prince Edward Island and the 40 foot, 112 h.p. "Mary Lou II" owned and operated by Captain Joseph Caissie of Maximville, Prince Edward Island. These vessels are almost indentical, and although similarity of vessels is not considered absolutely essential, it is an advantage if both vessels have similar towing power, over-all length and freeboard.

Normal "teething troubles" occurred, as was to be expected during the development of this entirely new technique. Eventual success resulted, however, in individual one-hour tows well in excess of 10,000 pounds of fish.

In 1970, small inshore vessels were rigged out for this fishing method under the federal-provincial shared cost programs, in all of the Atlantic coast provinces. It is estimated that in 1971 some 200 boats in this class will be actively engaged in pair seining.

In addition, the Industrial Development Branch, in 1970, extended the project to include 65 foot seine net vessels, and here again production was significantly increased, particularly in circumstances when fish were scarce.

During bad fishing weather, boats of this size do not come alongside but tow the net closed on parallel courses, maintaining a safe distance between them. The wing end of the net is passed by means of a messenger made fast between the danlenos.

It is now intended to rig these vessels with much larger nets (620 Vinge Trawls with greatly extended wings), since it is thought that production can be increased even more by this means. Net retrieval will be accomplished by means of net drums on each vessel.

CONCLUSION

It is hoped that this paper has shown what kind of man it takes to manage, direct and implement the development of fishing vessels, gear, equipment, operating techniques and new methods of fishing as well as to develop fisheries from unexploited and underexploited marine resources.

The paper illustrates how fishermen who became public servants, together with contracted fishermen, have managed, directed and implemented many successful projects. Such projects have resulted in the creation of new industries, and in increased earnings to fishermen, processors and allied industries; they have thus been beneficial to the general economy, particularly to the Atlantic Provinces of Canada.

This practical approach to fisheries development has been readily accepted by the fishing and allied industries and by provincial governments and has led to increased requests for technical assistance and to the creation and expansion of the Fishing Operations and Exploratory Fishing Divisions of the Industrial Development Branch. It has also created the need for the addition of Industrial Development Branch professional staff, such as the naval architects and engineers who make up our Vessel and Engineering Division. These men provide applicable ideas in new equipment, vessels and machinery to the Operations and Exploratory Fishing Divisions as well as directly to industry.

One most important point made in this paper is that fishing vessel and gear technology is emerging as a recognizable profession, the members of

which are the most competent to handle the over-all development of fishing vessels, gear and equipment, new methods of fishing and the establishment of new fisheries. Naturally, such men cannot operation in a vacuum: they require the support and advice of many professional and scientific disciplines such as engineering, naval architecture, biology, oceanography and economics in order to implement fisheries development work.

Industry recognizes this new profession and the proof of this recognition lies in requests to educational institutions, such as the Newfoundland College of Fisheries, to create courses which would qualify graduates at the professional level.

It has been necessary for former fishermen of the Fishing Operations and Exploratory Fishing Division to convince educational institutions that in order to create meaningful fishing vessel and gear technology programs, it is mandatory to select teachers only from those professionals experienced in the application of their particular discipline within the fishing industry.

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A New Midwater Trawl for Herring by W. E. Barraclough and W. W. Johnson, Bulletin No. 104 Published by the Fisheries Research Board of Canada, Ottawa, Canada, 1956.

Further Midwater Trawl Developments in British Columbia by W. E. Barraclough and W. W. Johnson, Bulletin No. 123, published by the Fisheries Research Board of Canada, Ottawa, Canada, 1960.

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Canadian Pair Seining Experiment 1969 by J. Rycroft, Industrial Development Branch, Department of the Environment, Ottawa, Canada.

The German One-Boat Midwater Trawl by Dr. J. Scharfe, Fishing News International, 110 Fleet Street, London, E. C. 4, England.

Pacific Fisherman, Miller Freeman publications, 731 S. W. Oak Street, Portland, Oregon, U.S.A.

ILLUSTRATIONS

INDUSTRIAL DEVELOPMENT BRANCH

ORGANIZATION CHART

TRAWLS

Canadian Atlantic Western Bottom Trawls, Models I - IV

Canadian Diamond VII Large Mesh Midwater Trawl

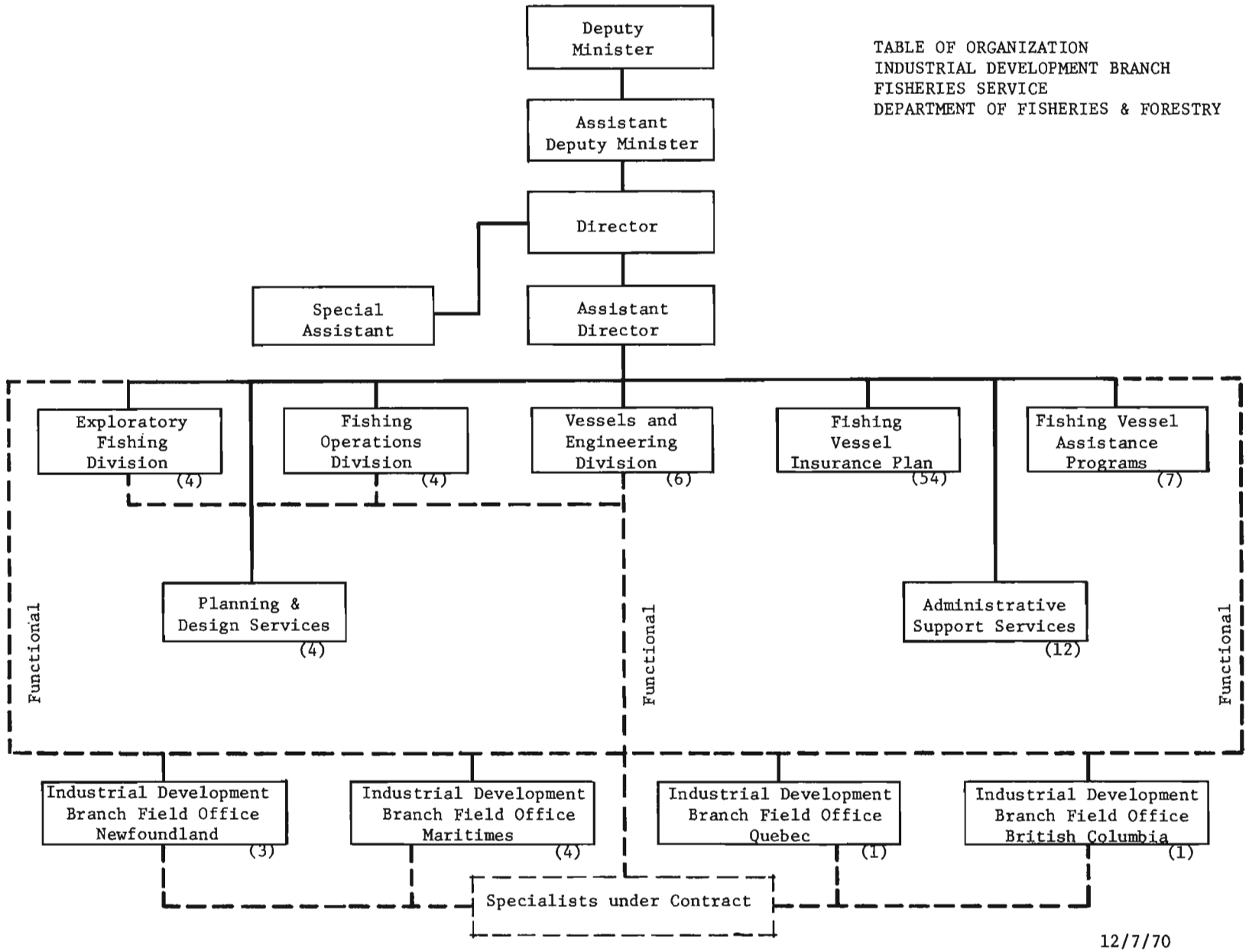
GENERAL ARRANGEMENT DRAWINGS

"LADY ANNA" Stern Midwater Trawl Conversion

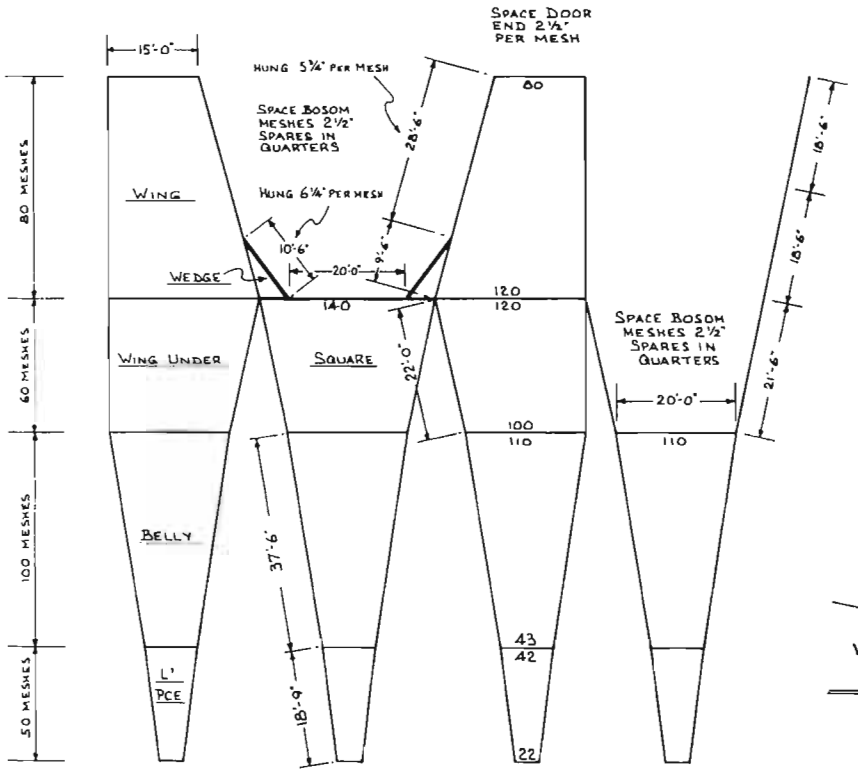
"MARY AND JAY" Stern Midwater Trawl Conversion

"RUPERT BRAND V" Stern Midwater Trawl Conversion

TABLE OF ORGANIZATION
INDUSTRIAL DEVELOPMENT BRANCH
FISHERIES SERVICE
DEPARTMENT OF FISHERIES & FORESTRY



12/7/70



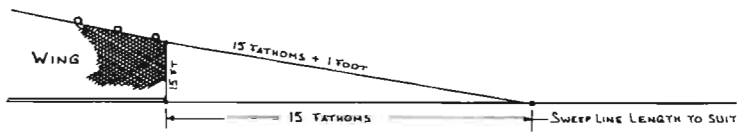
HEADLINE 98'-0" MADE IN 3 PIECES: 28'-6" + 41'-0" + 28'-6"

FOOT ROPE 137'-0" 7 PIECES

CONNECTED: 18'-6" + 18'-6" + 21'-6" + 20'-0" + 21'-6" + 18'-6" + 18'-6"
SPLICED: 18'-3" + 18'-3" + 21'-3" + 19'-9" + 21'-3" + 18'-3" + 18'-3"
FISHING LINE: 18'-9" + 18'-9" + 22'-2" + 21'-0" + 22'-2" + 18'-9" + 18'-9"
BOLCH: 20'-0" + 20'-0" + 23'-9" + 23'-0" + 23'-9" + 20'-0" + 20'-0"
HANGINGS: 6" + 4¾" + 2⅝" + 4¾" + 6"

MATERIAL:

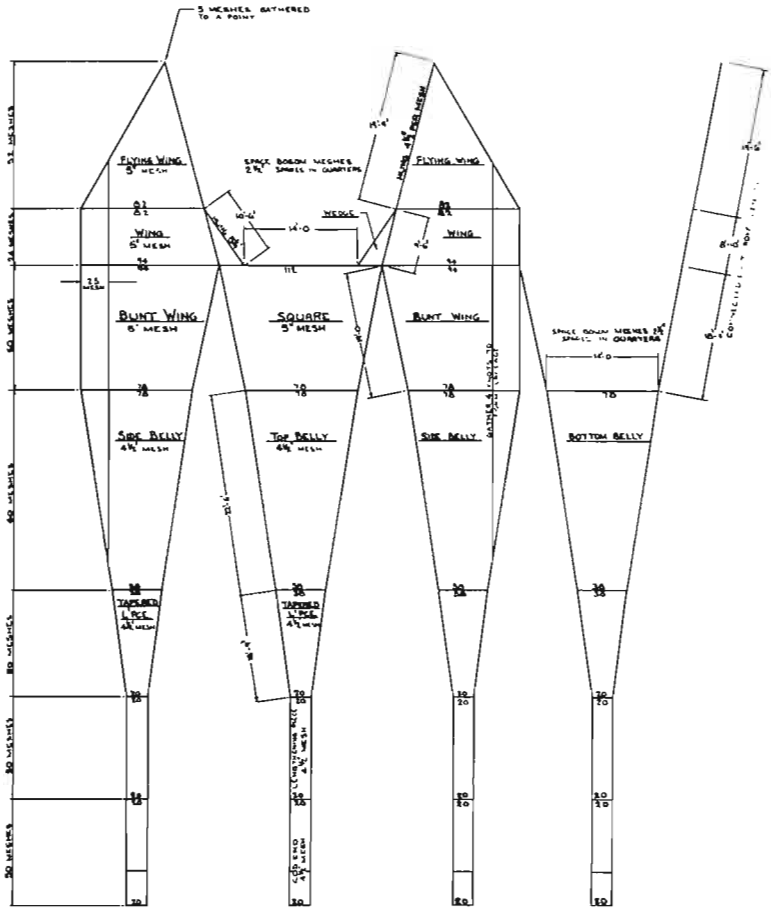
BRAIDED DRYLENE OR COURLENE 150 YDS/LBS, OR EQUAL.
TWISTED COURLENE 15/32 OR EQUAL.
№ 54 DRUMLENE OR EQUAL.
№ 54 DRUMFIL PRIMOLITE TREATED OR EQUAL.



BRIDLE DETAIL

ATLANTIC WESTERN TRAWL (MODEL I)	
INDUSTRIAL DEVELOPMENT SERVICE, DEPARTMENT OF FISHERIES OF CANADA, OTTAWA	
DES. BY W.W. JOHNSON	DATE: NOV. 8, 1963
DR. BY F. DOPPLINGER	SHEET 1 OF 5

I.D.V. 68-1-B



HEADROPE 74'-6" MADE IN 5 PIECES 19'-9" + 10'-6" + 14'-0 + 10'-6" + 19'-9"

FOOTROPE 107'-4" MADE IN 7 PIECES

CONNECTED	19'-6 + 8'-10' + 18'-4' + 14'-0 + 18'-4' + 8'-10' + 19'-6'
SPLICED	19'-0 + 8'-8' + 18'-2' + 13'-6 + 18'-2' + 8'-8' + 19'-0'
FISHING LINE	13'-6"
BOLCH	8'-10' + 18'-4' + 15'-0 + 18'-4' + 8'-10'

MATERIAL

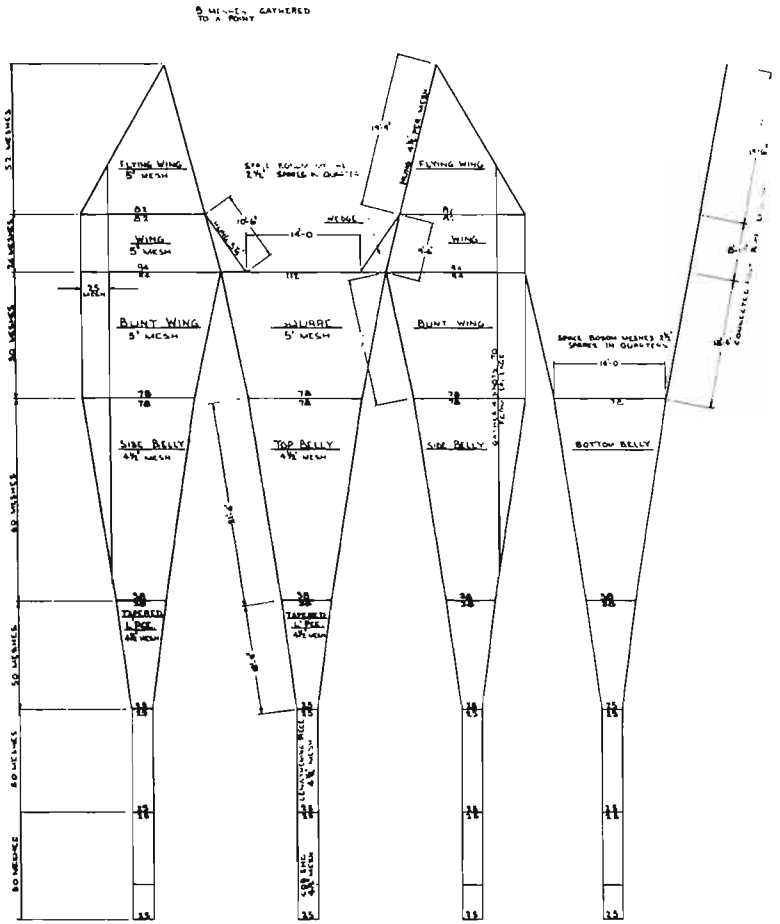
BRAIDED DAYLENE OR COURLENE 175 YDS/LBS. OR EQUAL.
TWISTED COURLENE 15/24 OR EQUAL.

BRIDLE DETAIL

ATLANTIC WESTERN TRAWL
MODEL 11A
GENERAL ARRANGEMENT

APRIL, 1970

LDV 70-D
SHEET 1 OF 4



HEADROPE 74 6 [illegible]

FOOTROPE [illegible] PIECE

CONNECTED [illegible] · 4·0 · 18·4 · 8·10' · 19'-6'
SPLICED [illegible] · 5·4' · 18' 7' · 8·8' · 19'-0'
FISHING LINE 12'-6'
BOLCH 8·[illegible] · 5·4' · 15'-0 · 18·4' · 8·10'

MATERIAL

BRAIDED POLYETHYLENE OR POLYPROPYLENE 150 LBS/LBS. OR EQUAL.
TWISTED POLYLENE 15/32 OR EQUAL

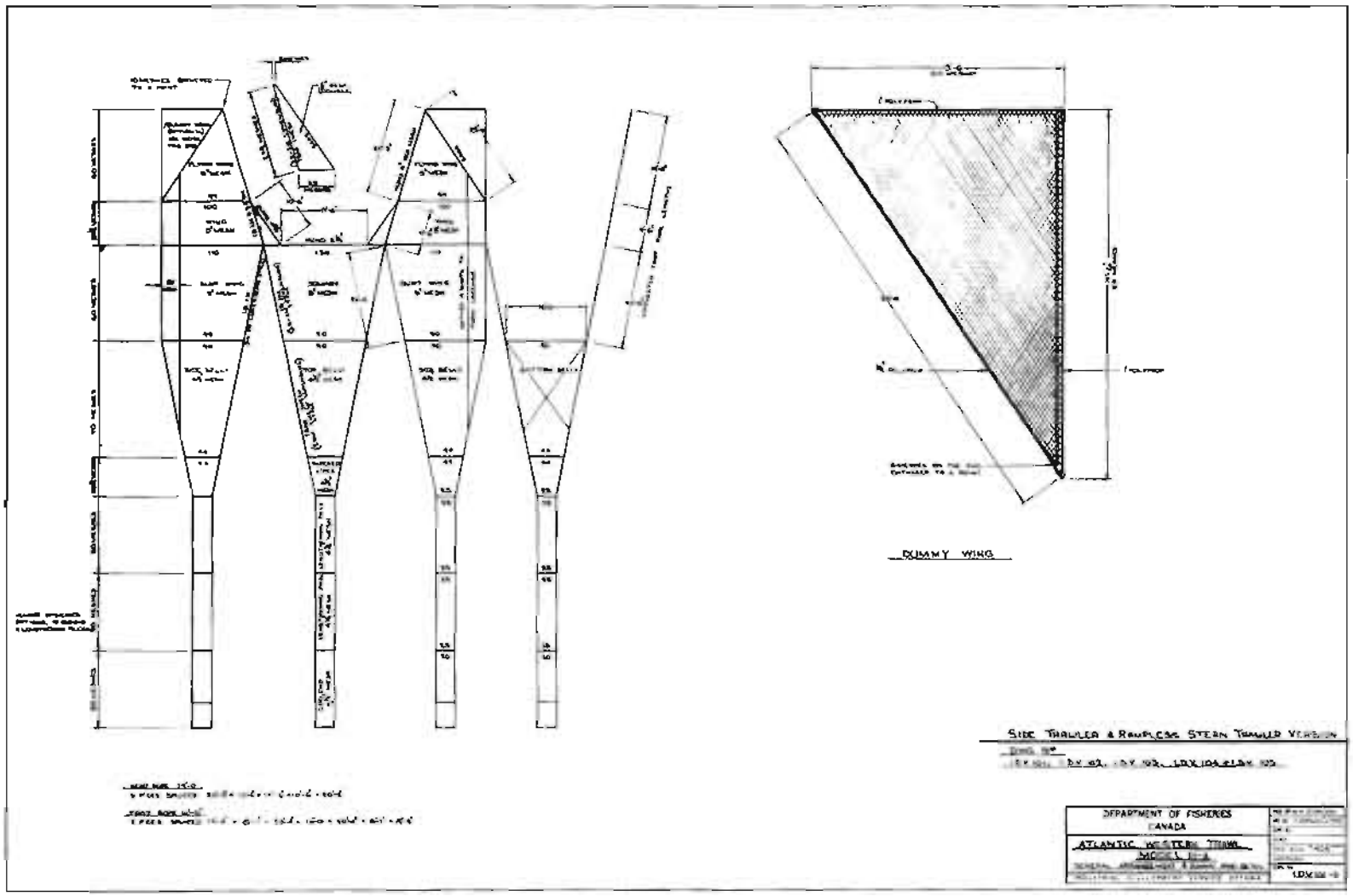
BRIDLE DETAIL

DEPARTMENT OF FISHERIES & FORESTRY
FISHERIES SERVICE

ATLANTIC WESTERN TRAWL
MODEL WB (STERN RAMP VERSION)
GENERAL ARRANGEMENT

[illegible] BRANCH OTTAWA

[illegible] | [illegible] | [illegible] | DWG. 298-D
[illegible] | SEPT. 1970 | [illegible] | SHEET 1 OF 4

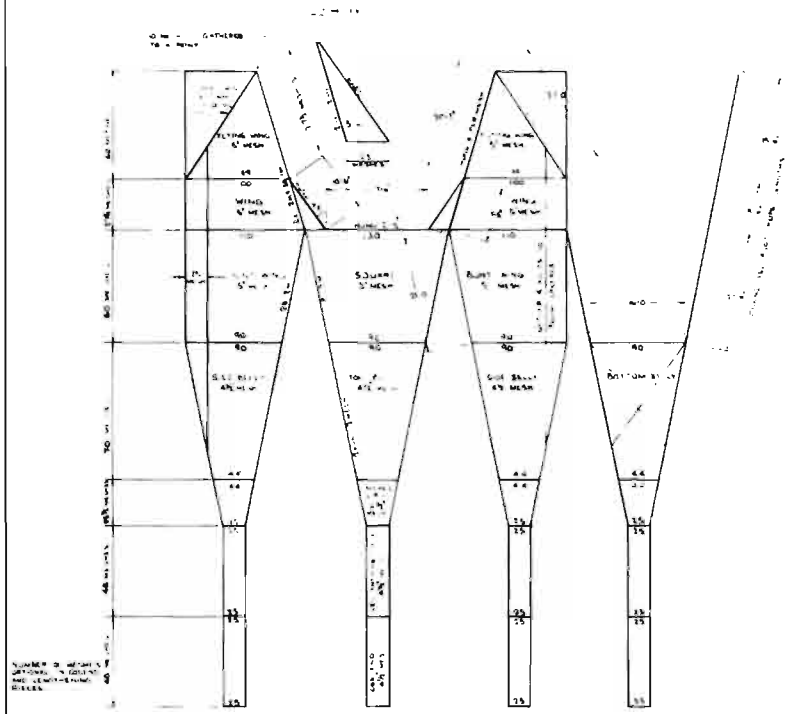


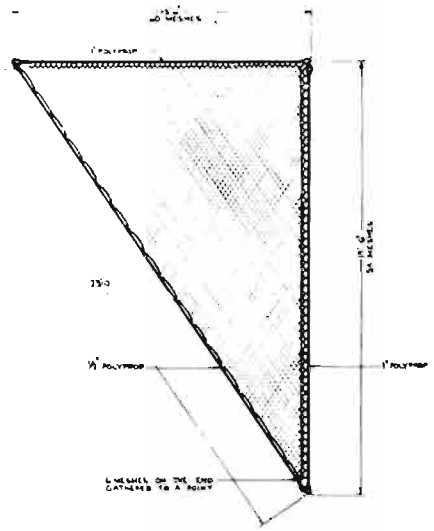
DUMMY WING

SIDE TRAWLER & RAMPLESS STERN TRAWLER VERSION

DEPARTMENT OF FISHERIES
CANADA

ATLANTIC WESTERN TRAWL



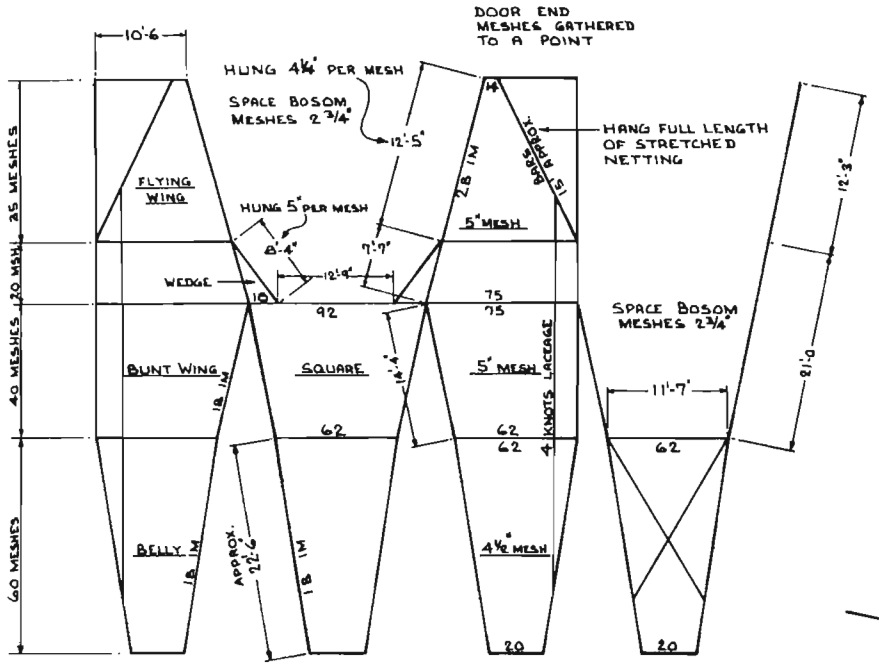


DUMMY WING

STERN RAMP TRAWLER VERSION

DWG Nos
I.D.V. 271, I.D.V. 272, I.D.V. 273, I.D.V. 274 + I.D.V. 275

DEPARTMENT OF FISHERIES CANADA	
ATLANTIC WESTERN TRAWL MODEL III-D	
FISHING DEVELOPMENT SERVICE OTTAWA	I.D.V. 271-D



HEAD ROPE 54'-3" MADE IN 3 PIECES 12'-5" + 29'-5" + 12'-5"

FOOT ROPE 78'-1" 5 PIECES

CONNECTED : 12'-3" + 21'-0 + 11'-7" + 21'-0 + 12'-3"

SPLICED : 12'-1" + 20'-9" + 11'-5" + 20-9" + 12'-1"

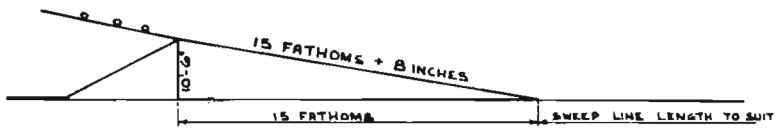
FISHING LINE : 12'-7"

BOLCH : 22'-6" + 12'-9" + 22'-6"

HANGINGS : 4½" + 2¾" + 4½"

MATERIAL :

BRAIDED DRYLENE OF COURLENE 175 YDS./LBS., OR EQUAL
TWISTED COURLENE 15/24 OR EQUAL.



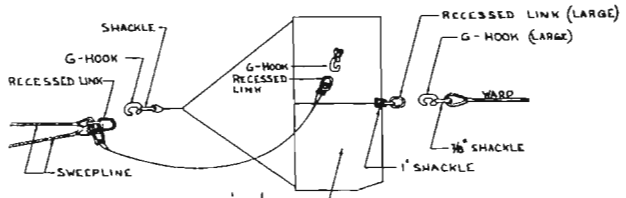
BRIDLE DETAIL

DESIGNED FOR QUEBEC DEPARTMENT OF FISHERIES
FOR 60' DRAGGERS

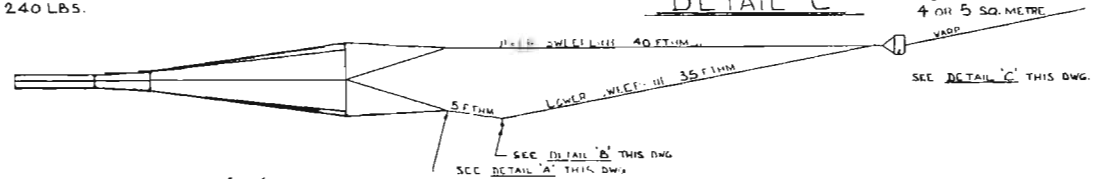
DEPARTMENT OF FISHERIES CANADA	DES. BY: W.W. JOHNSON
	DR. BY: T. McCALLION
	APP. BY:
ATLANTIC WESTERN TRAWL	SCALE:
MODEL IV	DATE: FEB., 1965
INDUSTRIAL DEVELOPMENT SERVICE, OTTAWA	DWG. NO: I.D.V. '72-8

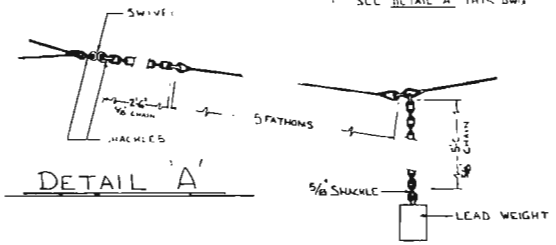
NOTE:

IN SHOAL WATER ONLY 40 FATHOMS SWEEPLINES AND 225 LB WEIGHTS ARE USED TO RESTRICT OPENING AND RAISE TRAWL FASTER.
IN DEEP WATER 60 FATHOMS TOP SWEEPLINES AND 55 FATHOMS LOWER + 5 FATHOM PIECE ARE USED WITH 315 LB. WEIGHTS.
LEAD ON FOOT ROPE FOR SHALLOW WATER FISHING APPROX 160 LBS. FOR DEEP WATER FISHING APPROX. 240 LBS.



DETAIL 'C'

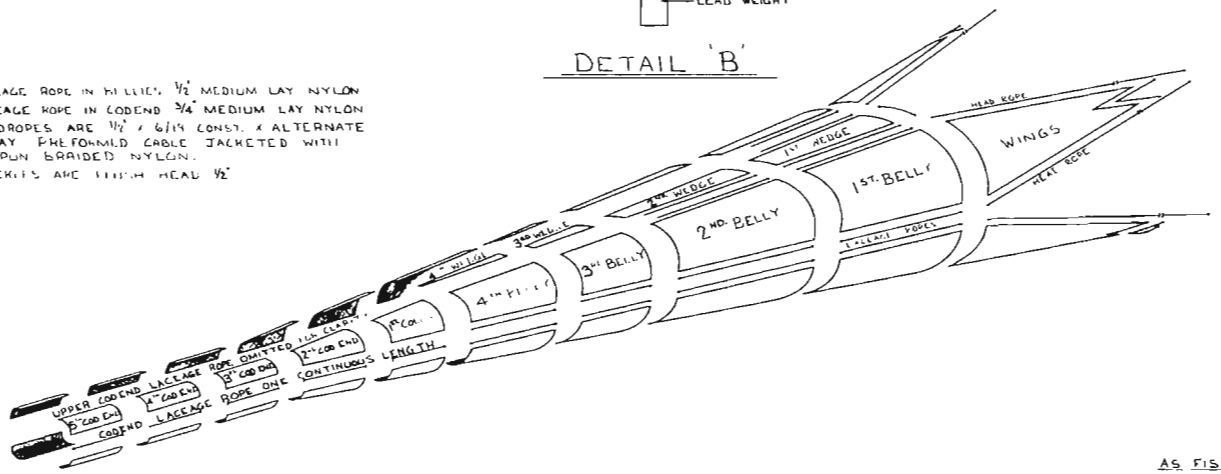


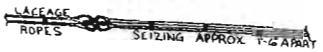


DETAIL 'A'

DETAIL 'B'

- LACEAGE ROPE IN BELLIES 1/2" MEDIUM LAY NYLON
- LACEAGE ROPE IN CODEND 3/4" MEDIUM LAY NYLON
- HEADROPES ARE 1/2" x 6/19 CONST. x ALTERNATE LAY PREFORMED CABLE JACKETED WITH SPUN BRAIDED NYLON.
- SHACKLES ARE SCREW PIN 1/2"





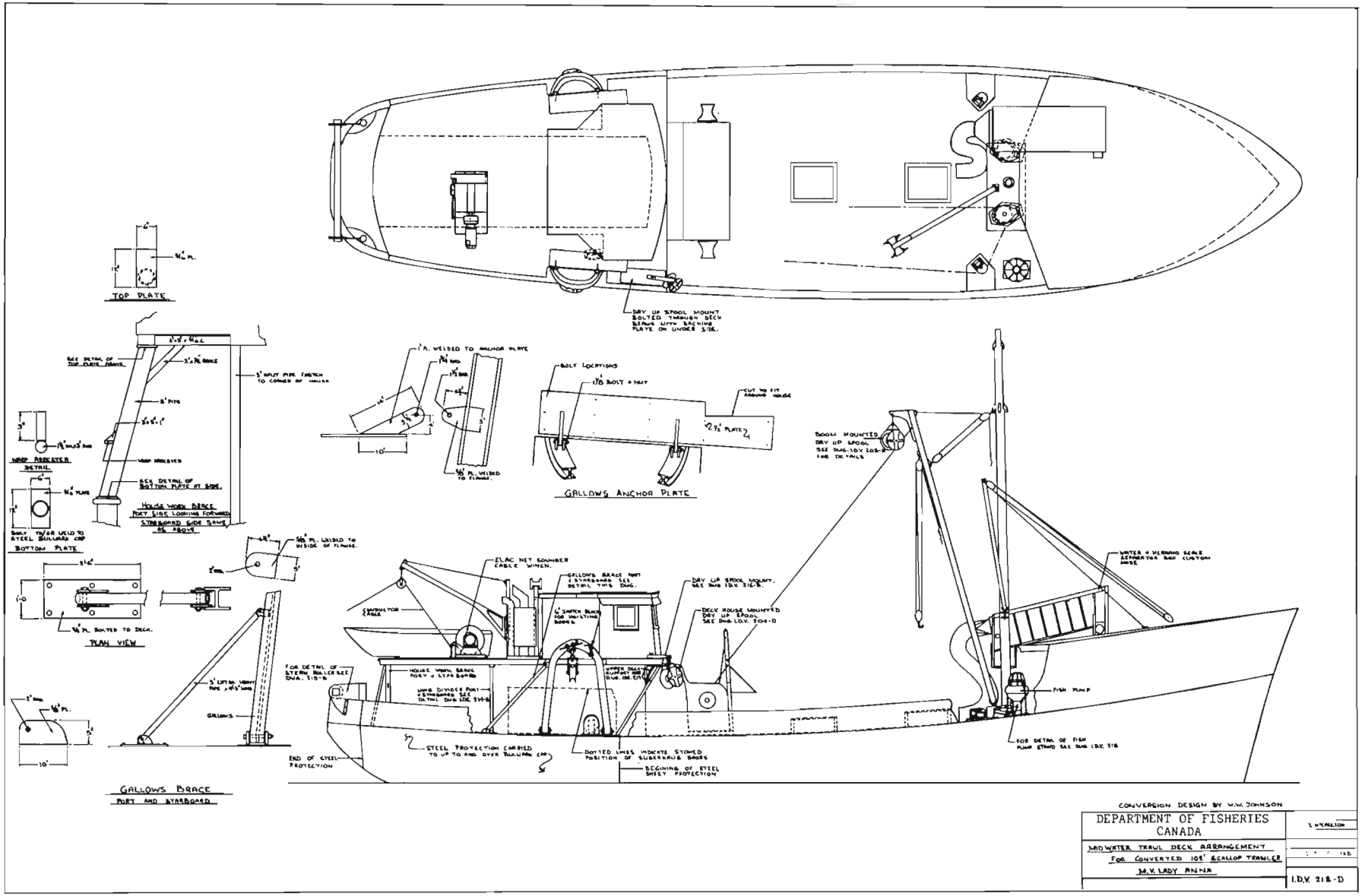
AS FISHED BY CAPTAIN [illegible] ON M.V. [illegible]

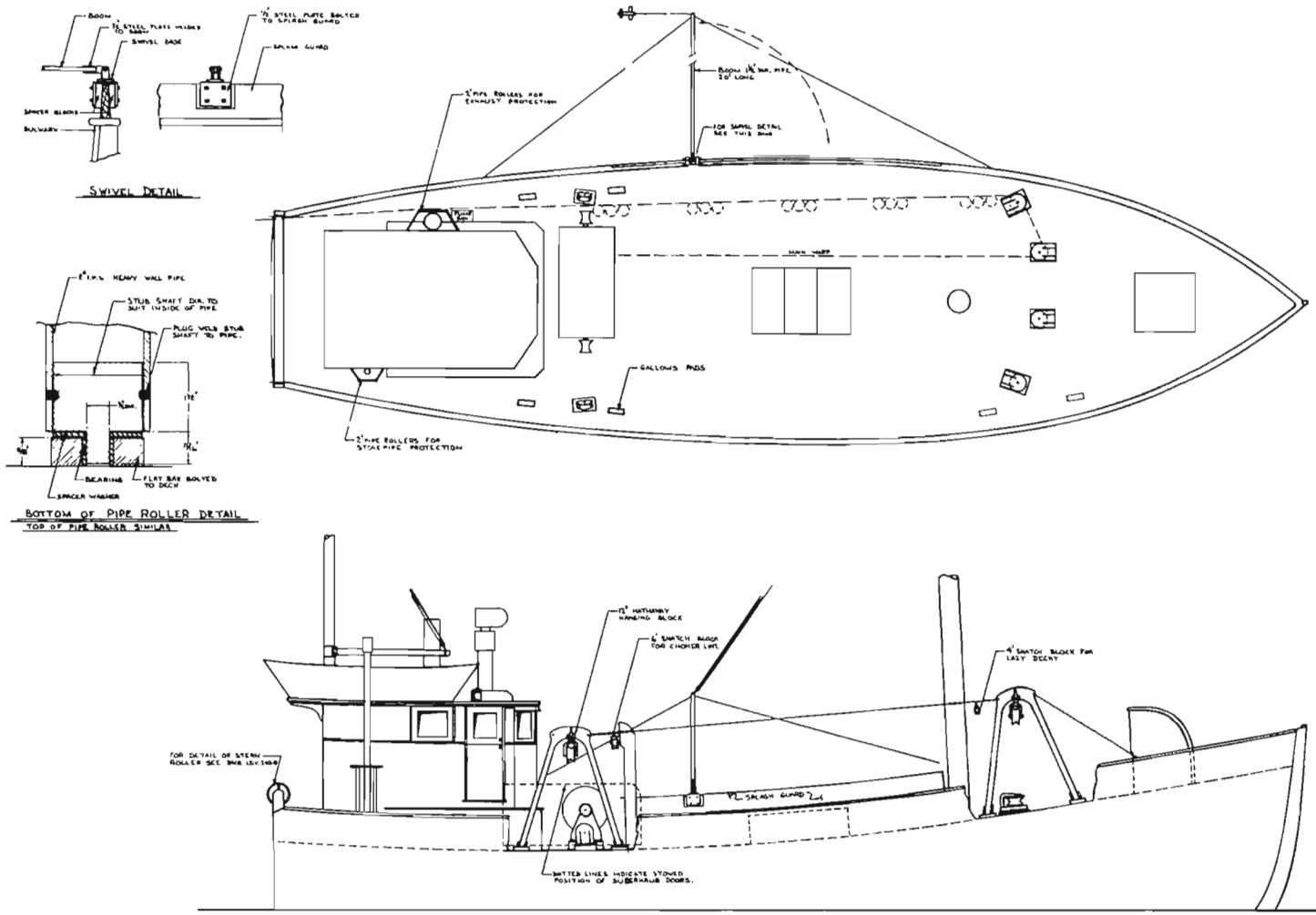
DEPARTMENT OF FISHERIES & FORESTRY
FISHERIES SERVICE

MODEL DIAMOND VII MIDWATER TRAWL
(LARGE MESH)

INDUSTRIAL DEVELOPMENT BRANCH, OTTAWA

W.V. TOMLSON	C. McCALLION		I.D.V. 311-c
NONE	FEB. 1971		

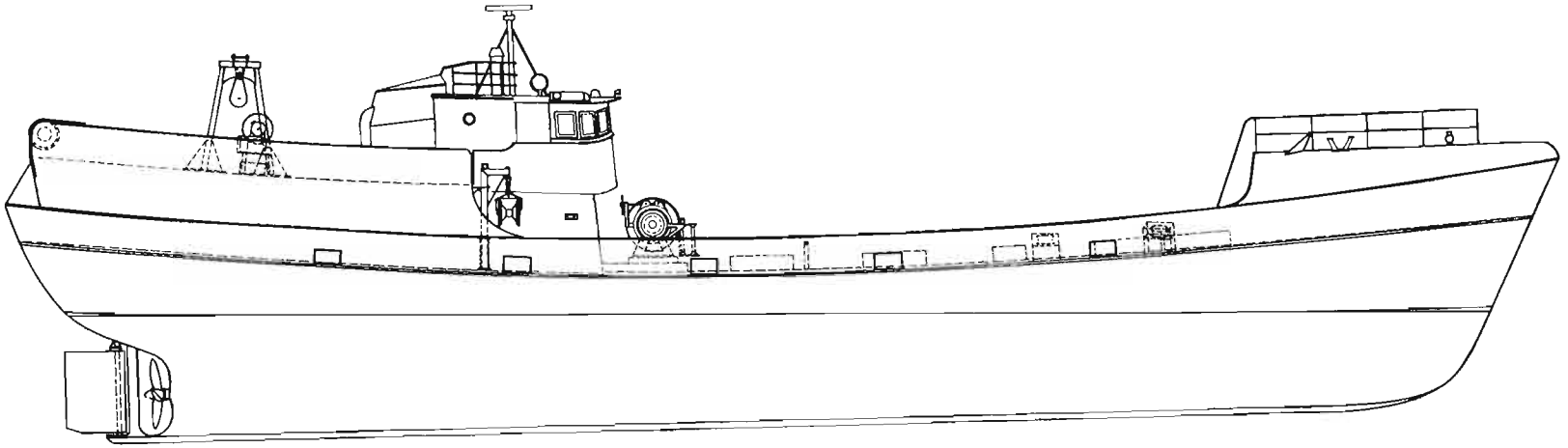

TOP PLATE
DRY UP SPOOL MOUNT BOLTED THROUGH DECK BEAMS WITH BACKING PLATE ON UNDER SIDE.
WARP ARRESTER DETAIL
BOTTOM PLATE
HOUSE WARP BRACE
PORT SIDE LOOKING FORWARD
STARBOARD SIDE SAME AS ABOVE
PLAN VIEW
GALLOWS BRACE
PORT AND STARBOARD
GALLOWS ANCHOR PLATE
BOOM MOUNTED DRY UP SPOOL
DECK HOUSE MOUNTED DRY UP SPOOL
STEEL PROTECTION CARRIED TO UP TO AND OVER BULWARK CAP
END OF STEEL PROTECTION
BEGINNING OF STEEL SHEET PROTECTION
FISH PUMP
CONVERSION DESIGN BY W.W. JOHNSON
DEPARTMENT OF FISHERIES CANADA
MIDWATER TRAWL DECK ARRANGEMENT
FOR CONVERTED 108' SCALLOP TRAWLER
M.V. LADY ANNA
I.D.V. 218-D

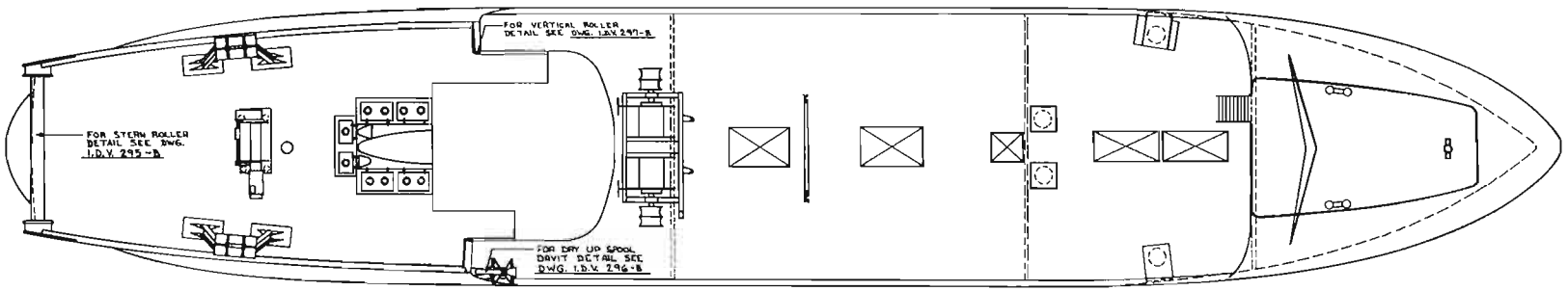


CONVERTED BY W. D'ENTREMONT
DESIGN BY W.W. JOHNSON

SEE DWG. I.D.Y. 240-C FOR STERN ROLLER DETAIL

DEPARTMENT OF FISHERIES CANADA	
MIDWATER TRAWL DECK ARRANGEMENT 'MARY & JAY'	
	I.D.Y. 239-C





DEPARTMENT OF FISHERIES CANADA	T.J. MCALLISTER
DECK ARRANGEMENT M.V. RUPERT BRAND V	OCT. 1969
	I.D.V. 294-D