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New Directions in Fisheries Technology

Proceedings of the Atlantic Fisheries Technology Conference

Charlottetown, Prince Edward Island
April 22–24, 1985

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Abstract

ROACHE, J. F. [ED.]. 1986. New directions in fisheries technology. Can. Spec. Publ. Fish. Aquat. Sci. 85: 123 p.

This publication contains the proceedings of the Atlantic Fisheries Technology Conference, held in Charlottetown, Prince Edward Island, April 22–24, 1985. The first conference of its kind held in more than ten years, it brought together delegates from the primary and secondary sectors of the industry and from both levels of government, federal and provincial. Speakers from Norway, Denmark, Scotland, England, the United States and, of course, Canada made presentations covering a wide spectrum of current and anticipated technological developments in the fishery worldwide. Three separate working sessions concentrated on fishing gear and equipment, the onboard handling and holding of fish, and inplant operations, respectively. But scientists and technologists were not the only groups to be heard. Several "non-technical" presentations were made by representatives of both government and industry, including an address by an inshore fisherman from Caraquet, New Brunswick on the evolving role of the modern fisherman. However, the impact of innovative technology on the industry's overall efforts to improve quality and reduce costs predominates throughout.

Résumé

ROACHE, J. F. [ED.]. 1986. New directions in fisheries technology. Can. Spec. Publ. Fish. Aquat. Sci. 85: 123 p.

La présente publication contient le compte rendu de la Conférence sur les techniques de pêche de l'Atlantique, qui a eu lieu à Charlottetown (île-du Prince-Édouard), du 22 au 24 avril 1985. Première conférence du genre à avoir lieu depuis plus de 10 ans, elle a réuni des représentants des secteurs primaire et secondaire de l'industrie ainsi que des fonctionnaires des gouvernements provinciaux et fédéral. Des donférenciers venant de la Norvège, du Danemark, de l'Écosse, de l'Angleterre, des États-Unis et, bien entendu, du Canada ont fait des présentations sur la large gamme de progrès techniques actuels et prévus dans le domaine des pêches à l'échelle mondiale. Les trois séances de travail ont surtout porté sur les engins et le matériel de pêche, sur l'entreposage et la manutention du poisson à bord et sur les opérations dans les usines, respectivement. Cependant, les scientifiques et les techniciens n'ont pas été les seuls à prendre la parole : les représentants des deux niveaux gouvernementaux et de l'industrie ont fait des présentations « non techniques », notamment une allocation d'un pêcheur côtier de Caraquet (Nouveau-Brunswick) sur le rôle changeant du pêcheur moderne. Toutefois, les répercussions des techniques innovatrices sur les efforts globaux de l'industrie pour améliorer la qualité et réduire les coûts ont été les thèmes dominants de la conférence.

Two hundred delegates — leaders in the fishing industry from the ranks of fishermen, processors, and two levels of government — attended the Atlantic Fisheries Technology Conference in Charlottetown, P.E.I., April 22–24, 1985. (*Above*) they are addressed on the opening day of the Conference by New Brunswick inshore fisherman, Donat LaCroix

Foreword

There can be no doubt that 200 delegates — industry leaders from the ranks of fishermen, processors, and two levels of government — attending the Atlantic Fisheries Technology Conference held April 22–24 in Charlottetown "got the message." Changing times have created a changed marketplace; product quality must improve; production costs must be reduced; and technology holds the key.

Sponsored by the Federal–Provincial Atlantic Fisheries Committee, the Conference took as its theme *New Directions in Fisheries Technology* and was intended to make clear the commitment by both levels of government to work with industry to enchance quality, efficiency, and profitability. Working sessions dealt with fishing gear and equipment, fish handling and holding methods, and in-plant operations; but scientists and technologists had to share center stage.

Delegates also heard a number of speakers from both industry and government on more general themes. Among them were Mel Gas, Parliamentary Secretary to the Minister of Fisheries and Oceans; Dr. A. W. May, Deputy Minister of Fisheries and Oceans, Ottawa; R. W. Bulmer, President of the Fisheries Council of Canada; and Peter Hjul, Editor of *Fishing News International* in London, England. In all, there was a total of 18 presentations by fisheries experts from Norway, Denmark, England, Scotland, the United States, and Canada during an intense few days.

By conference end, there seemed to be general agreement that the time for change was at hand. Structural adjustment in the East Coast Fishery — change dictated by an evolving international marketplace — is now mandatory to ensure survival. And new, innovative technology must be an important ingredient in any long-term strategy adopted by the industry. Government commitment to consultation and consensus was apparent throughout, but, in the proper scheme of things, industry must take the lead and government must provide support. Thus, accommodation becomes an absolute priority, if the future is to be secured.

Delegates must surely have come away from the conference with a heightened awareness of the possibilities, as well as the challenges, presented by the new technology. There was great advantage, too, in comparing notes with fisheries experts from Europe and the United States — much to be learned from their successes and much to be learned from their past mistakes. As a forum for the exchange of ideas and information, then, the conference must be considered a success. It certainly covered all the bases: quality, efficiency, communication, education, training, marketing, and technological innovation. If, however, consensus is a necessary first step toward concerted action to deal with problems confronting the East Coast fishery, then the Atlantic Fisheries Technology Conference most assuredly served to mark a good beginning!

OPENING SESSION

Welcoming Address

The Honourable Roddy Pratt

Minister of Fisheries and Labour
Province of Prince Edward Island

"This conference is most important at this time in the history of the Atlantic fishing industry . . . (It) will truly be a technical information milestone."

Mr. Chairman, ladies and gentlemen, on behalf of the Province of Prince Edward Island, I welcome everyone here tonight. I am very pleased that the organizing committee chose our fair city (Charlottetown) as the site of the Atlantic Fisheries Technology Conference. It reaffirms what I have always known, that Prince Edward Island is at the geographic centre of the Atlantic Fishing area and I hope this will be the beginning of future fisheries conferences being held here. We have the facilities and we welcome you.

Before I go any further, I would like to thank Bob Johnson for his introduction this evening. He indicated that I was going to be your guest speaker, in which case I can assure you your evening will be rather short.

However, I would like to indicate that we have had the opportunity of working closely with the Department of Fisheries and Oceans since I have been Minister and I would like to tell you that I am very fortunate in having Bob to work with, as was the case with his predecessor, Bill Murphy. We have had an excellent rapport with both men. That is one of the great advantages we have in a small province. We get to know everyone on a first name basis.

For instance, I was walking up the street today and I heard a horn tooting. I looked around, and an individual waved to me to come over. It was a man from the Department of Fisheries and Oceans, Small Craft Harbours Branch, who wanted to see me about something. We had a little chat, and, in 5 or 10 minutes, we had the problem solved. Small province/small jobs, maybe, but we get to know one another on a first name basis and we appreciate it very much.

As Minister of Fisheries and Labour, I have a twofold interest in your Conference. The fishing industry is one of the largest income generators in this province. Last year landings were 114 million pounds, for a landed value of $38 million. Over 3000 fishermen make their living in this way. I am also interested in the processing side, not only for the increase in value added, but also for the employment that the processing sector creates in the rural areas of the province. It is my hope that all fish caught by our local fishermen, be it lobster, crab, groundfish or Irish Moss, be handled and processed with quality in mind.

Your Conference will deliberate over the next 2 days on trends in fisheries technology and is very important to everyone involved in the East Coast Fishery. We must keep up technologically to maintain our position in the marketplace, both in terms of product form and quality. I see by your agenda that tomorrow you will be focusing on fishing gear and handling procedures. It is essential that the quality of the fish be maintained from the moment it is caught. It must be caught efficiently and in such a way that the fisherman may continue to make a decent living from the sea. This conference will go a long way towards informing fishermen of current trends in their industry. On Wednesday, you will be concentrating on in-plant operations and future technology in the plant. This is a rapidly evolving area of our fishery. Every plant must keep up-to-date with modern technology to remain competitive in the food industry. Fish quality provided by the fisherman must be maintained, and packaging must be efficient and in the varying forms demanded by the consumer. Your line-up of speakers will provide valuable information to the processing sector to assist them in their operations.

This Conference is, therefore, most imporant at this time in the history of the Atlantic fishing industry. You have chosen fishermen, processors, senior fisheries officials from all five Atlantic Provinces and have both Canadian and international speakers in attendance. This will truly be a technical information milestone.

I, as Minister of Fisheries, will be joining you as often as I possibly can, being that our Legislative Assembly is in session. But while you are on Prince Edward Island, I want to, quite naturally, thank you for coming here and I would certainly invite you to return later in the year when our Island is much more beautiful than it is now, so early in the season. If this is your first trip to Prince Edward Island, please do not let it be your last.

Once again, ladies and gentlemen, on behalf of the Province, I want to welcome you here and to thank you for coming. I hope that you enjoy our facilities and join us again before much more time has gone by.

Opening Address

A. W. May

Deputy Minister, Department of Fisheries and Oceans
Ottawa, Ontario

and

General Chairperson
Atlantic Fisheries Technology Conference

"The question is not whether we will have new technology in the fishing industry, but, rather, how we will approach its introduction."

Ladies and Gentlemen, on behalf of my colleagues on the Federal–Provincial Atlantic Fisheries Committee, I welcome you to the Atlantic Fisheries Technology Conference.

It is the first time in 11 years that the two levels of government have sponsored this kind of conference and I think it demonstrates the commitment by both levels of government to help the industry pursue technological innovation.

By now, we have all learned the hard lesson that the 200-mile limit and easy access to a huge resource are by themselves no guarantee of success. We still have to catch and process the fish in a cost-effective, profitable manner. Our fishery products compete with those of a number of other countries, and with a variety of non-fish products, for the consumer's attention. We must be as competitive as everyone else, or a little better, in terms of price, quality, and range of products.

Like every other industry in the western world, our fishing industry must face up to changing technological and market circumstances, and that means making some adjustments. In this or any industry, overcapacity, overregulation, poor quality control, poor management training, failure to apply new technology, and marketing weaknesses, all carry a price.

On our East Coast, we have a great renewable resource. Just to the south, we have the world's single greatest market. But we have to get the fish out of the sea and into that market at a price and standard of quality that will beat our competition — whether it's other fish, poultry, or meat.

Is it reasonable to expect the market to solve our problems for us, with higher prices? I doubt it; and even if prices went up today; we have to think of the next downturn. Equally, I doubt if we can expect fishermen to accept lower prices, or processing workers to accept lower wages. This industry is caught in a cost-price squeeze, and major sectors of the fishery have to deal with that situation to survive and prosper. This will require new and innovative technology to increase efficiency and improve quality.

Our major competitors have already begun introducing automated technology to their industries, and we will have little choice but to do likewise. The question is not whether we will have new technology in the fishing industry, but rather how we will approach its introduction. Will we be on the leading edge of the development and utilization of this technology, or will we be forced to adopt technology that others have developed. The choice is ours.

I am convinced the talent, expertise, and imagination exists in Canada to allow us to be world leaders in the development and application of new technology in the fishing industry — but we must also be willing and able to deal with the consequences that these changes will imply for the industry.

There is clearly no simple answer to the array of problems faced by the Atlantic fishery. It is just as clear that we cannot continue as we have in the past. We have to improve and, where necessary, find new ways to do things.

I know that the thought of blindly and aggressively pursuing the introduction of new technology in the fishery will cause concern about the loss of jobs that could accompany such a move — particularly in areas where already too few people are currently able to find productive work.

We can't afford to ignore changes that technology might bring to the labour force. But if the process is managed properly, and we develop, build, sell, and service new technology as well as use it, we would face mainly a problem of adjustment rather than an overall loss of jobs. It is quite possible that a higher technology fishery would employ fewer fishermen and plant workers than in the past. But when viewed as a total system, such a fishery has the potential to create more and higher quality jobs — especially if we ourselves create technology to satisfy not just our own needs but the demands of other industries around the world.

The choice of whether or not to adopt new technology is not ours to make. We will have to do so, like it or not. But we do have another choice: we can be followers, picking up technology developed by others; or we can be a leader in the field and a successful supplier to other nations.

This is the fundamental question which will face us over the next few days, in the next few months, and in the years to come. I think we have the right people in this room to give us a good head start in addressing that broad issue and I wish all of us luck. But let us find ways to make our own luck. In this industry some lucky breaks are long overdue.

Fishermen, as Businessmen, Cannot Ignore Technological[1] Change

Donat LaCroix

Inshore Fisherman
Caraquet, New Brunswick

"As I see it, the (Fisheries Development) Branch is constantly experimenting to give the fisherman the most modern technology so he can adapt it to his needs . . ."

It has been said that I am a composer, a little poetic at times and maybe I dream a little, but this morning I will not dream. I will speak of concrete things.

I have been an inshore fisherman for several years. I try my best to feed by family of six around the table every morning, and I can tell you, a loaf of bread does not last too long. So I thought I would give you my personal impression regarding the profession I practice.

I fish lobsters — my 375 traps are on the dock today because the lobster season begins the first of May. We thought, at first, the ice might not leave until later (last year we could not begin until the 11th of May), but this year we will begin on time. Between the lobster and the haddock seasons (the season last year began August 20), I fish by hook and line. I have my own hook design. I have heard also that there is a new circular hook on the market now and I would like to try it. Apprently they work really well.

By giving you my personal impressions, like this, I hope to show that, in the past, we have placed the fishing profession too far down the hierarchy of professions. If you could not be a doctor, a lawyer, an engineer, or an electrician, you went fishing. I think this was demeaning to the profession, which I believe is just as honourable as the others. But I also believe that, at present, more and more, we realize that the fisherman has important responsibilities. The fisherman must realize that he is a businessman and that the enterprise he is operating must be managed on the same principles as any other profit-making enterprise.

Compared to the deep-sea fisherman operating a boat costing in the millions, the inshore fisherman who wants to practice a varied type of fishing must invest $50,000 to 100,000 — really a small business in itself. His enterprise must be profitable, so he must be able to get the maximum amount of fish with the equipment he has at the lowest possible cost. After he has sold it, there must be a sufficient margin of profit to meet his needs. Like an old fisherman told me last year, "It's not the amount of fish you catch, but what's left in your pocket at the end that counts." That's what important.

The fisherman must realize that the fish he catches will go through many different stages before it finally gets to market. And the market has its own demands. His product will end up on the plate of the consumer like any other food and the consumer has the final say. He can decide to buy fish, meat, or other things. So fish has to compete with many other foods as far as taste and price are concerned. God knows, today, housewives check more and more closely what is in the cart when they pick up the groceries each week. I know, my wife certainly does. You see, the fisherman is also a consumer. He has his preferences and his standards like everybody else, and he must realize there is a limit to what the consumer will pay for fish. If its costs as much as steak, there is a chance the consumer will go for steak, but, if he goes for fish, you can be sure he will demand quality. That is only natural. So in his enterprise, the fisherman must aim for top quality fish, and I believe quality starts on board.

This is why the fisherman must be aware of all the problems bacteria cause in terms of the effect they have on quality. Fishermen must know how to deal with bacteria. They must watch onboard handling in order not to damage the fish. They must know about cleanliness and refrigeration. Certain steps must be followed, i.e. improved materials in the hold and for covers, proper insulation, and different types of containers. All these things help the fisherman to improve quality. Being aware of all this, a few years ago, for example, I had to make plans for the hull of a boat. I designed a removable hold, insulated, and made of fiberglass, so that, after catching lobster, I could, the same day, transform the boat to fish mackerel or herring.

While being aware of quality, the fisherman also must be aware of operating costs. There are construction costs. In the days of my grandfather, every fisherman built his own boat. Not too long ago, we heated with wood and made our own gardens, but all of this has disappeared. We have lost these skills.

[1]Presented in French.

Today they give courses in gardening because there has been a gap in the transfer of these skills. I myself had to go and see other people when I wanted to make my own garden. Last year in Caraquet, I saw truckloads of wood coming in — people are heating with wood again. I believe that the inshore fisherman (not the deep-sea fisherman, because he needs to specialize and this requires great expertise and complex technology) should build his own boat.

I am building a 50-foot boat now. I am not a boatbuilder, but I wanted to fish for herring and I needed the right boat. Because the costs were so high, I thought I would build one myself. It was once only a dream, but now it is nearing completion. The timbers are 6¾" wide and 1⅜" thick and I cut them myself. I found a maple tree that was long enough to make a keel and I started to build. But I did not have the knowledge, so I went to see an old fisherman and he gave me a plan for a boat that is not too wide, but built like the old dories which could use a sail. I thought "I'll build that boat, put a motor in it and I'll put a sail on it later to save fuel". I am crossing my fingers, but I hope it will work. While I was building that one, I also built a 20-footer for hook and line fishing. It was built from leftover wood from my first boat and it cost me $85. When I was finished, I thought I might as well cover it with fiberglass, and so I did. And all last summer I fished using that boat. I don't like talking about personal things like this, but I believe that if the inshore fisherman is encouraged to learn the skills he needs either in fishing schools or in some other way, he would feel more secure about doing these things himself and thus keep costs under control.

Today the fisherman can profit from available courses offered by the various fishing schools in navigation, marine mechanics, and welding, for example, to do most things on his own. I am for that philosophy . . . to do as much on your own as possible to keep costs down. When I built my first house, I did not know how, and my wife told me I was crazy. I did it myself, and when I sold it I got three times what it cost me. With the difference, I built myself a second home in Caraquet and it did not cost me anything.

The other day, a fisherman told me, "Donat, my lobster boat is getting old and if you hear of someone with a secondhand boat to sell, let me know." So I told him, "Build yourself one!". He said, "I don't know if I can." So I said, "Try!" And another day I asked him if he had found a boat and he said, "No, I'm going to build myself one." So I gained a convert.

My point is that, if in the fishing schools there were courses in boat building, fishermen would be more sure of themselves and it would give them confidence to at least try, and this would diminish their costs considerably.

As far as gear is concerned, the fisherman must find the kind that will allow him to catch the most fish while keeping his effort to a minimum. He must constantly adapt the fishing methods he uses to take advantage of newer, more efficient ways of doing things. The fisherman cannot ignore all the activity in that area, encouraged by the Fisheries Development Branch in an effort to improve fishing methods. As I see it, the Branch is constantly experimenting to give the fisherman the most modern technology so he can adapt it to his needs and in that way improve quality, operating efficiency, and profit margins. Last night I heard Frank Slade (Director, Fisheries Development Branch, Newfoundland Region) say they had a van here with a computer to study the problem of energy consumption, so this morning I went to see it. They gave me a questionnaire to answer because the boat I am building is prop-driven and I do not know if the propellor is the correct one. Today I will verify it. This is an example of something which is useful to me as a fisherman.

I believe too, that the organization of this conference shows that there is a desire to be in step with advances in fisheries technology. This will help a fisherman to run a more efficient enterprise. All of this makes good sense.

FIRST WORKING SESSION
Fishing Gear and Equipment

Chairperson: R. A. (Ray) Andrews
Deputy Minister of Fisheries, Newfoundland

Trends in the Development of Fisheries Technology in Scandinavia

Ulrik Jes Hansen

North Sea Centre, Hirtshals, Denmark

Abstract

Fishermen cannot fish their way out of trouble anymore. They must reduce operating costs, especially for fuel. Much research conducted in the Scandinavian countries in recent years has been in this direction, focusing not on ways to catch more fish, but on efforts to reduce costs. Fishermen share a sound natural skepticism of the scientific community and it is incumbent on scientists (and technologists) to prove their work to be of practical value and to facilitate technology transfer. In this paper, several examples of projects being carried out in the Scandinavian countries are discussed which attest to the practicality of fisheries research initiatives being pursued in that part of the world

Introduction

When we in Denmark investigate what is going on in the world, we often start with what is happening in Canada — investigations in fisheries biology, fisheries technology, fisheries economics, and many other fields. I hope that what I say here can be regarded as repayment of that debt.

There is no doubt that the fishing industry in Denmark, Norway, and Sweden is at a high stage of development compared with many other areas of the world, especially if one takes into account the great diversity of fishing methods that we use. There are various historical reasons for this. The fishing grounds around Scandinavia are rich and not too difficult to exploit. Exporting fish to southern Europe has been a major feature of the industry since medieval times, and this easily accessed market has nourished the desire for higher efficiency on our part. However, despite its present high level of development, the fishing industry in Scandinavia enjoys enormous development potential over the next decade or two.

The reasoning behind this conclusion is based on three factors. First, the fishermen and scientists and technologists are growing closer; many of the innovations used in the fisheries have had their origin in other fields, but the scientists/technologists are now showing more interest in adjusting these developments to the special needs of the fishing industry. In the end, this will result in much more effective hulls, motors, instruments, etc. Second, a new era has just begun, the result of the computer revolution. Its impact in the fishing industry, as in many other fields, will be enormous. Remotely sensed information about fishing grounds is but one example of the information which will be available to fishermen. Third, until now the fishermen have had very little knowledge of how fishing gear was working on the bottom, and of how the fish were reacting to the gear. Facilities such as remotely controlled underwater TV cameras have recently made that study possible and, for the first time, enabled gear designers to make use of the behavioural characteristics of the fish in order to make the gear more effective. It will also be possible, if required, to design gear which is more selective in mixed species fisheries and to produce trawls which operate with less resistance without losing efficiency. And the often elaborate design work can now be done easily in test tanks, where the effect of changes in the rigging can be seen and evaluated immediately.

Fishing Gear Research in Scandinavia

Although the Scandinavian countries are exploiting the same waters, there are noticeable differences between the fishing industries in Denmark, Norway, and Sweden.

One thing, though, is common to the situation in the Nordic fisheries: it is quite obvious that the resource can no longer be considered inexhaustible. So the fishermen cannot expect, any longer, to fish their way out of every problem. Also, as fuel prices have increased considerably, another big problem has arisen. The only way to solve it is to lower fuel consumption. Fortunately, this is possible because fishing, trawling in particular, is a heavy consumer, and research can be of help. Therefore, much of the research work in the Scandinavian countries is aimed at fuel consumption or, to put it in another way, the aim of the research is to ensure that the fishermen will benefit by reducing their operating costs and not by simply selling more fish. I will now take one country at a time and tell about the various projects underway in each to give you an idea of developments taking place in our part of the world.

Denmark

In Denmark, large-scale fishing gear research is fairly new. The gear manufacturers have, so far, been able to cope with the ever-changing needs of the fishermen and have supplied them with ever-improving gear. In spite of this and in spite of the high level of development in the entire Danish fishing industry, it was from the industry itself that the idea of the North Sea Centre in Hirtshals was born. This of itself makes the North Sea Centre a very unusual research and development centre.

The idea behind the Centre was to bring together, under the same roof, the private and public research institutions, the industry (fishermen and processors) and the public, to the mutual benefit of all. Provided the right facilities were established, research and development methods could be improved and directed to meet the requirements of the industry; a better understanding might be created between the public and the authorities concerning problems facing the industry; and the export industries could be strengthened.

Today 12 000 m^2, under one roof, is owned by the North Sea Centre. This institution leases facilities to seven other organizations and arranges conferences and other special events in support of their activities. The seven are involved in all aspects of fishing, ranging from fish biology to fishing technology to processing and packaging. (For further details, see Appendix p. 13 and 14).

The most eyecatching facility of the institute is the North Sea Centre flume tank. This tank is probably the reason why the institute, though young, is known worldwide. So far, it is the largest tank in the world, intended for the testing of fishing gear. The size is 1200 m^3 with a working section 21 m long, 2.7 m high, and 8 m wide. Newfoundland, I am told, is considering building a similar facility.

Primarily, the tank is used by trawl manufacturers who bring a model of their gear to be tested or adjusted, sometimes because it is a new design, and sometimes because they want a videotape of its performance under different conditions. This they use at exhibitions or as a service for their customers.

Another important tank function is demonstrations (workshops) for fishermen. These and other training programs really show its value because work in the tank is highly visual. This means that any skipper, after having seen a demonstration of his gear, will have a clear picture in his mind of how his trawl works under different towing and catching conditions.

Fishermen of all nations share at least one common characteristic — a sound and natural scepticism towards scientists — and Denmark is no exception! Therefore, it has been of the utmost importance that we have been able to collect more and more evidence on the reliability of what is seen in the tank. From underwater videotapes of full-scale trawls and the results of instrumented trials at sea, it has become evident that not only the overall geometry and drag of the model corresponds to reality, but also details in the shape and action of the trawls, their footropes, floats, etc., observed in the tank, have been duplicated and well illustrated by the tapes and measurements taken at sea.

Some Projects of the Last Few Years

Fuel-Saving Potentials in Trawling — The first part of this project (Wileman 1984) was aimed at investigating how much overall gear resistance is the result of the individual components (trawl warps, otterboards, netting, floats, and footrope gear) in order to decide which parts of the gear should be given further attention.

A total of 13 different sets of trawl gear were tested, and although there are major differences between the principal types of gear (bottom, pair, pelagic, etc.), within the same categories the figures are almost identical.

TABLE 1. Average distribution of drag in a bottom trawl.

Warps	5%
Doors	20%
Sweeps	4%
Footrope	10%
Netting	58%
Floats	3%

From Table 1, it is evident that the drag of the netting is always the most significant component, followed by the much smaller door drag. These were, therefore, the two components to concentrate on when trying to make new trawl designs, and the project proceeded to find possible ways of achieving drag reductions.

A technique was established at the North Sea Centre Flume Tank for measuring the resistance of full-scale netting material, and four different possibilities were considered to reduce drag. In Table 2, these are summarized together with

TABLE 2. Possibilities for reducing the netting drag.

Possible reductions	Materials tested	Saving Potential in an actual trawl
Alternative twine materials	PA, PET braided and twisted, some breaking strain	No difference
Thinner twines	Twine diameter reduced by 25% in upper and side panels	8% saving
Larger meshes	Mesh size doubled in upper and side panels	8% saving
Knotless twine	100 mm full mesh 60 mm full mesh vs. knotted mat.	18% 27%

the figures for what can be obtained when an existing trawl model has been carefully redesigned with respect to the change under consideration.

It is striking to see the potential for using knotless twine, and to see that, with smaller meshes, the savings increase. The netting should be used though in sections not greatly exposed to chaffing and damage, as the knotless twines available (at least in Scandinavia) are difficult to mend.

As far as trawl doors are concerned, three different possibilities were considered for reducing drag.

The first was a reduction in the angle of attack. Most trawl designs seem to have maximum spreading force when the door is rigged to operate at an angle of attack in the direction of towing of between 30 and 34°. At least in Denmark, but probably also in other countries, there is a tendency among fishermen to operate their doors at slightly higher angles (35° to over 40°), at which angles the spreading force is reduced and the drag is increased. Unfortunately, this information is of little use for the average fisherman because he has no possibility of measuring the angle, and the scratch marks on the keel of the door are often highly confusing. The only way, to date, to measure the angle is to use the flume tank.

Another way to improve the performance of a trawl door is to make it in a curved/cambered shape. Measurements of cambered doors versus flat ones in the North Sea Centre Flume Tank have so far confirmed that cambering a door will give a little more drag, but much more spreading force. It was found with a particular set of doors (a newly introduced cambered Vee-door) that the drag per ton of spreading force was less, up to 20%.

The third consideration was the highly disputed effect of fitting a vertical slot into trawl doors. This dispute is based on the fact that not every slot is a hydrodynamically effective slot! Some are, in fact, ineffective or negative in effect. With the trawl doors tested in the flume tank, it was found that an improvement of up to 15% less drag for the same spreading force could be achieved, providing the slot covered nearly the entire door length from the top of the door to the bottom.

Figure 1 indicates the relationship between angle of attack and spreading force for three otherwise comparable Vee-doors: one flat, one cambered, and one cambered with a slot.

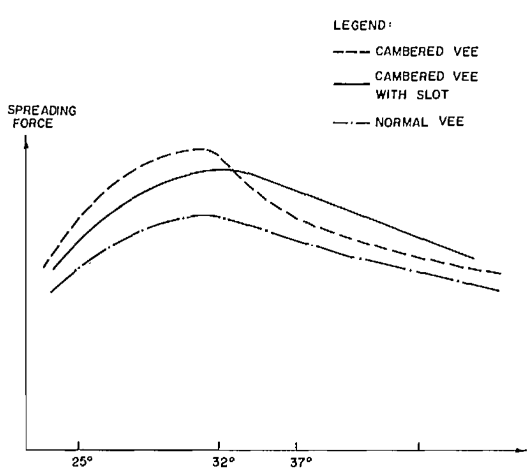

FIG. 1. The variation of spreading force of three different doors as a function of the angle of attack.

It clearly shows that this type of camber provides a better lift as compared to the flat door, and it also shows another feature which might be typical of the effect of the slot. This type of slot obviously does not add much to the spread of the door, but it might contribute much to its stability, i.e. as the curve is flattened out, the door will have its optimum spread at a wider range of angles or it will not be so sensitive to a slightly incorrect rigging or a bottom obstruction.

Double Trawl Systems — In several different fisheries, larger trawls towed by large vessels catch little, if any, more fish than the trawls used by the smaller boats fishing in the same area. These fisheries include nephrops (prawn) fishing, shrimp fishing in the North Sea and, to a lesser extent, the cod and flatfish fisheries. This is presumably because the fish are caught so close to the bottom that the only effective parameter is the spread of the gear, whereas the extra height given by a large trawl is of little advantage.

Many skippers have observed that they have sufficient power to tow two of the small trawls at the same time. This system with two or three towing warps, two doors and two trawls (Fig. 2) has been tested in the North Sea Centre Flume Tank several times during the last year. Fishermen wanting to try this new method come to us because they are anxious that the system be sensitive to changes in door spread, warp length, rigging of the trawls, etc.

Depending on how the profits of this system are measured, it seems that the gain is around 20–30%. The drag of two trawls is only 1.66 times the drag of one, but the spread is doubled.

Single Warp Flatfish Trawl — The idea behind this development is a need on the part of the smaller anchor seiners to find a substitute for the seine in those periods of the year when visibility in the water is so poor that flatfish will not react to the seine ropes. Another problem for the anchor seiners is interference by foreign beam trawlers, but when a solution was drafted, we could not help but acknowledge the success of these trawlers. The solution, which has been successfully tested in the tank, is a small trawl (or seine) attached directly, without bridles or sweeps, to small doors and towed off a single warp and david system. This is a simple alternative when the anchor seine cannot be used. It has some similarities to the double rig shrimpers used in the southern U.S. and other areas.

Two types of trawl were tested. One was of a conventional shape, the other being a little more unusual, but it is intended to be a close copy of a beam trawl. The trawl warp in this system splits into three bridles, the two outermost going to the doors as usual, but with the centre bridle being connected to a centre wing more or less covering the area between the wings.

Although these trawls look very promising in the tank, they still await full-scale testing at sea.

Norway

Fisheries research in Norway is considerable. Over the years, much of the work on gear technology has been devoted to passive gear such as lines, pots, and gill nets, and — because of by-catch problems — to developing selective trawls.

The work on line fishing has covered almost every aspect from finding new shapes of hooks (of which the so-called wide-gap hook has proven successful in cod, ling, and tusk

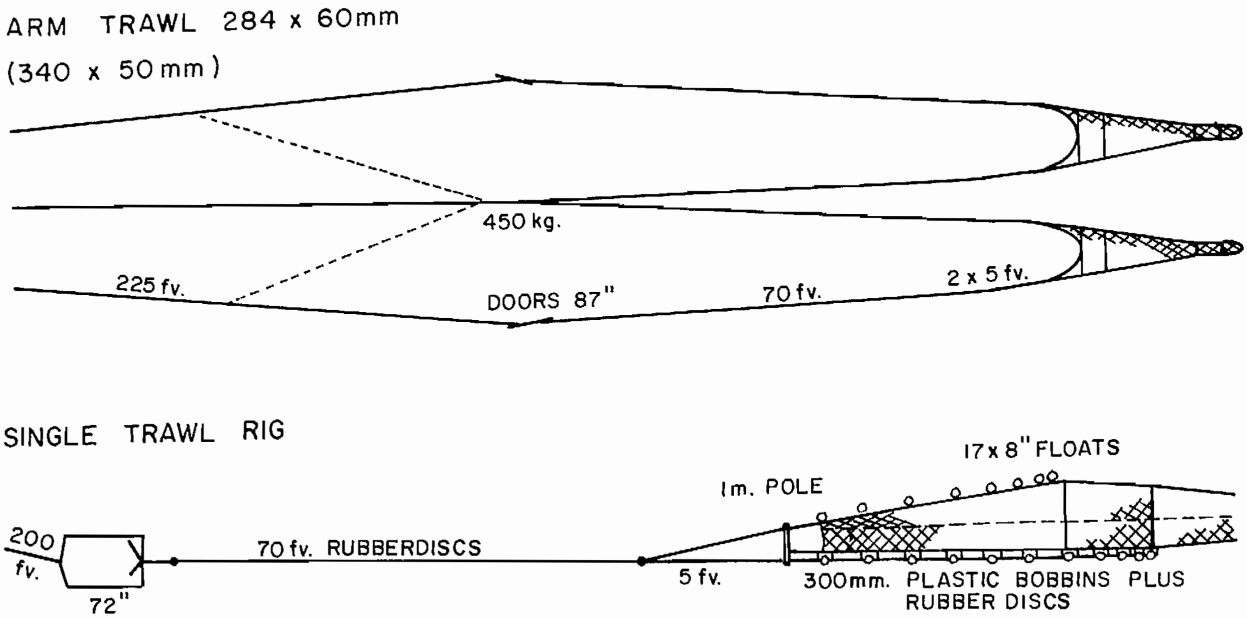

FIG. 2. Double trawl rig with three towing warps. The dotted lines indicate the two-warp arrangement when three-warps cannot be worked on the boat.

fishing) to the modifying of line haulers used in automatic line systems and necessitated by the introduction of the new nylon monofilament lines. Long-lining is very popular in Norway with boats of all sizes, and the amount of bait used is enormous. It is, therefore, natural that artificial bait is of major interest to the industry, and that research has isolated many important compounds and found the proper carrier for the chemical attractants.

When it comes to gillnetting — also a widespread fishing method in Norway — the monofilament and multifilament types are used. Many experiments have been done in finding the optimal hanging ratio, net height, and floatation devices for the various species. What might be of interest in this connection is that experiments have shown that baiting gill nets has improved flatfish catches.

Fisheries regulations, quotas and by-catch measures have caused serious problems for the big Norwegian trawler fleet. This again has encouraged efforts to devise new trawls which are able to sort the different species or to exclude undesirable species from the trawl. At present, experiments are being carried out on shrimp trawls with oblique guiding panels in the rear portion of the belly. The object is to guide the fish out of the trawl or into a separate cod-end with a suitable mesh size.

Another project is of major interest from a scientific point of view because of its unusual approach to the problem (Valdemarsen and Isaksen 1984). A so-called "Siamese Twin" trawl has been invented and consists of two trawls side-by-side on the same head and foot ropes. The two trawls are separated by an adjustable gap in the middle (Fig. 3). The basic idea behind this construction is to take advantage of the different behaviours of shrimp and fish. The swimming ability of the shrimp does not allow them to be guided in the direction of the gap. They are, more or less, filtered by the trawl. Fish, on the other hand, have on several occasions been seen to swim for some time in front of the centre part of the footrope before tiring and dropping back (Main and Sangster 1981). Preliminary full-scale tests have proven that the by-catch of fish in this trawl has dropped dramatically, 40–80% for haddock. The trawl, then, really works — you can adjust your by-catch percentage by widening the gap.

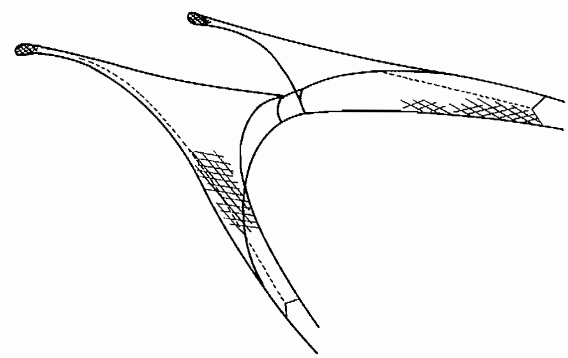

FIG. 3. Sketch of the siamese twin trawl.

Sweden

Sweden has suffered as a result of the introduction of extended economic zones. Its fishermen have been excluded from important fishing grounds in the North Sea, the Skagerak, the Kattegat and in the Baltic. This situation is reflected in the amount of research work on fishing gear and technology. Nevertheless, a new otterboard has been developed. It is a circular door, cambered, with one or more slots depending on the size of the door. This door provides an improved spread in relation to drag and, as it has a heavy bottom shoe, is well-suited for both bottom and pelagic trawling.

Conclusion

And that concludes my overview of the various projects in which we have been involved in recent years. We have some very clearly defined objectives in mind in our work which I might have defined in general terms. However, I felt it preferable to deal in specifics such as these. I hope I have given you some insight into where we are heading with these initiatives.

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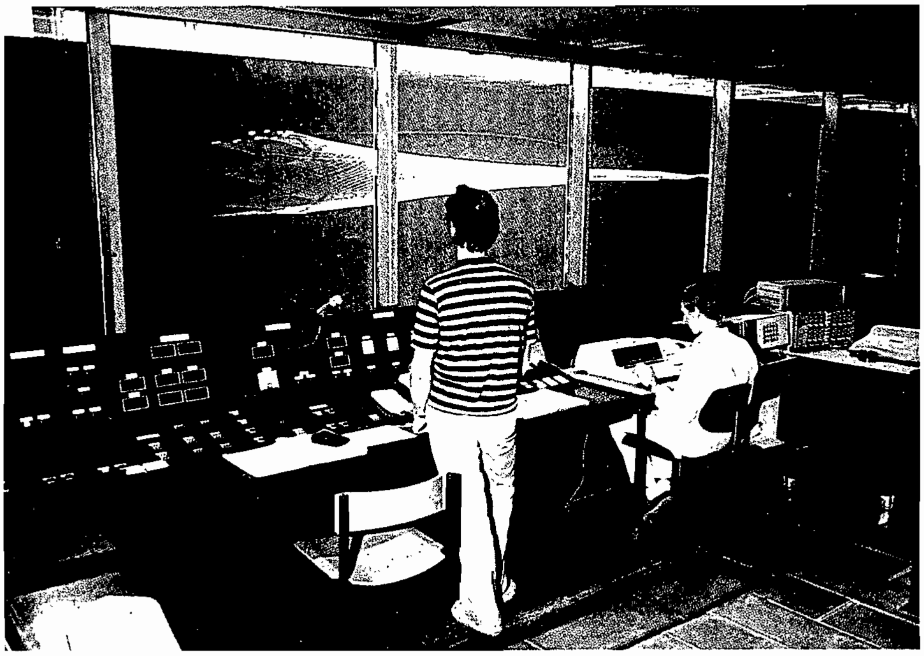
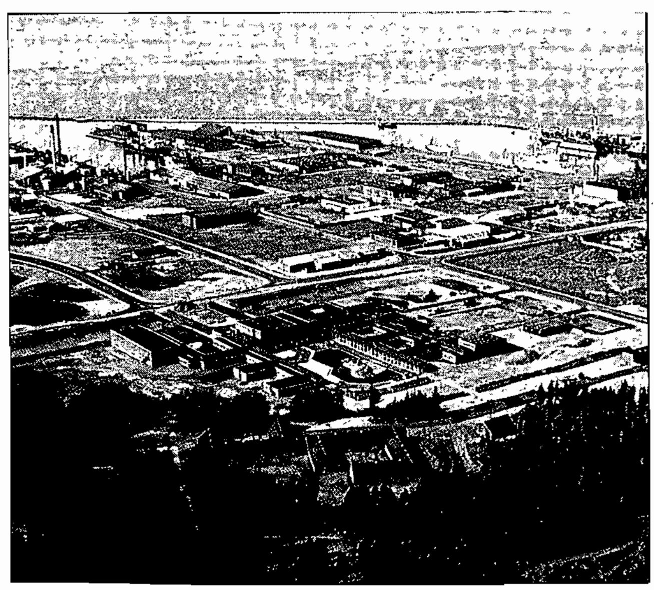


FTI's fields of activity
Gear research

Research and development activities in this area include the development of fishing gear which can improve catching efficiency, reduce energy consumption and improve both the quality of the catch and its selectivity by species and size of fish.

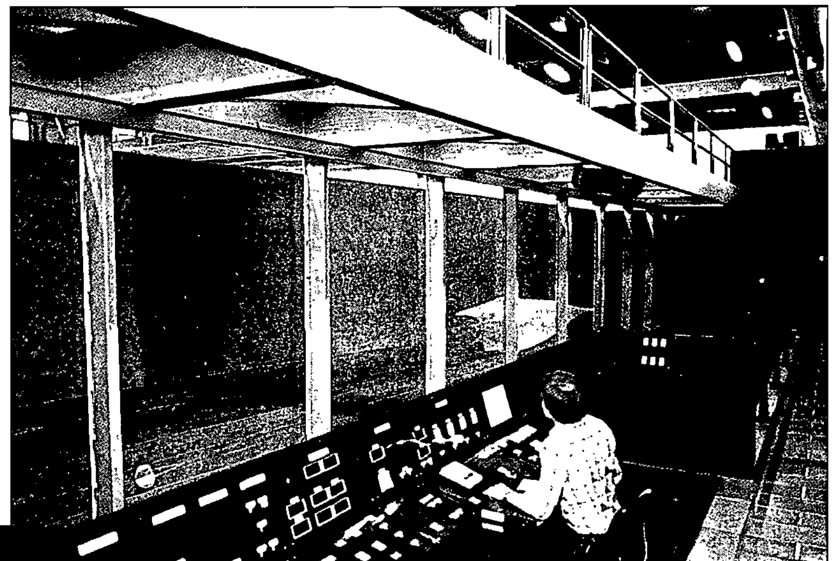


Gear testing

Model testing of fishing gear in the institute's 1200 cubic metre flume tank enables the measurement of gear geometry and resistance together with observations of the gear's performance under different conditions and rigging. The results of such measurements are documented by means of computer and video equipment. Testing is carried out for gear manufacturers and research institutions all over the world.
The institute also carries out full-scale testing and measurement of fishing gear at sea.

1 ➡

FTI's flume tank is the largest and most advanced of its kind in the world. The testing area, which measures 21x8x2.7 metres (lxbxh), is equipped with a moving floor such that the water flow and the bottom can move at the same speed. The tank is specially designed and equipped for model testing and for the demonstration of fishing gear, particularly trawl gear. However, it is also suitable for other types of tests particularly where the observation and measurement of underwater objects is required.



⬆ 2

The flume tank's control panel where the tests are monitored and the results collected and evaluated. The model measurements are converted to full scale by computer, so that the client can immediately have a clear idea of the fishing gear's performance.

The height of a model trawl used for deep water shrimp fishing off Greenland is being measured. The flume tank makes it possible to obtain precise measurements and observations.

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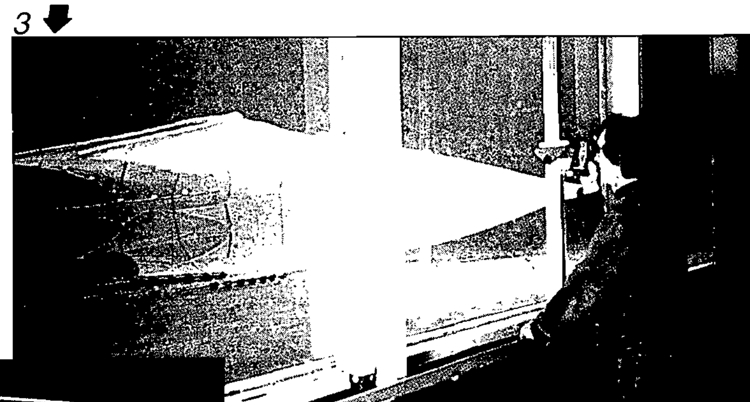

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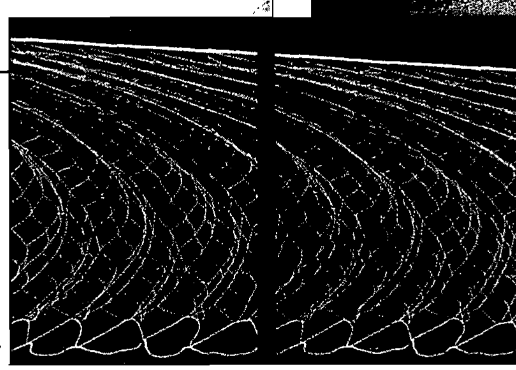

A number of successful tests of gill nets have been carried out. A nylon gill net for sole fishing can be seen under gentle tidal stream conditions.

General Overview of Developments in Trawl Gear and Fisheries Electronics

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Abstract

Twenty years ago, the large distant water, stern freezer trawler fleets were at their zenith. Roaming the oceans, they impacted on many stocks of fish, not because of the efficiency of their trawl gear or because of shipboard and trawl electronics, but rather, because of their sheer numbers in any given area. Many factors led to the demise of such vessels, which were superceded by smaller vessels in the 90–130 foot range, built primarily to exploit deep-water fisheries within European Economic Zones. Coincidental with the appearance of these smaller vessels were dramatic changes in trawl gear design, both ground and midwater trawls, trawl doors, ground gear and fish finding electronics, navigation aids and deck and trawl instrumentation. These "combination" trawlers are capable of harvesting and handling many species of fish in an efficient manner. This presentation highlights some of the major developments in fishing gear and electronic instrumentation for fish finding and for establishing trawl gear performance.

Introduction

Although the large, distant water, freezer trawlers represented major advances in ship design and onboard fish processing technologies, the trawl gear they employed was generally of traditional design made larger to utilize the power that was available in such vessels. One exception at the time was the exploitation of pelagic species using single vessel midwater trawls with a net sounder and the Superkrub trawl door.

Although the net designs then being used had been subjected to many performance studies by scientists, engineers and technologists, the trawl designer lacked the information which might be obtained by direct observation of either a full-scale trawl in operation or of models in purpose-built test tanks. The major breakthroughs came in the late sixties and early seventies with the construction of flume tanks and the development of diver-operated observation gear and underwater video. Traditional evolution of trawl gear was, of course, continuing and when all these new facilities and fishermen were combined, dramatic advances resulted.

Fish-finding acoustic instruments of that era were based mainly on thermionic valves and were limited mainly to paper chart presentations, although white line and seabed locked displays had begun to appear. Cathode Ray tube displays were monochrome and only showed the echoes from one transmission on an "A" trace type presentation.

Navigation was limited to the Decca Hyberbolic phase measurement system (in near-shore areas) and to Loran A and C, using CRT displays and hand operation. Radar and RDF, along with limited celestial navigation, made the fishing captains life no easier.

Trawl Net Development

The late sixties and early seventies saw a preponderance of ground trawl gear in many sizes but based almost exclusively on the traditional two-seam, full-wing, Granton style design. Some attempts had been made to improve the trawl by eliminating or cutting back the lower wings, which had areas of repetitive damage. But ripped out bellies and holed cod-ends were still hazards the deep-water trawl fisherman had to face. Early attempts at improving trawl performance seemed to concentrate on making the trawls' front-end performance better. Design concentration was focused on the size and shape of the square and upper wing area to improve headline height and the spread and cover of the trawl.

When the French built the first trawl-testing flume tank, a new tool became available and a new era in trawl design followed. Such tanks spread to England, Denmark, and Australia and designs could now be modeled prior to their full-size construction, while existing designs could be closely observed. The Marine Laboratory in Aberdeen, Scotland, developed an underwater observation capability at the same time so that more detailed information on a trawl's performance, and more importantly on fish behavior in and around trawls, could be documented.

Four-seam, or four-panel trawls, with improved headline heights, then began to appear with radically changed wing designs. Larger mesh sizes were utilized to reduce drag, thus permitting even larger ground trawls to be built and/or fuel utilization to be reduced. Towing bridle arrangements also changed to allow trawls to work over grounds previously considered to be too difficult to fish without incurring damage. These changes, along with different hanging ratios and net-panel tapering, significantly reduced belly and cod-end damage.

Midwater trawls also began to change, although the four-panel design of such trawls remained as an accepted feature. The most dramatic changes occurred in the mesh sizes used and in the front-end designs of rope trawls and "jet belly" trawls.

The impact of all this work now sees distant water vessels, equipped with ground and midwater trawls, working sometimes as solo operators and sometimes in pair combinations. The ground trawls being used have a high-rise capability with larger meshes, up to 32 inches in the upper sections. Then are generally rigged with three bridles, with the middle wire being attached to the fishing line or the gore (selvedge) rope, depending on the ground being worked. Fishing depths of up to 600 fathoms are not unusual, with towing speeds up to 4 knots being commonplace, when ground trawls are used in the single vessel mode. Midwater trawls have evolved into huge nets primarily built to work on mackerel and blue whiting and, again, high towing speeds in excess of 4 knots are the norm.

Trawl Door Development

As with trawl nets, the standard flat door made of wood and iron was the predominant door for many years on ground trawls. The Superkrub door was the main midwater door.

The first indication of change in ground doors came with appearance of oval-shaped and slotted doors. The primary purpose behind such designs was to improve spreading power and reduce drag.

The oval, cambered, slotted door originated by Morgere in France has seen wide use in many countries and in many variations, particularly in the towing bracket and back strap arrangements. Trawl doors are still subject to engineering research and design innovation, primarily to find a dual purpose door that will work on either ground- or midwater trawls. There is a great deal of interest in multifoil doors to meet this requirement. A Superkrub door, for instance, can be considered as a single-foil door; a four-foil door has recently come from Norway; a double multifoil door has been developed in Ireland; a circular dish single-slot door has come from Sweden; and a cambered oval single- or double-slotted door has been produced in England.

The older Vee-form door has found wide acceptance in the deep water fleet because of its bottom operating characteristics and its forgiving nature, but the number of different door designs and rigging arrangements is probably more extensive than the trawl net designs available today.

The midwater door has changed little from Krub's 1930's design. But there have been modifications to the towing brackets and attempts to make them work in shallow water with high-powered vessels and large midwater nets (the Lite door from the U.S. West Coast). With all the new door designs available, it will take some time to size the doors to suit each application and for the fisherman to learn exactly how the doors need to be rigged for the required spread, ground contact, and attitude.

Trawl and Door Combinations

Research work has indicated recently that trawl door rigging, both at the towing point and at the backstraps, is important in the catching efficiency of the gear.

Some years ago, many deep-water fishermen considered gear-spread *the* important catching parameter and it was common to see oversized, traditional, flat wooden doors being used. With the influx of new door designs, which are more efficient hydrodynamically, overspreading of trawl gear can, however, be the result. New doors usually mean a smaller size than would be considered for a traditional design or, alternatively, a larger net may be considered, if the new door is to be of the same size as the original door. Door spread not only influences wing-end spread, but also the attack angles of the associated wires and bridles. Overspreading can lead to lost fish.

Ground Gear Development

Heavy roller and bobbin rigs have not changed much over the years in the distant-water fishery. The one exception originated with the prawn fishery on the east coast of Scotland and their move to more productive, but more hazardous, grounds. Their original rubber disc ground gear did not provide much protection for their nets over rocky ground, so the first development was the addition of a larger diameter rubber disc at intervals along the ground gear. This larger disc was further modified by drilling an extra hole towards the edge of the disc and passing a soft rope through the hole, thus preventing the discs from rotating. This simple innovation produced the original "rock hopper" ground gear. The first versions of this rig were mounted on wire, but this made the whole ground gear rig stiff and unwieldy during the final phases of the haulback. The latest versions are rigged on chain to alleviate this handling problem.

Fish Finding Acoustic Devices

Paper displays and thermionic valves have given way to color CRT's and solid state devices and, along with computer techniques and signal processing, today's fish finding equipment has advanced dramatically.

The mainstay of the deep-water fishing vessel's fish finders is the vertical echo sounder. The machines are used extensively to determine seabed conditions for fish accumulations, for species identification, and for fish target depths. This is accomplished using the added sensitivity afforded by 8 and 16 colour displays, dual frequency operating modes, scale expansion and split-screen presentation. Historical records of a fishing trip can be stored on magnetic tape, via a cassette recorder, to be replayed later for further analysis.

Similar technology has been applied to sonar equipment for fish finding and advanced ground information. Sector-scanning sonars are still abundant, but omni-sonars, particularly of Canadian origin, are not utilized in the deep-water fishery.

Add-ons to acoustic equipment include signal processors that give the captain detailed information on ground conditions or fish concentrations by sound alert, thus reducing the time a display must be monitored.

Trawl Electronics

The net sounder has always been considered an essential piece of equipment for use on midwater trawls. The original cable-linked, downward-looking transducer has evolved into an up/down transducer with a temperature readout. Acoustic link netsounders are lower in cost and boast ease of operation, which has led to the development of true trawl net instrumentation. These new instruments can be used on ground or midwater trawls to indicate cod-end fish quantity and even to ensure that the trawl is fishing properly. Included in the packages are transducers for headline height, wing-end or door spread, and footrope depth. The modern deep-water trawler captain can easily determine if his gear has been shot correctly, if the trawl is fishing, whether its front-end geometry is correct and, finally, when to haul back as the cod-end fills up.

Deck Instrumentation

Warp tension meters and warp length meters have been installed as individual equipment for some time, but recently they have become part of the main winch as these units become automated. Winches with automatic control, usually based on a low-to-medium pressure hydraulic system, have proven extremely useful to deep-sea fishermen, working over new grounds. The ability of such machines to keep the trawl gear square during turns or to minimize damage over catchy or hang grounds has meant a further expansion of available fishing area to deep-sea vessels.

Navigation Instruments

The introduction of Loran-C certainly eased the task of the distant water trawler operator. Along with track plotters, both paper and video, this navigation system has had a major impact on the fishery. The ability to store and retrieve every fishing tow and to accurately locate hangs, has allowed more productive fishing with minimum gear damage.

Radar equipment continues to be an important part of a distant water trawler's wheelhouse equipment for nagivation and anti-collision uses. For a while, many European distant water trawlers were fitted with S-band as well as X-band radar, mainly for navigation in areas where radio navigation aids were not available or marginal at best. Radio fax equipment also is used onboard high-seas vessels to give the skipper weather information for his chosen fishing grounds or to allow him to consider alternative fishing areas. All high-seas fishing vessels tend to be double-equipped with electronics, mainly to ensure an uninterrupted voyage, to provide a fail-safe system.

Research and development on trawl gear electronics, deck machinery and vessel design is ongoing and vessels already in the distant water fishery will continue to utilize new ideas as they become available. Major advances will probably continue to come about in trawl doors and fish-finding electronics for the foreseeable future.

Trends in the Development of Fishing Methods and Gear

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Abstract

Canada is a world leader in fish exports, but this is not reflected by the level of technical advancement and competence in the primary sector, especially in Atlantic Canada. This statement is perhaps not as applicable to the offshore sector as to the inshore fleet of vessels less than one hundred feet L.O.A.

Recent technical developments can help fishermen catch fish more effectively within the confines of Canada's fisheries management policies, especially when emphasis is placed on fuel efficient and quality-oriented fishing techniques. One might be inclined to relate critical fishing pressure on vulnerable stocks with increased capabilities on a per boat basis, but this is not necessarily the case in Atlantic Canada. Overfishing, assuming that this occurs, is more reflective of the large number of boats which compete for a limited resource than with the wanton destruction of immature fish. The rejection of new technology on this premise, however, would be retrogressive. Technology can be directed towards the capture of fish at less cost, without necessarily increasing catch levels.

Emphasis, however, must be placed on selective, quality-oriented fishing methods and, even though trawling will remain the biggest earner in terms of total production of groundfish in Atlantic Canada, quality standards will, in future, demand that improvements be made in methodology and gear as a first step in ensuring a top quality product.

Advances in technology throughout major fishing areas of the world are being closely monitored for possible application in Canada. The importance of a dynamic development program is recognized globally and, consequently, contemporary research has become very sophisticated. The availability of computers and other aids, such as flume test-tanks and tow-tanks, are invaluable for perfecting designs of towed gear by means of scale models. Major efforts are being directed towards refinements which streamline gear performance in the interests of fuel saving and a reduction in gear wear and damage. In this way we can maintain an equitable rate of return from the allowable catch and ensure the perpetuation of our valuable resources.

This paper examines a broad spectrum of fishing technology in an attempt to accommodate a wide audience ... there should be something of interest to everyone involved in the fishery.

Overview of Fishing Gear Technology

The acquisition of knowledge in relation to fishing gear and fishing techniques is vital. Fisheries scientists and gear technologists are aware of the influences which affect available resources. Fishermen use this information to distinguish the relationship between the cost of gear and the rate of return it can generate. Fisheries managers need this knowledge to facilitate effective policy formulation in relation to stock and quota management.

Advances in fishing gear technology are primarily evolutionary, with subtle modifications and refinements being introduced on a continuing basis. These developments accelerate periodically, as radical changes occur through research and development and, in some instances, as they are introduced by innovative fishermen. Modern communications ensure that new ideas spread rapidly. And, occasionally, similar projects are conducted simultaneously in different parts of the world. Meanwhile, Canada is maintaining its efforts in the research and development of fisheries-related technology and, indeed, has pioneered certain innovations.

In the past 20 years, gear and technology development has accelerated as the result of economic stimuli. The momentum for development at present, for example, is related to ever-increasing fuel costs, an awareness of the need for quality, and the desire for cost-effective fishing operations.

Otter Trawling (Groundfish)

Otter trawling will remain the predominant fishing method used in Atlantic Canada in terms of total production. Vessels participating in this fishery are of almost every type, size and horsepower.

Because of the mixed composition of this fleet and the diverse areas fished, otter trawls and ancillary equipment, i.e. doors and groundgear, have evolved to suit the varying bottom characteristics and tidal conditions encountered. Scaling of net size to trawl equipment has been accelerated with the rising cost of fuel. These experiments have been conducted using larger mesh sizes or parallel ropes in non critical areas of the trawl. Cutaway lower wings are now a common feature in hard ground bobbin trawls, minimizing damage and reducing drag. New netting materials are being manufactured which have smaller twine diameter, but retain the necessary strength and abrasion resistance.

High fuel costs have also prompted trawl door designers to produce more fuel efficient units. A large number of vessels, less than 65 feet L.O.A., however, still use rectangular wooden doors. These have changed little in design for nearly a century. New trawl door designs, meanwhile, have incorporated hydrodynamic features to assist in obtaining optimum sheer angle, while reducing drag.

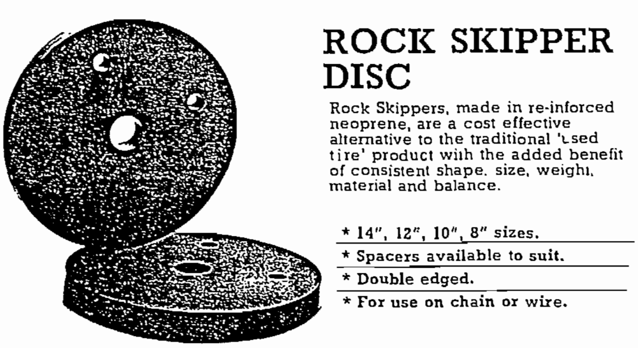


FIG. 1. Rock Skipper Disc.

Rigging of groundgear is now changing from conventional "roller gear" (i.e. spherical bobbins or wheels) to what is termed Rockhopper or Rockskipper footgear, using large diameter discs, usually 12–14 inches in diameter spaced out at intervals, with small discs (usually 4 inches in diameter) seized to the fishing line to prevent movement. When this arrangement encounters bottom obstructions (such as rocks), it tends to "hop" over them, hence the name. This rig has now been accepted by many small- and medium-sized trawlers which operate on very hard ground.

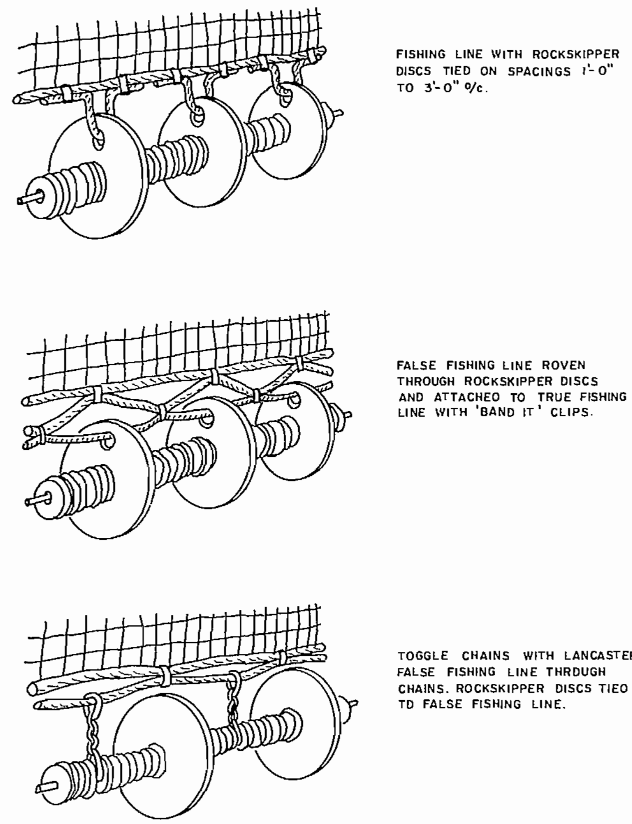


FIG. 2. Three variations of Rockskipper groundgear assembly.

It is obvious from underwater observations that many fish escape on completion of the tow, i.e. fish herded by the trawl components (sweeps and bridles) ahead of the footrope and even in the fore-body of the trawl simply swim away when the forward momentum of the net stops during hauling. This can be overcome to some extent by towing at full speed immediately prior to hauling and by using a flapper ahead of the lengthening piece. Alternatively, the winch should be powerful enough to overcome the propeller thrust and thus maintain net speed through the water during hauling. This is particularly important in pelagic trawling for fast-swimming species. The ideal solution to the problem would be a device with an electronic messenger which would, on command, bring the doors together, closing the net and preventing the escape of fish on which the vessel has expended fuel to herd them into the trawl's path. Closing the trawl mouth in this manner would also reduce drag (resistance) making the gear much easier to haul back.

Trawl Designs

The recent adoption of European trawl designs by Canadian netmakers is finding wide acceptance by the 65-foot class of trawlers. Many of these designs have been modified to suit local conditions, and experimental work has been done on the more commonly used nets in order to increase efficiency.

False headline panel experiments were conducted by the Fisheries Development Branch, Department of Fisheries and Oceans, Scotia–Fundy Region in 1984 and will be resumed in 1985. This attachment to the headline is designed to prevent the mass escape of haddock over the true headline, a recurrent phenomenon under certain conditions. Experiments are also being conducted with various colors of netting, to contrast with underwater conditions. It is thought that brightly coloured wings will assist in herding fish into the mouth of the net and, conversely, dark colours render the leading sections invisible to fish entering the trawl.

Multi-Purpose Trawl Doors

We feel that, since it is now possible to differentiate weight from surface area in trawl door technology, it should be feasible to design and construct trawl doors which have common weight characteristics, but different surface areas. One application would be where vessels, engaged in groundfish operations, switch to shrimp fishing. This (because of smaller mesh sizes) would alter the drag load behind the doors. Splitting the trawl door, and inserting an addition would create a larger surface area and thereby increase the spreading force to accommodate the increase in drag. By contrast some fishermen, when changing to shrimp trawling, take in one or two links on the lower backstrap. This creates resistance in order to maintain spread, but, in practice, is not fuel efficient and, in any case, the desired effect can be better achieved by increasing the surface area.

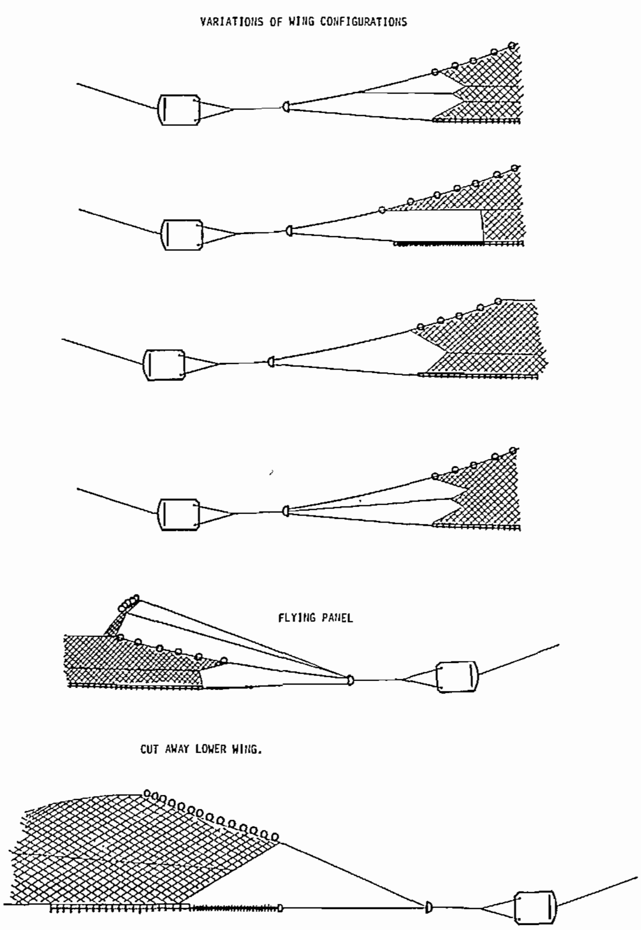


FIG. 3. Variations of wing configurations.

Pelagic and Semi-Pelagic Trawling

Everyone is aware of the fact that flatfish species generally live in close contact with the sea-bed, whereas round bodied fish, such as cod, haddock and pollock, migrate vertically throughout the colder bottom layers foraging for food. Conventional bottom contact trawl gear is currently used to harvest all demersal species, with a few exceptions.

Bottom contact assists in spreading otter doors and creates mud clouds which herd fish along the sweeps and bridles into the path of the net. Heavy ground gear, such as steel bobbins and rollers, protect the lower net sections from damage when fishing on rough bottom and also create a mud barrier below the fishing line. Bottom contact, however, creates friction and, therefore, drag (resistance), which, in turn, consumes a large quantity of fuel to keep the gear moving at optimum speed.

There is now a growing tendency in some countries to use a much more fuel efficient approach. They use pelagic or semi-pelagic gear to catch the higher swimming demersal species. Bottom contact is minimal and is achieved by hanging chains. Efficiency is increased since the net can have a high vertical opening, using light twine construction, and there is no net damage through bottom contact or deterioration of fish quality through debris in the cod-end. Drag is further reduced by eliminating heavy chafing gear. It makes good sense to harvest flatfish by means of specifically designed bottom gear, including heavy sweeps and bridles together with long wings and a relatively low headline, instead of a compromise rig designed for multi-species harvesting.

Pelagic trawling is no longer the exclusive domain of the larger offshore trawlers. Small inshore vessels can now prosecute this fishery, by either pair midwater, or single-vessel midwater. The main contributing factors have been net design and increased mesh size in the forepart of the net. This cuts drag (resistance) and improves water flow through the net. Consequently, it can be towed faster, which is more efficient. In addition, better netting materials are used and, sometimes, rope meshes are constructed. These rope "meshes" are now considered in terms of feet as opposed to inches.

Most pelagic trawling has been conducted using the "Superkrub" type door. These are not entirely suitable for ground contact, partly because of their high aspect ratio. And doors are now available which the manufacturers claim can be adapted for both demersal and pelagic fishing.

Advances of this nature in gear design may well result in smaller vessels being able to take an active role in the Gulf of St. Lawrence redfish fishery, and may even allow them to fish cod and other species, where diurnal migrations occur.

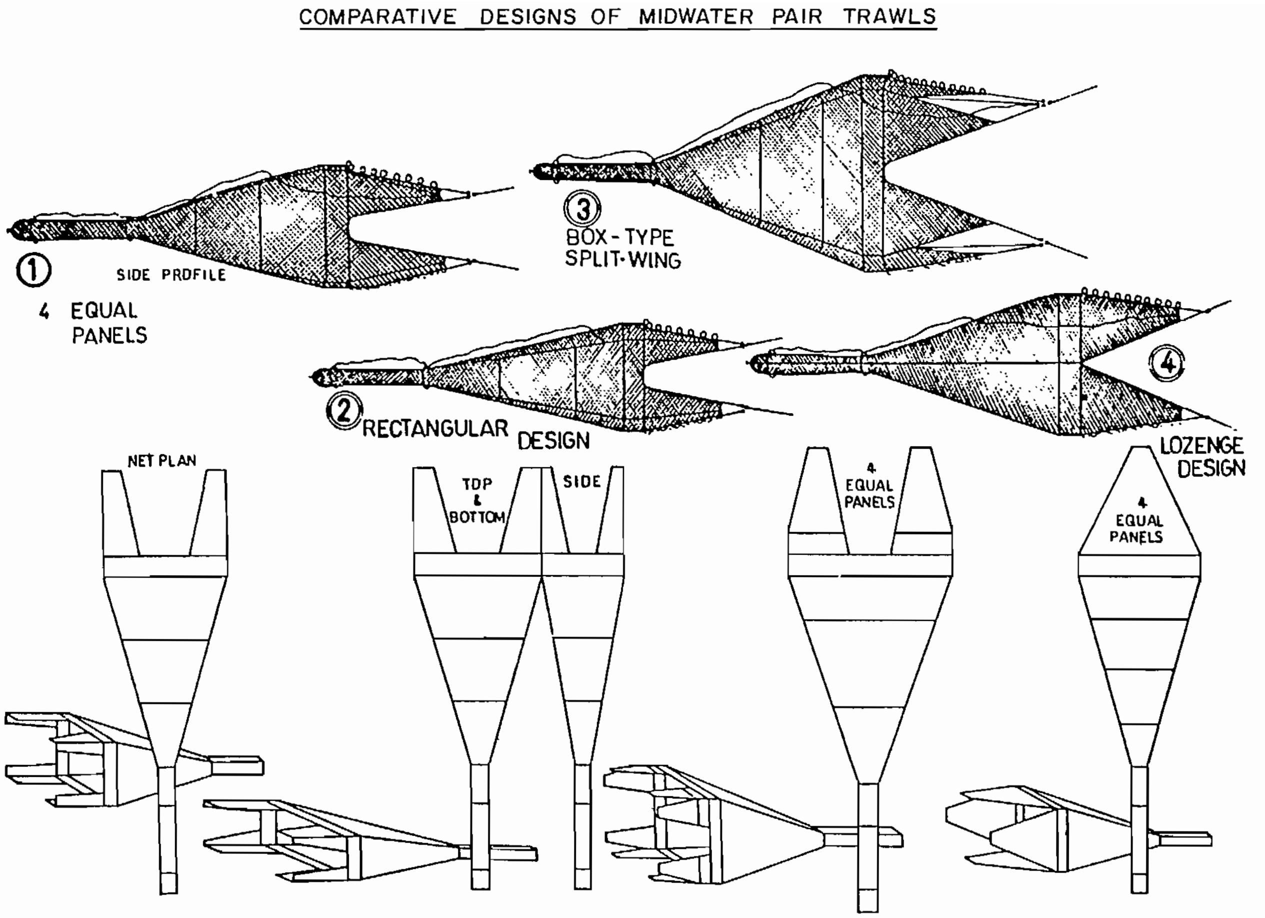


FIG. 4. Originally most midwater trawls were symmetrical as in 1 with four equal parts. Now more nets are rectangular in shape as per 2 with side panels smaller than the upper and lower panels.

Bottom Pair Trawling

Pair trawling projects have been successfully conducted by the Department of Fisheries and Oceans in several locations in eastern Canada. Low horsepower boats were used in these experiments. The merits of the technique are well known and large European vessels have demonstrated its viability. Recent developments have affected net designs and many nets now have 12-inch mesh in the wings and square and first top belly. Three bridle nets can be used, giving remarkable headline heights. One of the Departments's projects involved pair shrimp trawling, and shrimp were caught in reasonable quantities. Although positive results were obtained, further tests will have to take place to determine the viability of pair trawling for shrimp on a commercial basis.

At present, there are no large offshore pair trawlers in Eastern Canada (i.e. over 65 feet). Pair trawling requires a substantial amount of sweep wire with bottom contact. It also requires good station keeping and identical warp loads on each vessel.

An alternative pair trawling arrangement which merits discussion would be to include small trawl doors forward of the area to be swept. These units would have the necessary weight requirements to touch the bottom and streamlining would be possible since no sand cloud effect would be required from them. The actual weight of the doors would be calculated to offset the large diameter sweep wires currently used in the pair trawling technique. This method would also allow the vessels to tow at various speeds, according to size and species, by a simple alteration in the door weights. A more uniform swept area would be possible in conditions of heavy swell and could result in a reduction in the amount of sweep wire required (desirable on hard ground). We estimate that these units would result in an increase of drag load in the region of 6–7% but this could be offset by thinner main warps and sweeps. Finally, this may have a beneficial effect on a recurrent problem with pair trawlers in which obstructions, such as wires, are picked up on the sweeps and run all the way down the wing lines, causing net damage. Small doors like those described here would stop and hold any such debris.

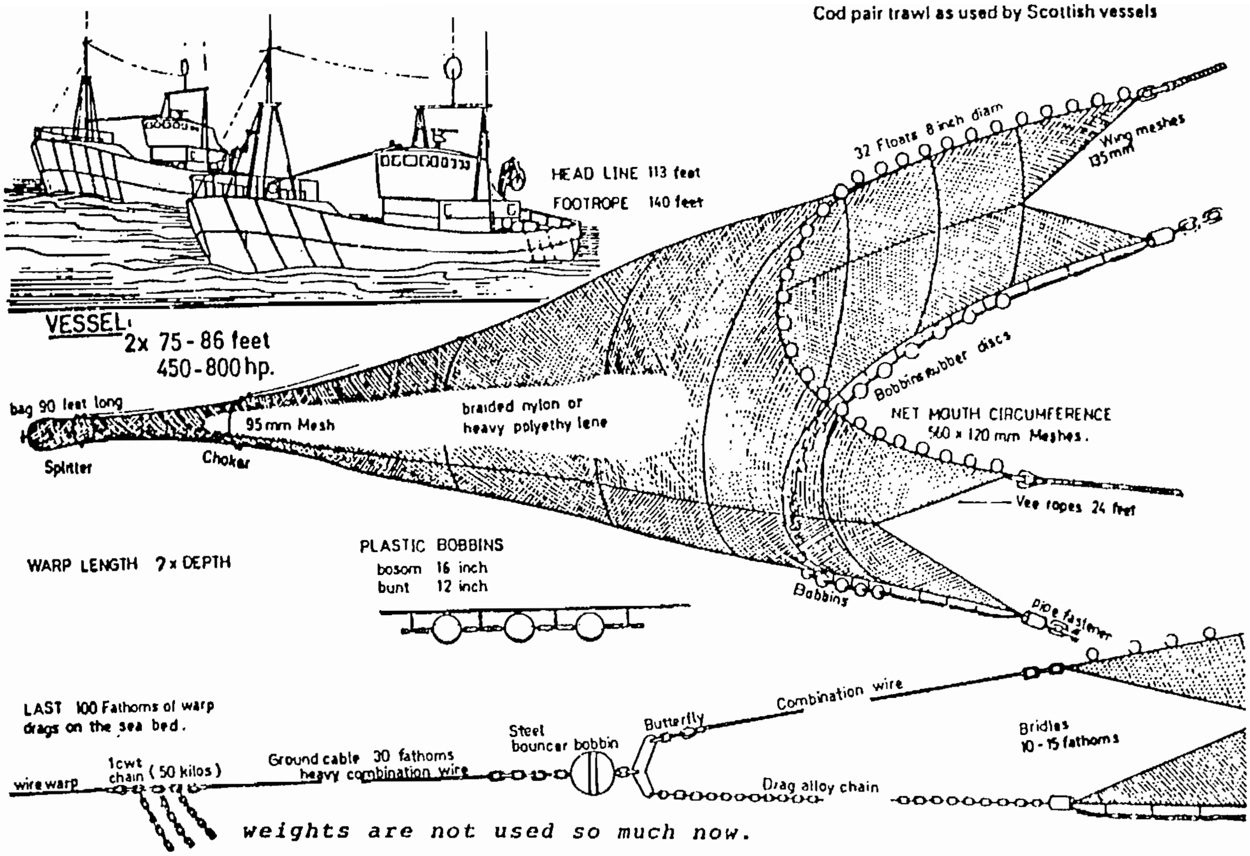


FIG. 5. Pair trawlers tow a large net between them. They set about 70 fathoms of warp for each 10 fathoms depth of water.

Separator Trawls

Underwater observations have shown that horizontal separation panels of netting, rigged at the correct height inside the net with independent cod-ends, will separate different species as they enter the net.

Experiments have been conducted in Canada to separate shrimps from redfish and other species but, as in many other countries, these experiments are ongoing. The objective is an acceptable level of separation, together with a net design simple enough to be easily repaired and, therefore, acceptable to the commercial sector. It is felt that the use of underwater cameras will be of paramount importance in solving the separation problem.

A most promising approach is being used by other shrimp fishing countries and will be tested by the Department of Fisheries and Oceans in the immediate future: a system whereby shrimp are directed through the extension piece into the cod-end by means of a funnel (or funnels) of small-mesh netting, while demersal species are encouraged to escape via large meshes in this critical area. Although many configurations of separator nets have evolved over the years, the funnel separator principal appears to be the most promising.

It is also interesting to note that pelagic and semi-pelagic trawl experiments, carried out in the Gulf of St. Lawrence and other shrimp fishing areas, showed that pink shrimp do, in fact, swim up off the bottom to varying heights, depending on their size, and that immature redfish remain within 4–6 feet from the bottom. Catches were made over a 3-year period with a pelagic trawl, fished with the footrope 6 feet off the bottom. Only large shrimp and large redfish were caught, with catch rates being comparable to and, in many instances, better than conventional bottom shrimp trawlers working in the same areas. These experiments are described in detail by Allen and Rycroft (1977).

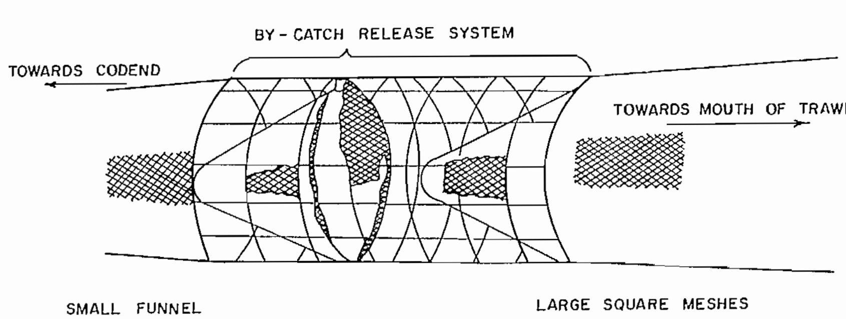


FIG. 6. Funnel separator net.

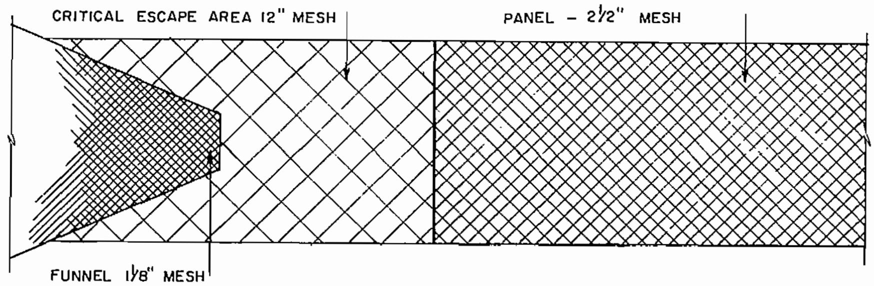


FIG. 7. Possible modification of shrimp separator funnel concept.

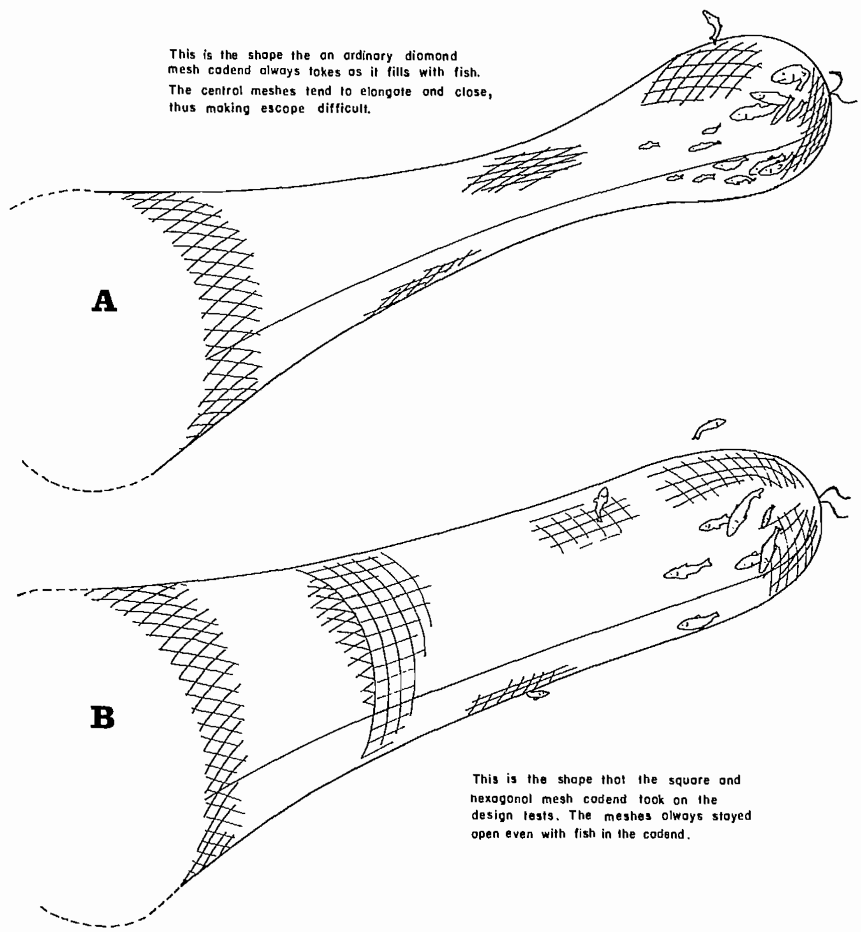


FIG. 8. (A) The shape that an ordinary diamond mesh cod-end always takes up as it fills with fish. The central meshes tend to elongate and close, making escape difficult; (B) The shape that the square and hexagonal mesh cod-end took on the design tests. The meshes always stayed open even with fish in the cod-end.

Square Versus Diamond Mesh Selectivity

One of the most undesirable characteristics of conventional otter trawls is their indiscriminate capture of immature fish. They do this because of the design of the trawl and its mode of operation. Fish are herded into a wide-mouth net which tapers back into a fairly restricted cod-end. Selectivity studies have shown that fish escape at different rates from various sections of the net with increasing frequency, until a peak is reached in the cod-end (Margetts 1963). However, this rate of escapement is sharply reduced, even using 130-mm mesh, as the cod-end becomes weighted with fish or debris, causing the diamond meshes in the lengthening pieces and front section to elongate. When this occurs, escapement is limited to a few rows of mesh immediately in front of the catch. Therefore, the practice of increasing mesh size is not a totally efficient method of ensuring the release of undersized fish.

The Atlantic groundfish fishery in Canada has always had to contend with a bycatch of undersized fish. With the declaration of the two hundred mile exclusive fishing zone in 1977, the bycatch incidence has increased. This can be attributed to the rapid increase in almost all Atlantic groundfish stocks, with younger year-classes predominating.

Consequently, a project was initiated by Scotia–Fundy Development Branch, Department of Fisheries and Oceans, in 1982 to study the selectivity of square mesh-diamond mesh. Initial results were similar to those obtained by Robertson (1983), however, small sample size prevented definitive conclusions. An underwater mobile camera unit was employed in 1983 and, although film quality was poor, visual results substantiated data analysis. A decision was made to continue the project to further investigate the advantages of square mesh gear and provide a greater data base on which to make a qualified assessment. Continuing experiments confirm previous findings and, in addition, prove that there is less work to be done on deck; fish caught are of a larger average size and there is little or no debris or small, unwanted species. The absence of debris means that commercially valuable species are not crushed and chafed, thus ensuring improved quality of the landed product. Further, underwater video observations demonstrate that, whereas diamond mesh cod-ends tend to roll and sway under tow, square mesh cod-ends remain stable. This indicates there is far less chafing against the meshes using square mesh.

It has been proven that normal diamond mesh turned on the square, weakens and in some cases distorts the meshes. Knotless netting, on the other hand, retains its shape and tensile strength when used in a square configuration. Experiments are continuing using knotless materials, and the scope of the investigation will be expanded to include nets used by Scottish Seiners. Researchers feel that it would be beneficial to trawl fishermen to adopt square mesh in the cod-ends of their trawls for reasons of stock conservation, quality control, and deck labour reduction.

Consideration is being given to the insertion of heavy-twine, large, square meshes immediately behind the footrope, to allow rocks and other debris to be screened out. And it seems obvious to us that square mesh would be an asset to the future of the industry.

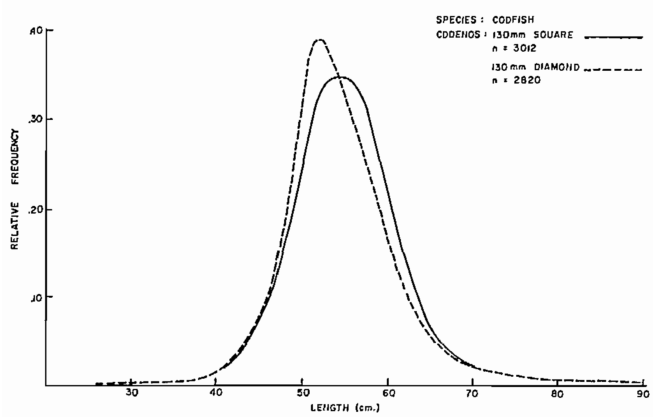


FIG. 9. Length distribution of cod from 54 replicate sets completed by research vessels during 1984.

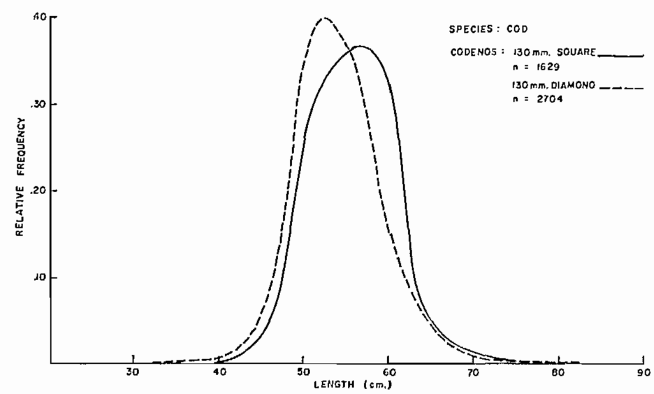


FIG. 11. Length distribution of cod from 22 replicate sets completed by the commercial vessel *Anne Jolene* during 1984.

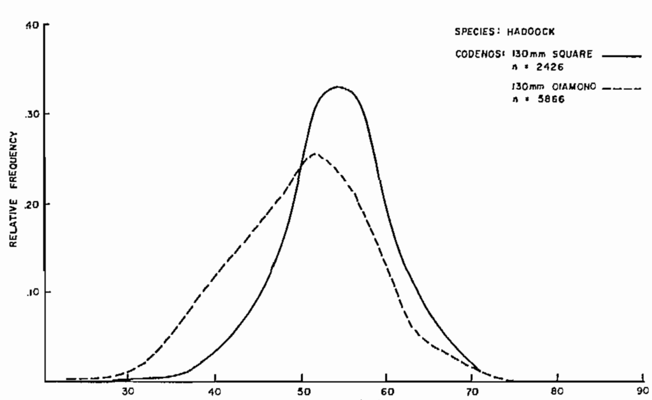


FIG. 10. Length distributions of haddock from 54 replicate sets completed by research vessels during 1984.

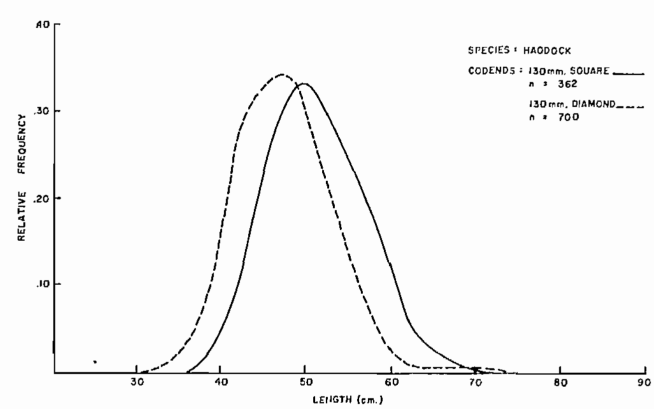


FIG. 12. Length distribution of haddock from 22 replicate sets completed by the commercial vessel *Anne Jolene* during 1984.

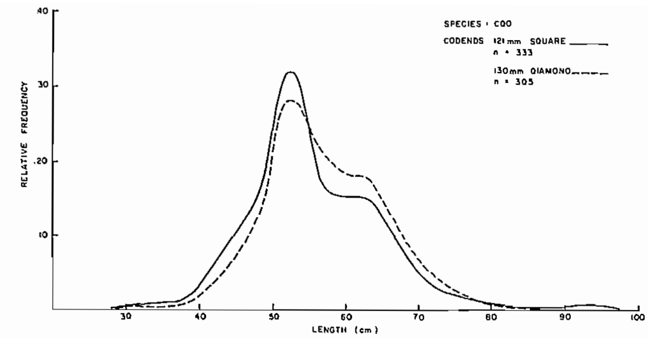


FIG. 13. Length distribution of haddock from 4 replicate sets completed by the commercial vessel *Anne Jolene* during 1984.

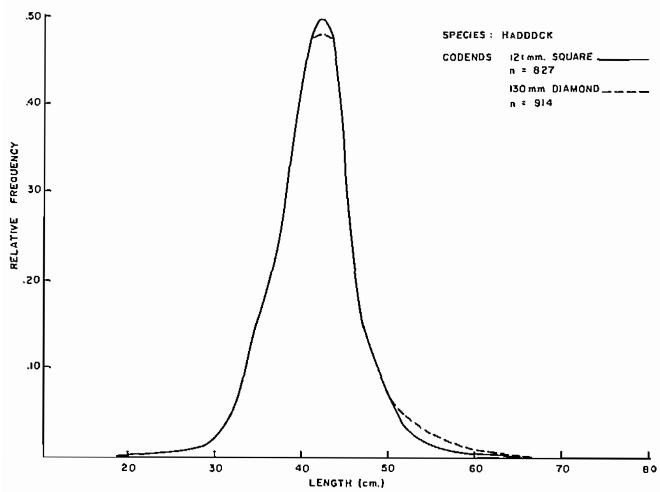


FIG. 14. Length distribution of cod from 4 replicate sets completed by the commercial vessel *Anne Jolene* during 1984.

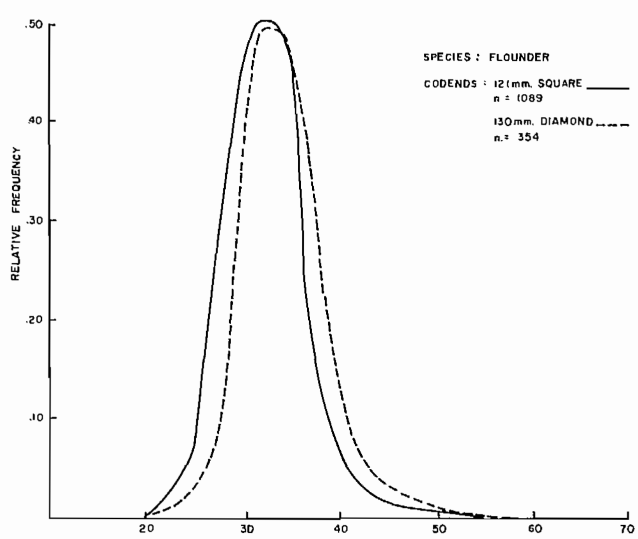


FIG. 15. Length distribution of flounder from 4 replicate sets completed by the commercial vessel *Anne Jolene* during 1984.

Scottish Seining

Seining is a mechanically efficient method of fishing in that a comparatively large net can be deployed with a modest expenditure of power. The encircling movement of the net and warps gives a high fishing efficiency so that a seiner can often compete, on smooth ground, with large trawlers Recent studies have indicated that seining is one of the more conservative methods of fishing, in terms of fuel consumption.

The pattern in which the gear is laid can vary, but is usually triangular with the vessel at the apex and the net in the centre of the base. The vessel, if "Danish Seining" (Anchor Seining), will be moored to an anchor while hauling. If the vessel, is "Scottish Seining" (Fly Dragging), it will be towing and heaving simultaneously. In either method, as the warps are hauled onboard, the net moves ahead closing gradually as the circle of ropes closes.

Scottish Seine Equipment

Nets

Early towed seines for flatfish probably evolved from beach seines with a long bag attached. Modifications were introduced as various grounds were explored and other species sought. The long wings of the early nets presented no problem to the "Anchor Seiner" but, with the "Fly Dragging" method, consideration had to be given to the towing power of the vessel. Early nets were constructed of organic materials, mostly cotton twine, hung on combination wire/manila rope. They were held open by glass floats and oblong lead weights.

In "Scottish Seining", which depends primarily on demersal groundfish such as cod, haddock, and hake, design emphasis was always on headline height. Adding extra web to traditional seine nets helped in the first stages, but as more webbing was added, it became counter-productive and increased the drag with no increase in headline height.

Synthetic netting eventually replaced natural fibres and the Vinge Trawl was introduced in the Scottish Seine fishery. The main differences between the traditional seine nets and the Vinge Trawl is the short wings and the V configuration or wing line, which allow far more headline height than the blunt end of the seine net. Another feature is the extremely tight mounting or hanging of the net which transfers towing strain to the webbing, rather than the headline and footrope. The wing lines need adequate length of bridles to allow the net to open and, before power blocks were introduced, there was a tendency to shorten these to reduce labour. This practice, however, led to inadequate net openings. Side panels were inserted to increase height even further, but flume tank data does not confirm any appreciable difference. The main complaint about this box type Vinge is that when a single end is encountered because one rope breaks, the net is easily distorted while under strain and goes out of fishing trim.

Mesh size has increased steadily to reduce drag and to increase headline height — 12-inch meshes in the wings and square are now common. Recent developments have been in "Rockhopper" seine nets where the lower wing is eliminated back to the quarter to reduce damage on hard ground. Groundropes for use on good ground have changed little, i.e. three inch circumference coir rope hung in bights from the

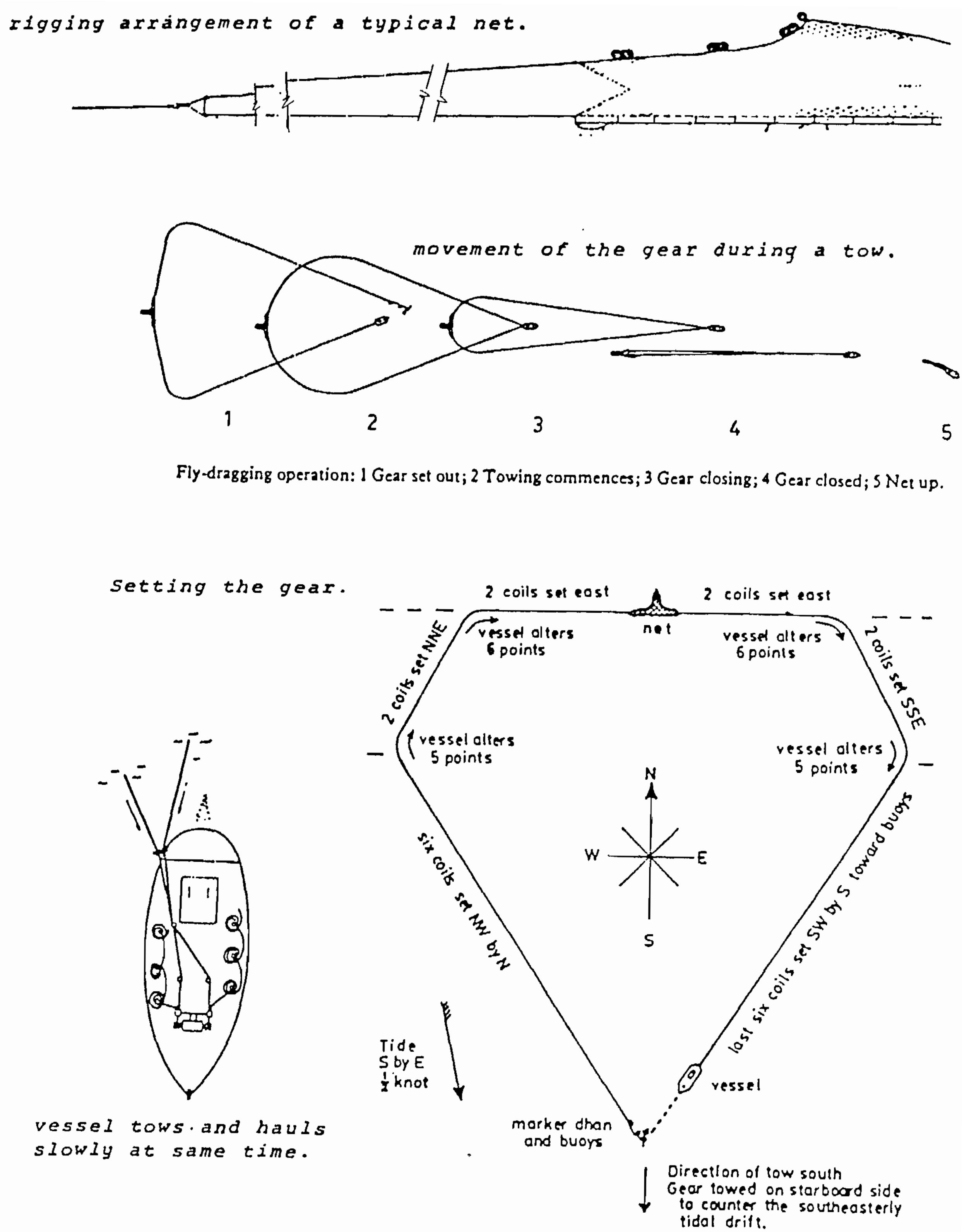
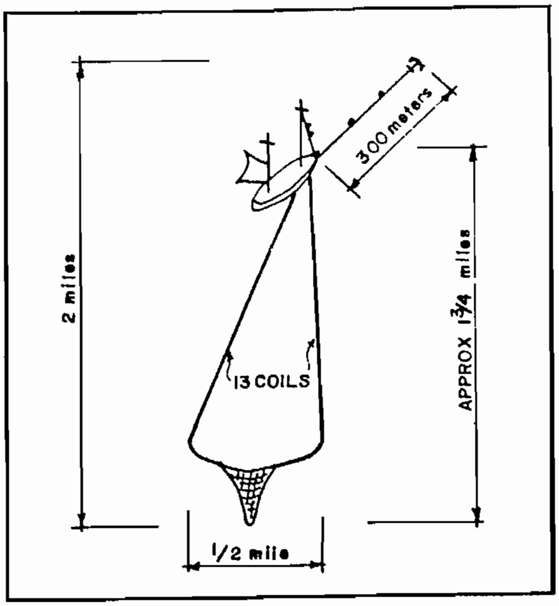
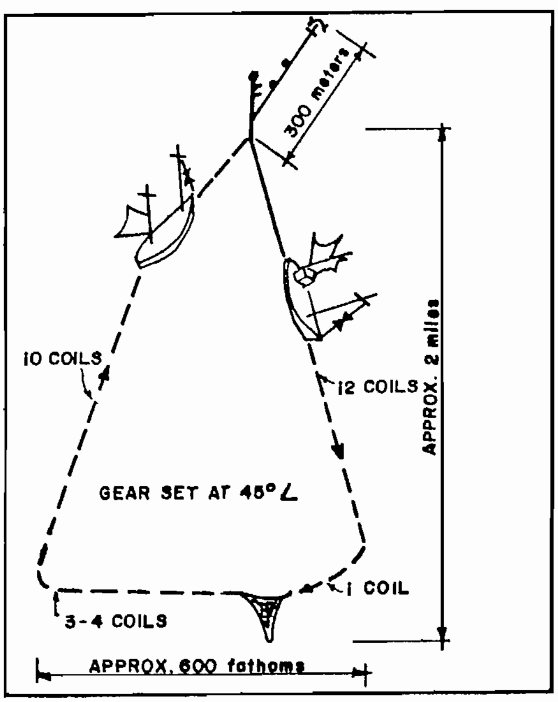


FIG. 16. Scottish seining. Bottom fishing with ropes. Ten to 14 coils of rope warps 2 3/8" to 3 1/2" circumference. Each coil measures 120 fathoms.





Tide running south and hauling on the starboard side if the wind is ESE (Top) and shooting gear south east and hauling on the port side with the wind WNW Force 4-5 (left).

In both cases, the anchor is 300 m approximately and has two large orange bladders, one large 35 ft. buoy staff, a radar reflector and buoy flags. The ropes are 19 mm fibre lead core with 13 coils in each side (1,560 fathoms) and the length of the net. Sometimes 14 coils are used.

FIG. 17. Anchor seining alternative setting patterns.

fishing line, with 4–8 ounce lead rings distributed at intervals. However, "Scottish Seining" is now being carried out on harder grounds and groundgear for this purpose has become heavier. Modern vessels now use 3½-inch and even 4-inch circumference ropes in some cases. The main problem on rough grounds is to prevent the net from tearing and, consequently, groundgear may consist of 20 feet of 8-inch Rockhopper discs in the centre with 6-inch Rockhoppers at the bunts tapering out to 4 inches at the wing ends. These are strung on wire cable with small 2½ inch discs spaced in between.

Experiments were carried out in Scotland many years ago using plastic bottom groundgear with lengths of chain (droppers) to raise the footrope off bottom and, in northern Norway, vessels are now using groundgear similar to the "dropper" chain system with good results.

These changes in materials and rigging have enabled vessels to fish grounds they previously avoided, In the past 10 years, many new areas have been fished successfully.

Ropes

Seine ropes were initially constructed of natural fibres such as sisal and manila. Raw material for these products became scarce in the late fifties and this, coupled with an increase in vessel horsepower, resulted in the adoption of synthetic materials. Contemporary ropes are constructed mostly of polyethylene or polypropylene as these materials do not absorb water. A lead core is included to allow the rope to sink. The Japanese use a mixture of synthetic and wire (combination rope) and this has been introduced in certain areas of Europe. Icelandic seiners frequently use all wire, but this was tried in the North Sea without success. It is probably better for use on hard or coral bottom. Expensive seine-net ropes are subject to considerable wear from contact, hence friction, with fairleads, the warping heads of the winch, and the V wheels of the coiler. Fully powered rope reels eliminate a great deal of this wear, but there are other factors which must be addressed.

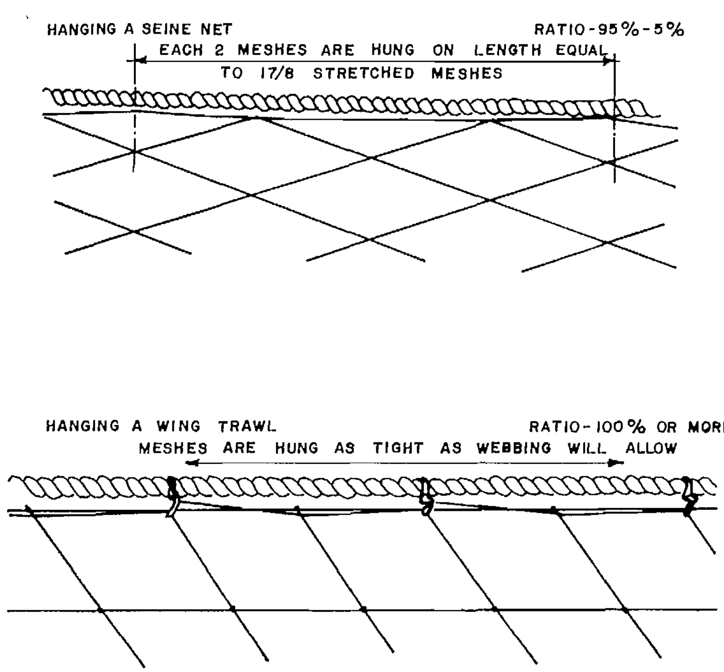
The primary function of the ropes is to drag over the seabed, creating a wall of mud or sand which herds fish into the path of the net. Nothing can be done to prevent damage to the rope due to towing around rocks or other bottom obstructions, however, there is another factor which wears rope *from the inside*. Sand and mud infiltrates the strands, and the "working" of the ropes causes abrasion and deterioration of the filament with which the strands are constructed.

The Department of Fisheries and Oceans, is currently investigating the possibility of constructing rope strands with flat (as opposed to round) filaments. The material will be polypropylene, polyethylene, or a combination of the two. It is felt that this configuration will inhibit sand and mud particles from getting between the strands. The square shape will result in a rope of greater external contact area. This means that there is less turns of rope on the warping head of conventional winches, less slippage, and therefore, less friction wear.

Rope Reels

The rope coiler played a major role in eliminating some of the ardous work associated with seining. However, the ropes continued to be stacked on deck manually and remained a constant concern to operators of open decked seiners in bad weather.

The next phase was Rope Storage Bins, which were



Method of hanging a seine net and a wing trawl. The seine nets were hung to 95% of the stretched length of the webbing cut on an all points or diamond mesh direction. Wing trawls are hung to over 100% of the stretched length of the netting cut on all bars or square mesh direction.

FIG. 18. Difference in hanging ratios between seine nets and wing trawls.

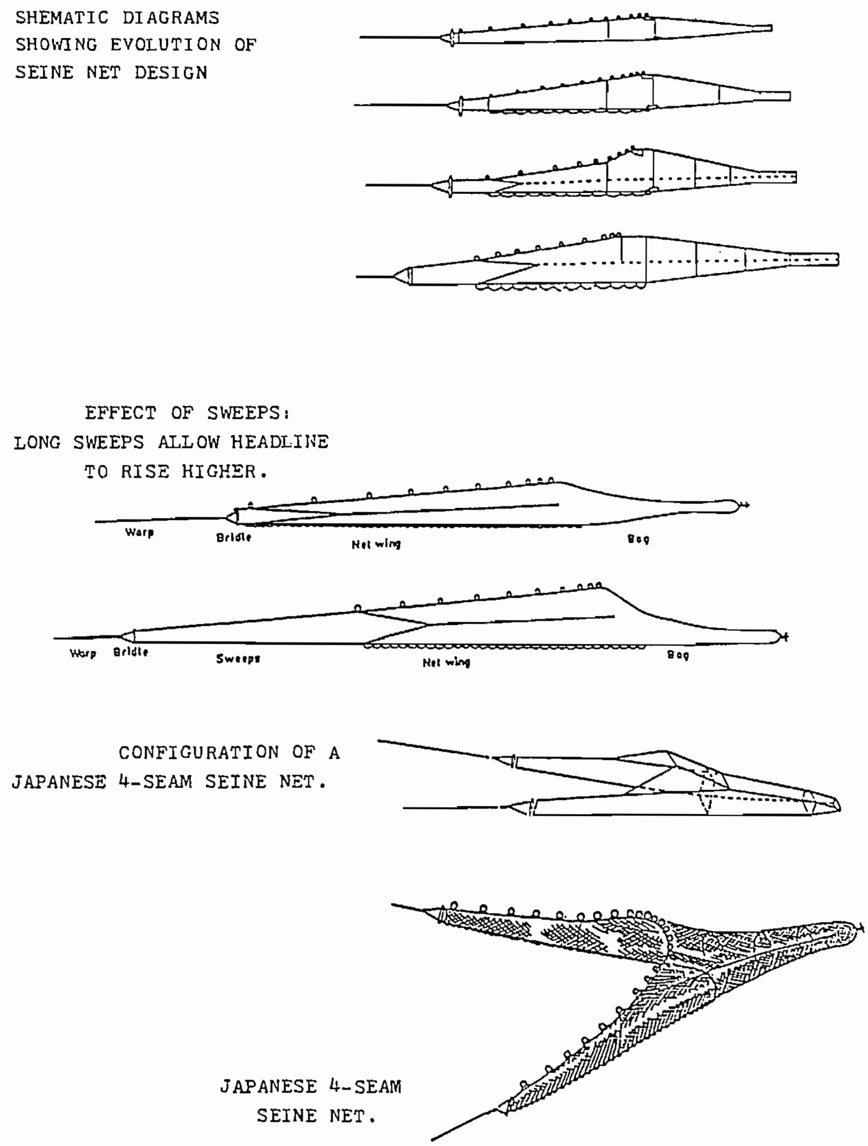


FIG. 19. Evolution of seine net design.

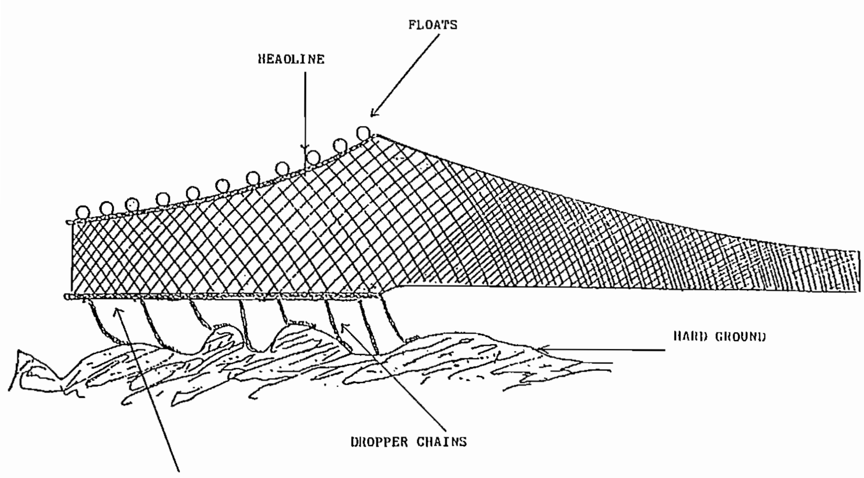


FIG. 20. Seine net rigged for hard ground.

basically square compartments below deck into which the ropes were fed from the coiler. Although this method was superior to stacking on deck, the square areas designated for the ropes were at the expense of fishroom space, and fouled ropes did result occasionally. These had to be attended to, at least some of the time, by crew members, and this took them away from other duties.

In the early seventies, the first Rope Reels appeared in Denmark, installed on board "Danish Seiners." The principle was adopted by Scottish Seiners and soon came into general use. At present, it would be safe to assume that nearly 100% of Scottish and Danish Seiners in Europe are equipped with rope reels. The figure is somewhat less among seiners in Canada, but installations have been increasing since the Fisheries Development Branch installed European type Rope Reels on several Scottish Seiners in the mid to late 70's in order to demonstrate their capabilities. The branch also carried out feasibility studies on Fully Powered Rope Reels, and in 1982, prototype reels were installed on a "Scottish Seiner" in Canada.

Fully powered reels are now in commercial production and, without question, they are the most advanced step in deck equipment for seiners in many years. The benefits of this system are numerous (Rycroft and Tait 1984).

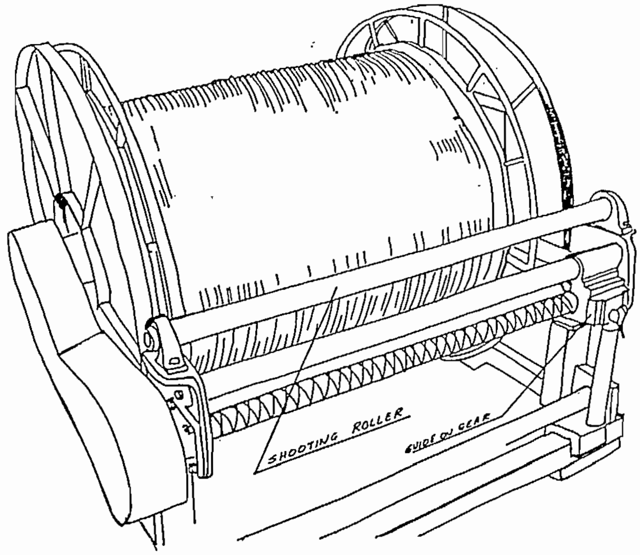


FIG. 21. Detail of Canadian fully powered rope reels.

Dual Purpose Rope Reels

Testing and evaluation of a prototype combined Seine/Trawl reel system will commence in the near future. The reels have been constructed incorporating the design features of Fully Powered Rope Reels, with additional structural strength and line pull capability. Side flanges will be added to store the necessary sweeps and wires required for trawling.

It is envisaged that Scottish Seiners or groundfish trawlers, utilizing this versatile deck machinery, will be able to switch from Scottish Seining to Trawling, at sea, in a very short time period. For example, if Scottish Seiners find fish on grounds unsuitable for that method, they will be able to adjust by shooting trawl gear, without returning to port to make the changeover. And when long periods of darkness occur, which are generally unsuitable for seining, the vessel can tow a trawl, thereby supplementing the catching effort.

Scottish Seine Power-Block

In 1953 Mario Puretic, a fisherman from San Pedro, California, conceived the idea of hauling a Purse seine through an elevated free-swinging, powered V-sheave. His idea quickly spread into countries which had purse seine fisheries. But it was not until 1967/68 that this innovation was introduced to "Scottish Seining." Feasibility tests were first carried out by the Marine Laboratory in Aberdeen, Scotland. A Standard Scottish Seine was hauled through a power block with good results.

In January, 1968, the White Fish Authority in the United Kingdom installed power blocks on two Scottish Seiners for trial and evaluation. Several modifications were required to the Purse Seine Power Block to adapt it for Scottish Seining. These included tapering the groove more acutely, in order to grip the bridles, and widening the sideguards to accommodate standard 8-inch floats. The block was also of open construction to facilitate laying in and taking out bridles or wings. Suspension of the block had to be modified to reduce free motion, by incorporating a semi-rigid joint on the crane bottom. Modern Scottish Seiners are equipped with free-standing cranes which give a high degree of versatility.

The Power Block configuration has changed little since the original versions, except that many Power Blocks used in Scottish Seining have integral motors giving a streamlined appearance and probably reducing risk of twine catching on the head, as sometimes happens with external gearing.

Most recent developments are the W form of Power Block, used to haul Scottish Seines with Rockhopper footgear. This type incorporates two heads, joined together to create a wide double groove. At present, experiments are being conducted with double drums for hauling heavier Rockhopper Seines, although the Power Block will still be utilized to haul the bag of the net.

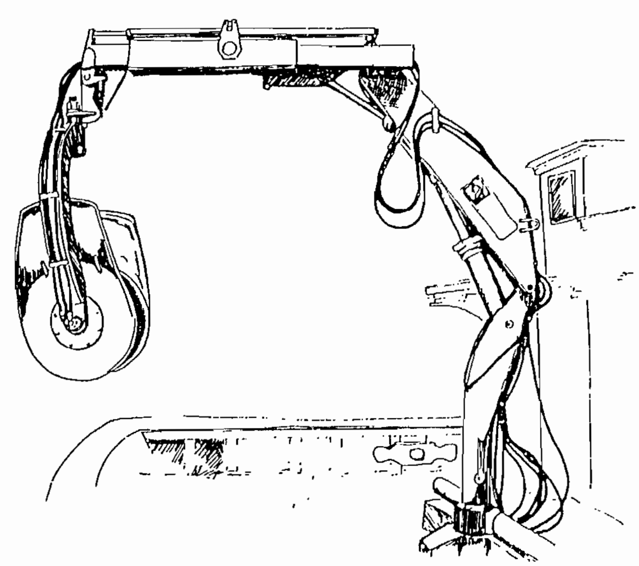


FIG. 22. General view of crane and power block.

Gill Nets

No real solution has been found to the long-term effect of lost gill nets. Fishermen can only ensure that every precaution is taken against loss. Many European and Asian fishermen never leave nets unattended overnight and hauling is carried out if the weather deteriorates significantly. Similarly, fish quality is maintained at a high standard by frequent hauling, thus allowing fish to be bled and gutted while still alive.

Tests conducted in the United Kingdom by the S.F.I.A. and video inspection of gear under fishing conditions both have indicated that the catching capacity of gill nets may be more affected by the fishing volume of the net (no. of meshes) than by headline height. During these tests, the majority of fish were caught in the middle and lower half of the net, but very few were caught along the foot rope.

Flume tank experiments show that tidal effect causes a bulging of the net as it is pushed down, and this may contribute to the overall efficiency of the net. Fishing volume is, of course, governed by other factors such as material, frame dimensions, buoyancy, hanging ratio, etc. Further experiments are being conducted to test the headline height theory. Nets will be modified with top attachments which are expected to stream out in the direction of the tide over the nets. These will deter fish from escaping over the top.

The nets are also being rigged to prevent excessive crab catches. The absence of fish close to the footrope in previous testing suggests that some ground contact can be sacrificed without affecting catch rates, So, the nets will be rigged with a coir footrope hung in bights with leads spaced along its length.

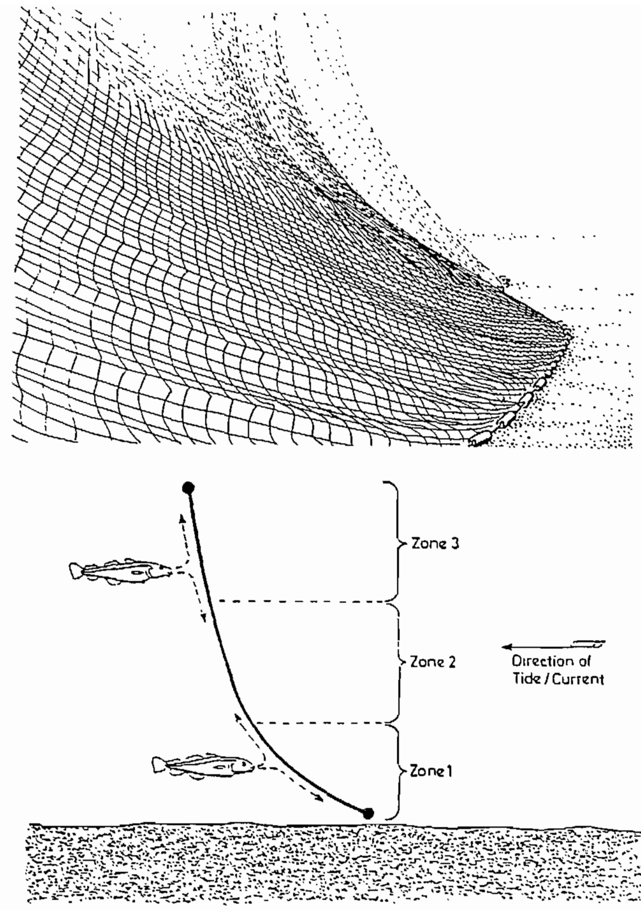


FIG. 23.

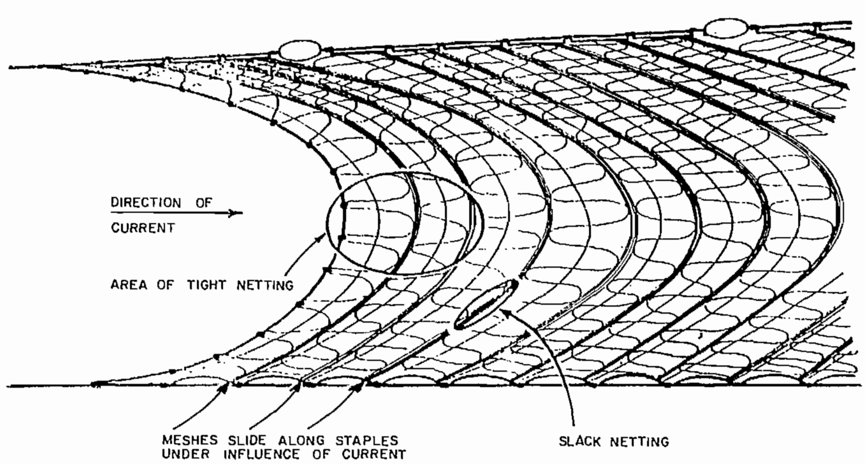


FIG. 24.

Gillnet fishermen in several countries have recognized that valuable species congregate in the vicinity of wrecks. They take advantage of this phenomena by rigging their nets in such a way that, even when set directly on top of a wreck, damage is minimal. In any event, the large catches justify the risk. There are special techniques employed in plotting the set, by means of sonar and vertical echo sounder observations, prior to shooting the nets. It is essential in wreck-netting for the vessel to remain on the gear during the soak period because a deterioration in the weather might cause a total loss of gear.

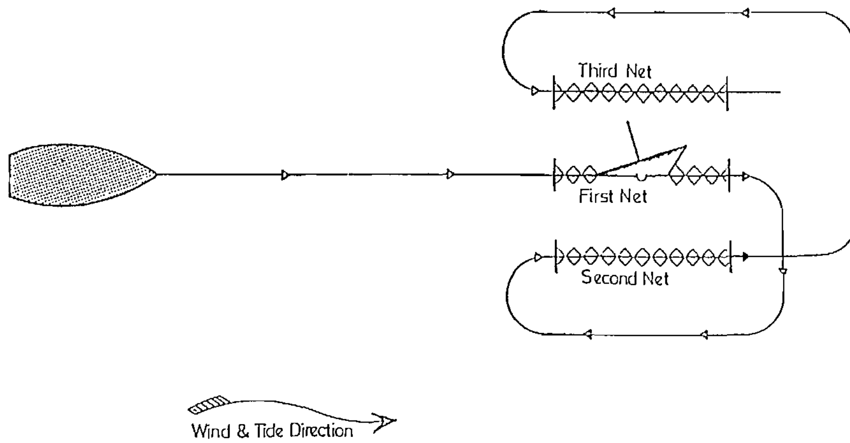


FIG. 25. Shooting of wreck nets.

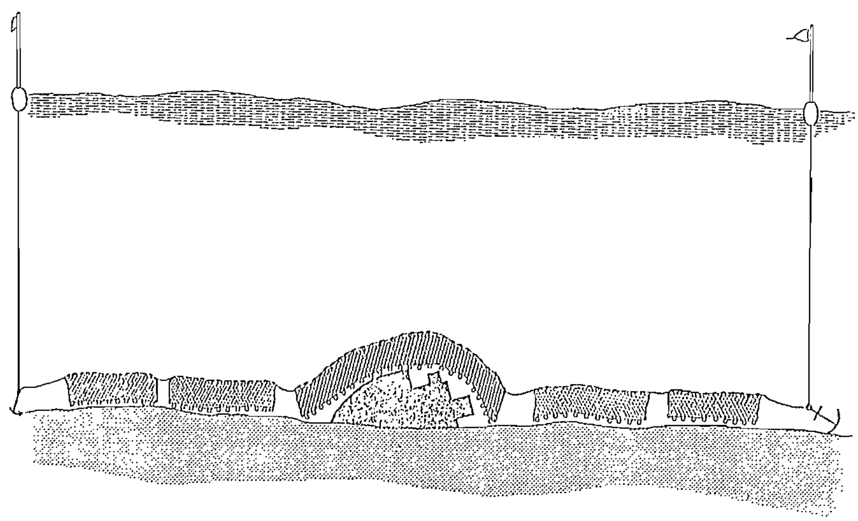


FIG. 26. Nets in position over wrecks.

Longlining

Hook and line fishing is one of the oldest methods of fishing known to mankind. Fishhooks have been located dating back to before the Stone Age. It is interesting to note that ancient hooks, carved from bone or stone, are very similar in shape to the circle hook used today. The great cod fishery of the Grand Banks was established as a hook and line fishery, and the schooner Bluenose, for which Nova Scotia is famous, was a salt bank schooner.

The popularity of hook and line fishing has declined rapidly in recent times. This has parallelled the introduction of modern trawlers, with engines to replace sails, synthetic materials to replace cotton, hemp and grass for netting and ropes, and the desire and need to land large quantities of fresh fish. The introduction of gill netting, with its reduced labor requirement, was responsible for a further decline in the number of fishermen engaged in the inshore longline fishery. However, longlining is still recognized as a low cost, selective, and fuel efficient method of landing high quality fish. With modern innovations to reduce labour, fishermen are again converting to longlining.

The introduction in the 1940's of powered haulers and synthetic materials was the first real improvement for the longline fisherman in several decades. This proved to be a boon and enabled him to fish deeper, more productive grounds than he ever could have done hauling by hand. No other major improvements were introduced until the Gill brothers of Newfoundland and a group in the Faroe Islands, separately, developed inexpensive random baiting systems of simple construction in the late 1960's and early 1970's.

In the early 1970's, O. Mustad and Son A/S of Norway introduced the "Autoline," an automated longline system which cut the bait and double baited each hook individually as the line was set. It also cleaned the hooks, untwisted the gangions and hung the hooks on racks for storage. At about the same time, Marco of Seattle, Wash., introduced the "Marco Tyliner," a random baiting system which utilized spoked wheels for stowing the overboard gear. Neither of these systems ever achieved sales in the volumes hoped for, perhaps due to the high initial cost or the radical changes in labour requirements. But they respresented the beginning of the modernization of the Canadian longline fishery which has seen a vast and confusing array of new technology, methods, and equipment being introduced within the past ten years.

There are now approximately nineteen different longline baiting systems available to Canadian fishermen, but only four are selective baiters. The remainder use a variety of methods for random baiting.

Circle Hooks

The circle hook is not a new concept. Tuna longline fishermen have been using hooks of this shape for years. What is new about them is the recent and sudden recognition in North America of their value in the halibut and other groundfish fisheries. A recent sea trial in Nova Scotia to compare the catching efficiency of circle hooks reported a catch of 128 halibut compared to 70 on an equal number of J-shaped hooks.

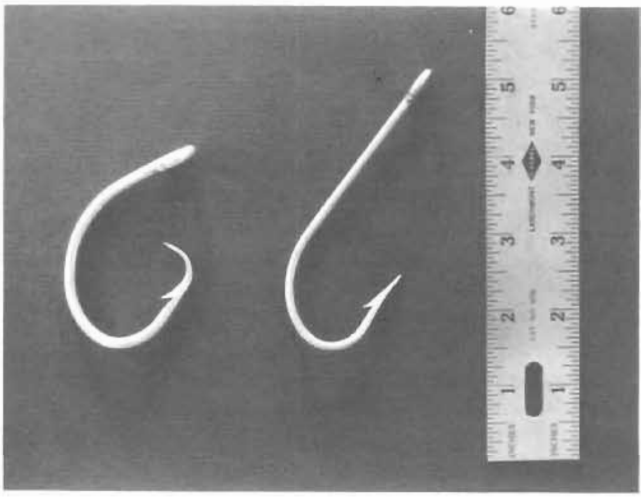


FIG. 27 Hook comparison: a circle hook and a traditional longline hook.

Scallop Rakes

Investigations on the use of scallop rakes, carried out by various agencies, show levels of catching efficiency from 15 to 25%, with mortality or injury to uncaught scallops of as much as 25%. Regardless of the accuracy of these figures, one must concede that the catching efficiency of traditional rakes is very low and that damage to the scallop stocks is high. In addition, large quantities of rocks are gathered causing damage to gear and danger to the crew. Short tows have to be made because of this accumulation of rocks in the rakes; time is lost, and fuel consumption is high.

Design changes to traditional Canadian gear have been rare, apart from minor changes to the sweep chain rigging and the addition of depressor plates. But the Department of Fisheries and Oceans is currently experimenting with several innovative approaches. Spring loaded, toothed blade rakes from Europe have been introduced in one or two inshore areas and, recently, limited success was achieved with a radically designed rake in the Nova Scotia offshore fishery. This rake relies on the lifting of scallops off the bottom by means of water turbulence, leaving rocks behind. In addition, experiments are being conducted using electrical impulses to stimulate scallops to "jump" into the path of the rake.

Work along these lines will continue and, with the cooperation and advice of scallop fishermen, it is felt that optimum efficiency will eventually result.

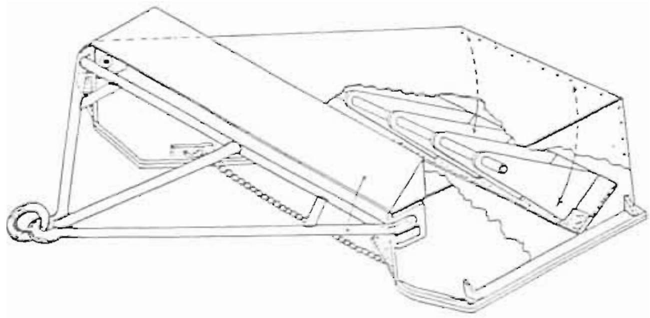


FIG. 28. Prototype scallop rake showing hinged blade designed to exclude rocks from the catch.

Underwater Video Cameras

Over the last 20 years, underwater camera techniques have progressed considerably. The oil industry makes extensive use of this technology in pipeline survey, bottom contour inspection, etc. One of the world leaders in the study of fishing gear is Torry Marine Laboratory in Aberdeen, Scotland. Diver-scientists from this establishment have specialized in studying fishing gear and have helped to refute many of the theories and myths concerning the performance of towed nets. From studies of fish behavior, it is now possible to design equipment to take into account various behavioral changes that occur in different species during actual fishing operations.

The versatility of the modern camera unit is such that it is quite common to manipulate it all the way back inside a towed net to the extension section. Also, various stationary camera units now exist to study fixed gear. We believe that this technology will continue to improve to the point where a headline mounted unit, similar to a net sounder transducer, will relay continuous wireless signals to a monitor on the bridge of a fishing vessel.

Training Simulators

With the rapid advance in fisheries electronics technology, the need for training in instrument use is greater than ever before. Simulator-assisted training is becoming essential for both beginners and experienced operators.

Data for all known operating conditions can now be easily incorporated into a system to simulate a wide variety of situations encountered at sea.

Pre-sea training for deckhands is also advancing in many areas, including safety, fire drill and basic seamanship. Some training schools have full scale models of a vessel's deck, including modern deck machinery and fishing gear which can be operated by students in a realistic environment. The main objective, of course, is to reduce the incidence of accidents and lost fishing time at sea.

Computer Technology Applications (Offshore)

We often hear the term "integrated fishing system" in reference to large offshore vessels. All fishing trips usually begin with a decision on where to fish. Data can now be obtained via satellite on relevant parameters, such as surface temperature and water conditions. On arrival at the predetermined area, following a route mapped by satellite navigation equipment, searching takes place with echosounders, sonar, etc. All details can be processed by computer, positioning the gear at the correct speed, height, etc. With a forward looking net sounder, it is now possible to monitor fish school movements and keep a midwater trawl at the correct height by increasing or decreasing towing speed as directed by the computer. Towing direction can be changed if fish are not seen in the direction of the tow, or, if a predetermined amount of fish has been caught, the tow can be terminated. Also, with a temperature sensor on the net, a warning can be given if the gear is being towed in the wrong temperature layer for the species sought.

Already winch units exist that are computer controlled, as in the Norwegian synchro system, with automatic shooting and hydraulic braking to a preset warp-length, and with automatic tension control to give warning of hookups. Every aspect of the gear will eventually be monitored by computer. These will include headline height, wing spread, wing end height, speed over the ground at the net, door spread, bridle angle, amount of fish in the cod-end and various drag parameters around the gear.

Future Developments

Developments in the form of innovative equipment, new techniques and new systems will continue; technology never stands still. Short term development must, however, be orderly with cost-effectiveness and landed quality in mind.

During the past thirty years, we have seen the evolution of synthetic net and line materials and sophisticated electro-acoustic fish finders which have revolutionized the industry. Then, there is Satellite Navigation, Loran C, and high-pressure hydraulic systems. Where do we go from here?

The electronic manufacturing industry is so competitive that we can reasonably expect the refinement of electro-acoustic fish counting systems to include species and size discrimination. Trawl systems will be linked to the sounder, and monitors on the gear will automatically control the fishing cycle.

The application of electricity including light, color, laser and sound impulses will receive even greater attention. And, even now, scientists are attempting to find means of attracting various fish species by isolating their sex odours! If artificial baits are possible — why not?

In 1965 Jean Frechet, then Regional Representative of I.D.B. in Quebec, stated in a paper entitled *Fishing Operations of the Future*, "Fishermen in the year 2000 may expect to scout surface fish through satellites." This is already a possibility via infra-red devices and the detection of fish oil slicks by means of spectrometers fitted on satellites. Mr. Frechet also mentioned the possibility of artificially induced schooling of fish, which is already a common practice in pelagic fisheries, using high intensity lights. In addition, rafts are used to create shadows in which certain species of tuna tended to congregate. High frequency sound waves attract some species and can be be used in conjunction with certain kinds of gear.

A new generation of fishermen has matured in an atmosphere of rapid scientific advancement and there has been a real change in attitude. Fishermen are ready to accept technological change and can discern the difference between genuine innovations designed to enhance their operations and other variations on established themes which are of no positive benefit. Fishermen, like everyone else, are subjected to high pressure advertising. We must, however, keep open minds and examine every new invention seriously. What may seem absurd today may become an accepted fact tomorrow.

This paper is not meant to be a learned treatise on gear technology. Our main purpose is to stimulate interest and we sincerely hope that we have done so. Technologists and researchers cannot work in isolation. We need the advice, ideas and — if appropriate — the criticism of fishermen. Dialogue is mandatory if we are to apply technology in the most appropriate areas.

It must be obvious that the evolution of technology in the fishery is dynamic and that new developments will be continuously introduced as time goes on. There are many agencies, many people dedicated to the enhancement of the welfare of Canadian fishermen. They have their fingers on the pulse of development all over the world, always seeking the opportunity of applying new techniques and technology in Canada. New technology can and must be applied in an orderly manner, for the benefit and perpetuation of two very valuable renewable resources, fishermen and fish.

Finally, the various agencies of government, both federal and provincial, which have the responsibility for development of the commercial fisheries are always available. If you have a problem, please remember they are there to help in any way they can.

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Prince Edward Island

Research efforts in P.E.I. are aimed primarily at aquaculture — mussels and trout. In addition, work is being carried out to improve overall fuel efficiency.

New Brunswick

New Brunswick successfully introduced pair bottom trawling in the Bay of Fundy, noteworthy in view of the strong tidal conditions. Ongoing projects are designed to improve fishing techniques in many of its aspects.

Nova Scotia

Nova Scotia is promoting rope-reels for Scottish seining and encouraging the adoption of net drums in the trawl fishery.

Newfoundland

Newfoundland adapted high-strength Kevlar in a three hundred and fifty mesh bottom trawl and reported a reduction of thirty kilograms in total weight measured against a similar polyethylene trawl together with fuel saving associated with the Kevlar small diameter, high strength webbing. Kevlar was also used successfully for trawl bridles.

Square mesh cod-ends are being tried in both inshore and offshore sectors and the results to date complement those of other researchers.

Automated long-lining is being carried out by a ninety foot, full-shelter deck vessel acquired by the province from Scotland. Catch rates have been as follows:

1983	1 562 957 lb of cod in 24 trips
1982	1 521 452 lb of cod in 22 trips

Trends in Canadian Fisheries Technology[1]

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Abstract

The fishing gear in use today has been developed over time through the combined efforts of experienced fishermen, gear manufacturers and fisheries researchers.

Various criteria dictate the characteristics of fishing gear: amongst these, selectivity is the most controversial. It is often seen by fishermen as a constraint on economic expansion, while scientists claim that selectivity is a way to improve the fishermen's lot over the medium to long term.

Greater selectivity in fishing gear represents, not a constraint to fishermen, but a tool to preserve the resource and a way to ensure a stable income to fishermen and, eventually, greater profits (because of its effect on product quality and market share). In an era of licencing, restrictions, and quotas, selectivity is the way to ensure a successful future.

Selectivity of Fishing Gear — Canadian Perspective

The various types of gear in use today all have their respective advantages and disadvantages. They have been developed over time on the basis of experience by the fishermen who use them and through regular communication and cooperation among fishermen, gear manufactuers, and fisheries researchers.

Generally speaking, the criteria establishing the characteristics of a net are efficiency and yield (the ratio of maximum catch to minimum capital and operating cost). To these should be added constraints such as grounds to be exploited, species to be fished, available horse power, type(s) of vessel used, and degree of selectivity desired.

It is this last constraint which will be discussed at some length because it has an important, direct influence on a number of aspects of the fishery — on stocks exploited, fishermen themselves, processors and, ultimately, the consumer.

Why Selectivity?

The Resource

Selectivity is one of the means of controlling the degree of exploitation of marine stocks, the preservation of which is increasingly considered essential in light of the current level of exploitation and the realization that, contrary to popular opinion, these resources are not endless.

In fact, overexploitation of a species can be either direct — with catches exceeding the ability of a species to renew itself (i.e. exceeding its maximum sustainable yield) — or indirect — when the fishing of one species leads to the exploitation of another species inhabiting the same grounds (as is the case, for example, with the shrimp fishery).

Catch

As far as catch is concerned, the selectivity of the gear used can have many advantages, provided, of course it does not unduly lower the size of the total catch, and hence, revenues. A selective net, therefore, must offer the fisherman some assurance of its ability to catch the species he is fishing (for example, shrimp versus fish), and also of its ability to catch the required size of creature (lobsters, crabs, or cod of a certain commercial size, for example). The advantage of this is to have less sorting to do onboard and to be able to respond quickly to a specific demand in the marketplace. Moreover, to cull be size and species permits an overall improvement in the quality of the catch brought onboard, (in the case of the trawl, for example, there would be less crushing and, therefore, improved quality of the raw material.)

Processors

Even if they are not involved in the actual fishing operation, processors are affected by the selectivity of nets or their

[1]Presented in French.

effectiveness in this area. In fact, individual size, particularly with fish, may directly affect the type of finished product which results, its cost price, and the market these products will enter.

Consumers

The resulting commodity will be better appreciated by consumers who are used to standardized products graded according to size and more in keeping with their normal eating habits (for example, eggs, chickens, peas, etc., all are now graded by size — small, medium, large).

How to be Selective

Now that we have established the reasons which justify our interest in the issue of selectivity of nets, we should ask the following question: *Is selectivity possible*? If yes, how? Under what conditions? At what cost? The answer to the first question, evidently, is yes. The majority of nets used today are more-or-less selective. Still, we need to know what level of selectivity we want to attain, and to what purpose. The second question requires a more complex response.

When used as a stock enhancement measure, one of the best examples of selectivity is offered by the mesh. The size of mesh used permits immature fish to escape, to survive and to reproduce. If later, the total weight of the recaptured escapees is greater than what escaped in the first place, the value of such a strategy is self-evident. (This is what justifies, on a mid-term basis, the implementation of this type of measure and it is the goal when using selective trawls in the shrimp fishery.)

Another way to obtain results is to design and use nets which allow all or most of a species to escape. I must admit here, however, that it is not possible to fish for each species with total selectivity. We must resign ourselves to the need to make certain compromises and to live with a certain degree of mis-exploitation. It goes, almost without saying, that this must be kept as low as possible.

If, aside from preserving the stocks, one aims for a certain size of catch or the elimination of undesired species, the problem is a bit more complex. Not only does one have to refer to physical characteristics of the species to determine the characteristics of the nets to be used, but one must also consider species behaviour.

Another element of complexity to be considered is the type of net to be used, fixed or mobile. In fact, the reactions of different species will vary considerably with different gear because they all do not utilize the same stimuli. The degree of selectivity, therefore, will vary according to the various combinations: gear type/species.

Fixed Gear

Among fixed gear types, the most widely used in our waters are: gillnets, traps, longlines, and pots. The first two are purely passive and their yield is determined simply by the presence or absence of the desired species and its propensity to be caught. In both cases, the question of selectivity is relatively simple, and relies mainly on a certain stiffness of the gear itself and on the hanging ratio of the webbing, as well as on its visibility, which can be a determining factor for certain species. On this subject, we should add that research on escape panels for cod traps has been carried out in Newfoundland and has provided interesting results; we might also mention that work done in Aberdeen, Scotland on the visibility of nets has made an important contribution.

The efficiency of longlines is based on the presence of fish, the bait (its efficient life), and the size and shape of the hooks used. In fact, the dimensions of the hooks directly affect the size of the fish caught, while their shape may well determine the species to be caught (adaptation of the technology to the size, shape, and behavior in question).

Bait can also influence selectivity, but only at the species level. (This is a complicated issue which varies enormously from one region to the next; we will limit ourselves, therefore, to simply mentioning the fact here.)

Pots have an efficiency evidently depending on the presence of the desired species and the efficiency of the bait, but also, on the behaviour of the species, before and after capture, since the catch is free to roam around inside the pot after capture (unlike gillnets or longlines).

I would like, at this point, to mention, briefly, research being done, most particularly in Quebec, on three types of traps: lobster, snow crab, and rock crab traps.

Tests on lobster traps go back to 1981 and carried through to 1983. We have tried to establish the optimum dimensions for escape vents on these traps so that only legal sized lobsters would be taken (bigger than 76 mm, bigger than 3 inches).

I will not dwell on the specifics since the work done already forms part of a published report on the subject. Let me simply say that we have been influenced in our work by the research of others and by biological studies done on lobster populations in our own waters (Cavanagh, C. 1980 — P.E.I. — Fogarty and Borden — Dourse and Thomas Nulk, Smolovitz, Templeman, and Wilder). We have, as a result of these studies, succeeded in determining a shape and size of escape vent which permits a 100% legal lobster retention (2% in number, or 8% by weight), while attaining a 93% rejection rate for undersized lobster.

An interesting fact to note here is that we have often recorded an increase in the commercial (legal) sized catch. This we have attributed to the fact that there is no trap saturation with the use of escape vents, a feature which permits efficient fishing for prolonged periods of time.

An important economic advantage must also be underlined; it has been estimated that in the Magdalen Islands 46% of the lobster catch is below legal limit and that the weight of pincers lost due to handling as well as fighting in the traps is around 49 200 lb, the equivalent of $98,400. Add to this the loss of $101,294 for mutilated lobsters, which sell for less than normal market value, and the total loss in the 1982 season amounted to approximately $200,000, far from being negligible.

In the case of the snow crab trap, we have compared the yields of the regular trap (Fig. 1) and the Japanese trap (Fig. 2). We have noticed a marked difference between the two types in the percentage of large crab captured. Our studies have indicated that, aside from the fact that the yield of any one trap is proportional to its volume, the incline of the slope of access has a determining effect on the size of catch.

Work using tanks is being done to try to determine, as we have for lobster, some basic parameters for experimentation with regard to terrain. Finally, in the case of rock crab, I would like to mention that this trap has given good yield,

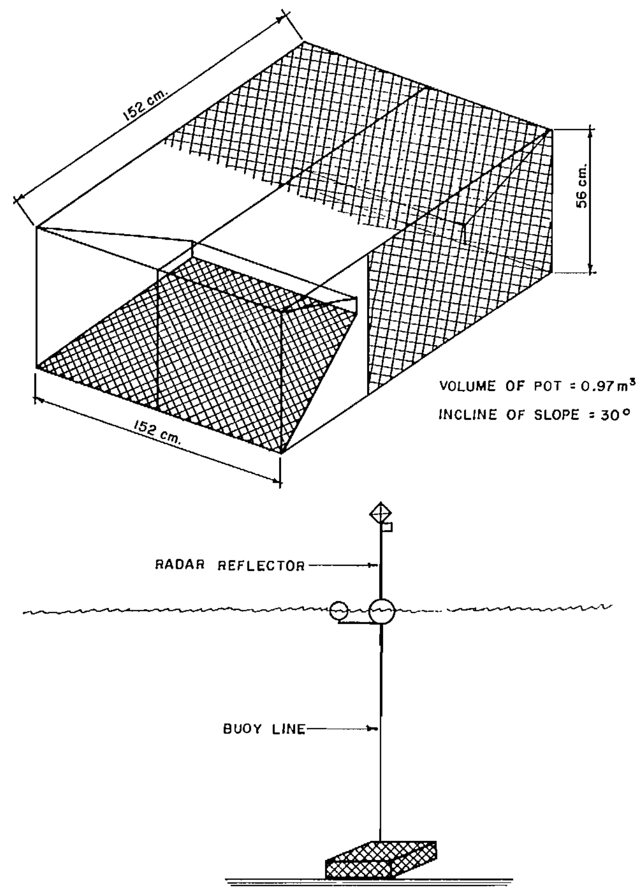

FIG. 1. Sketch of regular crab pot and method of fishing.

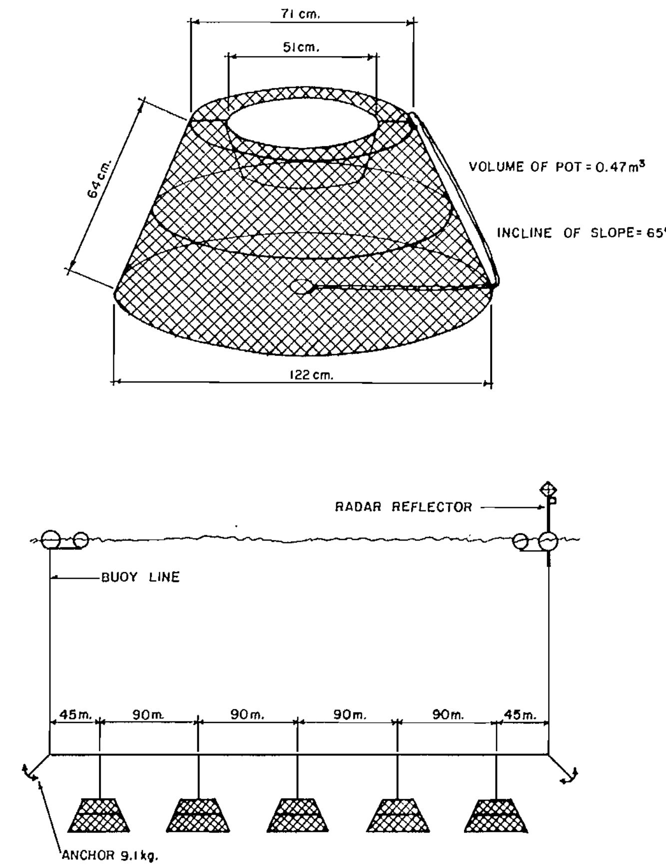

FIG. 2. Sketch of Japanese crab pot and method of fishing.

without taking a single lobster. This was the case even though the experiments were conducted in an area inhabited by both species and at a time of year when lobster is particularly susceptible to being caught (after moulting).

These examples show that it is possible, with fixed gear, to achieve very satisfying results in terms of selectivity, both in terms of individual size and species desired.

Mobile Gear

When we confront the question of selectivity in mobile gear, however, the problems are different than with fixed gear.

As a matter of fact, the yield of mobile gear is not solely dependent upon the presence of a species, but also on its behavior when faced with certain phenomena. If these phenomena resemble what is natural, behaviour by the species will be predictable, but if they are unknown to the species, varied and unusual behaviour will result. In this case, the screening of a species according to size will have to take into account, not only physical dimensions, but behavioral characteristics as well (juveniles may well behave differently from adults within the species). This will influence the size of gear, the towing speed, and so on.

It is data on the behavior of certain species (reactions by pelagic fish, for example) which have brought about the development of really spectacular trawls (rope trawls or big mesh trawls with 8 m or 26 feet of stretch mesh). These trawls have a tremendous fishing capacity (this work was done in Aberdeen) (Fig. 3 and 4).

On the Canadian side, certain things have been accomplished on the square mesh trawl, the super mesh trawl, and others, but we must stop at work done several years ago. This work was aimed at allowing a more selective shrimp fishery, eliminating by-catch of groundfish, particularly of juvenile ocean perch.

Among these three projects, which we will discuss briefly, the first used a pelagic trawl, and the other two used bottom trawls, to which were added a shrimp and fish separation system.

Pelagic Trawl

This trawl was selected by the Technology Branch, Environment Canada and the Research and Development Branch of Fisheries in New Brunswick (Fig. 5). It was tried at the same time as a Danish trawl, the Blaeksprutte, which has three bridles.

At first, the objectives sought were to maintain shrimp catch levels to some degree of consistency, night and day (thus eliminating vessel idle time) and to eliminate debris,

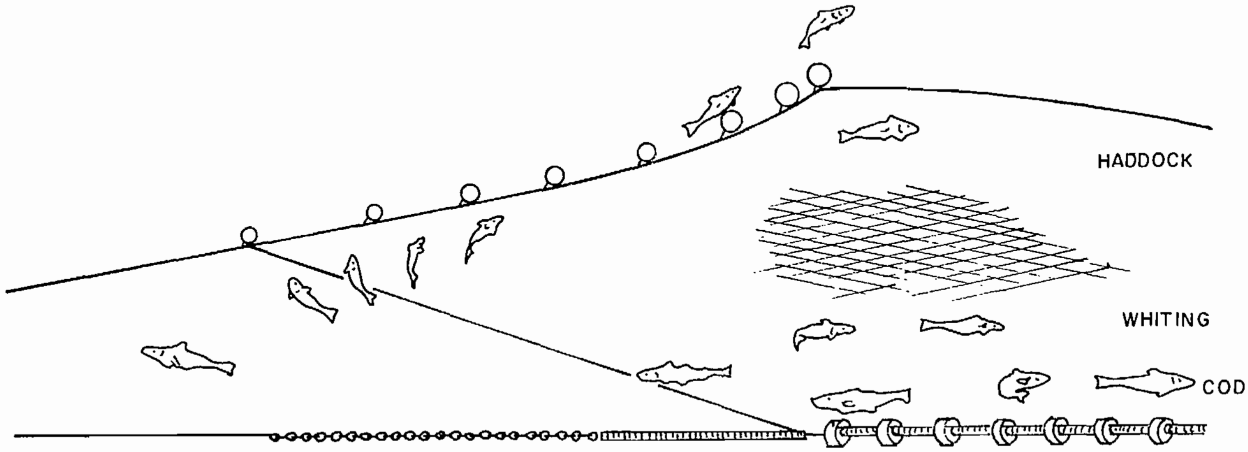

FIG. 3. Behavior of species in front of trawl.

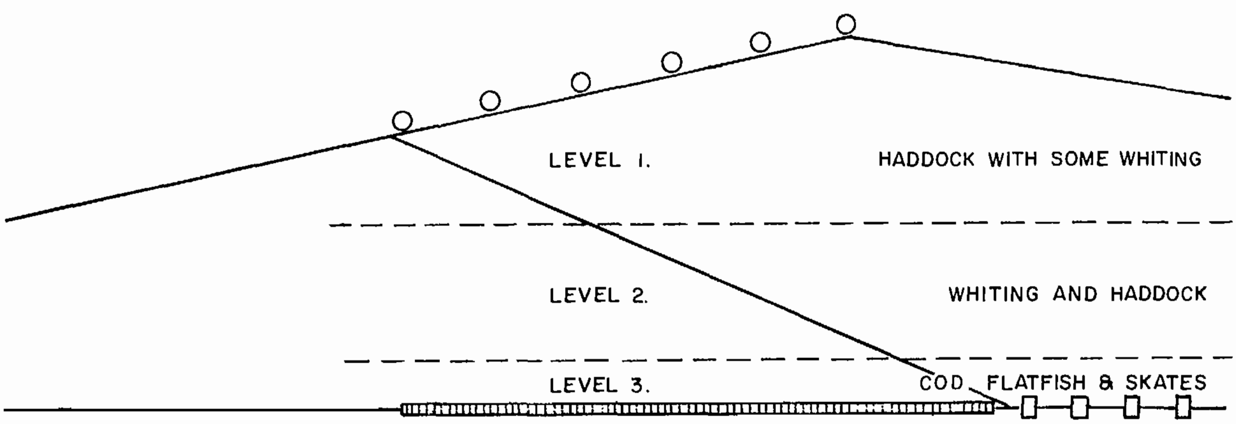

FIG. 4. Design of a separator trawl.

which can negatively affect the quality of the shrimp. The results achieved helped establish that such a trawl would also screen out immature ocean perch.

On the next page, we present (Fig. 5) a diagram of the pelagic trawl used during the 1978 comparative trials of the three different models. These studies were carried out by Jack Rycroft and his team and many reports on this work have been published. With this trawl we have obtained results in terms of selectivity nearing those obtained using the two other trawls, at least so far as eliminating most of the juvenile ocean perch is concerned. This was achieved by operating the trawl at a depth where there were relatively few juvenile ocean perch or in such a way that they could easily slide under the net.

Bottom Trawls

While Nova Scotia worked on selective trawls for shrimp, so did Newfoundland and Quebec. These used an internal system of selection designed to separate the shrimp from bottom fish and to eliminate captured juvenile ocean perch. The diagrams of these two trawls illustrate the similarity between the designs (Fig. 6 and 7).

The problem we were attempting to solve at the time had to do with the size of mesh established to conserve shrimp, but also to permit other species to escape. The principle used was based on behavioural differences between the two species; fish, more sensitive to the approach of the net, exhibit excape behavior, while shrimp react only to contact with a moving object.

Both trawls gave good results, but we must recognize they were not without their problems... a certain inconvenience. Fishermen were presented with a trawl more delicate in construction and more complicated than they were used to. Thus, its acceptance was not to the extent expected by researchers (at least in Quebec where it was not adopted at all).

Studies conducted since with a vertical shrimp distribution sampler designed and tested by our Research Station at Grande Rivière (Fig. 8) have made it possible for us to establish that it would be to their advantage for shrimp fishermen (if they keep using trawls having the same vertical opening of those currently in use) to ignore the zone situated between the bottom and one meter from the bottom and to simply hoist their trawls to work at 1 metre and above. Not only will the quantity of shrimp caught be greater, but there will also be less (almost no) debris among them and, inter-

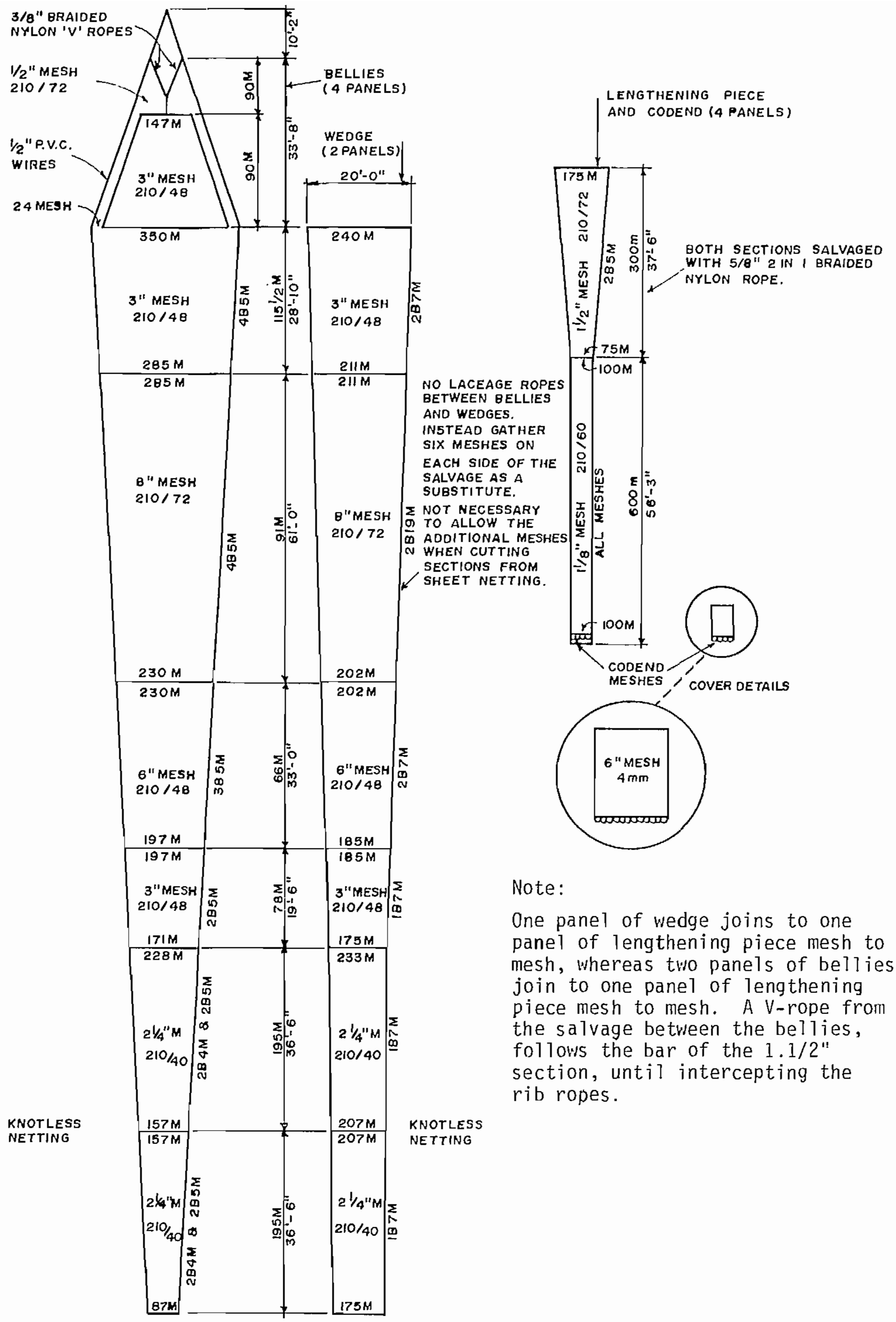

FIG. 5. The pelagic trawl used during the 1978 comparative trials.

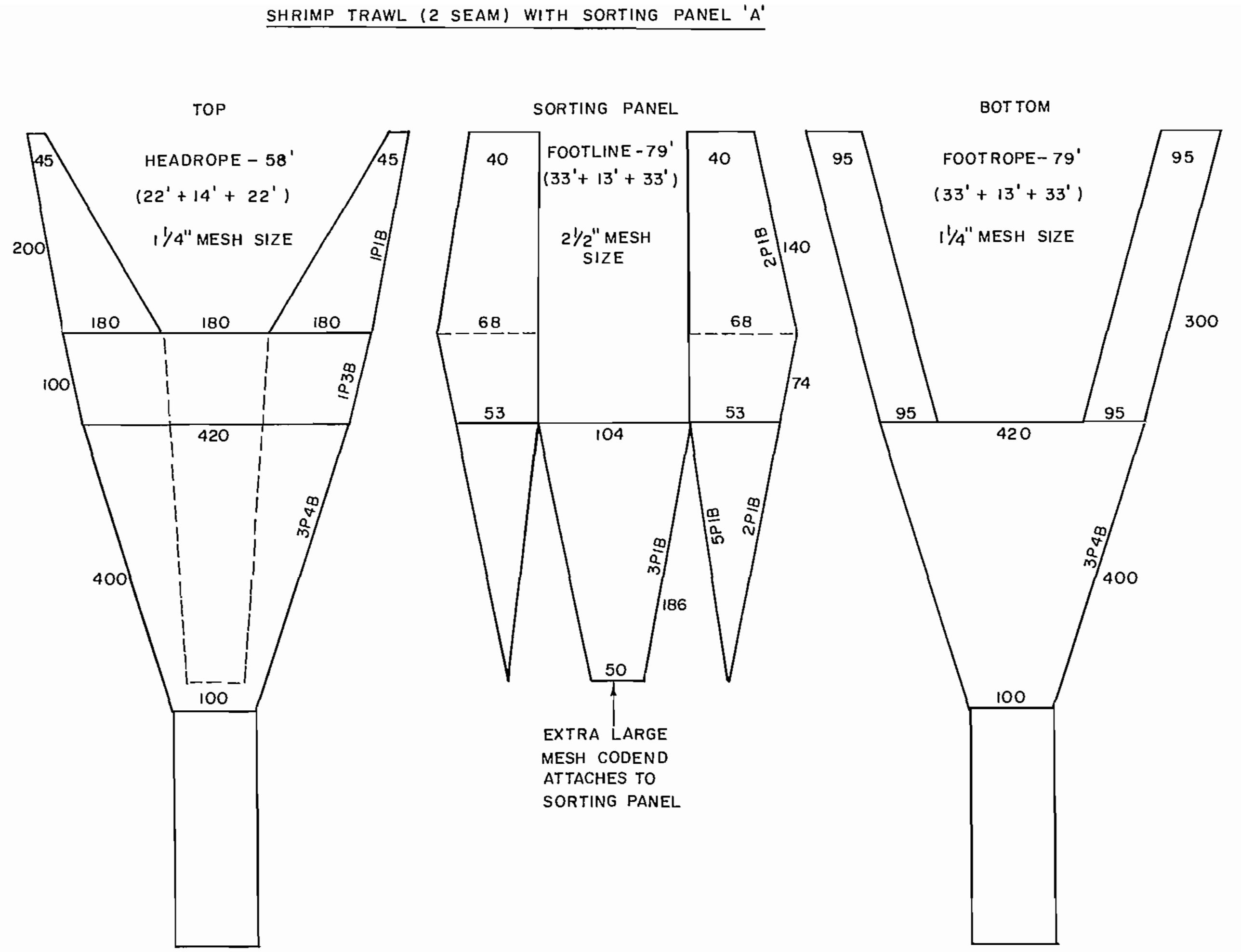

FIG. 6. Selective trawl for shrimp (Newfoundland).

estingly enough, the majority of small ocean perch will be eliminated as well. (According to results obtained in vertical samples, they are found on or near the bottom — within 1 metre.

This brings us back to the design of a large, vertical opening trawl, fishing at a predetermined depth, back to the studies done by Jack Rycroft and his team.

The trawl we are working on still catches bottom fish mixed with shrimp and perhaps, if the notion of quality marine products and of species fished by any given vessel (quotas per vessel) continues to be important, we will be forced to develop a trawl to catch solely shrimp and, consequently, to combine both types of trawl.

Before concluding, I would like to add that, today, net technology is becoming more and more sophisticated as demands become more numerous and solutions become more and more complex.

In this area, as in many others, computers have made an appearance and we may now take for granted that having passed from direct experimentation to the study of scale models in test tanks, the day is not far off when it will be possible not only to design nets by computer, but also to simulate their behavior, the three approaches being complementary.

We must, therefore, prepare ourselves for this new technology which will be one more tool in the hands of net designers and which will permit them to answer more effectively the demands of the fishing industry as a whole and of the fishermen in particular.

In conclusion, we can say that the evolution of techniques, gear, and available technologies which has occurred permits us to foresee the development of ever more selective gear. It will allow the escape of enough individuals to ensure that the total weight of recaptured cull is greater than that released in the first instance or it will allow the escape of part or all of a protected or non-desired species.

We must remember that selectivity alone does not constitute a universal panacea, but used with other measures to control fishing or overfishing, it can improve the fisherman's lot. Selectivity should not be considered a curb on fisheries development, rather as a tool, too often neglected, to be used to perfect our methods. It will not only preserve the resource, but ensure a greater profit for the fisherman who will be able to increase quality and gain a greater share of the market.

One important point remains: we must be aware of the vulnerability of the marine resource, of the limits of exploitation. This awareness has brought about an interesting development: marine resources are now considered a collec-

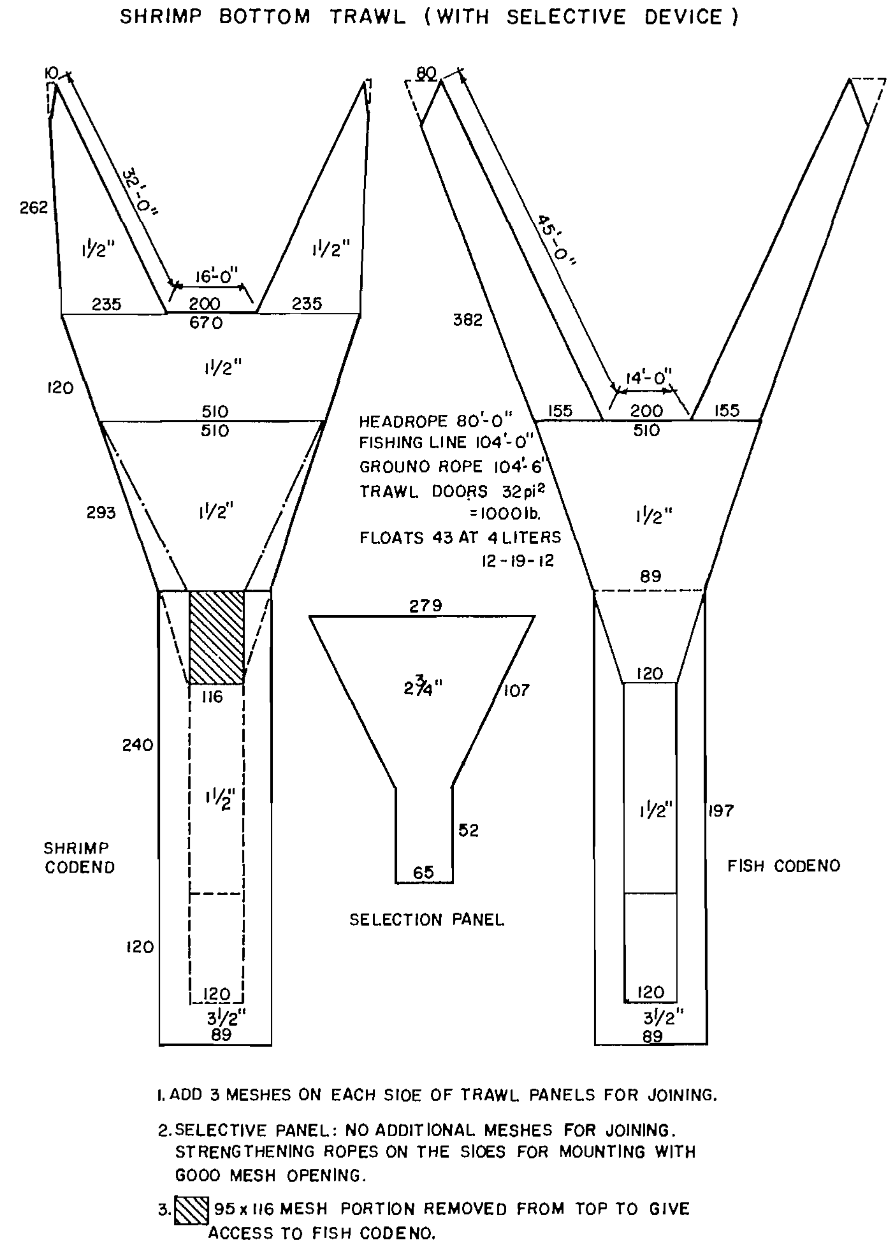

FIG. 7. Shrimp selective trawl (Quebec).

tive property, to be exploited for the benefit of the collectivity (country or region), which stands in opposition to the traditional situation in which exploitation has always been, until now, markedly individual in character. Now, at the level of the individual or the fleet, exploitation rates must be established which allow fishermen, if not to increase, to, at least, maintain a decent income.

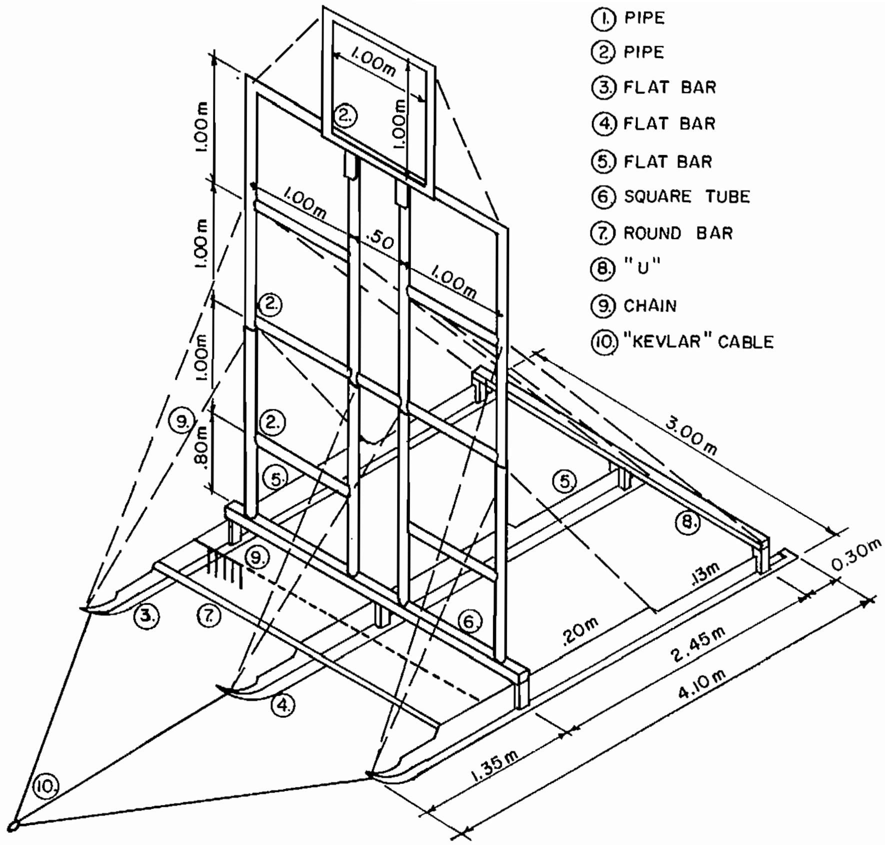

FIG. 8. Vertical sampler used in 1980.

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The AFTC was very much a media event. *Above*, Conference speakers, Captain David Tait, Halifax, Nova Scotia (left), and Mr. Ulrik Jes Hansen, Hirtshals, Denmark (centre), meet with members of the press. *Below*, CBC Television "farm and fisheries" commentator, Mac Campbell, interviews delegate Walter Bruce, President of the P.E.I. Fisherman's Association.

SECOND WORKING SESSION
Handling and Holding Fish on Vessels

Chairperson: D.A. (Sandy) MacLean
Deputy Minister of Fisheries, Nova Scotia

European Fish Handling and Holding Methods

Karsten Baek Olsen

Research Scientist, Technological Laboratory
Ministry of Fisheries
Technical University of Denmark

Abstract

Modern Scandinavian catch handling and holding methods will be described in some detail, as will short-term trends in the development of new methods.

Examples of practical deck layouts are included for vessels from thirty to one hundred feet, used to fish pelagic or demersal species. These vessels employ longline, gill net, and Danish or Scottish seine or trawl.

Catch handling and holding can be divided into several "unit operations" ... subdivisions of the process from the moment the fish are landed on board the vessel until they are unloaded. Examples of unit operations include: sorting, gutting, bleeding, chilling, boxing, holding, and unloading. These operations can be carried out in several ways. And the most popular methods currently in use are described. In practice, of course, the number of operations used depends on the species caught, gear required, vessel size, and duration of the voyage.

Introduction

The most common and most modern catch handling and holding methods used in Europe on board vessels, from thirty to one hundred feet, are summarized here together with short-term trends in the development of new methods. Special reference is made to Research and Development work in the Scandinavian countries.

The aims of this work are the following:

1) To improve the working environment on board fishing vessels to such a degree that no fisherman need leave his occupation prematurely for health reasons.
2) To maximize the quality of the landed fish (raw material). Quality should never be the limiting factor in the food use of catches from inshore coastal fisheries.

In Scandinavia, we try to meet these aims by introducing equipment which will eliminate heavy lifting, unsuitable working positions and rough handling of fish. By doing this, we are speeding up catch handling, thereby starting the chilling process much earlier than was previously the case.

Encouraging Investments in Catch Handling and Holding

Too often investment in catch handling and holding equipment is far below investment in equipment designed for catching larger quantities of fish at the lowest possible cost. It is absurd to concentrate on quantity, especially when fishing under a quota system because of a decreasing resource, when what we should be doing is to maximize catch values. It is not nearly enough to simply create individual technical solutions to these complex problems. It is not enough to subsidize investments in equipment which will improve quality. A system which correlates fish quality and high prices, thereby creating a cause-and-effect relationship between effort and profit, will be required on a short-term basis.

Quality and Storage Life of Fresh Fish

It is a well documented fact that holding temperature is by far the most important factor determining the storage life of fresh fish (Fig. 1, 2, and 9)*. It is not worthwhile to even consider other factors unless there is a controlled storage temperature between −1°C and 0°C. The availability and cost of ice are, therefore, very important. In Denmark, we have, as a result, established a very good infrastructure to deal with this issue.

In spite of this, it still occurs too often, especially in inshore fisheries, that we use too little ice and what we do use, we use in the wrong way. Ice costs in Denmark are around $10 (Cdn)/ton and account for around 1–3% of the gross value of the catch. Another important factor affecting quality is the time gap between landing the fish on deck and the start of the chilling process (Fig. 6 and 7). And then, too, the chilling rate must be considered (Fig, 3, 4, and 5).

Because delayed icing has a negative effect on quality, it is important not to "overtax" handling capacity. In trawling this can be done by using catch (filling) indicators on the cod-end to prevent more fish from being landed on deck than it is possible to handle within some reasonable period of time, for example, 2 to 3 hours. My point is that it is not advisable to depend on a fast turnover in the use of the landed fish to compensate for ineffective handling and holding.

Catch Handling and Holding Methods

Catch handling and holding methods can be divided into several so-called "unit-operations," subdivisions of the whole process from the moment the fish are landed on board the vessel until they are unloaded. Examples of unit operations could be methods for sorting, gutting, bleeding, chilling, boxing, shelfing, and unloading. Unit operations can be performed in several ways ranging from manual methods to fully automated operations.

I will now describe the most important unit operations in use in Scandinavia. How many operations are used in practice and the order in which they are used depends on the species to be caught, the fishing gear used, vessel size, and duration of the voyage. For the sake of convenience, the operations will be divided into methods used for species which — by law — need not be gutted immediately after catching (most pelagic species) and species which must be gutted immediately (most demersal species).

Pelagic Species (Herring and Mackerel)

The most important unit operations used for handling pelagic fish are the following: transferring the catch from fishing gear to vessel; raw material holding before handling; sorting/grading; transport to the hold for chilling; chilling/chilled storage; and unloading.

In general, the handling of pelagic species should be fast and rational, ensuring an early start to chilling, a high chilling rate, and homogeneous storage temperatures, around −1°C and 0°C. If you cannot start the final chilling within a short time, a pre-chilling method should be used (Fig. 22, 26a, 26b, and 27).

Transferring catch from gear to vessel

Trawlers use tackling (in lifts of up to 2 tons) or pumping.

Small herring gillnetters haul their nets and store their catches in the net until landing. The herring are shaken from the net by hauling them over a 4-inch PVC-tube.

Holding before handling

Traditional 1 metre high deck-pounds are used. Some trawlers pre-chill the herring in deck-pounds by icing. A few use CSW pre-chilling tanks (Fig. 22 and 27).

Sorting/grading according to size

Sorting is done by machines using vibrating bars with increasing distance between the bars. By-catch is often separated from the herring by hand (Fig. 23, 24, and 25).

Transport to the hold for chilling

CSW-RSW vessels pump their catches to a water separator. Chutes carry the catch to the tanks.

During boxing, the fish are normally transferred directly into the boxes by means of tubes.

The most advanced pelagic trawlers use a conveyor system leading the fish from the grader into the boxes. The boxes are often palletized in the hold (Fig. 23 and 24).

Chilling/chilled storage

Boxing is the most commonly used method. Box sizes are 20 or 40 kilograms. The majority are plastic.

There are only a few vessels in the 30- to 100-foot class using CSW-tanks.

Unloading

The boxed catch is unloaded in lots varying from single boxes to pallet loads, consisting of twelve 40-kilogram boxes.

CSW/RSW stored fish are brailed into boxes or 500-kilogram containers.

Regulations issued by the Danish Ministry of Fisheries concerning handling/holding of herring

Trawl- and purse-seine-caught herring should be boxed (an exception is made for RSW/CSW kept fish).

Herring caught with other gear should be boxed not later than 8 hours after catching. Normally, fish should be iced immediately after being caught.

In the period of November 1 to March 31 it is acceptable that icing take place within 8 hours.

Note: Regulations concerning icing do not apply to trap net boats and small open boats.

Demersal Fish (Groundfish, White Fish)

The most important unit operations used for handling demersal fish are the following: transferring catch from fishing gear to the vessel; sorting/grading by species; sorting/grading by size; throat cutting/gutting; washing/bleeding; transport to the hold for chilling; chilling/chilled storage; and unloading.

In general, the handling of groundfish should be rational, using methods which will ensure that the fish will be gutted, bled, washed and chilled as fast as possible after being landed on the vessel. If it is not possible to start the final chilling within a short time, a pre-chilling method can be used.

*All figures are grouped at the end of the paper for easy reference.

Transferring catch, gear to vessel

Trawlers and seiners (Danish and Scottish) winch the catch into deck-pounds. Usually, pounds with raised bottoms or with bottoms which can be raised hydraulically are used (Fig. 18, 19, and 21). The purpose of these designs is to ensure good working positions for the crew.

A few trawlers use CSW tanks for pre-chilling the catch (Fig. 22, 26a, 26b, and 27).

Gillnetters also use the same work-saving pound systems, often with a conveyor for bringing the fish to a gutting table.

Sorting by species

This operation is normally done by hand. The fish species are placed in baskets or pounds before, or in connection with, gutting.

Research work is being conducted to examine whether a COMPU-VISION system, i.e. a computer and TV-camera linked together, can be used for this operation.

Sorting by size

This is normally done by hand, before, during, or after the gutting process. Some automatic sorting systems (by width or length of fish), and using the COMPU-VISION system, are being tested here as well.

It is usual that sorting and weighing according to size and box load take place at the time of landing, before the auction is held.

Throat cutting/gutting

There is some difference of opinion among research institutes in Scandinavia, just now, as to the most effective method(s) of performing this operation. The subject of that debate is whether throat cutting should be separated by a bleeding period before gutting, or whether throat cutting and gutting should be one operation. This has something to do with getting whiter fillets. Throat cutting/gutting in a one-step operation will give good results — white fillets — as long as the fish is still alive. Throat cutting alone in live fish will, however, produce white fillets too, while bleeding has been shown to give best results if it is done in water (possibly iced) (Fig. 8).

When handling live fish — which is possible in fishing with longline or gillnet and using a small crew, only two men — it will be advantageous to do the throat cutting as a single operation and let the fish bleed in insulated containers using iced seawater. By way of contrast, it is just the opposite for trawling. After, the often, very long time it takes to handle a haul of several tons, the fish will no longer be alive. Here, performing throat cutting and gutting as separate operations will slow down the handling process; have a negative effect on quality (eg. colour); and result in delayed icing. Throat cutting/gutting, therefore, have to be done as a single operation. The most important factor is to work fast — throat cutting should be done within approximately 3 hours, or more precisely, before rigor mortis sets in. It has recently been proven that the time gap between landing the fish on deck and cutting the large blood vessels is by far the most important single factor determining the colour of the fillets.

To maintain a reasonable speed during the process, you have to mechanize handling using internal transport systems in combination with the fastest possible gutting methods. When gutting round and flatfish manually, we use gutting tables, transporting fish to and from the fisherman by suitable conveying systems. The fastest catch handling method, however, is the use of gutting machines for round fish with a speed of approximately 55 fish per minute for a fish length up to 52 centimetres and approximately 35 fish per minute for a fish length up to 75 centimetres. Gutting speed is six to seven times faster than with hand gutting.

The Dutch have recently developed a flatfish gutting machine. Speed, approximately 30 fish per minute.

Washing/bleeding

This operation is normally done in pounds (often with raised bottoms) in special bleeding tanks, either with a hydraulically operating tilting system or continuously, with special equipment (Fig. 11 and 12). (All washing/bleeding is done in running water.)

In machine gutting, a continuous washing apparatus is nearly always used, removing intestinal residues (Fig. 20, 21, 22, and 27).

In Scandinavia, there is also some disagreement regarding optimal bleeding time in water. In Denmark, we advocate icing the fish immediately after washing, while the Icelanders advocate a 5 to 15 minute bleeding time. We have found that, if the bleeding is bad, the fillets become pink.

Another problem is blood spots (extravasation) caused by breaking of the tissue. "Bruising" appears when the fish is still alive and is caused by rough handling — possibly in the fishing gear itself. It can be difficult to remove this kind of discoloration even if the bleeding is done by the best methods.

Transport to the hold for chilling

This is normally done by using baskets, in combination with chutes, leading to the fish rooms or boxes. From hydraulically operated washing tanks, the fish are often tilted to a chute leading to the hold.

When the systems are mechanized, a chute very often channels the fish directly to shelves, to a holding system for the different fish sizes, or to boxes.

Chilling/chilled storage

In practice, the fish are boxed or placed on shelves, spaced at between approximately 1 and 25 centimetres (only one layer of fish). Experiments on a few vessels have been carried out with insulated CSW-containers (Fig. 10, 17a, and 17b). It has been our experience in practice that shelving gives better temperature control than boxing and, therefore, permits a longer storage life (Fig. 3, 4, 6, and 7). However, CSW-storage in small containers gives a very high chilling rate and a low, uniform storage temperature (Fig. 3 and 4). And because excessive handling of the fish has a negative effect on quality, boxing might be preferable to shelving. In practice, however, fish are often not graded by size and weighed on board. These operations are done after landing but before auction. It is here that most of the initial advantages of boxing are lost.

Unloading

Shelved fish are unloaded, using baskets or boxes, which are filled as the shelves are removed. The fish are hoisted from the hold and emptied onto a conveyor leading to the manual sorting and weighing area.

Examples of Deck Layouts

Examples of practical deck layouts are illustrated for vessels from 30 to 100 feet, fishing for pelagic or demersal species, using longline, gill net, Danish or Scottish seine or trawl (Fig. 10, 13, and 27).

Some Conclusions

It is not easy to introduce rational handling and holding methods on existing vessels. Also, today it is often necessary to be flexible and to change fishing methods with very short notice, eg. from catching demersal to pelagic species. In the construction of new vessels, it is important during the planning stages that the skipper/owner, naval architect, mechanical engineer and fisheries technologist seriously consider catch handling and holding methods in order to reach the best possible compromise when giving the vessel its optimum design.

The most important consideration when introducing better handling and holding methods is to find the system which correlates fish quality and price.

As a long-term strategy, it is vitally important to point out to the fishermen what is considered to be quality handling and holding practice.

Fish technologists and researchers should take up the challenge of transferring old, established knowledge relating to the handling and holding of fish onboard into everyday practice. You only have to open your eyes when walking dockside to see how much there remains to be done concerning that most important procedure: PROPER ICING.

Praeterea censeo multam
glaciam esse applicandam.
(With apologies to Cato the Elder.)

STORAGE TEMP.	STORAGE LIFE
0° C	11-12 DAYS
-5° C	6-8 DAYS
3° C	5-6 DAYS
7° C	2-3 DAYS
10° C	20-30 HOURS

FIG. 1. Storage life of cod fillets at different temperatures.

NUMBER OF DAYS AT 10°C	5°C	REMAINING AT 0°C
0	0	12
1	0	8 (= 12 ÷ 1x4)
0	2	7½(= 12 ÷ 2x2¼)
1	1	5¾(= 12 ÷ [1x4 + 1x2¼])

CUMMULATIVE EFFECT OF TIME x TEMP.

FIG. 2. Storage life of cod after temp. load.

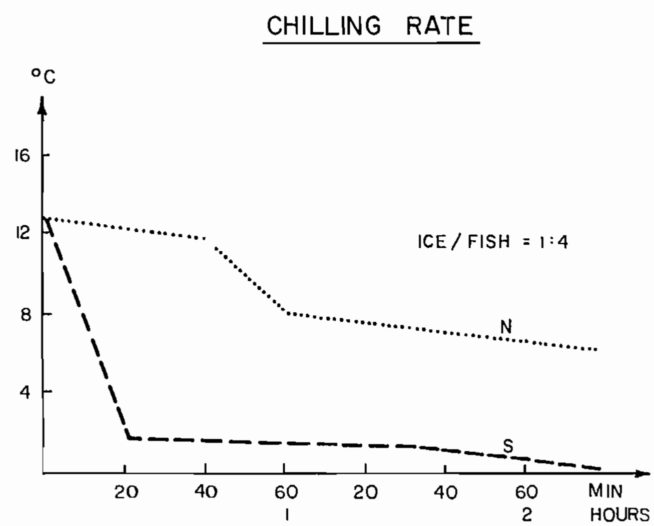


FIG. 3. Chilling rate by icing in boxes (N) normal and (S) C.S.W.

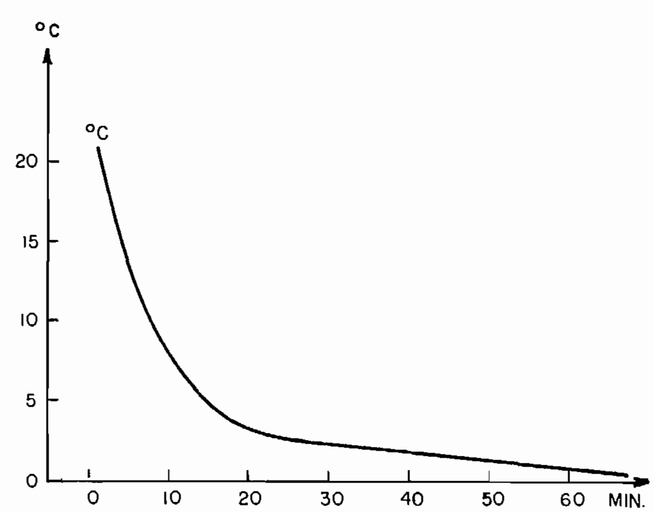
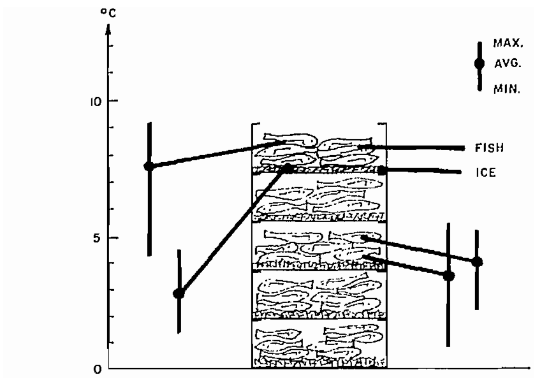


FIG. 4. Chilling rate of sole in 200 L C.S.W.



TEMP. AFTER 2 DAYS CHILLED STORAGE OF SOLE IN BOXES. AVG. OF 10 MEASUREMENTS AT EACH POINT. AMBIENT TEMP. 14°c

FIG. 5.

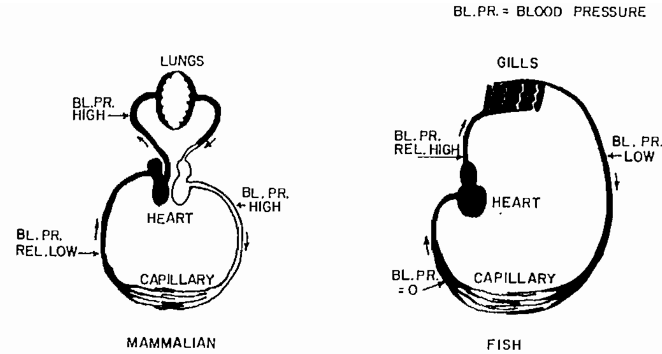


FIG. 8. Blood circulation: fish and mammals.

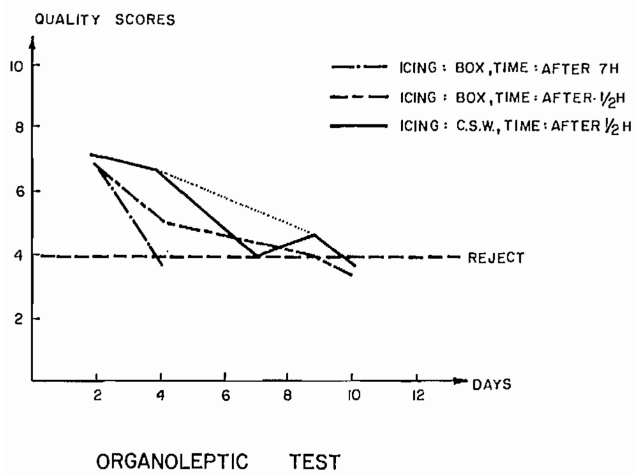


FIG. 6.

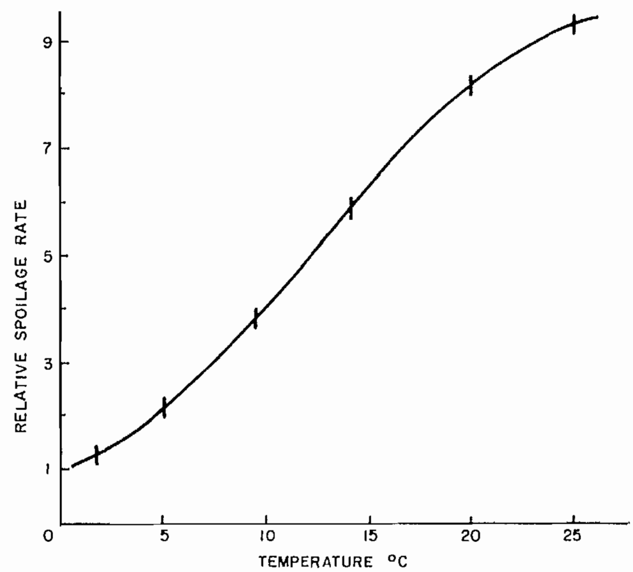


FIG. 9. Spoilage rate as a function of temperature.

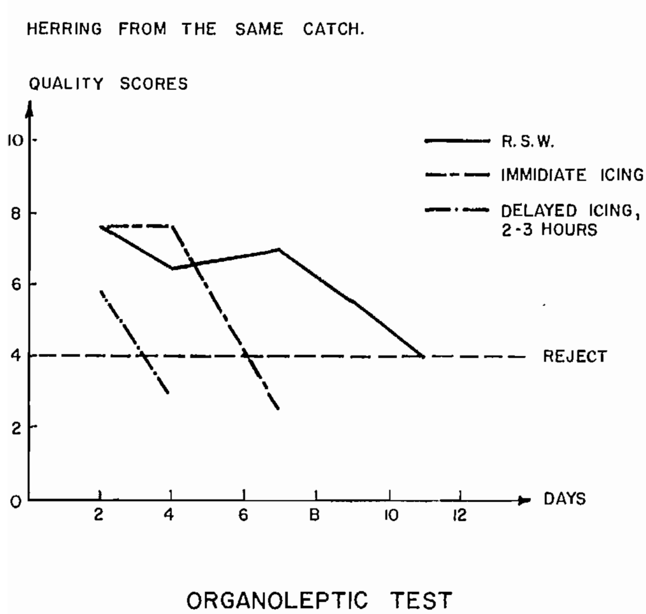


FIG. 7.

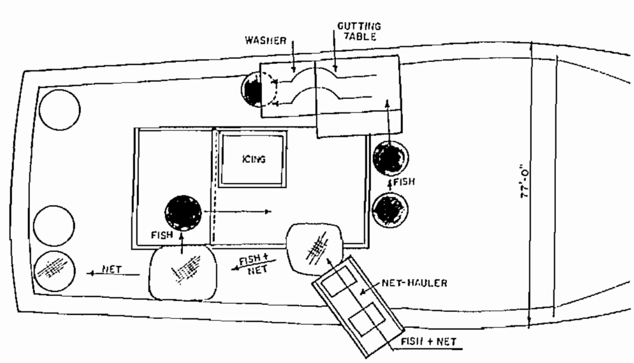


FIG. 10. Catch handling 30′ bottom gillnetter using insulated C.S.W.-containers.

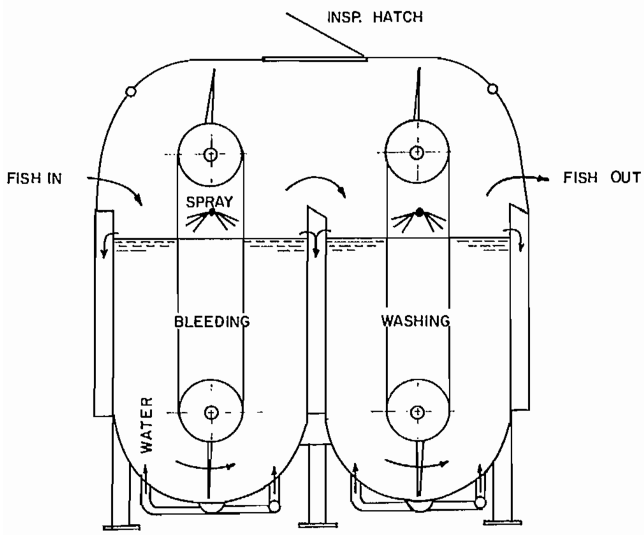


FIG. 11. Norwegian fish washer (F.T.F.I.).

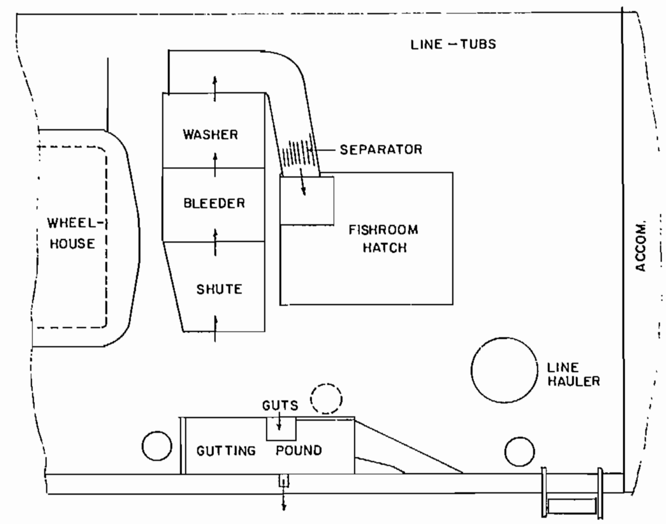
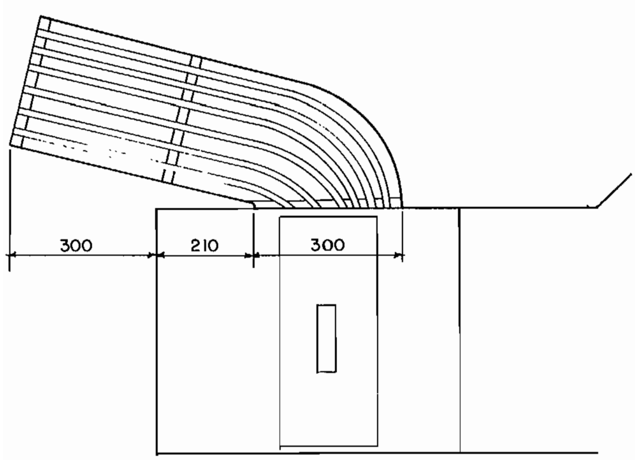


FIG. 13. Layout for longliner.



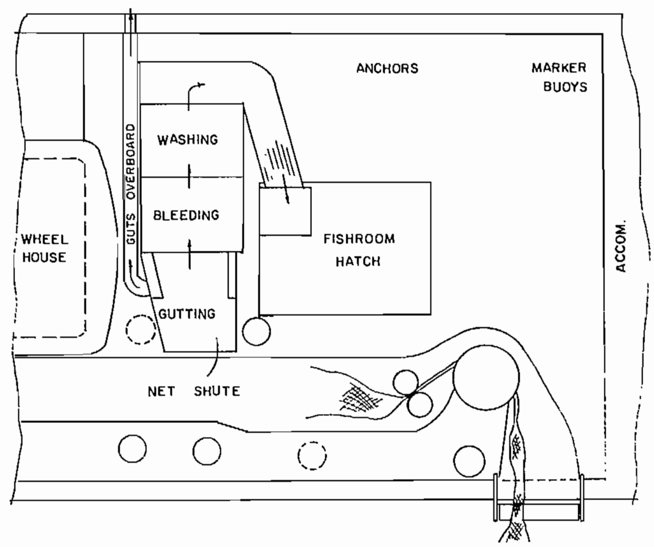


FIG. 14. Layout for gillnetter.

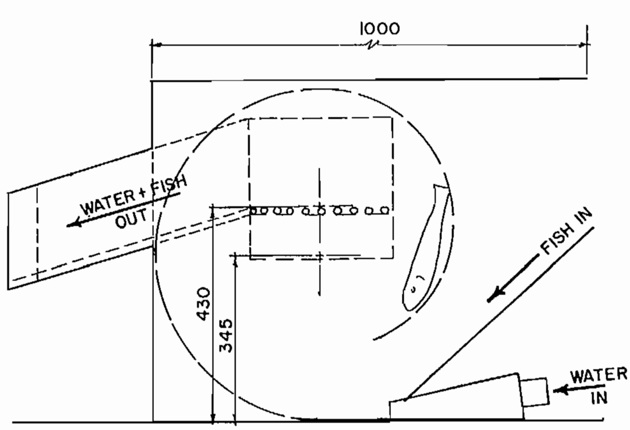


FIG. 12. Dutch fish washer.

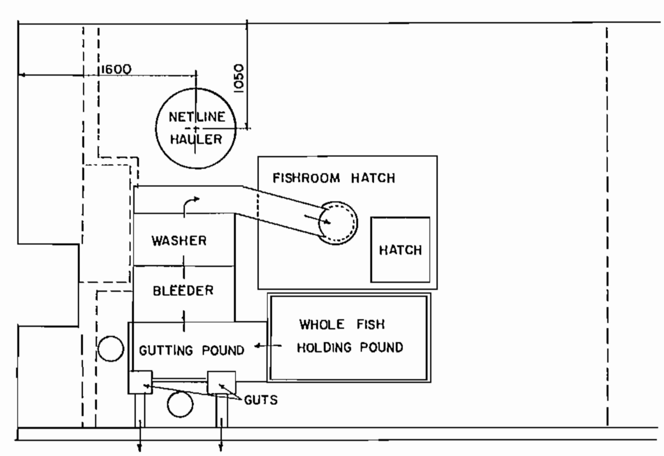


FIG. 15. Layout for a Danish or Scottish seiner.

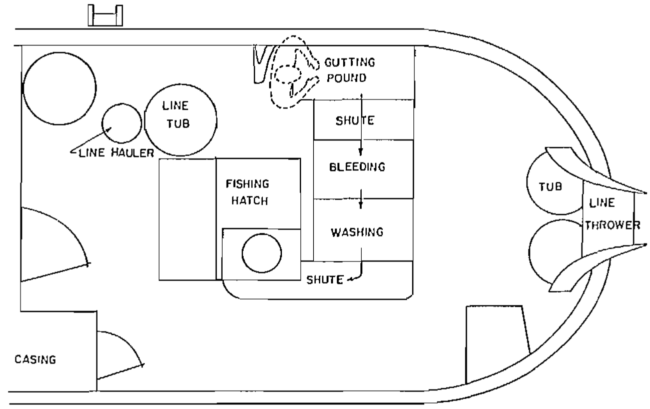


FIG. 16. Layout for 30′ coastal longliner from F.T.F.I. Norway.

a.

b.

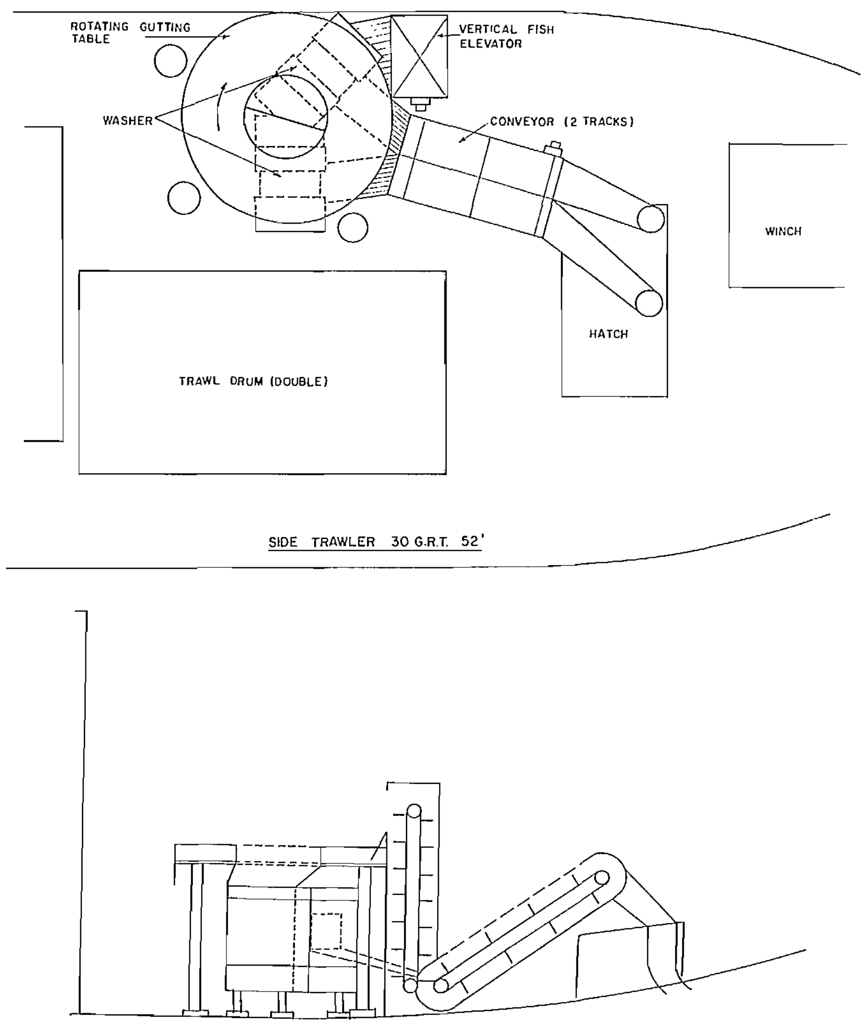


FIG. 17. Side trawler 30 G.R.T. 52′.

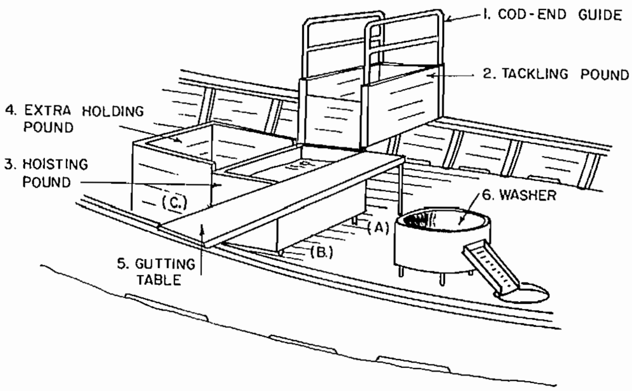


FIG. 18. Deck layout for manual gutting of white fish.

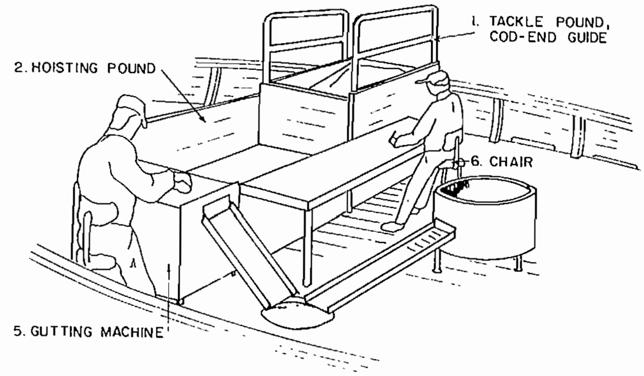


FIG. 19. Deck layout for machine gutting.

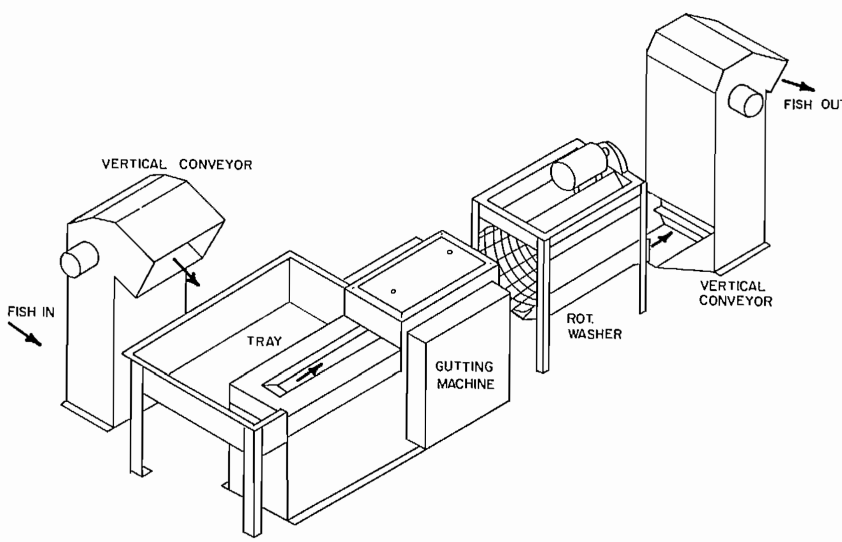


FIG. 20. In machine gutting, a continuous washing apparatus is used.

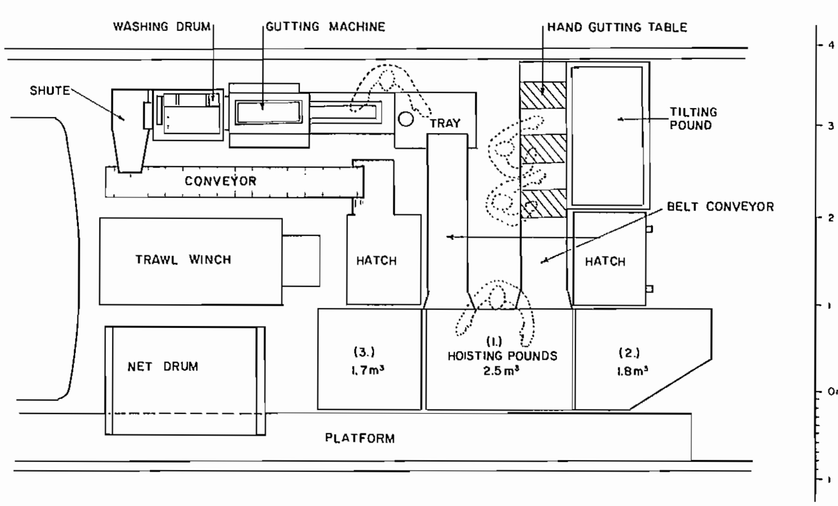


FIG. 21. Working deck layout 50 B.R.T. food fish trawler.

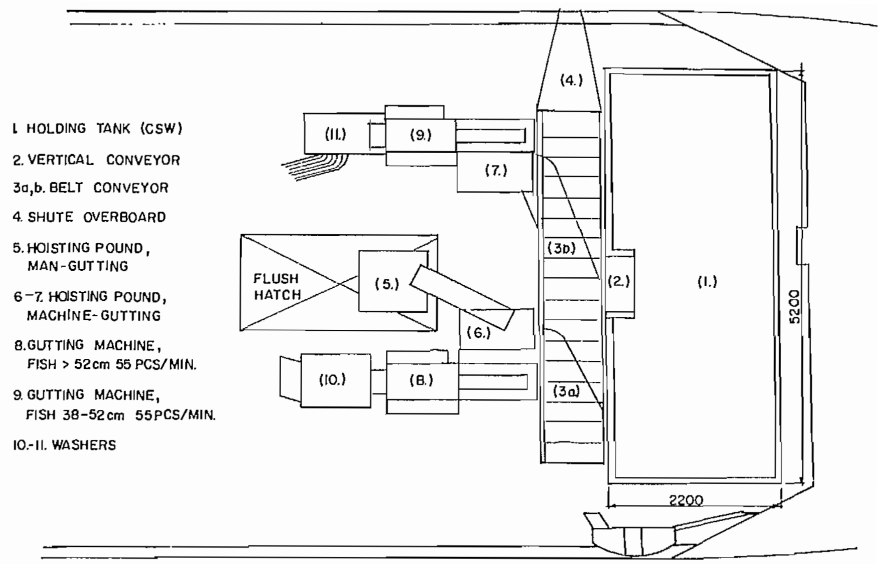


FIG. 22. 90′ semi stern trawler.

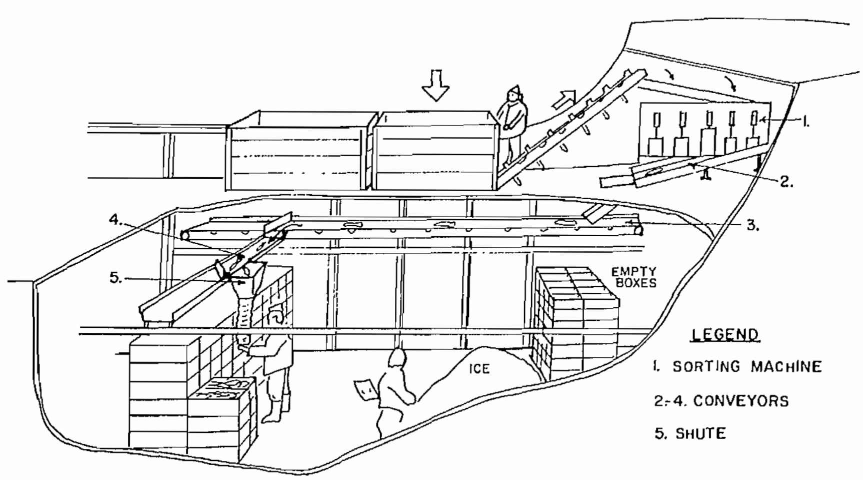


FIG. 23. Polar-system, mechanized boxing of herring.

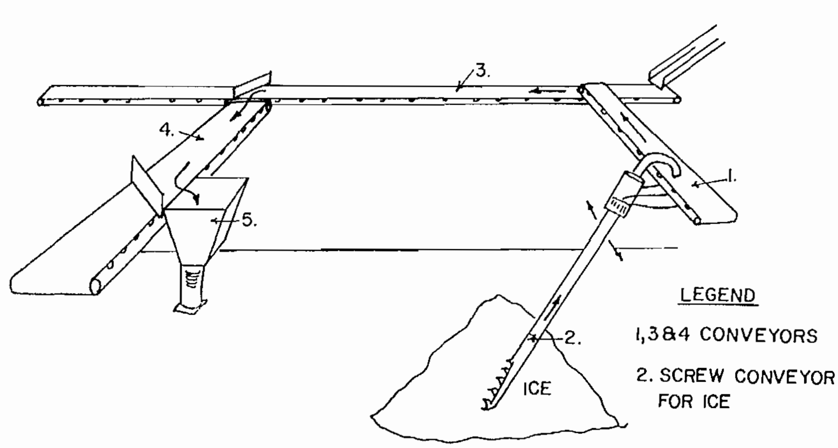


FIG. 24. A conveyor system carries fish to the boxes.

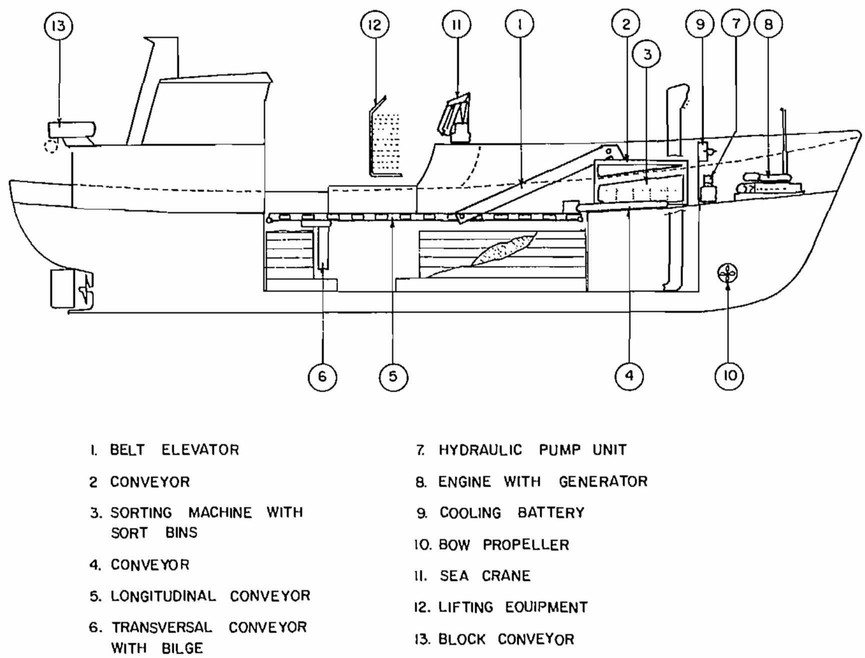


FIG. 25. Complete system — example.

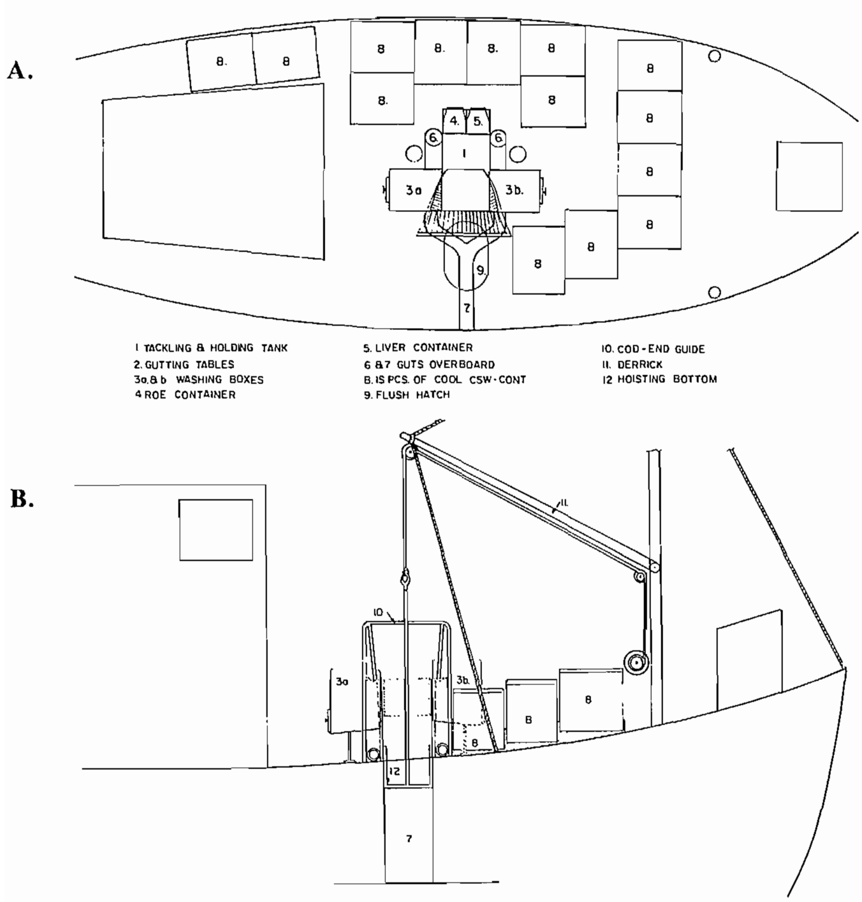


FIG. 26. Stern trawler 15 G.R.T. 36′.

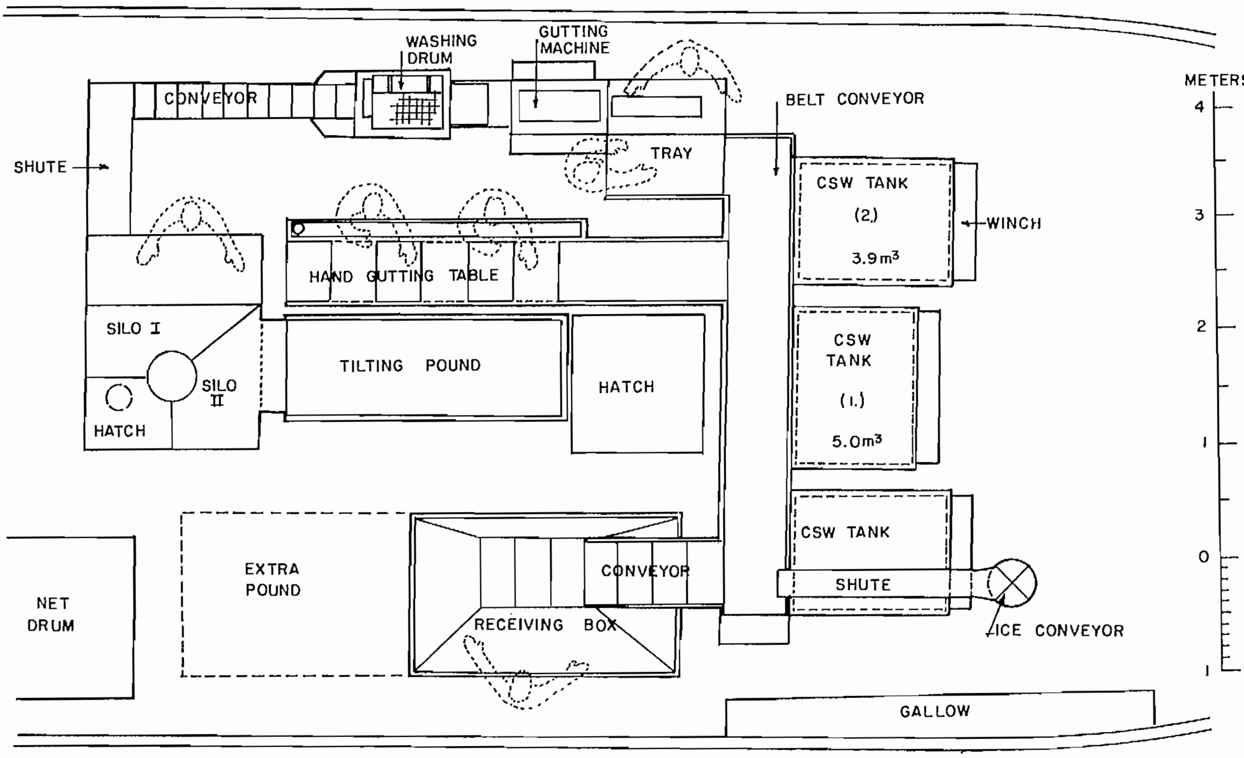


FIG. 27. Working deck layout 170 B.R.T. food fish trawler, 100′.

International Trends in Fish Containerization

Per Stromberg

President, Per S. Stromberg Limited
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Abstract

The boxing of fish is done by tradition or as a result of legislation in many countries of the world. Increasingly it is being done, or at least being seriously considered, because of pressure from the marketplace. Many different materials and designs have been used over the years. But recent experience has shown that there is not much use switching to boxes unless operational changes on board and ashore are introduced simultaneously to accommodate their use. The human element must also be taken into consideration.

In North America, boxing is still a relatively new concept, although things are beginning to change. Everyone is becoming quality conscious! Now that the box "has arrived", developmental work being done around the world to improve upon existing methods is examined.

Boxing fish at sea is done today, to at least some extent, in almost every fishing nation in the world. However, volume requirements, together with the desire to get the catch quickly into the fishhold, can still result in a lot of fish being stored in bulk; stowed in big compartments in the hold; or even, simply left in the open, on deck. The increasing demand for improved quality and higher yield has, however, caused some changes in methods used. In many countries, you see that improvements are being made ashore. For instance, in eastern Canada, we have seen drastic improvements in quality achieved by the change from the transportation of bulked fish in trucks to the use of large insulated containers. This innovation was introduced and supported by the Canadian Government (DFO).

But everybody knows that fish starts to deteriorate almost immediately in the net or trawl, and if treated badly early in the handling process, cannot be restored to high quality status later in the process. Proper handling onboard is also vital to the end result. Getting the catch quickly away from the deck, bled and gutted, and into the hold, is a must. In many countries short-shelving is also practiced. However, even short-shelving, which is better than bulking or penning, has disadvantages (fish get crushed or bruised) resulting in lower yield and shorter shelf life (in comparison to boxed). Furthermore, there is a loss of quality when the fish is moved an additional time during unloading. Once boxed, you move the box, not the fish, and very efficient unloading is possible.

In some countries, Norway, for example, the Department of Fisheries has imposed legislation to ensure that all gutted fresh fish is boxed on board. In Iceland, a premium of 11% is awarded to the crews of vessels landing boxed fish, in recognition of the fact that the fish plants get more first-grade fish and higher yield from boxed rather than penned fish. In addition, fishermen get better pay due to reduced shrinkage, which can amount to as much as 4%.

Boxing at sea, using wooden boxes, has been done for at least a 100 years in Scandinavia; in Scotland, it has been used for at least 60 years; in South East Asia and Africa, wooden boxes or fibre baskets have been in use for a long time in some fisheries; and in some South American countries, like Argentina, boxing also has a long history.

Although the fishermen of many countries have always known that boxing is important to maintain quality, the lack of suitable material (wood) has, historically, made bulking the only alternative for some (eg. Peru and Iceland).

Aluminum boxes designed for onboard use were introduced in the 1950's by Bernt Iverson in Bergen, Norway. In the 1960's, the first plastic fish boxes suitable for onboard handling were made by Alibert in France, GPG in England and in Norway by the Svein Stromberg Company (my father), and were also made available worldwide. But of course, this new material was also rather expensive, particularly for developing countries. Banciere group of fish companies in Peru saw the possibilities early, and when they presented the first plastic boxed fish in the Lima market in 1968, a premium of 80–100% was achieved over fish presented bulked on the auction floor. This resulted in an arrangement being made for the production of plastic boxes in Peru. With direct involvement by the Peruvian Department of Fisheries, several hundred thousand boxes were, in subsequent years, made available for fishing vessels and for use in distribution. This resulted in a drastic improvement in the availability of fresh, quality fish in diverse parts of the country and to a greater percentage of the population than ever before.

The use of plastic materials has become a revolution in the replacement of traditional materials; plastic material lends itself more readily to the creation of new and better designs in fish boxes. It must be admitted, in retrospect, that some of the first plastic fish boxes were not really suitable for the job they were supposed to do, boxing fish at sea, and this in some cases delayed their introduction.

Today, however, manufacturers have created new, improved designs, and a number of new companies have come into the market, e.g. Fisklaaden Packing in Sweden, Esbjerg Toverksfabrik in Denmark, Reinders in Germany, and others, including ourselves (Per S. Stromberg Limited, Norway).

Boxing fish at sea is a relatively new concept for some of today's great fishing nations. In Iceland, for example, boxing was introduced to the trawler fleet fairly recently — in the years 1971–75. Today, boxing is done almost 100% in the trawler fleet and 30–40% in the inshore fleet. The changeover was partly accomplished simultaneously with the building of new vessels, but you also see a lot of vessels which have been converted from the old system. (Some have even been lengthened in order to increase hold capacity.) When boxing is introduced, other measures also have to be taken — educating the crew on board; building cold store facilities ashore; and instituting box washing and box handling arrangements.

Past experience shows that there is not much point in converting to boxing, if you do not at the same time lay out the operation both onboard and ashore to facilitate boxing procedures. And, most importantly, the human element also must be adequately prepared for it.

Unfortunately, we have seen a number of unsuccessful examples where people at first very enthusiastically started to box fish at sea, but, after a short while, have given up, due to lack of preparation. Perhaps much of the blame in these situations lies at the feet of the box manufacturers. For instance, the handling of fish and boxes onboard can be very difficult if adequate changes have not been made to the hold. Problems arise when boxes with more than 150 pounds of fish and ice have to be moved (lifted by hand) in heavy seas. Therefore, the first rule is: Avoid moving fish in boxes; move the fish to the boxes.

In North America, boxing fish at sea is still a relatively new and not widely used method. However, because of the generally increasing awareness of the importance of higher quality, I understand that this is beginning to change.

Having worked over the years to try to change the handling methods for fish in North America, has certainly required lots of patience on my part. In 1968, at the Fish Expo in Boston, almost nobody could understand that it was indeed feasible to store fish in small boxes. The only positive reaction, at that time, came from some shrimp people in Oregon and Maine who bought several thousand for boxing cooked shrimp on board. A New Bedford vessel owner also bought a few hundred for boxing his fish on board (on a trial basis!). At that time, only quantity and volume seemed to matter — nobody cared much for quality.

Around 1970, some Norwegian-built trawlers were brought over to Nova Scotia with aluminum boxes aboard. I do not know if these were ever used because the holds were converted to take pen boards instead.

In 1974, a Newfoundland company had three trawlers built for boxing, each with about 3000 plastic boxes. Unfortunately, this project was also discontinued shortly thereafter.

Around 1980, several companies on the east coast started to show a little interest again. One company in Maine bought 700 boxes; another in New Brunswick bought 500. None of them have, so far, carried out their intention of using the boxes at sea.

A longliner owner, in Yarmouth, laid out his hold for about 700 boxes, and started out happily enough. Unfortunately, support, when landing the boxes ashore, was absent. The crew had to do a lot of extra work emptying and cleaning the boxes, and so, after a while, they took exception to that.

Another Nova Scotia company, at about the same time, started partial boxing with some of their vessels. And, as far as I understand, this is still going on with reasonable results.

In Newfoundland, in 1981, one trawler started boxing, another partial boxing, and since that time, the number of trawlers boxing has increased. (See next page.)I also understand that the Department of Fisheries currently has a program to encourage inshore vessels to use boxes.

In 1982, in New England, the New England Fisheries Foundation started a similar program aimed at quality improvement. This too involves boxing at sea. Interested vessel owners may borrow boxes from the Foundation, with the added bonus of an expert to go to sea to help out.

So what is the general trend around the world? Everybody is talking quality, and many people in the fishing industry are really doing something about it. In South Africa, onboard handling, storing and unloading (air unloaders) have been much the same as in Canada. During the last 2 years, a complete changeover to boxing at sea has started to such an extent that all existing wet fish trawlers are now gradually being converted to boxes. Seven new trawlers are being built in Spain for delivery this year to South Africa, all of them with boxes. In Saudi Arabia, the largest fish company has started converting its vessels for boxing. And in New Zealand, also, companies have begun boxing at sea. Sealord Products even had a freezer trawler changed to wet fish, and this vessel takes about 5000 boxes.

One major argument against boxing has been that there are so many small units to be moved. When unloading, each box is usually moved from the stack in the hold onto a handtruck, or the boxes are slid one by one to the hatch, or a conveyor is used.

Almost everywhere it seems, a lot of developments have been made and are being made in order to improve handling and storing fish on board, both from the point of view of improving quality and improving effieiency.

Big tanks with refrigerated sea water are in use for herring. They have also been tried for bottom fish. In 1972, in France, two trawlers were built around a container system. The containers took 600–800 pounds of fish, plus ice. The most interesting thing about this development was that the containers and handling systems were developed first, then the ships were built around the system.

But, of course, the problem is that there are already a lot of fishing vessels around, and it is difficult to simply scrap them. So we have to use systems which are adaptable to existing vessels. However, in the future, we must build vessels which are streamlined to accommodate the new storing and handling systems. And, if at all possible, the systems developed today and used in existing vessels, should be adaptable to vessels being built in the future.

Stromberg 90-litre boxes in use onboard the Fishery Products Stern Trawler *Zamberg* (53 m). The *Zamberg* was built in Marystown, Newfoundland, in 1981.

In Norway, tests are being conducted using containers of up to 2000 pounds capacity and with watertight lids for fish mixed with water and ice. Short-time storage shows good results; longer storage presents problems because of temperature differences between the top and bottom layers in the container.

Test projects, icing fish in various types of containers from 500 to 1000 pounds, are being conducted in several places. Fish in such containers, with heights up to about 24 inches, seem to be comparable in quality to 100-pound boxes when properly laid out and iced between layers.

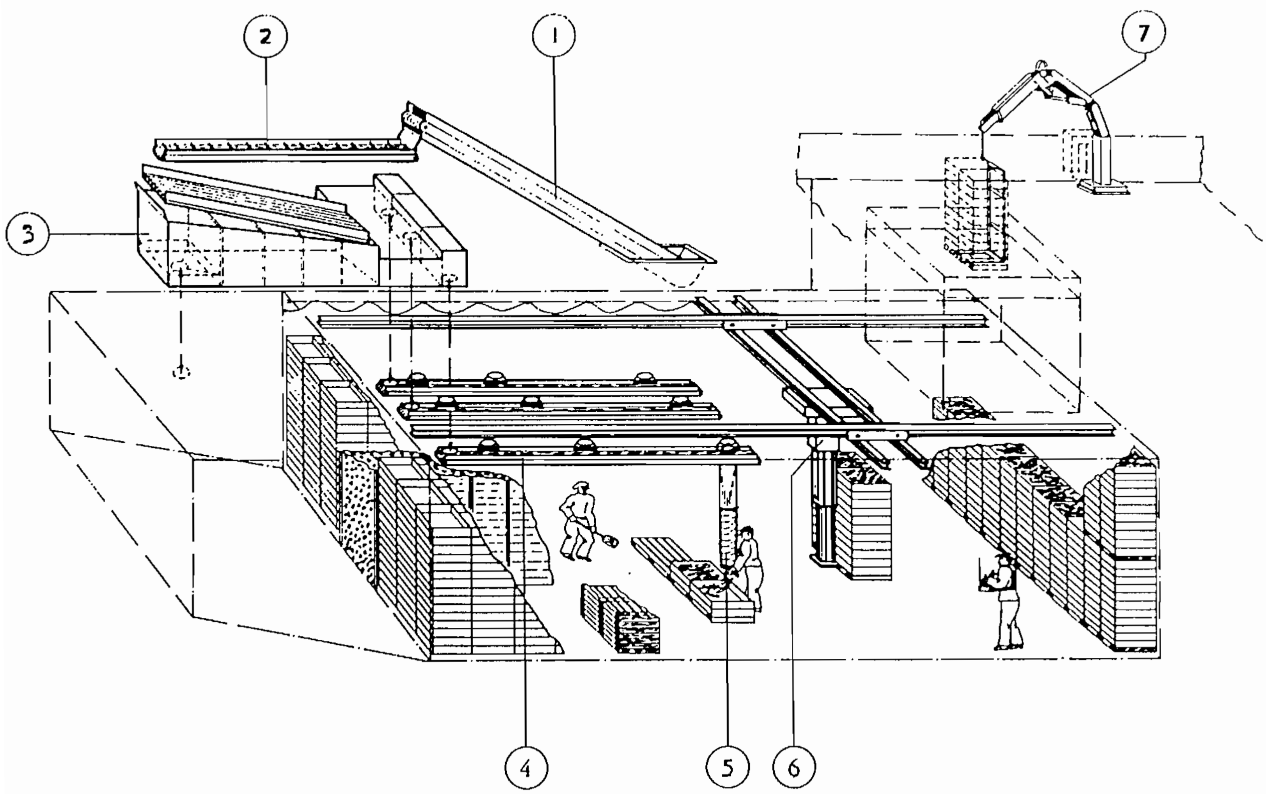
Various other containers and handling systems are under development. We will hear more about the Contrawl System and the collapsible container shortly.

The problem with all large containers is, of course, the difficulty of moving and stacking them on board most of the fishing vessels in use. It is much more convenient when you build a new vessel and can start from scratch.

In Sweden, much development work on handling larger units on board has been done by Krabbeskjaers Mekaniska Verkstad. As smaller boxes, 100 pounds, are widely used, the feeling is that if you can move 10–12 of these at a time, you have the same advantages as when moving a 1000-pound container. Last year, a crane system was installed in the hold of two vessels. This crane reaches over the whole fishhold, and moves pallets with twelve, 70-litre boxes (about 1200 pounds of fish). Stacks two pallets high — 2000 boxes or about 80 tons of fish — are unloaded in less than 2 hours, and the unloading operation is carried out by only one man in the hold.

New developments are being made all the time in fish-handling. At present, it seems that the 100–130 pound fish box is a very flexible unit, and may easily be used in existing fishing vessels and shore facilities. When unloaded, it can be handled in multiple units and it can also be fitted into future handling systems.

In Europe, plans are now being made to build trawlers which have 20- or 40-foot containers in 70- or 90-litre boxes (100–130 pound boxes). The unloading of these vessels will be done extremely quickly, and the containers will go directly into the fish plant, or direct onto trucks to reach different fresh fish markets within hours. This surely represents the wave of the future.



1. Belt elevator
2. Conveyor
3. Sorting machine with sort bins
4. Longitudinal conveyors
5. Portable bilge
6. Radio or cable guided travel
7. Sea crane

KRABBESKÄRS VERKSTADS AB
KVA fish on board
Handlingsystems

Boxing Systems on Offshore Trawlers

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Abstract

The positive effect on quality of boxing fish is now well-established. This has occurred at a time when the air unloader has become a liability because of the quality degradation caused to cod and haddock by its use. With all conventional boxing systems, some on-deck storage has been required, a real problem in northern waters. Fisheries Resource Development Ltd., with support from the Department of Fisheries and Oceans, therefore, has invented a flexible fiberglass container to deal with this problem, but vessel and port facilities have had to be modified accordingly. While results to date are preliminary, some tentative conclusions can be drawn regarding the outcome of the experiment and its possible implications for National Sea Products Ltd. and its employees. The results of this work, by definition, hold important implications for other organizations which may be considering the move from pens and/or shelves to boxes.

Introduction

The advantage of boxing fish, from a quality point of view, has been well-established from actual experience in Iceland, Norway, and Denmark on cod-like species and in Uruguay and Argentina on Merluza (hake). But the majority of vessels using boxes are designed for that purpose, and there have been only a few instances of vessels being converted or adapted to boxing during their operating lives.

Some economic data were available for this presentation, but little which could be applied directly to operations in Atlantic Canada.

Historically, fish has been cheap in Canada, especially in Newfoundland, and labour has been relatively expensive, so, during the 1960's and early 1970's, companies paid more attention to saving labour, than to improving quality.

It was during this period that the air unloader was introduced. Initially, this device was used in Portland, Maine, to discharge redfish. The "disease" spread to Rockland, Maine and, before long, plants throughout the Atlantic provinces were installing air unloaders, which substantially reduced wharf labour costs and increased the discharge rate. While cod and haddock suffered some quality degradation during discharge, the cost of this was generally acceptable in relation to the savings because of, the then, small differential paid in the marketplace for quality.

During the past 5 years or so, four factors have contributed to a greater concern for quality, so that today the air unloader is a liability:

1) The price of fish has escalated substantially,
2) Fish content, as a component of total product cost, has increased,
3) There is a much larger price differentiation between blocks and prime fillet packs, and
4) Firmness and wholeness of fillets has become a major quality determinant.

National Sea Products has, therefore, recognized the damage caused by air unloaders and, on a plant-by-plant basis, has either replaced the unloaders or taken steps to minimize their use.

Alternatives

A partial solution to the quality problem is to unload the vessels with mechanical unloaders (a sort of bucket elevator) or to revert to the simple "bucket and string" method used since the time of the Phoenicians! But, any system which involves disturbing fish in the pen does some degree of damage.

The ideal, then, is to have a system in which fish is unloaded in the same container in which it is stored (in ice).

This is the major advantage of the box. A secondary advantage is reduced pressure on the fish and, hence, slightly better quality than well-shelved and penned fish, and a slightly better yield from a given weight of fish in the cod-end.

Our St. John's Division, which is supplied with fish from six Cape Fox class vessels, is fitted with two air unloaders. Most of the site is occupied by buildings and equipment and the space to install a bucket unloader is limited. It was, therefore, an ideal location to experiment with a system of boxing.

Problems on the Vessel

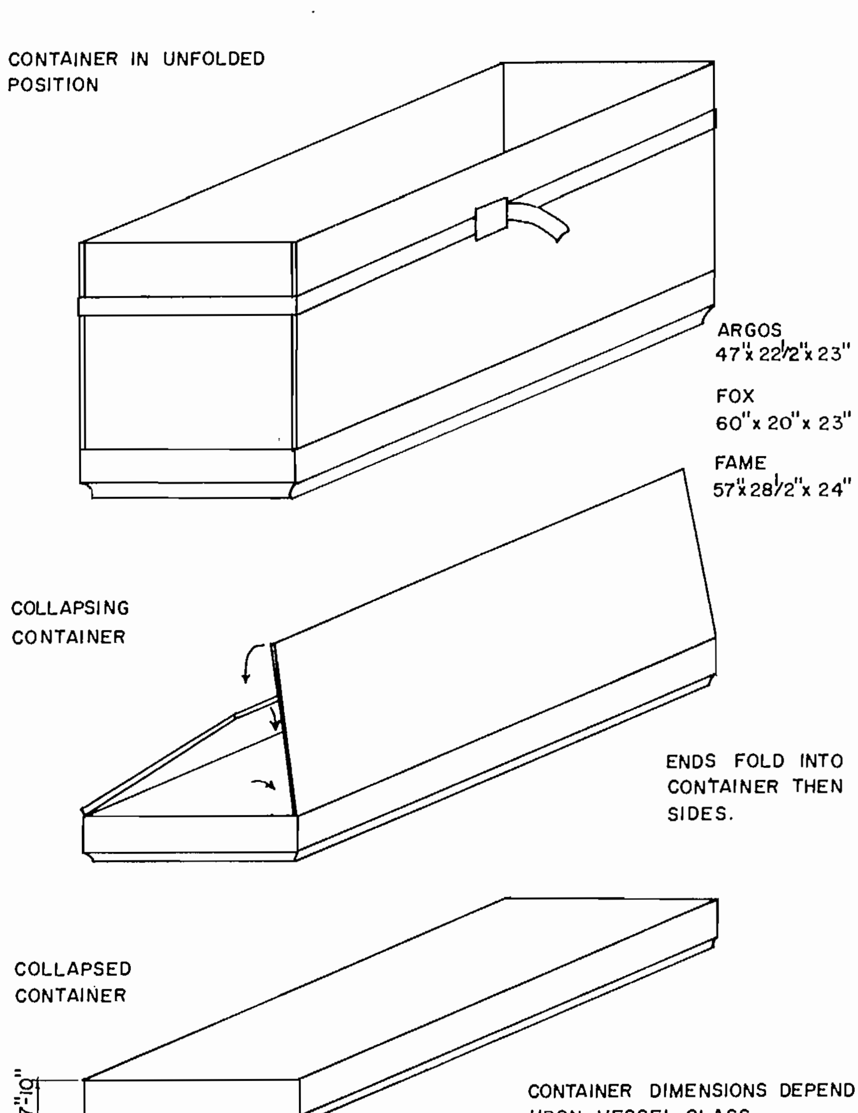
The Cape Fox class is a 150-foot L.O.A. stern ramp trawler with a fish hold capacity of 10 800 cu. ft. The processing room is to the stern of the vessel and adjoins the fish hold, which is situated near the center. The fish hold extends in height from the keel to the underside of the deck.

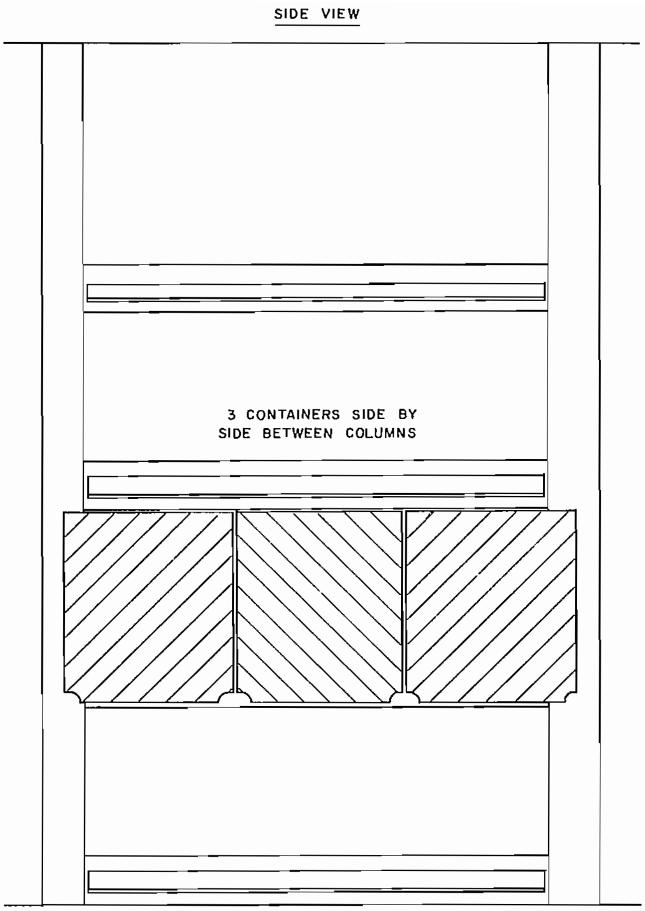
You will appreciate that with all conventional boxing systems, some boxes or ice, or boxes and ice, have to be stored outside the fish hold. In more hospitable waters such as the South Atlantic of Argentina and Uruguay, boxes can be stored on deck, but this is impractical in our waters.

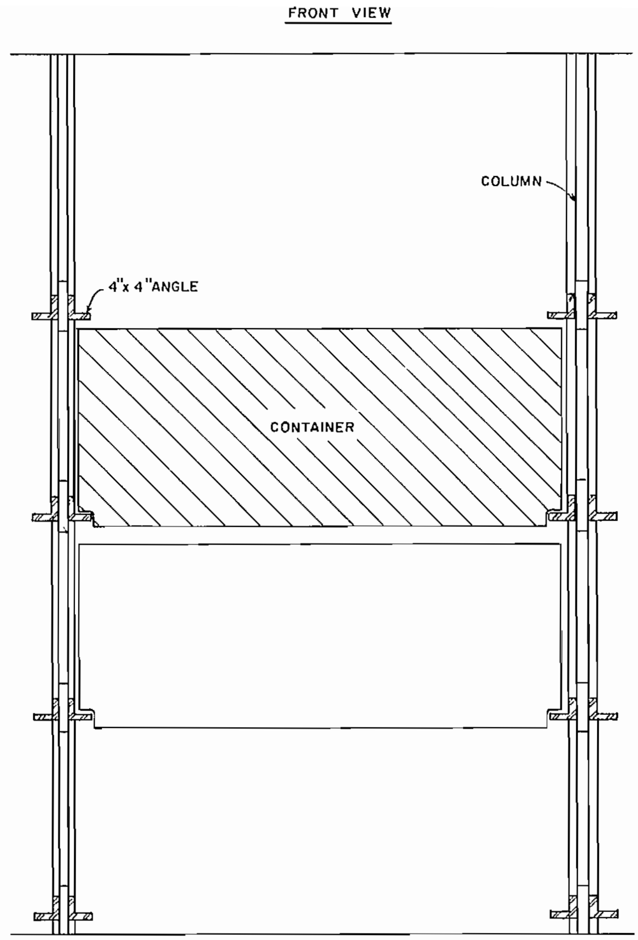
Space in the processing room is at a premium, so the problem was handed over to our research and development company — Fisheries Resource Development Limited — which with assistance and encouragement from the Federal Department of Fisheries and Oceans, especially from Mr. Frank Slade, set about to develop a solution. The FRD Engineering Applications Manager, Dave Cochrane, who is a materials handling engineer by profession, was assigned to the project and this has been his major task for the past year or two.

A collapsible fiberglass container was designed with dimensions of approximately 60″ × 20″ × 24″. The four sides are connected to the bottom with a rubber hinge so that,

F. R. D. COLLAPSABLE CONTAINER







when collapsed, four containers occupy the space of one erect container. The erect container is held together with a polyester strap.

The experimental containers, which are made in Atlantic Canada, cost about $200 each, but the price will be lower with quantity production. The straps, which seem very popular with the crew, cost about $4 a piece. Each container holds about 500 pounds of fish, plus ice. Its dimensions have been established at the optimum size to fit Cape Fox vessels and some other classes of the NSP fleet. In a typical cross-section of the fish hold, there are three or four containers in the outer pen, three in the run, and three in the centre, for a total of 9 or 10 containers per level on both port and starboard sides. Depending on the fish conveying equipment, there are three or four levels of containers, and in the Cape Fox, seven pen sections. Thus the total container capacity is between 468 and 524. And an ingenious method of portable roller conveyor sections and platforms has been devised to facilitate loading and unloading.

The Experiment

The centre pens of the Cape Smokey have been converted to hold 168 containers and sufficient units have been constructed. A deck mounted Hiab hydraulic crane has been fitted to unload full containers.

While the present unloading system is slower than unloading a vessel with air unloaders, we are confident that an improved system to handle two containers at a time can be designed which will permit unloading at a rate at least equal to plant fish requirements. In addition, work-study experiments indicate that, at higher catch rates, an additional person is required in the fish hold. If this person is taken from the existing crew, the vessel catch rate is reduced because there are less men bleeding and gutting. Hence, there may be a need for an additional crew member.

Factors Required for the Evaluation of a Boxing Experiment

At Sea

1) What is the capacity of the vessel with boxes vs. pens or other?
2) Is the catch, bleeding, and gutting rate affected by the boxing rate? (i.e. is boxing the critical element?)
3) Is extra crew required?
4) Will the crew handle boxes without additional pay (result — a higher price for fish)?
5) If the capacity of the vessel is reduced, the trips will be shorter, can some of the time saved be used for additional trips? And if so, will the total cost of the vessel, per year, be more or less?
6) What is the capital cost of retrofitting the vessel and what is the expected repair and replacement cost of the containers?

7) If only certain species benefit, what is the percentage of these to the total?
8) What is the actual cost to the company for the fish?

On Land

9) What infrastructure has to be installed to handle the boxes: capital and maintenance cost?
10) What is the value-added by improved quality of fish and by way of additional yield, reduced labour cost, and higher product prices (upgraded packs)?

Corporate

11) If the annual landings of the six Cape Fox class vessels is reduced due to boxing, what is the effect on corporate over-heads due to the reduced throughput?
12) How does the total investment and return on investment (R.O.I.) for retrofitting a vessel with collapsible boxes compare with other container systems and the alternates?

NSP Experience to Date

First, I must say that our results to date are preliminary. We are still in the process of developing the system and evaluating the experiments which have been done. Many of the factors mentioned, especially those involving crew, can only be properly assessed if the vessel is completely converted (you will appreciate that the centre pens on the Cape Smokey, which are converted, represent about one-third of total fish hold capacity).

I think it is accurate to say that, if we were to design a new wetfish trawler for our own use, it would almost certainly be containerized. But the question we must answer is whether or not a mid-life conversion to containers is economical, and if capital is short, does this cost represent the best use of what is becoming a very limited resource?

Certainly we have demonstrated that from a materials handling viewpoint, the so-called FRD system works. The quality of fish landed from boxes is, for the cod species, markedly superior to that of the same fish discharged by air unloaders. We have established that this quality improvement has a very tangible value. However, we have found that perhaps 40–50% of this added value can be obtained by more carefully unloading conventional vessels, that is, using mechanical or bucket unloading. Also, boxing will reduce the fish hold capacity to between 70 and 80% of the conventional amount, which should shorten many of the trips by a day or two. So, for the system to be economical, it will be imperative for each fully converted vessel to make two or three additional trips a year. We don't know whether or not the crews will make these additional trips for the same annual pay, even though it can be demonstrated they will have more total time ashore. Work studies indicate that, except at peak fishing times, the fish hold crew can box fish at the rate of delivery from the processing room. Undoubtedly, they are busier using boxes than penning the fish, and this, of course, has an impact on their attitudes. For peak fishing, we think it might be necessary, therefore, to carry an additional crew member.

The economics of boxing obviously improve by increasing the percentage of the catch which will benefit from careful handling. For St. John's vessels, about 40% of their catch is cod species. With a system of enterprise allocation, we can only increase this percentage by reducing the cod to be caught by other NSP vessels. And while this may be to the benefit of the boxed fish vessels, it may not necessarily benefit the corporation overall.

Note

While the diagrams are intended to give at least some idea of how the collapsed container is erected and how, once erected, it fits into the framing of the fishhold, they provide an impression which is, at best, incomplete. Mr. Langlands made use of a 10-minute video presentation to provide delegates a clear understanding of the technology in question. Portions of his speech are intended simply to amplify the visual and are not, therefore, completely effective in print, a difficulty which could be overcome only in part through the use of diagrams. We trust, however, that these, and similar/related diagrams elsewhere in these proceedings, will prove adequate to our purpose.

Practical Applications for Improving Fish Quality and Handling Procedures on Inshore Fishing Vessels

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F.L. Slade

Abstract

New fisheries regulations mean that inshore fishermen on Canada's east coast will have to modify fishing gear and improve their fish handling procedures. Among other activities, Fisheries and Oceans, in recent years, has conducted research to develop onboard handling systems to help fishermen meet the new standards. One innovation to come out of this work is the three compartment tank (1982) for bleeding, gutting, washing and icing fish at sea. An increase in revenue, the result of an increase in the average price per pound for system-equipped vessels in contrast to a control group of non-equipped vessels, is reported. But work continues, not only in an effort to improve handling procedures, but to improve vessel design, which tends to enhance them.

There are in excess of 29 000 inshore fishing vessels in Atlantic Canada. This number includes many types and sizes of vessel ranges from 18 to 65 feet. They are constructed primarily of wood and fish a wide variety of gear including otter trawls, gillnets, longlines, cod traps, crab pots, lobster pots, etc. The duration of fishing trips may vary for several hours to several days.

The implementation of dockside grading and vessel certification regulations on Canada's east coast means that fishermen may have to make modifications to their vessels and to improve fish handling procedures. Requirements to bleed, wash and ice fish, and minimum standards for onboard fish storage areas, together with maximum depth storage limits, may pose problems for many fishing enterprises. Also, the financial requirements and practical implications of pending regulations mean that options should be available so that fishermen can choose those best suited to their individual operations.

Fish handling practices vary with the type and size of vessel used and with the type of fishing operation. Materials and methods which work well for some fishermen may not be practical for others. Otter trawl operations differ from gillnetting, as do trapboat operations from longline operations. Each fishing technique requires unique, but sound and practical, handling procedures and equipment if landed fish quality and the viability of individual fishing enterprises are to be improved.

In 1982 and 1983, the Development Branch of the Department of Fisheries and Oceans undertook to investigate and develop ways and means for improving fish handling and storage methods onboard inshore fishing vessels. The problem of handling fish on inshore vessels was approached from several different angles:

1) How best to improve quality.
2) How to meet the new inspection regulations with minimum cost.
3) How to make the job easier for fishermen, both at sea and during unloading at dockside, and
4) How to reduce the overall cost of icing and handling of fish.

The option that seemed to address all of the above was the container (all types of boxes). However, because of the numerous shapes and sizes of vessels, it is virtually impossible to have a single standard size for all.

This paper will deal with practical applications for handling and holding fish on existing vessels in the following classes:

a) inshore open boats 18 to 35 feet;
b) trapskiffs 20 to 35 feet; and
c) inshore boats 35 to 65 feet.

We will also examine new designs in inshore vessels built to handle containers.

Open Boat Containerization

History

The type of open boat used in Atlantic Canada varies considerably from one area to another. In Newfoundland, the majority are under 25 feet, whereas in the Maritimes, they are usually in the 30–40-foot range.

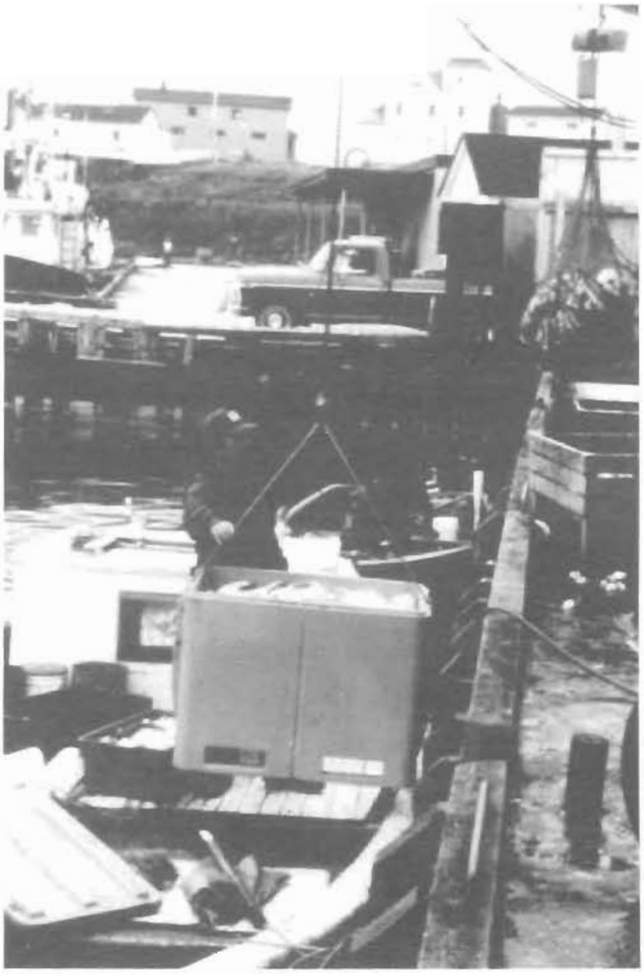
Containerization offers certain advantages over bulk storage (which in any event is difficult to provide on an open boat). It provides for the more sanitary storage of fish, improved ice carrying capabilities, and improved offloading efficiency. In addition, containerization allows for segregation of fish at sea; less ice is required (because of the insulation factor); and, with proper handling, containers can be used from year to year with minimum seasonal maintenance.

Open Boat Containerization

During the summer of 1983, a number of Newfoundland fishermen were asked to experiment with a 9 cubic foot insulated container which has a carrying capacity of 450 pounds of iced fish (this can be purchased off-the-shelf for approximately $280). Each unit measures 43″ × 22″ × 28″ outside (36″ × 19-1/2″ × 22″ inside) and comes with an insulated cover. Response to this particular size of container was quite positive for the following reasons.

a) It can be used in boats as small as 18 feet;
b) It can double as a wash box;
c) It permits fishermen to take ice to the fishing grounds in small open boats;
d) The need for ice is reduced by two-thirds because of insulation; and
e) It provides for ease of unloading.

While most fishermen felt that they could better utilize the space on their small boats with a different design of container, they felt it was a major improvement over holding fish in bulk.



Trapboat Containerization

History

The cod trap is one of the most labour and cost efficient methods ever designed for cod fishing. Developed in the 1860's by a fishing skipper, the use of this fixed gear has spread over much of the Newfoundland/Labrador and Quebec north shore. Improvements have been made to the original design and traps for capelin, squid, mackeral, and herring have been successfully developed.

The cod trap season is short and usually runs for a 6-week period, from May to August, depending on the inshore migration of codfish, which comes about as they are drawn near shore to feed on caplin and other pelagic fish. Seasons vary from area to area, usually beginning in late May or early June, peaking in June or July, and fading again in August.

Landings often exceed the processing capability of plants located in areas experiencing a good trap fishery, especially during the peak of the season. This occurrence, commonly called the "glut," usually results in a situation in which fish must be held over for several days before being processed. In many cases, fish are iced and transported via truck to other plants. The numerous handlings, movement of the fish, and time involved tends to lower the quality of both the raw material and the end product.

Trapboat Handline Methods

The possible implementation of dockside grading regulations in 1986 would mean that trapboat fishermen would have to change their fish handling methods to fully benefit. To meet dockside grading criteria, fish have to have an internal temperature of less than 38°F (5°C) at the time of grading. This temperature requirement means that trap crews would have to ice their catch at sea and use some means of protecting it from the elements. In addition, precautions would have to be taken to avoid handling of the fish that might result in bruising, (i.e. walking on the catch, excess storage pressure, etc.).

Development staff felt that a containerization system which provided: a means of reducing storage pressure; protection of the catch from the elements; space efficiency; and an efficient and effective way of offloading would greatly assist trap fishermen in meeting dockside grading criteria.

It was decided that an inexpensive system possessing durability, good insulating properties, and the capability to accommodate average daily catches would be needed. And so, containers were constructed of aluminum and contoured to the shape of the vessel. They have a capacity of seven hundred and twenty pounds (round fish) and each container has hoist-out attachments for offloading. Forklift capability for transportation to the plant and non-skid covers, were included which, in addition to protecting the catch, formed a working deck from which to operate the fishing gear. These attributes were all integral to the development of an efficient containerization system for trapboats.

While hauling the trap, half of each container cover is removed, (the piece nearest the side of the boat is left intact). This arrangement allows fish to be dipped into each partially open unit. The covered section provides a work deck from which to haul the trap. It also serves as a platform on which to place the twine of the trap, some of which is taken onboard during hauling operations.

The container arrangement allows ice to be taken to the grounds in two or three units. Fish dipped from the trap can be cut and placed into the containers to bleed. Ice can then be placed throughout the catch as required. At dockside, each unit can be offloaded and emptied onto the gutting table individually. Fish handled in this manner is much less susceptible to bruising and subject to minimum exposure to the elements.

Fishermen participating in the project felt that the containerized approach provided an easy means of using ice, afforded good protection for the catch and did not interfere with day-to-day operations. In addition, they felt containerization gave them more control over catch preparation at dockside.

A review of the project clearly indicated that the high cost of a custom-made aluminum containerization system was a major deterrent to acceptance of the system by trap fishermen. The developer is continuing efforts to design and manufacture insulated, rotational-molded, container kits which would be adaptable to most open fishing boats. If successful, such a system would be much cheaper and have greater insulating properties, while maintaining desired durability.

Containerization — Inshore Decked Vessels

Overview

The boxing of fish onboard some inshore vessels (35–65 feet) may be neither practical nor possible. Space for a sufficient number of boxes may not be available below decks. Boxes filled with fish are heavy (100+ lb) and require a height clearance at which crewmembers working in the hold can stand freely and not work in a stooped position. One alternative to using boxes or net bags is to containerize the catch.

Insulated fish containers of various capacities are widely used by the Newfoundland fishing industry, primarily for handling and transporting the catch on shore. Containers provide a sanitary and practical fish handling and storage method. With emphasis now being placed on fish quality on board, more fishermen have been using these containers to at least some extent to carry and hold ice.

Containerization

In 1983, the Development Branch of the Department of Fisheries and Oceans installed 14 insulated fish containers onboard a 55 foot gillnetter. Eleven containers, each measuring 44"L × 43'W × 46.5"H with a capacity of 2000 pounds, were placed in the hold. The remaining three units were put on deck to give a combined container capacity of 28 000 pounds. Prior to installation of the units, all existing stanchions and penboards were removed and the floor of the hold was raised some 8 inches to provide a level and smooth surface on which to place and manoeuver the containers. Manholes were installed to provide access to those containers not accessible through the hatch opening. The three containers secured on deck were filled with ice. A layer of ice, 6–8 inches, was placed in the bottom of the units in the fish hold in preparation for each trip. Fish picked from the nets were immediately dressed and put into the containers below deck. Crew members preparing the catch had access to all the containers, this allowed them to sort the catch by placing individual species into separate units. The ice carried on deck was spread throughout the fish as they were being put into containers. When the 11 containers in the hold were full, fish were put into the three on deck.

At dockside the deck units were hoisted off first, freeing up the deck area. When the hatches were taken off, the container directly under the hatch was hoisted out. A container on either side of the vessel was then moved, by means of a pallet jack, into the space vacated by the first container. The remaining containers were similarly manoeuvered into position under the hatch and hoisted out.

The crew of the vessel using the containers throughout the 1983 season were more than satisfied with the resulting positive aspects on fish handling. Due to the fact that the vessel was not landing under any dockside grading program, no evaluation of the impact of this fish handling and storage procedure on fish quality was attempted. However, containers were unloaded in less than fifty percent of the time it would have taken to unload fish held in bulk storage. Also, it might be expected that reduced handling would reflect positively on the quality of both landed and processed fish.

Onboard Handling System

In 1982 the Development Branch of the Department of Fisheries and Oceans designed a three-compartment tank for gutting, bleeding, and washing fish.

The handling system shown here can accommodate three different species — i.e. cod, turbot, flounder. It is comprised of a fish holding ramp, a wash/bleeding tank, which also serves as a table on which to cut fish, a cod bleeding tank, drainage chute, a manhole with covers and plastic fish boxes stored in the hold. The system is designed to afford a fishing crew the opportunity to bleed, gut, wash and ice at sea.

The onboard handling system is positioned on the port side of the vessel, between the hatch combing and bulwarks. The detachable drainage chute extends out over the vessel hatch or into a manhole. As the fish come out of the gear they are placed in the holding ramp where a crew member picks it up, bobtails or guts it, and places it in the appropriate compartment of the washtank.

When one or all compartments of the washtank are full, the door in each is raised allowing the fish to flow out of the tank onto a sloped drainage chute. They are held on the chute for a minute or two to drain.
Then a manhole cover in the deck is opened allowing the catch to slide down to the fish hold into pre-iced plastic boxes. Additional ice is placed throughout the fish in each box which is then stacked in the hold. These externally drained boxes hold approximately 40 kilograms (ninety pounds) of iced fish.

Offloading at dockside involves removing the fish holding ramp from its position over the hatch. Four to six boxes are then placed on a pallet and hoisted onto the dock. From here, the fish is taken for weighing and grading.

Results

To identify any benefits resulting from the use of a handling system, an analysis of both fish grades and prices received by vessels landing under the dockside grading experiment is in order.

Table 1 shows the average grades landed by the two vessels equipped with handling systems versus average grades landed by six other vessels not so equipped. It indicates improvements of approximately 18%, 13½%, and 11½% Grade A on cod, turbot and flounder, respectively, for the vessels using a fish handling system.

The increase in revenue associated with the increase in average price per pound for system vessels, attributable to the higher quality of fish landed, is demonstrated below. Using the eight surveyed boats operating out of the Bonavista area, we see that average landings for the 1983 season were approximately: 225 thousand pounds cod; 125 thousand pounds flounder; and 145 thousand pounds turbot. Had the dockside grading experiment been in place for the entire 1983 season, revenue could have been expected to increase by:

(225,000 × 2.47 cents)	=	$5,557.50
(125,000 × .85 cents)	=	1,062.50
(145,000 × .93 cents)	=	1,348.50
		$7,968.50

Hence, a boat utilizing an onboard handling system could expect to attain a revenue increase of nearly $8,000 on 495 thousand pounds of fish, as described above. In reality, landings are determined by fishing effort and may be higher or lower than those presented here.

The cost of equipping a vessel with an onboard handling system as used in this project is approximately $3,000, but varies with the number of fish boxes used. Table 3 identifies the costs of the handling system and the fish boxes used by the two project vessels.

TABLE 1. Average grades received by system and non-system vessel during 1983.

Species	Grade	Average % System	Average % Non-system*
Cod	A	62.5	44.33
	B	28	37.17
	C	9	17.17
	R	0.5	1.33
Turbot	A	80	66.5
	B	14.5	22.5
	C	5	10.5
	R	0.5	0.5
Flounder	A	88	76.5
	B	10	20.17
	C	2	3.17
	R	0	0.16

*The six gillnetters used for comparison purposes fished the same general area as the two project vessels and participated in the dockside grading pilot project.

TABLE 2. The average price per sound for three species for system versus non-system vessels in 1983.

Species	Avg. price/lb. system (cents)	Avg. price/lb. non-system (cents)	Difference/lb. system vs. non-system
Cod	24.2	21.73	2.47
Flounder	15.55	14.7	.85
Turbot	14.5	13.57	.93

TABLE 3. Item by item cost of system.

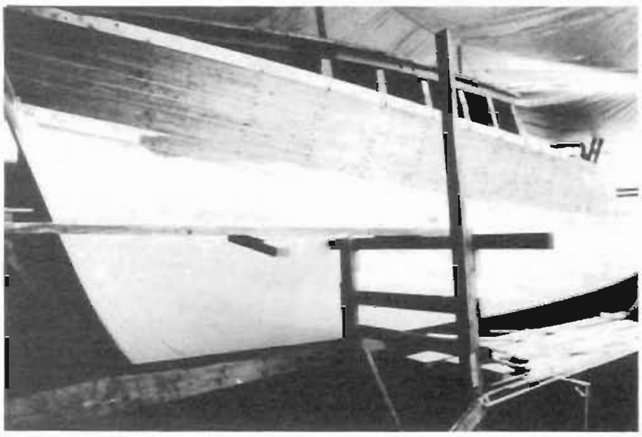
Item	Quantity	Cost/Unit ($)	Price ($)
Onboard Handling system	1	1,800	1,800
Bomar manhole (20")	1	375	375
Fish Boxes	100	13.50	1,350
		TOTAL PRICE	3,525

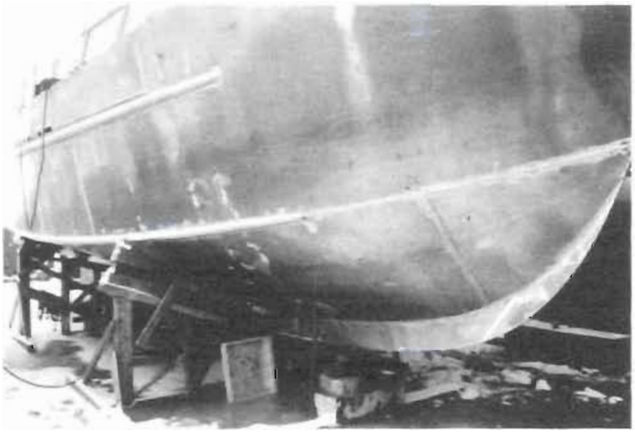
Conclusion

What I have just presented to you is a number of options we have explored to improve the quality and efficiency of existing inshore fishing vessels. But what of the future? We, as a Department, are looking at new designs in vessels that will make them more energy efficient and more comfortable for fishermen; deck layouts that allow for more efficient handling; and fish holds designed for the containerization of fish.

One such project is already underway at the College of Fisheries in Newfoundland.

Two vessels were designed around lower capital cost – lower operational cost, yet with capabilities similar to larger vessels. The two, one aluminum, the other wooden, are 13.7 metres (45 feet) L.O.A. with a beam of four metres (13 feet). The engines are Volvo Penta with 165 H.P. and should produce a top speed of 10 to 11 knots. Both vessels are of hard chine design. There were three reasons for choosing this design: hard chine hulls are cheaper and faster to build, provide a greater interior volume, and also provide a comparatively flat floor which is of considerable advantage in the use of containers. Both fish holds are fiberglassed and will be containerized with boxes holding approximately 500 pounds of fish.





What may materialize in the future is a standard container for inshore and offshore. If this occurs, vessels would be designed to accommodate them.

A Containerized Holding System for New Trawlers and a Computerized Fish Operations Monitoring System

Glen Etchegary

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Abstract

It is the offshore sector of the east coast fishery which has experienced major structural changes as a result of the severe economic conditions of recent years. The offshore sector is, at present, both capital and labor intensive, but quality improvement and cost effectiveness may hold the key to industry viability. This presentation deals with two projects involving Fisheries Products International and its collaborators: (1) a containerized holding system, the Contrawl Project; and (2) a ship operations monitoring system, the Inmarsat System. These projects, it is hoped, will improve raw material quality and the cost effectiveness of fleet operations for the organization. Some observers consider such projects "futuristic," but it will be the successful development of systems such as these which, according to the designers, will improve industry operating performance to the required level.

Introduction

The Canadian east coast fishing industry has experienced major structural changes in recent years as a result of the severe economic conditions experienced in the late 1970's and early 1980's. More specifically, the offshore sector has been the primary sector of the industry involved in these changes. In Newfoundland, Fishery Products International Limited was formed by the amalgamation of many companies, three of which have a long history in offshore fishing operations and which contribute over seventy percent of the company's total output. At the moment, the industry is striving to recover from its financial difficulties, consequently, we are faced with the greatest challenge we have ever known. The industry is both labor and capital intensive and we must take up the task of rendering it strong, viable, and efficient.

In general, there are two factors that will secure our future: our ability to effectively compete in an extremely competitive marketplace, through the marketing of high quality products that will stimulate consumer demand; and, improvements in cost efficiencies, to allow our products to be sold at competitive prices.

This presentation concerns two projects with which Fishery Products International is currently involved. In cooperation with the Development Branch of the Department of Fisheries and Oceans and several Newfoundland-based engineering and communications firms, the projects include a containerized holding system which will be developed for new trawler construction and a ship operations monitoring system which will improve our sea- and shore-based management ability to plan and control the harvesting effort.

The offshore trawler fleet has tremendous potential to contribute to the timely turnaround of our industry and even greater potential to contribute to the securing of its long-term viability through the improvement of raw material quality and the cost efficiency of fleet operations.

Before dealing specifically with these projects, it is necessary to provide you with a perspective on the Fishery Products International trawler fleet.

Our fleet of 56 trawlers is based in eight ports, as indicated below:

Catalina	— 11 Stern Trawlers
Marystown	— 15 Stern Trawlers
Grand Bank/Fortune	— 13 Stern Trawlers
Trepassey	— 6 Stern Trawlers
Ramea	— 3 Stern Trawlers
Harbor Breton	— 4 Stern Trawlers
Gaultois	— 4 Side Trawlers

Our projected catch in 1985 is in excess of 300 million pounds of raw material comprised mainly of cod and flatfish species (flounder, yellowtail, and greysole) with lesser catches of redfish, turbot, haddock, catfish, pollock, and halibut.

The resource is harvested on the Scotian Shelf, Banquereau Bank, the Gulf of St. Lawrence, St. Pierre Bank, the Grand Banks, Funk Island Bank, the Labrador Sea, Hamilton Banks, and Davis Strait.

Our fleet's primary responsibility is to consistently supply eight trawler-based ports with quality raw material at the lowest possible cost. The production capacities (raw material) of the plant sector vary from 100 thousand pounds per day to upwards of 530 thousand pounds per day, depending, of course, on the species processed and the quality and size of the material landed. Each plant has its specific production strengths and weaknesses in accordance with the species the plant was designed to process.

The annual operating costs of the fleet are in the tens of millions of dollars. The average age of the FPI fleet is 13 years which, when combined with the projected increases in allocations to our Company in the next 5 years, suggests that we will need to consider a major fleet replacement program within 4 to 5 years. The projected cost for a new trawler is approximately $14 million, with annual operating costs in excess of $2.5 million.

In reviewing the key points mentioned above:

1) Large fleet of ships — fifty-six.
2) Many plants with varying capacities and species requirements.
3) Fleets harvest resources in many areas which may or may not be in close geographical proximity to the port at which the vessels are based.
4) Varying catch rates and quality in each of the areas fished.
5) Fishing vessels are a heavy capital investment with significant annual operating costs.

You can see that the offshore fishing industry is complex and challenges our ability to optimize return on investment, taking into account the many variables that contribute to the success or failure of an operation.

Because of this great complexity, it is essential that industry management improve its ability to monitor, control and assess ship operating performance. Due to the substantial number of variables and uncertainties that are inherent in a fishing venture, we must be more aware of what takes place at sea so as to optimize our trawler and plant operations. The primary objective is to monitor individual ship performance with an eye to improving our production planning procedures.

Each vessel is considered to be a separate operating unit that is assessed on its individual performance. The management on each ship is responsible and accountable for the achievement of specific goals and objectives. The key criteria for assessing vessel performance include:

A) Raw Material Quality and Contribution to Plant Operations
B) Ship Operating Costs
C) Quantity of Raw Material Landed, and
D) Crew Management.

Therefore, it is essential that we strive for success by improving raw material quality and reducing costs. The projects we are about to describe can contribute enormously to the achievement of these objectives.

Project-Containerization (Contrawl System)

Trawler fleets in Canada, in recent years, have been attempting to meet the challenge of improving the quality of raw material which is being landed at our production facilities. In the face of severe competition, we have been forced to improve the quality of our finished products and we see the improvement of raw material quality as a key factor in achieving that goal. Since the establishment of the two hundred mile limit and the successful recovery of many of our fish stocks, we have seen our catch rates increase significantly. Perhaps, ironically, while resource recovery has been a great blessing, it has also increased the difficulty of achieving high quality landings. However, the problem is far from insurmountable.

At FPI, we have made some major gains at improving the quality of our raw material through:

1) major investments in boxing;
2) major investments in factory deck modifications;
3) major investments in port infrastructure to improve vessel turnaround and to efficiently handle boxes;
4) implementation of dockside grading;
5) improved selectivity by way of trawl changes through experimentation and consultation with captains, gear manufacturers, and gear technologists; and
6) programs to improve crew awareness of the effects of raw material quality on the value of the end product.

Our activities, to date, have produced very positive results and we will continue the effort to supply material required by our plants to produce high-value products.

The major contributing factor to the improvement of quality has been the implementation of a boxing program. While we are quite satisfied with the gains we have made, we regard the system of boxed fish as being somewhat inefficient, for two reasons:

1) It is very labour-intensive. With a penned holding system, our fleet operates with one man in the hold. A boxed holding system requires three, and the effort required by each man is substantially greater.
2) While the discharge time is comparable to air unloaders, we can readily see that boxing will not provide us with the flexibility to improve our raw material costs through higher annual landings. In-port time will remain the same or improve only marginally.

As a consequence, we are addressing the development of a containerized holding system for our vessels of the future. We refer to it as "The Contrawl Project."

The Contrawl Project is a joint undertaking between Contrawl Limited, Fishery Products International Limited, and the Department of Fisheries and Oceans/Department of Supply and Services to develop a mechanized container handling system for trawler in-hold use. Contrawl Limited, a consultant engineering firm, designed the system and FPI has agreed to install it on one of our trawlers, as a pilot project. The Department of Fisheries and Oceans and the Department of Supply and Services are providing the major share of funding. Included is the cost of preparing the design package, purchasing equipment, and covering installation costs. We, in turn, are absorbing the cost of downtime associated with the project, along with the reduced volumetric efficiency of the vessel.

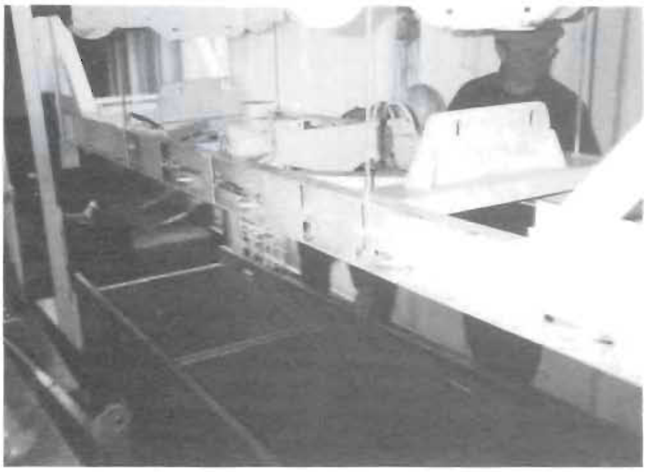
The Contrawl System does not require men in the fish hold. Containers fit into a guide-frame structure in the hold and are handled by an overhead travelling bridge, which is supported by the deck head. The system is chain driven by equipment located in an enclosure on the factory deck. The travelling bridge carries a lifter frame which is lowered to engage the containers when the bridge is in position. The containers are loaded with fish on the factory deck. Raw material is deflected into the containers from a supply conveyor. A second lifter frame is attached to the factory deck head, directly above the fish hold hatchway. This frame can be lowered down into the fish hold to engage containers, which have been positioned directly underneath by the inhold lifter frame. The containers are held in place in the hatch-coaming by retractable supports. The crew working around the coamings, place the fish in the containers. The lifter frames handle three containers, which are longitudinally aligned, end-to-end. The sequence of operation is programmed into a computer controller, which ensures an organized handling routine. Ice is added to the containers in port before they are loaded onto the vessel. One in three boxes will be filled with ice and placed on board in a manner that will always allow the lifter frames to handle one iced container in three. The icers working on the factory deck will mix the ice with the fish. The containers are approximately 17 cubic feet (480 litres) in volume and hold approximately 600 pounds of cod (gutted and iced). They are insulated and will be equipped with covers to facilitate truck transportation, if required.

For the pilot project, the trawler involved will be loaded and discharged using a crane mounted on the main deck of the vessel. It will handle one container at a time. We have chosen one of our "Atlantic class" vessels to be involved in this project. This type of vessel has its fishhold divided by a bulkhead. The smaller, forward-most compartment, will be modified to install the Contrawl System while the aft section will remain penned during the project. The volumetric efficiency of the forward hold will be reduced with the new system, as the framing will have to be stepped, in accordance with the lines of the hull.

It should be noted that this project is intended to test the workings of the system in a sea environment. The system will be removed after testing has been completed and the forward hold will be restored to its present condition. The Contrawl System is not suitable for permanent installation on existing vessels because of volumetric inefficiencies and because modifications are too costly. It would, however, form the basis for final design and fabrication on a new ship. We would then incorporate, with the containers, an automatic icing system and a high volume discharge and loading system.

We feel strongly that a well-tested and well-constructed computerized containerization system can provide us with enormous gains in vessel operating efficiency by maintaining a high level of raw material quality, comparable to what we are presently achieving in our boxing program, and through reduced in-port time, thus yielding increased annual landings. By increasing the catching capacities of existing and future vessels, we can reduce the long-term capital requirement for ship replacement.

Atlantic Class stern trawler *Atlantic Margaret*, 153' LOA, owned and operated by FPI, undergoing refit and installation of the Contrawl System at the Burin Refit Centre in Newfoundland.



An in-hold view of the travelling bridge and its set of three containers. These can be both manipulated and stored in the fishhold.

Forty-eight 480-litre boxes can be manipulated and stored in the forward hold of the *Atlantic Margaret*. This is done completely automatically after the containers leave the factory deck.

Project — Ship Operations Monitoring System

Besides striving to improve quality, we need to develop ways and means to improve our operating efficiencies. This includes harvesting more resource per working unit, while maintaining or reducing operating costs. This can be achieved. However, we must consider the variables affecting a large fleet.

1) Weather, ice,
2) Areas fished/proximity to home port,
3) Species harvested,
4) Marketing/quota constraints,
5) Species quality,
6) Vessel operating characteristics, and
7) Plant requirements.

To maximize the operations of our fleet and plants, we need to monitor more closely vessel activity so as to improve the overall production planning process. The efficient landing and sailing of trawlers depends on all these factors. And, in order to plan full utilization of our fleet, we need to be aware of what is actually happening on a more timely basis, so as to allow for more informed decision-making.

In 1985, we were approached by Grove Telecommunications Ltd. and asked if we were interested in assessing the Inmarsat System (Satellite Communications) for use onboard our vessels. While the system offered improved communications and complete confidentiality, it was, particularly at that time, a very costly means of transferring information.

However, we did express interest in the system, if it could be incorporated with a complete ship operations monitoring system. This included the monitoring of all factory deck, engine room and wheelhouse activities and functions. As proposed, it would allow improved ship management, both at sea and ashore, through increased awareness of vessel activity on an instantaneous basis. Once again, with better information, our entire production planning process could improve.

We proposed that the system should feed the following information to shore-based monitors by way of satellite transmission:

TASK	TIME
1. Position of Vessel	Each Tow
2. Weather	Twice Daily
3. Catch to Ramp	Each Tow
4. Catch Discarded	Each Tow
5. Catch to Hold	Each Tow
6. Position of Catch in Hold	Twice Daily
7. Species Breakdown	Each Tow
8. Quality — A. Bruising	Each Tow
B. Texture	
C. Parasites	
D. Jelly	
9. Temperature of Hold	Daily
10. Fuel Consumption	Daily
11. Exhaust Temperatures	Daily

Basically, most of the engine room and wheelhouse sensory requirements are available. However, it is the factory deck operations information that will, we hope, permit us to see a sufficient return on, what is expected to be, an expensive investment

Onboard fish monitoring system — The complete EDP system includes a computer, camera, monitor, output terminals, and software.

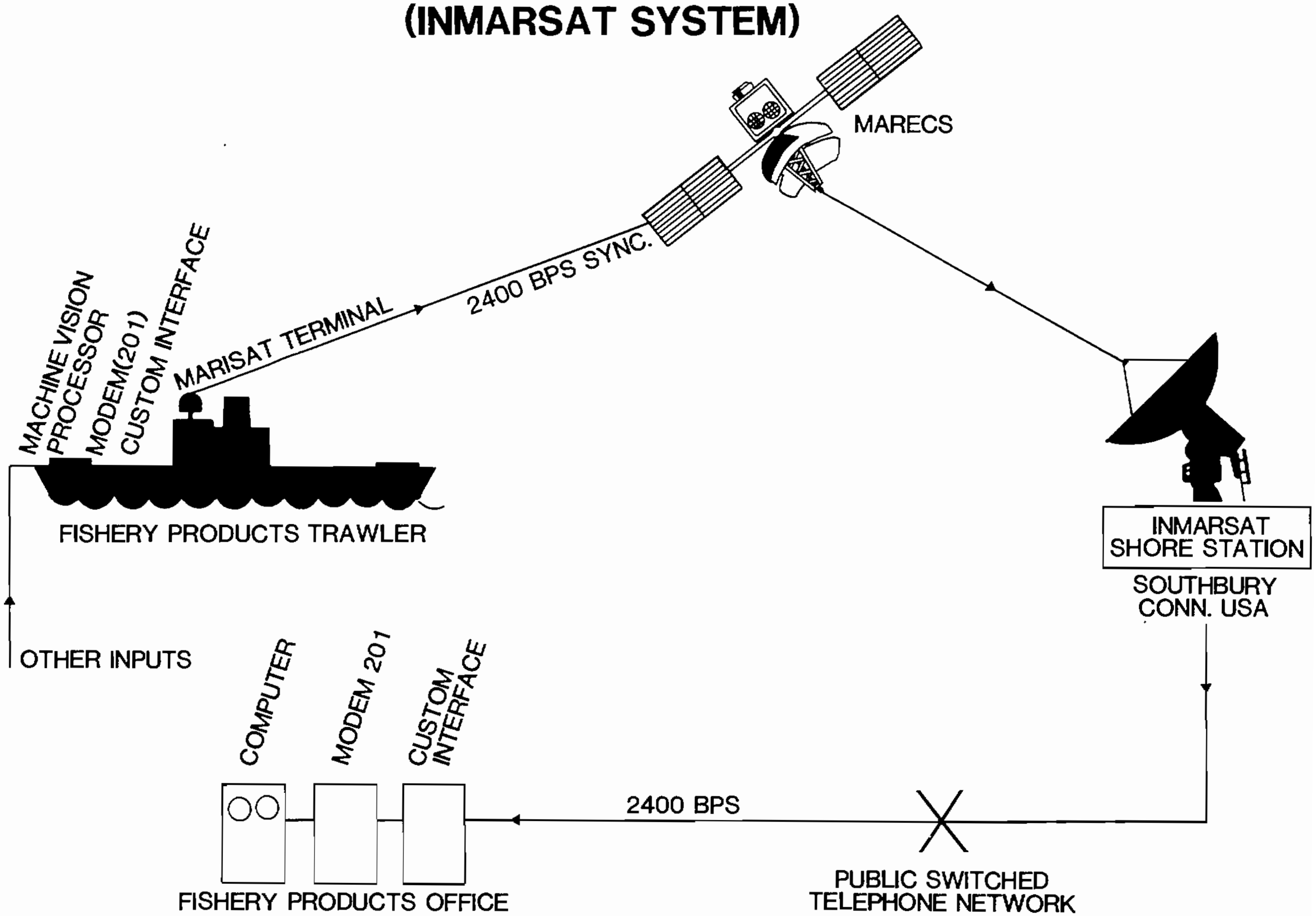
Specimen table — Fish are moved along a conveyor belt (circular in this case) for image assessment by an electronic camera (mounted on a metal arm and positioned directly above the conveyor). This data is then processed by algorithm to determine species, length, and weight.

The Development Branch of the Department of Fisheries and Oceans in St. John's has shown great interest in the project. They have been responsible for a contribution which was given to Grove Telecommunications Limited of St. John's.

Grove Telecommunications Limited has been working with Octek Inc., a U.S. subsidiary of the Foxboro Company, one of the world's largest manufacturers of process control instrumentation systems. At present, work is underway on the development of automatic sensory devices that assess species and size. This information will later be incorporated with an assessment of quality and the detection of species defects. State of the art technology known as "machine vision" will be used in this project. Raw material, travelling on conveyors will pass through the field of vision of equipment that will scan the images of the raw material and, with appropriate software programming, will detect the characteristics of species, as well as the size, from stored geometric data. If this particular project is successful, it will provide a base on which to build a larger and more comprehensive system incorporating all of the factors previously indicated.

A Computerized Fish Operations Monitoring System

(INMARSAT SYSTEM)



Artist's conceptualization — Inmarsat System.

The benefits of the system include:

1) An increase in vessel management's ability to assess raw material quality and engine room activity, consequently allowing them to more quickly react to problem situations;
2) An increase in shore management's ability to assess vessel performance on a timely basis for the purpose of improving ship scheduling and, consequently, production planning;
3) A reduction of government conservation and surveillance costs, through the timely transfer of discard and vessel position information; and
4) the application of the technology for in-plant use, particularly for product grading and product inspection.

Obviously, the system is far from being fully developed. Much more effort must be put forward in the development of sensory devices to assess quality, catch, and other factors. However, we are hopeful that we can attract the necessary expertise to bring it to completion.

Conclusion

The challenges facing the fishing industry are enormous, but we feel very positive. These challenges can be met!

Improving our quality and cost performance will play a major role in securing our chances of long-term viability. The goals we have set, in what some consider to be "futuristic" projects are attainable. And it will be the contributions from the successful completion of these projects that will see us improve our future operating performance.

Fish Handling and Storage Onboard Offshore Trawlers

Ken Rodman

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and Chris Cooper

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Department of Fisheries and Oceans
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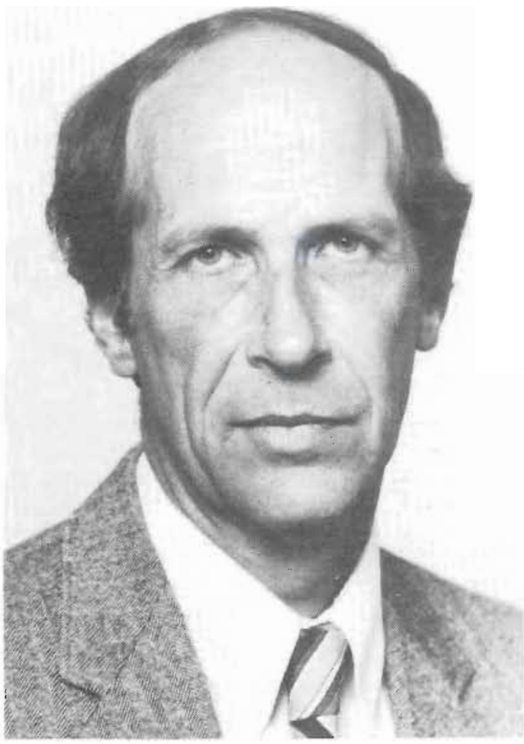
Ken Rodman



Chris Cooper

Abstract

Since the days of the sailing ships, there have been major technological advances in almost every aspect of the offshore trawler. The one area which appears to have lagged in development is onboard processing and storage of the catch. Some of the major problems with present onboard processing systems are discussed in this presentation, along with the potential benefits to be gained from systems analysis, attention to ergonomics, and containerization. The onboard storage options available and under development are reviewed and an assessment made of the probable net benefits and impact on trawler design. Recommendations are proposed on aspects which should be considered in the design of the next generation of offshore trawlers.

Introduction

Commercial fishing is Canada's oldest industry. In fact, it was the rich fishing banks and coastal waters of the Northwest Atlantic that led to the settlement of North America. The first two forms of fishing in the area were the "shore" and "bank" fisheries. The shore fishery took place in waters near the coastline where fishermen worked from dories using seines or handlines. The bank fishery was centered around rich fishing grounds further from shore. The men fished from platforms hung from the sides of vessels and they used handlines. In later years, trawl lines and gillnets were fished from dories which would return the catch to the mothership.

The "shore" and "bank" fisheries have evolved into: the INSHORE FISHERY and the OFFSHORE FISHERY. While the designation of the two types of fisheries has not changed significantly, there have been dramatic technological advances in almost every aspect of the industry, particularly in the offshore fishery. By far, the greatest technological advances have been in the vessels themselves. The wooden hulls of the salt bankers have been replaced by the steel hulls of the trawlers. Sail, as a means of propulsion, has been replaced by the screw propeller. Men, as a source of power, have been replaced by engines, winches, and hydraulics. Even the screw propeller has been the subject of technological change as nozzles to increase thrust and controllable pitch capability to optimize performance have been introduced.

Nowhere has the impact of technology been more dramatic than in the wheelhouse. The sailing ship depended solely upon the skill and knowledge of the skipper, supplemented by a few simple instruments. Compare that with the modern trawler with its myriad nagivation, sonar, and control systems.

Fishing gear, too, shows evidence of technological change. The simple handlines and dories have been replaced by large, efficient trawls, capable of catching 40 000 pounds of fish in a single tow. Modern methods and equipment are employed to land these large quantities of fish. But, this is where technological progess has stopped or, at least, proceeded very slowly. The means of handling, processing and storing fish onboard is still, for the most part, labour-intensive.

In the old days, the landed catch was first sorted and split on deck, then salted and stored in the hold. The entire operation was essentially manual, requiring men with knives to split and gut the fish, men with pitchforks to move it, and men with shovels to spread salt and stack the catch in the hold. But despite the introduction of mechanical equipment to facilitate processing and handling fish onboard, the current Canadian offshore wetfish trawler still relies heavily on manpower. To a large extent, men still gut fish with knives, sort it, and store it manually in pens. However, they don't shovel salt anymore, instead they shovel ice.

This has been a lengthy introduction to make the simple point that technological advances have been made in almost every facet of the offshore fishing trawler, with the exception of the handling and storing of the catch. What we hope to present today are:

a) the benefits to be gained from ergonomics and containerization;
b) the alternative stowage systems available for trawlers; and
c) a few thoughts on the next generation of offshore trawlers.

Introduction of Mechanical Equipment

This lack of progress in the handling and storage of fish has not been due to a lack of effort or to the absence of mechanical equipment. Devices are available such as gutting machines which, if properly maintained and operated, can effectively and continuously gut selected species of fish at a rate far in excess of a highly skilled gutter. Other reliable devices such as conveyors, flumes, and washers suitable for fish handling are standard throughout the shore-based industry.

What appears to have occurred in the Canadian offshore trawler fleet is the introduction of mechanical equipment in a more or less piecemeal fashion with insufficient attention to detail and the failure, in some instances, to properly design a flexible fish handling system. This oversight, in our opinion, lies at the very root of the so-called "quality problem" with Canadian fish products. Fish caught, utilizing the latest technology available, is handled with little consideration for its potential as a highly regarded and valued human food.

It is clear that the industry cannot continue in the traditional belief that more money can be made by simply dragging more fish from the sea. Fish is an exhaustible resource. In fact, the most desirable species are already fully utilized! Our attitudes will have to change!

On the other hand, we must not overreact and become obsessed with quality for the sake of quality. There is a happy compromise which can produce dramatic quality improvements at reasonable cost.

Productivity Improvements

If we were to examine the system for processing and delivering fish to the hold on a typical offshore trawler, we would find many opportunities to introduce improvements. Based on actual measurements and observations onboard several offshore trawlers, A. Orlic Associates Ltd. have estimated that improvements in the order of 20–60% are possible. The introduction of ergonomics and systems design to the processing deck can have a dramatic effect on productivity.

The question of "Why should we be concerned about productivity in an offshore trawler?" can be best answered if we first examine the anticipated benefits. These benfits can be enumerated from several points of view:

For the Crew:

1) Reduced physical strain and fatigue.
2) Potential for improved earnings.
3) Better working environment.

For the Vessel:

1) Enhanced ability to handle big tows.
2) Reduced processing times, thereby delivering better quality fish to the holds.
3) Potential for increased landings.

For the Processing Plant:

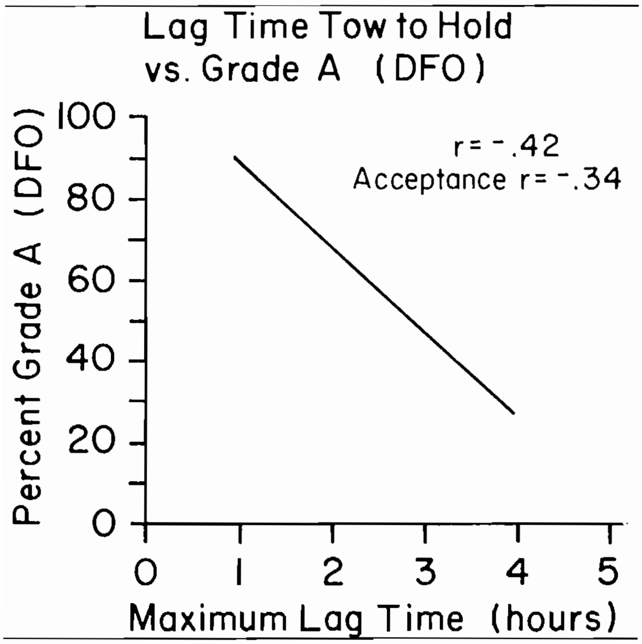
1) More consistent quality/fish generally of better quality.
2) Improved productivity and increased yields.
3) Potential for improved grade distribution.
4) Discrete lots of fish of the same age and quality.

These considerations are closely interwoven, however, so we will simply discuss the rationale behind them, rather than attempt to expand upon each point in turn.

A system designed to accommodate and optimize man's performance as a machine will generally reduce physical strain and fatigue. Thus he will be able to maintain a higher level of throughput over longer periods of time. This will result in faster and more gentle handling of fish.

Preliminary studies have shown a correlation between the landed docking grade and the time delay between landing fish in the cod-end and icing fish in the hold. The shorter the delay, the higher the overall quality. A reduction of one hour for example, can result in as much as a 20% increase in the quantity of grade A fish being landed. That translates into money.

IMPROVED QUALITY = MORE MONEY



A reduction in crew effort can also mean that more time will be available to undertake other quality-enhancing operations such as icing and boxing. This reduction of effort combined with improvements in working conditions can, in addition, produce very positive attitudinal changes. This can certainly have a profound effect on landed value. Finally, increased productivity can enhance the vessel's ability to handle the big tow, thus, potentially, enabling it to land more fish. It has been estimated that landings could increase by as much as five percent because fish are sometimes discarded if they cannot be stowed before the next tow must be hauled.

The dollar value of these potential benefits is difficult to estimate. However, it can be argued that an improved dockside grade distribution would enhance crew compensation and significantly improve final product value. Payback to re-equip a trawler has been estimated to be as rapid as one year. So...

What is an appropriate strategy to improve the handling system's productivity?

1) Optimize the use of mechanical gutting equipment and maintain it!
   — Ensure that the operator's sole task is to load the machine.
   — Ensure that fish delivered to the gutting machines are of an appropriate species and size. (Fish must be spread out and displayed to the hand gutters en route to the gutting machines. The hand gutter can then select those species and fish either too big or too small to be gutted effectively by machine. This should also reduce the requirement to inspect machine gutted fish.).

Observations and measurements onboard trawlers confirm that gutting machines are not being fully utilized and, in practice, perform only marginally better than a skilled gutter. This is due primarily to the fact that machine operators are often required to cull and sort fish.
In one case, an operator was actually required to supply fish to the manual gutters. In another, an operator was observed to stop feeding the machine in order to dress a halibut. Obviously, during that time, machine output was zero.
We cannot over-emphasize the importance of machine adjustment and maintenance. Therefore, operators and maintainers must be intimately familiar with the machine if they are expected to use it to full advantage.

Gutting Rate Comparison

Manual	1 Step Process (1 Man)	2 Step Process (2 Men)
	8.8 Fish/Man-Min.	7.5 Fish/Man-Min.
Machine	Typical Existing System	Designed System
	19 Fish/Machine	24 Fish/Machine

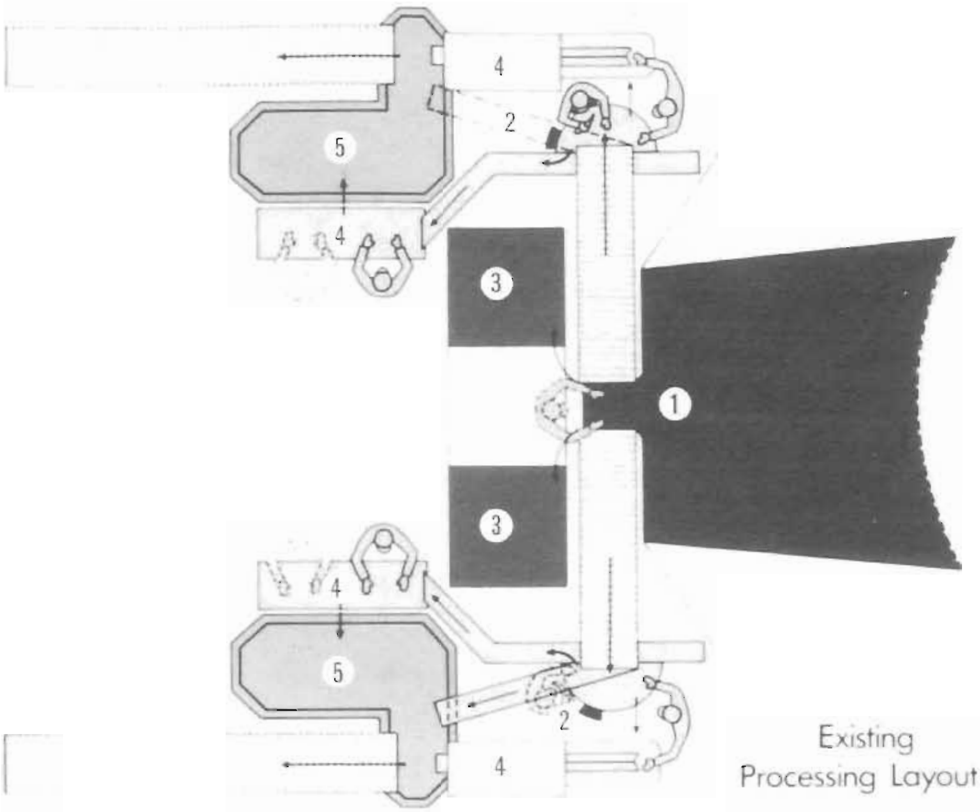
NOTE: These figures are averages based on actual, but limited, measurements.

2) Utilize the one-step gutting process.
   Observations and measurements have confirmed that the one step process is significantly more productive than the two step process. On average, a productivity improvement of up to twenty percent can be realized.
3) Design the individual work stations using sound ERGONOMIC design principals. By minimizing the necessity to bend and throw, a work station can reduce worker fatigue and strain, thereby increasing productivity.
4) Eliminate multiple or repeated handlings of fish.
   Maximum output can be achieved only if all wasted movement is eliminated. For example: Once a gutter has decided that a particular fish is to be manually gutted, he must complete the operation there and then, otherwise, system productivity will suffer.
5) Utilize conveyors, chutes, mechanical washers, flumes, etc. to ensure a gentle, steady and uniform flow of material. If the system does not operate continuously and smoothly, then none of its components can operate to full potential.

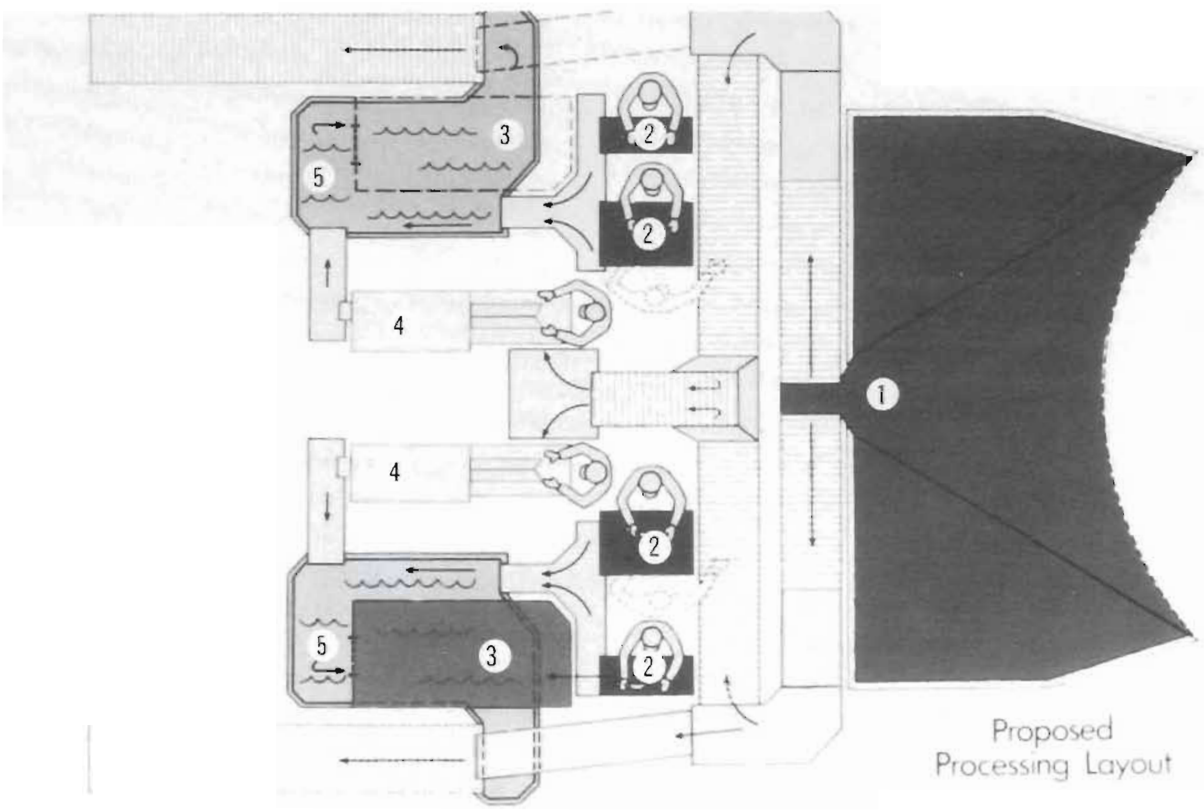
   Again, Orlic Associates observed that the handling system would often be forced to stop due to system bottlenecks, mismatching of process and stowage rates, and the failure of fish to move from station to station at controlled rates. These irregularities sabatoge productivity and cost money. Ideally, the process rate should equal the stowage rate.

If we were to compare the existing layout on the typical offshore trawler with one we have proposed to improve productivity, the significance of the required changes might not be immediately apparent. By direct comparison of various system flows, these differences are more easily seen and their significance more readily apparent.

Below, the numerically coded areas represent various processes and process flows.



— Area 1 depicts round fish.
— Areas coded 2 depict gutted fish or locations where manual gutting takes place.
— Areas coded 3 indicate where by-catch is held.
— Gutting machines are shown as 4 and washers as 5.



The diagram on the preceding page compares the routing of round fish through the processing section. There are no significant differences here except that provision would be made to ensure that the flow of fish between transfer points from the pound forward to the fish hold is steady and continuous with a minimum of manual intervention. The proposed system positions the manual gutters upstream from the gutting machines so that inappropriate fish can be removed and cut by hand. This difference is responsible for the principal advantage of the proposed system over the existing arrangement. In the proposed arrangement, the gutting machine operator's sole task is to feed the machine, since all inappropriate species and sizes have been previously culled out.

In a manual gutting option, design changes would ensure a comfortable and natural work station that does not require unnecessary lifting or throwing. Also, please note the by-catch holding areas. In the proposed arrangement by-catch is held over the wash tank, thus minimizing effort and physically separating those species from the principal species. Once the main species have been handled, the already gutted by-catch can be dumped into the washer and routed to the hold with minimum effort. It is important to note that in our opinion, the proposed arrangement is not optimal, but represents the best arrangement that we could envision within the very real constraints imposed by this particular class of vessel. However, productivity improvements in the order of 20–60% are anticipated!

Now that the fish have been efficiently and gently culled, gutted and washed, they must be delivered to the fish-hold quickly and at a rate compatible with the hold crew's ability to stow them. Again, the processing rate should equal the stowage rate.

It is not enough to improve any one aspect of the at-sea operation and expect significant benefits to accrue automatically. We must continue to exercise proper care if we are to maintain fish quality at the highest possible level.

Fish Stowage

Various studies and investigations worldwide have identified opportunities and benefits that containerization can provide.

Major areas where benefits are anticipated due to containerization include:

1) Reduced weight loss in iced storage (perhaps even an increase).
2) Enhanced landed quality (due to improved texture).
3) Enhanced fillet yield.
4) Reduced trimming requirement.
5) Improved productivity (due to improved texture and lack of physical damage).

NOTE: The exact magnitude of these benefits varies considerably, but have been repeatedly identified as significant.

The Atlantic trawler fleets have flirted with containerization in the past. There now appears to be a serious move toward containers, but to what system? A proper system of containerization is a good deal more complicated than simply putting fish into boxes. It must not reduce the vessel's ability to catch or stow fish; it must not be too labour-intensive; it should be simple to operate and maintain; it must facilitate unloading; and it must utilize a system of containers compatible with plant material-handling systems and storage facilities.

Alternative Systems

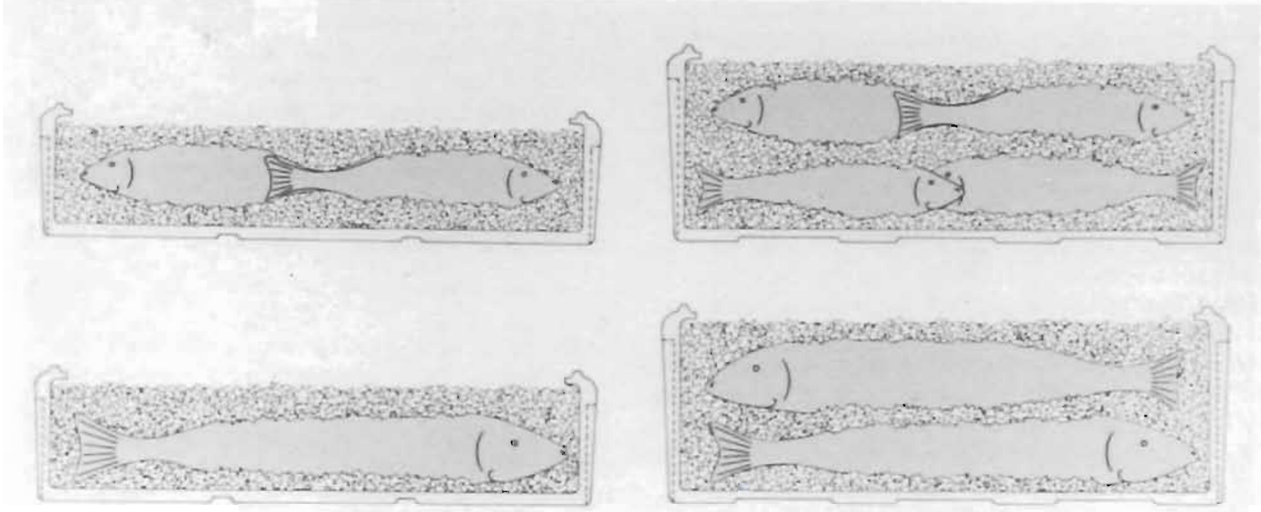
The following are some alternative systems of fish stowage.

The Pen System is the system in use today aboard most Canadian East Coast groundfish trawlers. It represents the base line to which all other alternatives are compared. It involves the stowage of fish with ice in alternating layers in fixed pens with internal shelves installed to reduce the static pressure on fish lower in the pen. This method is relatively simple and has changed very little over the years. Its principle advantage is that it is cheap, adaptable to various stowage rates, and makes maximum use of available hold space. The tools of the trade are simple and include the fire axe to break up ice, the shovel to move it, and, most commonly, the fork to move fish. It's principal disadvantage is that fish must be broken out of the pens and moved to an unloading device. This unnecessarily disturbs and, usually, damages it. Fish of various qualities are also mixed, further complicating the job of quality differentiation.

THE PEN SYSTEM

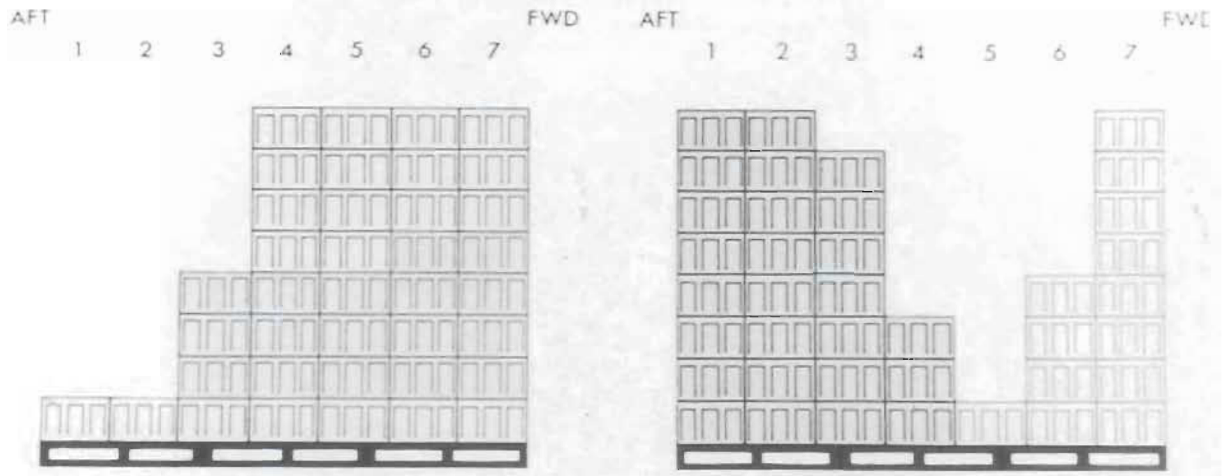
The European Box System is probably best represented by the Per S. Stromberg 70- and 90-litre boxes. These boxes have been successfully used by the former H.B. Nickerson groundfish fleet and, most recently, by several National Sea trawlers. And, I think, we now see evidence on the part of all companies in Atlantic Canada of their intention to move to one form of containerization or another. However, the European method is rather labour-intensive. It requires a careful pre-stowage arrangement of empty boxes and boxes filled with ice, so that ice is available at the row currently being filled with fish. The system's principal disadvantage is the large number of boxes to be handled and the fact that the box occupies as much space empty as when it is full. The hold, therefore, is always virtually full, making working conditions rather confined. Hold volume is also lost, thus reducing maximum carrying capacity. But the European System does offer the advantage of relatively low conversion cost and small unit size. Fish are delivered to the boxes where they are manually placed between layers of ice. This allows them to remain undisturbed until being dumped immediately prior to processing and has produced significant improvements in landed quality and yield.

THE EUROPEAN BOX SYSTEM

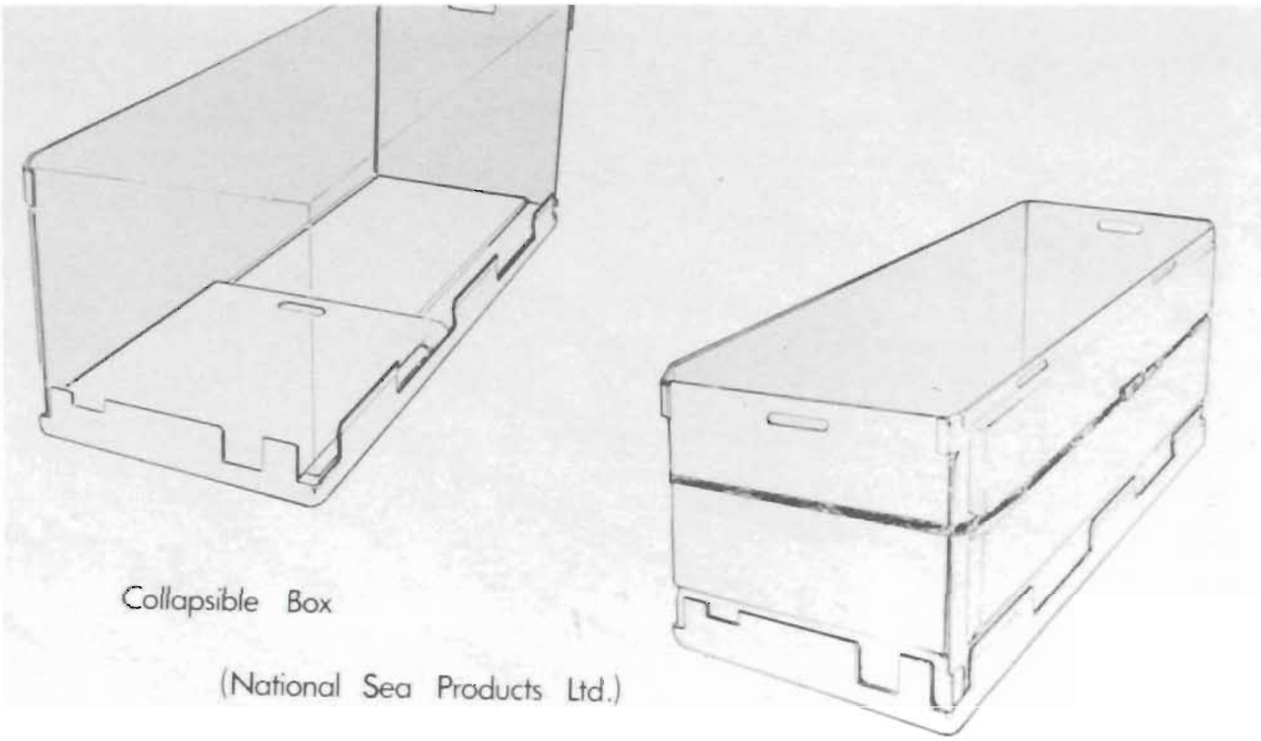


70 litres

90 litres

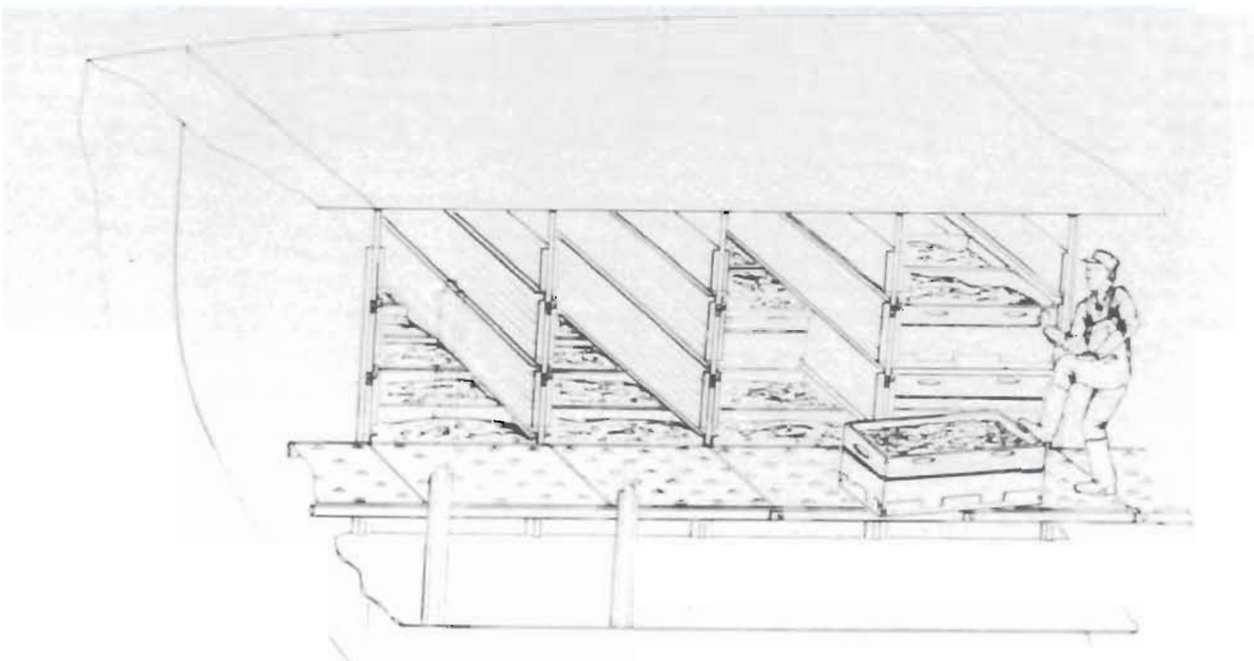


A variation in the boxing theme is the *Collapsible Box* developed by the National Sea Products Research and Development group, Fisheries Resource Development. This container system offers a potential solution to the storage problem during the transition phase from vessels designed to pen fish to vessels designed to containerize them. It requires minimal hold modification, as the boxes are supported on pen shelf supports. The box is collapsible (approximately three empty boxes can be stored in the space normally occupied by one full box). In use, the box is erected and positioned on shelf supports. Fish and ice are then delivered to it. Unloading is facilitating by a series of roller-ball sections hung from central aisle stanchions. The boxes are pulled from the pens manually and maneuvered under the hatch to be hoisted ashore. Sea trials are currently underway to evaluate the system's practicality under actual commercial fishing conditions.



Collapsible Box

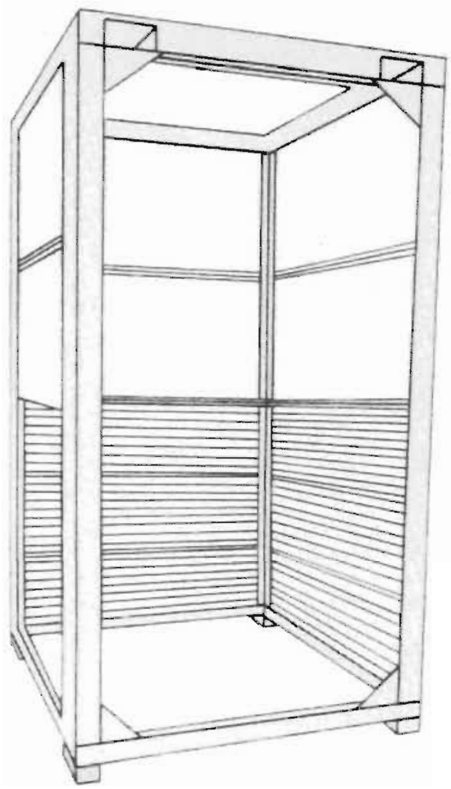
(National Sea Products Ltd.)

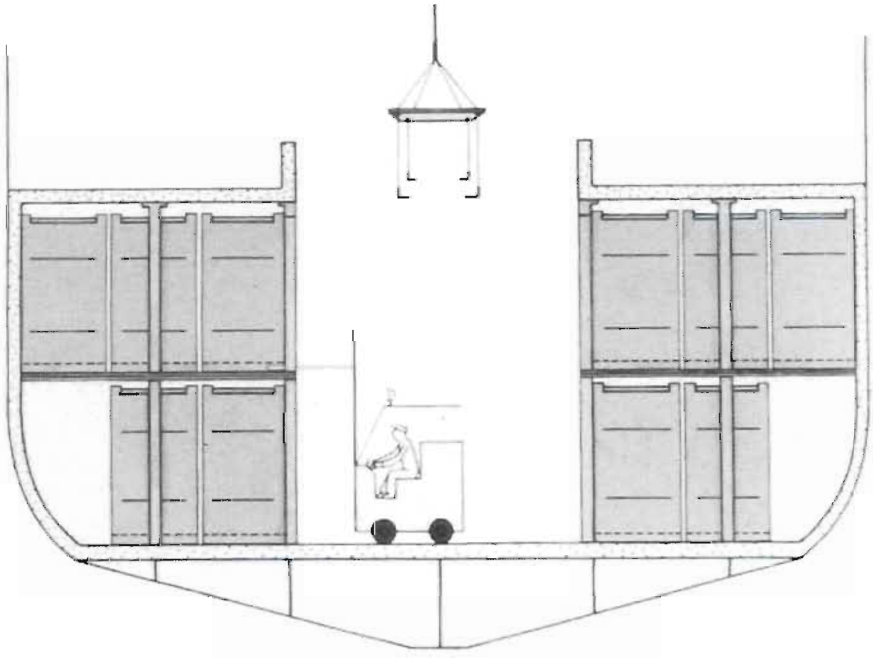


A rather clever solution to the fish containerization problem was developed by the French and has been in service for about ten years. It is known in Atlantic Canada as the *St. Pierre System*.

This system is perhaps best described as a removable pen. The fish hold is filled with a racking system to support and retain metal box frames. These are closed-in prior to filling, using more-or-less conventional pen boards. The box frames are approximately 6 feet high and contain an internal shelf to reduce static pressure on the fish. Fish and ice are delivered to the containers through a series of manholes on the processing deck floor. Suspended chutes direct fish and ice into the containers, thus eliminating the forking of fish and the repeated shovelling of ice in the hold. The vessels are fitted with large unloading hatches to facilitate the rapid unloading of the large containers using a shore-based crane. When the containers directly below the hatch have been off-loaded, a small fork lift is hoisted onboard to remove and deliver the remaining containers to the unloading hoist.

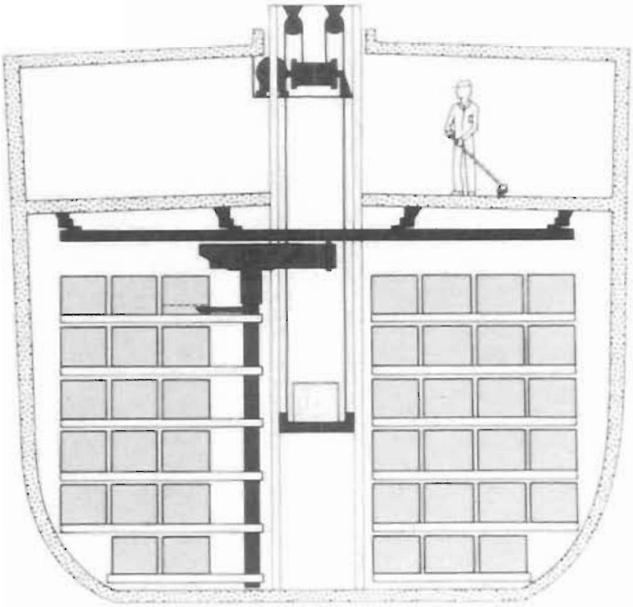
THE ST. PIERRE SYSTEM





A more complicated French design commonly referred to as the *French System*, employs rigid containers supported by an elaborate rack system.

This system was fitted to at least four trawlers in the early 1970's. Significantly better quality fish was reported, although unloading rates were rather disappointing.

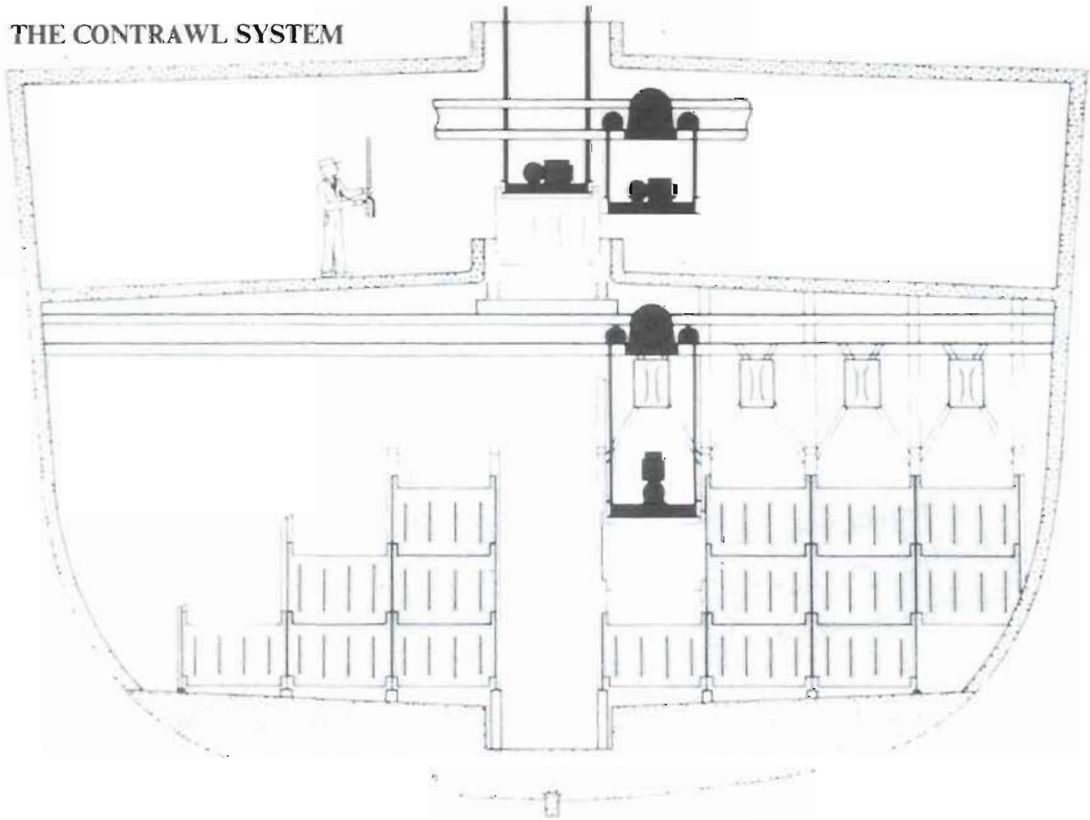


THE FRENCH SYSTEM

Contrawl System

The ultimate or high-tech alternative, currently under development, is the *Contrawl System* developed in Newfoundland by Fishery Products International Limited, Contrawl Ltd. and the BAE Group. This employs a system of interlocking insulated containers and lifting frames which

THE CONTRAWL SYSTEM



COMPARISON OF CONTAINERIZATION ALTERNATIVES.

Item	Pen	European Box	St. Pierre	Contrawl
Fish Stowage Rate lb/ft	30	22.5	25.5	21[1]
Discharge Rate 100 lb/h	30–50 Air Unloader Bucket Unloader	40 Two Hatches	80	150–200[2] 3 Systems
Net System Cost	–	$526,000	$440,000	$1,329,000 1 System
Per Trip Revenue Ratio	1.0	1.19	1.07[3]	1.07
Anticipated Maintenance	Low	Low	Moderate	High

NOTE: [1]Author's Estimate.
[2]Contrawl Estimate.
[3]Assuming 90% of 901 Box Quality.

SOURCE: Preliminary Design and Feasibility Study:
Container Storage and Offloading of Fish Aboard Offshore Wet Fish Trawlers by Evans, Yeatman and Endal (Assoc.) Ltd.

allow the movement of several containers at one time. The containers are delivered to the processing deck for filling and subsequently stowed below by a computer-controlled hold lifting frame. Up to three such systems would be employed on a large trawler.

This system is envisioned to operate largely without human intervention. There would be no personnel in the fish-hold, since it will be virtually filled all the time with containers. Control is achieved by utilizing a computer-based "controller" to keep track of the location of all containers, their contents, and the location of both lifting frames. An unloading rate in the order of two hundred thousand pounds per hour is estimated by Contrawl, utilizing three systems operating simultaneously. It is, therefore, suggested that an enhanced vessel turnaround time is possible.

These are but a few of the alternate container systems that are either currently in use or under development. Our purpose in presenting them is *not* to advocate any one system over another, but rather to stimulate discussion and innovation in this area.

Summary

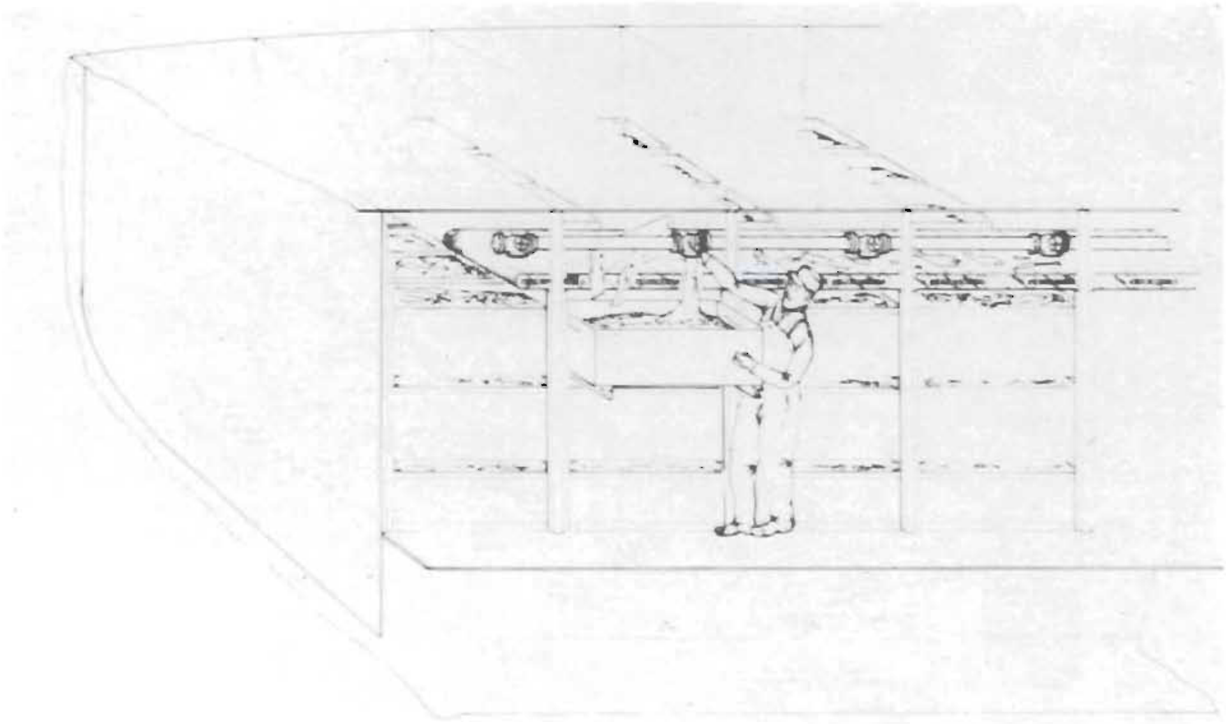
We don't for a moment pretend to have all the answers; but we believe we have some important observations that should be considered in the next generation of trawlers.

Basically, the present Canadian offshore trawlers are reasonable platforms which perform very well their prime task of catching fish. Deck layout, fishing equipment, hull and propulsion systems all appear well-designed for that task. The processing and stowage systems, on the other hand, appear to have been more of an afterthought than a prime consideration in their design. In the next generation of trawlers, it is this aspect which should receive emphasis.

We have identified several points which should be incorporated into any new design and the first of these is ergonomics. Quality fish from Canadian offshore trawlers will never be a reality so long as men are forced to work in ill-suited and cramped quarters. The design of the processing deck on many Canadian trawlers promotes poor ergonomics. As an example, compare the processing area of a typical Canadian trawler with that of a St. Pierre vessel.

St. Pierre Trawler

Typical Canadian Trawler



THE DRAWER SYSTEM

In it, the processing area utilizes almost the entire length of the deck whereas the Canadian trawler crams this function into the restricted stern area, for no apparent reason. The larger area for processing allows flexibility and facilitates introduction of new processing equipment.

The second point is that the system, whatever system is adopted, should be designed as exactly that — a system in which all functions match. The processing rate should match the stowage rate. The catch rate should match the processing rate. Fish will never be of consistent quality if they are allowed to lie around onboard trawlers for lengthy periods.

The third point is that the evidence overwhelmingly supports the need to adopt some form of containerization as the prime means of storing fish. The best container system could be one of those discussed thus far or it could be an entirely new concept such as the one we have named the "drawer system." It would utilize boxes of a size similar to the National Sea collapsible box. However, the boxes would be slung from supports similar to drawer supports, and during loading and icing, be pulled out into the centre aisle to facilitate access. (The centre aisle would use some other form of storage.) For unloading, the boxes would roll off the supports onto some kind of roller bed.

Whatever system proves to be best, it is our opinion that a separate ice delivery system, which delivers ice to the hold by means of a chute or hose, must be incorporated to get away from the laborious task of shovelling ice.

The final point is the design of the offloading system. With the high capital costs of new vessels, turnaround time is becoming increasingly important to maximizing return on investment. The unloading system must be an integreal part of the stowage system and the receiving line at the processing plant. It must be designed to avoid extra handling of the catch. Conventional vertical unloading through a topside deck hatch may have to be altered. For example, the Contrawl system is based upon a large hatch over each hold for unloading. In a trawler designed for this system, the clear topside deck area would probably have to be much larger than normal and the bridge pushed forward.

This begs the question of why trawlers must unload vertically. Many of the larger transport vessels incorporate concepts of side or bow loading. It is not an entirely new concept. Even in the days of sail, bow loading was an accepted practice.

In closing, we would like to leave you with this quote:

> "The development of fisheries is characterized by short periods of rapid change, alternating with long periods where progress is slow, giving rise to the traditional view that fishermen are conservative and reluctant to change."

In handling and stowage onboard offshore trawlers, we have just gone through a slow period; the next few years should be ones of rapid change.

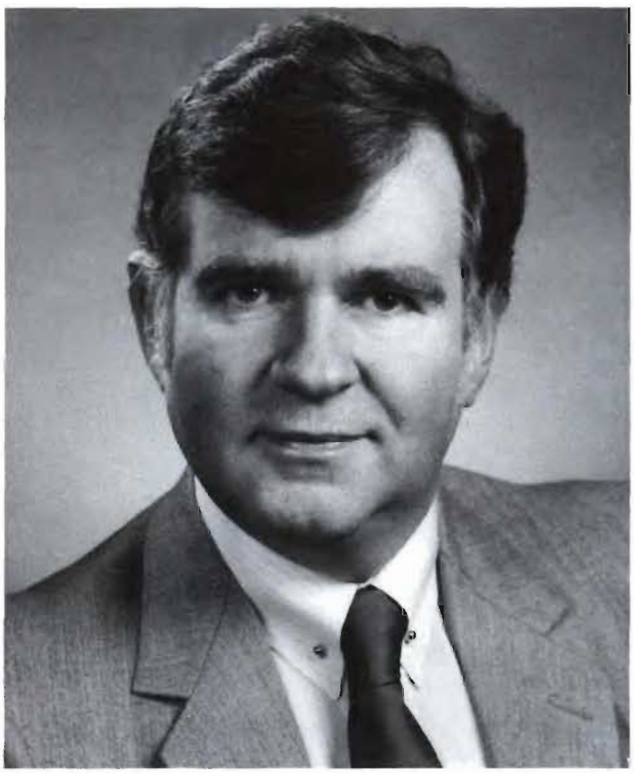
Between Sessions, there was ample opportunity for AFTC delegates to browse reference materials from a variety of sources. Photographic exhibits (like the one shown above), featuring scenes from throughout the five Atlantic Provinces, helped add flavour to the event.

Keynote Address

Technology Applied to the Cost-Price Squeeze in the Marketplace

R. W. Bulmer

President, Fisheries Council of Canada
Ottawa, Ontario



"Applying high technology to the fishing industry is expensive and time consuming. Canada lags behind in this area considering the volume of fish we sell ..."

Introduction

Let me begin by putting some parameters around the problem of cost-price squeeze in the marketplace.

Looking at the consumer price index in the USA and using 1971 as the index base of 100, we see that by 1982 the index for fish products was 318. This compares to beef over the same period at 287, poultry at 262, pork at 237, and all foods in general at 270. Costs in the fishing industry since the 200-mile limit, then, have been pushed through to the consumer. In fact, our relative price increases have been greater than for other protein products.

Looking at the U.S. retail price index for the period 1982 through 1984, we see that fish prices were about equal to red meats at an index of 144 compared to poultry at 125. Again, 1977 is 100. However, by the second quarter of 1983 with red meat retail prices stable, fish prices escalated again and finished 1984 at an index of 156. Therefore, fish prices not only increased faster than other proteins, they are relatively higher.

The first result of this is that fish consumption in North America has remained stable at about 12.8 pounds per capita in 1983. While 1984 does show some growth, it was all, or mostly, in canned tuna which was pricing down. A second result should have been that everyone was making more money. Unfortunately, as we all know, this isn't the case.

Let me use the Kirby Report of 1983 (The Report of the Task Force on Atlantic Fisheries) as the basis for my analysis. Of course, new cost and earnings data have been generated for Atlantic Canada, in studies done by Woods Gordon and the Fisheries Council in 1983, but the Kirby analysis is still correct and public. The sample of over 100 plants showed a net income of $18 million in 1977 and a net loss of $57 million in 1981 (see Appendix, p. 94). While Kirby's analysis touched on real selling prices, adjusted for inflation, currencies, and other impacts, allow me to focus for today's discussion on the cost of production.

Roughly, the principal components of operating cost in the fish processing industry, as a percentage of the cost of sales are:

Fish	55 to 60%
Direct Labour	20 to 25%
Packaging	5%
Manufacturing Overhead	15 to 20%

Within this last category, energy is about 3%. This list gives us some sense of priorities as to where technology needs to be applied.

Two factors stand out in the Kirby analysis.

First, labour costs represent a significantly larger share of the sales dollar in fish processing than, for example, in the poultry industry. For fish in 1980, labour accounted for 21.5% of total costs; in poultry 11.8%. This doesn't automatically mean we are paying too much or using too much labour. A poultry plant can function on an assured 12-month supply and can plan capital equipment requirements on a better supply base. But it is an area that technology advancement might affect in a positive manner.

Secondly, statistics show that the ratio of landed value of fish to product value received from sales has increased during the period studied. The fishermen's share of total product value increased from 37% in 1976 to 44% in 1981. Again, I would not conclude that too much is being paid for fish relative to market value of other products, but rather, that technology must deliver more product and with greater value added, if processor margins are to be increased.

In total then, looking at the last year of the study, gross margins in the plants studied were 12% of sales, and net income was 6%. Kirby points out that gross margin on average must be 19% to have a profitable industry, and that is what we are all here to discuss and plan for.

I would like to touch on four areas for your consideration: handling, product utilization, product innovation, and your role in improving profitability. I won't pretend, as a marketer and lobbyist, that I have the technical answers, but rather, I hope to provide some food for thought.

Fish Handling

Handling fish at sea, on the dock and through processing, has not traditionally been a mechanized operation. For years, it amounted to simple human effort, with the first mechanical adaptation being the application of a winch to a brailing or bucket unloader.

We still see a lot of human effort today, whether it is a hand jigger for squid, hauling a cod trap, or the long outlawed, but still trusty, prong.

During the fifties we saw the application of the power block on seiners, net drums, and stern trawls. That brought us to the era of the pump. On large seiners, the centrifugal water pump helped get the fish on board with less crushing. At the dock, we saw the application of the air unloader to offload vessels, particularly wet-fish trawlers. While most people cringe at the mention of air pumps and their effects on fish quality, you have to remember that processors in those days were looking at vastly increased landings. They were trying to lower the wage component of offloading and shorten turnaround times on vessels.

Where are we today? We have had some application of the use of chilled sea water to improve quality for herring, mackerel and salmon. We have adapted a few boats to boxed and iced fish. The trade-off is less volume per boat, but higher quality. If the quality does not translate to upgraded packs sold at higher prices, the reduced volume has a negative impact on margins. One project currently underway uses large storage containers onboard, but is basically applying the boxed concept. And freezing at sea, including the use of factory freezer trawlers, is a technology used by most deep sea fishing nations but denied to Canadian industry for a host of social reasons (which I will not debate in this presentation).

In general let me say that if fish, the raw material of production, accounts for 55–60% of total operating costs, then any study on the improvement of plant costs and profitability must start here. It should be a major area for both industry and government research and development projects. Fish handling at sea, as well as unloading ashore must be improved. Recent studies done by NEWLANTIC prove that you can't make a silk purse out of a sow's ear. Government policy deals with enforcement — introducing end-product grading and dockside grading. But you people here today have to invent the technology that makes the system achievable and cost efficient.

Product Utilization

If we have fish of improved quality coming into the plant, how can technology be applied to improve product utilization?

In some ways, the people who process chickens are to be envied. The moment a chick hatches, the date of slaughter is immediately known, and for its short life, the food, light, temperature, and walking space can be strictly controlled. In the end, plastic wrapped bundles of an almost identical foodstuff are on the shelf. Not so for fish processors! Fish can be handled and processed in a multitude of ways, and the end products offer the consumer a range of tastes and textures.

From a scientific point-of-view, the first consideration, and, therefore, a key input to assisting in-plant utilization decisions, is the biology of the fish. Fillet gaping is affected by the post mortem pH of the flesh, with lower pH levels increasing this undesirable effect. The premature development of strong cold storage flavour and odour can result in fish caught on grounds with abundant food. Even the amount of swimming activity will affect flesh colour. Few plants today are staffed to allow biological information to be considered in decisions such as product form, maximum storage times, etc.

The next phase in the utilization decision is market options. Obviously you can sell fish fresh, freeze it, smoke it, and can it.

We have spent most of the years since the introduction of the 200-mile limit talking about how the volume of resource affects the industry. How can we get it through the plant? Now, and I'm as guilty as anyone else, we talk about how the market must drive production decisions. Really, the middle ground, the area managed by the technical people, is where we must strive to meet and make production decisions that benefit the market, the margin and the profitability of plants. Packing red feed capelin does no one any good in the long term. Packing blocks that drive prices down isn't the answer either.

What can technology contribute? The first answer is more fresh fish. Packaging is an area to concentrate on. The cryovac fresh tray packed fillets are a step in the right direction. Value added at the plant; greater acceptability at the retail level; and less moisture loss are just a few of the benefits.

Better packaging is also needed so we can fly fish to markets. Airlines hate the mess, the water, the salt, and the smell that can occur from badly packaged fresh fillets. The Gen Pack was a great idea ten years ago. We need new, better insulated, drip proof boxes and we must use the new time-temperature strip that shows temperature changes during shipping. This would help the retailer know which fillets to merchandise first, would cut down his shrinkage and allow him to either reduce prices or, at least, to hold down increases. Packaging for fish in general is an underexploited concept — including boil-in-bag ideas, one-piece cans, etc.

Another encouraging area is fish irradiation. The Fisheries Council of Canada, working with the Department of Fisheries and Oceans, has done some consumer testing in this area. The idea is not repugnant to consumers. It is used widely in Holland and Israel, extending shelf life on fresh products to 16 or 17 days, without altering taste characteristics — a major benefit. We could truck fresh fish from all parts of Atlantic Canada to any point in the continental

United States. We need political action to have the process legalized in the U.S.; we need technical work on dosage levels; and we need engineering studies on locations for irradiators, including capital cost and impact on prices. But the possibilities are exciting.

A further area that must be worked on is species utilization. Our use of familiar species in known product forms has been maximized. Hake, mackerel, and other stocks must be examined for their ability to add income to both fishermen and processors.

Product Innovation

Any discussion in these areas begs an examinaton in general of product innovation. (Note, I did not say product development.) Product development occurs when an individual company takes a specific idea, perhaps fish nuggets, using a brand name, to the marketplace. We need more of these ideas certainly, but today, let's discuss innovation. Innovation is the generation of concepts which companies may or may not bring to actual product form. Some of the areas we need to be working on might be as follows.

The cook-and-freeze concept, using fish proteins, hasn't been scratched. Again, we see the Stouffer Lean Cuisine line selling so well that it can hardly be supplied. Saucing at plant level and boil-in-bag ideas are all open to add value, not volume, to the processor base.

The area of smoked products has not been thoroughly investigated in Canada. Nickerson's made a brief attempt and quit. Our smoked fish business still depends on old bloaters shipped to the Caribbean, the volume end of smoking. We should spend more time this summer, while we are barbequing beef, thinking about how smoking can be applied to something other than salmon.

Another key area we must work on is the utilization of more of the fish. A gutted, bled fish gives about 40–42% yield in fillets. The flesh percentage is 65–70%. Without landing one pound more, we must address the 20% we are currently sending off to be used as low grade fish meal. The Japanese, of course, have the jump on us in Kamaboko products. Volumes to the USA were about 4 million pounds in 1979. Last year it was close to 60 million. Even a landlocked school such as my old alma mater, Cornell, has developed minced fish products in frozen form, as additives, and as end products. Their minced fish spaghetti sauce was so successful in both taste and adding protein to a pasta meal that they now have a commercial joint venture in the USA with a food company.

Minced fish is just beginning to catch on. Food technologists can now give it flaky characteristics, and minced products from fatty fish are no more susceptible to deterioration than is the whole fish. Proper handling and inventory control will allow this technique to be used with many species. But any product innovation program must be convincing, if industry is to pick it up and do product development. Cornell, for example, took their ideas right through to in-store testing, with both advertising and sampling, before they approached the commercial market.

Let me touch on one more area where technology might impact on plant profitability. Let's look at the good old cod block, a product without innovation for 20 years. To cut a block on a bandsaw you have to raise its temperature from −21°C or lower to about −10°C. Even at that, a band saw will run as high as 15% loss (about 7% under optimum conditions). In addition, to re-form the blocks into shaped portions using pressure, the temperature has to be higher. Breadings don't adhere all that well, and, of course, you need more energy to refreeze the finished product.

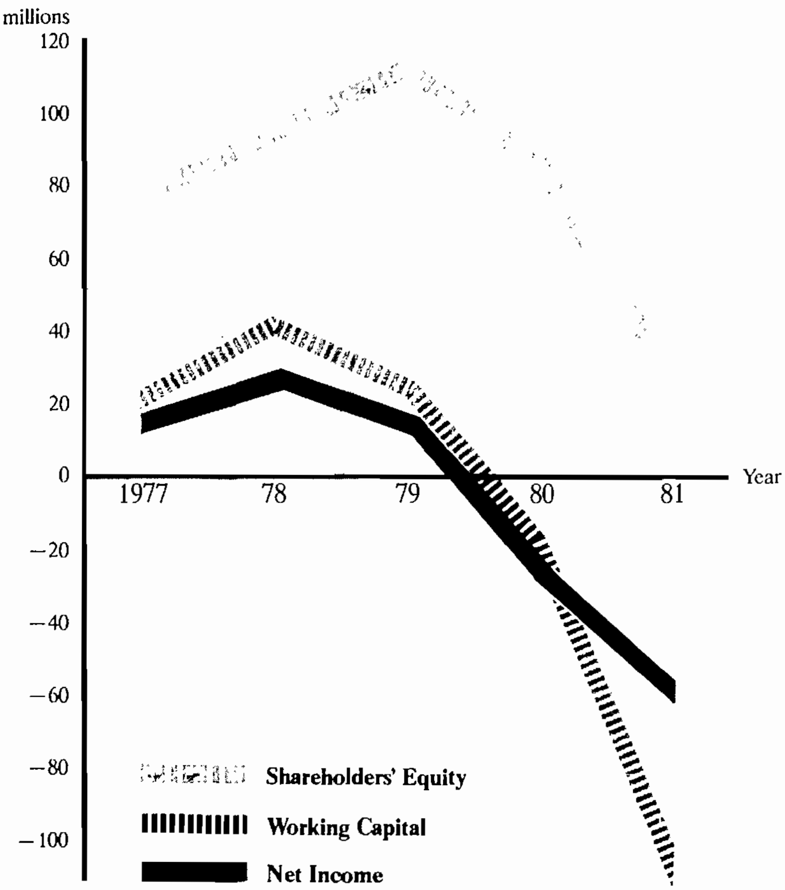
One idea might be to form the portion, or shaped fillet, directly from wet-material. This can be done from minced fish, chunks or fillets on food formers. At about −2°C the product will hold its shape for breading and need only be frozen once. Better material utilization results, as well as savings on cutting losses, and an acceptable consumer product — all at less cost than cutting a cod block.

These are the kinds of things we must be working on, whether we are industry people, academics, governments or private labs. Applying high technology to the fish industry is expensive and time consuming. Canada lags behind in this area considering the volume of fish we sell and its importance as an export commodity.

Consider parasites. Twenty years after the problem was identified, a problem that cost industry at least $50 million last year, where are we on mechanical detection and picking? The answer is nowhere. Any work that I am aware of is being done by the Baader Company or the University of Michigan. Eliminate candling, cut back on labour, and improve the end-product, and you have done something positive to margins, to prices, and to profitability.

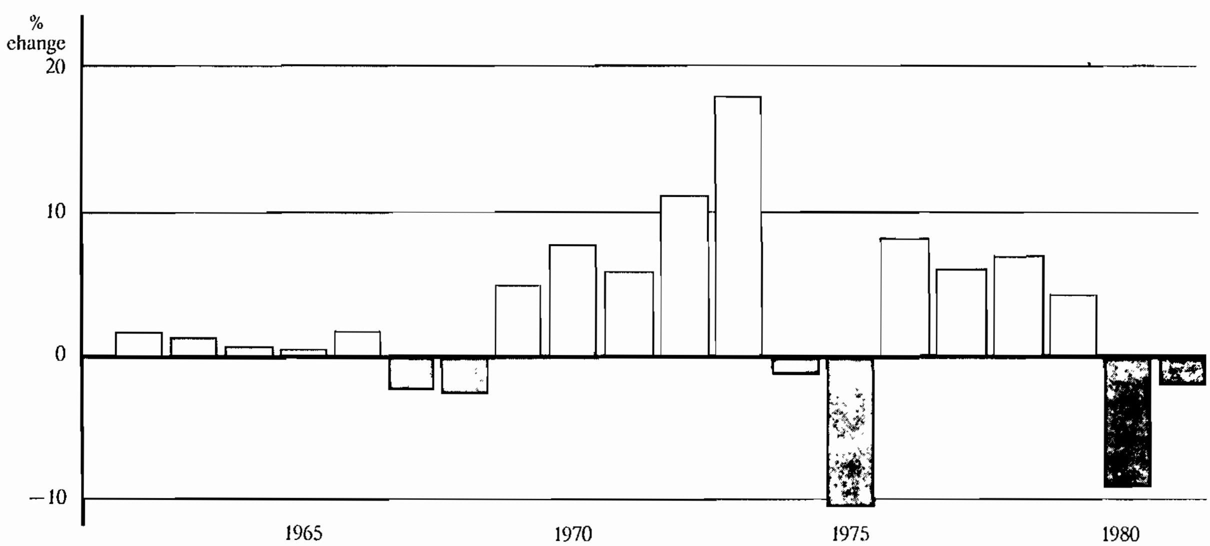
DFO is long on biologists and economists; it is short on engineers. Closing the technological labs was a great disservice to the total industry. Few, if any, processors are big enough to tackle the application of technology to the fishery. Certainly, none of them is profitable enough, at present, to begin to do so.

I hope this conference addresses not only WHAT needs to be done to apply technology, but HOW we are going to get on with the job.



Source: Table 5.6 in the Task Force Report

FIG. 1. Decline of the processing sector.



Source: Table 5.12 in the Task Force Report, derived from Statistics Canada data.

FIG. 2. Annual change in real market price of all Canadian fish products (adjusted to substract rate of inflation).

THIRD WORKING SESSION
In-Plant Operations

Chairperson: H. (Harry) O'Connell
Deputy Minister of Fisheries and Labour, Prince Edward Island

A Need for Change in the Technology and Management of Fish Processing

Robert W. Verge

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Abstract

Marketing problems and financial difficulties confronting the east coast fishery are merely symptoms — the processing sector is in need of fundamental change. This paper attempts to provide at least a partial answer to the questions, why is fundamental change required; where is the industry falling short; and what directions must be taken in the future to properly address the situation?

In the face of price- and quality-related shifts in consumer demand, processors in Atlantic Canada have not varied their product mix; product quality (texture) has been inconsistent; and production costs have not been adequately controlled. In addition, companies have failed to realize that their real competition is from other protein foods; and fishermen have failed to realize that their own economic survival depends on our having a viable, profitable processing sector.

Developments in technology, particularly in electronic sensing and computer control systems, can prove revolutionary, provided government addresses their social implications in adequate fashion. Greater flexibility, efficiency and control can, and must, be achieved, provided a proper processing system is introduced. But without proper production management, no system can give satisfactory results. With the system described here, combined with proper management, annual benefits could approach 27% of revenue. But this level of upgrading could prove to be tremendously expensive — in the hundreds of millions of dollars. In the short run, therefore, better management, complemented by selective replacement of the components of our existing system, is recommended.

Introduction

Fish processing in Atlantic Canada is in need of fundamental change. Financial problems and difficulties selling our products in the United States are symptoms of that need. In many ways, the transformation that must take place will be just as revolutionary in its effects as the change from salted to fresh/frozen production that began 50 years ago.

Today, I hope to give at least a partial explanation of
— why fundamental change is needed,
— where the industry is failing at the present time, and
— what direction it must take in the future.
To develop an understanding of these issues, it may be helpful to review some of the industry's history.

Changing Markets

For 450 years, the fishing industry in Atlantic Canada produced mainly salted and dried fish products. Fish were generally in abundance; they were caught close to shore during a summer fishery; and they were processed by the fishermen themselves. After drying in the sun, they were sorted by size and quality and shipped to markets in Europe, primarily for poor people.

Increasing adoption of freezing and refrigeration technology during the past 50 years has resulted in development of an industry which produces primarily frozen products. More processing activities have to be performed and more sophisticated technology has been adopted for harvesting and processing fish. Processing of fresh/frozen products is both more capital-intensive and more labour-intensive than processing saltfish.

With these changes in the industry have also come major changes in the market areas being served. Now, most products are sold in North America — mainly the United States — where consumers are more affluent and have more choices of foods available to them. Fish processing in Atlantic Canada is now very much integrated into the total North American system of food production and distribution. As such, it is affected by trends and other changes which affect the demands for all food products.

For years, these trends have indicated that Atlantic Canada's fish processing industry has a tremendous opportunity. In North America, a whole generation has grown to maturity with concerns about health, fitness, and the negative impacts that foods and environmental conditions can have on personal well-being. By these people, fish is generally seen as a light, healthy food, high in protein but low in calories and cholesterol, consistent with their lifestyles.

In many other parts of the world, there are food shortages and rising populations. Improved management of fish stocks since Canada's declaration of a 200-mile limit has allowed large increases in fish catches and more growth is expected in years to come.

There are great needs for the food value contained in our fish and increasing quantities of fish are available for harvesting. Ordinarily, that should be a formula for commercial success, but the industry has had 5 consecutive years of financial distress. Something must be drastically wrong.

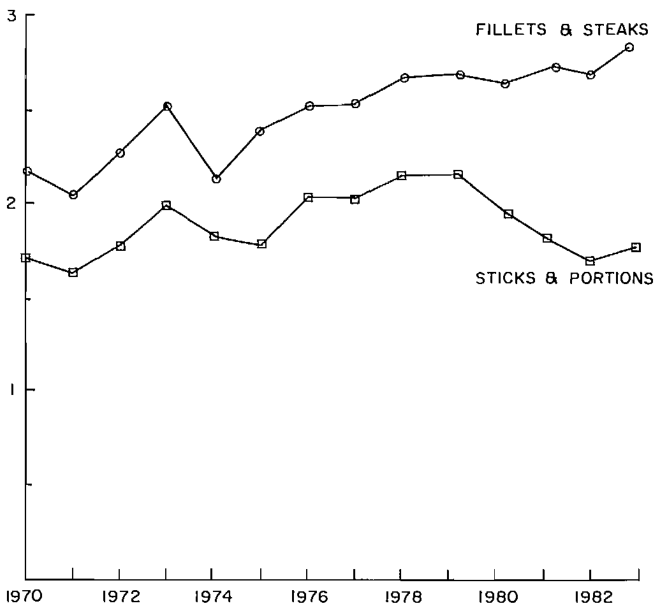

FIG. 1. U.S. Consumer Price Indexes.

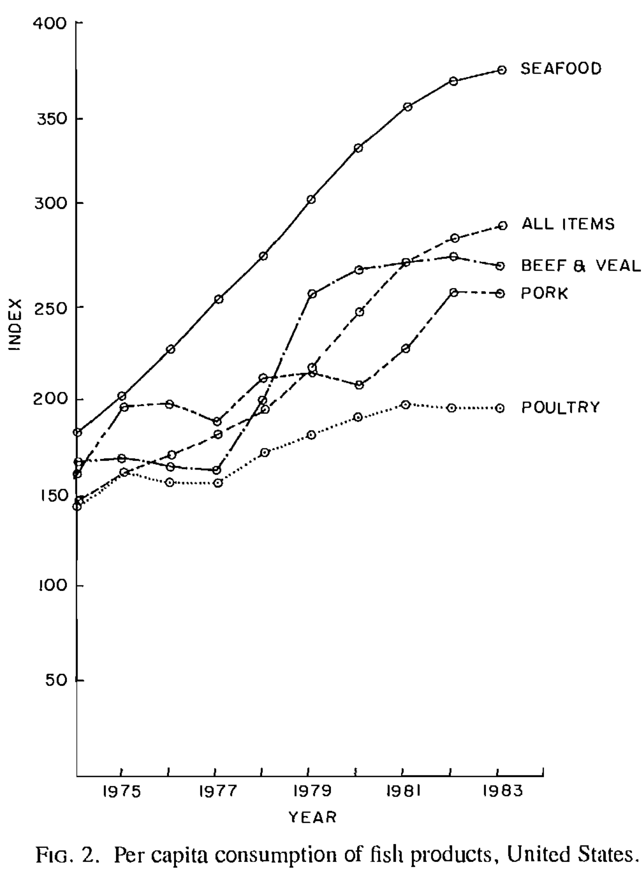

FIG. 2. Per capita consumption of fish products, United States.

Causes of Failure

From 1970 to 1983, per capita consumption of seafood in the United States market remained fairly steady (Fig. 1), at between 12 and 13 pounds per year, approximately 6% of the combined consumption of red meat, poultry, and seafood. In contrast, per capita consumption of poultry products increased from approximately 48 pounds to over 65 pounds per year, while red meat products experienced a drop in consumption.

Why didn't some of the increase in demand for poultry products shift toward seafood instead? I believe the answer lies in consumers' perceptions of the value they receive when they purchase the different products.

From 1967 to 1983, the consumer price index for seafood products in the United States grew at a much faster rate than the corresponding index for any of the nearest substitute foods. The index for poultry increased the least (Fig. 2).

The contrast is even greater, when the producer selling price index for Canadian fish products is plotted on the same graph. Prices Canadian fish processors received for their products increased even more rapidly from 1967 to 1983 than the U.S. consumer price index for seafood (Fig. 3).

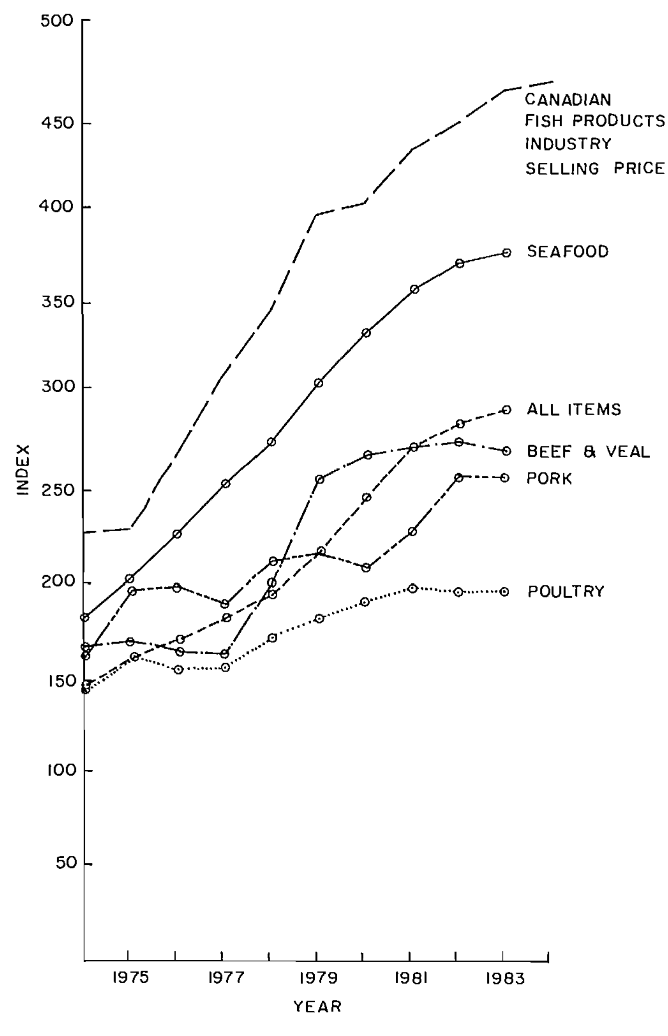

FIG. 3. Canadian fish products price index and U.S. consumer price indexes.

In effect, United States consumers have had to pay an increasing price premium for Canadian fish products compared to alternative protein foods. Despite that, consumption held fairly steady. How much more Canadian fish could have been sold in the United States market, if it had been priced more competitively?

Although overall consumption of seafood by Americans has changed very little on a per capita basis, there has been some shifting between categories. Fillet packs have been showing an upward trend in consumption since 1974, while sticks and portions made from blocks have been decreasing since 1978. Despite this clear shift in preferences by consumers, many fish processors in Atlantic Canada have not changed their mix of products accordingly. In 1984, there were huge surpluses of inventoried blocks glutting the market, depressing prices.

The quality of Canadian fish products has received a lot of adverse publicity over the past few years, sometimes correctly and sometimes not. Canada is the world's largest exporter of fish products and it is inevitable that these products encompass a large range of types and qualities. Canada's Atlantic fishing industry, in particular, produces a lot of very good quality products.

A study of the quality of the industry's products was carried out in 1983 – 84 by the NEWLANTIC Group for the Fisheries Council of Canada. For groundfish, the results indicated that the main problem was inconsistency of product characteristics, primarily due to texture, which made it difficult for a buyer to rely on getting the same quality fish in the same package time after time.

Canada's Atlantic fishing industry has failed to achieve economic success

- — despite opportunities presented by changing consumer lifestyles and eating patterns,
- — despite increases in the prices for fish products which greatly exceeded corresponding increases in prices for substitute food,
- — despite increasing availability of raw materials, which are presently underutilized, and because
  - — it has failed to offer the right products to the marketplace, and
  - — it has failed to increase operational efficiencies.

Companies in the industry have failed to realize that their competition is primarily from poultry and other protein foods, rather than other fish processors in Atlantic Canada or even in Europe. Fishermen have failed to realize that their own economic success is dependent on having a viable, profitable processing sector, because processors will always resist paying more for fish, if they cannot make money from processing and selling them. Fishermen and processors have a commonality of interest in making changes in their industry to improve the returns they can obtain from it.

Can there be any doubt about a need for fundamental change in the way the fishing industry in Atlantic Canada operates? I don't think so. I think the only real issues are related to the directions for change and the ways in which change can be accomplished.

Problems with Existing Production Systems

Why has the industry failed? There are many reasons and they even vary from one company to another.

Companies have not necessarily failed to see the shift in demand from blocks to fillet packs. Many have not been able to change their product mixes, because of limitations imposed on them by the quality of their raw materials. Fillet packs generally require a higher level of texture quality than blocks. Existing methods used for harvesting and handling catches often result in poor texture, restricting them from being used for production of fillet packs and causing processors to lose opportunities to earn extra revenue. Furthermore, existing production methods are not satisfactory for sorting inherently variable raw materials into products with consistent characteristics.

Regardless of the products being produced, many processors have not done a good job of controlling production costs. Profits have been non-existent or marginal, even with prices rising faster than those of alternative products. European fish processors have been able to obtain significant shares of the United States market for fish products, despite higher transportation costs to ship their products.

This situation is likely to get even worse. Developments currently taking place in technology, particularly in electronic sensing and computer control, have the potential to revolutionize the fish processing industry. Some of this technology can be used to replace labour, but it will also allow greater control over processing activities and product characteristics than is now achievable. Applications of the new technology to fish processing are still in the early stages of development but can be expected to be increasingly available over the next five to ten years.

If efforts are not made to improve operating efficiencies, the industry in Atlantic Canada will become even less competitive than it is at present. Governments will have to subsidize the industry with even more money, if it is to continue to operate for social reasons.

Toward Improved Performance

Overall, the principal function of fish processing is to convert fish into products in demand in the marketplace. Fish processing is subject to extreme variability.

- — in processing demands, imposed by both raw materials (which vary by species, size, quality, and availability) and a broad range of products which can be produced from them (which vary in their specifications for quality and size, because of the way they will be used), and
- — in processing capabilities, because of dependence on human labour, production systems which often are poorly designed, and inadequate production control systems.

This variability has increased with production of fillet packs. The tasks that have to be performed have increased drastically in number and complexity. Unfortunately, the industry's production systems and operating methods have not changed as fast as the demands placed upon them. This has resulted in inconsistencies in production performance and product characteristics.

In the new marketing environment, greater control is needed over the inherent variability of fish processing. Since fish are living organisms which are fragile and highly perishable and the human beings who process them are also very different, variability cannot be eliminated. However, it can be both

- — reduced, through better systems for harvesting, handling, and processing and better focusing of production activities, and
- — directed, through properly designed and implemented control systems.

Greater control will provide flexibility to respond to changing situations. To improve operating efficiencies, it will also be necessary to improve execution of key processing tasks to obtain better yields and consistency in grading fish by size and quality.

I would like to illustrate how these overall objectives — more flexibility, efficiency, and control — can be achieved.

The plant shown in Fig. 4 has been designed to process a 100 thousand pounds of raw material per 8-hour production shift. Capacity in the different areas has been designed to permit a balanced flow throughout.

Some particular key features of the plant illustrated in Fig. 4 are outlined below.

1) Fish are sorted mechanically by size and visually by approximate quality:
   - — to improve production planning,
   - — to obtain better yields from filleting and skinning machines,
   - — to simplify on-line grading decisions, and
   - — to obtain greater consistency of final product quality.

2) Raw materials are stored, iced in containers, in refrigerated holding facilities:
   - — to preserve wholesomeness and texture, thereby improving yields, product mixes, quality, and labour productivity.

3) Skinning and most filleting are mechanized with state-of-the-art equipment:
   - — to obtain consistently good yields and throughput rates, and
   - — to reduce labour costs.

4) Tables for hand filleting, trimming, and packing are designed with individual work stations and work surfaces to facilitate production of a range of products:
   - — to allow maximization of value obtained from raw materials,
   - — to allow efficient production of products with customized features, and
   - — to allow measurement of individual work performance.

5) Work stations are adjustable for workers with different physical characteristics and with features which reduce worker fatigue from repetitive activities and repeated lifting:
   - — to obtain consistent execution of work methods by different workers, and
   - — to reduce deterioration in performance due to fatigue.

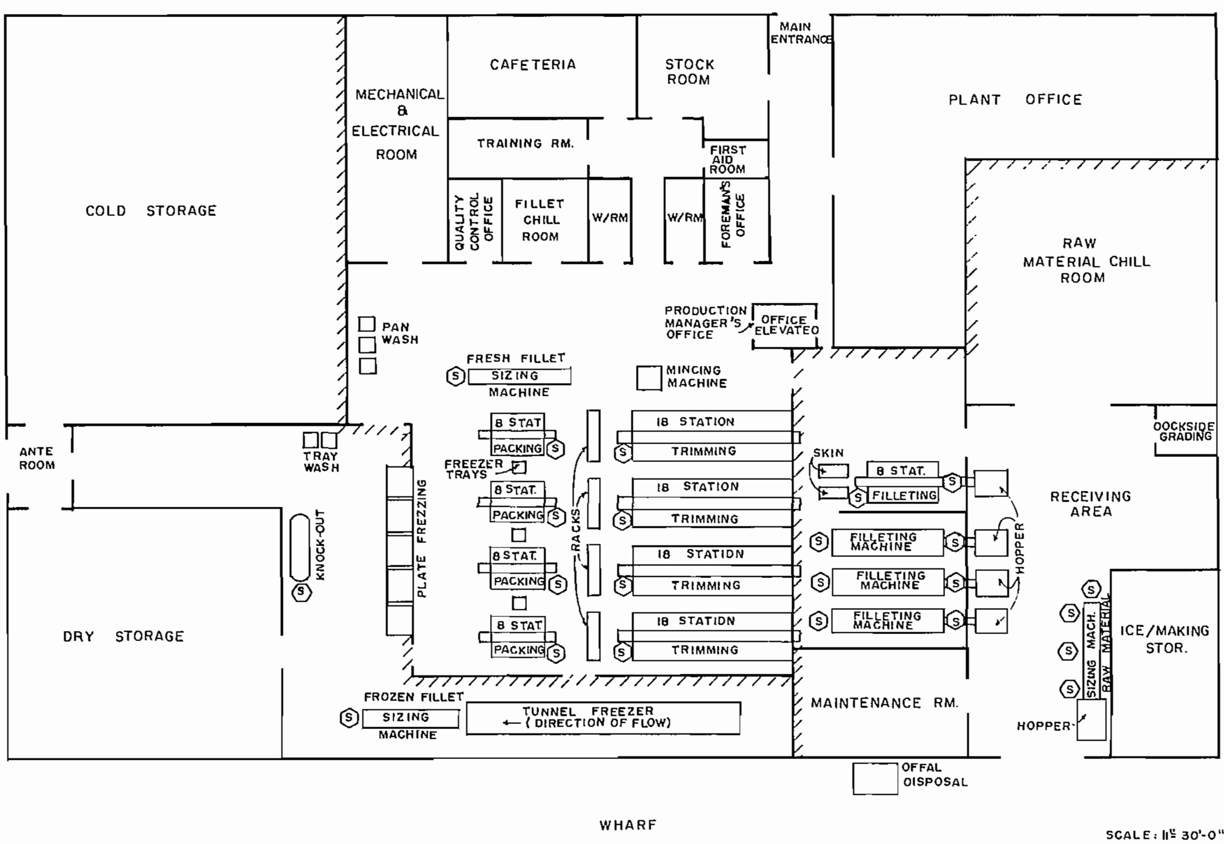

FIG. 4. Plant designed to process 100 thousand pounds of raw material in one 8-hour production shift.

6) Materials are handled in containers, on conveyors in processing tables, and on racks and trolleys for movement of products between processing steps:
   — to reduce in-process drip losses and texture damage, and
   — to improve operating efficiency and control of in-process inventories.

7) A properly designed production management information system is in place, with electronic real-time capture of data from the plant floor:
   — to provide early detection of out-of-control situations and facilitate corrective action, and
   — to improve execution of key processing tasks and consistency of production performance.

8) Production capacity is balanced at the different work stations:
   — to prevent backlogs of in-process products, which would result in deterioration of yields, product mixes, and product quality,
   — to provide flexibility for processing different products,
   — to optimize the ratio of direct to indirect workers, and
   — to facilitate control of operations.

9) Areas with distinctly different working conditions are physically separated and a pleasant working environment is created in areas where most people work:
   — to improve working conditions and morale, which contribute to higher levels of motivation and operating efficiency.

10) Process flow lines are unobstructed; main processing areas are open in design; and service areas are located close to people who use them:
   — to contribute to improved overall operating efficiency.

There are many other detailed features (Fig. 5) of this plant that are interesting, but it is not possible here to go into them all. What is remarkable, however, is that few of the features illustrated are really new or different. Most are readily available to anyone. They are simply all combined into one system with all of the aspects needed for production to be both effective and efficient. Most fish plants in Atlantic Canada have some of the components of the production system outlined, but only a few are close to having all of them. At nearly all plants, some benefits can be obtained from changing the hardware components of their production systems.

However, the missing ingredient that can improve performance at all plants, regardless of their design features, is better production management, including
— maintenance of production facilities and equipment to keep them in peak operating condition,
— selection and training of workers and supervisors, so they have appropriate skills,
— clearly defined responsibilities and accountabilities,

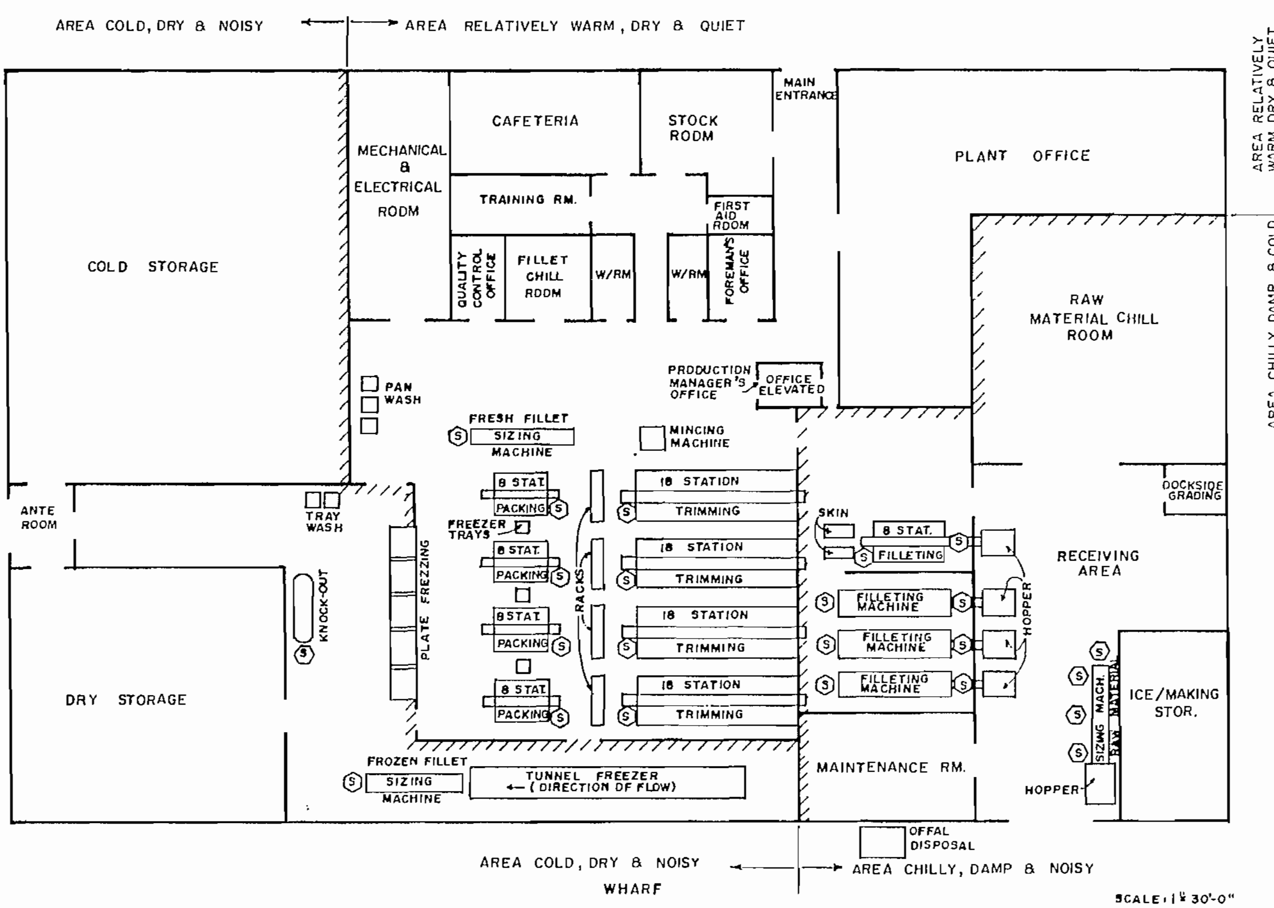

FIG. 5. Detailed features of plant in Fig. 4.

— proper planning of production based on the characteristics of the raw materials available, and
— using information from a well-designed production management information system to detect where and why things are going wrong and taking action to correct them.

Without proper production management, no system will give satisfactory results. With it, any system will function better.

Appropriate tools and the right approach to production management will allow an improvement in the competitiveness and profitability of fish processors in Atlantic Canada. Some of the benefits potentially available can be illustrated (Table 1).

What is worthy of note in Table 1 is that the total approximate annual benefits represent nearly 27% of revenue. The table likely even understates the benefits available, because of limitations in some of the data used. Benefits of corresponding magnitude have already been obtained or exceeded by processors in some cases. However, it also must be recognized that obtaining these benefits will require incurring extra costs for investment and, in some cases, for operations.

Managing the Process of Change

Making all the changes that are needed will be extremely expensive, in terms of the initial outlays of capital that will be required. Upgrading of facilities on an industry-

Table 1. Potential for profitability improvement by Newfoundland groundfish processors.

1.	IMPROVED YIELDS			
	Approximate Annual Groundfish Catch, MT		300,000	
	2% yield improvement, MT		6,000	
	Value @ $1.434/lb.			$18,951,540
2.	IMPROVED PRODUCT MIX			
	Approximate annual exports of frozen groundfish products			
		lb.	$	
	Fillets	86,600,000	141,734,000	
	Block	77,642,000	98,568,000	
		164,242,000	240,312,000	
	Reduce Block Production to 20% of total			
	Fillets	131,393,600	215,045,500	
	Block	32,848,400	41,701,670	
		164,242,000	256,747,170	
				16,435,170
3.	IMPROVED PRODUCT QUALITY CONSISTENCY			
	Approximate value of exports of all groundfish products from Newfoundland		$257,956,860	
	5% increase in net sales revenue, due to better quality consistency			12,897,840
4.	SYNERGISTIC EFFECT			
	Increased Yield × Improved Product Mix × Higher Price			
	6,000 MT × 2203 lb./MT × $ 16,435,170 / 164,242,000 lb. × 1.05			1,388,820
5.	IMPROVED LABOUR PRODUCTIVITY			
	Approximate annual groundfish catch, MT		300,000	
	Approximate labour input @ 70 lb. processed per labour hour		9,439,900 hours	
	Approximate cost @ $8.00/h.		$ 75,519,200	
	Reduction in labour costs, due to 20% increase in productivity			15,103,840
	TOTAL APPROXIMATE ANNUAL BENEFITS			$64,777,210

$$\frac{\text{BENEFITS}}{\text{REVENUE}} = \frac{\$\ 64,777,210}{\$240,312,000} = \mathbf{27\%}$$

wide basis will likely cost hundreds of millions of dollars. It is unrealistic to expect such upgrading to take place all at once.

In the short term, profitability can be improved through better production management and selective replacement of existing components of production systems, in areas where economic returns on investment can be expected to be greatest. This approach should help the industry to become profitable and allow it to make additional investments out of the income that will be generated.

Different companies and plants represent substantially different circumstances in terms of location, raw material supplies, production systems, management skills, and financial well-being. Accordingly, solutions to problems are likely to be most cost-effective, if they are tailored to the individual circumstances which exist, rather than applied to the industry as a whole.

Fish processors in Atlantic Canada have many opportunities. Finding the best way to take advantage of them will not be an easy task and the best answer in one location will not necessarily be best in another. Considerable judgment and discretion will have to be applied in dealing with individual circumstances. The future of the industry will be only as good as the decisions that are made.

In trying to improve fish processing operations, two other external but related issues must also be addressed, as follows:
1) improvement of raw material quality; and
2) the economic and social trade-offs between labour and technology.

Raw material quality currently represents a substantial limitation on what is achievable by fish processors. The problem is more acute for some than for others. Better harvesting, catch handling, and transportation methods will have to be adopted than many of those now in use.

Productivity improvement is usually associated with reductions in labour. Considerable potential already exists in our industry for automation of some processing tasks, particularly filleting and materials handling. Other labour-saving technologies are currently being developed. While the economic considerations for an individual plant in adopting such approaches are often fairly clear, the implications for the larger regional economic and social structures often interfere with the decision-making process. Somehow, this issue must be resolved in choosing the directions which will have to be followed in the future.

The U.K. Fish Processing Industry

Francis Clark

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Abstract

One striking feature is apparent in events like the Atlantic Fisheries Technology Conference, and that is the similarity of the problems that fishing people face the world over. We must hunt or farm our raw material; our secondary sector, processing, is in a period of transition; and, there is, universally, intense competition in the marketplace. The moment has arrived for us to begin to adapt: to develop new expertise, management skills; to revitalize processing through major capital investment; and to develop a willingness to change our ways of doing things. Many U.K. processors in recent years have collapsed because they ignored the need to change; they let events overtake them. Changes in the Canadian fishery will be no less traumatic but, from the European experience, you should learn to harness change to your advantage and to see that those who ignore the need to change, don't survive. The industry must recognize that it is the ultimate consumer who is the provider of all our livelihoods and, so, we must organize all our resources to satisfy his expectations.

The U.K. fishing industry exists in the midst of a constantly changing social environment. But there is a growing desire for new and improved foods, dietetically advantageous and nutritionally valuable. Using these criteria, fish is highly acceptable, provided there is adequate quality control. And that means standards — enforceable, universal standards. The imposition of these standards may result in some operators going out of business, but this is an opportunity to rationalize and then to improve the industry as a whole. Finally, there is technology. Versatility through technology will allow a wider product range and a better utilization of raw material. This will be expensive, but, if there is any role for government in the fishery, assisting in the advancement of technology serves the purpose. Our future course is clear. It is to prosecute the fishery responsibly; to welcome quality control and the new technology; and to sell the advantages of fish to consumers, to educate. On an international basis, we must discuss and share both information and our experiences for the benefit of the industry as a whole.

Introduction

In the course of running my businesses in Scotland, much of my time is spent travelling the world meeting people in the fishing industry. One striking feature arising from these meetings is the similarity of problems that fishing people face, almost irrespective of their location or the size of their operations.

It would be naive to suggest that all the problems are exactly the same, for, clearly, the economic and social structures of our countries are different. Indeed, the strengths and weaknesses of the respective fishing industries vary enormously from country to country, but within these differences we share the same basic constraints:

1) a hunted raw material;
2) fragmented processing; and
3) strong competition in the marketplace.

We, in the United Kingdom, have undergone a traumatic period establishing ourselves within the European Economic Community (E.E.C.). Over the last 15 years, our fishing patterns have altered dramatically in both pelagic and demersal sectors, with the loss of the Icelandic waters, and the stoppage of the North Sea herring fishery. Such changes in a highly traditional environment have been painful, with severe effects on people (jobs) and communities alike.

Against this backdrop, major social changes have occurred, with more women working and a growing demand for convenience foodstuffs. Indeed the pattern of fish retailing has substantially changed, with the demise of independent fish mongers, and the growth of frozen fish products through multiple retailers. In a relatively short period, about 15 years, both our catching side and our retail outlets have changed dramatically. Caught in the middle of this upheaval has been the proeessing seetor, having to adapt faeilities to faee the changes imposed at both the intake and outlet ends of our businesses.

The ehanges have not been easy. Adaptation has required three major resourees for sueeess.

1) A different range of expertise, with greater emphasis on professional business skills.
2) Major capital investment on proeessing and packaging equipment.
3) A willingness to make changes, to meet the changing environment.

The third point may seem self evident. However, many U.K. processors have eollapsed in the last few years, simply by ignoring the need to change and letting events overtake them.

Let me stress to you that, in my opinion, the changes required within the Canadian industry are no more traumatic than those experieneed within the U.K. over the last few years. But one lesson that you can learn from our experienee is this: those who harness change to their advantage have an opportunity to strengthen their position; those who ignore the need to change, don't survive.

The Marketing Situation

The increasing shift towards one-stop shopping and eentralization of foodstuffs into one retail outlet has resulted in the demise of the independent operator and the growth of multiple supermarkets. Within the U.K., four retail chains now merchandize 60% of all food eaten, and the 10 largest account for over 75% of the total food market. Sueh concentration of buying power among multiple retailers has greatly affected the marketing of fish and fish produets. All sectors within the frozen sector are dominated by multiple retailers, with branded produets such as Birds Eye and Findus lying alongside the house-brands of retailers sueh as St. Michael for Marks and Speneer, J. Sainsbury and Teseo as leaders in their field.

The small number of major outlets within the retail seetor has created a group of speeialist proeessors, eaeh eapable of supplying large volumes of fully proeessed products in carefully controlled quality environments. In general, eaeh of these processors' businesses revolves around a key account, which can monopolize up to forty percent of the supplier's capacity. The balance of their output is absorbed by the remaining major multiples, who in turn, require baek-up and range extension from their own key supplier.

The close interdependence that develops between retailer and processor is a key factor in ensuring that the proeessor's products remain desirable to the end-eonsumer, at a priee that is competitive with other protein alternatives. Inevitably, of course, the processor is mueh more dependent for his livelihood on the retailer than viee-versa and, in terms of bargaining power, frequently laeks the strength to be able to withdraw his products if profitability is not assured. I must tell you, however, that over the last few months, there has been a substantial shift in attitude by many of the multiple retailers, who now clearly recognize the benefits of having loyal and professionally run suppliers. This has manifested itself in positive responses to priee negotiation and eonsiderable assistance in the aehievement of profitability among major processors. The future of many medium-to-large sized processors, who employ between 200 and 2000 employees eaeh, depends on a elose relationship with a multiple retailer, in either a brand or private label format.

There are, of eourse, several other market opportunities within the U.K. and I will toueh on these briefly.

The wholesale market absorbs a wide range of produets from several small to medium-sized proeessors. The wholesaler, in turn, markets to small, independent retailers or eatering establishments. By and large, quality is not a high priority within this seetor and so it represents little innovative opportunity for proeessing.

The eatering market has developed rapidly over the last decade, again representing ehanging soeial habits and higher levels of disposable ineome. Of eourse, we faee diffieulties in converting variable raw material into identifiable portion-controlled units, but in general, eatering does represent sound margin opportunity, if proeessing techniques ean be harnessed to meet speeifie eatering requirements. Quality requirements within the eatering seetor are extremely variable, ranging from the very highest for top quality restaurants and hotels down to the lowest for institutional outlets sueh as prisons, schools and hospitals.

The fresh fish market has seen a major decline over the last 20 years. The number of fresh fish shops has fallen from over 12,000 in 1964 to around 3000 eurrently, again relleeting ehanging eonsumer habits. However, over the last eouple of years, the multiple retailers within the U.K. have been endeavouring to expand their range of fresh foods, establishing in-store bakeries and buteheries, thus portraying the freshness eoneept of the old fashioned independents.

Similarly, a few have entered the fresh fish market with "in-store" fish slabs and ehilled, pre-paeked produets. If they are successful in attaining a larger market share, it is likely that the supplies will be provided by medium to large proeessors, already supplying a frozen range.

The major market interest, nevertheless, still lies in frozen products for the multiple supermarket trade. Over the years we have witnessed a revolution in the degree of sophistication attainable in the proeessing of fish. There are ready meal dishes sueh as Fish Pasta, Fish Risotto, Rolled and Stuffed Flatfish as well as a wide range of natural, breaded, battered and smoked fish, in a whole variety of paek types. The development of eonvenience products has met inereased competition from red and white meat proeessors and, in general, attempted to stimulate demand from the younger, affluent, eonsumers.

The constant need for innovation and development is both costly and time eonsuming, but ensures that the eonsumer maintains an interest in, and desire for, fish products. The development of the fish finger was only the beginning of an evolutionary proeess, and Canada, like the rest of the Western World, must eonstantly keep paee with changing eonsumer needs.

The New Consumer

In the past, the objeetive in fish processing was invariably to maximize profit. I have to tell you that the U.K. experienee is now vastly different. Gone are the days when a housewife would buy fish onee or twiee a week as a matter of routine. The younger purehaser has to be entieed to buy. We have to offer quality and value as well as eonvenienee, if she is to be persuaded to buy fish rather than beef, ehieken, lamb, or whatever.

Our industry must recognize the ultimate consumer as the provider of all our livelihoods and must organize all its resources to satisfy their expectations.

In simple terms, the supply chain must meet the following criteria:

1) The retailers must offer the correct range and regular quality at an acceptable price.
2) The processors must offer continuity and regular quality at an acceptable price to their customers, the retailers.
3) The fishermen must offer continuity, regular quality and reasonably regular volumes, as weather and quotas permit. After all, as first link in the chain, if they do not service their customers, the processors, properly, then the rest of the chain doesn't stand a chance. We, in the U.K., still have a long way to go in the integration of our industry, but at least we have, by and large, identified the direction necessary to achieve our objectives.

Infrastructure and Operations

Having identified the market requirement, let me now outline the infrastructure and operational activities of the process itself. Let me start with our local source of supply:

The majority of fish landed in the U.K. is sold at auction dockside by companies representing the interests of each of the boats. Although the boxing of fish is carried out prior to sale, no fixed unit of measurement is used when the processor buys. It is, therefore, in the processor's interest to have representation at dockside to ensure that quantity and quality are checked prior to purchase. Due to the fact that fish is landed daily at several ports throughout Scotland and England, and because price can vary at each, the larger processor co-ordinates his buying centrally to maximize any price advantage which may be available at specific ports. With raw material cost representing up to 60% of total cost for the processor, you will appreciate the importance of balancing the plant's requirement against the availability, price and quality of what is available at any given time.

For the processor, a problem still exists due to fluctuations in quantities landed, caused by both weather and season, and by the fact fish is sold by auction. The price paid can fluctuate dramatically day-to-day. While some small processors can pass this price fluctuation on to their customers, the larger frozen fish manufacturers must take a longer-term view, and average out the ups and downs. Once purchased, the fish is dispatched to the processors located throughout the U.K.

Our processing industry is comprised of three clearly identifiable sectors:

The first of these is the traditional, independent fish merchant, who employs only a handful of people, and concentrates upon the procurement, filleting and selling of fresh fish, normally to wholesale buyers.

The second is the medium-sized processor, specializing in a particular product and market profile. These companies normally employ up to two hundred people and concentrate in areas which need specialist processing techniques. Entry into this part of the industry is more difficult because of the high level of processing expertise required for success.

The third sector is the large processor who supplies the high volume frozen retail markets with an extensive range of natural, breaded, and smoked products. These companies employ in excess of 500 people and concentrate not only on branded, but also "own label" product manufacture.

The techniques and equipment used within these three separate categories vary enormously. At one end of the spectrum, the operation is so basic that there is no need for heavy capital investment in sophisticated modern equipment. Similarly, the processing techniques and facilities which are used are elementary, and tend to have remained unchanged for many years. This has resulted in a sector suffering from appallingly low hygiene and processing standards, and has contributed to the demise of the fresh fish market.

The rise in the consumption of frozen fish within the U.K. over the past 10 years and the move by the consumer to higher value-added and convenience products, has required this part of our industry to adapt and change many techniques and methods. The need for these changes has been brought about by several factors. With the consumer moving away from traditional fish fillets to a more value-added product, it has meant a need for heavy capital investment in more advanced technology to allow the manufacture of more complex products. This has required changes in methods seen most clearly in final pack types presented to the consumer. The development of new packaging concepts has been undertaken by both the retailer and manufacturer, and we have found that experience gained within other industries (for example meat and poultry) has been of value when developing techniques within our own industry.

Because of the rise in the purchasing power of the multiple retailer, with the consequent increase in dependence upon them by the manufacturer, it has become necessary to accept many rigorous and costly changes to existing practices. Far greater emphasis is now placed on quality control to ensure that consistently high standards are achieved. While this is seen as vital, if customer confidence in the product is to remain, it nevertheless means that the cost of this activity must be borne by the final product. To emphasize the importance of quality control, most retailers employ teams of food technologists, whose job it is to police the factories which produce for them. Without adequate investment in appropriate facilities, manufacturers cannot expect to supply this sector of the market.

The processor has also recognized the need to improve methods and equipment to increase efficiency. In the U.K., as adequate margins have become difficult to achieve, recognition of the importance of increasing plant efficiency has developed. And, although still a labour intensive industry, the development of new technology has resulted in a reduction in the number of workers employed.

Perhaps one of the most obvious areas where this has occurred is in filleting, where the growth in machine cutting has resulted in a reduction in the requirement for skilled labour. However, with the introduction of greater mechanization, the need for better maintenance and engineering resources has increased. We have found it difficult to attract quality technicians into the fish processing industry, due to its unattractive image, and its inability to compete financially with other industries for this scarce human resource.

Additionally, as raw material costs have risen, we have concentrated on areas where benefits may be achieved from meaningful yield control. This has created a need for more accurate and flexible grading and measuring equipment, and the use of micro-processor technology in the development of yield control systems. Unfortunately, due to the lack of research and development carried out within the U.K. by fish processing machinery manufacturers, it has been necessary to look abroad for much of the technical expertise and equipment found in our factories today. The experience of the Scandinavians, Germans, and other Europeans has proved invaluable, as we have modernized parts of our industry and harnessed change to our advantage.

The ability to store partially processed raw material has helped flatten out fluctuations in raw material supply. This has proven vital to ensure that customer loyalty is maintained by guaranteeing that a full range of products is always available. Distribution for the major multiple retailers is carried out by independent haulage companies, who transport into cold storage centres for later distribution to retail outlets.

Management Skills

I have talked at some length about changes in production techniques and equipment which have occurred in our industry to take advantage of different market trends, and would now like to spend time explaining the changes in management skills which have been necessary to handle the change.

The re-training of management in the skills now required to run modern fish processing plants is both costly and time consuming. Many old and traditional attitudes still prevail. However, I believe there is now an underlying acceptance that pure industry knowledge must be supplemented by professional management. The need to understand people, legislation, cost control, industrial relations, production planning, quality assurance and many other aspects of business, has created a need for a manager with more than simply industry experience.

We have found it necessary to recruit academically bright, but totally inexperienced, young people and to train them specifically to our requirements. Although in the long term this policy will pay dividends, resulting in a nucleus of sound management talent becoming available, it will still be several years until the full benefit is felt.

The Future

In this presentation, I have attempted to give you an impression of the U.K. fishing industry as it currently stands. Let me now turn to what I think the future may have in store for us.

Clearly, we face a constantly changing social environment with human expectations climbing to greater heights. One aspect of this evolutionary process will be a growing desire for new and improved foodstuffs, dietetically advantageous and nutritionally acceptable.

We, in the fishing industry, are fortunate in that the image and versatility of our raw material is highly acceptable for diet conscious and adventurous consumers. Fish is frequently recommended as a key source of protein for calorie controlled diets. Surely it is only a matter of time, until the whole Western World is counting calories rather than only those attempting to lose weight. We, in the industry, will have a role to play in educating the consumer of the advantages of fish and, then, in gearing up for the inevitable increase in overall demand.

Another aspect of meeting future expectations will be a vastly upgraded system of quality control. Currently, within the U.K., major variations exist not only in the standards of processing facilities, but in our end products themselves. I am convinced that it is only a matter of time until we have operating codes of practice for all aspects of the industry, culminating in some form of quality mark on the end-product. Without such a step, we will fail to provide the consumer with the consistency of quality she has already come to expect in most other foods. It is also my view that all companies engaged in our industry, whether as fishermen, processors, wholesalers, retailers or distributers, should be licenced and only able to operate under licence.

Infringements of quality and/or handling misdemeanors could be dealt with and, if the offence were significant, loss of licence might be the ultimate sanction. Imposition of such standards will result in many small operators going out of business and this I clearly welcome. It heralds the opportunity to rationalize and, then advance, the industry on a stronger and more orderly footing.

Within the framework of new technology, it is vital that we advance our technological skills and achieve the key objectives of improved efficiency and greater versatility. Sadly, improved efficiency will result in lost jobs as fewer tasks are performed manually. But we must achieve our ends as inexpensively as possible; the market will not recompense us for inefficient practices.

Versatility through technology will hopefully provide advantage in two areas:

First, it will assist in developing a wider range of products through alternative life prolongations and added value processes.

Second, it will provide means for better utilization of our raw materials. This is not only true in terms of conservation, but also through maximizing human consumption of the complete fish.

Such technology will be expensive and only affordable by businesses currently generating a profit. It strikes me, however, that if local and central governments have any role to play in assisting industry sectorally, the advancement of new technology is the place to begin.

We in the U.K., and in Europe generally, have experienced major difficulties in agreeing to a workable conservation policy that is fair to all. Clearly, it is within all our interests to ensure that we have sufficient stocks for the foreseeable future, and to adopt a pragmatic approach to the allocation of quotas. I am deeply concerned that we still allow industrial fishing on a major scale, and would hope that we gradually reduce the quantities of fish allocated for non-human consumption. Here again, governments have a role to play in protecting our medium to long-term futures by controlling short term greed.

To summarize, we have at our disposal an excellent raw material:

— Let us, within the primary sector, fish our stocks sensibly and recognize that we are part of a food product supply chain.
— Let us, within the processing sector, welcome controls on quality and expand our use and application of new technology.
— Let us, as spokesmen for our industry, sell the advantage of fish to our customers, and educate consumers to the healthy eating fish can provide.
— And lastly, let us communicate effectively on an international basis, to discuss the major issues facing us and to share our experiences, for the benefit of the fishing industry as a whole.

New Technology for In-Plant Processing

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Abstract

We would have to go back 10 years to find technological parallels in the United Kingdom to the current state of affairs in Canada. However, by learning of recent developments in the U.K., Canadians will perhaps gain new insight and perspective into present developments.

New technology tends to be introduced on a reactive rather than a proactive basis, as a response to pressures external to the industry. Market pressures, political decisions, financial difficulties, the existence of non-utilized or under-utilized resources, etc. have all conspired to bring about new developments in technology in the fishery. These developments have, nonetheless, been quite significant, at least in the U.K., and the author catalogues and describes some of the most important British in-plant innovations. He describes work done at the Torry Research Station, Aberdeen, in chilling practice, quality measurement, processing machinery, refrigeration/freezer plant and equipment, and resource utilization, including the manufacture of fish meal.

Introduction

What is new in technology is a matter of definition — it depends on where you stand at any given time. I now realize that our new technology and yours are not quite at the same level. I would have to go back 10 years to find situations in the U.K. which would resemble what is taking place in Canada right now. However, it is important to get a wider perspective, so all is not lost. For example, when you consider the intense effort we are expending to utilize every last gram of our relatively inferior resource, it will put your own efforts in this area into perspective.

There are marked differences in processing throughout Europe; there has been no common pattern in the application of new technology. Therefore, what I have to say relates to U.K. industry only. My selection of topic is also greatly influenced by recent and current work by Torry Research Station (TRS), which is the U.K. Government's establishment concerned with fish handling and processing research and development.

New technology has been generally introduced as a result of pressure evolving from other developments, rather than the new technology itself dictating changes in the industry. Political decisions, such as the introduction of exclusive fishing zones, had considerable repercussions in U.K. fish handling practice as did regulations and standards introduced by our accession to the European Economic Community. Market changes were also a major reason for new technology development. The supermarket, for instance has largely replaced the fish monger, and this has meant changes in methods of preparation and presentation. In the past, U.K. industry was mainly concerned with primary processing, but with changes in marketing, the work of the more progressive firms now takes the form of a full food-processing operation, with the continuous production of finished retail products.

Requirements to improve profitability, to use available, but otherwise not fully utilized resources, to improve yields, to optimize the utilization of limited catches and other pressures have all resulted in new technology.

Chilling Practice

With the advent of improved packaging materials and machinery and the realization by supermarkets that a fish-selling counter can be both attractive and profitable, interest in extending the shelf life of chilled fish products has been revived.

It has been known for many years that bacterial spoilage can be retarded to some extent by high concentrations of gaseous carbon dioxide surrounding the fish (*1*). Unfortunately, this treatment can result in greater than normal quantities of drip and pack collapse, which makes the package unattractive. The problem however, can be alleviated by the dilution of the carbon dioxide atmosphere by other gases, and it is in this respect that in the U.K., as elsewhere, there has been a good deal of experimentation to determine the optimum composition of gases for modified atmosphere packaging (MAP). So far, it has been found that gas mixtures of 40–60% carbon dioxide and 20–30% oxygen, with the balance made up of nitrogen, are most effective in extending shelf life of white fish fillets and shellfish without excessive drip *(2)*. Tests with fatty fish, such as herring, show that MAP *(3)* was found to be only marginally better than vacuum packing and, for such products as hot smoked mackerel, MAP had little benefit. More recent, and as yet unpublished work *(4)*, shows that MAP is particularly effective with shellfish products. Extension in shelf-life of 30%, 80% and 80% were achieved, respectively, with scampi, scallops and cocktail crab claws.

The extension in shelf-life obtained by MAP depends on what quality standard is defined. It was found that for high-quality life, MAP can give an added shelf life of 3½ days at 0°C for white fish fillets, but this is extended to 6 days if a medium quality standard is used.

The data from tests not only illustrated the effects of gas packing, but also the effect of temperature on spoilage. Lowest rates of spoilage and greatest extension of shelf-life occur, as might be expected, at temperatures close to 0°C. With a rise of only 1°C, in the range 0° to 3°C, the storage life is decreased by about 20%. The maximum benefit from a fairly expensive packaging procedure will therefore only be realized if the product is kept at all times at the lowest temperature possible and one area identified for special attention to achieve this aim is quick cooling after packaging, both for MAP products and products in other types of packaging *(5)*.

Fish can quickly rise in temperature during processing, with the product reaching ambience on occasion. In summer months, this can mean production temperatures as high as 20°C. After packaging, it is usual to store the product in a chill-room within master cartons or containers stacked on pallets; therefore, re-cooling time can extend to many hours, with a subsequent loss in potential shelf-life.

To meet the requirement for a quick chilling method to suit existing production lines, a system using very low air temperatures of −35°C and an air velocity of 6 metres per second has been investigated *(6)*. This effectively freezes the outer few millimetres or so of the surface of the product so that, on equilibrium in chill storage, a temperature of 0°C is achieved. There are no detectable adverse effects of this surface freezing, and a chilling time of 4–5 minutes for produce in trays with a plastic overlap, makes the method suitable for a continuous in-line process. This quick cooling of the packaged product has been shown to save about 49 hours in the potential shelf life at 0°C, when compared with cooling in bulk in a chill-room.

Fish Quality Measurement

The monitoring of the fish temperature during processing, transportation, and storage can be used as a record of possible product deterioration; and a number of devices and systems have been suggested for this purpose.

The relationship between rate of spoilage and temperature has been related to the rate of bacterial growth which is given by the derived equation *(7)*:

$$R = b(T - To)$$

where R is the rate, b is a constant,
T is the temperature and
To is a characteristic intrinsic temperature for the organism.

This equation also describes the relationship between the resistance in a resistance thermometer and temperature, and this may be incorporated into an integrating system.

In a more recent version developed by TRS *(8)*, the non-linear change in resistance of a thermistor is used to drive a voltage controlled oscillator. The output is counted by a clock circuit modified to read a maximum of 24 days at 0°C, i.e. real time is only displayed at a constant temperature of 0°C. The display represents the equivalent number of days storage at 0°C and, at present, this is limited in the commercial model to a usable temperature range of 0°C to 15°C. This device shows some deviation from the true spoilage rate at higher temperatures. A later modification *(9)* has corrected this characteristic and extended the range, but the errors involved in the simple version seem acceptable to the retail industry, representing only 2½ hours in 2½ days at 15°C for a product having a shelf life of 14 days at 0°C.

The device at present, is used mainly to give an overall picture of handling and marketing conditions, but it can be miniaturized and cheaply produced en masse, therefore, it may eventually be manufactured in non-returnable form. Meanwhile, the concept of time/temperature integration has been extended to the development of inexpensive test strip integrators suitable for inclusion in the material used to package fish.

Fish Processing Machinery

Primary Processing Machinery

The rapid growth of microelectronics has had an inevitable influence on recent fish processing machinery developments. For instance, the introduction of electronics to provide automatic adjustments to cutting tools, an operation performed by computer-controlled step motors, has more than doubled the potential throughput of a filletting machine for small gadoid fish *(10)*. This development has had a significant impact in countries like the U.K. where a high percentage of current demersal landings come within the 27–45 centimetre overall length range of the machine.

Composite Fillet Machines

Since the U.K. has only a limited involvement in the manufacture of fish processing machinery for the more widely applied processes, such as gutting and filleting, research and development work has been concentrated on new, or relatively new, requirements, rather than being directed towards competing with well-established equipment manufactured in other countries. The fish compositing machinery now under development is a typical example of this type of application

Composite fillet machines are now in use in the U.K., but the quality of the product is only suitable for a limited market, notably enrobed frozen products. The reason for this is that, during the forming process, the fish is broken into smaller pieces, with some of it even pulped, and there is an inevitable change in texture. Enrobing the fillets masks, to some extent, this change in texture, but the defects are still detectable. The present development at TRS *(11)* is devised to produce a composite fillet which is otherwise unchanged from its basic components and, with the possible aid of binding agents, produces a product that can be sold uncoated, even in the chilled state. This development is now at a Mark II

FIG. 1. The TRS (Torry Research Station's) prototype machine for forming composite fillets.

stage, with the main effort being put into the development of a loading mechanism to speed up the output (Fig. 1).

There has been a long-standing need for standardization in the fishing industry, particularly by outlets such as supermarkets. The harvesting of fish in the wild, however, does not allow the degree of standardization achieved by other food industries. A solution of sorts is provided by expensive and wasteful grading or resorting to such products as fish portions or fish fingers. Compositing of fillets opens up the possibility for more natural looking products to be produced in a standard form using both smaller and larger fish for the raw material. Already modification to the basic machine allows some degree of shaping and contouring to give a more realistic fillet shape (Fig. 2).

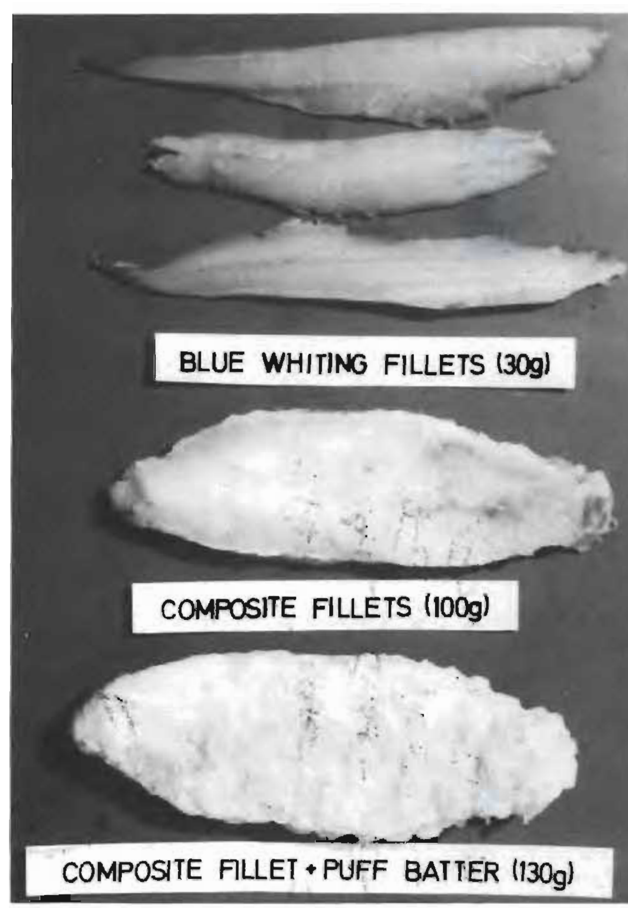

FIG. 2. Three stages in the manufacture of composite fillet products.

Sorting and Sizing

Sorting by size, shape and weight are now possible, using optical or electronic sensors, combined with the inevitable microcomputer. Sorting and grading by colour has also been shown to be a possibility (*12*) and recent work by TRS (*13*) has shown the method to be suitable for product identification and as a measurement of the quality of fish minces.

Check Weighing

Check weighing is a well-established procedure, and developments in this field are heavily weighted, if I may use the obvious pun, towards the introduction of computer technology, in association with, the now, well-established electronic balance (*14*). Machines are capable of handling various forms of fresh and frozen fish products at production rates of over 100 pieces per minute. Their main function as weight graders may also be supplemented with additional facilities, such as catch weight pricing. Check weighing machines are also used in production control, checking on yields, performance of individual workers, and any other sensible factor in the production line.

Crab Meat Separation

Machines for processing crab, especially for the separation of shell from crab meat, mainly originated here in North America, but a recent development in the U.K. has been a machine which, it is claimed, is both simpler to use and cheaper (*15*).

Originally, the product from this machine was very finely divided, but modifications made as the result of cooperative work with TRS, greatly improved the particle size, texture and yield of the recovered meat. The product now compares favourably with that of more complex and expensive machines. When processing *Cancer pagurus*, much of the available white meat is extracted from claws, legs and body. Yield is subject to type, components, and the condition of the crab processed, but claims for a possible recovery of 90–95% are typical.

Resource Utilization

A prominent feature of recent U.K. fish processing research and development has been work to improve the utilization of the resource. This work has been mainly concerned with the handling and processing of certain potentially interesting species, known to be catchable at reasonable cost, but not used by the trade. But it has also resulted in improved utilization of the present catch (*16*).

Species that have attracted most attention are blue whiting, mackerel, scad (horse mackerel) and small gadoids generally. Much is now known of their particular characteristics and requirements with respect to handling, processing and storage, but, as yet, other than in the case of small gadoids, commercial utilization in the U.K. has not progressed to the stage of making a significant impact on the resource.

The work on improving utilization of the present catch has concentrated on the preparation and use of minces (*17*) and development of the composite fillet concept (*18*). The use of deboning machines offers one of the most promising methods of achieving high yields, and this has attracted the attention of technologists in the U.K., as well as in many other countries. The reduction of contaminants in mince and the improvement in colour were given a good deal of attention. The removal of discoloration, small bones, and fragments of skin and membrane by washing and sieving were studied, but the subsequent removal of the water to return the mince to its original water content also resulted in a considerable loss of solids and soluble nutrients. Therefore, washing and dewatering are clearly operations that should be circumvented, if at all possible. Other methods were therefore investigated including the use of a machine to remove part of the fish skeleton, more effective bleeding, careful orientation of the raw material when presented to the boning machine, and better control of the boning machine operation. All of these resulted in appreciable improvements in the quality of recovered mince, although it sometimes resulted in lower yields.

Another development in minced fish technology has been the creation of simulated flake-like texture in recovered mince (*19*). The process starts with a blend of lean and fatty fish, alginate and colouring matter which is formed into heat-stable, cohesive layers. The layers can be shaped into a variety of forms including products which realistically simulate canned salmon and tuna.

New freezer designs and developments in the U.K. have usually evolved as the result of new requirements, rather than the other way around. Hence the vertical plate freezer was designed in response to the need to freeze whole fish at sea and, more recently, a continuous air blast freezer was the result of the increased demand for individually quick frozen (IQF) products. This type of product is usually small or of a shape which allows quick freezing and results in relatively short freezing times. For the same reasons, thawing times are also quick, therefore, any delays after freezing will result in the product quickly warming up. Quick handling after freezing is essential and a continuous operation is best suited to meet this need.

FIG. 3. The "Torry" continuous air blast freezer for IQF (Individually Quick Frozen) Products.

A continuous air blast freezer (Fig. 3) designed by TRS has a number of novel features and other attributes which make it well suited for a wide range of IQF products (*20*). The freezer has a flat stainless steel belt with air flow above and below. This means freezing is unhampered through both upper and lower surfaces of the product. The flat belt allows products to be readily released after freezing so products such as skin-off fillets and reformed fish products can be unloaded without damage. Even with more delicate products, release is aided by a defrost, incorporated below the belt at the freezer outlet. The belt is returned outside the freezer and washed and wiped on the return to the loading end, allowing a high standard of hygiene to be maintained. The return of the belt unfrozen to the loading end also allows fish to be loaded more quickly, and the better spacing achieved ensures a high degree of freezer utilization.

The freezer operates with an air velocity of 10 metres per second, which is double the speed used in other freezers, and this has been achieved with only a 15% increase in fan power requirement. The result is a more efficient, smaller unit requiring less floor space.

Finally, the freezer has been operated for 24 hours when freezing small fillets, without the need for a defrost. This has been achieved by good cooler design and layout and the improvement in this respect can be appreciated more readily by contrasting the above defrost requirement with one of every 2 hours, observed in a freezer of poor design. This freezer has now been in operation for a number of years and its use has been extended to other food products, such as individual steaks.

In some installations, two freezers are used in tandem, with one doing the initial freezing, which is followed by an enrobing process. This can involve the addition of batter and breadcrumbs, followed by flash frying, then hardening off in the second freezer before transfer to the cold store. In some of these cases, the second refrigeration requirement is equal to the first.

The vertical plate freezer has undergone little change in its fundamental design since it was conceived and used in 1955 for freezing fish at sea. There have, however, been a number of refinements, including the use of hydraulics to operate the freezer and improvement in the sealing to allow the retention of added water. One practice, established when using vertical plate freezers, was the use of paper inserts between the plates, before loading. This coated multilayer paper bag allowed water to be added to strengthen the block and give protection against physical damage and oxidative rancidity during subsequent handling and storage. The paper also provided sufficient friction to enable blocks to be stacked safely in the hold of the vessel. A plastic material, Fric-film (which has a roughened surface), has now been added to the list of suitable materials for this purpose (*21*). The friction coefficient of the material is much the same as for the paper inserts, with the added benefit of providing a tougher and more durable wrapper.

Cold Storage Design and Operation

Frozen fish is probably most vulnerable, in terms of adverse product changes, during the cold storage stage of the process from processing to marketing. Even small differences, which make conditions less than ideal, can become significant if long-term storage periods are involved. Weight loss or dehydration of the product is the most obvious, and one of the most significant, changes during storage. A survey in the U.K. (*22*) showed that, even in stores designed for a nominal operating temperature of −30°C, the rate of weight loss can be high and differences between stores can vary by as much as a factor of 40. Observations made during the survey illustrated that operational, rather than design factors, accounted for inferior storage conditions. Therefore, this aspect of cold storage has been given close attention in recent design and development work. We felt that the quickest way to achieve improvements was to provide the operator with more extensive, detailed information about the store operation and also the means of analyzing the data. As a result, a system is under development which is based on the use of a microcomputer, and it has now reached the stage of full scale commercial trials (*23*). Programs developed for the microcomputer indicate current status and, by reference to stored data, trends can be readily detected and assessed to determine whether adverse conditions are developing. Information is presented as tabulated, graphical or diagrammatic displays on a visual display unit (VDU) or it may be presented in the form of a printout, giving a more tangible record which can be used in other ways. Visual and printed records of the frequency and duration of door openings have identified a major source of unnecessary heat gains. In this case, the system was being used to check on the operators and their compliance with instructions, but it can also detect a faulty door-closing mechanism.

One of the problems encountered in cold store operation is the continual build-up of frost on cooler surfaces, reducing their efficiency and necessitating frequent defrosting. Defrosting is normally done on a routine basis, invariably using a time clock to initiate the automatic defrost procedure. This method, however, takes no account of the rate of frost build-up and defrosts may therefore be either too seldom or too frequent. A device has now been developed to monitor frost build-up on the surfaces of the cooler (Fig. 4) (*24*). The device consists of a spectrally matched pair of infra-red emitting diodes and pin diode detector which generates a signal proportional to the amount of infra-red radiation reflected from the target area. This area is one cooling fin viewed edgeways which, as the ice thickness increases, reflects more of the incident radiation. If the system is calibrated in terms of ice thickness, at a certain signal level, the defrost cycle can be initiated. By controlling the whole operation with a microcomputer and by monitoring all the relevant information, the system can be optimized for minimum energy loss and minimum temperature change in the stored produce. In a more simple arrangement, the signal can also be used to initiate the activity of light emmiting diodes (LED) arranged as a bar display so that the operator is presented with a visual indication of the frost build-up on the coolers and he can make his own judgement on whether a defrost should be initiated.

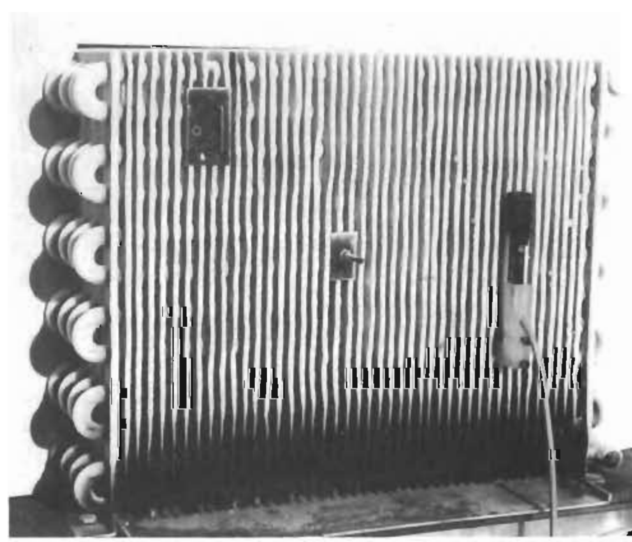

FIG. 4. Frost detector located on cooler.

Refrigeration Plant

Real refrigeration expertise is scarce and a reliable refrigeration plant expensive; therefore, a system which allows experts at a remote central control to monitor the refrigeration equipment may have particular relevance to many situations in Canada.

The TELSTAR system, developed by a U.K. company, is a dedicated microcomputer system which allows any type of refrigeration plant to be controlled automatically (*25*). Its main feature, however, is that it allows communication by means of a modem and telephone line, between the on-site unit and a central control point, where experienced staff can monitor to ensure that everything is working correctly. The communication is two-way. It can send regular readings or an emergency call to the computer at the control point, which can store the information on a disc or print it if required. The operating characteristics of the plant communicating with the computer are known, so that even if the plant in question is apparently functioning normally, the system is able to detect when an undesirable tendency develops and the owners can be informed if corrective action is required. In addition, the frost detection device mentioned earlier, has been incorporated into this system to give an additional item of information for monitoring and control.

Other than developments to be covered later in this presentation with respect to fish meal production, no significant new technology has evolved for saving energy in the fish processing industry. However, one well-established method, involving the recovery of heat from refrigeration plants, has been introduced and is now given consideration when new refrigeration facilities are contemplated.

Condenser heat is used for supplementing factory heating and for heating water, but little attention has been given to the peculiar circumstances of fish processing operations. The methods used are therefore ill conceived, often badly controlled and, as with the heat pump, maximum benefit is usually available in the summmer months, when it is least required. Work is now in hand at TRS which will bridge the gap between well-established energy saving technology and the special requirements of the fish processing industry.

Fish Meal Manufacture

Generally, developments in fish meal processing equipment are initially aimed at meeting the special needs of large plants sustained by an industrial fishery. There is often a delay before new technology is applied to the smaller plants in the U.K. which operate using processors' waste as their main source of raw material.

All fish meal factories in the U.K. now operate with indirect dryers since they are under pressure to reduce atmospheric pollution and this type of dryer is generally less offensive.

Pollution control, mainly by treating the air from the dryers, a major source of odour, has been an important area for research and development. The system now favoured consists of a two-stage treatment, consisting of a scrubber/condenser followed by incineration in the boiler used to supply steam for the plant. To operate this system effectively, the flow of air through the dryers has to be reduced to give an air-to-vapour ratio of one to one at the dryer exit. A further improvement is achieved if the air is recirculated to the dryers after the scrubber/condenser. This means that the quantity of air to be incinerated is now confined to that leaking into the dryers, plus air ducted from other equipment to the system for treatment. When operated correctly, the treatment system effectively eliminates odour from this source, but other sources still must be kept under control by good housekeeping.

Two major improvements resulting in energy saving have now been applied in U.K. plants (*26*). A number of installations use waste heat evaporators (WHE) with a fuel saving of about 20%. This method is designed to use the heat in the dryer air for the concentration of stickwater. The other method, called mechanical vapour recompression (MVR), has recently been installed in a U.K. plant and in it the vapour from the evaporator is compressed to increase its temperature so that it can be used again. This method effectively reduces the energy requirement by about 75–85% and the total cost of evaporation by about 20–30%. A possible future development may be the use of MVR in conjunction with a dryer which operates with no air. A similar saving may result.

And with that, I think I have covered a whole spectrum of things — work being done at the Torry Research Station. I hope you have found this information to be of some value in your deliberations.

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LUNCHEON ADDRESS

Luncheon Address

Mel Gass

Parliamentary Secretary to the Minister of Fisheries and Oceans and M.P. for the Constituency of Malpeque, Prince Edward Island

on behalf of
The Honourable John Fraser

former Minister of Fisheries and Oceans

"As new technological developments take place they are bound to cause some readjustments. That is the price of change. But we will pay a bigger price if we fail to change."

As you know, I am here representing the Honourable John Fraser, Minister of Fisheries and Oceans; but in a sense, this conference itself also represents Mr. Fraser. Five provinces and the federal government sponsored this meeting, to bring together key people from all parts of the Atlantic fishery. That kind of cooperation and consultation, both federal–provincial and government–industry, shows the approach the Minister wants to take in general. I will try to relate that approach to the questions you face at this conference.

You have been talking about new directions in fisheries technology. For that matter, people everywhere today are talking about new technology — space shuttles, high tech, microprocessors, the information revolution — to the point that it can get confusing. Sometimes people wonder whether to be optimistic or scared. Will technology help us or hurt us, will it make jobs or take them away?

In a time of change, it is natural that some people in the fishery ask similar questions. Does the fishing industry really need much change or improvement? Has new technology got the potential to help the industry? And if it does, can the people involved, fishermen and processors and government, make it work?

Those questions are so big, maybe we should sneak up on them from behind. Instead of new directions, suppose for a moment we glance back at old directions in fisheries technology. From the start, there has been only one basic goal: getting the fish from the water to the market at a profit. All the fancy machinery has to serve that purpose; the blueprints have to help the bankbook.

In search of profits, the fishing industry has already made great technological changes, especially since World War II. You probably know people, as I do, who fished from open boats with make-and-break engines, or even from sailing vessels. Now we see new engines, new hull materials, radars and sonars and lorans, new sizes and shapes of vessels, with everything aboard from baiting machines to computer systems. And processors now take for granted freezing and fish-handling systems that their fathers thought were revolutionary.

This industry has shown it can take up new technology. And Canadians have made many of the innovations. Fishermen here developed the use of sonar in purse seining; and Japanese fishermen today buy Canadian fishing sonars. The drum seine, refrigerated and chilled sea water, fish pumps, the new random baiters, and the still newer rope reels, all came from Canadian initiative.

Why did the major post-war changes work? For one thing, there was opportunity for growth, the result of post-war prosperity. But besides that, the new technology was something people could get their hands on: they could see how it would help them catch more fish and make more money. It was people-oriented, practical, and profitable.

Some new technology came from fishermen and the private sector; some originated with government people; and a lot came out of shared projects between industry and government, both federal and provincial. In the 1950's and 1960's, new trawls and nets and other gear, new fisheries like crab and shrimp, all came into place through this kind of pragmatic cooperation.

Most of the new technology went towards catching and producing more fish; and for years this seemed to work well. Canadians caught and packed large volumes. We have had more than our share of fishing highliners and of aggressive companies moving lots of fish in tight markets.

But you all know the more recent history. First the fish got scarce, and that caused a lot of trouble. Then the 200-mile limit and careful management gave us more fish; but the new volume was no total cure. In Newfoundland, for example, from 1976 to 1982, the amount of fish caught increased nearly 50%, and the landed value nearly tripled; but the industry still has serious problems. It is the same story in most places on the Atlantic: too few bright spots, too many fishermen and processors hanging on by their fingernails.

Why did profits vanish, or almost vanish, for so many boats and plants? Everyone can name his own reason — fuel costs, gear costs, labour costs, interest and exchange rates, seasonal gluts and shortages, or problems with quality, yield and marketing. But they all add up to the same thing: we are spending too much and getting back too little from the market. If an enterprise loses money on every pound — and that has often happened in recent years — then the more fish you take aboard, the deeper you sink. There is only one way out: we have got to get the fish to market with more value added and at less expense.

That requires a number of improvements, in different parts of the industry. But besides dealing with problems one by one, gaining a little here and there, we need to think about the way everything fits together. Fishermen deal with the wind and tide and fog and the fish and everything about their vessel; they are expert at taking all those factors into account. But that is only the start. To get the right product to market at the right time and place, and in the right package at the right price, involves more factors at every turn. And instead of one captain, there are many, each running his own section of the resource-to-market system — and any one section can throw off the rest.

The industry in the past showed it could change. Today it needs to change again. Apart from all the studies of the fishery, the profit margins themselves, or the lack of them, say loudly and clearly that we can stand some improvement. We have got to find the ways to spend less on the fish, or sell them for more money, or both.

Can new technology help? Judging by our competitors in Europe, the answer is yes. They often get more value than we do from equivalent fish, and that helps them compete in our markets.

As you know, there are good reasons why their industry developed differently. Often they had smaller volumes of fish to handle, and more local markets, fewer tariff barriers, and more employment alternatives, which reduced the supply and raised the price of labour. All those things made the Europeans concentrate on high value rather than volume; and so, we see them boxing and icing fish, and using many mechanized and computerized ways to handle the product.

Similarly, there were good reasons why our industry stressed volume; but high production no longer guarantees profits. In today's circumstances, a greater stress on mechanization and value added has helped the Europeans; and depending on the case, it should help us.

We can use European tricks and some of our own. As you have seen at this conference, our development workers have demonstrated that there really are ways to cut fuel and other costs, to raise yield per pound, to enhance quality and value — sometimes by 3, 4, or 5% — which all counts — and sometimes by 10, 20, or 30%, or even more. It is not pie-in-the-sky, it is down-to-earth practicalities. Other industries have done it — think for example how the makers of home furnaces doubled their efficiency after the fuel crisis. The fishing industry can make its own gains.

Given good planning and cooperation, we may carry through some technological changes not just piece-by-piece, but on a system-wide basis. You have talked here about the inshore fish-handling system in Newfoundland. That system used only cheap and simple tools — containers and net bags and some hoisting and handling gear on the wharf. But it produced great gains in quality and product yield. Wherever you look in Newfoundland, you see the big gray containers carrying ice for the boats or fish for the plants. That is because government–industry cooperation applied the new system quickly and effectively, throughout the inshore fishery.

It is the thinking behind the technology that counts. And some of today's new computer technology fits right in. It can measure and monitor and control processes, in a kind of mental mechanization. We see it in everything from Loran navigators to squid-jigging machines to the prototype Contrawl system you have heard about, for moving containers automatically.

More than that, the new computers may help the whole fisheries system work together more efficiently. They can exchange great amounts of information at lightning speed, along the coast or around the world. I am told some industries are already using in-plant computers to monitor the whole flow of supply and demand, and help the managers plan production. Computers, of course, will never eliminate human judgment. But, will automation and computers eliminate human labour, and take away jobs?

As new technological developments take place, they are bound to cause some readjustments. That is the price of change. But we will pay a bigger price if we fail to change. This industry still faces a stiff challenge. We will either compete or collapse. And to compete in today's circumstances, we need to become cost-effective, which means using the right technology.

In that sense, technology preserves jobs, and creates new ones. If technology only took jobs away, the work force would have stopped growing 200 years ago, with the steam engine. Instead, the Industrial Revolution got stronger and stronger, and somehow it kept giving more and more jobs to more and more people. The more profits this industry gets by cutting costs and enhancing value, the more money goes into the pockets of fishermen, plant workers, and everyone else involved. By force of circumstance, we have to make some adjustments. And the industry has made similar changes in the past. The only question is: Will we again get to work and turn new technology to our best advantage? Or will we resist it and give our fishing industry competitors and the meat and poultry industries a head start?

I realize that in trying to change technology today, there is a handicap or two. When it was a matter of more production, the fisherman could make his own changes on his own vessel and see the results: a bigger catch. But when it comes to enhancing quality and cutting costs with all kinds of technical tricks, the changes can be more complicated, and the results harder to measure.

And there is a related question. I will quote a key conclusion of a recent federal task force on technology development. The authors said that when government tries to push technology onto an industry, it is like pushing a chain. To make it work, industry must pull on the other end. It is easy to get into the habit of importing technology or relying on government to do research and development. Rather than looking for new fisheries technology to be provided on a platter, government and industry must work together to help build it more and more from the bottom up.

In technological development, the Minister wants the industry to take the lead. As far as possible, the Department will base its own technological work on the industry's views. Mr. Fraser believes the best way to create people-oriented, profit-oriented technology is to let the people themselves do the orienting. In that regard, the Minister wants to invite your ideas, as fishermen and processors. If you see a way to make things work better in your sector and in the industry overall, we are listening.

I speak for the Minister, the Department, and, indeed I believe, for the provinces, when I say that this conference demonstrates our commitment to cooperation on technological change. We hope it begins the progress to more efficiency, more value, more money. We do need changes, and we can make those changes together; but we can only do so if we get your commitment and your cooperation. That is your opportunity and your challenge.

CLOSING SESSION

Conference Overview
The Fishing Industry of the Future

Peter Hjul

Editor, Fishing News International and Fish Farming International
London, England

"What I have heard (here) convinces me that the (fishing) industry is vigorous, aware of its needs, and confident of its future."

Abstract

Current projections of a 100 million ton catch of fish (all species) worldwide by the year 2000 may prove elusive. Most viable stocks and grounds are now being exploited to capacity. Meanwhile, management measures, including licensing and quotas, can be expected to increase. Emphasis, therefore, must be placed on economy of effort and efficiency in fish-finding methods — "hunting." But there will also be developments in stock enhancement through fish farming and ranching. Ideally, the "hunting" and "farming" of fish will be complementary, not competitive, activities, best managed by one branch of government, the department responsible for the fisheries.

We may have, in the future, to reconsider our attitude to fish as a low-cost source of protein and to try to establish for it a first-class image. Quality will be the key. Handling, processing, packaging, and distribution will, therefore, all have to improve. In the latter case, computer-linked distribution and marketing systems will become commonplace.

But, overall, there continue to be compelling reasons to be optimistic about the future of the fishing industry.

You may have noticed that every time during the past few days that a speaker has finished a presentation, I have thrown away a piece of paper. I have gradually watched everything I was going to say to you wittled down by all of them; they have done very well, very eloquently, just what I had intended to do at this wind-up session. The presentations have thrown light on many aspects of our industry and on its many problems, but have also given us the encouragement we need to recognize that these problems are solvable and will be solved in the near future. Please forgive me, therefore, if I touch upon some of the same points.

Whenever I am asked to speak about the future, I get terribly apprehensive. Over the years, there have been many predictions made about the future; some have come true; most have not. I also have the seasoned apprehension of both a journalist and a politician that a structured outline of the future of the fishing industry borders on the impossible. I think it was the great English parliamentarian of the 18th century, Edmund Burke, who said it is a common disposition of mankind to complain of the age we live in, to lament the past, and to conceive great hopes for the future. The past few days have underlined the fact that people in our industry are no exception to that adage.

We have to look ahead in fisheries even if only to ask, will there be a future for the industry? Now, I hate to start out as a pessimist, because I am, basically, an optimist about the fishery. I have been involved with the industry for over 35 years, all over the world, and I have seen or heard nothing to make me lose confidence. But, if I may digress, we must prepare for an eventuality which might threaten our future. There is a possibility that the strident campaigns for the protection of marine mammals could, one day, extend to the fish we catch and to the way in which we kill them. This timely warning was given last November by the Whaling Commissioner of Norway at a Seafood Conference in London, after we had suffered Brian Davies at length on the iniquities of the Canadian seal hunt and what he was proposing to do about them. Conservation bodies need causes; the seal hunt serves that purpose at the moment. But already in Britain, where we do not have a seal hunt, we have a lunatic fringe of animal protectionists who are threatening to attack angling and anglers for their "cruelty" to the fish. We are, therefore, fearful that, if this campaign is successful, it might later spread to the commercial fishery. I believe that in your battle to preserve the seal hunt, to maintain the necessary culls, and to fight the ignorance of the European parliament and other bodies, you are in the front line of this struggle and, in the long term, you may be helping to preserve the fishing industry around the world.

But back to fishing . . . first, what are the world prospects for the resource? I think, when we look at the future, we have to go to the Food and Agriculture Organization of the United Nations' (FAO) estimates for a set of figures we can work with to make our projections.

The FAO forecasts hover around one hundred million tons as the "possible" harvest by the year 2000. This is down from the estimate of one hundred and twenty million tons of fifteen years ago when we talked of krill, lanton fish, etc., and some people were talking in the two hundred million ton range as being within the realm of possibility. We have now become much more realistic, and this is evidence of our increasing maturity as an industry. These forecasts are an indication of need, what we hope we are going to get, rather than what we will likely get — you can't invest on this basis; we have to be careful about these figures.

The reality today is that the present broad estimate by the FAO is that the catch in 1983 was 76½ million tons, all fisheries, all species, and slightly lower than 1982. There is no indication of any substantial increase in subsequent years up to the present. That leaves us over 20 million tons short of that reduced target level set by the FAO for the year 2000. There are potential sources available to us (krill, in my opinion, is not one of these); lanton fish, squid, and other species are available. But the thing about underutilized species is that they are underutilized for two very good reasons: (1) they are difficult to catch; and (2) nobody wants them. And in the Canadian context, I have heard no one here discuss great stocks of any sort, which are not being utilized at present. Obscure species, therefore, may represent an academic exercise as far as most of you are concerned. So management of stocks, at least in the European Economic Community, will become crucial. Estimates and projections of stocks will become more and more accurate and fishermen will have less and less cause to argue against quota allocations.

One of the other things we can look towards, and something which is already happening in several countries, is that the surveillance of the great new areas we have claimed, the 200-mile economic zones, will become much more vigorous and, therefore, more effective. It will be less easy for outsiders to poach stocks and less easy for insiders to infringe upon quota regulations brought in to preserve them. Among the 12 nations of the European Economic Community, beginning next year, we will be thinking very hard about methods of surveillance. Aircraft, ships and control centres, following Canada's lead, will be used extensively. Developing countries, too, can be expected to follow suit.

We will gain in knowledge of what is in the sea and in our ability to gauge the resource. Remote sensing through satellite, using computer analysis, was going to be part of my prognosis, but then I realized that we were projecting these things 15 years ago, for today, and they have not really happened on schedule, although, admittedly, we are making progress. Twenty years ago, we were saying that, instead of complicated fish finding arrays in fishing vessels, a single vessel in the fleet would be comprehensively equipped to act as a fish finder and tracking centre; and this has fallen by the wayside over time. One of the biggest advances in the past 15 years has been in electronic fish finding, the linking of transducers and microcomputer technology which permits a relatively cheap, relatively small echo sounder to do all the work of a tracking vessel, but right from the fishing boat itself.

Fifteen years ago, a superb research ship had been completed in Iceland and she amazed us with the utter complexity, detail and amount of investment in her surveillance system and in her echo integration systems. Much of what she had then, a normal, medium sized trawler now packs into her wheelhouse. Whether we will see the same advances in the next 15 years, I rather doubt. I think we are reaching the limits in the perfection of fish-finding technology. But then, the sheer ingenuity of the electronics companies may yet prove me wrong.

We must, in vessels, expect the package console. We now have a mass of instruments spread around the wheelhouse and the thinking today is to package these into a single console, compact and conveniently located.

Inmarsat and the use of satellite for relaying information to home base to improve ship and fleet management is something we heard about from Glen Etchegary yesterday. I am a great believer in this system and in Satcom; it has great potential, and will be of great benefit to deep-sea fishermen everywhere. When we can use this system for telex and teletext transmission, we will be into something very important.

Not so long ago, crystal ball gazers like myself would stress the possibilities of boosting catch capacities in fishing vessels. We can still do so. We have heard about advances in gear, boat design, nets, lines and everything else. But we also need to think about the limitations of what I like to call "sea hunting." The greatest weakness is in the amount of catch each vessel, or each fisherman, can extract. We are into the age of the quota, the vessel licencing age. What will happen is that each vessel and each fisherman will be restricted in terms of what can be caught. We know the resource and we know it is not inexhaustible. So the efficiency of the boat and the organization of effort will be critical to the future of the fleet. Costs will have to be controlled. We must harvest fish as cheaply as possible and sell it for the best price possible.

Boat building is not cheap. There will be a trend back to series building, a simple design to cover a number of vessels. One example is Napier & Co. in Scotland, which has designed a very efficient, compact boat, 60 feet long, which can take nearly 100 tons of fish in the hold. Several vessels of that kind have been built. Also, there is a trend back to processing at sea, the earlier collapse in this trend notwithstanding. In certain parts of the world, a factory ship is an advantage; I suspect you would find that to be the case in certain parts of Canada.

Where fishing is linked to processing and distribution or to a port auction, there is a need for delivery discipline. With catches being allocated through quota systems and licencing, the fisherman will need to learn, particularly in market auction areas, that to penetrate the best markets, you have to really suit the boat to that market. You cannot simply "do your own thing," you have to adjust your way of doing things to the market and also to what the processor wants and needs. You have to think of the needs of your customer ashore.

Certain stocks are under pressure. But there are stocks which are recovering. One of the most interesting of these is the Atlantic herring, which I believe will be one of the most important stock resource developments in the next 5 or 6 years, particularly for the Scandinavians. However, there is a problem here too — in the years when the stocks were at a low ebb, processing capacity was allowed to erode. Now that they have rebuilt, there is some anxiety about our ability to process the catch. This serves as only one example of "the fishing industry of the future" fishing some of the stocks of the past.

And this brings me to one of my favorite subjects — aquaculture, another of the areas of the industry which will develop in the near future. We have seen sensational developments in Norway. In a relatively short period, the Norwegians have turned the Atlantic salmon from a wild creature of the sea into a domestic animal, probably, with trout, one of the first domestic species of fish in the world. The Norwegians project they will be producing eighty thousand tons of farm salmon by 1990. If you add to that the Scottish and Faroe production, and the production in Iceland, we can expect by that time something of the order of 110–120 thousand tons of farm salmon on the market. At the same time, we have seen other developments in fish farming around the world; in Britain, we are now farming turbot, milk fish, mullot, carp, trout and tropical prawns. And aquaculture is still relatively new as an intensive form of production; we have much to learn. A particular hobby horse of mine is that aquaculture be put where it belongs, in departments of government dealing with fisheries. In many countries, aquaculture is treated as an extension of agriculture; but Norway, in particular, is proof that this is not the way to go.

Aboard ship, we can expect to see increasing care in the handling of the product, boxing and so on. But I am disappointed that the emphasis is always on reduction of manpower, reduction of labour costs. I am acutely aware that in my own country, we have 3.6 million unemployed, and many of them with no prospects of employment — ever. I think this problem of unemployment is one of the acute problems of modern, developed societies. And I think we should be thinking not of always reducing manpower, but of producing quality fish, a commodity which is becoming increasingly valuable. In that case, perhaps we need more crew on some of the boats which produce it, more people to put it carefully into boxes. The Japanese have a lesson for us here because their factory trawlers always have more crew than other factory trawlers, and they argue that they are particular about the fish they bring in and they therefore want people to do the sorting; they don't want machines to sort for them. Perhaps, then, there is room on vessels, which land a high-priced product, for more crew on board. This is perhaps anathema to people trying to run fleets, but something we should at least think about.

Again, looking at the future, and, again, looking at electronics, we can expect close interaction between the catcher and the buyer. One aspect of this is the distribution of information and the capacity to act on it. We have already seen impressive developments in data services. In my own group, we have developed a market information service in the European Economic Community which provides instant information on market prices in 18 auction markets. It is computer analyzed, through teletext in London, and to subscribers within 20 minutes. The service has only been marketed for a year, but is beginning to catch on rapidly. I believe that one day this system will be installed aboard fishing vessels and skippers fishing in a common area, like the North Sea, and looking for a market, will have a choice. The computer will do the calculations for them, considering price in a given market and fuel costs to get there, so they will get the best deal possible. That might cause a glut in a given market, or a stampede of sorts, but we will cross that bridge when we come to it — after the service is installed and working on the ships.

An inevitable result of these developments will be that, once we have the information, once we have the electronics, once there are standardized weights and measures, and standardized quality measures, there can be electronic shopping. This will trickle down to the retail level and is the wave of the future in the marketing of fish.

Another development will see resurging fish stocks, like herring, used in aquaculture, as fish food, for salmon for example. I am talking about more expensive and better constituted fish foods and not the animal meal we are all familiar with. The Norwegian and Swedish fish feed manufacturers, extremely progressive people, have already begun to look at this possibility.

We cannot examine the future development of fisheries around the world in isolation from the Third World. Canada has an excellent reputation in this regard. You have done much useful, thoughtful work in the developing countries. I hope you will continue to do so. I spent some time in India recently and there I saw the value of some of that work and what it is doing for communities and how it is actually improving standards of living. We can always do more.

To conclude my star gazing, fishing remains, as we must be aware, the only modern food producing industry dependent on "hunting." It suffers all the constraints and problems that this dictates. The accent must remain on efficiency and quality, but also, now, on enhancement, through fish ranching and farming. What I have heard convinces me that the industry is vigorous, aware of its needs, and confident of its future.

Conference Wrap-up

A. W. May

Deputy Minister of Fisheries and Oceans, Ottawa
and
General Chairperson
Atlantic Fisheries Technology Conference

"We really don't have any choice when it comes to technological change. To remain competitive and for our industry to grow, we have to both develop and adopt new technology of every kind."

I have been around since the time when the first stern trawler was introduced into Canada, so that certainly dates me. And we have now reached the point where people in the Department are telling me that the age of the electronic chart has arrived. All you have to do is turn on your video screen, call up your chart, plug into the satellite to see what the latest hazards to navigation might be, and you are in business. And other marvellous things are on the horizon. But big is not always beautiful, and we have heard at this conference that some very small things can have some very large payoffs.

However, we really don't have any choice when it comes to technological change. It will happen. To remain competitive and for our industry to grow, we have to both develop and adopt new technology of every kind. The only choice open to us is whether we take up the challenge and become leaders, or whether we become followers — to stand still in this area is to lose ground. We have the expertise; we need the will, the collective commitment to get on with the job. The responsibility is a collective one. Fishermen and processors have to assume responsibility for providing for their own futures. And government must assist and work with the industry.

Perhaps this conference, jointly sponsored by the two levels of government — the federal government and the five Atlantic provinces — is an example of the kind of commitment that exists and can be tapped. Together we are entering a new era in the field of fisheries technology, an era of new developments in computer simulation and monitoring, underwater video, flume tanks, etc. It might be said that the need to change and to adapt to change has been recognized because we have had to accept the requirement to be cost effective and to better utilize the resource. And the intelligent use of technology is an important factor in achieving these two objectives.

The general advances taking place in electronics, computers, marine engineering, etc., all contribute to our ability to develop and adapt technology to the fishery. We have the tools, the knowledge, the will, but perhaps we need a game plan. And of course, technology is not the only factor here, but definitely a major one. There will be tradeoffs involved as change occurs, but that does not mean we should back away from them. It argues that we should work harder to better understand just what is happening and just what tradeoffs really are required.

To summarize, then, we have no choice regarding technological change; but certainly a choice in how quickly we move forward and whether to lead or to follow. But that is not a choice, that is a challenge — the challenge we should all take away from this conference!

Thank you, very sincerely, to all who participated in our conference, most particularly, to the speakers. I am sure they were well rewarded by the reception they received here.

I would like also to thank the organizers. And I would like to say that we have had a very successful conference. There have been the usual fringe benefits from an event like this one, people meeting, talking, sharing ideas — a very important part of the communications process.

I have thoroughly enjoyed the small part I have had to play and the opportunity to meet and renew acquaintances with so many of you attending. I wish you all a safe journey home and look forward to other occasions of this kind in the future.

AFTC Overview/Wrap-up Session chaired by DFO Deputy Minister, Dr. A. W. May. Speaker for the Session was Peter Hjul, Editor, Fishing News International. Seated at the Head Table (facing delegates) are many of the Conference speakers, participants in a final question and answer period which was also part of the Session.

APPENDICES

Appendix A — Agenda

MONDAY — APRIL 22, 1985
Evening

14:00 – 20:30 *Registration*

20:00 *Opening Announcements*
F.L. Slade, Conference Organizer
Welcoming Address by:
The Honourable R. Pratt*
Minister of Fisheries
Prince Edward Island
*Mr. Pratt was introduced to the delegates by:
Robert Johnson, Area Director
Department of Fisheries and Oceans
Prince Edward Island

21:00 – 22:30 *Reception:*
Hosted by the five Atlantic Provinces

TUESDAY — APRIL 23, 1985

08:30 *Opening address by:*
General Chairperson
A.W. May, Deputy Minister, Fisheries & Oceans

09:00 *Introduction by:*
Mr. Claude LeBouthillier, Regional Manager
Department of Fisheries and Oceans
Caraquet, New Brunswick
— *Speaker:*
Donat Lacroix, New Brunswick inshore fisherman
— *Topic:*
— *Fishermen, as Businessmen, Cannot Ignore Technological Change*

09:30 *Session Chairperson:*
— R.A. Andrews, Deputy Minister — Newfoundland
Session Topic:
Fishing Gear and Equipment
International Perspective
— Speaker:
Ulrik Jes Hansen — North Sea Centre, Hirtshals, Denmark
— *Title:*
Trends in the Development of Fisheries Technology in Scandinavia

10:15 Break

10:45 — *Speaker:*
Duncan Amos — Director, Marine Advisory Service, University of Rhode Island, U.S.A.
— *Title:*
General Overview of Developments in Trawl Gear and Fisheries Electronics

11:30 Canadian Perspective
— *Speaker:*
David Tait — Fishing Gear Consultant — Halifax, N.S.
— *Title:*
Trends in the Development of Fishing Methods and Gear
— *Speaker:*
Philippe Fontaine — Coordinator, Harvesting, Dept. of Agriculture, Fisheries and Food, Quebec
— *Title:*
Trends in Canadian Fisheries Technology

12:30 *Session Chairperson directs discussion*
Topic: Fishing Gear and Equipment

13:00 Lunch Break

14:00 *Session Chairperson:*
D.A. MacLean, Deputy Minister, Nova Scotia
Session Topic:
Handling and Holding of Fish on Vessels
International Perspective
— *Speaker:*
Karsten Baek Olsen — Ministry of Fisheries, Denmark
— *Title:*
European Fish Handling and Holding Methods

14:30 — *Speaker:*
Per Stromberg — President, Per S. Stromberg Limited, Norway
— *Title:*
International Trends in Fish Containerization

15:00 Canadian Perspective
— *Speaker:*
Ian Langlands — Vice-President, National Sea Products Limited
— *Title:*
Boxing Systems on Offshore Trawlers

15:30 — *Speaker:*
F.L. Slade, Director
Fisheries Development Branch, DFO, Nfld.
— *Title:*
Practical Applications for Improving Fish Quality and Handling on Inshore Fishing Vessels

16:00 Break

16:30 — *Speaker:*
Glen Etchegary — Vice-President,
Harvesting, Fishery Products International
— *Title:*
A Containerized Holding System for New Trawlers and a Computerized Fish Operations Monitoring System

17:00 — *Speakers:*
Ken Rodman — Chief, Engineering Services
Chris Cooper — Naval Architect,
Fisheries Development Branch, DFO, N.S.
— *Title:*
Fish Handling and Storage Onboard Fishing Vessels

17:30 *Session Chairperson directs discussion*
Topic: Handling and Holding of Fish on Vessels

18:00 Dinner

19:30 *Informal discussion sessions:* experts will be available to answer specific questions from delegates.

WEDNESDAY — APRIL 24, 1985

08:30 *Introduction by:*
F.L. Slade, Director
Fisheries Development Branch, DFO, Nfld.
— *Speaker:*
R. Bulmer, President,
Fisheries Council of Canada
— *Topic:*
The Application of Technology to the Cost/Price Problem in the Marketplace

09:30 *Session Chairperson*
Harry O'Connell,
Deputy Minister, P.E.I.
Session Topic:
In-plant Operations
Canadian Perspective
— *Speaker:*
Robert Verge — President, NewLantic Group
— *Title:*
Need for Change in Technology and Management of Fish Processing

10:30 Break

11:00 International Perspective
— *Speaker:*
Dr. Francis Clark, President,
Clipper Seafoods, Scotland
— *Title:*
The U.K. Fish Processing Industry

11:45 — *Speaker:*
Jack Graham — Chief, Engineering Section,
Torry Research Station, Scotland
— *Title:*
New Technology for In-Plant Processing

12:30 *Session Chairperson directs discussion*
Topic: In-plant Operations

13:00 *Luncheon* hosted by Department of Fisheries and Oceans, Master of Ceremonies — H. O'Connell, Deputy Minister, P.E.I.
Address by:
Mel Gass, Parliamentary Secretary to the Minister of Fisheries and Oceans
Introduction by:
A.W. May, Conference Chairperson

14:30 *Closing Session:*
Speaker:
Peter Hjul — Editor,
Fishing News International
— *Topic:*
The Fishing Industry of the Future

15:00 – 16:30 *Conference Wrap-Up:*
Dr. A. W. May

Appendix B — Speaker's List

Mr. Duncan Amos, Director
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Mr. Philippe Fontaine
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