Energy and Fish Harvesting

— conference proceedings

Coordinator: Walter G. Scott
Naval Architect
ACKNOWLEDGEMENT

Walter Scott, who organized and chaired the conference which is recorded in these proceedings, died very suddenly in February of this year. Walter was well known as a naval architect with a wealth of expertise in matters relating to the fishing industry. As well, he was an accomplished artist and musician.

He recognized, before most, that rising energy costs would play a significant role in fishing operations, and he undertook a number of projects aimed at improving the energy performance of the harvesting sector. The fact that the conference on Energy and Fish Harvesting was such a successful undertaking was a direct result of Walter's determination and tireless devotion. We therefore dedicate these proceedings to him.

David Lemon
Fisheries Development Branch
Fisheries & Oceans
Halifax, N.S.
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N.S. Dept. of Fisheries

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AUSSI DISPONIBLE EN FRANCAIS
CONFERENCE WELCOME
by T.J. Hayes
Director, Fisheries Development (Maritimes)
Department of Fisheries and Oceans

It gives me great pleasure to welcome all of you here today to our Conference on Energy and Fish Harvesting. In addition, a special welcome is in order for all of our out-of-town guests. Sponsored by the Department of Fisheries and Oceans this is a first step in taking a serious look with industry at the harvesting energy situation. The express purpose of the conference is to provide a focus on the potential effects of ever rising energy costs on the harvesting sector of the fishing industry and to generate discussion on potential solutions to these problems.

We are extremely happy today with the response that we have had to the idea of organizing this conference. This is evidenced by the fact that we have 24 speakers who will be making presentations on a wide variety of energy related topics during the next two days. The Moderators have been carefully chosen to ensure productive technical sessions.

I would ask that all of you please take note that the conference proceedings including the discussions are being recorded for a publication at a later date. Therefore, please use the microphones provided at all times including the open discussions.

OPENING ADDRESS
by Dr. A.W. May
Assistant Deputy Minister,
Atlantic Fisheries Services
Fisheries and Oceans Canada

Mr. Chairman, Ladies and Gentlemen, if there has been one well-used phrase in the fishing industry over the past decade it is perhaps “the challenge before us”. In fact we have been challenged so often that some of us are getting a little bit punchy. But in the past that phrase has been used with respect to such issues as attaining the 200 mile limit, allowing the fish stocks to rebuild, achieving consistently high fish quality, and so on. Today, really, is no exception. We again face a challenge and it is one no less crucial than some of the ones I just mentioned. We have to identify and we have to implement measures to reduce energy costs in the East Coast fish harvesting sector.

The first step in meeting this challenge must be a thorough and honest acceptance of the potential scope of the problem. Here in Canada we perhaps have developed a false sense of security. Federal Government subsidies on imported oil have protected us from the enormity of the energy crisis. While most of the world’s attention has focused since 1973 on the growing power of OPEC we have been occupied and preoccupied with the rehabilitation of our fisheries. That rehabilitation and the resulting increase in catch rates has perhaps offset, at least to some extent, the increasing energy costs and softened the impact of rising costs of other kinds.

However, while we were reaping the benefit of the 200 mile limit and sensible conservation measures Canadian diesel oil prices tripled between 1973 and 1980. Now that the rate of improvement in catch rates in most instances has leveled off and will be leveling off we have to accept the reality that energy prices have not and will not, and we can no longer afford to be complacent on that issue if indeed we ever were.

Our National Energy Program makes it quite clear that Canada is headed toward the world price for oil. The impact of those increases can no more be avoided by the fishing industry. The problem is out of our hands; we can, however, help in determining solutions.

In order to succeed, we must work together and be prepared to listen and learn from those who have begun to deal with the problem and be willing to make changes in traditional attitudes and in fishing practices.

This conference is a beginning. Over the next two days we have, you have, the opportunity to lay a solid foundation from which to build a sensible, reasonable and, I remind you, absolutely essential energy conservation program for the East Coast fishing sector.

There are several sessions planned over the next two days; the first will assess the current situation and draw on the views of all sectors of the industry. Before we can begin to find solutions we must know how the problem is perceived by fishermen, by processors and by Governments.

The next step is to focus on the investigative work already done on monitoring and improving energy use. In this area we are most grateful for the participation of international experts who have joined us to share their experience and knowledge. Having been faced with world oil prices for a number of years, nations such as Norway and Great Britain for example, have been forced to deal with the impact of these prices and have made substantial headway in research and development for their particular fisheries.

On behalf of all Canadian participants, I went to welcome our international guests, and thank them in advance for their contribution to this conference.

The third aspect of the discussions over the next two days will be a series of presentations on the influence of various fishing operations on energy performance and, finally, a session on future prospects for developing a more energy-conscious industry.

But there is another aspect to this conference that will not be found on any agenda. It is a commitment that we are serious about dealing with
this issue. We can spend the next two days talking about it, analysing it, and making plans for the future. But it will mean little more than two days away from your fishing boats, or telephones or desks unless collectively there is a determination to break the back of this problem. And if we don’t break it, I can assure you that it will probably break us. We either find ways to reduce energy consumption in the harvesting of fish or before too many years, it may not be economically viable for many fishermen to put to sea. Unless ways are found for small inshore and midshore fishermen to reduce their energy costs, we will make a mockery of the policy of encouraging an independently-owned fleet. It would be something like expecting a taxi driver to make a reasonable living with the basic ground rule being that he must drive a Cadillac.

A few years ago, on an occasion of this sort, I used the phrase that I thought was a self evident truth to illustrate a point, and it has been quoted back to me many times; I said you can not catch the same fish twice. Maybe I can add to that today, you will not even try the first time if it costs 50 cents to catch it and it sells for 25. That is the extreme, but the point is no less true; we have to reduce the cost of fishing or fishing may not be worth the trouble. Fleets have had to tie up in the past because costs exceeded the economic return.

Attention to energy consumption in the fishing industry is not a program of course in isolation from other goals within the industry. I mentioned earlier that one of the challenges already being faced is that of producing consistently high quality fish. To this end, we must recognize that certain fishing methods, such as longlining, Scottish seining, and Danish seining not only produce better quality but are also fuel efficient and must be encouraged.

Over the next two days we will learn that significant results in energy reduction do not necessarily depend on major modifications or sophisticated costly equipment. We can begin with a reduction of 5-10 per cent in fuel usage immediately through an education program on more fuel efficient operational practices coupled with minor modifications to vessels and gear. That alone, simply doing things a little better than we are doing without changing anything very much, can represent a potential saving of up to $10 million by the end of this year.

As will be pointed out during the course of our discussions, another five per cent annual reduction in fuel can be achieved through conversion to fuel efficient fishing methods, use of modified and newly-developed fishing gear and the gradual introduction of fuel efficient vessels. It cannot all be done overnight, but every little bit will help. A penny saved in this instance is a penny earned, and with fuel prices expected to increase by at least 15-20% annually for the next five years, there is no doubt that pennies will count.

I think it must also be clear or be made clear that any measures undertaken in the name of fuel economy must not result in an increase in harvesting capacity. Our goal remains to ensure a reasonable return for fishermen, and any increase in capacity, which in some instances is already over-extended, defeats that purpose.

Achieving cost reduction will require rethinking at a number of levels. The Department of Fisheries and Oceans, for example, is re-examining its fishing vessel subsidy program for ways in which it can be restructured to provide incentives for quality-oriented procedures and equipment. There is potential in this program for us to also incorporate incentives toward fuel efficiency and we are examining the program with that goal in mind.

On the part of fishermen I believe there must be a fundamental change in the nature of competition between vessels. Traditionally, the criteria for success has been who can catch the most fish the quickest. I suggest at least one new criterion for success will be who can catch the best fish on the least fuel.

There must also be increased emphasis on design, repair, and maintenance of gear, such as synthetic ropes and netting which are made from petroleum products and are therefore subject to the same kind of cost increased as the petroleum itself. The Department of Fisheries and Oceans recognizes that the great bulk of research and development required to make sensible decisions on energy conservation measures is beyond the means of the fisherman. We accept the lion’s share of the responsibility to undertake the required research; however, our efforts will be meaningless without the cooperation of the fishing fleets in allowing us to monitor their activities as they relate to fuel consumption and their agreement to provide us with the necessary feedback to enable us to make recommendations on ways to better utilize the fleet and reduce energy costs.

We have some ideas to put forward over the course of this conference. Those, as well as your ideas, will be discussed and debated over the next two days. So let’s get on with it with an open mind and firm in the resolve that this challenge, like other serious challenges in the recent past, can and will and must be overcome.
The purpose of the first session of the conference is to outline the situation as it currently exists in the Atlantic Fisheries. In total, the individual presentations will present a composite look at the fishing industry itself with possibly only a side glance at the role energy involvement plays in overall resource utilization.

The following sessions will address specific aspects in greater detail. The usefulness of what is being attempted here can only be assessed following careful reflection on all the points raised and discussed during the Conference. I believe that it would be unrealistic and useless for us to look at individual presentations as being anything more than small sections of a comprehensive background that is being constructed.

Because I am a representative of a provincial Department of Fisheries I would like to emphasize the provincial viewpoint that this type of examination is very important provided everybody accepts the obligation of accomplishing some definable benefit from our joint efforts. At the risk of repeating something already said I suggest that we try to avoid the danger of setting our objectives either too high or too low, but rather bring a focus to bear on some very basic considerations. Even when one remembers that the total world catch of fish is something in the order of 60 million metric tonnes annually the combined Canadian Atlantic Coast harvesting effort is very significant — significant in terms of providing major economic stimulus and also in terms of being an activity wherein even gradual improvement in energy utilization can reflect in tremendous savings.

The fishery in Atlantic Canada comprises many different species and is dependent not only on this fact but also on upon geographical considerations and a wide range of harvesting methods, many of which are quite intensive users of mechanical energy. While many experts are predicting major changes in fishing methods in years to come, including the greatly increased use of passive gear such as huge moored traps instead of the currently popular active gear such as trawls and seines, it seems almost certain that gas and oil fueled internal combustion engines will have a major role to play in our Atlantic fisheries for many years to come.

If we need some measure to indicate just how important it is to look for means to conserve the way in which our energy resources are utilized, I would point out that there are in excess of 10,000 boats of more than 30 feet in length involved in the Atlantic Coast fishery of Canada. Even a 10% saving in fuel used would have a tremendous influence on the viability of many of these enterprises and would of course contribute greatly to national energy conservation efforts.

Provincial interest in the matters involved in this seminar is very high; already positive although limited results have been achieved through utilization of existing industrial development program. We hope that when the seminar results and conclusions have been distributed, both the Federal and the Provincial representatives of Government will be more fully informed and therefore better able to combine their efforts with those of industrial representatives towards better use of energy, both at sea and in land based operations.
ENERGY USE BY THE INSHORE SECTOR
THE PROBLEMS . . . THE OPPORTUNITIES
by Cecil Shaw
Eastern Fishermen’s Federation
Halifax, N.S.

At present, there are about 20,000 inshore fishing boats in the Maritimes. At least half of them are operated by full-time fishermen and therefore, burning anywhere from 1500 gallons of diesel fuel a year to 4000 gallons of gasoline. In addition, we use an average of 15-20 gallons of oil in a season. In total, it represents a substantial amount of non-renewable energy and a tremendous expense.

We do realize that our sector must look to more efficient use of this energy and we are aware of the fact that there are many opportunities for saving in the way we operate. But, we do not necessarily look to the naval architect to solve our problems, nor do we consider that the design of our boats is even the major problem. There are several areas where we do look for advice in cutting waste, and that is the objective of this presentation.

The following is a list of such areas, with summaries of the type of solutions we are looking for:

1. Design of propellers
   – Better use could be made of new materials:
     – fibreglass
     – stainless steel
     – etc.
   – Evaluation of a higher torque propellers
     – Could give a 5% increase in efficiency

2. Use of Kort Nozzles
   – Design of nozzles for small boats
   – Better use of new materials; fibreglass, etc.
   – Evaluation of movable nozzles
     – Makes the rudder unnecessary
   – Evaluation of fuel savings
     – Could be as great as 15%
   – Evaluation of increased towing power
     – Save on engine size

3. Greater Reduction Ratio Gears
   – Could swing a larger propeller
   – Greater efficiency
   – Save wear and tear on parts
   – Reduce fuel consumption

4. Encourage Greater Use of Diesel
   – Greater efficiency
   – Lower fuel consumption, 50-60%
   – Greater torque under load
   – More hours to the gallon
   – Lower maintenance costs
   – Cheaper fuel
   – Preferred insurance rates
   – SAFER!

5. Improve the Training Facilities
   – Changes and advances will require better

fisheries training programs
   – Better use of existing provincial training facilities, work on their own engines
   – Installation of fuel consumption meters
     – even vacuum gauges!

6. On-hand Advice for New Boat Buyers
   – How to match propeller to gear
   – How to match propeller to reduction equipment

In summary, the inshore fishermen have identified a number of areas where we are ready to change our equipment and accept new designs. It will be difficult to get many of us to change the gear we want to fish, the location of our preferred fishing grounds, or the style of our boats, but, there are areas we are ready to look at. There are areas where the federal government must help us. By working together, we can reduce the demand for costly imported oil.

One area of particular interest is the Diesel conversion program. Such a program was introduced into the Prince Edward Island fishery last year and has met with wide approval from the inshore fishermen. Details are attached here which indicate the tremendous savings which can come to both the fishermen, the government and the country as a whole. The Eastern Fishermen’s Federation requests that all provincial governments look at the possibility of implementing such a scheme, and that the federal government do likewise; this is the greatest, and most beneficial step towards fuel saving which can be encouraged throughout the industry.

DIESEL ENGINE CONVERSION PROGRAM

Summary:
This program will provide P.E.I. fishermen with an incentive to convert from gasoline to diesel engines. The diesel engine consumes less fuel and requires less maintenance than the gasoline engine. The diesel engine has a longer life and safety advantages over the gasoline engine. Vessel insurance costs for boats with diesel engines are less.

These factors will enable a fisherman, by converting to diesel, to drastically reduce his major operating expenses – fuel and maintenance costs.

To assist the industry in making this change, 50% of the cost difference between the diesel equivalent of the fisherman’s existing marine gasoline engine will be provided to a maximum of $3,500.
Objective:
To assist P.E.I. fishermen in converting from gasoline to diesel engines in existing fishing vessels thereby conserving fuel and reducing the fisherman’s annual operating costs.

Background:
One method of enhancing the economic viability of the P.E.I. fishery is to reduce its operating costs. A major component of these costs is fuel expense. With rapidly escalating fuel costs and potential fuel shortages, the industry must gear itself to more energy efficient propulsion systems.

Diesel engines consume 50% less fuel than conventional gasoline engines. Gas engines turn at high speeds, consume large amounts of fuel, and must be geared down to get the desired bollard pull and to improve propeller efficiency.

Another advantage of diesel engines is their low maintenance cost. Since fuel is injected into the engine, there is no need for spark plugs or other ignition parts. Tune-ups are not required as often as for gasoline engines and with proper care, a diesel engine has a much longer life than a gasoline engine.

Important factors in favor of the diesel engine include its closed operating system and lower operating temperatures. These features reduce the fire hazard on the vessel. Such safety features are recognized by marine insurance companies (including the Federal Department of Fisheries and Oceans) which offer lower rates on vessels powered by diesel.

Program Description:
The program will provide an incentive to P.E.I. fishermen amounting to 50% of the cost difference between the diesel equivalent of the fisherman’s existing marine gasoline engine. The program will operate for four years, to give the industry sufficient time for orderly conversion.

Implementation:
The Economics, Planning & Statistics Div. will administer the program under the direction of the program manager. Written applications will be required as per Operation Policy #13 (see attached). Each successful applicant will be required to sign an agreement with the Minister in respect to his obligation for five years. Monitoring of the program will be an ongoing process with respect to uptake by commercial fishermen and benefits derived.

Financial Considerations:
At an average cost of $12,000 for a diesel engine and $5,000 for a gasoline engine, the average incentive grant at 50% would be $3,500. Over the four year life of the program approximately 250 diesel conversions would be assisted for a total cost to Government of $875,000. Of the 250 conversions it is expected that 50 would be assisted in the first year for a total outlay of $175,000.

Benefits:
The installation of 250 diesel engines in those vessels now using gasoline will result in substantial fuel savings. Diesels consume half the amount of fuel gasoline engines consume. The average fisherman using a diesel engine will save 1,400 gallons of fuel per year over its 12 year life or 16,800 gallons. Converted vessels totalling 250 will save 16,800 x 250 or 4.2 million gallons.

Conversion to diesel engines will represent a significant financial saving to the fishermen in fuel, maintenance and insurance costs. Other benefits include longer engine life which is twice that of a gasoline engine and the reduction in “down time” to the fishermen.

(i) Fuel costs would be cut by 50% annually by conversion to diesel engines.

For a fisherman involved in the lobster, scallop and/or ground fisheries, this would represent an annual saving of 1,400 gallons of fuel,

1,400 gallons x $0.55 per gallon = $770

(March, 1980 cost/gal.)

(ii) Engine maintenance currently costs the fisherman with a gasoline engine $250 per year and a diesel engine $100. The conversion will save the fisherman an additional $150 per year.

(iii) Vessels having diesel engines receive a preferred insurance rate over those using gasoline. The saving is $1.25/1000/year. The average vessel cost is $22,000. Thus the annual saving is 22,000 x 1.25 = $27,500.

Fuel saving 1,197
Maintenance saving 150
Insurance saving 28

Annual saving per fisherman 1,375

250 fishermen x 1,375 = $343,750 annual saving resulting from the program.

Since the life of a diesel engine is 12 years, the average saving of $343,750 will be realized over the life of the engine. The total benefit to the fishery resulting from this program would be:

$343,750 per year x 12 years = $4,191,000

Total Benefit $4,191,000

Total Government Expenditure 875,000

Benefit Cost 4.7

This program is intended to benefit 250 of the Island’s approximate 1,500 fishermen. Most of the remaining 1,250 have either already converted to diesel or will be by utilizing existing vessel construction subsidy programs. Given total participation by year 5 it is expected that the Island’s fishing industry will save upwards of 1.5 million gallons of fuel annually.
DIESEL ENGINE CONVERSION PROGRAM
OPERATION POLICY #3

A. Objective:
   To assist fishermen in converting from gasoline to diesel engines in existing fishing vessels thereby conserving fuel and reducing fishermen's annual operating costs.

A. Assistance Provided:
   The Department of Fisheries will assist P.E.I. fishermen by providing 50% of the cost difference between the diesel equivalent of the fishermen's existing marine gasoline engine to a maximum of $3,500.

C. Regulations:
   (1) This policy applies only to P.E.I. fishermen who are actively engaged in commercial fishing in the province.
   (2) Written application shall be made and the Minister's approval granted prior to equipment purchase and installation. The application is to be forwarded to the Minister, P.E.I. Department of Fisheries, P.O. Box 2000, Charlottetown, P.E.I. C1A 7N8
   (3) The estimated cost of the installation must be established in advance and approved by the Minister.
   (4) Fishermen qualifying for assistance must agree to the terms and conditions as specified in an agreement with the Minister.
   (5) Each fisherman must submit all vouchers to verify the actual cost of the diesel engine (with standard equipment).
   (6) Payment (i.e. 50% of the actual cost difference approved by the Minister up to a maximum of $3,500) will be made to the applicant if he provides evidence that he has paid for the total costs incurred or jointly to the applicant and the supplier if not paid in full.
   (7) The fisherman will not sell or otherwise dispose of the diesel engine within five years except with the approval of the Minister. Failure to do so may result in repayment to the Minister of any unforgiven portion of the grant based on 20% per year forgiveness.
   (8) Only vessels between four and ten years old are eligible for assistance.
ENERGY AND INSHORE FISHERY IN NEWFOUNDLAND

by Clifford Doyle, Inshore fisherman, Nfld.

When I speak of the inshore fishery in Newfoundland, I am referring to boats under 65 feet. In that category, there are some 200 longliners or vessels over 35 feet. Under 35 feet I have heard so many different figures on the number that I will not even bother to quote one. I can tell you that it is a large number.

As a general rule, boats under 35 feet are usually powered by gasoline motors while boats over 35 feet generally powered by diesel engines. These motors range from 10 horsepower outboard motor, used in lobster fishery, to a 520 horsepower motor used in the otter trawl fishery by a 65 foot longliner.

Historically, energy was not thought of as being a serious matter. Our first fishing boats were powered by sails and wind power was rather cheap – the price of a piece of canvas: Our first engines were also very economical. These engines were old “make and break”, cheap to buy and cheap to run. There were a great variety of them, such as the old Coakers, Regals, Hubbards, Acadians, Imperials, etc. They were built to be economical for unless they were, no fisherman could afford one. These engines were improved and modified until we reached the type of engines we have today. With all of the improvements there also came an increase in the consumption of fuel. For the first twenty or thirty years this did not bother fishermen for the price of fuel remained fairly constant. Even in the middle 1960’s with a government subsidy on the price of oil the increased volume of fuel didn’t bother the fisherman. It was not until the late 60’s and early 70’s that fishermen began to see what was happening. Fuel consumption was increasing with the modification in engines and so was the price of fuel, and I might add a dramatic increase. I would imagine the same basic philosophy prevailed in the manufacture of marine engines as did in the manufacture of car engines. There was no thought for conservation or any foresight as to what would happen with fuel prices. I would imagine at that time, it was a little bit fictitious to predict oil prices of $1.10 per gallon for diesel and $1.25 per gallon for gasoline (fisherman’s price).

When we speak of fuel oil used in the inshore fishery, most people get the impression we are talking about diesel fuel. That is not true, as at certain times of year there is more gasoline burned than diesel fuel. It is probably from April to July, that we experience the greatest consumption in gasoline. During that time, inshore fishermen are involved in the seal fishery, lobster fishery, cod trap fishery, and in many areas, the Spring herring fishery. As I mentioned earlier, boats under 35 feet generally use gasoline, and most of the boats used at that time of year in those fisheries would be open boats using that fuel. With the dramatic increase in the price of gasoline, it has placed a great deal of economic pressure on fishermen especially the lobster fishermen where about 99% of the boats involved use gasoline. We have seen the price of gasoline increase from about 20c per gallon in the sixties to approximately $1.25 per gallon today. This is an increase of over 600% in about 15 years. Most of this increase has taken place in the last five years. Nevertheless, the incomes of fishermen have never been able to keep pace with their expenses.

There is one other factor with which I find difficult to deal and that is the regional price of gas and diesel in Newfoundland. There is absolutely no relationship between the price of fuel in St. John’s, Port-aux-Basque, St. Anthony and Goose Bay or Cartwright. We have a very small amount of oil that is trucked into this province. Most of it is moved by boat tanker system. If a tanker leaves a given refinery somewhere in North America and heads for St. John’s, St. Anthony, Goose Bay, etc. I find it difficult to believe that the difference in cost of transportation is enough to account for the difference in price. For example, during the last fishing season we purchased diesel oil on the Northern Peninsula of Newfoundland in August and paid 85c per gallon. During that same time, we travelled to Black Tickle, Labrador, within the same province, and paid up to $1.39 per gallon. The price was fluctuating at that time, on the Coast of Labrador, between $1.25 and $1.39 per gallon. This shows a difference of about 40c - 50c per gallon. Would it be logical for us to pass this increase on as a legitimate cost for transportation? I find that one a little hard to swallow. We also have the situation in Newfoundland and it may hold true for the rest of Atlantic Canada where the price of oil rises overnight. All our bulk stations generally fill-up in the Spring and Fall. Yet, during the year we may have a half dozen increases in the price of fuel. I’m not accusing anyone, just asking the question: Does the price station operators pay for fuel have any relationship to the price we pay for it? If so, what is the relationship and who are the guardians of our rights for fair prices. We have heard the phrase “Windfall-profits” but most of us disassociate ourselves from it and refer to it as political jargon.

There is another aspect of our inshore fishery in Newfoundland with which the price of fuel is playing a role. This aspect is the mobility of our fishermen. Traditionally, our fishermen in “small open boats” and “schooners” have fished the Gulf of St. Lawrence and North East Coast of Newfoundland, in conjunction with the Labrador Coast. We have fishermen from Trinity Bay and Bonavista Bay, who have fished as far North as Makkovik. We have had fishermen from the West Coast of Newfoundland who have fished as far North as Smokey. This
mobility of our inshore boats still holds true today and is increasing instead of decreasing. Today, we have a great number of boats that fish as far South as Port-aux-Basque and then move as far North as Black Tickle, Smokey and Makkovik. Some of our small inshore boats are the most mobile in all of Canada and may move as much as 500-600 miles in the period of one fishing season. You can very easily see that the ever increasing price of fuel is having a devastating effect on the incomes of these people. If these fishermen stay at home their income is reduced because there is a decrease in total catch. Yet, if they move away from home, their cost as a percentage of catch is rising continuously. If the price of oil continues to increase in leaps and bounds, and the price of fish does not increase at a faster rate, fishermen will not be able to sail their boats 400-500 miles to catch fish. It just doesn't make sense to expect us to do it, thereby placing the burden of society's employment problems on our back without help from anyone.

Unfortunately, as fishermen we are placed in a very precarious position with so many people expecting so much from us, and giving so little in return. The price we pay for everything has no relationship whatsoever to our incomes. Most other groups in society are able to work within the boundaries of the Cost of Living and other expenses. For example, if the cost of living increases 10% in a given year, most groups take that as a benchmark and no one expects them to settle for less. Yet in the fishery, we have never been able to get an increase that shows some relationship to our increased costs. We can never get to talk about the cost of living because other factors such as cost of energy in the fishery keep us occupied trying to keep our heads above water. Both levels of government, I might add, have not been much help in dealing with this problem. Some work has been done lately by the Federal Government but it is still far from a comprehensive energy saving program.

For many years in Newfoundland, we have been rather "backwards" in dealing with energy and its relationship to fish harvesting. For example, the policy of our Provincial loan board has always been that we should install the minimum horsepower in any boat. This has caused a great many problems, since there is no reserve of power.

1. Engines have to be replaced earlier than they normally should.
2. We have very few multipurpose boats (boats that have the horsepower to switch freely from one fishery to another).
3. Boats are operating below normal efficiency.
4. A greater than average consumption of fuel.

I am told this was proven this summer on the North East Coast of Newfoundland. The Federal Department of Fisheries engaged three boats in an experiment with the same gear, under the same operating conditions. The result was that the boat with the largest horsepower proved to be the most fuel efficient because it was under less strain. If this is not true, I stand to be corrected but if it is true, then there is not much good that can be said about the policy of our Loan Board. You may think I am a little bit off the subject, talking about the Loan Board in Newfoundland, but I just wanted to show you the burden that a Government policy can place on the backs of the fishermen. All these factors bear a relationship to fish harvesting for who ends up paying all the costs? I doubt if I have to give you three guesses.

I think the time has now come to give you some figures. It seems everyone else is doing it these days, so I suppose fishermen will have to get used to dealing with such phrases as "percentage of total catch" and "percentage of Capital Costs". There are so many different sets of figures floating around that I hesitate to use any for fear of conflicting with one or the other. We find the Federal Department of Fisheries has one set of figures and so does the Provincial Department of Fisheries. We also have such independent groups as "Fisherman's Management Services Ltd." and "Nordco" who have their own sets of figures. Now, I will confuse you more and give you a combination of all so as not to intimidate one or the other.

First I would like to give you some prices of gasoline and diesel fuel over the last few years and maybe a couple further back so as to jog your memories. In 1945, I am told the price of gasoline and diesel fuel was 15¢ and 12¢ per gallon. In 1968 it had only risen to 26¢ and 20¢ respectively. In 1975, it had risen to 45¢ and 44¢ per gallon. Then the price of fuel started to jump 5¢-10¢ at a time until today, 1981, and I emphasize it is only Spring of 1981, we are paying $1.25 for gasoline and $1.11 for diesel fuel for marine use.

1. From 1945-1968 - 23 years - approximate increase - 70%
2. From 1968-1975 - 7 years - approximate increase - 75%
3. From 1975-1981 - 6 years - approximate increase - 275%

The later figure would be about 300% increased on the coast of Labrador. These figures I'm sure are not stunning to most of you but for those of you who have not bought a gallon of gas lately to go out"turing" or "jigging", then these are the cold hard facts. These figures are hard to imagine since the price of fish has not come close to matching such increases but the reality of it is the situation where a sober man once said to a drunk: "God, you look terrible" and the drunk replied "You should see it from my side." The same situation exists with inshore fishermen, you have to see it from his side to get the reality of it.
Prices of Gasoline and Diesel Fuel

<table>
<thead>
<tr>
<th>Year</th>
<th>Fuel Type</th>
<th>Per Gallon</th>
<th>Approximate Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1945</td>
<td>Gasoline</td>
<td>per gallon</td>
<td>15¢</td>
</tr>
<tr>
<td>1968</td>
<td>Gasoline</td>
<td>per gallon</td>
<td>26¢</td>
</tr>
<tr>
<td>1975</td>
<td>Gasoline</td>
<td>per gallon</td>
<td>45¢</td>
</tr>
<tr>
<td>1976</td>
<td>Gasoline</td>
<td>per gallon</td>
<td>50¢</td>
</tr>
<tr>
<td>1977</td>
<td>Gasoline</td>
<td>per gallon</td>
<td>57¢</td>
</tr>
<tr>
<td>1978</td>
<td>Gasoline</td>
<td>per gallon</td>
<td>65¢</td>
</tr>
<tr>
<td>1979</td>
<td>Gasoline</td>
<td>per gallon</td>
<td>73¢</td>
</tr>
<tr>
<td>1980</td>
<td>Gasoline</td>
<td>per gallon</td>
<td>83¢-86¢-92¢</td>
</tr>
<tr>
<td>1981</td>
<td>Gasoline</td>
<td>per gallon</td>
<td>$1.25 (March)</td>
</tr>
<tr>
<td>1945</td>
<td>Diesel</td>
<td>per gallon</td>
<td>12¢</td>
</tr>
<tr>
<td>1968</td>
<td>Diesel</td>
<td>per gallon</td>
<td>20¢</td>
</tr>
<tr>
<td>1975</td>
<td>Diesel</td>
<td>per gallon</td>
<td>44¢</td>
</tr>
<tr>
<td>1976</td>
<td>Diesel</td>
<td>per gallon</td>
<td>49¢</td>
</tr>
<tr>
<td>1977</td>
<td>Diesel</td>
<td>per gallon</td>
<td>56¢</td>
</tr>
<tr>
<td>1978</td>
<td>Diesel</td>
<td>per gallon</td>
<td>63¢</td>
</tr>
<tr>
<td>1979</td>
<td>Diesel</td>
<td>per gallon</td>
<td>71¢</td>
</tr>
<tr>
<td>1980</td>
<td>Diesel</td>
<td>per gallon</td>
<td>82¢-85¢-91¢</td>
</tr>
<tr>
<td>1981</td>
<td>Diesel</td>
<td>per gallon</td>
<td>$1.11-$1.15</td>
</tr>
</tbody>
</table>

It is very difficult to break it down to percentages, because there are so many different factors. I should point out that crab boats operate in the same fishery. For example, “Gillett Fishery” one on the North East Coast of Newfoundland, and the other on the Northern Peninsula, both have a different set of circumstances. One boat may have six-seven hours of steaming time while the other has only two hours. Obviously, the first will burn the most fuel. Our boats, in some fishery, cannot fit into an average for all of Newfoundland but averages must be done by area. In our other fisheries, crab, otter trawling, shrimp, etc. each has different operating costs. There is only one thing on which we can generalize and that is fuel took the biggest percentage of capital costs for all sectors in 1979 and 1980. This figure may go as high as 20%-25% of total operating costs. This could be as high as 7%-8% of gross sales which in turn could amount to as much as 1½¢ per pound of fish. So it is easy to see that the price of energy is having a devastating effect on fish harvesting. Boats in Newfoundland from 55 feet - 65 feet spend from $5,000-$19,500, in fuel and oil. Boats from 35 feet - 55 feet could range from $2,600-$8,500, in fuel and oil in one year. There is a great variation in cost and it all depends on which fishery or fisheries you are involved. These figures are startling when you look at some of the incomes derived from these expenses. We must also remember, even though fuel is a great cost to fishermen, there are also many other costs. Often, the captain and his crew receive very little from the remainder of the income.

After shocking you with these figures, I would now like to close by saying that if there ever was a straw to break the camel’s back it is the cost of energy to fishermen. If something is not done to control the price of gasoline/and diesel oil/and other related oils, the inshore fishery will be destroyed. There is no way we can afford to keep fishing at today’s costs. We have seen seminars on Northern Cod, Groundfish, Atlantic Herring, this seminar and many others but each is in isolation of the other.

When are we going to see someone put all this “brain-storming” together and come up with a comprehensive fisheries policy to deal with such things as the ever increasing cost of energy. If you look at the many problems in the Gulf of St. Lawrence Groundfish Fishery, you will find that many are related to the cost of such things as energy, and the resulting decreasing incomes of fishermen. Decreasing the number of fishermen and increasing the quotas per capita, though desirable, are not the only answers to our problems. We must deal with such costs as energy, and try to get a handle on it now, not five years from now. We must deal with these basic costs to fishermen so that not so much pressure will be placed on “Volume of Catch” to deal with our income problems.

I’m sure in the next two days my points will be further stressed as others make their presentations. Thank you Mr. Chairman for this opportunity to speak on behalf of inshore fishermen of Newfoundland.
ENERGY AND FISH HARVESTING  
A PRINCE EDWARD ISLAND VIEW POINT

by Bruce Lewis, Program Manager 
Resource & Harvesting  
P.E.I. Dept. of Fisheries

The Prince Edward Island fishing fleet is somewhat unique as it is 99% inshore with respect to the number of vessels. The small boat fleet has evolved out of necessity more so than choice. There are 72 points of landing on P.E.I. with as few as two and as many as 130 boats in some harbours. Of the 72 landing points, only two fishing harbour entrances have sufficient water to accommodate vessels with a draft greater than three and one half feet. The shifting topography of the Island's sandy coastline is such that the greater number of vessels in the fishery must be shallow draft to navigate the harbour entrances thus we are inshore oriented by necessity first.

Greater than 100 feet LOA  1 vessel  
Between 65 feet and 100 feet LOA  4 vessels  
Between 50 feet and 65 feet LOA  3 vessels  
Less than 50 feet LOA  1,496 vessels  
Total Fleet  1,504 vessels

Inshore vessels on P.E.I. are characterized by their multi purpose nature. The majority of fishermen participate in the lobster fishery and at least two additional fisheries be they groundfish, scallops, herring, mackerel, Irish moss or whatever. The hull form of the typical inshore vessel can be described as a semi displacement hull. An average hull speed would be in the order of 8-9 knots; however, at full throttle many boats because of their planing characteristics are capable of speeds ranging from 12-18 knots.

The majority of the inshore fleet use gasoline engines, possibly 15-20% have diesel. The 1979 Inshore Earnings Study conducted by the Department determined that fuel accounts for 13% of the annual expense of the average inshore enterprise. The following table indicates the fuel consumption per day and per hour at sea for various fisheries.

<table>
<thead>
<tr>
<th>Lobster G. Nets</th>
<th>Otter T.</th>
<th>Scallops</th>
<th>Moss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Av. Fuel/Day</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gal. Gas</td>
<td>19.9</td>
<td>20.8</td>
<td>35.8</td>
</tr>
<tr>
<td>Diesel</td>
<td>14.0</td>
<td>17.5</td>
<td>39.6</td>
</tr>
<tr>
<td>Av. Fuel/Hour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(at sea)</td>
<td>2.7</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Gal. Gas</td>
<td>2.7</td>
<td>2.5</td>
<td>2.8</td>
</tr>
<tr>
<td>Diesel</td>
<td>2.1</td>
<td>2.7</td>
<td>2.3</td>
</tr>
</tbody>
</table>

The figures given in the table cannot be used to draw any concrete conclusions because of the small sample surveyed and the many other variables associated with gathering such information. They do indicate, however, that to an inshore fisherman the total amount of fuel consumed per day at present is more related to time at sea than to the type of fishery involved. For example, groundfish gill net fishermen are generally in port by 3-4:00 p.m. where as the inshore otter trawler returns between 7:30-8:30 p.m.

In theory one would expect clear operational influences dependant upon the type of fishing. For example jigging, longlining and gill net fishing should be energy efficient fishing methods when compared to otter trawling, pair trawling and pair seining. In other words fixed gears should demand less fuel than mobile gears. Further efficiencies can be realized within these broad categories as for example pair seining is more energy efficient than otter trawling and longlining more energy efficient than gill netting. What should happen in theory may not happen in practice particularly when influenced by individual preference and a history of comparatively low fuel prices.

We believe it is fair to state that a great number of vessel operators have a heavy hand for the throttle. "Happiness is" to many, a bone in her teeth and a tail feather breaking water ten to twelve feet astern. This of course does little to conserve energy, and is rather an expensive habit. As costs in general increase fishermen are forced to pay more attention to their business expenses. Energy is an expense the individual can economize on.

Ever increasing energy costs may eventually motivate all fishermen to ease back on the throttle. When that day arrives fishermen will give more serious thought to the factors he can control that relate to energy usage. The following comments relate to those major areas we believe provide an opportunity to fine tune the fisherman's energy requirements:

1. Vessel design
2. Type of engine (gas versus diesel)  
3. Propulsion Systems (nozzles and C.P. Propellers)  
4. Method of fishing  
5. Fishery Management

1. Vessel Design

Vessel design has always been an important development area for the fishery with changes relating to the introduction of advanced technologies. In the future energy will be an even greater motivator for new hull forms. On Prince Edward Island new vessel designs must be cognizant of the influence of

10
the shallow harbour entrances common to most island ports.

While our traditional vessel designs permit the luxury of speed they do little to enhance seakeeping quality or the efficient use of energy. A number of fishermen do make a conscious effort to reduce fuel consumption at present simply by running at lower engine r.p.m.'s. However, when the traditional Island vessel is loaded with fish the rate of fuel consumption increases substantially above that level which a more appropriate hull form would demand. We see this as an area for development and expect new energy efficient hull forms will enter the fishery as the cost of fuel increases.

Two important factors affecting hull design are tradition and government policy; tradition is difficult to change. Government policy such as expressed by the Vessel Subsidy Program or the Groundfish Management Policy with its existing freeze on licences and size of replacement hulls will seriously influence vessel design. However, it is entirely possible that ever increasing energy costs may supercede the influence of the above noted factors. For example, why should an Inshore fisherman sail a 45 foot vessel capable of carrying 20,000 lbs. of fish to the fishing grounds every day for an average pay load of 1,500 lbs. of cod.

Increasing costs in general and that of energy in particular may be the catalyst to a better rationalization of vessel design to the use intended.

2. Type of Engine

Regarding the type of engine, there is a more noticeable trend these past two years on P.E.I. toward replacing gasoline with diesel engines. For many fishing enterprises the diesel has had a number of benefits such as reduced fuel cost per gallon and consumption per hour, greater replacement age, lower annual maintenance expense, and a minor saving in vessel insurance premiums. The average replacement age of a gas engine in the Island fishery is four years while that of the diesel is seven years.

The decision to convert to diesel must be an economic decision and will not suit every fishing enterprise particularly as the costs are changing. So far, the average six cylinder diesel engine costs slightly more than twice the cost of a six cylinder gasoline engine ($9,500:$4,500) and similarly with eight cylinder engines. The price of fuel is, however, changing as the following figures indicate and the trend to higher prices for diesel fuel is expected to continue. As the demand on diesel fuel increases so will the price.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug. 1977</td>
<td>$0.720</td>
<td>$0.607</td>
<td>8¢</td>
</tr>
<tr>
<td>Aug. 1978</td>
<td>$0.774</td>
<td>$0.692</td>
<td>8¢</td>
</tr>
<tr>
<td>Nov. 1979</td>
<td>$0.871</td>
<td>$0.794</td>
<td>8¢</td>
</tr>
<tr>
<td>Mar. 1980</td>
<td>$0.918</td>
<td>$0.857</td>
<td>6¢</td>
</tr>
<tr>
<td>Mar. 1981</td>
<td>$1.260</td>
<td>$1.220</td>
<td>4¢</td>
</tr>
</tbody>
</table>

Interest rates fluctuate and more recently not for the better. P.E.I. fishermen with adequate security can borrow money at the prime rate for short term loans (18.25%) and 14.25% for long term loans from the Provincial Lending Authority. The fact that fuel costs are rising and interest rates change simply illustrates that careful consideration must be given before any decisions are made on the type of engine.

3. Propulsion Systems

The recent increase use of G.R.P. as a building material for inshore vessels will greatly extend the working life of the inshore fishing vessel. Given a longer vessel life what may appear at first hand to be expensive adaptations could very well prove economical particularly in terms of energy consumption. Here we refer to the introduction of the Kort Nozzle and the Controllable Pitch Propeller. Both devices should provide advantages in terms of energy consumption as well as fishing efficiency.

The C.P. propeller in particular can better match the blade to the job at hand as it can be adjusted for towing or steaming. The standard propeller is simply an acceptable compromise on two points of efficiency. The additional towing power afforded by both can provide the advantage of possibly a smaller engine or using a larger net. A Kort nozzle and a controllable pitch propeller will be evaluated on two inshore vessels on P.E.I. during the 1981 fishing season.

4. Method of Fishing

The fishing method is another area that can influence energy costs; this is a generally accepted point of view. The figures quoted on page two of this paper indicate the method of fishing that gives the shortest time at sea is to date the energy saver. Thus it would appear that hours at sea and not gallons per hour are the factor in the inshore situation at present. It is possible that for most fishing enterprises such is the case. This does not, however, mean that operational differences cannot affect in a positive way the fuel consumption in gallons per hour. As long as steaming time is carried out at full throttle fuel consumption will be high. This means that a gill net fisherman who races out to his gear, races from one set to the next and then races back to port can expect to burn as much fuel per hour over the fishing day as the otter trawler who is running steady all day. If the gill netter were to reduce his engine r.p.m.'s to the most efficient level his fuel consumption per day and per hour would
show an improved decrease. Much of the responsibility therefore in terms of energy consumption is strictly in the hands of the vessel operator.

Otter trawlers and scallopers have very little down time as far as the engine is concerned during any fishing day as compared to a gill netter or a longline fisherman. One would assume that the horsepower requirements of the otter trawler are in balance with the size of net and doors being towed. It would appear that otter trawlers which tow at ½ steaming r.p.m.'s could either take advantage of a smaller engine or tow a larger net. This is possibly another area that can use fine tuning in terms of energy.

One aspect of fishing methods previously referred to is that of pairing smaller vessels as a pair seine or pair trawl combination. The feasibility of these operations was demonstrated when fuel prices were less critical than they are today. The economic advantages associated with pairing should be even greater given rising fuel costs.

Upon reviewing the opportunity areas for development of energy efficiencies it becomes evident that what is being sought, in effect, is a balance between the various inputs. The vessel design, the type and horsepower of the engine and the propeller adaptations must be in balance with one another and this combination in balance with the task required. In a multi purpose fishery this fine tuning becomes somewhat less effective as the maximum requirement for all factors may only be useful for 25% of the vessel's fishing year.

5. Fishery Management

Management of the fisheries is in part the allocation of available resources to competing elements within the harvesting sector. Within this framework there has been a demonstrated preference given to inshore vessels. Inshore vessels on P.E.I. are dependant upon the fish coming to them and not the opposite. As the cost of energy per pound of fish increases the value of harvesting the resources available with inshore vessels will increase. Energy therefore will play a deciding role in the development of future resource management decisions.

Rising energy costs could change the entire complexion of the industry. Rising costs and static prices for fish at dockside are forcing fishermen to sharpen their pencils and look for ways to increase the narrow gap between expenses and returns. Energy usage provides a number of areas for improvement. The Province of P.E.I. will endeavour to assist the transformation to an energy conscious future fishery.
ENERGY UTILIZATION: OFFSHORE VESSELS AND PROCESSING PLANTS

by Lester G. Riche
V-P, Fisheries Products Ltd.
St. John's, Nfld.

First, let me put into perspective the Company I represent to give you some idea of our scope and possible problems vis-a-vis energy.

Fishery Products Ltd. operates nine major fish processing plants with an employment in processing of over 5000 employees at peak periods. Our capacity to freeze collectively per eight hours is about 500,000 lbs. This requires fully maximizing machinery to get highest possible production. The amount of processing machinery and freezing are large in our Company, and effective production dictates maximizing full use of machinery and equipment. In addition to the nine main processing plants, we operate 42 deep-sea vessels, all in excess of 140 feet. These vessels, if operating full time, could make about 1500 trips per year to the fishing grounds, lasting 10 days each and ranging anywhere from six hours to 48 hours steaming time to reach the fishing grounds.

Collectively then, our demand for and use of energy is quite significant. In our Company, the use of energy and methods of conservation and proper utilization are of paramount importance. Other than attempting to sort out Government fishing policy, the effective use of energy and its proper conservation causes us major concern.

Energy in Fish Harvesting

In the operation of a large trawler fleet such as ours, we, of course, monitor regularly energy consumption as it relates to fish catching. The following table shows how our costs relate to catching for the period 1960-1979.

<table>
<thead>
<tr>
<th>Year</th>
<th>Fuel Costs/lb. in cents/lb.</th>
<th>Lube Costs/lb. in cents/lb.</th>
<th>Landings in millions lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>.46</td>
<td>.04</td>
<td>25</td>
</tr>
<tr>
<td>1961</td>
<td>.45</td>
<td>.03</td>
<td>33</td>
</tr>
<tr>
<td>1962</td>
<td>.47</td>
<td>.04</td>
<td>24</td>
</tr>
<tr>
<td>1963</td>
<td>.47</td>
<td>.04</td>
<td>24</td>
</tr>
<tr>
<td>1964</td>
<td>.47</td>
<td>.04</td>
<td>24</td>
</tr>
<tr>
<td>1965</td>
<td>.47</td>
<td>.04</td>
<td>24</td>
</tr>
<tr>
<td>1966</td>
<td>.47</td>
<td>.04</td>
<td>24</td>
</tr>
<tr>
<td>1967</td>
<td>.49</td>
<td>.09</td>
<td>63</td>
</tr>
<tr>
<td>1968</td>
<td>.65</td>
<td>.11</td>
<td>50</td>
</tr>
<tr>
<td>1969</td>
<td>.74</td>
<td>.12</td>
<td>63</td>
</tr>
<tr>
<td>1970</td>
<td>.82</td>
<td>.10</td>
<td>56</td>
</tr>
<tr>
<td>1971</td>
<td>1.01</td>
<td>.14</td>
<td>64</td>
</tr>
<tr>
<td>1972</td>
<td>.82</td>
<td>.10</td>
<td>56</td>
</tr>
<tr>
<td>1973</td>
<td>1.01</td>
<td>.14</td>
<td>64</td>
</tr>
<tr>
<td>1974</td>
<td>2.37</td>
<td>.21</td>
<td></td>
</tr>
<tr>
<td>1975</td>
<td>.82</td>
<td>.10</td>
<td>56</td>
</tr>
</tbody>
</table>

It is quite obvious from this brief analysis that our energy costs per pound have escalated substantially from the mid-seventies on. The early rise in costs from the late 60's to the late 70's relates directly to the catch/unit of effort. However, from 1978-79 our costs relate more to increased energy costs than fish availability. Catch rates per vessel in the late seventies and eighties indicate that fuel prices per pound of fish caught are not increasing as fast as the escalating price of fuel. With improved catch rates in certain areas, our fuel costs per pound are lower than anticipated, but putting the mid-seventies catches into 1980 costs, the figure could easily be three to four times that shown.

The above statement is made for the average yearly consumption per pound of fish caught. However, if one did an analysis of fuel costs per trip, we would show costs escalating much higher than three cents per pound toward the last end of the season as catch rates decline and exploration becomes more extensive.

In terms of fuel purchases, our trawlers use approximately 7.2 million gallons per year. With this amount of utilization, we must be concerned with the proper use and conservation of fuel to maintain costs of the finished product.

To help us better utilize fuel, the company is attempting several projects. The first is a proposal made to the Department of Mines and Energy. This program would involve a pilot project to accurately monitor trawler performance under different operating loads. To assist in this series of projects, we propose to use a micro-computer based system recently developed and applicable to marine engineering. To the best of our knowledge, this system has never been utilized in the Atlantic trawler fleet. To date, we have not had a reply from Mines and Energy, however, preliminary indications are that it will be accepted and implementation can begin.

In addition, we are implementing a program to use a fuel catalyst to obtain better combustion. Also, two new trawlers at present under construction will be installed with a heat recovery system to extract heat from exhaust stack gases. Our Company monitors regularly, on a trip basis, fuel consumption and is investigating methods to work with Captains to reduce fuel use.
Fish Plants

In terms of fish plants, as outlined earlier, our volume and size are large and energy consumption is high. It must be realized that all of our plants, with the exception of one, were built prior to 1970 and as such, were not built with energy conservation as a factor. At that time, energy was cheap. To assess where we are, we continue to monitor energy use.

Figure 1 shows a breakdown in cost of energy – fuel and electricity for plants for the period 1971-1978. It can be seen that cost of energy escalated quite substantially after 1976. While electricity has stabilized, fuel costs continue to rise.

SERVICES UP 325% (BILL IS 4 TIMES THAT OF '75) - ASSUMING SAME YIELD FROM RAW MATERIAL
Table 1 shows the average market price for fish fillets – 1975 and 1979.

<table>
<thead>
<tr>
<th>Product</th>
<th>1975</th>
<th>1979</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cod:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Block</td>
<td>.60</td>
<td>1.03</td>
</tr>
<tr>
<td>Fives Bone in</td>
<td>.62</td>
<td>1.00</td>
</tr>
<tr>
<td>Ones</td>
<td>.72</td>
<td>1.03</td>
</tr>
<tr>
<td>Tails</td>
<td>.92</td>
<td>1.35</td>
</tr>
<tr>
<td>Average</td>
<td>.71</td>
<td>1.10</td>
</tr>
<tr>
<td>Flats:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Block</td>
<td>.62</td>
<td>1.15</td>
</tr>
<tr>
<td>Ones</td>
<td>.83</td>
<td>1.46</td>
</tr>
<tr>
<td>IQF 4 oz. and over</td>
<td>1.17</td>
<td>1.80</td>
</tr>
<tr>
<td>Average</td>
<td>.87</td>
<td>1.47</td>
</tr>
</tbody>
</table>

In 1979, production in F.P. plants had increased by 100 per cent over a period of four years. Over the same period, the net return from the market product, mainly cod and flatfish, had increased approximately 55 per cent. During this same time period, the cost of services, as indicated in Figure 1 had increased by 325 per cent. The rising cost of services has surpassed the market price increases of the main products by about 2.5 times for flats and about 3.1 times that of cod. Based on current trends, assuming the same production and fuel consumption as that of 1979, our fuel costs will double from the present level. Electricity costs will rise from the present 1.4 million per year to 3.0 in 1985. (This assumes a 15 per cent rate increase on electricity).

From the above, one can foresee that costs to process fish will escalate substantially in the future, based on increased energy costs alone.

To attempt to reduce energy loss in rather old plants, we are continuing programs to upgrade machinery such as compressors, boilers, pumps, etc. These are items which did not require insulating in the past. Also, buildings are being refurbished and upgraded with insulation wherever economically feasible.

We have also proposed to government, a program involving retrofitting. Through a study carried out by Shawmont Nfld. Ltd. we have demonstrated that we have high energy losses due to infiltration and conduction. Our company is now ready to retrofit a plant in an attempt to significantly reduce energy loss and provide the proof that saving will justify large investment. When retrofitting a plant building, insulation factors would be upgraded, stratification fans would be installed, energy user controls would be improved for better management and infiltration would be decreased by upgrading building maintenance and making more changes to buildings.

The wise use of electricity and fuel oil in the catching and processing of fish will continue to be a main area of concern. In fish harvesting, we are left with few alternatives than fuel, and to maintain costs we must be more efficient. On the processing side, electricity as an energy source may be a future alternative if it can be provided at a consistently lower rate.
FIGURE 2 SHOWS PRODUCTION VOLUME FOR PERIOD 1976-1979. IT SHOWS THAT THE VOLUME OF PRODUCTION HAS SHOWN A 100 PER CENT INCREASE OVER THIS PERIOD. THIS RELATES TO SOME DEGREE TO THE ACQUISITION OF A MAJOR PLANT.

Figure 2

PRODUCTION IS UP 100% FROM 1975
- ASSUMING SAME YIELD FROM RAW MATERIAL

YEAR

FILLET PRODUCTS (lbs.)


80 x 10^6
70 x 10^6
60 x 10^6
50 x 10^6
40 x 10^6
Even before the words "Energy Crisis" became of common use, fishermen operating in the Gulf of St.-Lawrence were practising a certain form of energy conservation that could be summarized as follows: "What you do not have to do onboard should be done ashore". This general rule also applied of course, to fishermen elsewhere that had similar operating conditions.

The main reasons at the time for acting that way were first to limit the construction cost of the fishing boats, second to save on the boat maintenance costs, and third have things that had to be done with power done as much as possible ashore using the usually much more economical power as supplied by the public utility firms. As an example, in 1979, it was costing Hydro-Québec 11.6¢ to generate a kw/h of electricity in diesel plants and in turn the same kw/h was sold an average of 2.2¢. I doubt very much that small diesel plants as fitted onboard our fishing vessels can be operated for less than 12¢ a kw/h making quite obvious the fact that the same theory still applies today and even more so when we consider the rate at which the price of fuel and other petroleum products increases.

But what about the energy that class of fishing boat has to spend? Can we do something about it? And is anything being done? Of course the answer to the second question is "Yes" but I am afraid that the answer to the third one is "Very little right now".

What can be done?

First, I believe that we should think twice before we install refrigeration equipment on gulf trawlers that make trips lasting less than a week. We then should consider that in most cases shore-power-made ice, frequently sold at a loss by governments or processors, is available and that there are now excellent fishhold insulation techniques and materials. Refrigeration in this very specific case does not necessarily insure quality but I am not sure that this is the proper time and the proper place to debate this question any further.

What about the propulsion group?

Owners of gulf vessels never had the necessary motivation for refining the propulsion system of their boats. Fuel was abundant and cheap, and the hardware expensive and not always wisely applied and users almost never trained in its proper use. So far nozzles and variable pitch propellers have gained very little acceptance with that category of owners. In 1980, the cost of fuel per pound of landed fish in the group I work with was 1.4¢** a pound for dragged gear and fixed gear vessels. An average of around 4.6¢ in the consumer's plate.

The amount of 1981-1982 dollars spent to install that still expensive hardware might look quite insignificant in a few years from now when the price of fuel reaches a dollar a litre. That represents 25.5¢ a pound at today's rate of consumption for the consumer, not counting the energy used for processing, freezing, transporting and storing the product.

Why is it then that nothing much is being done right now to improve the energy consumption performance of that category of boat?

I think that there are two main factors and a score of others of lesser importance. First, the modern less-than-thirty-meter-boat is not such a bad floating palace. A great deal of ingenuity goes into its design and construction, making it a fairly efficient harvesting machine.

Secondly, no one is in the proper frame of mind to do anything really meaningful at this time. The fishing industry as a whole is going through hard times and there are more pressing problems to deal with. Loan boards in general and other groups dealing with fishing fleet financing, are yet to be convinced of the urgency of the situation. Boat owners have a natural tendency to try to solve their higher operating cost problem strictly by working to increase their income. Boat builders have problems of their own, starting with inflation and ending with a shrinking market, and finally the influence of the technical groups in the various fisheries departments of the different governments has diminished so much during the '70's that we very seldom hear from them any more although they could do a lot to help since energy conservation at the primary level of our industry is in a very large part a technical problem.

A lot is being said about energy conservation. Unfortunately not all of it makes much sense, and not all that is being done is that much efficient. If our industry is to do something worthwhile about it, guidelines will have to be established, people will have to be motivated, technical help will have to become available at no or very low cost, and money will have to be made available, too, to pay for the necessary equipment and modifications to existing boats.

Finally, I believe it is of the utmost importance to remember that fish harvesting is carried out by burning non renewable energy resources.

*12.3¢ when adding the depreciation.
**5¢ for shrimp trawlers and 3.3¢ for the large (130') gulf based vessels.
OPERATIONAL FLEET MANAGEMENT IN NOVA SCOTIA
Leonard S. Small, P. Eng.
President, Small Brothers Limited, N.S.

Although I will be speaking on behalf of the operation of fleet trawlers in Nova Scotia, I might point out that I will be talking relative to small trawlers.

Soaring fuel costs are being felt by small trawler operators; however, in the past few years increasing values and shore landings have reduced the impact of these increased costs. At the same time as oil prices continue to rise and fish prices and landings level off, the impact of oil costs will be more fully appreciated.

In almost every case the captains and crews of the small trawlers, whether privately owned or company owned vessels, are basically responsible for the efficient or inefficient use of the fuel in fishing operations. This should be an incentive for the efficient use of fuel.

Small trawlers are usually designed with hull dimensions to provide the largest fishing platform in the shortest waterline. Although this can provide efficient operation at normal towing speeds the resulting block co-efficient of these hulls can cause high wave making resistance at even moderate steaming speed. The small trawler, which is normally fuel efficient while fishing, can lose its efficiency in fuel consumption quite rapidly as the relation between the time spent steaming to the fishing grounds or looking for fish increases in relation to the time spent fishing.

To illustrate this I picked six trawlers, more or less at random, two 45-foot trawlers and four 65-foot trawlers and I took pounds landed over a 12 month period per gallon of fuel burned.

In this chart, compare the efficiency of the vessels in that table . . . A & B are basically the same type of vessel fishing from the same port. However, vessel A fished close to the home port and vessel B sailed to look for fish. One landed 48 lbs. per gallon while the other landed 28.98 lbs. per gallon. The same comparisons can be made with boats E & F, which are 65 footers; they are similar ships that fished from the same port. In the first E & F comparison over a 12 month period, one landed 38.01 while the other landed 44 lbs. per gallon. But in one particular three month period in which the boats fished continually, you will notice that F landed 60 lbs. per gallon compared to 38.

As fuel costs rise, I think if you take the boats that are in the 20 lbs. per gallon range and do the figuring you will find that they are probably not going to be capable of fishing. That cost of fuel is going to be too high in relation to the total fish landed.

Comparing the other boats; the 65-foot vessel C fished for a higher valued fish than did the vessels E & F. Vessel D fished out of the same port as E & F and landed approximately the same. It ranged in the second lot in the three month period, approximately the same as it did in the first.

I made this comparison because such boats as vessel F which lands 60 lbs. per gallon of fuel will continue to be able to fish no matter how high fuel costs go, whereas the vessels down in the 26-28 lbs. per gallon are just going to be out of it.

There are other methods of increasing the efficiency of smaller vessels including use of shrouded propellers or Kort nozzles, and the variable pitch propeller. Although I have no figures to prove or disprove the increase in fuel efficiency of these, it seems very reasonable that a Kort nozzle properly designed for small trawlers at towing speed with the resulting increase in towing strength would increase the fuel efficiency of the operation. I would doubt that a variable pitch propeller could increase the efficiency of the steering ability of a small trawler unless it was very carefully operated by the skipper.

I would suggest that the fuel efficiency of small trawlers depends upon: 1) the careful operation and good judgement of the skipper, and 2) the location of the home port being as close as possible to the fishing grounds.
I welcome this opportunity to present the viewpoint of the Fisheries Council of Canada on the subject of energy conservation, particularly as it relates to the primary harvesting sector.

There can be no doubt that the fishing industry faces many serious problems in the next few years as fuel prices continue to escalate at an ever increasing rate. The survival of the industry in its present form may even depend on how well we are able to minimize the overall impact of future oil prices through energy conservation and higher means of improving the efficiency of fuel use for catching fish.

My remarks are intended to highlight some of the important issues and constraints from the industrial standpoint that will affect the overall ability to deal with the problems as well as some constructive suggestions on how everyone concerned can move towards workable solutions.

First of all, however, I would like to congratulate Mr. Walter Scott and his Department of Fisheries and Oceans for their initiative in organizing this seminar. The seminar represents the first real attempt in Canada to focus attention on the very real problems in the fishing industry resulting directly from Canadian and world oil price situations.

Looking at the list of speakers and all topics I am sure everyone attending will leave with a much better understanding of the issues. Perhaps with some positive ideas and solutions and with the realization that joint effort and cooperation between all levels of government and various industry sectors are essential we may achieve significant improvement in energy efficiency.

There are many highly complex issues connected with Canadian energy policy and its effect on the national economy. Discussion of these is clearly beyond the scope of this presentation or indeed this seminar. It would, however, be appropriate to highlight a few of these issues which are unique to the fishing industry.

First, on the matter of comparative position. Since there is a very high energy requirement needed to catch and process most species of fish and to store and transport finished products to world-wide markets, it might be easy to conclude that the Canadian fishing industry should be in a most favourable situation in relation to other countries who are already subjected to the full impact of OPEC dictated world oil prices. However, the current market situation does not support this superficial conclusion. A closer examination of the many other factors which influence the sale of Canadian fish products would certainly suggest the necessity of keeping the escalating production costs at, or preferably below, the average inflation rate for competing food products. This industry does not have the luxury of being able to pass increased costs directly to the consumer. The extent to which rising energy prices force our production costs to increase faster than the rate of inflation will weaken the industry's competitive situation vis-a-vis pork, beef and poultry and threaten the survival of many sectors in their present form.

The effect of energy costs on the industry's future should not be underestimated.

On the question of energy conservation in vessel productivity, there is no doubt that the impact of inevitable fuel price increases must be minimized by sound energy management programs with the objective of making more efficient use of dwindling oil resources. Energy conservation techniques can help to lower net fuel consumption through the elimination of wasteful and extravagant practices developed in times of abundant cheap energy supply. However, in the fishing environment overall vessel productivity can have an even more significant bearing on the landed cost of fish. It is worthy to note that during the rapid increase in oil prices from 1977 through 1979 the fuel component of the landed cost for fish remained steady or perhaps even declined due to the higher catch rates resulting from the declaration of the 200 mile fishing management zone.

More recently, however, catch rates have reached a plateau and fuel cost per pound landed has again risen dramatically.

With existing fishing vessels it will be very difficult to substantially reduce the net consumption of energy. The possibility of improving vessel productivity may offer the best chance of restraining the increase in catching costs resulting from higher oil prices.

It is important that this issue is fully weighed and understood by those responsible for fisheries management and energy policy in government cycles. From the industry viewpoint equal emphasis must be given to improving vessel productivity and reducing net fuel use.

During these two days we should hear a great deal of technical information on new energy efficient technology that can be applied on all types of fishing vessels, and much of this will become standard features as the Canadian fleet evolves during the 1980's. This will not, however, solve the more immediate and pressing problem of improving fuel performance in the existing fleet. Since most of these vessels were designed before the 1973 oil crisis many would be considered inefficient by today's standards and yet they have 15-20 years of expected operating life left under normal circumstances. Some improvements could not doubt be made through extensive retrofit programs but the financial feasibility remains questionable.

While industrial retrofit with government support
has proved valuable ashore the situation is vastly different in the marine sector of our industry. High conversion costs and loss of earnings during refit compound the problems. Worse yet, government aid is not readily available.

A potential solution is an earlier than normal replacement of the older vessels by more efficient boats. Here again there is a strong financial constraint. It has been discussed in other forums that it is doubtful if the industry can even hope to finance the normal fleet replacement and expansion needed to achieve maximum social and economic advantage from the resource potential available to Canadian fishermen.

The long term viability of the existing fleet will depend on how well industry and government can jointly cooperate to alleviate the serious energy problems associated with these boats.

On the subject of speed reduction, much has been said and written about the effect of vessel speed on fuel consumption and how offshore trawlers in particular are relatively inefficient when operated with three running speeds near design maximum. On the surface it would seem reasonable to assume that adoption of the maxim "slow-down – save fuel" would offer an immediate possibility for reducing fuel costs. It would be very nice if the solution was that simple but, unfortunately, such is not the case. As pointed out earlier overall productivity is probably a more important factor in improving energy efficiency.

The revenue potential of cargo vessels can be computed against operating costs to determine optimum speed for any given voyage. Such a solution is not so easily found for fishing vessels because of the many variables like catch methods, landed and market value of the fish, distance from home port and weather conditions, all of which can be changing from day to day. These difficult parameters can be further complicated as issues such as fish quality, formulas, fishing quotas and the destruction of fishing gear from reduced power are also considered.

This point is made merely to suggest that fishing operations are highly complex and that simple pat solutions to all related problems are unlikely to accomplish very much. A great deal of work is required to define fleet management and operating techniques that can be made practical and help improve energy efficiency.

Just a brief word on oil dependency. While attention is being given to reintroduction of sail power in fishing vessels I believe that it is safe to say for the foreseeable future that fuel oil will remain the only practical energy source for fishing vessels. Until the national goal of energy self-sufficiency is reached our industry remains highly vulnerable to international circumstances beyond Canadian control. At the same time, the importance of our industry has been recognized by the fact that fishing, along with agriculture, has been given the highest priority status for fuel allocation in the event that the Energy Supply Allocation Board considers it necessary to invoke the fuel rationing powers that are vested with it. As an industry we must demonstrate our responsibility by taking all possible steps to ensure that we do use our fuel wisely and avoid waste.

Given the magnitude and complexity of the problems it is apparent that a concerted effort is needed to alleviate the impact of increased energy costs. I have avoided the term "subsidy" when referring to support that industry might expect from government agencies. In the Atlantic region any funding provided by government should be regarded more as an investment and a partnership with the private sector, with government assuming the role of the silent partner while industry makes the venture capital productive.

From work done on shore based retrofit and demonstration projects designed to reduce consumption it can be shown that even with grant levels of 60% of the total project cost the return on investment to the government can be higher than the effect of ROI to the private sector partner. This of course stems primarily from the fact that our current oil prices are based on crude oil costs less than half the price paid for imported oil.

I believe that the assistance offered by the Nova Scotia EnerSave program recognizes the important role that government can play as a silent partner in providing energy related venture capital for wise investment in the private sector. At the same time the EnerSave program also recognizes that selection, implementation and management of conservation projects is best left directly with industry.

Because of its wealth of knowledge of the issues involved the Department of Fisheries and Oceans would provide the ideal vehicle for coordinating the efforts of government with industries, just as Mines and Energy have done elsewhere. However, this should be undertaken without the desire to use the opportunity to exact further control over the fishing industry.

What are the constraints in preventing the implementation of effective conservation projects and what is required to help overcome obstacles that slow progress in this vital manner?

First, technical and professional assistance. Because of its fragmented nature, there is generally not available within the industry the broad depth of professional and technical talent that is needed to provide solutions to these complex issues. Those engineers and naval architects directly employed by fishing companies are fully occupied in the operational aspects of our business. However, in this regard we are not much different from other industries. This fact is again recognized by the EnerSave program which helps companies expedite conservation work by providing grants to permit hiring of outside help from consultants or other qualified people. For the harvesting sector there is an
The immediate need for qualified technical people to undertake work in such areas as developing energy awareness and education programs, helping vessel operators better use their existing equipment, defining and designing retrofit programs and establishing the financial feasibility of these, setting up accurate monitoring systems and programs to determine clearly the viability and practicality of evolving technology applied to fishing vessels, and finally, proving and demonstrating new vessel management in fish catching techniques that will increase vessel productivity.

The Department of Fisheries and Oceans staff together with those from institutions such as the Bedford Institute of Oceanography and the Nova Scotia Research Foundation can make major direct contributions in this regard. The universities and engineering schools in this region with adequate funding can also assist as can specialized consulting groups with expertise in marine and fishing problems.

Financial considerations: The EnerSave program for industrial retrofit takes into account limitations on funds available for investment and energy projects have to compete for these limited resources on a pay-back basis with other investment opportunities. Grants are provided to permit otherwise less attractive but important energy saving projects with reasonable investment standards so that projects are not delayed for lack of financial resources. Again it should be pointed out that the investment return for the private sector can only be calculated using the artificially low oil prices in effect when the project is reviewed. Any additional aid provided by the government can be offset by reduction of the subsidy paid on imported oil.

On new vessel construction, it is important that all new fishing vessels should incorporate as much energy saving technology and design sophistication as possible since it is obviously cheaper to incorporate these features during vessel construction. The concept of Life Cycle Costing now widely used in building design should be applied to determine optimum hull and equipment selection for fishing vessels. Again, however, the optimum design may change depending on the value used for fuel oil and overall calculation (should this be the price paid by the vessel owner or the true oil price prevailing at the time). If the latter is used can the vessel owner justify or even be able to finance the extra cost involved in building the more energy efficient vessel?

These are serious questions that need to be addressed. It may well be that existing vessel construction subsidy programs are counter productive in their present form. Maybe a variable rather than a fixed grant system would provide more incentive to building the maximum amount of energy efficiency into new boats. The increase in grants could again be considered as additional government investment in ultraefficient fishing crafts.

I think Dr. May in his opening remarks came fairly close to addressing the point that I am trying to make, that the funding for vessel construction may have to be reviewed.

An examination of all regulations which influence the design of fishing vessels may well reveal anomalies that create inefficient situations. Is it possible for example, that arbitrarily selected overall lengths for fishing vessel classes to meet licensing regulations, are not in themselves forcing owners into designs which are inherently inefficient? Perhaps a more flexible measure of fishing power or capability for licensing purposes would allow for more creative design of less wasteful hull forms, without destroying the balance between the various ship classes.

In conclusion, these remarks only highlight some of the many important issues and constraints, and much more discussion is necessary to define a comprehensive program for controlling the energy component of the cost of catching fish. There is a great deal of work to be done and this must be started now. The catching sector of our industry unfortunately was lulled into a false sense of security with protected oil prices and improved catch rates for a three year period and is now somewhat behind other industries, even the processing sector of our own business. It is my hope that this seminar will have the effect of launching a well thought out program for energy conservation that will enjoy the full support and cooperation of all sectors of the Canadian fishing industry in its broadest possible sense, incorporating fishermen, processors, suppliers and government agencies.
JOHN MARSTERS: CONCLUDING REMARKS

I would like to comment very briefly on what the preceding speakers have discussed in some detail. Our first speaker was Cecil Shaw and he brought to us the perspective of the Inshore Fishermen. He talked about things that could be done and he mentioned problems and in each of these we talk about fuel, because that's really the crux of what we are talking about. He mentioned some of the programs that could be initiated and some of these are underway in the various provinces and by various levels of government. He mentioned one in particular: the diesel engine conversion program in Prince Edward Island.

We moved on to Clifford Doyle and he gave us an illuminating look at the Newfoundland fishery. This presentation was particularly interesting for those of us on the mainland because we saw that while problems had a sameness there were differences, such as the cost of fuel and what it might cost to operate in one area versus another while still looking at pretty much a fixed return on the product. He said that the earnings for the fishermen had to increase and there had to be an evening out of opportunities.

Bruce Lewis discussed what is happening in the Prince Edward Island area and stressed that in Prince Edward Island we are dealing mainly with an inshore fishery. He said there were many things that could be done to improve the situation there and that most of these were modest and common sense in nature. He mentioned fishermen speeding to the fishing grounds and back, wasting fuel when there was no real necessity to do so. He mentioned the gradual conversion from gas to diesel engines, although the savings are not as great as they once were.

Pierre Côté referred to some of the problems in the Gulf St. Lawrence and I don't think those he outlined were very different from what the rest of have experienced, but he suggested some definite steps that could be done to reduce the costs, including nozzles and variable pitch propellers. This pleases our Provincial Department representatives because we have already been doing some preliminary work in that area. He pointed out the landed and sale value of fish and what you had to do to keep this as high or as favorable as possible.

Leonard Small continued, illustrating the differences in boats and how and where they were used. There is a tremendous difference and certainly a real potential for change. He touched on the fact that the design of vessels themselves have to be looked at in considerable detail. Hull forms that we are using in some cases are efficient in other cases they are not. He stressed the fact that the costs of all our vessels are climbing very rapidly, almost getting to the point where it's out of sight.

Jack Baille talked about cost factors. He mentioned the fact that our dependency on oil is not going to change greatly, but that there are opportunities for replacing older vessels with more efficient vessels, at the same time being very aware that this introduces a lot of difficulties, too. This is due to the fact that the price of vessels is going up very rapidly and you may have been operating a vessel that has depreciated and replacing it with a new vessel at a much higher cost.

DELEGATE QUESTIONS/COMMENTS:

Al Boyden, Nova Scotia Department of Fisheries (Development Division): I would like to thank all those speakers that we heard this morning. I found their talks extremely interesting. There is one thing I'd like to mention, our friend from Prince Edward Island made it quite clear that one of his biggest problems is the fact there is so little water over the bar for their vessels to come in, therefore they have to be shallow drafted vessels. In this regard he also mentioned that with different types of fishing: A) Passive type fishing and, B) Trawling type operation, it's very difficult to get a propeller and engine matching combination which fills both bills. In other words, there is no such animal as a multi-purpose fishing vessel. I can remember many years ago, long before purse seining was introduced in the North Sea we had combination vessels which went trawling or dragging as you call it here in the summertime and in the winter, but in the late summer and fall they went drifting for herring. Those vessels used steam and there were two different types of propeller. One was used for steaming to and from the fishing ground and the other one was used for trawling during the periods of the year when they were actually dragging a trawl behind them. Maybe this could be applied to some of our Canadian fisheries. I know that in many cases the vessels go out in different types of fishing in different times of the year so maybe this could be investigated. The other point with regard to nozzles, we are experimenting in this regard in this province at present and we have three or four vessels that are being fitted, some of which have already been completed and trial tests are being run. It will be interesting to see how these compare to the vessels with a high H.P. One thing worries us and apparently also worries the people in Newfoundland. It would appear that our fishermen, being the aggressive conservative types that they are, are looking for bigger and bigger power plants. We have some vessels operating at present in the 65’ range which have 750 H.P. engines. This is really worrying us. We had in Newfoundland a problem with the loan
board, as was stated earlier. The fishermen are concerned about the loan board being too restrictive in not allowing higher H.P. to be fitted. Later on when other speakers make their presentation some of these questions will come up and perhaps be answered.

Vern Powell, Nova Scotia Department of Mines and Energy: Has there been some thinking and planning on the part of the Provincial Department and Federal Department and industry in general about how we are going to make out when the price of energy goes to the world level as it is in most of the other countries with whom we’re competing. Are we going to have to look at some completely radical changes as to how we bring the produce ashore or is there any thinking on the subject. Perhaps Mr. Marsters or Mr. Baillie could comment.

Jack Baillie: I think that this is the point that I was trying to make in my comments. As an industry we have fallen behind, in my view, other industrial sectors. We have been lulled into a false sense of security by the fact that we had increasing catch rates for a while which really negated the increase in oil costs; I think now we are really faced with a situation and I again suggest this conference can be a real first step towards solving some of these problems.

Tom Hayes: In addition to what Jack has just said, we have certainly done some thinking in the Federal Department and Dave Lemon will be presenting a paper in the afternoon session that will reflect some of the potential problems that we see as a result of these over increasing fuel prices.

John Marsters: There is one answer and I think it probably is premature to try to sort of sum up on that kind of thing until later on in the conference.

Peter Mathews: I would like to follow what was said with respect to the H.P. that is being installed in fishing vessels. Certainly, our experience as operators of large vessels is that the larger the H.P. the more efficient the vessel has become. And I think it is important when talking about H.P. that we talk about the total efficiency of the vessel. In that regard I was very interested to hear what Clifford Doyle said about the experience in Newfoundland with the experiments that they conducted. I think perhaps it would be interesting if he could expand that. I’m certainly not aware of those experiments and I think that they are rather pertinent to our discussions.

Clifford Doyle: I don’t know if I have much to add to what I’ve already said. I was told about the experiment which the Federal Department of Fisheries participated in and I said I stood to be corrected if that was not the case and the result was not what I said. But the experiment was in Otter trawling using three boats, one having a horsepower of approximately 230, another one with a horsepower of approximately 520. Under the same operating conditions and the same stress, the most fuel-efficient after a period of trials was found to be the one with the greater horsepower. I’m not sure, but I think that this information would be available from Federal Fisheries in Newfoundland. As fishermen we thought this way all along and this is why I say that the policy of our loan board has been too restrictive in terms of H.P. We found that a lot of the vessels, even government built vessels, were fitted with horsepower that was not sufficient. We found that the number of fishermen who acquired these vessels, even though the vessels were only one or two years old, are stripping out the motors and installing new motors because they are inefficient. So this is why I stress that point. I know there is such a case as over powering a vessel. But if you don’t have the power, you can’t handle the vessel, and you are limited as to what you can do; very limited. The resale value of your boat is down, probably by 100% because the market is limited as to where you can sell your boat if your boat is not constructed properly in terms of enough H.P. So this is why I’m a little bit amazed at the policy of our (Newfoundland) loan board with regard to such things as horsepower in a boat.

Marvin Barnes, Department of Fisheries and Oceans: I think what Mr. Doyle is referring to was a short experiment done in an exploratory fishing program undertaken by our Branch last year in Newfoundland, where we were looking at single vessel trawling versus pair vessel trawling. The single vessel was a 65 footer just over 500 horsepower. The pair were 53 footers with 200-300 horsepower. Now, in this particular study, a very preliminary study on energy on these vessels was done by Nordco. I understand a paper will be given later in this seminar by John Foster from Nordco on the subject.

Reg Kingsley, Newfoundland, Department of Fisheries: I’m not here today to defend the loan board in Newfoundland but there are some comments that I would like to make. First of all, as far as I know, the loan board is financing vessels with up to 520 horsepower in 65-foot boats for dragging and I really don’t know how much higher we would want to go. Certainly there is a concern that some vessels operators are installing horsepower well beyond what they need. We do have trawlers with 250 horsepower in 55-foot vessels; I don’t believe all of them are inefficient. One in particular that I am aware of last year reported 1.5 million pounds of groundfish on roughly 12,000 gallons of fuel. I think that’s a pretty good record. In the meantime we do appreciate concerns about underpowered and we are looking at nozzles as a means of overcoming this rather than installing higher horsepower. On one of these particular boats, a 250 horsepower vessel, we are in the process of installing a nozzle and have outfitted fuel monitoring equipment; we will be watching that very closely. On the average, since the 1960’s, the installed horsepower in Newfoundland vessels has increased by at least 100%.
I have heard comments before from fishermen that you do need a lot of reserve power to increase the life of the engine. It is my understanding that the life of an engine is rated on its continuous duty and therefore I would like to know if anybody has some comments on whether operating it at its rated duty will in fact shorten the life of the engine as opposed to operating it at somewhat less than its rated duty H.P. On the question of vessel design, we have heard comments that there are at least several factors that influence design, one of which is government policy. We have regulations on the length of vessels, and what has been happening is a tendency to increase carrying capacity by increasing the beam of the vessel because of the restriction in increase in length. I feel that it's time for some of these regulations to be addressed. I understand that in S.W. Nova Scotia there is a 45-foot limit on druggers. Of course, the distinction between inshore and offshore in Atlantic Canada in 65 feet and the tenancy I think in many cases is to make some of these vessels as broad as they are long, but for steaming purposes that doesn't improve fuel efficiency. Just one other point I would like to make concerning the loan board in Newfoundland.

The loan board has had a policy over the years not to finance gasoline engines, primarily for safety reasons; so we don't have the same extensive use of gasoline engines in Newfoundland.

**John Morton, Gourrock Industries:** I've heard probably seven or eight people this morning speak about nozzles in various forms on fishing vessels. We have some experience on the west coast of the United States and Alaska with a great many trawlers and they went through the same fever about four or five years ago installing nozzles on everything that was built; however, from watching the industry out there at present you will see that nozzles are out just about as quickly as they are put on. I think that most of the industry out there has come to find that with long steaming distances being encountered more and more in the fisheries, that Kort nozzles are really efficient when your towing, but when you're looking at perhaps steaming to Alaska and coming back or fishing on grounds 1800-2000 miles away and more and more of your time is involved in running, the Kort nozzles really are not all that efficient. At present there is a great deal of work going on in rudder designs. These are independently-funded fishermen that we deal with out there. Some of the other things that they are looking at are plotting devices for fixed gear, in particular with the larger crab boats and the larger longliners to assist in the more rapid recovery of gear.

One other point that I would like to have clarified; we in industry are not sure what is allowed as far as mid-water trawling involving vessels of under 100 feet - 45-65-foot vessels; a great many people come in and ask if they can rig up for mid-water trawling and, if so, can they use this gear inside the Bay of Fundy area or out on Browns or Georges. We feel as a gear industry that mid-water trawling does have its applications, particularly on species such as red-fish and pollock when fish are farther up in the water, and it's a far more efficient gear than standard bottom gear.

**John Marsters:** With regard to the preceding question there are a number of things that I very much wish we were in a position to answer; one that springs to mind besides that is the relationship of licensing and quotas as well as size and types of vessels because to some degree I think every government department has had headaches about these issues and certainly many, many fishermen have, but I'm afraid that that's beyond the scope of our seminar today. It's quite appropriate to point out the limitations that some regulations may have and I certainly hope that they are stressed and brought to the attention of the official concerned. The results I can't predict.

**Gastien Godin, Association Professionnelle des Pêcheurs du Nord-Est du Nouveau-Brunswick:** It stands to reason that it is impossible to look at the problem of energy in isolation from or independent of another problem in the fishing industry; notably that of fish quality improvement and how it relates to boat construction, gear type, etc. I think, it is important . . . that it is imperative at this time to take exception to part of Mr. Côté's paper, in particular one paragraph dealing with refrigeration units, where he states that they do not necessarily improve quality.

I think it is important to stress that if this is true, then at some point, we must question the consistancy of government policies as they pertain to the industry. A few years ago, the Department began subsidizing refrigeration in order to improve quality. Now, this program did have some positive effects on improving quality. Several fishermen benefited from that program and installed on their boats refrigeration units which have proved very beneficial when it comes to quality improvement and the relation between quality and energy.

What is important to note, I think, since there has been in fact a comment to that effect on quality, is that as far as we are concerned, there are several of our boats in North-Eastern New Brunswick - middle distance boats - which have these refrigeration units aboard and we can affirm, Mr. Côté, that the undertaking has proved exceedingly beneficial.

Allow me to quote a couple of short extracts from letters we received from two processors who have bought fish from these fishermen. There is one here for the crab fishery of which the company is Baie Chaleur Packers, and the letter states that since a certain boat owner from Cavenagh acquired a refrigeration system, "we have noticed an enormous improvement in the quality of crab he has delivered us".

Concerning the shrimp fishery is the same sort of comment; "Since the M.V. Le Surois has had a refrigeration unit aboard, we have noticed that quality
has markedly increased. That is to say that the proportion of top quality product is greater than last year." All this provides very concrete proof.

What is important to note above all is that industry and fishermen as a whole presently consider that, at the quality level, this has possibly been the most important innovation to come along in the last few years. I think, it is important to comment in view of Mr. Côté's paper. The rest (of the paper) on the other hand was, in our point of view, excellent.

Pierre Côté, Pêcheurs Unis du Québec: You can see the danger in making general statements on a very precise technical point. First, I would like to remind the audience that when I was speaking of refrigeration just now, I was speaking of groundfish. I was not referring to crab; very conscious of the fact that I was, (talking about groundfish) when I made the statement and that crab was one case which did not pertain to the statement I made.

Secondly, what I wanted to point out foremost was that it was necessary to be extremely careful not to make up for a lack of insulation with the cooling action of a refrigeration unit, because at that point, one is replacing insulating material, which persists for the life of the boat.

I would also like to emphasize one very important thing which is perhaps not the case in Northern New Brunswick, but is the case with us. That is, in the case of the cod fishery where gutting must be done aboard, I am firmly convinced that the time the cod spends fully exposed on the deck to the sun while waiting to be gutted, is far more important than the temperature it meets up with in the hold.

Peter Kinley, Lunenburg Foundry and Engineering: I would like to address a question to both our federal and provincial fisheries representatives. There has been a lot of talk this morning about the use of Kort nozzles and controllable pitch propellers but not much has been said about the capital cost of investment in these different things. I feel we should not lose sight of that particular problem. Both these devices are expensive and difficult to retrofit into certain vessels. Great increases in efficiency could be obtained by proper selection of the propeller corresponding to the engine, the gear and the hull form of the vessel. I would like to ask whether any work is being done by the Departments regarding systematic series of fishing hull forms. As we all know the standard type of inshore fishing boat is quite commonly a semi-displacement hull but very little work has been done with regard to weight adaptation of propellers and I feel that a lot of work could be done at very little capital cost to the people in that area.

John Marsters: I'll respond to that on behalf of the provincial people; first, and a very general response because I recognize what you are saying Peter and there is a great deal that can be done. You just touched on one thing that we really haven't talked about and that is a need for standardization of the vessels to the extent to which it is practicable.

Our department in Nova Scotia is working in that direction but I can't say that we are taking giant strides and I suspect that if Mr. Hayes responds for the Federal people he will have to say much the same kind of thing. But it's certainly good to hear somebody else suggesting this, and, yes, it's certainly a valid point.

Allan Billard, Eastern Fisherman's Federation: I was just going through some figures and discovered how efficient the inshore fishery can be; for instance, if we go to higher Torque propellers in some of our smaller boats, we could save about 5%. If we get a Kort nozzle design for some of our smaller inshore boats we could save maybe as much as 15%. If we better match the reduction ratio to the gear we're using and the wheels we're spinning with as much as 15-20% increased efficiency. Of course the switch to diesel, which is the one thing we are really pushing for right now could save as much as two-thirds of the amount of fuel we use. Now, if as Bruce Lewis pointed out, all the inshore operators become a little more aware of how much fuel they use and treat it with a little more common sense, we could save maybe 5-10% of the fuel we use. When I added up all those figures, apparently the inshore boats can come back from the fishing grounds with more fuel than they took out. . . .
Mr. Milne: This afternoon we will start getting into the specific theme of this conference. We have authors who will cover the whole spectrum from fuel costs to diesel engine efficiency, and I think that’s the most obvious area in which fuel economies can be made. There are other aspects that I hope will be exposed this afternoon and tomorrow which show that things aren’t always as obvious as they seem. I say that because I’m a naval architect. Twenty years ago I was involved in a fisheries department conference in Ottawa. At the time I was concerned by the fact that virtually every fishing boat I looked at was being pushed beyond its reasonable hull speed. Every ship that was bought, I won’t say built, but every ship that was bought was in my terms, overpowered. That was because I was interested in purity of design which means not just functional design but efficient design. Efficient design to me was the one that gave you the most speed for relatively the least power. But I learned, that efficiency isn’t always equal to profitability, and it’s my hope that in this conference we will somehow find a way to grasp the means by which profitability can truly be gauged. I know that the fishermen want to get home as fast as possible to make the best market. I know that the engineer wants to drive his ship at the least cost in either gallons per knot or dollars per knot. However, when we try to relate these two things we find that there are a lot of other aspects that come into it. This afternoon we are not just going to talk about fuel costs and diesel engines, we are going to talk about ways of monitoring... Ways of actually measuring what we are doing. It’s rather surprising that after all these years we are only beginning to see that there are other aspects to the problem.

I think in Europe they met the problem long before we did. I don’t know if they have solved it but I do recall that when we were trying to put the most power into the smallest package we were able to look at European engines that certainly were more efficient than ours, but even so we found that the most profitable vessel was the vessel with the maximum power.
A REVIEW OF FUEL COST TRENDS IN THE CANADIAN ATLANTIC FISHERIES

by P.M. Jangaard
Chief, Program Development Division
Fisheries Development Branch
Department of Fisheries and Oceans
Halifax, Nova Scotia

Paper Presented by D.W. Lemon
Fisheries Development Branch

Summary

Modern fish harvesting and processing operations are highly energy intensive. At current Canadian fuel prices, the energy used by large trawlers to catch fish can represent as much as 5-6 cents per pound of fish landed (11-13 c/kg); i.e. about 50-60% of the price currently offered for redfish or 30-50% of the price for cod. This represents 15-18 cents/pound of fillets and additional energy-related costs are added to the product during processing, freezing, storage and transportation. The fish meal plant, a vital link in the processing chain, is a heavy user of energy for cooking and drying. In addition, fishing gear is manufactured from fibers made from petroleum-derived chemicals and has therefore increased in price in relation to world oil prices. However, other fishing methods such as longlining and Scottish seining can reduce the fuel component of the landed cost to 1-2 cents/pound.

The fishing fleet on the East Coast of Canada used an estimated 80-90 million imperial gallons of fuel in 1980 at a cost of $60-70 million; i.e. 12-14% of the total landed value of fish and shellfish. The same quantity will cost $90-100 million in 1981, and could then represent as much as 18-20% of the landed value on a total fleet basis.

A successful development program could rapidly achieve substantial savings on the fuel bill for the East Coast fleet. It is reasonable to expect that an immediate education program on better operational practices together with minor modifications to vessels and gear could result in a 5-10% reduction in the use of fuel representing a potential saving of up to $10 million by the end of 1981. In addition, conversion to fuel-efficient fishing methods, use of modified and newly developed fishing gear and the gradual introduction of fuel-efficient vessels could reduce total fuel consumption by another 5% per year. By 1985, a fuel saving of perhaps 25% as compared to 1980 should be possible representing a dollar value in the range of $35-40 million based on fuel prices projected for 1985.

The recent sharp increases in oil prices have had a serious effect on the viability of the fishing industry in countries around the world, especially since there has not been a corresponding price rise for the end products in the market place. The Canadian industry has been fortunate in that in the years between 1976 and 1979, catch rates for most groundfish vessels increased at a rate similar to the increases in fuel costs, and landed values at even higher rates. However, for several reasons, landings and landed value levels fell off or actually declined slightly in 1980 and are only expected to increase at a more moderate rate in the near future. Simultaneously, fuel prices are expected to increase by at least 15-20% a year for the next five years. In countries where world fuel prices are in effect and catch rates have held steady or declined, some segments of the fishing fleets are in serious trouble. For instance, a number of large shrimp trawlers in the Southern United States have been forced to tie up; trawlers in Northern Norway are in serious financial difficulties since fuel costs per pound fish landed were estimated to be about 12 cents in 1980 – almost three times higher than those in Canada for comparable vessels.

Although considerable publicity has been given to the worsening cost situation, only some large fishing companies have actually taken positive measures, however sporadic, to lower fuel consumption in their plants and to build maximum fuel efficiency into future vessels. Only scattered and uncoordinated efforts are underway to assist smaller companies and individual fishermen who own their own vessels. Planning should be intensified on a comprehensive multi-year development program aimed at substantially reducing the amount of fuel used by the fishing industry while maintaining the volume of landings and improving fish quality. Considerable savings can be achieved on existing vessels by measures such as lowering speed, whenever possible, better insulation, proper hull and machinery maintenance, installation of nozzles on trawlers etc. New vessels can have numerous fuel-saving measures incorporated such as improved hull design, the use of two engines, controllable pitch propellers, use of heavy fuel oil etc. Since up to 60% of the energy put into an engine can be lost as waste heat in the exhaust and cooling water, a special effort should be made to use this energy for heating...
or refrigeration purposes. Fishing methods such as longlining, Scottish and Danish seining, pairtrawling etc. use less fuel than single trawling and conversions to these methods should be facilitated. Considerable improvement can be made in trawls in order to reduce drag, and therefore energy consumption, and deck gear and other equipment can also be improved.

Background

Oil Price Developments

The so-called energy crises and the national debate currently raging as a result of the federal budget presented in the fall of 1980, has focused attention on the effect high energy prices will have on the economy in the future.

Since the growing power of OPEC (Organization of Petroleum Exporting Countries) started to affect world oil markets in 1973-74, oil prices have been increasing sharply. Between 1973 and 1980, Canadian diesel oil prices approximately tripled in spite of the fact that Canadian prices are kept considerably lower than world prices through Government subsidies on imports.

Following a year or two with lower world demand and a slight oil surplus, the trouble in Iran has recently been a major cause for concern. Since Iran was the second largest oil exporter in the world after Saudi Arabia in 1978, the revolution there, and the war with Iraq, has seriously affected world supplies and started a new round of price increases.

World oil prices CIF Montreal are compared with past and proposed Canadian wellhead prices and Toronto prices (which include taxes) in Fig. 1. It can be seen that domestic prices will be climbing steadily at a projected 15-20% per year over the next few years as a result of increased wellhead prices and taxes proposed in the National Energy Program.

Effect on Fishing Industry

As mentioned in the Summary, the Canadian fishing industry has been cushioned against the dramatic increases in world oil prices by the lower domestic oil price maintained by the Government, and by increases in landings and landed values experienced by many vessels to compensate for fuel price increases. However, there were some dramatic changes in 1980. (Table 1) Atlantic Coast landed values for all species levelled off or decreased slightly for a number of reasons which included lower scallop and squid landings and marketing problems for some species. However, no measure of effort, such as hours at sea, is available for the past few years and comparisons are therefore only approximate. It is expected that total landed values will only increase at a moderate rate in the next year or two. Since fuel prices can vary considerably from area to area due to transportation costs, bulk discounts etc., the Industrial Selling Price Index for Diesel Fuel issued by Statistics Canada has been used as an additional indicator of fuel cost increases. (Table 1) It can be seen that this index has been increasing at an average annual rate of 20% since 1975 and is projected to continue this climb at similar rates. (Fig. 2.2)

The spread between the Industrial Selling Price Index for the Fish Products Industry and that for Diesel Fuel also started to increase in 1980 indicating that it is not only the harvesting sector that is feeling the energy cost squeeze. (Fig. 4)

An index that can be used to measure the increasing cost of fishing is fuel cost per unit weight landed. This indicator not only shows that there has been a considerable increase in the cost per pound of fish landed by large trawlers, but also that there is a large difference between various fishing methods. (Fig. 5) Longlining, gillnetting and Scottish/Danish seining are the least energy consuming mobile fishing methods for groundfish and some large stern trawlers, that have to travel to distant fishing grounds, are the heaviest energy consumers. Information obtained from cost and earning studies and from fishing industry spokesmen indicates that some large stern trawlers had fuel costs as high as 5-5.5 cents per pound fish landed in 1980. The average for Atlantic Coast offshore trawlers was somewhere between 3 and 4 cents. For the period 1970-74, the average fuel costs per pound were about 0.8 to 1.1 c/lb., but in the period 1977-79, the values levelled off due to the increased catch rates experienced by trawlers.

Although there are wide differences in the fuel consumption of existing draggers and trawlers due to design of vessel, engines used, their maintenance, distance travelled to fishing grounds, species landed, type of gear used etc., the fact remains that single vessels towing gear will consume more fuel than so called passive gear types. However, modern trawlers can be relied upon to deliver fish to processing plants or a regular basis regardless of season or weather, thereby ensuring continuous production.

Energy-efficient fishing methods are those where engine power is not called upon to make vessel and gear move through the water continuously, but is mainly used for hauling with the vessel essentially stopped. These include Scottish and Danish seining, purse seining, longlining, gillnetting and fixed gear such as traps and weirs. Scottish and Danish seining are classified as towed gear, but the net is only pulled for a short period to assist closing and therefore this operation can be carried out with relatively low-horsepower vessels. Pair seining will further reduce fuel costs.

Limited Canadian data indicate that Scottish/Danish seiners could land fish at a fuel cost of 1.5-2 cents/lb. fish in 1980. Longliners show a similar range depending on the distance from home port and the species sought. Inshore and nearshore longliners from Nova Scotia fishing for cod and haddock landed fish with a fuel cost as low as 1-1.5 c/lb., while the cost for vessels fishing for halibut in deeper water offshore could go above 2 c/lb.
More comprehensive calculations carried out in Norway indicate that the fuel cost per pound fish landed in 1980 when fuel costs were approximately 39 cents/litre (Canada approximately 15 c/l) were: inshore fishing 2-3 c/lb. Scottish/Danish seining 2.5-3.0 c/lb., offshore longlining 3-7 c/lb., factory freezer trawlers 6-7 c/lb. and wetfish trawlers 12-14 c/lb. By comparing these Canadian and Norwegian fuel cost figures, it can be seen trawlers will be relatively much more affected than longliners and seine netters as fuel prices increase.

Recent Danish data confirm these findings (Fig. 6). Fuel and lube oil costs for large trawlers increased from 14% to 21% of gross fish sales in 2½ years between 1978 and 1980. In contrast, gillnets and Danish seiners only had a moderate increase from 3-5 to 5-8% in the same period.

Specific Measures and Potential Benefits

In view of the serious implications of higher fuel prices on the economic viability of the Canadian fishing industry, especially vessels, a number of measures can be taken in order to substantially reduce the fuel consumption in harvesting, handling, processing and transportation. These measures will be closely linked with steps being taken to improve the quality of Canadian fishing products.

A multi-year development program on harvesting energy conservation would have the Department of Fisheries and Oceans as the lead agency, in close co-operation with DREE and other Governmental agencies and the fishing industry.

The following section identifies certain areas where development leading to lower fuel consumption is possible.

Vessels

a. Existing vessels

Since most of the trawler fleet on the Atlantic Coast was designed before the oil crisis started in 1973/74, they are generally inefficient users of energy. Because of shape, duties, operational influences etc., fishing vessels are not good performers in hydrodynamic terms compared to most other craft. (Fig. 7) Changes in operational procedures combined with conversions, modernizations etc. could be carried out as in the following examples:

- Fuel monitoring. Electronic fuel monitoring devices to be designed and installed on vessels in order to monitor fuel consumption under all conditions of weather, fishing, travelling, seasons, etc.
- Economical speed. Substantial savings can be achieved by reducing speed although the actual value of time saved against costs incurred has never been properly analysed and understood. For example an 80 foot vessel that will do 11.2 knots at the maximum (designed) continuous rating of the engine will save 30-40% fuel by reducing speed to 10 knots. The time lost is about 10% and the cost of this time, for instance on plant operation, must be evaluated against fuel consumption in each case. Rough seas, currents and wind will affect these values and a carefully conceived education and demonstration program must therefore be initiated at the operational level and for industry trainees to enable supervisors to make correct decisions.
- Load factor. The consumption of fuel per horsepower varies with the load factor and engine speed. Considerable savings can be achieved by using better combinations of propulsion system elements.
- Propellers. Bigger and slower is best; a propeller should rotate as slowly as possible since propeller efficiency generally increases with lower revolutions. This may be achieved by changing operational procedures, by changing the propeller or changing the flow of water to the propeller by nozzles etc. Controllable pitch propellers can also lower fuel consumption considerably.
- Hull maintenance. New coatings and improved hull surface materials and cleaning techniques will be investigated. More attention has to be given to fairing appendages such as edges of screw apertures, stern posts, stern tubes, arrangement of anodes, coolers, sonars etc.

b. New Vessels

Large fuel savings can be achieved by proper design of new vessels and astute selection of major equipment and systems. Individual vessel owners usually do not have the resources to achieve maximum fuel efficiency from their new vessels and there is therefore a wide scope for developmental work and advice in this area. Areas to be considered in designing new vessels are:
- Improved design from all aspects for better fuel economy. Vessels designed before 1973 were mainly concerned with capacity, fuel efficiency was a secondary consideration.
- Choice of propulsion and auxiliary engines. Large improvements in fuel economy are possible in this area, and a major study is envisaged in examining generation systems in use and those which might become feasible.
- Elements in new fuel efficient systems will probably be the use of two or more engines with integrated distribution systems where propulsion, refrigeration, electric, hydraulic and general service energy can be drawn as best suits the needs. Solutions must of course be tailored to the vessel, the fishing gear(s) to be used and the operational envelope in which it is expected to function most of the time.
- Choice of propeller systems. Larger, slower turning propellers and controllable pitch
propellers can be considerably more fuel efficient than those in common use on many fishing vessels. Most trawlers have compromise propellers that are not designed for peak efficiency in either main duty (steaming or towing). The use of nozzles will maintain towing capability while decreasing fuel consumption.
- Waste heat utilization. Only about 40% of the engine energy input is used to propel the vessel; the rest is lost in cooling water, exhaust, etc. With proper design this energy could be used for heating water and living space, for refrigeration and ice making, for cooking shrimp, for producing fresh water from seawater etc.
- Heavy fuel oil. The use of heavy fuel oil has received considerable attention in Europe where the price differential between heavy and light fuel oil is much greater than in Canada. Consideration should be given to this alternative in future planning of vessels also in Canada.
- Insulation. Additional emphasis should be placed on improved insulation onboard vessels to reduce refrigeration requirements for the fish holding area and heating requirements for living quarters.
- Alternate energy sources. Although it is quite unlikely than there will be a complete return to wind or coal, a limited use of sails or wind-powered generators could introduce fuel savings on some vessels.

Fishing Methods and Gear

There is enormous scope for development work leading to improved energy performance in this sector which can be roughly divided into:
- a) conversion to other fishing methods and
- b) improvements in fishing gear and equipment, and perhaps most importantly how these interact.

Conversion to Other Fishing Methods

A decision to convert a vessel to another fishing method cannot be made on the basis of fuel savings alone, but factors such as the effect on fish quality, suitability of vessel, expected catch rates, access to the resource etc., must be considered. Some conversions can be made at minimum expense such as:
- From single vessel trawling to pair trawling. Since trawl doors which contribute up to 30% of the total gear drag are eliminated in pair trawling, much less power is required to pull the net. Similar vessels with relatively small engines can therefore be used. It is estimated that for equivalent power (two vessels vs. one), catches for a pair trawling pair vs. a single vessel can range anywhere from 2:1 to 5:1. Pair vs. single boat midwater trawling will give similar savings.
- From single vessel Scottish seining to pair seining. Although single vessel seining is fuel efficient, pair seining will increase catches due to the larger area of bottom being swept thereby decreasing fuel costs per pound fish caught.

Other possible conversions which would involve vessel modifications include:
- From single vessel trawling to longlining. If catch rates are comparable, fuel savings of 50% could be achieved. Even with lower landings, the quality of long-line caught fish is considered to be better.
- From single vessel trawling to Scottish/Danish seining. The fuel cost per pound fish could be reduced by about one half by converting to seining where enough fishing grounds with suitable bottom is available.
- From squid trawling to jiggering. Some conversions have been carried out, and in addition to fuel savings in catching, a superior quality squid is obtained.

Development, Modifications and Demonstration of Fishing Gear

There is a vast scope for development in this field.
- Trawling and trawl gear. Since the high power requirements in trawling are needed to pull a heavy trawl along the bottom or in midwater, any measure taken to lessen this drag will save fuel. Proper design and use of doors is extremely important since up to 30% of the towing power is used to overcome the drag from the doors. Trawls with rope or large meshes in the wings will save fuel.
- Longlining gear. Although longlining is fuel efficient and produces quality fish, very little gear development took place up to about 10 years ago. Development initiatives are underway to mechanize and even automate this labour-intensive fishery thereby making it more attractive to convert to longlining from trawling.
- Seines. In recent years there have been significant advances in the design and construction of seine nets and also in on-board handling and hauling gear. Considerable scope still exists for improving these energy efficient gear types (purse, Scottish - Danish - Lampara - Beach Seines).
- Gillnets. Although gillnets are considered to be energy-efficient, the quality of gillnet caught groundfish is generally considered to be inferior. Improvements in hauling gear could reduce soak time, and thereby fish quality, but a low priority will be given developments of this gear.

Fishing Strategy

A substantial amount of fuel is used looking for fish. Improvements in, and the proper use of electronic fish finding gear together with systematic collection and processing of information on catches, catch rates etc. could greatly reduce the time and fuel spent on searching.
Conclusions

The examples listed above indicate that there is vast scope for development programs leading to better use of energy by the fishing industry on the East Coast of Canada. The Department of Fisheries and Oceans is taking the lead in developing comprehensive programs to take advantage of these opportunities which are expected to result in large savings for the industry. Conversely, if no action is taken, many fishing enterprises will have increasing financial problems as fuel prices continue to rise. It is very unlikely that fish prices will increase at similar rates in view of recent market developments.

The Fisheries Development Branch in the Maritimes Region has taken the first step by convening the seminar on Energy and Fish Harvesting in Halifax.

In the fields of vessel and harvesting technology a small group of professionals is available within the Department. However, there are no facilities in Canada for developing and testing gear, and new designs would have to be tested abroad. In view of the tremendous energy savings possible by the use of properly designed and operated fishing gear, serious consideration should be given to the construction of a flume tank facility on the Atlantic Coast. This facility would also be used for advanced training purposes; an essential part of any program if optimum results are expected to be achieved.

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<td>13.9</td>
<td>288,252</td>
<td>28.6</td>
<td>119.4</td>
<td>245.3</td>
<td>243.4</td>
<td>18.2</td>
<td>160.6</td>
</tr>
<tr>
<td>1978</td>
<td>1,153,231</td>
<td>15.0</td>
<td>415,899</td>
<td>44.3</td>
<td>216.6</td>
<td>278.0</td>
<td>273.8</td>
<td>12.5</td>
<td>193.1</td>
</tr>
<tr>
<td>1979</td>
<td>1,211,605</td>
<td>5.1</td>
<td>493,910</td>
<td>16.7</td>
<td>275.9</td>
<td>334.5</td>
<td>328.7</td>
<td>20.1</td>
<td>251.9</td>
</tr>
<tr>
<td>1980</td>
<td>1,150,000 (Est)</td>
<td>-5</td>
<td>470,000 (Est)</td>
<td>-5</td>
<td>438.8</td>
<td>335.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CRUDE OIL PRICES IN CANADA

FIGURE 1
FIGURE 2

CANADA
ATLANTIC COAST
CHANGES IN LANDED VALUE
AND DIESEL FUEL INDEX
SINCE 1970

YEAR

PERCENT

DIESEL FUEL INDEX
LANDED VALUES

YEARS

1970 71 72 73 74 75 76 77 78 79 1980

1970 71 72 73 74 75 76 77 78 79 1980
CANADA
DIESEL OIL PRICE DEVELOPMENTS

PROJECTED AVE. NATIONAL DIESEL PRICE FED. SALES TAX INCL.

TYPICAL NOVA SCOTIA DIESEL PRICE

TYPICAL EAST COAST BULK DIESEL PRICE

DIESEL FUEL INDEX STATISTICS CANADA

YEAR

1972 73 74 75 76 77 78 79 1980 81 82 83 84 1985

CAN. $/IMP GAL

INDEX

1972 73 74 75 76 77 78 79 1980 81 82 83 84 1985

0 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80

100 200 300 400 500

0.00 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80

1972 73 74 75 76 77 78 79 1980 81 82 83 84 1985

100 200 300 400 500

FIGURE 3
FIGURE 4

INDUSTRY SELLING PRICE INDICES:
FISH PRODUCTS INDUSTRY VERSUS DIESEL FUEL

YEAR
INDEX
1974 75 76 77 78 79 1980
150 200 250 300 350 400 450

DIESEL FUEL INDEX
FISH PRODUCTS INDUSTRY INDEX
CANADA
ATLANTIC COAST
FUEL COSTS PER POUND FISH LANDED

FIGURE 5

LARGE TRAWLERS

DRAGGERS

LONGLINERS
SCOTTISH/DANISH SEINERS
DENMARK

FUEL AND LUB. COSTS AS PERCENTAGE OF GROSS FISH SALES (LANDED VALUE)

FIGURE 6
Abstract

This paper attempts to identify key areas for fuel saving activities in fishing, giving rough figures for the saving potential.

Large savings may be achieved by proper choice of speed, by operating existing vessels and machinery properly, and by selecting energy efficient fishing methods.

Very interesting possibilities exist for making new vessels more energy efficient.

The aim of the paper is to stimulate discussion on fuel saving, and to point to the most profitable areas for exploration in this field.

Preamble

1. The aim of this presentation is to stimulate discussion on fuel economy in fishing, an industry squeezed between dwindling resources on one hand, and increasing fuel prices on the other.

The figures presented here are "Guesstimates" that will be revised as we gain more insight into the fuel usage and practice in the different fisheries.

They are based on a number of internal memos produced at our institute last year.

These memos served as guidance and a base for discussion on where our institute should concentrate our efforts in the fuel saving field.

They also serve as a starting point for projections on the relative competitiveness of various methods of fishing in the face of rising fuel prices, work that is just now getting under way.

It is my belief that discussion on these matters may be of great benefit, a proper evaluation of the fuel saving possibilities may be of immense value to people now investing in new vessels and equipment. (Note: In March 1981, the Norwegian Krone was worth approximately 22 cents Canadian.)

2. Energy intensity in food production.

Usually studies into this field deal with energy input and output, or energy input into each gram of protein produced.

A housewife buying food for dinner is not very concerned about the number of M.Joules or grams of protein she buys, she compares the cost per pound of the various foodstuffs and the less money she has in her purse the more important this consideration is.

Based on widely varying figures available on energy input into production of poultry, mutton and beef.

I have tried to figure out the energy input per kg of foodstuffs that compete directly with our frozen fish fillets in world markets, and compare them to our own products.

Table 1.

<table>
<thead>
<tr>
<th>Foodstuffs</th>
<th>MJ/Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef: range fed, Argentina, N. Zealand</td>
<td>3-5</td>
</tr>
<tr>
<td>Beef: grass fed, US, UK, N. Zealand</td>
<td>16-42</td>
</tr>
<tr>
<td>Beef: feed lot, US</td>
<td>120</td>
</tr>
<tr>
<td>Poultry UK (1972)</td>
<td>60</td>
</tr>
<tr>
<td>Fishing UK (1972)</td>
<td>80</td>
</tr>
<tr>
<td>Fishing Norway (1978)</td>
<td>80</td>
</tr>
</tbody>
</table>

The value shown for fishing in Norway is average for frozen fillets.

3. Energy Use in Norwegian Fisheries

Table 2 reflects the great difference in fuel consumption for different methods of fishing in the Norwegian fisheries.

It shows kilograms of fuel per kilogram of gutted and headed fish larded (fuel ratio).

Table 2.

<table>
<thead>
<tr>
<th>Method of fishing</th>
<th>Fuel ratio: kg fuel/kg fish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottom trawling, middle water</td>
<td>1,0</td>
</tr>
<tr>
<td>Bottom trawling, near water</td>
<td>0,6</td>
</tr>
<tr>
<td>Longlining, middle water</td>
<td>0,3</td>
</tr>
<tr>
<td>Longlining, near water</td>
<td>0,2</td>
</tr>
<tr>
<td>Coastal fishing</td>
<td>0,1</td>
</tr>
</tbody>
</table>

Based on this table we have estimated energy input into each kilogram of frozen fillets on the Norwegian market.

Results are shown in table 3.

For trawling, the energy input from the fishing operations amounts to from 50-85% of the total input.

If we compare energy input for beef from table 1 with the energy input into fillets, it seems evident that frozen fillets are quite vulnerable to increases in fuel prices.

It is also evident that fillet production based on longlining is less vulnerable than if it is based on trawling.

It is also clear that an effort must be made to bring down fuel consumption in our industry if it is to
Table 3. Energy input per kilo frozen fillet (Norway 1979).

<table>
<thead>
<tr>
<th></th>
<th>Trawling</th>
<th>Trawling</th>
<th>Longlining</th>
<th>Longlining</th>
<th>Coastal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Middle water</td>
<td>Near water</td>
<td>Middle water</td>
<td>Near water</td>
<td>fishing</td>
</tr>
<tr>
<td>Fishing</td>
<td>MJ/KG</td>
<td>%</td>
<td>MJ/KG</td>
<td>%</td>
<td>MJ/KG</td>
</tr>
<tr>
<td>Processing</td>
<td>13</td>
<td>12</td>
<td>13</td>
<td>17</td>
<td>13</td>
</tr>
<tr>
<td>Transport</td>
<td>10</td>
<td>9</td>
<td>10</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Distribution</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Total Input</td>
<td>112</td>
<td>100</td>
<td>77</td>
<td>100</td>
<td>52</td>
</tr>
</tbody>
</table>

Fillet yield is 50% of the headed and gutted fish landed.

remain competitive.

The question arising is then: Where are the most profitable areas to explore for fuel saving?

4. Areas for Fuel Saving.

So far we have identified the following worthwhile areas for further investigation, but it is safe to say that the list will be added to.

a. Speed and power reduction
b. Choice of fishing methods
c. Improved propulsion systems
d. More flexible machinery systems
e. Use of heavy fuels
f. Improved auxiliary power systems
g. Improved hull forms
h. Waste heat recovery
i. Engine de-rating
j. Improved use of controllable pitch propellers
k. Improved fishing gear
l. Alternative energy sources
m. Fish forecasting

We have “guesstimated” the fuel-saving potential for each of these areas, some of the figures are quite reliable, others are outright guesswork.

5. Speed and Power Reduction

The smaller and middle-size Norwegian fishing vessels are grossly “overpowered”.

In the top of the speed range resistance increases with speed in the 6th to 8th power.

A 10% reduction in free running speed therefore reduces fuel consumption by 30-40%.

On a yearly basis this would give the following estimated fuel savings:

- Trawling : 12-15%
- Longlining : 15-20%
- Coastal fishing : 20-25%
- Purse seiners : 20-25%

The total estimated saving for the Norwegian fleet: 60-80000 tons a year.

The question of economical speed is presently being investigated, and is dealt with in the paper “Fishing Vessel Speed and Fuel Economy” by Digernes and Endal.

6. Choice of Fishing Methods

From table 3 it is quite evident that there are considerable savings involved switching from trawling to longlining. Approximately 25% of our food fish is taken by trawlers.

Reduction in fuel consumption for food fish by switching to passive methods is estimated at 15 to 20%.

7. Improved Propulsion System

Reduction of propeller design rpm and number of propeller blades are effective ways of reducing fuel consumption.

Such actions are usually limited to new vessel constructions.

EXAMPLE:

Seiner 185 feet, speed 16 knots, power 3600 hp at 350 rpm on the propeller.

If propeller speed is reduced to 200 rpm and propeller diameter increased accordingly, the necessary power is reduced to 3000 hp at 16 knots.

Rule of thumb: A 40% reduction of design rpm for the propeller will reduce fuel consumption 15% when free running.

Additional benefits may be reaped by reducing the number of blades.

Reducing number of blades from 4 to 2 will reduce fuel consumption an additional 15%, for a total of 30%.

Draft limitations and hull design may hamper such development, as propeller diameter increases.

A 110 ft vessel with 2200 hp, 4 bladed propeller at 14 knots running at 350 rpm has a propeller diameter of 2.47 m.

A 2 bladed propeller at 200 rpm and 14 knots, requires only 1500 hp, but the propeller diameter is increased to 3.76.

A 30% reduction in power here calls for a 30-40% increase in propeller diameter.

For very slow speeds and low power (longlining etc.) a “second” gear may be fitted to allow the propeller to run at very low rpm.
Longlining is a type of fishing where only a fraction of main engine horsepower is used.

For such fishing a twin engine installation may give a reduction of fuel consumption from 4-8% depending on the pattern of fishing.

An installation as indicated in fig. 2 would give 3 power ranges 2, 4 and 600 horsepower, which would allow full advantages to be gained from economical speed considerations.

Additional savings may be achieved in longlining by introducing a 2-speed propeller arrangement, allowing both the engine and propeller to run under optimum conditions at low vessel speeds.

9. Use of Heavy Fuels

To burn heavy fuels, present technology requires main engines with a speed of less than 750 rpm.

Almost all of our large seiners and trawlers may be converted to heavy fuel, using a dual fuel system, where marine diesel oil and heavy fuel are mixed in an emulsifier in proportions to suit the engine load.

The only attraction with heavy fuel is its cheapness, compared with marine diesel fuel.

The price of 1500 sec redwood marine fuel is normally 50-60% of diesel fuel.

The curves in fig. 3 shows price development for fuel.

On the other hand, the use of heavy fuel will lead to increased maintenance and trouble which will off-set fuel savings.

Estimated cost saving potential 25%.

10. Improved Auxiliary Power Systems

Electrical power systems on fishing vessels were grossly underdesigned 20 years ago. Designers overreacted and a lot of oversized inflexible power systems were installed. Lightly loaded generators, depending on type of engine, may have extremely poor fuel efficiency.

A lot of shaft generators were installed, driven by the main engine at full rpm, using C.P. propellers for vessel speed control.
This is an extremely fuel-wasting method of producing electric power.

Modern shaft generator systems allow change in main engine speed, and electric power produced by the main engine may then be 15% cheaper, due to lower fuel consumption.

Modern main engine-driven generating systems make it possible to produce electricity using heavy fuel, with a potential reduction in the fuel cost per KwH of 50%.

Savings potential for a typical Norwegian trawler would be:
N. kr 50-100,000 per year, and half that for a middle water longliner.

11. Improved Hull Forms

The importance of hull forms probably plays an exaggerated role in the minds of naval architects.

As economical speed is reduced by increasing fuel cost, so is the importance of hull form on fuel economy.

Introduction of bulbous bow may have some effects at higher speeds. Fuel saving potential over best current practice 2-3%.

There is, however, need for much work on very beamy vessels, with special benefit for the near water and coastal fleet.

12. Waste Heat Recovery

Over 60% of the energy in the fuel oil is lost in exhaust gas and cooling water.

This energy may be used for heating, for cooling and for production of electric power.

Suitable technology is not developed for fishing vessels in this field.

Annual expense for auxiliary power on a Norwegian trawler may amount to N. kr 180,000 or 15% of the total fuel bill.

If suitable technology is developed (exhaust boilers, turbo-generators), 120-150,000 may be saved on electric power production.

13. Engine De-Rating

Economical power will be reduced as fuel prices increase.

As a result, existing engines will be too big as time goes on, with poor fuel efficiency as a result.

Changes may be made to timing, turboblowers and injection nozzles, that may improve fuel consumption 2-5%.

14. Improved Use of Controllable Pitch Propellers

The CP propeller is extremely popular in the Norwegian fleet, and is fitted to an estimated 95% of
our vessels.

We suspect that a considerable amount of fuel is wasted by improper practices when operating the propeller.

Properly used, the CP propeller is an asset in fuel conservation, improper use may turn it into a heavy liability.

The best fuel consumption is obtained by maintaining design pitch, and keeping the engine loaded for maximum fuel efficiency.

When reducing vessel speed this should be done by reducing rpm, not by reducing pitch.

Reducing the load to 25% by constant rpm from A to B, (Fig. 1) gives poor fuel consumption.

Reduction along the constant pitch line DC gives a much better result.

The efficiency of the propeller is benefitted by the same procedure, as can be seen from the diagram below.

**Figure 4**

To achieve maximum performance is a matter of education and instrumentation.

Savings potential is from 0-15%, depending on present practice.

15. Improved Fishing Gear

Reduction of trawl resistance will effect fuel consumption, and improved catch rates on longlines will affect the fuel ratio.

Preliminary figures for possible improvement is a 30% reduction in resistance for trawls, and 50% increase in catch rates for longlining.

16. Alternative Energy Sources

A complete return to sailing vessels in fishing is rather unlikely, but a substantial part of the energy may eventually again be taken from the wind and waves. It is however very difficult to estimate the saving potential, our best guess at the moment is that for longliners 15-25% of the fuel may be saved by wind and wave power.

17. Fish Forecasting

A substantial amount of fuel is spent looking for fish.

A systematic collection and processing of information on catches, catch rates, observations, etc. may serve as basis for fish forecasting in the future.

We are presently unable to even guess what effect such a system would have on fuel consumption, but we are working on it.

This paper represents our institute's first attempt at putting figures on the savings potential of various actions that may be taken.

Some of the figures given are fairly accurate and realistic, others are more or less guesswork.

My hope is that the paper will stimulate discussions on these matters, discussions that will provide additional insights into the field of fuel-saving.
WHITE FISH AUTHORITY PROJECTS RELATED TO FUEL CONSERVATION IN FISHING VESSELS
by J.S. Foster, Naval Architect
White Fish Authority
Industrial Development Unit

Introduction
The White Fish Authority was set up in 1951 by the British Parliament to reorganise, regulate and develop the white fish industry of the country. It acts as an agent of the Government in operating various statutory schemes intended to promote the economic well-being of the industry, some of the schemes are financed by the Exchequer and other by a statutory levy on the industry.

The term "white fish" is one which often causes puzzlement, it is defined in the Acts which set up the Authority as any fish found in the sea, except herring, salmon and migratory trout. It includes crustaceans, molluscs and shoaling, oily pelagic species other than herring. The industry, based on the exploitation of the herring, having its own statutory body in the form of the Herring Industry Board, was established in 1935.

Later this year, both the Authority and the Board will be abolished and a new organisation known as the Sea Fish Industry Authority will be set up in their place. This new body will take on the duties of the present bodies in attempting to promote and develop the efficiency of the industry as well as serving the interest of the consumer. Inevitably part of its programme of development will be in the form of project work to reduce or make more effective the use of fuel oil by fishing vessels. Examples of the work, which has been carried out by the Authority to further these aims, are as follows.

Performance Trials
Before any attempt can be made to improve the economy of any operation it is essential to observe the manner in which the operation is carried out and if possible, to measure and record various parameters which can demonstrate the effectiveness of the operation. All methods of deep sea fishing - trawling, purse seining, lining, etc. require a vessel to operate in regimes far removed from the steady state free running mode which traditionally is considered as one (if not the most important) design requirement to be satisfied. In practice the vessels spend as much as 75% of their time at sea in regimes far removed from this condition. The ability of a vessel to be able to work its gears effectively and to handle and stow its catch in a safe and acceptable manner are the criteria which will dictate the viability of the operation since ultimately it is what is brought up in the cod end or on the hook which pays the bills.

To understand the operations of fishing vessels it has been the policy of the Authority to institute performance trials on selected vessels. These trials consist of measured mile and fishing trials. The measured mile trial is used to establish the power/speed relationship for the vessel. The results of these trials are always of interest to fishermen as it demonstrates how expensive the last knot of speed can be in terms of fuel used. Fig. 1 shows the power/speed curve for a 24-meter multi-purpose seiner/trawler. It can be seen that the last knot of speed required an extra 160 horsepower which on the basis of typical consumption of 0.35 pounds/BHP/HR means an extra 56 pounds of fuel per hour consumed. At a nominal price of $336 per ton the cost of one hour's running at this speed is $20.2 as against $11.8 at 9.0 knots. The cost to run 240 miles would be $485 at 10 knots and $315 at 9 knots. The question arises "is it worth it?". The only person who can really answer that question is the skipper and he must justify it in terms of profitability. Whilst the speed/power curve can demonstrate in a neat classical way the premium to be paid for increased speed, the bulk of the fishing trip expenditure occurs during the actual fishing operations. Incorrect strategies in the use of equipment or the mode of gear handling result in higher trip costs. The fishing trials carried out by the Authority staff are aimed partly at obtaining measurements of equipment performance. This information is then fed back to the designers and manufacturers of the equipment with the aim of helping them to validate their design procedures and hopefully produce a more efficient unit, and partly to investigate the manner in which the skipper is handling his boat and equipment to see if lessons can be learnt about correct procedures to be used. It was from such trials that the results shown in figure 2, figure 3 and 4 were derived.

Figure 2 was obtained from a fishing trial conducted on a 240 foot stern trawler fitted with a 2380 horsepower engine running at 275 revs/min. and a Liaaen controllable pitch propeller of 0.137 feet in diameter. P/D Ratio = 0.70 (full power at full speed). The gearing was 1:1. The purpose of the trial was to examine how best to use the propeller and engine. The trials were carried out on clean ground using a bottom gear of the Granton type and consisted of towing the gear at four engine speed settings and at six different propeller pitch settings. The parameters which were then measured were:

- Shaft Torque
- Wind Speed
- Shaft Speed
- Wind Direction
- Ship Speed
- Pitch
- Warp Tension
- Roll
- Propeller Pitch Setting
- Heave

From the figure it is evident that for all values of warp tension there is an optimum pitch/diam value of 0.527. On this particular vessel because of limitations on minimum engine revs to achieve satisfactory...
electrical generation capability, the optimum pitch/diam ratio could not be used below 11.5 tons. The range of tensions required in service lay between 7 and 10 tons so that for minimum power conditions engine speeds of 180 and 215 would be required. If it was possible to operate in this region then the power required for towing would be 100 horsepower less than that normally used at 250 revs/min, the average shaft speed currently used. This would produce an annual saving of $17,684 in fuel cost. Whilst this approximates to only 2% of the annual fuel, cost the difference between that which could be achieved by running at optimum revs and pitch as against constant maximum speed would be as high as 6% or $53,000.

Figures 3 and 4 can be used to demonstrate the same point; that misuse of equipment can lead to higher fuel costs. These figures were derived from a fishing trial where the object was to record the behavior of pelagic trawl with the intention of providing basic information on the respond characteristics of these types of trawls in order to develop an active fishing simulator. This simulator has been developed and is used by the National College in Hull to introduce skippers to the problems of towing pelagic trawls. Indirectly this is helping to save fuel and costs as it enables the skipper to make mistakes without using ship time or paralysing a real trawl. From an analysis of the information collected it was possible to plot diagrams as shown in the figures. From figure 3 it can be seen that by increasing the power to the propeller, the thrust increased causing the warp tension to increase from 11 to 15 tons. To achieve this a power increase of approximately 400 horsepower was required and an elapsed time of 10 minutes was necessary before the net levelled off at a constant depth 22 fathoms above the original towing point. To maintain this level a total power of 1500 horsepower was necessary. If on the other hand, the winch is used to haul the net then a shift of 20 fathoms would be achieved in approximately four minutes for the dissipation of a lot less total power or fuel as illustrated by figure 4. This figure shows the effect of shortening warp length by 50 fathoms. To achieve this type of performance it is necessary to have a winch capable of hauling against an initial pull which in this case was 11 tons. Whilst vertical movement of the trawl can be achieved both quicker and with the use of less fuel by using the winch it is not without its risks if the trawl is being towed close to the seabed. If changing position is to be carried out using the winch then due allowance must be made for the fact that during the time the winch is being started up and the ship is slowing down, the trawl will sink. The operation should not be carried out unless there is sufficient power in hand to initially lift the trawl prior to starting the winch or alternatively the trawl is being towed into deeper water.

Gear Development
Two projects are currently in hand for the improvement in two methods of fishing; these are mechanising of long-lining and electric fishing.

Long-Lining
Long-lining has traditionally been a very labour intensive method of fishing. With the general extension of fishing limits to 200 miles and the introduction of Exclusive Economic Zones (EEZ) it was thought by the Authority in 1975 that greater efforts should be made to mechanise long-lining. The reasons for this were:

1) The loss of traditional trawling grounds would put greater pressure on those grounds available for trawling and therefore ways should be found to encourage greater exploitation of non-trawling grounds. Whilst handling of nets had already been mechanised through the use of the power block or net drums, long-lining was still very labour intensive with the major demand on labour being in baiting the hooks. If fishermen were to be encouraged to take up this method then some form of mechanisation would be required.

2) Because line fishing is highly selective, with the size of the hook dictating size and age of fish, it was felt that vessels engaged in this method of fishing would be more acceptable to fishing nations when seeking revised fishing quotas.

3) Encouraging fishermen to adopt a passive system of fishing would require less fuel to be used than that required for trawling.

With these facts in mind, the Authority has developed the Autoclip system which is now ready to go into production. The system has been designed for vessels of 45 feet in length and upwards. A prototype system has been at sea for fourteen months and has been successful both commercially and economically in that the skipper has used it without subsidy other than being loaned the equipment at no charge.

The basis of the system is a plastic clip with which the snoods (hook and trace) (Fig. 5) can be automatically attached to and detached from the main line. The removal of the snoods enables the base line to be stored on a reel and the snoods in a storage rack such that the hooks are in an oriented position for feeding through an automatic baiting mechanism when shooting.

The items of equipment which make up the complete system (Fig. 6) are:

Hook Storage Rack
Each rack carries 100 hooks. The hooks are contained on an upper stainless steel folded section with clips on a rail at the foot of the rack. Racks are designed to fit onto the shooting rig where they align with a similar rail section onto which the snoods are transferred for shooting.
Shooting Rig

This mechanism performs the function of attaching the snoods to the line whilst it is being shot over the stern of the boat and baiting the hook during the operation.

Snood Attachment

A storage rack is fitted to the shooting rig where it is locked in alignment with the magazine rack. Clips are then fed manually from storage rack to magazine rack. Since the hooks are connected to the clips by the trace, the hooks are also transported onto the magazine rack.

Forming part of the clip rail of the magazine rack is the clip feeder mechanism. This consists of a long stroke double acting pneumatic cylinder powering a ratchet tooth which engages with the stack of clips on the rail. A low pressure air supply gives a constant force on the clips, pushing them up to a hammer which drives them onto the moving line. The line is constrained to run through the rig by a series of pulleys and in the location of the hammer, an anvil supports the line against the impact of the hammer. Having pressed the clip on the line, the hammer pivots out to receive the next clip, the fastened clip pulling clear of the hammer and running with the line.

As the clip travels with the line, the snood draws the hook off the hook rail into the hook track which guides it down a 45° slope to baiter level and orientates it for entering the baiting section.

Baiting

The baiter consists of a vertical tube above a base plate. At the bottom of the tube a horizontal guillotine knife blade is positioned to move across the opening of the bait tube cutting through any projecting bait. Thickness of bait is governed by the height between knife and base plate.

The bait feed tube incorporates a toothed feeder rack which is reciprocating up and down by spring loaded single acting cylinder. The rack is powered up, the teeth riding over the bait and on the spring loaded down travel, the teeth grip, transporting the bait down.

The snood attached to the line pulls the hook along the hook track and into contact with the bait. Bait and hook then travel onto the bait tension lever which consists of two tensioned claw shaped wires which rotate the bait onto the hooks to ensure it does not fall off.

Hauling Rig

The function of this rig is to release the snood clips from the line so that they can be manually stored on the storage rack. The rig is mounted on the vessel between a line hauler at the starboard rail and a hanging block on the port rail. The line is hauled by the hauler through the hauling rig from the hanging block and the snood released from the line by a pneumatically driven hammer forcing the clip off.

Line Hauler

Almost any type of line hauler can be used i.e. Spencer Carter 1000 pound hauler with vee wheel.

Line Storage Drum

Drum capacity 2 miles of 7 mm diameter line (drum capacity 950 mm OD x 900 mm wide).

Low speed, high torque hydraulic motor drives the drum with a relief valve in the circuit limiting the pull on the line to the required tension.

The drum is connected hydraulically in series with the line hauler and acts as a take up spool retrieving the line as the hauler pulls it in. To enable the drum to free wheel when the line is being paid out, a by pass valve is fitted. A disc brake assembly on the drum enables the rate of pay out to be checked as required.

Hanging Block

A large diameter flat section pulley with deep flanges suspended from a davit is used to bring the line inboard. It is not possible to use a normal three roller fairlead since the high radial load generated as the clip rides over a small roller would cause the line to pull out of the clip. Using the large diameter pulley overcomes this problem.

Anchors

Apart from the main anchors at each end of the line it is necessary to set intermediate anchors. As the line is stored on a drum and contained in the shooting rig when shooting, it was not possible to fasten an anchor onto a loose bight of line as one would with traditional lining and special snap on anchors had to be developed. These anchors have been designed to quickly and easily attach to the line aft of the shooting rig.

Operation of the System

Shooting

1. The line from the line drum is led aft, via the pulleys and fed through the shooting rig.
2. Hook storage rack fitted to shooting rig and a quantity of the clips transferred to feed mechanism.
3. Mackerel bait, headed and tailed is placed near baiting section and system ready to shoot.
4. Anchor and Dahn are tied to line aft of shooting rig and let go.
5. Brake on line drum released. Vessel accelerates away from dahn and line pulled off drum and through shooting rig.
6. Bait is fed down bait tube, rig switched on causing clips to be attached to the line at the desired spacing set on the control box (control exercised from a line driven pulley
which activates a magnetic reed switch once per revolution. One revolution is equivalent to 0.3 m (1 foot). Control box can select from 4 pulse to 16 pulse intervals i.e. spacing of 1.2 m (4 feet) to 4.8 m (16 feet).

7. As the hooks pass through the baiter section they are baited and continue out of the baiter into the sea. For soft bait, the spring loading on the tension arm is reduced, and for hard bait increased.

8. As hooks are used up, more are transferred from the hook storage rack. Empty racks are replaced with full ones, the shooting rig continues to function using hooks on the magazine section whilst the storage racks are changed.

9. Shooting speed is controlled by the skipper in the wheelhouse.

10. When an anchor has to be attached, the rig is switched off, stopping the attachment of the hooks, the anchor snapped onto the line and the rig switched on again. This operation takes a few seconds typically there being only 3 m (10 feet) of bareline either side of the anchor.

11. At the end of the shoot vessel is slowed down and stopped such that the line can be disconnected from the drum. A dahn and final anchor is then connected to the released line which is then let go.

**Advantages of System**

1. Elimination of manual baiting. For 5000 hooks this is estimated at 6 hours.
2. Baiting efficiency is 90%.
3. Shooting speed 4.5 knots. Could possibly be increased by modifying electrical control system.
5. Variable snood spacing, enabling the gear to be set to suit the fishing conditions.
6. Detachable snoods giving efficient gear stowage and eliminating the problems of fish removal.
7. Safety. All the hooks are contained in the mechanism and their attachment can be stopped at the touch of a switch, bare line only being shot.
8. Speed. Automatic baiting means that the line can be reshot immediately after hauling.
9. Compactness. System can be installed in vessels as small as 33 feet.

**Crew Opinion**

The system has enabled a crew of four to have the capability of handling the same gear as would require a crew of seven.

**Electric Fishing**

A fish subjected to an electric shock will be stimulated to dart away from the source of power. It is very easy to administer a shock to such fish as sole, plaice and certain species of shrimp which are partially buried in the sand of the sea bed. If the timing of the electric shock and the response can be controlled then the fish can be made to move upwards into the path of an approaching trawl.

There are obvious advantages in applying this principle to trawling and most important is the reduction or elimination of tickler chains and chain mats used on the fishing gear engaged in the flat fish fishery. Not only do the chains require a lot of power to tow and hence cause high fuel consumption, but they churn up the sea bed and can destroy food sources and immature fish.

The White Fish Authority has been experimenting with electric fishing for the past three years mainly with the objective of saving fuel for those vessels engaged in flat fish fishing.

The basic electric fishing system is not new. It was developed in America some time ago for catching brown and pink shrimp in the Gulf of Mexico.

The Authority was sufficiently encouraged by the American reports to try a modified form of the equipment on the high value Dover Sole, plaice and other flat fish species.

To ensure satisfactory comparison between electric and non-electrified fishing gear, 4 meter beam trawls have been used in the first development.
stage. This work has now been finished and the gear is being used commercially for a year to make serious assessment of its potential in routine working conditions on a double beam trawler.

This trawler is of 22.5 meters overall length built in 1918 and re-engined in 1956 with a Kromhout 240 horsepower@ 600 revs/minute. The choice of a double beam trawler for the first experiments was made because it simplified the mounting of the pulse generator on the trawl. Extension of the technique to otter trawling is the next step and this stage of development is intended to take place this year.

**Basic Principles**

In electric fishing, the tickler chains (fig. 7) are replaced by a lightweight set of trailing electrodes (fig. 8) fed by a series of electrical impulses from the ship. These impulses produce an electrical field giving the fish a mild electric shock causing them to make "an involuntary flight reaction" making them jump off the sea bed into the path of the trawl.

The advantages of this system are:

1. **Fuel Saving** – because the gear is lighter its resistance is lower and to keep it on the sea bed the vessel has to tow slower the combination of which reduces the fuel consumed. The trials have indicated levels of fuel saving of 40% whilst fishing amounting to about 18% over a complete voyage.

2. **Reduced Gear Replacement Costs** – gear costs form a substantial part of the expenses of vessels fishing flat fish. The replacement of costly chains and shackles, which are liable to very rapid wear, is completely eliminated and this more than compensates for maintenance costs of the electrical system.

**Electric Fishing System**

1. A generator, giving 240 volts single phase 50 hertz @ 16 KVA.
2. An Isolating Transformer.
3. Bridge Control Unit to convert AC supply to pulsed DC.
4. Two self tensioning electric/hydraulic net sounder type winches fitted with 250 metas (135 fathoms) of welding cable type 036 ITQ.
5. Two pulse generators mounted on the beams.
6. An electrode array towed ahead of each trawl.

**Fishing Gear**

This consists of two 4 meter beams fitted with round bellied nets.

The ground rope was 29 feet x ½ in diameter chain covered with 6 inch rubbers in the bosom and bunt sections, an electrified 15 foot transverse chain and five galvanised wire electrodes trailing from the beam (Fig. 8).

The 240 volt AC supply from the Alternator is fed to the bridge control unit via the isolating transformer. This unit essentially converts the AC to continuous pulsed DC for each output channel. The input is rectified and the positive half sine waves fed via 25 mm² welding cable to the pulse generator on the trawl. The return path of the electrodes to the ship is through the sea water and the total voltage drop of the system is about 225 volts.

The pulse generator unit on the trawl contains a bank of capacitors totalling 10,000 micro farads which store the energy transmitted down the cable and release it in short pulses to the electrodes. The whole unit is enclosed in a stainless steel body fitted with transformer oil to help in heat dissipation and is well sealed against sea water.

The charging of the capacitors continues for 13 positive half waves. The timing unit then operates the trigger network to discharge the stored voltage across the electrode array on the trawl. The frequency of impulses called the pulse repetition frequency (PRF) was finally set a 4 per second (4 hertz) with the electrode voltage at 210.

A number of electrode arrays were used to give adequate electrification of the whole trawl mouth area.

It is important that the electrodes are in contact with the sea bed to give good stimulation to partially buried fish. The galvanised wire electrodes were developed as being the cheapest and most effective.

**Performance of Electrified Trawls**

It would appear that whilst the electrified trawls are not catching any more fish than conventionally rigged trawls they do reduce the cost of catching them for the reasons stated earlier i.e. reduce fuel and gear costs. Other advantages quoted by the skipper of the vessel in which the gear has been worked are:

1. The electric trawl because it is lighter does not dig in as deep as the chain rigged trawls. The effect of not digging in is a considerable reduction in rubbish being ploughed into the net, this permits the trawl to be towed for longer increasing effective fishing time. In addition the reduction in rubbish reduces the load on the crew in sorting the fish and then shovelling the rubbish overboard.

2. The system allows fishing over softer ground.

3. The fish quality is improved as they do not suffer abrasion damage from contact with the chain mat of the conventional trawl. This improvement in quality is reflected in higher prices at the market.

During the 1978 trials the fish catches were lower than for vessels fishing conventional gear. This was not unexpected as considerable experimentation was taking place to find the best electrodes, PRF and voltages. By 1980 catch rates were very favourable and the vessels gross earnings were up.
60% compared to a vessel of similar size and horse power using conventional gear, whilst catches were up by about 40%.

Fuel savings are the other major consideration. When using the electric rig consumption was 3.5 gallons of oil/hour. Using conventional gear the figure was 6 gallons/hour. After making allowances for steaming and operating the larger generator, the fuel saving is estimated at at least 18% over a weekly cycle.

The disadvantages of the system is that there is a need for an AC power supply. Many small vessels considering switching to electric fishing may find that their generator capacity, if it is AC at all, is insufficient. A new generator of adequate power could cost around $14,000. The remaining equipment costing in the region of $50,000 for a double beam trawler including spares and cable winches.

The next stage in development is to adapt the electric system to the otter trawl. This will create more problems than were encountered with the beam trawl since warp length used are longer than that with the beam trawl. The cable carrying the electric impulses will be required to be longer and the problem of cable abrasion on the sea bed could be considerable. In addition the length of cable in the water will require more powerful self tensioning winches. Whether these problems will produce a solution which is not as economically attractive as that for the beam trawl, the Authority hope to be able to prove by the end of this season’s fishing in the Autumn.
Figure 1

PROPPELLER SHAFT POWER, SHAFT REVOLUTIONS AND
PROPPELLER THRUST PLOTTED AGAINST SHIPS SPEED
THROUGH THE WATER (RESULTS CORRECTED TO STILL AIR AND TIDE FREE CONDITIONS)

SHIPS SPEED (KNOTS)

0 1 2 3 4 5 6 7 8 9 10

PROPPELLER THRUST (TONS)

0 1 2 3 4

PROPPELLER SHAFT POWER (HP AND KW)

0 (75) 100 (225) 200 (150)

PROPPELLER SHAFT REVOLUTIONS

0 100 200 300

hp 400 kw (300)

Figure 1
OPERATING RANGE WITH ELECTRICAL GENERATION FROM MAIN ENGINE

SHASH HORSEPOWER

PITCH/DIAMETER RATIO

TORQUE 35000 FT-LB

13 TON 5 KNOTS
12 4-65
11 4-3
10 3-9
9 3-5
8 3-1
7 2-75
6 2-35
5 1-90
4-50
3-2
2-20
1-40
0-60

Figure 2
1600 MESH BY 20 cm
ENGEL MIDWATER TRAWL
ACCELERATION TRIAL 4

FIG. 6b.
1600 MESH BY 20 cm
ENGEL MIDWATER TRAWL
ACCELERATION TRIAL 5.
1600 MESH BY 20 c.m. ENGEL MID WATER TRAWL EFFECT OF HAULING 2 LENGTHS
CRIMP FORMING SWIVEL

BRAIDED LINE

SNOOD CLIP

MONOFILAMENT NYLON

SNOOD

HOOK

CRIMP
LAYOUT OF THE 'AUTOCLIP' SYSTEM ON THE ALISON JANE
Chain Mat Rig

Figure 7

Frame Chain 10m (33 ft.) × 125mm (5 ins.) × 22mm (⅞ ins.) link.

Groundrope 11.1m (36 ft.) × 22mm (⅞ ins.) dia. swr. with 230 × 180mm rubber rollers and 150mm rubber discs.

Chain Mat = 3 link squares of 16mm (⅜ ins.) dia. chain
Total weight of Chain Mat = 0.55 tons
Total weight of Fully Rigged Trawl = 1.9 tons

16mm (⅜ ins.) 'D' Shackles

56
Detail A
- D Shackle
- 14 mm Prestretched Terylene Rope
- 20 mm Prestretched Terylene Crossrope
- Plastic Tube
- Rubber Disc
- S.S. Shackle
- Copper Ferrule
- Electrode Supply Cable (Bolted to Ferrule)
- Electrode (20 mm dia.)

Detail B
- Electrode ((20 mm dia.)
- S.S. Shackle
- Plastic Tube
- 14 mm PP Rope Strop
- Transverse Chain Electrode
- 2 Shackles
- 75 mm (3 ins.) Rubber Disc

Detail C
- Insulated Supply Cable
- Transverse Chain Electrode
- Nylong Rope
- Rubber Cont’n.
- Non Insulated Supply Cable
- Ground Rope

Trailing Wire/Transverse Chain

Fig. 8
A PROGRAMMABLE DATA LOGGER FOR ENERGY MANAGEMENT USE
by Hugh A. Macpherson, P. Eng.
SEIMAC LIMITED

Introduction
The topic of energy management in the fisheries is both complex and wide-ranging. The very fact that this seminar is scheduled to extend over three days is evidence of this. Energy management is a subject requiring consideration and input from a host of supporting professionals in addition to professional fishermen. Naval architects, marine engineers, equipment designers, economists, operations analysts, captains, fleet managers and process engineers can all contribute to the goal of improving upon our use of energy in the landing and processing of fish. In reaching their conclusions concerning the catching and landing of fish investigators must analyse data which describes the workings of the fishing vessel in quantitative terms. This involves some sort of instrumentation and data logging system on board and I would like, in this paper, to present some ideas on this activity. The paper will first discuss some of the technical requirements of a logging system and then give a brief description of one design for Fisheries Development Branch (DFO).

Requirements
To define, and then design, a data logging system, requires setting out a statement of requirement which should answer the following questions:
(a) What are the inputs to be measured and logged,
(b) With what accuracy must they be measured, and
(c) At what frequency and how much data is to be collected?

Inputs
A list of the potential measurements could be as long as the imagination allows. Clearly almost all activities on board ship involve the expenditure of energy but equally clearly some are dominant. This list of factors to be measured then becomes one of relative priority.

At the top of the list one must put fuel consumed, the basic input to the energy equation. Most studies on energy consumption relate engine output in bhp to various activities which occur throughout a trip. Although this gives a reasonable picture of the relative importance of the various factors in the energy equation it does not account for energy lost in the basic process of converting fuel to useful work – that is, engine efficiency. Improvements in fuel utilization of up to 15% for well tuned and maintained engines point to the necessity of fuel input measurements rather than simply engine output to identify this potential source of energy savings. Following from this reasoning then one must consider shaft torque and rpm as vital inputs to a logging system. Propeller pitch is equally useful in developing the relationships which relate pitch/diameter ratios to most efficient engine operating ranges. These four measurements, coupled of course with a log of real time, provide a basic picture of engine operation. For engine efficiency, consideration of other parameters such as fuel rack, air and exhaust temperatures, etc. should also be recorded.

The second set of parameters concerns vessel activity; speed, winch operation, warp tensions and vessel motion. All of these with the exception of warp tension, are usually available from the normal vessel installation or are easily instrumented.

In a more detailed examination of specific energy consumption areas, additional instrumentation would be necessary to provide data on precise speed through the water, environmental data and the performance of auxiliaries.

In summary, then, a basic data logging system should examine the following:
(a) Fuel consumed (requires measurement of forward and return lines)
(b) Shaft rpm
(c) Shaft torque
(d) Time
(e) Propeller pitch
(f) Speed
(g) Ship motion (pitch and roll)
(h) Warp tension (or failing this at least a reading of winch activity)
(i) Expandability for more detailed investigations.

The selection of the vessel instrumentation to provide the necessary inputs to the logger is a complete study in itself. We will be concerned here only with accuracy requirements, logging rates and data storage.

Accuracy
Both accuracy and repeatability must be considered. The latter is important in the "before and after" type of measurement designed to test the efficacy of an equipment modification or change in operational procedure. Considerations of accuracy require some knowledge of what the data is to be used for and thus an idea of the trade-offs between very precise measurements and cost of the measurement. In the case of a data base application the same degree of precision is not as vital as in a dedicated examination of the performance of a piece of equipment. In our list of measurements shown previously, one would likely rely on the shipfitted equipment for speed and propeller pitch and the accuracy here could not be expected to exceed 3 to
4%. One questions therefore the need for much greater precision than this in the other measuring devices. Since most of the commercially available fuel flow meters, torsionmeter, pressure sensors, thermocouples, etc. quote accuracies in the order of 1% there would seem little need to strive for more precise instrumentation. This measure of accuracy poses no particular constraints on a digital logging system since the very common 8-bit capability gives better than 1/2 of 1% accuracy. The need for a measure of repeatability without the requirement to engage in an expensive calibration program implies the use of pulsed sensors rather than analog wherever practical.

We have now established that some 10 inputs would suffice for a simple logging system designed to provide data base information and that 8 bits of information per reading would be sufficient.

**Frequency of Measurement and Data Quantity**

If we can determine the frequency at which measurements must be made we would then be in a position to define the storage requirements of our data logging system.

Figure 1 and Table I (adapted from Bennet, et al) show a typical trip profile and the percentage of time one could expect a trawling vessel to be engaged in its various activities. These figures are for a particular type of operation out of the United Kingdom and would not necessarily reflect the profile for local operations. For simplicity's sake one can assume half the time we spend fishing (80% towing and 20% handling) one third of the time in passage and the remainder changing grounds, laying to or avoiding weather. There would thus appear to be three separate modes of operation; a steady state, a quasi-steady state and a period of rapid changes in

![Figure 1](attachment:image.png)

**Figure 1**

*Power Demand During a Typical Fishing Cycle*
energy use. Within the steady state condition a logging interval of once per hour would likely be acceptable. The quasi-steady state (while towing) might require logging intervals of 6 times per hour and there are times within this period, such as during winch operation, hang-ups or the maneuvering of mid-water trawls when there are rapid changes in energy consumption requiring a much more frequent logging interval. While shooting or hauling, the logging rate might need to be greater and in periods of rapid maneuvers a rate of once every 10 seconds might be useful.

### Table I

<table>
<thead>
<tr>
<th>Activity</th>
<th>Percentage of Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passage</td>
<td>37</td>
</tr>
<tr>
<td>Changing Ground</td>
<td>11</td>
</tr>
<tr>
<td>Avoiding Weather</td>
<td>11</td>
</tr>
<tr>
<td>Fishing – Towing</td>
<td>34</td>
</tr>
<tr>
<td>– Handling</td>
<td>7</td>
</tr>
</tbody>
</table>

Activity as a Percentage of Total Time of Voyage

Let us now examine a theoretical trip of 14 days using the following criteria:

- Number of points – 10
- Resolution – 8 bits (½ of 1%)

<table>
<thead>
<tr>
<th>Log</th>
<th>Number of Bytes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log Sequential Number</td>
<td>5</td>
</tr>
<tr>
<td>Time</td>
<td>9</td>
</tr>
<tr>
<td>Fuel Consumption (instantaneous)</td>
<td>7</td>
</tr>
<tr>
<td>Fuel Consumption (total)</td>
<td>7</td>
</tr>
<tr>
<td>Speed</td>
<td>6</td>
</tr>
<tr>
<td>Propeller Pitch</td>
<td>5</td>
</tr>
<tr>
<td>RPM</td>
<td>5</td>
</tr>
<tr>
<td>Warp Tension (stb)</td>
<td>5</td>
</tr>
<tr>
<td>Warp Tension (port)</td>
<td>5</td>
</tr>
<tr>
<td>Winch Activity</td>
<td>4</td>
</tr>
<tr>
<td>Ships Pitch</td>
<td>4</td>
</tr>
<tr>
<td>Ships Roll</td>
<td>4</td>
</tr>
<tr>
<td>Distance Run</td>
<td>5</td>
</tr>
<tr>
<td>TOTAL</td>
<td>66</td>
</tr>
</tbody>
</table>

Thus a total of 165,000 bytes would need to be stored each trip. This is within the capacity of most readily available cassette tapes.

### Table II

<table>
<thead>
<tr>
<th>Activity</th>
<th>Hours</th>
<th>Logging Rate</th>
<th>Total Number of Logs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passage</td>
<td>110</td>
<td>1/hour</td>
<td>110</td>
</tr>
<tr>
<td>Fishing – Towing</td>
<td>134</td>
<td>6/hour</td>
<td>804</td>
</tr>
<tr>
<td>– Handling</td>
<td>34</td>
<td>30/hour</td>
<td>1620</td>
</tr>
<tr>
<td>Lying To</td>
<td>58</td>
<td>6/hour</td>
<td>348</td>
</tr>
<tr>
<td>TOTAL LOGS</td>
<td></td>
<td></td>
<td>2282</td>
</tr>
</tbody>
</table>

Logging Requirement for a 14 Day Trip

Allowing for some contingencies one would state a requirement for maximum of 2500 logs/trip. The number of bytes required for each log we estimate as follows:
A Programmable Logger

General Requirement

We have postulated a data logging requirement wherein the data rate varies from one log every 2 minutes to one per hour. This raises the question as to what, or who determines the rate of logging. Clearly, a fixed rate is not useful. If one used a rate frequent enough to catch short term events then a great amount of redundant data would be collected and if one selected a fixed longer interval, say 10 minutes, then significant events could be missed. The rate, therefore, must be variable and for the system to operate unattended the logger itself must make the decisions on how fast to log. These decisions would be based on a number of factors; various parameters departing from a set value, a combination of these two, a combination of parameters changing, operation of the winches, or in special circumstances, human intervention into the process.

Since the threshold limits, rates of change and types of inputs will vary from vessel to vessel the logging system must be easily programmable. An equally cogent argument for an intelligent, programmable logger is based on the variations one can find in the ship-fitted sensors. The log should present the final data in readily understandable units without the need for post-trip processing other than that needed for simple format editing.

It was earlier mentioned that the data for a single trip of the type defined could be stored on a single cassette tape. Longer trips or a more comprehensive logging regime would probably exceed the capacity of the common tapes thus forcing the operator to change the tapes. The use of a 9 track tape or disk storage would eliminate this difficulty. However, both are considerably more expensive than cassettes and are not well suited for engine room operation. They also require more maintenance.

There is not an agreed standard on formats or order for the storage of this type of energy management data. The vessel logging system therefore can be programmed to store data in any convenient order. By using standard ASCII characters and by providing the facility for outputting data via common serial or parallel data ports we can achieve a good measure of compatibility with other computer systems which may be used to process or plot the measured values.

One further constraint on our logging system arises again from the variation in the vessels. The system should be completely self contained as regards power supply or be able to be operated from several of the more common supplies.

A Data Logging System

The proposed system designed to meet the performance objectives developed in the preceeding discussion is shown in Figure 2.

It is partially custom designed and partially assembled from existing off-the-shelf modules. It consists of a customized data sampler unit, a Hewlett Packard 9915 programmable logger, and a power supply.

Data Sampling Unit

The Data Sampling Unit (DSU) examines the multiplicity of different input signals presented to the data logger system from the sensors and periodically transmits digitized data samples over a standard communications circuit (RS232C standard) to the 9915. This system is presented in Figure 2 and the attributes of the DSU summarized in Table IV.

The DSU consists of an Intel 8748 microcomputer, a data storage memory, an uninterruptable calendar clock, input and output circuitry, and a main power supply. The basic DSU has been configured for up to 16 analog input signals, four pulsed input signals and 8 digital inputs. It has 3 status outputs and RS232C output. The analog input signals are sampled digitally at a pre-defined sampling rate. These samples are converted from binary numbers to base 10 numbers and are then transmitted to the 9915. Pressure sensors, temperature sensors, wind speed sensors and many others typically produce analog outputs. Some sensor signals may require amplification or conversion from current loop to voltage prior to digitization. The wire-wrap circuit boards used in the DSU permit addition of the required pre-digitization circuitry.

A fuel monitoring system must cope with many pulsed, or counting inputs. RPM is usually determined by counting the number of pulses received from the sensor over a known time interval. Often the sensor is a magnetic pick up sensing teeth on the flywheel gear. Since there may be a large number of teeth (pulses) per revolution, good accuracy is achieved. The "paddlewheel" or turbine type fuel flow sensor produces a pulse train. Depending on the sensor up to 25,000 pulses per litre may be expected. The ship's speed log typically produces 200 pulses per nautical mile or less. To accurately indicate log speed the DSU measures the time interval between pulses. For the newer speed logs up to 20,000 pulses per Nm may be available. In this case the DSU can be programmed to count pulses as done for RPM.

Digital inputs and status outputs are available if required. Engine or other alarms can be monitored using such inputs, with the required input signal conditioning. As indicated in Table IV considerable opportunity for expansion and modification of the DSU have been provided to meet the expanding and as yet not fully defined energy management program needs.

The DSU Configuration for its First Sea Trials

The first sea trial of this system employs a DSU in the Basic configuration. The DSU is programmed to sample the four pulsed inputs; Fuel Supply line,
Fuel Return line, RPM and Ship’s Speed Log. The Ship’s Speed Log produces 200 closures per Nm, hence the pulse interval is measured and inverted to yield speed. To condition sensor output signals for transmission to the DSU, miniature signal (pulse) amplifiers were built and mounted on the sensors. Propeller pitch ahead is converted from a pneumatic signal to a voltage using a silicon bridge pressure transducer. This signal is passed through one of the two differential amplifiers in the DSU and then presented as an analog input. The ship’s roll is measured using a pendulum potentiometer and sampled as an analog input. Every five seconds the analog inputs and the pulsed inputs are sampled and this data, along with the calendar time, is presented to the 9915 via the RS232C data link.
The Logging Device

Selection of a logging device is based on a number of factors; data storage capacity, programmability, reliability and cost among them. A number of manufacturers produce suitable devices. In this case we selected the Hewlett-Packard 9915A on the basis of low cost, ease of operation and easy access to program generation facilities.

The 9915 examines the data which comes in from the digital board every 5 seconds and carries out the following logging process. The data is first converted to the correct engineering units, that is the number of digital pulses is translated into gallon/hour, feet pounds, degrees, etc. Following this the 9915 compares these values with limits which are entered by the logging program. Do the values exceed or are less than a given limit, has the value changed by a certain amount over the last 10 seconds, or 10 minutes, has a certain event occurred? Depending on the answers the 9915 would then proceed to log the values on tape. Under steady state conditions the 9915 would log at set time intervals.

A significant advantage in using an intelligent logger such as this one derives from the ease of making changes in the calculation used to convert pulses into real units. The 9915 is reprogrammed using the BASIC high level language. Table V shows a comparison between using BASIC and microprocessor language to perform a simple arithmetic operation.

The 9915 is simple to operate. The program is stored either in EPROM or on tape and is automatically loaded when power is turned on. The

Table IV - Hardware Attributes of DSU

<table>
<thead>
<tr>
<th>FEATURE</th>
<th>BASIC CONFIGURATION</th>
<th>OPTIONS/EXPANSIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog Inputs</td>
<td>- 16 inputs, 0 to 5 volt, filtered and overvoltage protected, sampled to 8 bit (0.4%) resolution.</td>
<td>- Additional inputs, groups of 16 as required.</td>
</tr>
<tr>
<td></td>
<td>- 2 differential amplifiers, protected inputs. Used with thermocouples, Wein bridges, etc.</td>
<td>- Current loop inputs (4 to 20 ma).</td>
</tr>
<tr>
<td>Pulsed Inputs</td>
<td>- 4 pulse counting inputs. Maximum rate of count of 10000 pulses per second. Voltage protected inputs.</td>
<td>- Optically isolated current.</td>
</tr>
<tr>
<td>Digital Inputs/Outputs</td>
<td>- 8 TTL levels all inputs or all outputs.</td>
<td>- Further pulse counting inputs (groups of 3).</td>
</tr>
<tr>
<td>Status Outputs</td>
<td>- 2 open collector status lines (100 ma)</td>
<td>- As needed.</td>
</tr>
<tr>
<td>Communication Outputs/Inputs</td>
<td>- 1 output, RS232C at desired baud rate (9600 standard).</td>
<td>- 1 input/output, RS232C at desired baud rate</td>
</tr>
<tr>
<td>Digital Computer Hardware</td>
<td>- INTEL 8748 microprocessor</td>
<td>- RS422/RS422 communication or 20 ma current loop if required.</td>
</tr>
<tr>
<td></td>
<td>- Program Memory of 2280 bytes</td>
<td>- Additional 2048 or 4096 bytes as needed; no alterations required.</td>
</tr>
<tr>
<td></td>
<td>- Data Memory of 2280 bytes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Calendar clock with battery backup (uninterruptable) supply</td>
<td></td>
</tr>
</tbody>
</table>

Table V

This table compares the amount of programming needed to add two numbers, I1 and I2, to produce a value of I3.

<table>
<thead>
<tr>
<th>Programming in BASIC</th>
<th>Programming in Assembler for a Typical Microprocessor</th>
</tr>
</thead>
<tbody>
<tr>
<td>I3 = I1 + I2</td>
<td>MOV/RO, # $11LOW</td>
</tr>
<tr>
<td></td>
<td>MOV/A, @R0</td>
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<tr>
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<td>MOV/R3, A</td>
</tr>
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<td>INC/R0</td>
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<td></td>
<td>MOVA, @R0</td>
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<tr>
<td></td>
<td>MOV/R2, A</td>
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<tr>
<td></td>
<td>MOV/R0, # I2LOW</td>
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<tr>
<td></td>
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<td></td>
<td>MOVA, @R0</td>
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<tr>
<td></td>
<td>MOV/R4, A</td>
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<tr>
<td></td>
<td>MOV/R3, A</td>
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<td></td>
<td>ADD/A, R5</td>
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<td>MOVA, R3</td>
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<td></td>
<td>ADDC/A, R4</td>
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<tr>
<td></td>
<td>MOVA/R0, # I3HI</td>
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<td>DEC/R0</td>
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<td>MOVA/R0, A</td>
</tr>
<tr>
<td></td>
<td>MOVA/R0, A</td>
</tr>
</tbody>
</table>

Basic/Assembler Comparison
Summary

This paper has described some of the factors involved in designing a logging system for vessel energy management studies. The essence of such a system is expandability and ability to cope with change. A system meeting these criteria has now been placed in service.
KORT NOZZLES – POWER WITH FUEL ECONOMY


SYNOPSIS: Although “Kort Nozzles” have been fitted to various types of vessel for almost 50 years, some scepticism still exists within the fishing industry worldwide. Perhaps this is only natural as we have taken fish from the sea for thousands of years; but as fuel costs soar, ANY WAY of cutting operating costs and improving fishing performance has to be considered in today’s economic climate. This paper looks at Kort nozzle design strategy and illustrates the performance of fishing boats fitted with Kort nozzles in recent months.

How a Nozzle System Works

A conventional open propeller produces thrust which is transmitted through the shafting to propel the boat.

Figure 1 illustrates simply the action of a nozzle which gives increased thrust, hence overall efficiency, without increasing engine power.

Due to the suction action of the propeller, water is accelerated through the nozzle mouth causing a pressure drop in this region. The pressure on the outer surface of the nozzle remains sensibly the same therefore a pressure difference is created across the aerofoil nozzle section which, acting on the flared entry area of the nozzle, produces additional forward thrust.

With a nozzle system therefore, propeller thrust plus nozzle thrust is produced.

The total thrust from the nozzle and propeller combined is greater than that produced by a comparable open propeller but actual ‘propeller thrust’ is normally lower than that of the open propeller. This means less load on the thrust block and gearbox. Thrust from the nozzle is transmitted through the hull via the nozzle hull connections.

This nozzle thrust component is a maximum at conditions of 100% slip, zero boat speed and progressively reduces as boat speed increases until a point is reached where the nozzle becomes ineffective and creates drag. However, with fishing boats this point is normally above the boat’s maximum speed and therefore the nozzle is effective over the whole boat speed range.

Because of the increased speed of water through the nozzle, a propeller working in a nozzle must have more pitch than an open propeller to absorb the same horsepower, at the same rpm, at the same boat speed, i.e. under the same propeller design conditions.

Compared with an open propeller with the same ‘design conditions’ a nozzle system will give 25% to 30% more thrust at the bollard condition (zero vessel speed where the nozzle is most effective) and between 20% to 25% more at towing speed.

Much larger increases are sometimes achieved but this only occurs where the ‘design condition’ of the open propeller and nozzle propeller is not the same. This point will be discussed later.

The importance of propeller design cannot be stressed too highly as the success of any propulsion system is measured by the efficiency with which the machinery design conditions are satisfied to suit the boat’s operating requirements, which leads us to the next section.

Figure 1. Action of Nozzle

65
Propeller & Nozzle Design Strategy

It is no good having a powerful engine if this power cannot be used at the required boat speed, either towing or steaming, and many examples have been found where a boat was fitted with a fixed pitch propeller with a pitch unsuitable for the boat's operation. This was the case for the U.K. fishing boat "Angelus" described later in the paper.

Variable pitch or 'two pitch' propellers have advantages for certain operating requirements where full engine power can be used for towing and steaming. Kort nozzles have been fitted in conjunction with both types of propeller, examples of which are given in Table 1.

Before continuing further, it is worth considering the relationship between thrust and horsepower and the importance of propeller diameter in this respect. After all, thrust or warp pull is probably the most important performance criteria for a 'towing' boat. However, a high engine power does not always mean a high towing pull as some owners have realised when boats with smaller engines have 'out-pulled' them.

Propeller diameter, pitch and number of blades, together with d.h.p. (power delivered to the propeller) are the main factors governing thrust. The following formula shows the relationship between these variables:

\[ \text{THRUST (long tons)} = \left(\frac{\text{d.h.p.}}{0.24}\right) \times \text{prop. dia. (ft)} \times B \]

The well known Barnaby coefficient, B, varies with propeller pitch for a given propulsion system. Number of propeller blades and type of nozzle section also affect this coefficient.

Consider a boat with 365 b.h.p. engine, giving 340 d.h.p. taking account of transmission losses, 61" propeller diameter and pitch/diameter ratio 0.905.

### Table 1

<table>
<thead>
<tr>
<th>System</th>
<th>( \beta )</th>
<th>Thrust (long tons)</th>
<th>Thrust (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 bladed open prop.</td>
<td>0.0300</td>
<td>4.32</td>
<td>9,678</td>
</tr>
<tr>
<td>3 bladed prop. in Kort nozzle</td>
<td>0.0400</td>
<td>5.76</td>
<td>12,904</td>
</tr>
<tr>
<td>4 bladed open prop.</td>
<td>0.0310</td>
<td>4.46</td>
<td>10,000</td>
</tr>
<tr>
<td>4 bladed prop. in Kort nozzle</td>
<td>0.0413</td>
<td>5.95</td>
<td>13,323</td>
</tr>
</tbody>
</table>

Fixed Kort Nozzle with Two-pitch propeller as fitted to the U.K. boat "Margaret Jane"
This illustrates the variation in thrust produced by 3 or 4 bladed propellers of the same diameter, with or without nozzles, but is the diameter correct?

Having selected an engine we can see from the above that propeller diameter should be as large as possible for a towing boat to give the highest possible thrust. Diameter will therefore be constrained by the space available in the boat's stern aperture and with this in mind, a suitable gearbox ratio can be selected. In some cases the diameter may have to be reduced to satisfy other operating requirements or available gearbox ratio, however, the bigger the diameter, the greater the possible towing power.

Selection of propeller diameter is therefore of prime importance for either an open propeller or Kort nozzle system.

When considering conversion of an existing boat to nozzle propulsion it is Kort design policy to select the largest propeller diameter compatible with the boat stern aperture and the engine/gearbox installed.

In some cases the hydrodynamically correct diameter cannot be fitted due to lack of space in the stern aperture and a propeller of reduced diameter must be fitted. However, it is propeller diameter and not nozzle outside diameter which is the key factor.

A Kort nozzle can always be designed to suit the space available and are supplied complete with hull connection plates above and below the nozzle designed to suit each individual boat. Following a laid down installation procedure, these plates are removed, trimmed and refitted by the yard on site.

This problem can be minimised and sometimes avoided with a new boat if the stern aperture is designed to suit the optimum ring nozzle. Even in this case, hull connection plates would still be designed and supplied with the Kort nozzle to ensure an adequate connection capable of evenly distributing the nozzle thrust to the aft end structure of the boat.

The question of the 'right' propeller diameter was raised before a recent conversion at the A.F. Theriault yard, Nova Scotia.

The stern dragger, "Benric", has a 365 b.h.p. CAT engine running at 1800 r.p.m. with a 6:1 gearbox and before conversion, was fitted with a 56" diameter four bladed open propeller.

A 61" diameter propeller was fitted with a fixed Kort nozzle which was the largest for the stern aperture, although 67" diameter would be the maximum for this engine and gearbox. Previous boats of this type had been fitted with a ring nozzle of 54" propeller diameter.

U.K. boat "Dolly Mop" with fixed Kort nozzle
Compare the following bollard pull figures which speak for themselves:

<table>
<thead>
<tr>
<th>System</th>
<th>Bollard Pull (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>56' open propeller</td>
<td>7,400</td>
</tr>
<tr>
<td>54' propeller in nozzle</td>
<td>10,750</td>
</tr>
<tr>
<td>61' propeller in Kort nozzle</td>
<td>12,000</td>
</tr>
</tbody>
</table>

Another factor influencing propeller diameter in Kort nozzle design is propeller blade loading and tip speed. Tip speed being a function of diameter and shaft r.p.m.

When blade loading and particularly tip speed, is high, the possibility of erosion of the nozzle inner surface due to propeller tip cavitation is increased.

Where this situation cannot be avoided a stainless steel insert would be fitted in the Kort nozzle, however, in overcoming this problem another is created. Electrolytic action between the adjoining stainless and mild steel in a seawater environment!

The deterioration of the butt welds between the two materials can be dramatic if these welds are not of excellent quality.

For this reason Kort nozzles are not fitted with stainless steel inserts unless absolutely necessary and it is often better to build the nozzle with a thicker than normal mild steel plate in way of the propeller tips if this problem is anticipated. This is especially true in cases where a boat may lay idle for long periods and/or the boat will operate in an area where the salinity of water is high.

For the majority of fishing boats a high propeller tip speed can be avoided by careful selection of diameter and shaft r.p.m. at the design stage.

Having selected propeller diameter, Kort nozzle and propeller are designed as a matched system to suit the operating requirements of the boat.
Propeller Design Condition

A variable pitch propeller can absorb full engine power at all boat speeds. A two-pitch propeller enables full power to be absorbed at pre-selected pitches for steaming and towing speeds.

With a fixed pitch propeller full power can only be absorbed at one speed, the ‘design condition’ of the propeller.

Speed is important for a boat which has to steam long distances to fishing grounds. In this case, a propeller can be designed to absorb full power from the engine when steaming, but towing ability will be slightly reduced as the propeller will absorb less power from the engine at a towing speed as the propeller is ‘overpitched’ for this condition.

Similarly, the propeller could be designed for towing but when steaming the propeller will be underpitched therefore full power cannot be absorbed, resulting in a slower steaming speed.

For these reasons the ‘design pitch’ of a fixed pitch propeller is of vital importance if the boat is to operate as required by an owner. This fact applies equally to an open propeller or nozzle propeller.

It is therefore essential that the propeller is designed after consultation with an owner to suit the operating requirements of his boat and a compromise is not made by fitting the most readily available stock propeller.

Kort Nozzle Types

There are two types of nozzle, a Fixed nozzle which is attached to the hull around the propeller and a Steering Nozzle which replaces a conventional rudder and rotates about the propeller tip axis.

A fixed Kort nozzle is most commonly fitted to fishing boats and can be attached quite simply to new and existing boats of all types of hull material. The connection may be made by welding (to a steel boat) or bolting (to wooden or glass boats).

The steering nozzle, or Kort nozzle rudder, is almost exclusively fitted to new boats where the optimum arrangement can be achieved at the design stage.

For fitting to an existing vessel, extensive modifications would be required to sterngear, stern aperture and possibly steering gear, as the rudder head torque is increased when a nozzle rudder is fitted.

This type of nozzle is fitted to fishing boats where good manoeuvrability is required and many larger stern trawlers have been fitted with this type of nozzle. Full control of the boat may be achieved from full ahead, during a crash stop, and when running astern.

It is also possible to increase hold capacity as length required at the boat stern for a steering nozzle installation is less than that required for a conventional rudder working behind a fixed nozzle or open propeller.

For either type of nozzle, the construction is similar and designed to suit the installed engine power. The bigger the power for a given diameter the

“Araho", 119ft. Steel stern dragger built by Gamage Shipbuilders, Maine, U.S.A.

Kort nozzle rudder fitted to "Araho".
more internal frames required, with a corresponding increase in plate thickness. As mentioned previously a stainless steel insert is only fitted when essential.

From the foregoing it is clear that there is no such thing as a "standard" nozzle or "standard" propeller and Kort nozzle systems are designed to suit each individual boat. Hull connection plates are supplied with a fixed Kort nozzle and where a Kort nozzle rudder is installed the rudder stock, coupling bolts, pintle and pintle housing are supplied with the nozzle, together with a propeller designed for the boat service requirements.

Advantages & Disadvantages

Compared to an open propeller a Kort nozzle system gives increased thrust for a given engine power. This has been proved beyond doubt for fishing boats of all types.

The way in which this increased thrust is used depends very much on the policy of the skipper or boat operators.

For an existing boat to achieve the maximum benefit a new propeller should be fitted, designed to suit the nozzle flow conditions. In some cases, however, it is possible to trim the existing propeller for use in the nozzle if it is in good condition and the pitch and blade area are compatible with design requirements.

After conversion the increased thrust can be used to tow larger, heavier, gear or tow the normal gear at lower engine r.p.m. (hence power), reducing fuel consumption and wear and tear on the engine. This should give longer engine life and reduced maintenance costs.

A skipper may opt to tow his gear at a faster boat speed or use the extra power available to maintain towing speed in bad weather.

Ken Gibbs, owner and skipper of the U.K. fishing boat "Angelus", made the following comments after his boat was converted to nozzle propulsion. (Details of the boat are given in table 1). "Unfortunately we are at present suffering from fuel pump trouble and, with hindsight, we feel this may have affected our pull effort and results since the same symptoms were evident then. A pull of 3.75 tonnes or 8268 lbs. had been predicted for the nozzle installation.

During the short time trawling, the advantages seemed good. The pull in bad sea conditions was far better at 800 r.p.m. than at 950 r.p.m. and over with our open propeller. The warps were tight at all times as opposed to slack and falling warps under open propeller conditions. It is plain that we have a tremendous increase in power and if I keep the gear I have used in the past, we will have no need to use more than 850 r.p.m. to reach the speed needed to catch Mackerel and the faster swimming types of fish. Prior to fitting the nozzle, we could only catch these species of fish in very favourable sea conditions. We shall have to wait, however, until the shoal fish arrive in the local grounds to prove this statement."

This boat is a classic case where the original open propeller was unsuitable for the boat's service requirements. "Angelus" works on very short trips but had a free running design open propeller. The owner realised that a propeller designed for an intermediate speed between 'towing' and 'steaming' conditions would be more suitable for his operation.

This was the design strategy when the Kort nozzle was installed and trials of this wooden boat showed a 57% improvement in bollard pull performance. This large increase is partly due to the added nozzle thrust and partly because more engine power was absorbed due to the propeller design condition.

Adverse comments from Ken Gibbs were:

"The only disadvantage is in turning the vessel, the turning circle is now larger but no real problem. The steering is more difficult; there seems to be more load on the rudder and more wear on the rudder and more wear on the rudder pintle. There is a loss of speed of approximately ½ knot!"

There are fears that a boat will always lose steaming speed when a Kort nozzle is fitted. This is not strictly true as so many other factors are involved.

The speed of some boats has actually increased after conversion to Kort nozzle propulsion!

The maximum speed of a boat will depend on boat length, hull shape and the engine power available to push it through the water.

With a nozzle system there is added resistance due to the nozzle, but at or near the maximum boat speed the full resistance will be high in itself. Therefore, the more important factor is the power available from the engine to overcome this resistance which is controlled by the design condition of the propeller.

It is possible to lose speed simply by changing the propeller. If a boat has a 'steaming' design open propeller and this is changed for another fixed pitch propeller which absorbs full engine power when towing, less power will be absorbed when steaming causing a significant speed loss. This fact applies whether or not a Kort nozzle is fitted.

When a fixed Kort nozzle is fitted, the deadwood area aft is increased therefore the boat will tend to be more reluctant to turn.

Propeller race speed is increased giving a slightly increased load on the steering gear which would be noticed when applying the helm with, say, a chain steering system. For most boats however, the existing steering gear would be of sufficient capacity for use with a fixed nozzle. When the rudder is hard over, the nozzle exit is partly blanked off, restricting water flow from the nozzle. This particularly important when running astern where manoeuvrability is a problem whether or not a nozzle is fitted. It is therefore preferable to increase helm angle steadily for the rudder to be effective and it should be noted that steering thrust can only be produced when the propeller is turning. As the
deadwood area is increased, cross flow of water is restricted which affects the boat’s ability to ‘swing the stern’ with the propeller stopped.

Depending on the type of rudder it may be advisable to modify the rudder area or increase the balance. In some cases a more positive steering effect can be achieved by fitting a circular or angle bar section to the aft edge of the rudder.

Some boats, however, report no change in steering characteristics after a nozzle has been installed and the foregoing points can be summed up by saying:

"With a fixed nozzle fitted, a boat will handle differently but after a very short time most skippers have the feel of the boat and manoeuvrability becomes no real problem."

For a new fishing boat superior manoeuvrability coupled with increased thrust can be achieved by fitting a Kort Nozzle Rudder. Smaller turning circle and increased acceleration into a turn are possible with this type of nozzle. Carrying capacity can sometimes be increased or registered length reduced for a new boat design as less space is required in the stern aperture.

In designing a new boat and selecting the propulsion system the advantages of nozzle propulsion should be borne in mind.

An engine of lower power can be installed with a nozzle system to give the same thrust output as a larger engine with an open propeller. Not only will operating costs be reduced, but smaller fuel tanks could be fitted increasing the hold capacity of the boat. Alternatively, sea time could be extended for the same fuel carrying capacity.

In some Kort nozzle installations noise and vibration characteristics of the boat have been improved partly due to correct propeller/nozzle design and partly due to improved water flow to the propeller which occurs when a nozzle is fitted.

With some wooden and GRP boats vibration has been noticeably reduced by the Kort nozzle tending to stiffen up the aft end structure.

A nozzle can provide excellent protection for the propeller from a damage by trawl doors or grounding. Some protection is also given from warps or nets, although should these be dangled in front of the nozzle, it would be pretentious to say that they would not foul the propeller, as would be the case if the nozzle were not there.

Fuel Economy

Fuel is now the biggest single operating cost for most fishing boats and energy conservation is vital for everyone. Fuel saving cannot be guaranteed by fitting a Kort nozzle, as this depends on the type of boat and its operation, but more thrust is available for a given engine power.

In fact it would take an engine of 35 - 40% more
power to give the same thrust output under towing conditions which shows that fuel saving is possible as fuel consumption is directly related to b.h.p. It also follows that if a skipper goes flat out using the full b.h.p. of an engine, fuel saving would be nil!

An owner may consider fitting a turbocharger to an existing engine to uprate performance but this increases fuel consumption and required maintenance. A Kart nozzle gives increased thrust and will go on giving it with the minimum of maintenance. A coat of paint when the hull is cleaned and replacement of the zinc anodes fitted for cathodic protection is the only maintenance required.

It is not very often that fuel consumption figures before and after fitting a Kart nozzle are made available by an owner, but a Belgian owner recently supplied the following information after 5 trips back in service.

<table>
<thead>
<tr>
<th>Trip</th>
<th>Before</th>
<th>After</th>
<th>Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 days 8 hours</td>
<td>11,250</td>
<td>8600</td>
<td>2650 (23.5%)</td>
</tr>
<tr>
<td>7 days 4 hours</td>
<td>8,750</td>
<td>6800</td>
<td>1950 (22.3%)</td>
</tr>
<tr>
<td>5 days 11 hours</td>
<td>6,800</td>
<td>5200</td>
<td>1400 (20.6%)</td>
</tr>
<tr>
<td>7 days 20 hours</td>
<td>9,900</td>
<td>7500</td>
<td>2400 (24.2%)</td>
</tr>
<tr>
<td>7 days</td>
<td>8,900</td>
<td>7000</td>
<td>1900 (21.4%)</td>
</tr>
</tbody>
</table>

Consumption is given in litres. One gallon is approximately 4.55 litres.

This Dutch built steel boat "Sabrina" has a CAT engine rated at 285 b.h.p. at 1800 r.p.m. with 3.5417:1 gearbox and a 51" diameter open propeller was originally fitted.

Owner, J. Welvaert, was obviously very pleased with the performance after the 1250 mm (49¼") diameter Kart nozzle had been installed and the bollard pull trial performance increased from 7720 lbs. to 8820 lbs. He also commented that lubricating oil consumption is reduced by approximately 20%.

From discussions with skippers, the general average fuel saving after a nozzle is fitted is around 15%, however, the above results indicate that a greater saving is possible.

**Table 1** gives data for a range of boats in various parts of the world which have been fitted with Kart nozzles in recent months. Where an existing boat has been converted, bollard pull trial figures are given where possible before and after conversion. The speed figures quoted should be taken purely as a guide as it is not always possible to carry out accurate steaming trials for every boat.

It is worth looking at the performance of one or two of these boats in detail.

**"Maggie-Marie" – 32 ft. Glass Boat**

Fitting a Fixed Kart nozzle to this type of ‘day-fishing’ boat has proved to be very popular in the U.K. and has also confirmed that the increased thrust from a nozzle system can be of benefit to all sizes of boat.

The nozzle can be designed to suit a standard hull and be compatible with various engine installations. For a particular boat, the propeller can then be designed to suit the engine/gearbox to be fitted. With glass as the hull material, the nozzle may be attached by bolting through the full and solepiece or with a new boat, the nozzle supports can be taken through the hull and bonded into the aft end structure. This arrangement would be preferable, as a complete nozzle ring can be maintained to give a very solid connection.

**Figure 2** compares the performance of a standard 32ft. boat with and without a nozzle. Identical engines of 108 b.h.p. at 2500 r.p.m. with a 3:1 gearbox ratio were installed. The curves show the thrust produced over the boat speed range for the nozzle system and conventional open propeller. In this case, the nozzle propeller was designed favouring the free running condition, therefore, a further increase in towing thrust could be achieved at the expense of free speed by designing the propeller for this condition. The increased thrust enables a vessel of this type 'to trawl alongside similar vessels with a higher installed power. The ability to maintain trawl speed is also important as the vessel is able to continue fishing under adverse weather conditions. Having comparable towing power to similar vessels with 150 b.h.p. in itself reduces operating costs as fuel bills will be lower and may also reduce the capital cost of a new vessel.

Line 3 shows the performance of "Maggie-Marie" which has a 88.5 b.h.p. engine and nozzle of the same diameter. The performance with this engine and nozzle system is slightly greater than that with the larger engine and open screw under trawling conditions but some loss of speed occurs due to the lower installed power.
"Sigburbara" – 85ft. Steel Boat

This Icelandic stern trawler has a 3 bladed variable-pitch propeller working in a fixed Kort nozzle.

Curves of thrust over the boat speed range are given in figure 3 for this propeller with and without a Kort nozzle.

The increase due to the nozzle can be clearly seen and it is interesting to note that at full speed, the thrust produced is almost identical with either system. The performan with a 4 bladed fixed pitch propeller is also shown which gives an indication of

"Southern Comfort" – 1st 32 ft. glass boat fitted with Kort nozzle in 1977

37 ft. GLASS BOAT with fixed Kort nozzle

**FIGURE 2** 32FT GLASS BOAT

- ENGINE: FORD 108 BHP AT 2500 RPM
- GEARBOX: 3:1

<table>
<thead>
<tr>
<th>THRUST-LBS</th>
<th>1000</th>
<th>2000</th>
<th>3000</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOAT SPEED-KNOTS</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

- ENGINE: FORD 108 BHP AT 2500 RPM
- GEARBOX: 3:1

*Estimated Resistance*
performance with this size engine without a VP propeller. Due to the compromise in design condition there would be a slight loss in towing and steaming performance.

As a further illustration, curves of thrust against engine r.p.m. have been plotted in figure 4 for bollard and 3½ knot towing conditions. Thrust is proportional to r.p.m. squared and this relationship must be a straight line through the origin. The thrust produced by the VP propeller working as an open screw can be achieved at lower r.p.m. when a nozzle is fitted.

The table given in figure 4 indicates the saving in fuel which could be achieved under these conditions which would reduce operating costs considerably over the course of only 1 year.
“Benric” – 65ft. Stern Dragger

The Kort nozzle conversion on this boat was carried out by the A.F. Theriault yard, Nova Scotia for Captain Raymond King.

As mentioned earlier in the paper, the question of propeller diameter was discussed at length before an order was placed and figure 5 shows thrust curves over the boat speed range for the alternative nozzle systems and original open propeller. The ‘design condition’ for all propellers is 3½/4 knots towing.

At the time of printing this paper bollard pull trial results for the new Kort nozzle system were not available to substantiate these curves, however, it has been reported that the maximum reading of a 10,000 lbs. gauge was exceeded!

The curves are given in good faith as attainable figures with this engine producing the full rates power of 365 b.h.p. at 1800 r.p.m.

It should be noted that the open propeller bollard pull trial gave 7400 lbs. and the curve shows 8700 lbs., which suggests that the engine may not have been developing full rated power when these trials were held.

The illustrations show that the Kort nozzle was fitted following a straightforward procedure and the installation looks ‘right’ for this boat.

![Figure 5: Chalutier Arrière De 65 Pieds](image)

Conclusion

Probably due to the traditionally conservative nature of the fishing industry world wide, owners are either ‘for’ or ‘against’ a Kort nozzle system depending on their own experience in comparison with an open propeller.

Some feel that their fishing methods would not be improved, whilst others are quick to report the ‘tremendous’ increase in towing performance. Two conflicting arguments which underline the fact that it is the operators requirements which are of prime importance at the design stage.

One factor to emerge from this paper, which has been proved in reality, is that there is more involved in Kort nozzle design than simply ‘bolting one on and off we go’ – as more than one enterprising skipper

Kort nozzle installation “Benric”

has found out to his cost!

With the major fishing nations of the world seeking exclusive limits and developing countries, expanding their own industry, traditional operations and fleet requirements are changing. At this time of change where owners are encouraged to improve their existing boats or forced to invest in new boats for a different operation, a Kort nozzle system can be the simplest and most effective method of uprating performance and give economic operation.

Power with fuel economy – it’s worth thinking about!

Acknowledgements

The opinions expressed in this paper are entirely my own although I am indebted to Kort Propulsion Co. Ltd. for access to design data, trial results and experience gained. Special thanks are due; to colleagues for constructive comments; to my wife for patience whilst writing this paper; to Sylvia Bellamy for the speed with which the manuscript was typed; and to the many boat owners whose often forthright comments bring practical reality to the designer.
<table>
<thead>
<tr>
<th>VESSEL NAME</th>
<th>LOA (ft)</th>
<th>HULL MAT</th>
<th>V (KNOTS)</th>
<th>ENGINE TYPE</th>
<th>HP</th>
<th>BLADES</th>
<th>TYPE</th>
<th>DIA (mm)</th>
<th>DIA (ins)</th>
<th>NOZZLE TYPE</th>
<th>PULL (POUNDS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARNI FRIDRIKSSON</td>
<td>127</td>
<td>STEEL</td>
<td>12%</td>
<td>MAN</td>
<td>2x498</td>
<td>3</td>
<td>VPP</td>
<td>2360</td>
<td>93&quot;</td>
<td>RUDDER</td>
<td>NEW 34,173</td>
</tr>
<tr>
<td>SIGURBARA</td>
<td>75</td>
<td>STEEL</td>
<td>10%</td>
<td>CAT</td>
<td>565</td>
<td>3</td>
<td>VPP</td>
<td>1700</td>
<td>67&quot;</td>
<td>FIXED</td>
<td>NEW 18,976</td>
</tr>
<tr>
<td>THISLDUTO</td>
<td>58</td>
<td>WOOD</td>
<td>9%</td>
<td>BAUDIN</td>
<td>382</td>
<td>4</td>
<td>FPP</td>
<td>1400</td>
<td>55&quot;</td>
<td>FIXED</td>
<td>NEW 11,795</td>
</tr>
<tr>
<td>MAGGIE MARIE</td>
<td>32</td>
<td>GRP</td>
<td>8%</td>
<td>LISTER</td>
<td>88.5</td>
<td>4</td>
<td>FPP</td>
<td>700</td>
<td>27 1/2&quot;</td>
<td>FIXED</td>
<td>1,984 2,447</td>
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<tr>
<td>ARAHO</td>
<td>119</td>
<td>STEEL</td>
<td>12%</td>
<td>CAT</td>
<td>1125</td>
<td>3</td>
<td>FPP</td>
<td>1930</td>
<td>76&quot;</td>
<td>RUDDER</td>
<td>NEW 28,680</td>
</tr>
<tr>
<td>CONGENER</td>
<td>85</td>
<td>STEEL</td>
<td>10</td>
<td>HEDE</td>
<td>630</td>
<td>3</td>
<td>VPP</td>
<td>1600</td>
<td>63&quot;</td>
<td>RUDDER</td>
<td>NEW 18,078</td>
</tr>
<tr>
<td>VON</td>
<td>88</td>
<td>STEEL</td>
<td>10%</td>
<td>M.BLK</td>
<td>685</td>
<td>3</td>
<td>VPP</td>
<td>1900</td>
<td>74 1/2&quot;</td>
<td>FIXED</td>
<td>NEW 21,606</td>
</tr>
<tr>
<td>SUFFOLK HARVESTOR</td>
<td>130</td>
<td>STEEL</td>
<td>13%</td>
<td>L.BLK</td>
<td>2x900</td>
<td>4</td>
<td>VPP</td>
<td>2490</td>
<td>98&quot;</td>
<td>RUDDER</td>
<td>NEW 56,220</td>
</tr>
<tr>
<td>FRAMTIDIN</td>
<td>152</td>
<td>STEEL</td>
<td>13%</td>
<td>MAK</td>
<td>1500</td>
<td>3</td>
<td>VPP</td>
<td>2120</td>
<td>83 1/2&quot;</td>
<td>FIXED</td>
<td>31,968 39,685</td>
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<tr>
<td>BOY JAMIE</td>
<td>50</td>
<td>STEEL</td>
<td>9</td>
<td>BAUDIN</td>
<td>215</td>
<td>4</td>
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<td>1150</td>
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<td>5,201 7,386</td>
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<tr>
<td>MARGARET JANE</td>
<td>68</td>
<td>WOOD</td>
<td>10%</td>
<td>CAT</td>
<td>495</td>
<td>4</td>
<td>2 PITCH</td>
<td>1700</td>
<td>67&quot;</td>
<td>FIXED</td>
<td>NEW 17,637</td>
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<tr>
<td>SABRINA</td>
<td>68</td>
<td>STEEL</td>
<td>9%</td>
<td>CAT</td>
<td>285</td>
<td>3</td>
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<td>1250</td>
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<td>FIXED</td>
<td>7,720 8,820</td>
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<tr>
<td>ANGELUS</td>
<td>58</td>
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<td>9%</td>
<td>KELVIN</td>
<td>255</td>
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<td>FPP</td>
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<td>FIXED</td>
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<td>BOGEY ONE</td>
<td>66</td>
<td>STEEL</td>
<td>9%</td>
<td>GM</td>
<td>340</td>
<td>4</td>
<td>FPP</td>
<td>1400</td>
<td>55&quot;</td>
<td>FIXED</td>
<td>8,378 13,008</td>
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<tr>
<td>BENRIC</td>
<td>65</td>
<td>WOOD</td>
<td>10</td>
<td>CAT</td>
<td>365</td>
<td>4</td>
<td>FPP</td>
<td>1550</td>
<td>61&quot;</td>
<td>FIXED</td>
<td>7,400 12,000</td>
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<td>DOLLY MOP</td>
<td>75</td>
<td>STEEL</td>
<td>10</td>
<td>CUMM</td>
<td>470</td>
<td>4</td>
<td>FPP</td>
<td>1400</td>
<td>55&quot;</td>
<td>FIXED</td>
<td>NEW ENGINE 13,008</td>
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<tr>
<td>FRUIT DU LABEUR</td>
<td>46</td>
<td>WOOD</td>
<td>8%</td>
<td>GM</td>
<td>174</td>
<td>4</td>
<td>FPP</td>
<td>750</td>
<td>29 1/4&quot;</td>
<td>FIXED</td>
<td>NEW ENGINE 4,950</td>
</tr>
</tbody>
</table>
"SAVING ENERGY"

Presented
by F.S. Barlow
for Gerard Innocenzi
Moteurs Baudouin
Marseille, France
Area Manager for Canada

I believe all present may be aware of the high cost of energy in Europe, and saving fuel has been the top priority for Europe during the past ten years.

All European engine-builders spend large sums on research to reduce specific fuel consumption, and increase thermal efficiency, and the following examples will demonstrate that Baudouin are working with a certain degree of success in this field.

This is not the only subject that should be researched. This Conference should allow us to explore all possibilities more deeply.

If it is important to reduce fuel consumption it is of equal importance to ensure that the reduced fuel consumption is used or transformed in the most efficient way to give maximum thrust at the propeller.

There are several factors involved in saving fuel and the following is an attempt to illustrate the most important aspects:

1) The Hull – all the important aspects relating to resistance.
2) Hull speed limitations – the most economical Hull speed.
3) The operational influences on a vessel.
4) Engines and the overall propulsion equipment.

By considering all the foregoing we will be looking for increased efficiency, and thereby reducing the amount of fuel used, and increasing the profitability of the vessel.

First the Hull:

Fuel consumption of the marine engine is proportional to the power developed, and the power is directly proportional to the resistance of the vessel.

The resistance of the Hull must be carefully considered in detail, such as:

- The length to breadth ratio.
- Prismatic coefficient.
- Position of buoyancy centre.
- Penetration angle at waterline, etc.

A serious study of these factors allows a real approach to minimum resistance. In many countries the adopted forms more often result from tradition and experience, rather than from a serious study, and this is unfortunate.

With this lack of study it is sometimes necessary to add ballast, thereby increasing the displacement and the resistance of the Vessel, and consequently the need for more power.

The trim of the boat also plays an important role.

It is judicious that the boat be in her best lines whether loaded or unloaded.

If precautions are taken to reduce the hydrodynamical resistance of the hull, we must not forget the need to reduce the superstructures and therefore reduce the aerodynamical resistance.

Finally, we must pay attention to the condition of the Hull, the quality of the skin to minimize frictional resistance, avoid turbulence as much as possible. This requires anti-fouling treatment and in the case of steel hulls anti-corrosion treatment must not be neglected.

2) Now Secondly the Vessels Speed:

Fishing boats, with few exceptions, are displacement Hulls. The resistance of these forms in function of speed or the coefficient of speed is easy to calculate.

SEE FIGURE NO. 1 & 2

This curve shows the speed limit of two hulls and the power requirements. It becomes obvious from these curves that a small sacrifice in vessel speed will produce worthwhile economy in fuel costs and increase in speed will be expensive.

One of the essential elements in saving energy would be to have longer water lines without changing any other characteristics not even the dead weight; we would then obtain relatively finer boats.

Unfortunately they would be more expensive. But this increase in price could be compensated by a decrease in the installed power, the speed remaining the same.

SEE FIGURE 3

This diagram clearly shows the importance of vessel speed in relation to energy consumed. A 7% drop in vessel speed in this case would reduce fuel consumed from 100% to 50%.

If the vessel speed is reduced by 50% the fuel used drops to a very low figure of 4% of the full speed value.

The speed of the vessel is therefore of vital consideration in the original design concept.

3) Next Comes the Operational Influences:

A boat has to operate in rough seas, the resistance must increase with respect to sea conditions. A decrease in the speed of a boat with given power is very sensitive and working in rough weather conditions becomes more expensive.

We must also consider the difference between active fishing and passive fishing. Obviously the fuel consumption of a gillnet fishing boat is only related to the power to overcome the resistance of the vessel.

Conditions are quite different in the case of a trawler owing to the resistance of the trawling gear: the resistance of the net must be added to the resistance of the vessel. Any decrease in this resistance has the direct result of saving fuel.

Some of the solutions for reducing resistance can be:

1) The use of longer nets.
2) Floats with wings.
3) Trawl doors with hydrodynamical forms.
4) Optimum leading angles to the doors to obtain the largest opening of the net at the right speed.
5) Using lighter trawl doors, scientifically designed to give best results.

The foregoing deals with the Hull form and external influences and we will now cover the propulsion package.

4) The Propulsion Equipment:
First of all the Engine:

BAUDOUIN manufacturers two sizes of engines, one size of 1600/1800 R.P.M., and a smaller engine of 2600/3000 RPM. How are they situated in the range of present Diesel engines?

In the power brackets of 100 to 800 horsepower we can define 3 types of engines:
- low speed engines: less than 800 RPM.
- medium speed engines: from say 800 to 1250 R.P.M.
- high speed engines: over 1250 RPM.

Baudouin’s studies have indicated that they should build high speed engines generally in accordance with the World Wide Trend, and for many years they have produced designs on this concept, at the same time maintaining acceptable piston speeds and BMEP.

Baudouin have developed 2 sizes of Marine engines, the “P” engine of 150 M/M bore x 150 M/M stroke running at 1800 RPM.

Their latest product being the Model F11, 115 M/M bore x 105 M/M stroke runs at a continuous speed of up to 3000 RPM and by adapting an oversquare configuration they are able to maintain acceptable piston speeds comparable with low speed units.

Examples:

<table>
<thead>
<tr>
<th>P/RPM</th>
<th>Bore x Stroke</th>
<th>Speed in M/S</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAUDOUIN</td>
<td>400 HP/1800</td>
<td>150 x 150</td>
</tr>
<tr>
<td>&quot;</td>
<td>234 HP/2600</td>
<td>115 x 105</td>
</tr>
<tr>
<td>Low-Speed</td>
<td>1440 HP/1000</td>
<td>130 x 273</td>
</tr>
</tbody>
</table>

A much more detailed study is of course desirable and several other factors should be considered, such as the bore size, cylinder loading and power per unit of piston area, etc.

We do not mean to say that the specific consumption of high-speed engines is better than low-speed or medium-speed engines.

The old fashioned 4 cycle slow speed engine has acquired a good solid reputation and is able to show a good fuel consumption. You might argue that the high speed engine has yet to show equal results.

On the other hand the slow speed engine up to say 800 horsepower is fading out mainly due to its high cost, size, and weight.

With the research and development in progress the fuel consumption of the high speed engine is almost equal to that of the slow speed engine and there are a number of options with additional room for further development and improvement.

- Indirect injection systems with prechamber have given way to direct injection systems.
- An engine with central prechamber injection compared to direct injection has produced an engine with 8 to 10% better consumption.
- Turbocharging is being further developed to provide engines with improved thermal efficiency: recovering the energy contained in the exhaust gas; by a better combustion – improved method of charging the cylinders, and improved turbulence, and improved injection equipment.

Baudouin engine design is centered on Marine application and because of this certain aspects should be noted.

SEE FIGURE NO. 4

- This is an illustration of the specific fuel consumption. With an industrial engine the consumption is usually minimum between 50 and 70% of the engine speed, and maximum at 100% speed. With the Marine engine the target has been to obtain a good consumption between 70 and 100% of full speed to match working requirements.

SEE FIGURE NO. 5

- This shows the form of the specific consumption at constant RPM and with various loading.

A marine engine is used not only at full load. Consumption is also important on partial load. Baudouin have succeeded in keeping the consumption constant down to 68% load.

SEE FIGURE NO. 6

- The engine torque is very important.

This shows a significant improvement in torque characteristics in developing the F11 engine from the DF engine.

With the DF engine the maximum torque is at 2200 RPM and the delta torque is 3%.

With the F11 engine the maximum torque is at 2000 RPM and the delta torque is 7%.

For example, when a resistance to the Hull demands an increase in the torque of 3% the DF engine drops to 2200 R.P.M., whereas with the F11 the engine drops only to 2480 RPM, this provides a benefit.

These are some aspects which characterize a marine engine for which the choice of the turbocharger and the choice of injection equipment are a function of the working conditions, especially for Marine application.

Saving energy should not only be considered from the point-of-view of the engine builder, however, one should think of the entire profitability of the vessel. In other words fuel cost in relation to the value of fish caught rather than the specific fuel
consumption.

The high-speed engine by its smaller volume and especially its shorter length allows builders to reduce the length of the engine room and save the corresponding space for “productive” accommodations. For a vessel of given length and power, the high speed engine will permit either a larger fish hold capacity or reduce the size of the vessel.

- length of a turbocharged low-speed engine – 430 HP – 400 RPM - 7 cyl. = 4000 mm
- length of a naturally aspirated high-speed engine – 430 Hp - 1800 RPM - 12 cyl. in Vee - 2850 mm, including gearbox
- length of a turbocharged high-speed engine – 440 HP - 2800 RPM - 12 cyl. in Vee - 980 mm, including gearbox
- length of a turbocharged low-speed engine – 370 HP - 400 RPM - 6 cyl. = 3600 mm
- length of a turbocharged high-speed engine – 400 HP - 1800 RPM or 380 HP - 1600 RPM - 6 cyl. in line = 2310 mm, including gearbox
- length of a naturally aspirated higher speed engine – 234 HP - 2800 RPM - 12 cyl. in Vee = 1815 mm, including gearbox
- length of an engine of the same speed but turbocharged – 240 HP - 2600 RPM - 6 cyl. in Vee = 1465 mm, including gearbox

All these are benefits not to be ignored.

High speed diesel engines running at 300 RPM are perhaps something new to most people attending this Conference but it is the trend for the future.

With the improvements in materials and careful design they have been developed to run on continuous full load duty with a service life equal to any of the slower speed variety.
- Periods between overhauls are no less.
- Fuel consumption is equal if not better, and by careful attention to design these engines are as safe and reliable as any other.
- The installation techniques are identical to any other prime mover.

We have dealt with the hull and engine characteristics but as everybody knows an efficient engine is useless unless attention is paid to the choice and design of the propeller.

The Propeller

SEE FIGURE NO. 7

This slide shows where the energy is absorbed and how much is used on usefull work. A poor marriage between the prime mover and a propeller could well result in further losses 5 - 10 or 15% or more.

It may be a shock to some people present to see how much power is used in effective work at the propeller.

SEE FIGURE NO. 8

As all Marine Engineers know the efficiency of a propulsion system depends on getting the right aperture in the vessel, the most efficient propeller for the duty of the vessel, and the right gearbox ratio to turn the shaft at the right speed and this diagram is intended to give an idea – roughly speaking, of how the efficiency improves with the diameter.

In Eastern Canada there appears to be many boats improperly put together with inefficient systems, inadequate apertures to accommodate the right propellers for the job in hand.

Enough is to say that Baudouin believe that the first cost of getting it right at the beginning will pay a handsome profit over future years by the savings in fuel costs.

This, of course, is what this Conference is all about and we figure it may be a fairly long ordeal getting people to do things correctly.

SEE FIGURES 9 & 10

This slide shows the difference between a free running propeller against a propeller designed to produce Bollard pull.

FIG. 9 could be as for a pleasure craft or Longliner.

FIG. 10 could be as for a Tug.

SEE FIGURE 11

This is a compromise propeller as used for a Trawler – striking a compromise between free running and the pull needed for dragging a net at slow speed.

C.P. Propeller

SEE FIGURE 12

This slide shows the performance of a controllable pitch propeller in relationship with the fixed pitch. With the ability to adjust the blade angle, optimum blade angle can be selected to obtain full power from the engine during trawling.

In the same way, blade angle can be adjusted to use full power and best use of energy for free running.

The conclusions are that less power can be used for a given thrust, or perhaps more important, a larger net can be used for the same power.

Baudouin is one of very few Companies who manufacture and supply the complete package – engine, gearbox and C.P. propeller, and it is felt that as our fuel costs rise the CP systems will have greater appeal in order to reduce operating costs of Inshore Fishing Vessels.

The Nozzle

SEE FIGURE 13

All people in the Marine business are familiar with the propeller nozzle, and this slide shows the benefits that can be delivered by fitting a nozzle around the propeller for certain duties. This is an
excellent addition for a trawler and you can see benefits in the case of either a fixed pitch propeller and a CPP propeller.

We now have 6/7 new Inshore Trawlers fitted with nozzles giving very good results and fuel economy.

We find that a 45 foot Trawler with 234 BHP with fixed propeller and nozzle will give about the same bollard pull as a 350 horsepower vessel without nozzle.

Generally speaking we find the nozzle will increase thrust by about 30%. It will not improve free running speed, in fact it will reduce free running, maybe in the order of .2 or .3 of a knot.

SEE FIGURE NO. 14

High Speed Gearbox

In order, again, to save energy Baudouin is developing higher ratio gearboxes by adding a speed reduction gear to the standard reverse reduction gearboxes.

With an engine speed of 1800 RPM-shaft speeds can be reduced to 200 RPM – 9 to 1 ratio. Here again increased thrust and better fuel economy.

SEE FIGURE NO. 16

This shows the comparative benefits and economy of getting the shaft speed down to 200 RPM.

Twin Engines “Father & Son”

We cannot conclude this paper without mentioning a twin engine installation, that is two engines of equal or unequal power usually called “Father & Son.”

SEE FIGURE 15

This slide shows the performance of the single engine of 500 horsepower and what can be achieved by running the second engine of 400 horsepower.

The point here really is to show what can be saved by running on one engine if the duty calls for this kind of operation – only .7 of a knot loss in speed by shutting down one engine of 400 horsepower.

A “Father & Son” arrangement is perhaps ideal for a Patrol Vessel, maybe certain types of Fishing Vessels – a Longliner for example.

In conclusion – what Baudouin is telling us is this:
1) All Inshore Vessels should be scientifically designed, bearing in mind the duty – some vessels are designed in this way, of course, but many leave much to be desired.
2) It may cost more initially, but if not properly thought out they will cost a fortune in fuel to operate in the years to come.
3) Baudouin are prepared to take a Hull design – study it, make suggestions to modify it to improve efficiency and supply the whole package and warranty the results.

4) It is their view that vessel designs should specify the pounds of thrust required per horsepower or pounds of thrust per litre of fuel consumed. This is what they call the Baudouin plus.

Baudouin are able to successfully respond to the need for fuel efficient vessels and – GEC Diesels Inc. are here to assist.
Lw1 = 45°  \( \Delta = 50 \)

Lw1 = 65°  \( \Delta = 150 \)
Figure 3

% of speed in function to % of power

% of consumption per hour

% of consumption per hour
CARACTERISTIC CURVE OF SPECIFIC CONSUMPTION

Figure 4
Figure 5

Consumption in function to the load
Figure 6

TORQUE COMPARISON FROM DF to F11
Figure 7

EHP  DHP  SHP  BHP

40%  92%  96%  100%

50%  

EFFICIENCY IN %
Figure 8

Propeller efficiency in function to
- propeller dia.
- rpm propeller
for given power and rpm

Efficiency or thrust

55%

50%

40%

Propeller dia.
SPEED PROPELLER

Figure 9

BOLLARD PULL PROPELLER

Figure 10

- 1 Developed power by engine
- 2 Absorbed power by propeller in free running
- 3 Absorbed power by propeller in bollard
CÔMPROMISE PROPELLER

- 1 Developed power by engine
- 2 Absorbed power by propeller in free running
- 3 Absorbed power by propeller in bollard
- 4 Absorbed power by propeller in trawling

Figure 11
Constant power = 400HP
RPM propeller = 300
Propeller dia. = 1720

PROPELLER THRUST FONCTION TO SPEED

Figure 12
Constant power = 400 HP
RPM propeller = 300
Propeller dia. = 1720

Figure 13
RESULTS OF BAUDOUIN STUDY ON 65' WOODEN FISHING VESSEL FROM DRAWINGS SUPPLIED BY CHETICAMP BOATBUILDERS WITH CONSIDERATION TAKEN TO A MAXIMUM BEAN OF 21'-8"

POSSIBLE PERFORMANCES

<table>
<thead>
<tr>
<th>Longliner application</th>
<th>Baudouin engine</th>
<th>B.H.P.</th>
<th>R.P.M.</th>
<th>Gearbox reduction</th>
<th>Propeller dia/pitch</th>
<th>Speed knots</th>
<th>Bollard pull in lbs.</th>
</tr>
</thead>
<tbody>
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<td>6P15SRCM</td>
<td>400</td>
<td>1800</td>
<td>503:1</td>
<td>64.5&quot;×46&quot;</td>
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<td></td>
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<td>1800</td>
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<tr>
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<td>1800</td>
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<td>61.5&quot;×60&quot;</td>
<td>10.70</td>
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<table>
<thead>
<tr>
<th>Trawler application without propeller nozzle</th>
<th>Baudouin engine</th>
<th>B.H.P.</th>
<th>R.P.M.</th>
<th>Gearbox reduction</th>
<th>Propeller dia/pitch</th>
<th>Speed knots</th>
<th>Bollard pull in lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>1800</td>
<td>5.3:1</td>
<td>64.5&quot;×43&quot;</td>
<td>10.15</td>
<td>9174</td>
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<tr>
<td></td>
<td>12P15M</td>
<td>430</td>
<td>1800</td>
<td>6:1</td>
<td>64.5&quot;×44.5&quot;</td>
<td>10.25</td>
<td>9614</td>
</tr>
<tr>
<td></td>
<td>12P15SM</td>
<td>500</td>
<td>1800</td>
<td>6:1</td>
<td>64.5&quot;×56&quot;</td>
<td>10.50</td>
<td>10494</td>
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<table>
<thead>
<tr>
<th>Trawler application with propeller nozzle</th>
<th>Baudouin engine</th>
<th>B.H.P.</th>
<th>R.P.M.</th>
<th>Gearbox reduction</th>
<th>Propeller dia/pitch</th>
<th>Speed knots</th>
<th>Bollard pull in lbs.</th>
</tr>
</thead>
<tbody>
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<td></td>
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<td>61.4&quot; dia.</td>
<td>10.00</td>
<td>12496</td>
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<td>12P15M</td>
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<td>63&quot; dia.</td>
<td>10.15</td>
<td>13376</td>
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<tr>
<td></td>
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<td>1800</td>
<td>6:1</td>
<td>63&quot; dia.</td>
<td>10.40</td>
<td>15400</td>
</tr>
</tbody>
</table>

**Note:** Above performances are given with the following tolerances: speed + or - 0.2 knots  
Bollard pull + or - 5%
Twin engine 12P15SR + 6P15SRC

Consumption per hour L/H
BAUDOUIN ENGINE
400 HP at 1800 rpm

- 1 Fixed propeller w/o nozzle (300 rpm propeller) reduction 1/6
- 2 C.P.P. propeller w/o nozzle (300 rpm propeller) reduction 1/6
- 3 Fixed propeller with nozzle (300 rpm propeller) reduction 1/6
- 4 C.P.P. propeller with nozzle (300 rpm propeller) reduction 1/6
- 5 C.P.P. propeller with nozzle (200 rpm propeller) reduction 1/9

Figure 16
DELEGATE COMMENTS/QUESTIONS:

David Stewart: Regarding alternate fuels, has anybody thought of another liquid fuel like methanol or something more exotic like hydrogen, or do you see that in your crystal ball 5 and 10 years down the road?

Mr. Milne: While we all known that there are many people experimenting with fuels in the laboratory and in the engine manufacturing companies, I don’t believe that anyone has tried to run an engine on fish oil. Do any of our panelists have information regarding serious research that would be of interest to this group.

Mr. Foster: In the U.K. there is a project underway using water additives. This has been applied in terms of public transport systems, e.g. buses. The findings so far are not encouraging; there seems to be so many variations which can influence the total economy of the operation. At this stage it’s really not worthwhile.

Marius Lemkeek, Nova Scotia Department of Fisheries: I would like to make some more comments on propellers. Besides being a naval architect, I enjoy sailing. One thing you know from racing sail boats is that it is very important to get clean air to your sails, otherwise you lose a lot of thrust. I think the same thing applies to propellers as well. I have seen many wooden boats with huge stern construction which gives a very disturbed flow towards the propeller and I’m sure you can never get a good propulsion efficiency with this disturbed flow action. I think the area can be better arranged to maximize fuel economy. Are matters of this nature ever researched? How much thrust you can get by the best stern post arrangement?

Norman Parsons: From our experience in retrofitting Kort nozzles to boats, if you look at the propeller aperture from the aft looking forward the very big area of the propeller blade is taken up by the width of the deadwood and we always, in quoting performance, take account of some of these factors. In our experience with a wide deadwood such as this or wide sternpost there can be a reduction of up to around about 8 or 10% as Mr. Yeatman was saying. If at all possible it’s preferable to fine out the square stern post area on a timber vessel above and below the propeller shaft support and this can be done quite easily by the boat yard.

Mr. Milne: That prompts me to make a remark that crossed my mind earlier when people were talking about reducing the number of blades; that’s all very well but if you have two blades vertical stern post you can imagine the kind of vibration you’re going to have with two blades hitting the post at the same time or coming in conjunction with the post at the same time. So there are other considerations besides pure economy.

Bob McIiwaine, Department of Fisheries and Oceans, Vancouver: I thought I should mention some of the points raised at an automotive engineers conference in Vancouver recently on fuels of the future and engine changes. One thing that was quite striking was an estimate by a representative from Imperial Oil, that consumption of gasoline and home heating oils would go down over the next 10 years probably due to the use of natural gas and other substitutes for gasoline. In the next 10 years there will be considerable increase in the consumption of diesel. He also discussed the standard diesel fuel for 1990 and it’s a much more viscous fuel and a lower quality fuel all around than the current diesel fuel. There was also discussion on the use of gas alcohol, using pure alcohol, as is used in Brazil where some of the cars are run on straight alcohol and other combinations; liquid natural gas, compressed natural gas and so on, and these are quite useable in automotive engines or the gasoline engine. However, with the diesel engine, particularly, it’s very difficult to burn anything in the higher speed diesels other than diesel fuel.

John Osborne, Nova Scotia Research Foundation: I have a question regarding investigations into monitoring energy efficiency. Could these investigations be a local activity or do they involve imported technology?

Mr. MacPherson: It’s desirable to keep it local; I think it is an area we can get into and undertake with some success.

Mr. Parsons: Kort Propulsion has set up a licensing agreement with HMW Industries in Halifax. While we supplied the first installation to the Benric there are two or three other jobs on the go which are definite orders and HMW will be manufacturing locally. So it’s not all an import situation.

Mr. Baillie: I have a question for Mr. Parsons in regard to the Kort Nozzle. Could you give us some indication of what sort of relative payback periods there might be in the case of a retrofit situation for existing boats, both in terms of Canadian oil prices and international situations where they are paying close to the world price for the oil? What is the normal payback period in a conversion job?

Mr. Parsons: That’s a very, very difficult question to answer specifically because it really depends how the vessel is used. I can only quote to you the figures given by the Belgian owner in the paper I gave; I won’t specify a value but that installation was fitted in June of last year and I saw him last week and discussed the whole installation with him and he said that he had paid for the installation cost and the cost of the nozzle and propeller in four to five months. Now that is an exception, but I would say that certainly within a working year you would regain the cost of the installation under normal (average) working conditions. But if you would like I will investigate in more depth and give some specific figures on
installations in the U.K. and Europe and the installation on the Benric here in Nova Scotia. Perhaps Mr. Scott could arrange for the skipper concerned to add his contribution on the performance since the nozzle was fitted.

Mr. Yeatman: Perhaps Mr. Parsons will correct here but in a lot of retrofit projects that we have been involved with and looked at, you have to remember that with a given aperture, when you change from an open propeller to a nozzle propeller the optimum revolutions also change so that you may, if you want to get the very most out of the nozzle installation, have to look at a new ratio for the gear box or a different speed for the engine. It's very difficult to give a pat answer to your question, because if you want to go the whole way then you have a larger capital cost.

Mr. Parsons: I would add one comment, in all the retrofit installations which we have done we have never, never had to change the gearbox. If the existing propeller on the boat is the optimum open propeller for the engine gearbox combination, then by putting a nozzle system on with that gearbox the optimum propeller diameter will still fall within the speed range of that gearbox. It might not be 100% optimum but the working range of pitch required for the propeller would give satisfactory operation.

Reg Kingsley, Newfoundland Department of Fisheries: Mr. Barlow mentioned that as little as 40% of the power that's delivered to the shaft is available as effective horsepower. I've seen some figures indicating that for towing trawls even less might be available. Some measurements that I saw, dating back several years, indicate that of the power delivered to the shaft, as little as 25-30% of it is actually available for towing the trawl and these figures came from warp tension measurements and speeds during instrumented trials on fishing gear. I wonder if Mr. Foster in the course of the extensive investigations that the White Fish Authority has done on trawl gears, might have some comment on that and indicate whether 25-30% is indeed a typical figure.

Mr. Foster: The short answer is yes. You can improve on that, get it up maybe to 27%-28% but it's a fact of life, you're not going to improve on that 25% really and in a free running boat, you should anticipate that you're going to be up in the 55-60% range. It's just a fact of propeller law that that's what happens.

Dick Stewart, Yarmouth: I'd like to ask Martin Yeatman if there is any speed advantage to be gained by installing a bulbous bow on a boat under 100 feet, 75-100 feet, or would it serve any other purpose.

Mr. Yeatman: I debate it; in average weather I think the bulb will stop the boat as much as it helps. Of course you can design a hull with a bulbous bow and in smooth water it will be more efficient, there is no question about it, but not, I think, in the range you are talking about. When National Sea put a bulb on their first series of stern trawlers, they were not terribly happy with it. Perhaps the form of bulb used could have been improved. National Sea has gone a quasi bulb in their latest series of stern trawlers; I don't know whether they have any hard figures on the results that they would care to tell us about. One is very skeptical about towing tank predictions when you bring them to full scale. It's not a thing we can be very scientific about. But in the range you are talking I really can't see the value of a bulb.

Dave Stewart: Mr. MacPherson, in assessing your data logging system I noticed you were just looking at the ship roll and pitch. Did you consider any other environmental conditions, such as the wind speed or wave height, or anything that would affect the sea worthiness or the seakeeping abilities of the vessel.

Mr. MacPherson: Yes, we use the catch-all phrase by saying the system is expandable. Basically, if you are looking at wind speed and direction you normally would be either coming off with a single output or some sort of simple analog voltage, 0-5, 0-10 volts, and both of these are relatively easy to digitize and put into the spare channels in the system. As far as wave height goes, I don't know of any better system right now than the experienced seamen writing down what he thinks the wave height is.
Mr. Kingsley: For the benefit of the people who have just joined us this morning, we heard yesterday of the need in the fishing industry for increased emphasis on energy efficiency and this came through loud and clear from fishermen in different areas of the Atlantic Region. Some of the suggestions put forward for improving energy consumption relate to a wide range of vessel hardware including nozzles, monitoring equipment, engines etc. We were also reminded of the need for careful design in fishing vessels and to consider such things as waste heat recovery systems. One of the suggestions put forward in a paper had to do with improved fishing gear and a choice of fishing methods. Also, we were told that we should be giving more thought to fleet management systems.

This morning we were going to address several of these items in particular; improved fishing gear, the choice of methods, and the need and considerations in a fleet management system. We are also going to have a look at some of the energy implications on the processing side in a paper entitled "Energy and Fish Quality". For the benefit of those who haven't been close to some of the work that's been done in fishing gear research during the past few years I just would like to make a few comments. This type of work is relatively new in the scheme of things; it's about 20-25 years old in North America and Europe. In the early days of fishing
Mr. John Foster: The experiment that I'm going to discuss was indeed a very short one, more correctly called a pilot study. Effectively, what we attempted to do was to look at one vessel compared with a pair of vessels, and to monitor carefully what fuel consumption occurred during each of the phases of operation and for the trip as a whole. We had hoped that there would be substantial catches with which to compare fuel consumptions. The work was done for Fisheries and Oceans Industrial Development Branch in Newfoundland. The project was very much an ad hoc experiment, and not part of the main activity for these boats. We had to fit in what we could in terms of measurements as quickly and as unobtrusively as possible. One of the problems was the time of year in which we operated, which was the end of November-December of 1980. Weather conditions were extremely bad and the fishing throughout that general area of Trinity Bay and Bonavista was at an all time low. Consequently, the catch levels were very low, and I'll come back to that when we look at some of the results. This overhead shows the three vessels concerned, The Lady Kenda, a 65-foot boat compared with The Lone Venture and The Cape John Venture.

During the course of these tests, we set out to measure fuel flow, exhaust temperatures, r.p.m. and fuel soundings. The fuel soundings work was done very much as a backup, almost as a continuous calibration of the flow meters. In other words, were able to check that the boat use of fuel per day did correspond to the sum of all the fuel used in the various operations. At the same time we measured warp tension; prior to the experiment we did a reasonable bollard pull just to look at the general performance of these vessels and we continuously monitored speed depth and heading. The experiment then was that these vessels went out to sea and they were given the broad guidelines that they should fish as near as possible in the same area and that they should tow where possible on parallel courses. Having been associated with many comparative fishing experiments in the past I know that that wasn't going to control but for the purposes of the experiment we felt that this would be adequate.

In the case of the pair boats, we wanted to make sure that all of the load wasn't being taken on one side. There was a certain amount of coming around because of that slight difference in power and the fact that these two skippers were comparatively inexperienced in pair trawling.

Emphasize the use of two terms to measure appropriate performance. One is specific usage, which is simply the fuel consumed divided by the amount of fish landed, and specific cost, where you compare the dollar values. It's rather important to keep in mind that difference, because if you do any comparisons with one fishing method the cost of both the fuel and the landed values will be high, but with specific usage, the thing at the top, the fuel will still be high but the fish landed in terms of weight will be small — so it's important always to keep those two factors in mind.

I want to draw your attention to some Newfoundland examples; this slide comes from another study that we have been doing for the Fishing Industry Advisory Board in Newfoundland where we assessed various vessels in the province by looking at fuel consumption from several points of view. From our tests the size of engine and vessel performance are things that far out-weigh the performance in other aspects.

These are the plotted usage figures for the single boat experiment, and as you will see they vary because the catches we obtained were so low. I don't believe that it's fair or sensible to actually make the comparison of the two gears used in this experiment.

This slide illustrates pair bottom trawling. On the basis of the figures shown the single boat operation was clearly doing far better, but I must stress that the numbers of fish caught were not adequate for us to make those sort of comparisons.

We have produced some examples, based on good weather conditions, for a one week trip, a typical four day trip, of how the fuel consumption between the single and the pair would have operated. These are the consumption rates that came from all the flow meter measurements. It appears that the single boat operation compared with the combined two boats was coming out at about 86%. Those numbers don't move very much even when the operator has further steering time. To be practical, I'm well aware that as you increase that steaming distance there comes a time when the smaller boats are not able to participate for other reasons, e.g. weather conditions, etc. but in terms of confining it to this particular pilot study, there are the numbers.

There are several points I wish to make in my summary as they relate to the numbers that you have seen. A comment first, however, regarding it. The Lady Kenda and her skipper. After the first week of the trial, and after we allowed him to see the flow meter, he decided that by cutting his r.p.m. down to 70% (instead of 100%) he would cut his fuel in half; the reduction in speed was about 20%, so it was quite a job from that point onwards to get him to operate the way he would normally. Overall, the pair boats were using 22% more fuel when you added the two together compared with the single vessel. The propeller on the Cape John Venture was
mis-matched in terms of diameter pitch and gearbox. The single boat was using about 44% of its available power for towing and essentially that is too low and the pair trawlers were down at around the 40% mark whereas in reality they certainly should be in the 60-65 range for efficient operation. We are not pretending that this was an efficient operation in the sense of everything being matched.

What I believe comes out of this is an ongoing need for monitoring, looking at all the vessels to determine what sort of gains can be made in various areas of vessel design, operation and maintenance.

In closing, I would like to make brief reference to a project on the South West Coast of England with which I'm involved. The project involves a number of 38-foot vessels of about 125 horsepower, doing a mixture of single boat and pair boat operations. The difference in fuel consumption, and remember these vessels are able to change from one to the other and they have chosen to go pair, is roughly in the ratios 3½ when they are operating as pair vessels, against 4½ when they are operating as a single boat operation. As a combined version that's still a considerable jump. However, looking at their catches (they catch flat fish, cod, anything that's on the bottom), the catches break at about 3-1. In other words, 1½ on each of the pairs against 1 on the single. So the pairs are getting an increase of 100% in terms of catch.
ENERGY EFFICIENT ASPECTS OF SOME FISHING GEAR
by J. Rycroft
Chief, Operations Division
rfisheries Development Branch
Department of Fisheries and Oceans
Maritimes Region

Introduction

Energy-efficient fishing gear in Canada at the present time is synonymous with cost effectiveness. This means quite simply that a reduction in the fuel consumption of vessels in actual fishing operations reduces the catching expenses, hence an increase in the profit margin for the landed product.

In some countries, however, cost effectiveness is not the main consideration. Availability of fuel is critical and for this reason fishing vessels are tied up or operate on a limited basis. Perhaps then, we should be aware that in the long term, even in Canada, we may be subject to conservation of fuel in this context rather than how much per gallon (or litre) it is costing to carry out any particular operation.

The chief culprits in terms of high fuel consumption are, of course, the vessels which carry out any kind of towing function and this paper will, therefore, consider possible improvements and options for these fisheries with particular emphasis on inshore and middle distance vessels. Since no actual measurements or comparisons have yet been carried out in Canada except in the case of pair versus single boat bottom trawling, much of the content of the paper consists of what is hopefully propounded as sensible advice together with an attempt to foresee what the distant future may look like if the trend in price and availability of fossil fuels continues to deteriorate as appears inevitable.

Another aspect of fossil fuel conservation often overlooked is synthetic netting twines and since these are mostly derived from a fossil fuel source, we must examine ways and means to design nets which will be less vulnerable to damage and wear.

Foreword

Fuel economy has not been an important consideration in the evolution of the Canadian fishery. Like many other countries Canada has developed an intensive groundfish trawling industry and even in other important fisheries such as purse-seining and scalloping the cost of fuel has not affected the course of development events. Other countries which have large fishing fleets find themselves in the same predicament; indeed in some instances the cost of fuel is a secondary problem, the availability of fuel having resulted in many vessels being laid up.

An examination of so called fuel efficient fishing methods must take into account productivity when compared with less fuel efficient methods and by the same token modifications to fishing gear and changes in fishing strategies to improve fuel efficiency will not be accepted unless the current level of production is maintained. With this in mind we have looked at both inshore and offshore sectors of the groundfish industry and probably the most fuel hungry fishery of all, scalloping. There are no ultimate panaceas offered for all instances where excessive fuel consumption is apparent; however, the recognition of inefficiency in this regard will hopefully stimulate discussion at this conference and perhaps subsequent dialogue leading to improvements in fishing strategies and the type of gear used.

Passive Gear

This presentation would be incomplete if we neglected to mention the more obvious fuel efficient fishing methods which mostly fall into the “passive” gear category as opposed to towed gear which requires a high level of fuel consumption. It is not intended to describe “passive” fishing methods, since they are well known; however, advancements in mechanization and automation allow consideration as alternates to trawling in as much as catch rates can be comparable, gear damage minimized and the catch value increased by landing a high quality product.

Automated/Mechanized Longlining

Several auto/mechanical systems are now available which facilitate the baiting and handling of the gear. In some instances components of a system may be installed on boats ranging from the small inshore class to large offshore vessels. Perhaps the most interesting development which inshore fishermen will find attractive is the so called “Random Baiter” several types of which are now available in Canada. Recent trials have shown that the percentage of successful baiting is sufficiently high to warrant the installation and the cost is reasonable.

Completely automated systems entail a high capital investment and each vessel owner must consider this in relation to operational benefits.

Cod Traps

Since 1969, experiments have been carried out by scientists of the United States Marine Fisheries Service with the offshore fish traps, to catch Sablefish, (anoplopoma fimbria). These experiments have been carried out using several different types of traps, beginning with modified king crab pots and cylindrical traps and later rigid rectangular traps and
TWO TYPES OF FISH TRAPS

RIGID RECTANGULAR BLACK COD TRAP
USED ON PACIFIC COAST OF NORTH AMERICA - 1973
APPROX. DIMENSIONS: LENGTH 96, WIDTH 32, DEPTH 32

COLLAPSABLE MORTON COD TRAP TO BE USED IN NORTHERN NOVA SCOTIA - 1981
APPROX. DIMENSIONS:
LENGTH 36
WIDTH 32
DEPTH 12

Figure 1
finally collapsible rectangular traps. The latter proved successful and were fished in the longline mode.

Though Sablefish or Black Cod belong to a different family than Atlantic Cod (Gadus Morhua) the two were thought to have some similar behavioural patterns which suggested that the latter species might be caught in traps in Nova Scotian waters. Therefore, in 1973, trials were initiated to determine the feasibility of using this type of gear on the east coast.

This project was carried out by the Nova Scotia Department of Fisheries in co-operation with the Industrial Development Branch, Fisheries and Marine Service, Environment Canada.

The results were very poor in the three areas fished and 600 lbs. of Cod from 20 traps was the largest catch.

No further work has been done since that time, because, it was concluded by the people involved that behavioral patterns of Atlantic Cod are such that they cannot be caught using this system.

However, with the new emphasis on fishing gear which is energy efficient and produces better quality fish The Fisheries Development Branch plans to carry out a pilot project this year using a Cod trap of a different design.

This is a collapsible Cod trap manufactured by Morton Trap Company in North Carolina. The entrance is constructed with a split webbing, entrance giving an 11½" high opening allowing large fish to enter while preventing fish from escaping. The webbing is No. 18, 3" stretch nylon. The base is constructed of ½" rolled steel.

The traps are dipped with two coats of plastic "net dip" and are black in color, holding capacity is 54 cubic feet and total weight is 32 lbs. It has a large bait well for long sets.

The project using this system is to be carried out in the general area of Bird Island Bank in Northern Nova Scotia. It will get underway in June, 1981 using 6 traps.

Examples of the trap used in 1973 and those to be used in 1981 are shown in Fig. 1

Towed Gear

The best approach to this, the most critical area of fuel consumption is to consider towing requirements for various types of towed gear. Seine netting, whether called Scottish or Danish must be included in this category, although it may be argued quite reasonably that this is an encircling operation. Scalloping is probably the most fuel hungry fishery to be found anywhere and therefore, qualifies for this category.

Seine-Netting

Fuel consumption per hour of actual fishing time is thought to be approximately one-half of that required for trawling. However, there are critical restrictions on the use of this gear, the most important one being that in order for the ropes which actually do most of the fishing (i.e. herding fish by means of an encircling operation into the path of the net) require a smooth sea-bed, either mud or sand or gravel. It is generally accepted that given the ideal bottom conditions, seine-nets can, in fact, out-fish trawls. However, the objective of the present exercise is to attempt to show a lower fuel requirement per hour of fishing and one would have to concede that seine-net fishing demands a far lower fuel consumption than trawling.

The level of technology required to successfully operate a seine-net is somewhat complicated compared to trawling. It demands a comprehensive understanding of tidal and wind influence in addition to a good grasp of the variations in hauling speeds and other refined fishing techniques necessary to fish effectively for various species.

The net remains practically stationary during the initial stage of the operation while the circle of ropes are being closed, driving fish into the mouth of the net. It is only when the ropes come almost together that the wings of the net start to close and at this point the fish are grouped ahead of the foot rope. Fish are not overcome by the speed of the net over the bottom but are gradually encircled and trapped by the gear. This is why nets used for Scottish seine-netting usually have much longer wings than those of modern trawls.

When the wings of the net have closed, the crucial stage of the fishing cycle is complete and no more fish can be caught. Roughly one-third of the ropes should now be onboard and the remainder of the operation consists of hauling in the gear, as quickly as possible.

Because, the fish are not exhausted by being overcome by the gear and because, the meshes of the net remain wide open, the catch contains few small fish and those that are taken onboard are of top quality. Trawl caught fish, on the other hand, may have been crowded in the cod-end of the net for several hours together with much trash and due to the radical elongation of lengthening piece meshes when the trawl is towed at perhaps 3 to 4 knots small fish remain in the cod-end, blocking the meshes and to some extent negating the effectiveness of regulated mesh size. For these reasons and also because seine-net caught fish from inshore vessels in Europe is rarely more than one week old when landed it commands top market prices.

Pair Seining

This is a fishing method based on the principle of Scottish seining except that two boats employ an "open" set technique which covers more ground. As with pair trawling, the drag is divided between two boats and fuel consumption is very low.

N.B. We must accept that pair-fishing techniques are fuel efficient; however, the main constraint is always the ability of two skippers to work together. Usually, this is achieved simply by each vessel...
Figure 2.

PATH OF NET

SHEPHERDING EFFECT OF BRIDLES

- fish movement
- bridle catching up with fish
BRIDLE SHEPHERDING EFFICIENCY AT VARYING ANGLES OF ATTACK

(A) NARROW ANGLE

PATH OF NET

fish is vulnerable to gear
distance fish swims at greater than cruising speed is small

(B) BROAD ANGLE

exhausted fish lost to gear
distance fish swims at greater than cruising speed is large.
risk of exhaustion and loss of fish over or under bridle

Figure 3

WFA
IMPROVED HERDING EFFICIENCY WITH MUD CLOUDS FROM DOORS

Figure 4
having a net and using the nets alternatively when the net of one particular vessel is in use, the skipper is in control for that period.

**Trawling**

This fishing method will receive the greatest attention, since it is thought that trawling is the most critical area where there is room for refinement and improvement which can result in maintaining the present catch level with a reduction in fuel consumption and gear damage.

**Trawl Doors**

It is a common misconception that to be truly effective doors must be set for maximum shearing force i.e. to obtain the maximum spread of the gear. Many contemporary trawls, designed for optimum headline height require a shearing force at the doors of perhaps 30° to the direction of tow, (Fig. 2). Too wide a bridle angle results in increased drag and in fish being lost over or under the bridles, (Fig. 3). Large doors which will increase the spread of the gear, or doors set to obtain a wide shearing angle require long sweeps and/or bridles in order to ensure that the angle between the doors and the wing ends is not too obtuse. This arrangement obviously will cover more bottom area than catching more fish; however, there is an optimum length of sweep plus bridle for any given net at which the relationship between efficiency and drag is acceptable. In fact, at more than 45° angle of attack, most bottom doors become unstable and tend to fall down.

Increasing the angle of attack will decrease the headline height of the net by stretching it horizontally and other distortions occur which stretch the bosom corner meshes and allow netting to drag on the bottom often causing damage.

The towing brackets of most flat trawl doors are set by the manufacturer to give a certain angle of attack, and this remains the same no matter what size the door happens to be. (Some variation may be obtained by altering the position of the back-strap). The fisherman buys a set of doors which are purported to be adequate for the horsepower of his boat's engine, with little or no regard for the size of trawl to be used, the rigging of the trawl (i.e. ground gear) or the main species to be caught.

Trawl manufacturers are caught in the middle of the horsepower headline height equation and because they are, after all, in the business of selling gear have no other recourse but to recommend a certain size of net for a fairly wide range of engine horsepower.

We are presently endeavouring, (because we have a vast range of inshore fishing vessels with widely varying towing capabilities, despite vessel size and horsepower) to establish a more precise measurement of towing capability based on bollard pull. This also is not precise but I think a realistic criteria which can be used in conjunction with vessel horsepower. We have in Eastern Canada many vessels which can boast perhaps 300* horsepower. These may be Cape Island or other shallow draft vessels, possibly with gasoline engines and 2/1 or direct drive.

It is particularly difficult to match horsepower to gear size if one considers that the thrust of the propeller should be measured at no more than three-quarter throttle. It would not be reasonable to match trawl and door size to the maximum R.P.M. of the engine for obvious reasons.

**Towing Speed**

It is interesting to consider the effects of varying towing speed. It is a well-known fact that if we double the towing speed, we increase drag fourfold. However, it has been observed that the total drag of trawl gear increases at less than a square law, and due to this we can assume that the flexible net changes shape with speed and become more streamlined, whereas the door cannot change shape and always follows the square law. The effect of this is that speed changes affect the doors more than they do the net. When we increase speed, the extra pressure on the front of the door will cause the door to turn outwards, (because the drag from the net will increase more slowly than the door drag). As the angle of attack increases, the door drag will also increase and if the door was angled at optimum shear previously, its shear will decrease and the spread of the doors may actually be reduced. The nose of the door will also tend to be lifted as speed increases.

The points noted above indicate some of the problems which occur when we try to get a good match between doors, net and towing speed.

It is difficult to make adjustments to doors at sea, due to the lack of sophisticated measuring instruments necessary for accurate comparisons. In practice, we can examine the shoes of a door for wear and get a rough idea of its towing attitude, and make adjustments on the strength of these observations. We can also get a good idea of door spread on stern trawlers, by measuring it again one metre further aft. The difference in the two readings when multiplied by the warp length in metres will give us the spread between the doors. To this figure we must remember to add the actual distance apart of the warps at the towing blocks. On side trawlers we simply measure the distance between the warps one metre aft of the towing block and multiply this by the length of warp in use (in metres).

Before making adjustments at sea, it is recommended that the average of a few runs is taken and that allowance is made for tide.

By increasing door spread by towing harder or changing to more efficient doors, but keeping the bridle lengths the same, the angle of attack of the bridle is increased. One could assume, in these circumstances, that catch rate would increase because the gear is now sweeping a bigger area of the sea-bed and more fish should be vulnerable to
RELATIVE APPROACH SPEED OF BRIDLE

(A) NARROW ANGLE

V = towing speed
R = relative speed of approach of bridle to fish

(B) BROAD ANGLE

Figure 5
Figure 6

SHEER AND DRAG COEFFICIENTS OF RECTANGULAR FLAT DOOR IN GROUND CONTACT AGAINST ANGLE OF ATTACK

![Graph showing shear and drag coefficients against angle of attack.](image-url)
APPROXIMATE MATCH
OF DOOR SIZE (VEE DOORS)
TO HP

Figure 7
VEE DOOR PERFORMANCE

GEAR: 12 fm TRAWL, 5'-4" VEE DOORS, 5:1 WARP TO DEPTH RATIO

0.80 TONS, 60 ft

0.82 TONS, 55 ft

0.85 TONS, TOTAL WARP LOADS, 52 ft, SPREAD

FIGURE 8
the gear. However, it appears that no significant increase in catch rates results, partly no doubt, because the decreased headline height resulting from increased door spread allows more fish to pass over the headline, but also because the increased angle of attack on the bridge means more fish are exhausted and pass over, or under the bridge before coming within range of the net.

Much more work remains to be done on the behavior of fish in contact with gear before really definite conclusions can be drawn as to; for example, the optimum angle of attack on the bridge. Nevertheless, the knowledge gained up to now has given gear technologists some guidelines and limits to work on, particularly, with relation to speed and bridge angles. It is likely that further improvements to fishing gear design will result as the reactions of fish to each component of the gear becomes better understood.

Once the fish has been herded into the catching area of either the trawl or the seine-net, it swims along in front of the footrope or the ground gear. At this point the fish are swimming at well over two knots in the case of the seine-net or nearly four knots in the case of a trawl. They are, therefore, swimming now above their maximum cruising speed and rapidly using up their stores of energy. Haddock have been seen swimming at two and one-half knots in front of the seine-net and place swimming at two and one-half knots in front of the footrope. Two minutes is, however, the longest time during which this behavior has been observed. Individual fish are seen to turn and swim back through the mouth of the gear, typically keeping in line down the centre of the funnel away from the netting wall; sometimes, however, the fish will turn and swim briefly forwards with the net.

Table 1. Summary of Main Trawl Door Characteristics

<table>
<thead>
<tr>
<th>Door Type</th>
<th>Common angle of attack</th>
<th>Corresponding hydrodynamic characteristics</th>
<th>Fishing suitability</th>
<th>Experience Record</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional rectangular flat</td>
<td>40°</td>
<td>Sheer CL</td>
<td>Average to poor</td>
<td>A,B good to poor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Drag CD</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lift/drag ratio C_L/C_D</td>
<td>1.14</td>
<td></td>
</tr>
<tr>
<td>Rectangular cambered</td>
<td>35°</td>
<td>1.26</td>
<td>Good</td>
<td>A, B, good to poor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.81</td>
<td>(difficult to right if fallen over)</td>
<td>C poor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.55</td>
<td>Overall efficiency</td>
<td></td>
</tr>
<tr>
<td>Oval, flat slotted</td>
<td>35°</td>
<td>0.86</td>
<td>Average to good</td>
<td>A, B, C good to good</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.63</td>
<td></td>
<td>Poor to average</td>
</tr>
<tr>
<td>Oval cambered slotted (Poly-valent type)</td>
<td>35°</td>
<td>0.93</td>
<td>Average to good</td>
<td>A, B, C good to good</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.74</td>
<td></td>
<td>Average to good</td>
</tr>
<tr>
<td>Rectangular Vee type</td>
<td>40°</td>
<td>0.80</td>
<td>Average to good</td>
<td>A, B, C good to good</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.65</td>
<td></td>
<td>Poor to average</td>
</tr>
<tr>
<td>Rectangular flat special design (diverting depresser)</td>
<td>40°</td>
<td>0.82</td>
<td>Average to poor</td>
<td>Very good to good</td>
</tr>
<tr>
<td>Rectangular cambered high aspect ratio for midwater trawling (Suberkrub type)</td>
<td>15°</td>
<td>1.52</td>
<td>Very good</td>
<td>A, B good to poor</td>
</tr>
</tbody>
</table>

For quality of seabed: A = good ground, even absence of boulders, etc.  
B = medium ground, stones, no sudden major depth changes  
C = bad ground, large boulders, uneven, sudden and major depth variations  

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Trawl Nets

Modern trawls are designed to minimize contact between the vulnerable twine and the sea-bed. Often the lower wings are cut back or eliminated entirely and the lower bellies are tapered upward so that the cod-end is clear of the bottom (Figs. 11 & 12). Double or three bridle rigs allow for adjustment so that bottom contact can be heavy or light as circumstances warrant. This is achieved by either taking in the lower bridle or letting out the upper bridle to give heavy contact and vice-versa. Shorter lower bridles allow the headline to lift while shorter upper bridles have the opposite effect. Horizontal net spread usually increases with a lower headline height.

In considering the resistance of a trawl, the angle of netting to the direction of tow is an important factor. Sharply tapered panels present a greater surface area to the flow of water and, therefore, create more resistance than slowly tapered panels. A trawl which has a long slow taper down the bag will offer low resistance as the netting panels are closer to being parallel to the direction of tow.

Trawls which require small meshes in the last bellies and cod-end; such as, shrimp trawls must have additional length to allow water to pass through, thus cutting down on back pressure inside the net. The effect of back pressure is to blow the fish out through the larger meshes in the forebody of the trawl.

Mesh sizes can be very large in the wings and front of the trawl since this part of the net simply acts as a leader and as long as the gear is in motion fish will rarely pass through.

Some so called "Super Mesh" midwater trawls have mesh sizes more than three metres and "Rope Wing" trawls employ parallel ropes in place of meshes, (Fig. 13).

In 1976 the Fisheries Development Branch utilized an "Explosion Panel" in the design of an experimental midwater shrimp trawl, (Fig. 14). The effect of this was to allow water to pass through, thus reducing resistance. The shape of the large meshes in this panel were, however, elongate and since few shrimp were seen to be meshed in this section it was presumed that there was no loss of catch.

The Branch is presently planning to utilize flexible stainless steel wire to replace ropes in a pelagic rope wing trawl. It is felt that the resultant effect will be to further decrease resistance and allow the net to have light contact with the bottom. This should prove effective for offshore mackerel during the winter months and, also, for high swimming demersal species, such as, pollack and cod.

The flotation of a headline of a trawl is, of course, usually achieved by attaching floats, although in some instances kites are used. Floats, having a positive buoyancy tend to lift the net, opposing the downward gravitational pull of weights on the footrope. This vertical lift, however is partly negated by the resistance of the net and the floats themselves to the water flow. It is interesting to note, (Fig. 10) that 11" floats have a lifting force almost three times that of 8" floats and one would, therefore, presume that a smaller number of large floats will provide equal lift with less resistance.

Kites provide lift only when in motion since the upward force depends on the angle of attack in relation to the direction of tow (usually not more than 30°). There is no comparative data related to lift x drag for floats and kites available at this time. Floats are, however, considered more convenient in terms of handling onboard.

Figure 10

Lift From Different Types of Floats

Readings obtained by measuring the weight of Seine net leads to balance the floats in water.

<table>
<thead>
<tr>
<th>Size</th>
<th>Make</th>
<th>Type</th>
<th>Lift lbs</th>
<th>Kilos</th>
</tr>
</thead>
<tbody>
<tr>
<td>5&quot;</td>
<td>Phillips</td>
<td>Aluminum</td>
<td>1.7</td>
<td>0.77</td>
</tr>
<tr>
<td>5&quot;</td>
<td>Nokalon</td>
<td>Plastic</td>
<td>1.96</td>
<td>0.89</td>
</tr>
<tr>
<td>5&quot;</td>
<td>More</td>
<td>Plastic</td>
<td>2.0</td>
<td>0.91</td>
</tr>
<tr>
<td>5&quot;</td>
<td>North Star</td>
<td>Plastic</td>
<td>2.25</td>
<td>1.02</td>
</tr>
<tr>
<td>5&quot;</td>
<td>Permoliift Minor</td>
<td>Plastic</td>
<td>2.67</td>
<td>1.21</td>
</tr>
<tr>
<td>6&quot;</td>
<td>Phillips</td>
<td>Aluminum</td>
<td>3.23</td>
<td>1.46</td>
</tr>
<tr>
<td>6&quot;</td>
<td>Arra 6635</td>
<td>Plastic</td>
<td>3.18</td>
<td>1.44</td>
</tr>
<tr>
<td>6&quot;</td>
<td>Nokalon 34758</td>
<td>Plastic</td>
<td>3.91</td>
<td>1.77</td>
</tr>
<tr>
<td>8&quot;</td>
<td>Phillips Deep Sea</td>
<td>Aluminum</td>
<td>7.41</td>
<td>3.35</td>
</tr>
<tr>
<td>8&quot;</td>
<td>Rosendahl</td>
<td>Plastic</td>
<td>6.93</td>
<td>3.13</td>
</tr>
<tr>
<td>8&quot;</td>
<td>Nokalon</td>
<td>Plastic</td>
<td>7.85</td>
<td>3.55</td>
</tr>
<tr>
<td>8&quot;</td>
<td>Arra 6637</td>
<td>Plastic</td>
<td>8.84</td>
<td>4.0</td>
</tr>
<tr>
<td>8&quot;</td>
<td>Nokalon Deep Sea</td>
<td>Plastic (Yellow)</td>
<td>5.69</td>
<td>2.57</td>
</tr>
<tr>
<td>8&quot;</td>
<td>Nokalon 34758</td>
<td>Plastic</td>
<td>8.62</td>
<td>3.90</td>
</tr>
<tr>
<td>10&quot;</td>
<td>(Twin Lug)</td>
<td>Plastic</td>
<td>11.05</td>
<td>5.0</td>
</tr>
<tr>
<td>11&quot;</td>
<td>Rosendahl</td>
<td>Plastic</td>
<td>21.44</td>
<td>9.7</td>
</tr>
<tr>
<td>11&quot;</td>
<td>Nokalon</td>
<td>Plastic</td>
<td>21.8</td>
<td>9.9</td>
</tr>
</tbody>
</table>
SECTIONS IN A TYPICAL TWO SEAM TRAWL
IN PERSPECTIVE

NOT TO SCALE
SMALL DETAILS OMITTED FOR CLARITY
NOTE TENDENCY FOR SLACK TWINE AND COD-END TO DRAG ON SEA-BED
TYPICAL MODERN TRAWL TAPERED TO AVOID BOTTOM AND COD-END CONTACT OF TWINE

SIDE VIEW
Figure 13

3-BRIDLE BLAEKSPRUTTE TRAWL
WITH ROPE WINGS
Figure 14

2462 MESH SHRIMP MIDWATER TRAWL

CODEND

SHOWING EXPLOSION PANEL AND ELONGATED COD-END
Pair Trawling

The Fisheries Development Branch, F & O Maritimes Region has introduced and demonstrated pair bottom and pair mid-water trawling in several inshore areas, and while no direct comparisons with single boat trawls have been made, it is generally agreed that individual vessel fuel consumption is less than two-thirds of what it would have been had the vessels been trawling individually. Of course, no trawl doors are used and since doors contribute approximately 30 per cent of the total drag, even with a net which has twice the swept volume of a single boat trawl the total drag will be much less.

Assume a total drag of 3 tons for a single boat trawl.
then door drag = approx. 1 ton.
Pair trawl with net twice as big.
total drag will be 4 tons or 2 tons each vessel.

In practice, this comparison is not exact since pair trawlers use much greater warp to depth ratios, thus increasing warp and ground gear drag. Even so, the savings in fuel in a pair operation can be quite significant. In addition, it is thought that vessel and gear noise in a single boat operation tend to frighten fish away from the mouth of the trawl, especially in shallow water. Pair trawling, on the other hand, is a much quieter operation and, in fact, in shallow water engine noise from two boats tends to drive fish into the path of the net. Add to this the fact that the herding effect of the warps and ground gear is much more effective, (similar to the function of seine-net ropes) the catch rate measured against fuel expended is greater.

There are other important factors; such as, the capability of the pair trawl to fish on rougher bottom than a single boat trawl. If the gear comes fast, one boat can possibly tow the other out, thus not losing the tow — and saving fuel. (Fig. 15).

Model Testing

The resistance of trawl gear is measured; fairly accurately, by means of warp tension meters. In order, to design for optimum performance with minimum resistance, however, the availability of a flume tank is of paramount importance. Trawl net and door manufacturers in Europe today would find it difficult to sell their products; for instance, without test tank data in order to validate the properties and advantages of a certain design. Theoretical models are no longer acceptable and on many occasions the fishermen requires to see a model in the hydro-dynamic mode before buying. Perhaps one day we will be privileged to have a test tank in Canada, in order, for Canadian net manufacturers and fishermen to have the same advantages as their counterparts.

Scallop Rakes

There have been several estimates made of the efficiency of scallop rakes used in Canada and other countries. Some researchers have stated that efficiency can be as low as 12 per cent, i.e. only 12 per cent of the scallops in the path of the rake end up in the bag. On the other hand, as many as 25 per cent of the scallops over which the rake passes are damaged and do not survive. This inefficiency can be considered poor utilization of fuel, in addition, to being wasteful of the resource.

Offshore rakes used by boats of 700+ horsepower weigh about 5,200 pounds and are towed one on each quarter. Depressor plates and rock traps (chain bellies) are used, but many rocks still pass over the arrangement of chains and into the bag, (Fig. 16). Towing rocks around is, obviously, to be avoided if possible and engineers of the Fisheries Development Branch Maritimes are presently studying this problem together with the conservation aspects of scallop gear.

Inshore ("Digby") rakes (Fig. 17) are towed by boats of about 160 horsepower with as many as seven rakes on a towing bar. The total gear weighs about one ton. Usually, these boats can only tow before the tide, having to steam back after each tow. Various types of rakes have been tried including European designs; however, Canadian inshore fishermen appear to prefer the traditional rakes.

The whole scallop fishery requires examination and while no solutions are offered here, the relationship between fuel consumption, hours fished, catch rates and damage to the resource is probably amongst the most critical in the whole industry.

Future Trends

One is sometimes inclined to think that development has reached the point where little else is possible. Technology, however, never stands still and new developments will occur to counteract whatever problems are created by factors, such as, fuel cost and availability. Looking in the crystal ball one could see possibly finer, stronger twines and wider acceptance of knotless netting which has a lower resistance. Trawl doors will be controllable to close or open the net at will and perhaps sound or light will be used to lead or herd fish into the path of the net.

High swimming demersal species will be harvested solely by pelagic nets fished close to rough bottom, obviating the need for heavy ground gear which will only be needed for flatfish species.

Net monitoring systems will be widely used on both pelagic and demersal trawls to ensure that net configuration, trawl door behavior and catch rates are at the optimum level.

Fish farming and Sea Ranching will become a reality. Already there are positive moves in this direction and it is not outside the bounds of possibility that in the not too distant future fish husbandry will be just as conventional as animal husbandry is now.
Figure 15

SHOWING SWEPT AREA COMPARISON BETWEEN SINGLE AND PAIR TRAWLING METHODS. (NOT TO SCALE)

OTTER BOARDS

STEEL BOBBINS

0.25 MILE
CANADIAN OFFSHORE SCALLOP RAKE

Figure 16
INSHORE "DIGBY" SCALLOP RAKE

TOP OR BOTTOM VIEW

FISHES BOTH WAYS, REGARDLESS TOP OR BOTTOM IS TOWARD THE OCEAN FLOOR

Figure 17.
Discussion

There is no doubt that much is being done and that much more can be done to reduce the drag of towed gear and thus conserve fuel. There is a strong tendency by fishermen, however, to increase the size of their gear to take advantage of improved door or net design, even to the point where horsepower curve of the boat's engine is being used in the upper range when fuel efficiency is the poorest. Sound common sense is a vital key, without which improvements in gear design become pointless.

One could argue that catching more fish in less time is in itself an economy in fuel consumption but this brings us into the field of stock conservation, quotas and other considerations outside the scope of this paper.

It can be recognized that towing faster does not necessarily catch more fish. In fact, it may catch less if the fish are off bottom since the net headline will be lower.

Electronic fishing aids are not dealt with in this paper as they are considered to be outside the scope of fishing gear. It is hoped that this subject will be dealt with by other speakers since it is an aspect of modern fishing which is important, perhaps even critical in both the search and catch modes of fishing as it relates to fuel conservation.

Finally, it has to be said that a better understanding of the resource, species migratory patterns, behavioral characteristics, temperature preferences etc., will allow fishermen to catch fish with minimal fuel consumption.

MODERATOR’S COMMENTS:

Mr. Kingsley: A few comments on Jack Rycroft’s presentation. We note the interest in long-lining as a fishing method which uses less fuel than the towed gear. We feel in Newfoundland there is significant scope for development of this particular type of fishery. In designing trawls there are other things to consider. The reaction of the fish to the bridles and so on, all these things place constraints on the gear designer and these have to be considered very carefully. One item that Mr. Rycroft mentioned, also brought up by Mr. Foster, was the mis-match between the trawl and the boat. This poor performance is often due to improper propeller installation and the danger of trying to design a multi-purpose vessel. The trawler mentioned by Mr. Foster, to my knowledge, was designed as a purse seiner and it ended up a dragger. There are things that have to be looked at very carefully before you can move from purse seining to dragging.

Mr. Rycroft used some figures about otter boards and their spreading performance and drag coefficients. It is well known that if you change the shape of an otter board by putting a curve on it, you can reduce the drag. Midwater trawl otter boards have as little as one quarter the drag of a similar sized bottom trawl otter board and this is simply due to the different shape of it. This is something which hasn’t caught on in this part of the world for bottom trawling. I understand the Japanese do use a Suberkrub type otter board but they’ve reduced the height of it so it won’t topple over on the bottom, and I raise question as to why we aren’t using more of them in this part of the world.

Those are some sobering thoughts. I think that no matter what account you read of the influence that the skipper has on the success of a fishing operation, you will find it’s the skipper’s ability which usually makes the difference. You wonder really what that ability is: is it because he does know where to find the fish or that when he gets there he knows how to catch them better, perhaps by keeping his gear in better shape? The fleet information system is a possible source of equalizing the difference in skippers and that would apply to obviously a larger company that operates a fleet of vessels.

I think the conflict that seems to be on the horizon between increasing catching efficiency and in managing the resource is looming ever larger. Dr. May in his opening remarks said he didn’t want to see any increase in catching efficiency or catching capability and yet people from the industry tell us that is perhaps the single most effective means of increasing or decreasing their costs. A lot of thought will need to be given to that problem. The alternatives are to use less efficient fishing methods and spread the quota systems, spread the catch out over a longer period, or take it all in a short time and tie up the boats. That’s something I think that certainly is going to have to be addressed.
ENERGY IMPLICATIONS OF FISHING FLEET STRATEGY

by T.B. Nickerson
Nova Scotia Research Foundation Corporation
Dartmouth, Nova Scotia

Most of the literature on Energy in Fish Harvesting focuses on energy efficiency improvements in the design and operation of the individual fishing vessel and its gear. The energy efficiency possibilities associated with the operation of a fleet of vessels as a coordinated unit have received little attention, probably because of the industry tradition of every vessel operating independently in its search for fish resources. In this paper the constraint of “every man for himself” is relaxed and the energy efficiency implications of one possible coordinated fleet strategy are considered.

The intent of the paper is to put forward the theme that fleet operating strategies can be a significant factor in energy efficiency and should be considered as part of any comprehensive examination of ways to improve the energy efficiency of fish harvesting. It is hoped that the Paper will stimulate discussion of both the theoretical and practical realities of various fleet strategies and their energy efficiency implications.

The objective of a fleet strategy is to take advantage of fleet size to achieve a result which is greater than could be achieved by each vessel working independently. To take advantage of fleet size requires a cooperative effort among the fleet vessels and hence some loss of independence for individual vessels. Foreign fishing fleets have used a variety of fleet strategies including information sharing, use of one or more vessels to do trial fishing for the fleet, and squadron fishing. It is generally considered that these concepts, involving some loss of skipper independence would not be suitable for the Canadian fishing fleet. However as the price of fuel continues to rise and the possibility exists, however remote, of fuel shortages all available methods of improving fuel efficiency must be considered.

To illustrate the potential of a fleet strategy based on a fleet information system it is convenient to consider the Atlantic Canadian Offshore Trawler Fleet. This mobile fleet, comprising more than 100 vessels fishing over most of the Atlantic Canadian Continental Shelf, is the major year-round supplier of fish to the processing plants. In terms of energy usage, i.e., kg of fuel used per kg of fish landed, the offshore trawler is not as efficient as other methods of harvesting the same species. However any comparison must recognize the unique ability of the offshore trawler to land fish twelve months of the year and to fish in distant waters.

The operational mode of the offshore fleet, i.e., the search for and harvesting of fish over a large geographic area, makes it a suitable candidate for a fleet information system.

Traditionally each vessel in the offshore fleet operates as an independent entity in its search for fish resources. Each skipper decides when and where to fish, when to shift grounds in search of a higher catch rate or more desirable species, where to move to avoid bad weather, etc. Each skipper makes these decisions on the basis of past experience, intuition, and whatever knowledge of current conditions he is able to obtain. His success in making the right decision is a governing factor in determining the success of the vessel. The skipper who makes the best decisions will land the most fish and earn the most money for himself, his crew, and the vessel owner. As a result of this success he will attract the best crew and be assigned the best boat. The best crew and equipment will in turn increase the catching efficiency of the unit.

The variation in skipper ability can result in a variation of up to 2:1 in the fish landings between a top line skipper and a mediocre skipper using the same type of vessel and gear. The fuel consumed by the two vessels, assuming an equal number of days at sea for both boats, will be approximately the same. Hence the vessel with a top line skipper can achieve an energy usage which is half that of the identical vessel operated by a mediocre skipper. Any improvement in the decision-making ability of skippers will have a positive impact on energy efficiency.

A fleet information system is one way to take advantage of the existence of a fleet of vessels to improve the decision making ability of skippers and hence improve energy efficiency. The concept of a fleet information system is simple – every vessel in the fleet would report regularly (probably every six hours) to a fleet operations centre. The report would give location, current catch rate by species, and weather conditions. Vessel reports would be used to update an information base. Each skipper in the fleet could access the information base to determine fishing conditions at all reporting locations and could use this information on current conditions to assist him in deciding where to go in search of fish or, if he is presently fishing, in deciding whether or not to move to another location. After several years of operation the information system would also be able to provide historical data on any location to complement the information on current conditions.

The preceding theory is very nice. The practical realities for fleet information systems may seem insurmountable in the current Canadian fishery.
environment. However . . . as the fuel prices increase the fishing environment will change. How far, how fast it will change is hard to predict. But the fact is it will change and change for the worse in terms of energy costs is indisputable.

The results of a computer simulation model of a fleet information system developed in the early 1970's indicated that the improvement in skipper decision-making resulting from the use of current information on catch rates at all locations could result in a 50% increase in total catch compared to a skipper whose decisions were based only on experience and intuition.

While many factors have changed in the past decade, and the original model considered two extreme cases (no current information and complete current information), the results are indicative of the possible improvements which can result from coordinated fleet action.

The practical prospects of implementing a fleet information system (or any other fleet strategy) depend to a large extent on the feasibility of modifying the tradition of "every man for himself". System analysis studies can predict the likely benefits of a fleet strategy – industry must decide whether the benefits justify a change in traditional operating practices.

From an energy efficiency perspective most fleet strategies contribute to an improved energy usage by increasing the quantity of fish landed with little or no increase in fuel consumption. This approach to improving energy efficiency has the potential to achieve as much if not more than can be achieved by efforts to reduce fuel consumption. Together the two approaches have the potential to achieve a significant improvement in fuel usage in fish harvesting, an improvement that will be increasingly necessary to maintain the competitive position of fish products with respect to other protein alternatives.

There would certainly be some concern I presume on the part of the Department of Fisheries & Oceans that goes against the grain of catching more fish; however, it is also feasible to say that you catch the same amount of fish using a reduced effort. And if you look at the future in energy usage you are going to need both approaches.

In most of the discussions in the last two days we have been talking about looking ahead five to ten years; look beyond that period 10 to 20 years and the energy situation will continue to get worse. There is no real prospect in terms of liquid fuels, or in my opinion, any improvement in fuel costs or in fuel availability. The fishing industry is going to have to adapt to these realities.
ENERGY AND FISH QUALITY

by John H. Merritt, P.Eng.

Fisheries Research and Technology Laboratory Technical University of Nova Scotia

Summary

The fish industry, in common with other branches of the food industry, consumes substantial amounts of energy in handling, processing and distribution of fish and fish products and in many instances has introduced measures to reduce energy costs. More work and study is needed in order to enable further savings. In any case, however, good product quality must not be sacrificed if real savings are to be made. Refrigeration and drying are two processes which demand particular attention, since they are widely employed in the industry.

Introduction

At a time when energy costs are rising sharply it is pertinent to consider not only the energy needs for the harvesting of fish but also the needs for the handling, processing and distribution of fish and fish products. Many of the questions which arise here are common throughout the food industry and are being given a fair amount of attention.

How important is the cost of energy and how far have increased costs changed the food industry? In fact the changes have been only minor ones; we have not yet gone 'back to the land' with bucket and hoe and by and large we have not abandoned the processes and practices which consume large amounts of energy. Disaster seems unlikely but there will be further changes. Industry has been making some economies and will have to give increased attention to the efficient use of energy. It looks as though the price of energy in relation to other prices will continue to rise. Also we can expect government to bring increased pressure for saving by the introduction of higher fuel prices and legislation including tax laws that will encourage capital investment in order to save energy.

Against this background, methods of processing and practices in handling, storage and distribution will have to be kept under close review.

Preservation Methods

Should some of the common methods of preservation be abandoned on grounds of high energy consumption?

We shall not have to make such stark choices in the foreseeable future. There may be, however, some shifting of demand from one kind of product to another according to cost in the normal way. A number of studies of energy costs in various food processes have been reported \(^1\)\(^9\) but there are substantial discrepancies between the results.

Löndahl\(^10\) has discussed some of the difficulties in arriving at comparable data. In Table I he shows comparisons of energy costs according to four separate studies. Typically, there are substantial differences, a number of them not fully explained. In short, we do not have precise information enabling strict comparisons between canning, freezing, drying, etc. Cost calculations are of greatest interest, therefore, when they are concerned with the saving of energy on an actual processing line or distribution system where comparable costs are known.

It has been observed that generally the consumer turns toward food that is 'fresh', or approaches the fresh article, as the amount of wealth increases in society and as good processing facilities and rapid distribution become available. Thus the demand for fresh and frozen foods has become more widespread and today there is a large world trade in frozen fish, with Canada as a major exporter.

Nevertheless there remains an important place for fish processed by other means, curing, canning, etc., by which flavour and texture are altered substantially. Research into more efficient methods of production that will save energy, for example by the use of the heat pump in drying, has been taken up.

The amount of energy used in fish processing factories has been estimated at 720 kWh per tonne of raw fish. Two processes, refrigeration and dehydration, deserve special attention because they are widely employed in the Canadian fish industry.

Refrigeration

The cooling of fish is essential for the maintenance of high quality. It takes a number of forms which can be divided into two main categories, chilling and freezing.

The amount of energy used can be estimated only roughly. We do not have precise figures for the annual production of ice but, according to the amount of fish landed in Canada, it should be greater than ½ million tonnes. The energy required to produce this amount will be about 30 million kWh. The amount of energy used in the freezing of fish, more than a quarter million tonnes, will be at least as great. Further there are large amounts of energy used in mechanical refrigeration systems for the storage and transport of chilled and frozen fish.

No doubt industry will invest a considerable sum on freezing and associated plant equipment over the next few years, possibly some of it for freezing at
sea and the preservation of presently underutilized species. An assessment of various refrigeration schemes will have to be made from the point of view of energy consumption and in the light of trends in processing such as the production of more individually quick frozen items.

**Dehydration**

Dried salted cod is marketed in several European, Carribean and other countries and indications are that demand will remain high. Drying has a number of advantages over other methods of preservation, especially in that dried foods generally are easy to transport and store. On the other hand, existing mechanical fish dryers are dependent on favourable ambient conditions and they tend to be wasteful of energy.

In rough figures, dried fish products for direct human consumption account for more than 150,000 tonnes of fish per year and fish meal for animal feeding accounts for more than 250,000 tonnes per year of the landed catch. Fish meal manufacture requires 30 to 60 kg of fuel oil and 25 to 35 kWh of electric energy for each tonne of raw material processed. The corresponding figures for dried fish products will be somewhat higher.

**Energy and Fish Quality**

Analyses of costs which take insufficient account of product quality and the consumer's preferences are not worthwhile. While this might appear to be an obvious point and therefore hardly worthy of mention, it is remarkable how often quality is given a low place. There is no more glaring example of this than in the storage of frozen fish. The temperature of fish in cold storage is often too high, with poor quality the result.

Frozen fish should be stored at -30°C. This has been demonstrated conclusively by the results obtained by commercial cold store operators for more than 20 years. Yet there are those who advocate the raising of temperatures in order to save energy! On the other hand, the amounts of energy used in cooling fish and other frozen foods that have been warmed and suffered loss of quality through poor handling, transport and display practices are surely large.

**Environmental Factors**

There are, of course, environmental problems associated with food processing and the fish processing industry is no exception. Furthermore, while the cost of energy is rising, the need to reduce pollution and nuisance from factories also is increasing. Often the means of dealing with these problems involve consumption of energy. It will be essential to select carefully the processes and plant to be employed and sites for factories with a view to water treatment, waste recovery, odour abatement, etc.

**Present Status**

A number of examples are available to demonstrate that appreciable savings in energy can be made, especially when new factories, etc. are built, by the application of existing knowledge. Although the discontinuous nature of many of the operations in the fish industry is an obstacle, sometimes heat recovery systems can play a role. Also much can be done to reduce energy costs by following best present practices in handling, processing and distribution.

**References**

Table I
Comparison of energy cost calculations for frozen and canned vegetables
(1, 4, 6, 7)

<table>
<thead>
<tr>
<th></th>
<th>Energy Consumption kWh/Ton</th>
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<tbody>
<tr>
<td></td>
<td>Frozen</td>
</tr>
<tr>
<td>Harvest</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Processing</td>
<td>2.815</td>
</tr>
<tr>
<td>Freezing/canning</td>
<td>1.450</td>
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<tr>
<td>Packaging material</td>
<td></td>
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<tr>
<td>Storage (packing material)</td>
<td></td>
</tr>
<tr>
<td>Transport</td>
<td>690</td>
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<tr>
<td>Storage, retail</td>
<td>2.240(2)</td>
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<tr>
<td>Light heat</td>
<td>500</td>
</tr>
<tr>
<td>Storage home</td>
<td>1.455(3)</td>
</tr>
<tr>
<td>Preparation</td>
<td>2.195</td>
</tr>
<tr>
<td>Waste, fish etc.</td>
<td>320</td>
</tr>
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</table>

1) 6 months bulk  
2) 1 week  
3) 2 weeks  
4) 26 weeks bulk  
5) 165 days bulk  
6) 20 days home
SAIL-ASSISTED FISHING
by Francis J. Morey
Vessel Designer and Fisherman

Mr. Francis J. Morey: First of all, what I am discussing today is sail-assist not full-sail power. Sail-assist was a technique that was very common when the old schooners were steam powered. You have your sail set and according to your trim and a tack to the air you are powering at the same time. This takes that last few percentage points of strain or load of the engine and it's at the upper end of the fuel curve that the last knot costs you a lot of fuel.

I have some drawings of some vessels that I've worked on in the last two years to illustrate my remarks. One is in an advanced stage of design and is a 96-foot longliner. There are certain factors to be considered with regard to a sail-assisted vessel: a displacement hull for starters. You need a good prismatic coefficient, which is a designer's term for the finesse and the ease of the hull moving through the water. Once you've done that to either an existing vessel or you design and build a hull that has those qualifications, then you can add sails; there is no reason not to take advantage of the situation that you have developed. Sails are a relatively inexpensive way to capitalize on the ease of your hull moving through the water. If you're going to go into a retrofit, you would analyze the hull of the boat and that will predicate what kind of rig you're going to put on it and how advanced it can be. A new vessel is different since you can incorporate into the design all the characteristics you need; you can install the optimum sail rig and you come closer to perfection as far as sails are concerned. Using that as your two broad scopes you can save on fuel, from 10 to 40%; 10% for a retrofit dragger when steaming back and forth to the ground and 40% for a longliner that designed and newly built. The latter takes into consideration the 40% not only because of sails, but also the hull shape, better coordination of engine gear, propeller etc. These are the two main categories by which you determine with what kind of vessel you're going to be working. Another point when you get into sails is to make use of yachting circle technology; the development in sails and sail handling equipment over the past ten years has been extensive. It's an explosion of technology that's developed through the America's Cup races and other races. Sail cloth is very advanced with water jet lumes, weaving cloth that literally has no stretch in the warp direction, which is usually the weak direction of the cloth. As the wear resistance of the cloth has been expanded you could realistically put a set of sails on a boat and expect, even commercially, to get five years of use. Along with the hardware that's been developed to handle these sails, you can keep your numbers crew exactly the same. If you're going to have to increase your crew, then it's going to be a self defeating situation.

This drawing is an example of a new design for a sword fisherman. He wanted a 96-footer and he wanted it to do 11 knots. What we've done with this sloop rig, that's a single masted rig, is to be aware of the angle of the shaft of the sails when you're motor sailing, and this requires that you design a close-winded vessel. In this case the owner was more interested in creature comforts and he's got a very large foc'sle; his trips are longer than most ground fishermen. When we started designing the boat, I designed a hull that is adaptable to any fishery. Dragging would be probably the worst use of a design like this. The vessel's specifications are: 150 tons displacement, a hull speed of about 10½ knots and will reach hull speed at 20 knots of wind without any external power. She has a 400 horsepower engine with a variable pitch wheel which would allow the captain to run at its r.p.m.s. which are optimum for the fuel curve and then feather the blade wheel to adjust the speed as the sails started to take over the load and then eventually, if the wind in too high to actually feather out the blades, to reduce drag and be under sail totally.

DELEGATE
COMMENTS/QUESTIONS:

John Osbourne, Centre for Ocean Technology, Nova Scotia Research Foundation: Mainly to Mr. Rycroft on the question of productivity vs. efficiency which has recently been very significant for us with a very big dollar sign attached... In general it seems to me that these are always trade-offs, that the graph of productivity vs. efficiency has one point on it but usually it's the line. You get into a situation where productivity is important or efficiency is acceptable. So which way are we going to go... how do we make it possible for somebody to find out beforehand which way it will be decided?...

Mr. Rycroft: I hope I understand the question... what I said was that I wasn't sure whether we should be looking at catching fish in less time and thus saving energy or whether we should spread our limited resources over a longer period within the limits of the quotas and other regulations that we have. I don't think I am qualified to say which way we should go. I know as an ex-fisherman and having been in the business for a long time that it would make sense to me that if you can catch the same amount of fish in half the time by more efficient gear, then you will save the energy or the fuel that you would have expended over a longer period. That seems to make common sense. That's about all I can say in answer to your question. I hope that clarifies it a little bit.
John Foster, White Fish Authority: I would like to direct a couple of points at the other John Foster and Jack Rycroft about the pair bottom trawling. First of all, you are tying a direct comparison between a two boat operation and one boat operation in trawling mode and my understanding of two boat bottom trawling is that what is effective is the combination of Scottish dragging and trawling using a lot of warp, with two boats towing together as they haul up the gear. John Foster has indicated there is benefit to this. But I would also like him to outline the disadvantages because for all the advantages you get there are disadvantages, and my understanding is that because two boat trawling is a seining operation one tends to operate in a spot fishing mode, you’re not fishing as a trawler. You are not towing extensively for two or three hours across the ground. You spend a lot more time searching with two boat operations so that you get your mark and then you shoot on it as if you were shooting a seine set. To that extent I’m surprised at the difference between time spent between hauls for the two boat operation and the one boat operation. The single net trawler was spending one hour between tows, while the two boat operation was only spending ¾ of an hour. I would have thought with the problem of handling the two boats, getting the two boats along side each other to pass the net across, getting the net back and squaring yourself away that you would spend more time in the two boat operation hauling and shooting gear than you would with the single boat operation.

Also, there is a question of weather limitation. I would imagine, particularly if you are using wooden fishing boats, that you are more limited by weather than you are with a single boat operation, because you have to keep the boats away from one another and in doing that you make life more difficult in transferring your wing end across the one boat which is doing the hauling. Jack mentioned that the two boat operation will handle rougher ground. I find that surprising because with the length of warp out, which is effectively your bridle, you’re going to stand more chance of fouling up your gear in any rough ground. It’s my experience that when you’re on rough ground, you tend to use a much heavier ground rake, you tend to shorten your bridle top so that you don’t have as much wire in ground contact which makes it easier to lift the net over any rough ground you come across. I would like some elaboration on that point as well.

John Foster, Nordco: I think what you wanted me to do was to list the disadvantages and explain something about them. You introduced some of those as you talked, but you left out what is probably still the biggest key difficulty with pair trawling, and that’s getting two skippers to agree that one of them will make the decisions. I mentioned the very successful operations in the southwest of England which I’m sure the other John Foster knows about. And the biggest problem, after three years of operation in that area, is one skipper not being willing to have his partner make the decisions; that is disadvantage number one. This lies in with the sort of problems about fleet management which Tom Nickerson talked about; that a fisherman by definition has chosen that career, partly so that he didn’t have to cooperate with a lot of other people, etc.

The next disadvantage is the question of distance from grounds. The biggest saving does indeed come when you’re able to fish and keep steaming time to a minimum. The improvement that you may get from pair trawling does fall off with distance from the ground. I don’t agree with John Foster’s point that it’s only spot fishing. It is true, that like seine netting, if you are able to search around and spot fish, then there is a tendency with pair fishing to do that more often than dragging, but it’s not a prerequisite. On the question of operations in bad weather; it’s true that passing over the line, keeping a good and perfect distance apart, which is very important in the operation of pair trawling, becomes more difficult as the weather gets worse. However, I think we must be careful that if you’re comparing a large boat with two smaller ones, you are loading the comparison. I feel the experiment I was describing in the southwest of England was more realistic, in the sense that all of the boats, nine or ten of them, are approximately the same size and despite all the problems, more of them operate in pairs than do singles. I think that must say something, because the weather conditions there are not particularly great. An interesting point that I would also like to raise is that, in pair trawling where you are using a scope length of maybe ten times the depth; with that amount of wire out (perhaps with chains on the last 20-30-40 fathoms to even further increase the weight), the gear is in hard contact with the ground and therefore you are going to have a lot less damage if the grounds are smooth. However, my experience in pair trawling has been that those vessels don’t avoid the rough ground anymore than the single boat does, because nine times out of ten that’s where the fish are and you take your damage because the catch makes it worthwhile doing so.

Peter Kinley, Lunenburg Foundry
Engineering: Mr. Foster, I applaud your definition and use of the terms “specific usage” and “specific cost” of fuels. It’s these kind of non-dimensional parameters that are needed to properly compare the results of different tests and reports that come out so that the maximum benefit can be realized by the industry. But I feel the economic report is not complete without mention of the capital recovery costs incurred in constructing and maintaining two vessels rather than one; the lost opportunity costs of operating the two vessels independently and the increased labor cost of using two crews to operate the vessels. I feel we should look at the results from the standpoint of economic cost effectiveness, rather than simple fuel usage, as mentioned in the report. My question is whether these economic factors will
be included in your final written report.

Mr. Foster: The answer to the final part of your question is no. In trying to compare within a gear type, for example, single boat dragging, and doing an economic assessment of whether that boat is viable; that is difficult enough but if you then try and straggle between fishing methods it gets even more difficult. Going back to that southwest England operation, I was horrified to discover that two thirds of the vessels are owned by non-fishing people who are using them as much for tax write-offs as for fishing. Against that kind of background, and remember they're paying a pound ($2.70) a gallon, so the fuel component there is even worse than what we are up against. The key point comes back to what I think Reg Kingsley was saying in relation to the total economics of the situation. With the pair operation, if you are going to pick up an increase in catch of 50%, you have three to one comparison between the two boats and the single boat operation. Even with low fish prices it swamps the economics of the other things, including fuel and other points you mentioned in terms of pay-back period on your boats, etc...

Mr. Doyle: Mr. Foster, I would like to ask a further extension of that question. Maybe it's a little unfair, because as you explained your experiment was short term, but if you take two boats pair trawling each with 250 horsepower and a single boat trawling with 500 horsepower which would be the most efficient?

Mr. Foster: In terms of fuel, according to the pilot experiment we did, somewhat to my disappointment and surprise, the single boat operation came out best. It was an 86% difference, a small difference, but nevertheless the single boat did better. If you then look at other data that has been gathered it does seem that in the comparison you are making of two boats of 250 as against one of 500 there isn't all that much difference. I come back to this question, if weather conditions are satisfactory, if the fish are near enough to home to make it sensible, then the pair boat operation with its bigger net spread, its use of the shepherding technique, is better than the single boat, because it appears that you get an increase in catch per trip equivalent to something like 50% more. Given those circumstances I have no hesitation in saying that the pair is better. Also, there are all those disadvantages that the other John Foster wanted spelled out again, but if you can, taking all these into account it still seems to come right down that side (pair).

Mr. Doyle: From a fisherman's point of view, I think most of the fishermen in my area would agree that the only time that they would go pair trawling would be if they were incapable or did not have the efficiency to do it alone. There are so many other factors involved in this sort of thing, like the cost of operating two boats. You are talking about maybe six or seven men sharing in a catch instead of three men, and paying the insurance on two boats which today is astronomical for 55 and 65-foot boats. I would hate to see us put too much emphasis on trying to improve fuel efficiency by using two boats instead of one. Your experiment did not show that; you showed that one was more fuel efficient than two. I'd hate for us to spend too much time on that sort of thing and not look at the other costs involved because when it comes down to the fine points, there is really not much point in saving 5% in the cost of your fuel if you're going to decrease the income of your crew by maybe 15-20%.

I would like to ask Mr. Kingsley a question. It is my understanding that even in England the boats are operating as you pointed out with a 125 horsepower drop rating because they don't have the power. Would that not also hold true for the boats that were involved in the experiment off the East Coast of Newfoundland – The Judy, Cape John Venture and The Lone Venture? Does it make good economic sense to have boats of that size built? My experience in Newfoundland over the last few years is that half the boats that have been built for a given purpose are now being moved to other types of fishing. Boats, as you pointed out, that were built for seining are now going into otter trawling. If these boats had had proper motors installed with suitable horsepower, they would not have all the problems they have today.

Mr. Kingsley: I see your concerns Clifford, I think a trawl can be designed to match the towing capability of any trawler, and 230 horsepower in my opinion is suitable to tow trawl which is of adequate size to take commercial catches. I think that you would have to have good reason to re-engine that particular vessel to tow a bigger trawl. You would want to be alongside somebody who was taking much larger catches than you were before you would be able to address that properly. In the meantime, had that boat been designed as a trawler it would have had a different propeller and a different hull form. If you wanted to meet all conditions, then the answer would lie in a controllable pitch propeller. That would solve some of the problem. In the meantime, if this particular boat wants to continue dragging then I think from what we have heard in the last couple of days, a nozzle with a new propeller designed to suit the nozzle and the vessel would be the answer.

Mr. Doyle: I understand what you are saying. There is one other point I would like to make. All the things we have been talking about in the last couple of days worry me. A fisherman should install Kor: nozzles, variable pitch propellers, pair trawl instead of single trawl, and if we find fish we should let everybody else know so they can save fuel at somebody's else's expense. I hate to see so much emphasis placed on the fisherman. It seems the onus is being put on the fisherman to do everything to save energy. If you look at the economics of the situation, in terms of installing all this extra gear, is it worth it? We are talking thousands and thousands of dollars. Some of the things that were proposed
yesterday would cost anywhere from $20-60,000 for an individual boat. Is it worth it to be talking about this sort of thing for 45, 55 or even 65 foot boats? I’m not very optimistic if we’re going to deal with it from that point of view. I did like the comment that was made by the gentlemen from federal Fisheries, who said if we catch twice the amount of fish in half the time, that we would be better off. . . . .
SESSION IV:

"WHAT ARE OUR FUTURE PROSPECTS?"

President
Technical University of Nova Scotia

Our panel this afternoon has a simple task: to tell us what the future will be. Yesterday we discussed what was occurring in the Atlantic Fisheries, and looked at what is happening in terms of new technologies, both here and elsewhere. This morning we looked at the effects of fleet operation and gear upon the energy situation in the fishery, and this afternoon our speakers will address the question of where we go in the future.

In our discussions this afternoon we should remind ourselves that we will have change. There are a variety of factors that determine this point and I've listed these factors on the basis of short and long term. I've put them on our board; they may help to structure our discussions throughout the afternoon.

We are going to have an increased cost in energy, we are going to have new technologies and systems and it will be up to us whether we put them to work in our fleet. We are obviously developing here and elsewhere new concepts of fleet management. We have a need in this region, because of the introduction of the 200 mile economic zone, to catch more fish as fish stocks increase, and therefore have a need to sell more fish and presumably a need in order to exploit all markets, to improve our product quality. Affecting our fleet operations is the whole question of regulations. Over the long term we have another very major factor and that is the question of the ratio of energy consumption to the production of the protein, when one considers that fisheries is such a high energy consumer.
PERSPECTIVES OF CANADA'S ENERGY FUTURE

by Dr. E.P. Cockshutt
National Energy Council of Canada

First, I would like to examine with you the energy supply situation as it existed in Canada a hundred years ago. In this diagram, the size of the circle is proportional to the total amount of energy on supply, the total amount of energy used in 1880. As you can see it was a renewal energy economy in 1880. Half the supply was from wood, a quarter from animal power; coal, wind and hydro provided the rest. If we move forward one century the pie is significantly bigger in terms of area; it is twenty times the energy consumption of 1880 – roughly speaking, a factor of five in population and a factor of four in per capita energy usage. That yellow-gold for oil is significant; 40% of our energy supply at present comes from oil and another 20% from gas, the residue being supplied by one of the renewable forms, including hydro-electricity. Nuclear energy at present supplies something like 2% of our national energy usage. To see what we do with that pie, let me remind you that in global terms, we slice our energy three ways. One third is used in buildings, mostly in heating and cooling, with smaller components for water heating and for all the other chores: lighting, cooking etc. Transportation uses another third with road transport dominating in this area. The remaining one-third is industrial use of energy, primarily for process heat. Additionally, large components of our petroleum fuels are in fact used, not as energy, but as chemical feed stocks, and finally significant components go into generation losses. At this point we look at the ingredients, not as our present supply system, but moving from present supply towards the future. The familiar oil well of course reminds us that we’ve been on a real oil bonanza, with oil obligingly flowing to the surface of the ground in various convenient locations. Hence, we have been living rather high on our energy diet in terms of oil.

As conventional supplies become depleted we are going to offshore oil sources and to sources in the high Arctic. The other major source of petroleum in the future is the tar sands. We have depended for a significant portion of our national energy supply on hydraulic power; we will continue to do so but we will be going ever farther afield to find highhead hydro. Closer to home, the harnessing of tidal power is perhaps actually going to make commercial sense in the next decade or two. Every seven years there is a cycle of somebody re-discovering it, getting extremely excited, retiring to do some sums on the actual cost, losing interest and then the cycle repeats itself seven years later; I think you can chart it back to about the 1920’s.

Coal is going to play a significant role in Canada’s energy future. At present it is running at about 10%. Wood is already providing a significant portion of energy supply in Canada and undoubtedly will be used in increasing quantities. I mentioned the use of wood wastes. Many pulp and paper mills and sawing mills have simultaneously noted high energy cost and a waste disposal problem; a solution is to burn wood waste to raise steam to produce electricity. It is obvious and we are going to see a greater contribution from forest mass to the national energy supply.

The potential of solar power: People have tended to say solar doesn’t make sense in a country as far north as Canada. In quantitative terms, in Halifax year round, the average is about 140 watts per square meter; in the sunniest portion of the world, the Sierra Desert we are talking about perhaps 280 watts per square meter. So we are only a factor of two different from the highest solar radiation level. Unfortunately, part of our problem is that solar radiation is most readily available in the summertime when we have least need of it. Hence, in most cases we are looking only for solar assistance in meeting heating loads of houses. The longer term solar option, direct conversion from solar energy to electricity is the subject of an enormous international effort to harness and economically exploit solar radiation. These small cells are normally assembled into large trays and they must be used in combination with storage systems.

In wind energy, the vertical axis windmill is an energy conversion device which was re-invented by NRC engineers about fifteen years ago. The development had taken place and we were looking for patent protection when it turned out that approximately fifty years earlier a French inventor, George Darias, had invented the vertical axis, or egg beater windmill. We moved from the wind tunnel to the large installation on the Magdalen Islands. That windmill is about 120 feet in vertical dimension and 80 feet in horizontal diameter, producing approximately 250 kilowatts of power. However, the machine we are now building has a three-fold increase in diameter, essentially a 10 fold increase in power from that Magdalen Island machine. The project will stand about 350 feet off the ground, will produce between 2 and 4 megawatts of power. Finally, the energy gap between the supply and demand in Canada will have to rely on one or two sources which can be expanded to fill the gap. The nuclear source has an important role in getting us through the next twenty or thirty years.

What are we looking at after the year 2000? To start with, I’m assuming that there are valiant efforts at conservation and that the pie that I’ve sketched is only marginally larger than our present total energy usage. Whether we can in fact achieve that level of conservation remains to be seen, but the economic incentives are going to be very, very strong in
pushing us in that direction. Notice that that golden energy commodity, oil, is foreseen as shrinking to about 20% of our national supply, with gas probably bringing it up to 30%. Hydraulic power will undoubtedly expand from its present already large position and occupy something like 30% of our national energy supply, not only with highhead installations farther and farther from centres of population, but additionally in tapping low head sources, such as tidal power, and much lower heads in convenient rivers and streams. In terms of coal, we see a doubling of usage from something under 10% to something over 15%. Wood we see as being by far the most significant of the renewables, contributing something like 7-8% of our national usage, in the year 2005. Solar, perhaps hitting 1 and 3/4% of the total supply, and wind about 1/2 of 1%.

My work is in the renewables. I would remind you that the length of time required to bring a new energy technology to maturity is usually three or four decades. I would further submit that increased contribution from the renewables means that in 75 or 100 years Canada will be able to live in a fully self-sufficient energy mode. Finally, nuclear energy will have to be used to fill what, even with conservation, will be a very significant gap and, in our estimation, will have to provide in excess of 25% of our total energy usage in the year 2005.

To summarize, let me leave three thoughts with you for the energy outlook just after the turn of the century. Canada will still be using considerable amounts of conventional hydro-carbons at that point in time. I suggested about 20% of our supply would still be in oil, a large fraction of that, of course, coming from the tar sands. The bad news is that that oil will be increasingly expensive. Synthetic energy carriers, energy fuels that we manufacture from other sources, in particular hydrogen and alcohols, will become increasingly available, but the bad news is that they, too, will be very expensive. People have been somewhat mislead in thinking hydrogen or alcohol will be significantly cheaper than the fuels they are displacing. I’m afraid there will be disappointments in that direction.

In addition, there is significant technology development for increased efficiency of energy use. Things like heat pumps, come to mind, but the bad news there is that those too will be expensive.

How do you relate the energy scenario for the year 2000 to the fishing industry? My answer is that high quality fluid fuels will be required for the fishing industry to continue. The most likely assumption, at least for the next 25 years, is that hydrocarbon fuels, conventional gasoline and diesel fuels, perhaps of lower quality, will continue to be available for fishing use. Two alternatives, however, will be showing up early in the next century, and we will see a gradual phasing in of them. One is synthetic fuels... basically the alcohol class of fuel. We see it being available by liquefaction or other conversion of natural gas and subsequently drawing on either wood biomass or coal. There is a synthetic liquid fuel in the future which makes particular sense in Canada because of the supply of natural gas, coal and wood. In the longer term, we see a completely different type of synthetic fuel, namely hydrogen. The most exciting thing about hydrogen is that it gives you the potential of using hydraulic energy or uranium as the prime source in the fishing boat. It essentially permits electrolysis of water to produce hydrogen of a very high quality, but difficult to handle as fuel. In Canada’s energy future there seem to be significant quantities both of hydraulic and nuclear energy. There is little doubt about the availability of a variety of energy sources for the fishing industry through to the year 2000; energy availability will almost certainly be dominated by conventional hydrocarbons to 2000; two distinctly different energy carriers or synthetic fuels which will be available early in the next century.
ENERGY CONSERVATION –
A NOVA SCOTIAN VESSEL OPERATOR’S VIEW

Presented by: Peter Matthews
Vice President - Fleet
H.B. Nickerson & Sons Ltd.
North Sydney, N.S.

1. Introduction

We welcome the opportunity to put forward our views about the rapidly rising cost of fuel and what we plan to do to combat it. We are fortunate in Canada, that so far our fuel costs are well below world levels. That does not mean we should be complacent. We know that this situation cannot last and within a few years we will be paying the world price for fuel or somewhere near it. The challenge is to use the few years grace that we have, to implement fuel conservation policies so that we will be competitive when our prices reach world levels. We must pursue this immediately and aggressively.

H.B. Nickerson operates a fleet of approximately 35 fishing vessels. The fleet is diverse in nature and comprises offshore wetfish stern trawlers ranging in size from 130-150 feet with 1050-2400 horsepower main engines, scallop vessels of wood and steel usually 100-110 feet long with 600-900 horsepower main engines, a steel 115 foot purse seiner and several small wooden danish seiners and longline vessels of between 42-60 feet. While some of our fleet is very modern, the average age is 12 years. From the above brief description of our fleet it can be seen that we have direct operating experience with varying sizes of vessels and many different types of fisheries.

2. Comments on Existing Performance

We are only too aware of the dramatic results when the speed/power and projected fuel costs are combined. During the last year our fuel prices have increased by 35% and this is only the beginning. It is essential that we review our present practices constantly and take a hard look at the experience of European and Scandinavian vessel operators to see which of their energy conservation programs might be applied to our fisheries. It is important not to be stampeded into believing that all energy conservation programs developed for the European and Scandinavian fishing fleets and fleet replacement programs should be applicable to the Canadian East Coast Fishery. We have many advantages, such as near access to most of our fishing grounds, and fish stocks that are recovering, since Canada’s Declaration of the 200 mile limit, to levels that only a few short years ago were undreamed of. Our trawler catch rates per sea day on traditional species such as cod, haddock, and pollock have increased by 72% in the last three (3) years, while in many parts of Europe and Scandinavia the reverse has been the case.

We have reviewed the work of Anders Endel and his colleagues in Norway with respect to horsepower installations for fishing vessels and fuel consumption comparisons for various types of fishing methods. This has been admirably done and contains much advice that can be useful to us. However, operation of our trawler fleet has shown that with respect to fuel consumed, our trawlers consume approximately 0.4 kg fuel/kg of fish landed. This is more than twice as good as the Norwegian experience.

Despite the better experience in Canada, trawling operations consume more fuel than longlining or other coastal fishing activities. When it is considered that the Canadian Trawler fleet enables year round employment to be maintained in many regions, and better utilization of plant facilities to be achieved, it can be argued with considerable justification that the extra expenditure in fuel used by the trawlers is a very good investment. It must also be remembered that for some species and stocks the offshore trawler is the only means of harvesting.

Similarly we are aware that many Icelandic owners have turned to heavy fuel as a solution to their fuel cost problem. For them this probably makes very good sense. We are aware that Iceland has a different economy than Canada, and different trading patterns. They barter fish to Russia in exchange for high quality heavy fuel. This clearly gives Icelandic vessel owners a decided interest in using heavy fuel oil, despite the additional maintenance costs.

3. Comments on Canadian East Coast Fish Management Policies

Before detailing energy conservation plans, it is appropriate to comment briefly on some of the fishing regulations which have been imposed on the groundfish industry by the Department of Fisheries and Oceans, and which have either significantly added to fuel consumption on a regular fishing trip or have effectively denied operators access to fishing technology that would reduce overall fishing costs, including fuel consumption.

Specific examples are:
(a) Regulations on the Scotian Shelf, which require a vessel to return to port to land non-regulation mesh gear, if the vessel commences the trip fishing for, say, redfish and subsequently wishes to divert to, say, cod and haddock using regulation mesh gear.
(b) Regulations which require a vessel to remain in a specific area (Georges Bank) for the whole trip, regardless of the fishing results, despite the fact that other vessels fishing in close proximity to the
boxed area may be achieving high catch rates.

(c) Management regimes, which plan to totally deny Nova Scotian and South Coast Newfoundland trawlers, access to prolific fishing grounds (Gulf of St. Lawrence/Sydney Bight) near their home ports, and to "compensate" them with fish on the Labrador grounds, adding four (4) days or more steaming time per trip.

(d) Management philosophies based on imposition of trip limits, which artificially shorten the length of the trip (for reasons not related to the keeping quality of fish) consequently increasing catching costs and fuel consumed.

(e) Management regulations designed to spread the catching of fish over longer time periods, without any reference to the economics of catching fish or increased fuel consumption – e.g. split season for 4VsW cod.

(f) Regulations which in their effect have denied operators access to freezer/factory trawler technology for catching groundfish.

Many Nova Scotia operators, several years ago, concluded that Freezer/Factory Trawlers of more than 200 feet in length with high freezing capability, were the most suitable vessels for exploiting the Labrador fish stocks, due to the advantages of improved quality of landed fish and lower operating costs as a result of a higher ratio of fishing days to steaming days than are experienced with wetfish vessels. In particular freezer trawlers make possible a far greater ratio of fishing days to steaming days (due to larger hold capacity) and thus have much better fuel per pound landed performance than wetfish trawlers on distant grounds. The regulations in force have denied operators access to this type of vessel.

Clearly, we must get away from regulations such as those just described. All too often our fisheries have been managed in crisis, and regulations have been introduced which have been poorly thought out and which have taken little or no account of the cost of catching fish. Whilst many of these regulations have been objectionable to us in the past, their worst effects have been mitigated by the 'cheap fuel policy'. This will not be the case in the future, as our fuel prices rise to world levels.

In my personal view, which does not necessarily represent my company's view at this time, a promising way to reduce the problems and to establish our Fisheries Management Policy on a more stable basis, is to determine fixed percentages of each stock between inshore and offshore sectors and then allocate the offshore quotas to each company or operator as a fixed share of the quota. This is the so-called "property rights" system. Thus, having received a fixed allocation of fish (which could be bartered between operators) each company would be free to decide exactly how and when the fish could be taken, using the fishing technology each individual deems appropriate.

4. Plans for Our Existing Fleet

The constraints imposed by the average age of our fleet, which is typical of many other operators in Eastern Canada, has lead us to conclude that for the most part radical solutions are not the answer for better fuel conservation in our fleet. We have concluded that if fuel is to be conserved it can only happen by taking advantage of many fuel saving opportunities, which for the most part are common sense and represent good engineering practice. (They have not been fully implemented to date because fuel has been underpriced relative to the cost of other design options and operating practices.) Individually these may only give small savings, but if pursued aggressively and diligently they will add up to a significant fuel reduction, without any loss of fishing efficiency. Accordingly, it is our intention to implement a program of steady improvement rather than one of radical change. While improving our current operation we shall be accumulating a data base, which we hope to use to plan our future activities in the energy conservation field on our vessels.

In doing this it is our intention to look at the whole operation from ocean to market in evaluating the effects of any changes planned. For example, we feel that to look at fuel consumption in isolation is misleading unless it is linked to catch rates, species, plant and market requirements, not to mention the effects of Federal Fish Management Plans. All these factors will heavily influence any analysis of the effects of conservation activities. There is a tendency, understandable and overdue, to focus now on the consumption of fuel in fishing almost to the exclusion of other cost factors. Unless we find ourselves in the position where fuel is actually rationed (and thus absolutely limited in supply), the analysis of any fuel conservation program must be in terms of total economic costs and benefits.

Items that we have reviewed for inclusion in our Company's Marine Energy Conservation program are described.

4.1. Hull/Hydrodynamics

4.1.1. Speed reduction

All too often when fuel conservation is discussed the classic graph showing speed against fuel consumption is produced. Most operators are only too well aware that very significant fuel saving can be effected by only a very marginal reduction in speed. When considering this however, it is common to get carried away by the impact of the graph and to ignore the lost fishing opportunities that result from the speed reduction.

In most cases steaming to the grounds over long distances, our experience has been that the value of the fish that would have been lost, had the vessel reduced speed, and the contribution that this makes to the plant operation, far outweighs the value of the fuel saved. Even with fuel at three times our current levels, this would usually still be the case. Another
factor to be considered is that under the existing strict fish management policies working within fixed total allowable catches for each stock, a reduction in speed and consequent loss of fishing opportunity, will mean a reduced share of the total catch.

Given the above, we have difficulty convincing ourselves that speed reduction is desirable at the present time, except in circumstances where it is obviously sensible, such as when an early arrival in port leaves the vessel waiting several hours before it can be unloaded.

4.1.2. Maneuvering/Fuel Monitoring

As opposed to speed reduction when steaming, we see significant opportunities for fuel saving while maneuvering vessels during fishing operations when lining up on a tow, preparing to shoot away the gear and so forth. Sensible use of pitch and/or r.p.m. in such circumstances would result in fuel savings without loss of fishing efficiency.

With this in mind, we are very interested in the application of fuel flow meters or fuel computers on our vessels. These visually illustrate to our Captains and Engineers exactly how and when they use fuel. We believe that given the right incentives, proper use of this sort of instrumentation could lead to considerable fuel saving. To realize the full potential we believe fuel consumption should be reflected in the “lay” arrangement. This is discussed more fully later.

4.1.3. Hull Condition

Bottom growth and plate corrosion significantly increase resistance, which in turn drives up fuel consumption. These facts are well known and most owners dock their vessels at least once a year to clean and paint the bottom.

Ice is notorious for removing bottom paint and exposing the hull to corrosion and opportunities for bottom growth between dockings. Consequently, we are particularly interested in a paint system developed in Finland, specifically for conditions such as ours. Tests on vessels operating in the Baltic ice conditions have shown that the new paint system has remained intact for two years. The improved protection has resulted in less frequent dockings being required and fuel savings (for merchant vessels and ice breakers) of 10-13%. The system is expensive, but results are so encouraging that it is our intention to investigate this opportunity in the very near future.

4.2. Space Heating

Many vessels are electrically heated which is extremely wasteful of fuel, despite usually high standards of insulation. Electric heat does however, have the advantage of requiring little or no maintenance. It does not run the risk of freezing up as happens with water systems and does not require to be checked continually by a watchman when the vessel is in port, as is required for oil fired systems. For new construction, exhaust boilers and/or engine coolant heat exchangers for accommodation heating make sense. In the future retro-fitting of these systems to some of the more modern vessels may make economic sense, but this does not appear to be the case at the present time. What does make sense are simple procedures such as to thoroughly check existing insulation to locate poorly protected areas, provision of door closers to prevent unnecessary ingress of cold air to the accommodation and turning back thermostats to 60°F when the vessel is in port.

4.3. Machinery

4.3.1. Installed Power

Our existing practice is to reduce the power output of our main engine installation so that engine combustion develops maximum efficiency. This is done in accordance with the engine manufacturers recommendation and normally results in the engine developing 80% of full rated power.

Further reductions in the installed power by de-rating or other means appears to us to be unproductive. The only result will be poorer combustion and higher maintenance costs. Moreover our operating experience shows that our most powerful vessels are also the most productive. Thus, despite their higher fixed and operating costs, high catch rates have enabled them to be among the most efficient and cost effective vessels to operate. In terms of fuel consumption/pound fish landed they use less fuel than our smaller vessels.

We believe that it is very significant that similar results have been experienced in Iceland. There, owners have concluded that the larger vessels (170-210 feet) in their wetfish trawler fleet are the most productive and despite concerns over fuel costs there has been a radical reduction in Icelandic longline and gill net vessels in favour of the offshore trawler.

4.3.2. Maintenance

(1) Ashore

We see it as essential that an on going program of routine checks are established as part of the shore maintenance operation to check log records and analyse these to ensure that pumps, injectors and turbo chargers are operating correctly to get good combustion in the engines. Injectors in particular must be checked regularly for opening pressure and spray. These procedures are elementary, but can create serious inefficiencies if not followed.

(2) Onboard

Our engineers for the most part do little or no onboard maintenance. In too many cases, log books are inadequately kept and little or no performance monitoring, fault diagnosis or corrective measures are taken. There is ample room for improvement in the area of good onboard house keeping and simple maintenance procedures, which will reduce inefficient operating of the engine.

We are about to implement a program of good
onboard record keeping and analysis, to ensure our engineers are aware of the need to change injectors, clean turbo-charger filters and other simple jobs so that efficient fuel combustion can be maintained throughout the trip, rather than waiting until the end of the trip for such work to be done by the shore maintenance crew. This again is simple good engineering practice, but regrettably is rarely done consistently at the present time.

4.4.3. Data Logging

As part of a program to ensure that better records of engine performance during the voyage are kept, we are working with a progressive young electronics company located in Dartmouth, N.S., Seimac Ltd., to install a modern data logging system on one of our vessels. This is being sponsored by the Industrial Development Branch, Fisheries & Oceans, our hosts at this seminar. It is planned to continuously monitor and record:

(a) Fuel rack settings
(b) Peak cylinder head pressures
(c) Exhaust temperatures
(d) Lube oil pressure
(e) Cooling water temperature
(f) Turbocharger pressure
(g) Scavenger pressure and temperature
(h) Propeller pitch settings.

We are hopeful that the unit will be an economic and sensible tool for installation onboard our vessels, which will not only prove useful for our shipboard engineers, but will help in our shore maintenance program and give us a good basis for predicting the effect of changes in operating parameters.

4.4. Fuels and Oil

4.4.1. Heavy Fuel

For the most part existing engines in our vessels are not suitable for burning heavy fuels and we doubt we would consider conversions of this nature. Our feeling is that longer term benefits may well be in the use of blended fuels. We are only just beginning to investigate this.

4.4.2. Oil Sampling Program

We already have in place a continuous program of sampling engine lubricating oil and hydraulic oil, for the purpose of reducing usage of these expensive items. Samples from all our vessels are sent away on a regular basis for spectrographic and physical analysis. Computer records are kept of viscosity, ash content, flash point and metal content, and from these maintenance advise and oil change recommendations are made. With this program we have reduced our lube oil usage and added an important tool to our maintenance program. This has reduced lube oil and maintenance costs and assisted in detecting at an early stage, when a serious problem is developing.

Very little of our lube oil is re-cycled by passing through purifiers. We see this being essential in the future to ensure that we get maximum usage out of the oil.

4.4.3. Synthetic Oils

Until very recently we have been reluctant to consider usage of synthetic oils for our main engines, due to the cost being up to five (5) times more than we pay for conventional oils. We have however, received information from vessel operators in the United States, which has made us reconsider our position towards synthetic oils. If claims made for these are shown to be correct when used in a marine environment to:

(a) Reduce engine friction
(b) Reduce fuel consumption
(c) Increase oil life
then there is little doubt that there will be a major swing towards their use on fishing vessels.

Subject to further discussions with both engine and the oil manufacturers, we plan to make trials with synthetic lubrication oil on one of our vessels during the course of this year.

4.4.4. Waste Oil

At one time we used to pay for waste oil to be trucked away from our vessels for disposal. Today all waste oil is mixed with bunker 'C' for plant use with a consequent saving of fuel. At one plant waste oil from the vessels has cut their fuel consumption down by 8%.

4.5. Incentive to Conserve

There is no doubt that in Canada the 'cheap' fuel policy has produced little incentive to conserve fuel at the present time, despite all the discussion on the subject. This is clearly demonstrated by the continued escalation of fuel consumption in Canada, at a time when consumption in all other industrialized countries is declining.

Price escalations will force Canadian vessel operators to focus their attention on good conservation policies, but in our view the full benefits will not be realized until our sea going personnel are fully involved in implementation of conservation policies. The Captain, Mate, Engineers and perhaps other crew members are the key people involved in practicing good ship handling and energy conservation programs. We see a change in the 'lay' (settlement arrangement) as being essential to any long term improvement in energy conservation, so that Captain and crew are given a direct incentive to conserve. This would involve the crews' earnings being linked to both fuel consumption as well as catch for each voyage. This is done now on our scallop and longline vessels and is common on skipper-owned vessels. We have no doubt that this will have to be addressed to our trawler fleet. It is possible that a change in the trawler lay as detailed above, supplemented by good onboard fuel consumption monitors, may well be the most effective conservation technique of all.

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4.6. Fishing Gear Design

We currently use high-opening, two seam nets as bottom trawls on our trawlers. These are typically made of 4 or 4.5 mm braided polyethylene and used with polyvalent trawl doors and heavy foot rope gear to keep the net on the bottom. Our experience has been that the heavier the foot rope, the better the nets appear to fish. We changed to the high opening trawls about six (6) years ago with very beneficial results, and at the present time we do not believe that a change to another type of net is warranted.

In the longer term however, we believe that there is much work to be done in the field of gear design for bottom trawls used on single boat offshore trawlers. We envisage trawls with 300-400 mm mesh sizes made of light nylon twine using light foot rope gear and smaller more efficient doors than are used at the present time. Development of nets such as these, which are truly suitable for our conditions, should lead to important reductions in our fuel consumption.

5. New Construction

In addition to continuing with good house keeping practises outlined for existing vessels, new construction permits a whole range of opportunities for fuel saving to be incorporated into the vessel design.

On conventional trawlers using a c.p. propeller and power take offs driving generators for ships service and winch, the need to maintain constant main engine r.p.m.'s for electrical generation makes it almost impossible to take advantage of important fuel saving measures.

In addition the full benefits of the c.p. propeller can not be realized as the requirement to maintain constant r.p.m. means that when slow speed or idling conditions are required the c.p. must be in the low pitch position. Under such conditions a waste of fuel takes place in the order of 10% or more. Clearly for any new construction it is important to arrange the propulsion system so that it can be independent of the requirement to generate electrical power.

I will describe briefly some of our thoughts on this and other energy saving features that we are incorporating in a new trawler which is being designed for us.

5.1. Engine Arrangement and Electrical Generation

The main engine will be designed to drive a C.P. propeller via a reduction gearbox, with speed being controlled by either pitch or engine R.P.M. variation. A generator driven off a gearbox P.T.O. will be designed to supply ships service while steaming, when constant R.P.M.'s can be maintained.

Prior to fishing the generator driven from the gearbox P.T.O. will be switched off automatically and electrical generation will come from an auxiliary generator. This will supply ships service and all electrical demand for the trawl winch when shooting. This will then permit engine R.P.M.'s to be varied during fishing to obtain maximum fuel saving.

The trawl winch will be driven by a D.C. motor, fed via an AC/DC thyristor converter, providing the same basic operational characteristics as a conventional Ward-Leonard system.

During hauling operations one auxiliary diesel generator set will not be sufficient to cover the electrical power demand for both ship's service and trawl winch. Consequently a second auxiliary diesel will automatically start when the load comes on to provide the additional power requirement. Should one auxiliary be out of service, the P.T.O. generator can be brought into service, by maintaining constant R.P.M.'s during fishing as now.

Figure 1 shows a proposed machinery arrangement as described above, and figure 2 shows the power consumption comparison between a c.p. and fixed propeller. Our investigations indicate that an installation as described, using modern electronic technology for automatic operation of the equipment could lead to fuel savings in the order of 10-15% when compared with conventional installations.

5.2. Main Engine

We propose to operate the vessel on marine diesel. The choice of main engine has not been made at this time, but we are strongly disposed towards those engines which can be easily converted to use heavy fuel, should we wish to use this in the future.

5.3. Propeller

The hull has been designed to take a very large propeller, which will be run at low R.P.M.'s to get better propeller efficiency.

5.4. Heating

Waste heat from the engine will be utilized for the accommodation heating system, through the use of an exhaust gas boiler.

5.5. Insulation

We proposed to significantly upgrade insulation of heated spaces over conventional standards.

5.6. Hull Form

The vessel will be very beamy by conventional standards for European and Scandinavian Trawlers. Not only does this give good stability, so necessary for our climatic conditions, but in our view this improves the sea keeping characteristics.

We plan a full range of model tank testing of the hull, both with and without a bulbous bow, to optimize the resistance and sea keeping qualities of the vessel. Despite the very high cost of conducting a full range of tank testing, our past experience has indicated that this is a very worthwhile investment.

Conclusion

The rational approach to energy conservation by an integrated fishing company must use an economic cost-benefit framework based on total system
performance – from net to table. For example, an excessive concentration on fuel consumed while catching fish runs the risk of missing the main point – which is to produce fish products for the market as competitively as possible.

This said, there are nevertheless three important impediments to better energy use in the fishing industry.

The first is the relative cheapness of fuel in Canada which until now has not produced the required incentive to really conserve. This circumstance has changed and we must respond to it.

The second impediment is the age structure of the fleet and the difficulty (and expense) of rapidly introducing the radical design changes needed to achieve maximum savings. There are practical limits to sensible retrofitting.

The third impediment is more readily addressed. I refer to the management policies of the Government which, because of an increasingly complex set of restrictions on fishing activity, have greatly increased the steaming time needed to catch fish while at the same time effectively barring the freezer/factory technology that could offset some of this disadvantage.

The first of the three impediments is rapidly disappearing. Even quicker progress could be made if the trawler lay arrangement incorporated an incentive to save fuel.

I have outlined several ways in which we are coming to grips with the technical impediments. For the most part this means adopting a number of more or less common sense practices on our existing vessels. For new trawler construction, a reduction of 30% or more in the fuel consumed per pound landed seems to be achievable.

As for removal of the third impediment – I am afraid we shall have to defer to our hosts, the Federal Government.
Estimated power consumption of fixed pitch propeller versus controllable pitch propeller - free running vessel - assuming losses of cp-propeller at zero pitch and full speed = 20%

A = power cons. curve f a fixed pitch prop. (variable speed)
B = power cons. curve f a contr. pitch prop. (constant speed 100%)
C = power cons. curve f a contr. pitch prop. (reduced speed 50%)
D = power cons. curve f a contr. pitch prop. (reduced speed 40%)
E = example: at 75% speed powersavings are still 10% with fixed pitch prop. characteristic, i.e. speed reduction and combined pitch/speed control

Possible fuelsavings out of specific fuel consumption of a diesel motor (g/kWh) running partially loaded are another reason to opt for a speed-reducible system. The hatched space shows the possible powerprofit of combined pitch/speed control only.
TRAINING MARINE ENGINEERS FOR THE FISHING INDUSTRY

by G. Greenland, B.Eng., M.Eng., P.Eng.,
Head, Mechanical Engineering Technology
College of Fisheries, Navigation,
Marine Engineering and Electronics
St. John's, Newfoundland

The Government of Newfoundland and Labrador has stated in its five year plan titled "Managing All Our Resources" that one of its objectives in the fisheries sector is "to mobilize training facilities and programs as a means of increasing harvesting efficiency and ensuring adequate standards of safety at sea". By simply stating this objective, the government has recognized that there is a problem or rather that there are many problems. One of the main areas of concern today deals with the shortage of trained marine engineering personnel in both the fishing and shipping industry.

In terms of energy conservation or alternative energy consumption, it is the marine engineer who plays the leading role on board ship. It is this individual who operates and maintains the main energy producing/consuming equipment and, correspondingly, it is this person who must possess a high level of technical expertise and skills. Generally speaking, mechanical equipment which is "finely tuned" and maintained in accordance with manufacturer's specifications can be regarded as operating at peak efficiency. However, this is not to say that such equipment cannot operate outside the limits of the manufacturer's recommendations (and usually does), but rather that there is a penalty to be paid in terms of either service life and/or energy consumption for such operation. An every day example is the untuned automobile which billows clouds of black smoke as its operator tries to coax it to accelerate.

In the case of marine engineers, there are really two problems: the first concerns the severe shortage of such personnel; and the second deals with the low level of training and skills possessed by many presently in the industry. To illustrate this point, I would like to quote from a report recently submitted to the Government of Newfoundland and Labrador: "There is evidently a shortage of skilled personnel to work in plant and trawler maintenance or as seagoing engineers. It is general for most mates to be operating on permits or waivers from the Canadian Coast Guard; in one fleet about 20% are ticketed mates. Most First Engineers have full paper qualifications but perhaps only 5% of Second Engineers have certification. These statistics are indicative of the lack of people experienced in these activities on the peninsula (and perhaps even in eastern Canada) since Coast Guard regulations allow any qualified officer to demand a position to replace an officer operating by "permit". Up to the present no such requests have been made. For four recent positions as certified engineers two individuals were recruited from Nova Scotia and a third changed company within Newfoundland and remains unreplace after several months. Recent advertising for third class engineers resulted in no applications which is the reason why all companies offer such positions to mechanically minded deckhands.

The Burin trawler refit operation of Fishery Products recently attempted to recruit 40 maintenance workers but experienced difficulty in finding suitably experienced supervisors. A man from Labrador was the only person applying for the position of foreman. Upon the death of the Marine Superintendent at one plant his assistant was promoted and he remains unreplace after several years.

These problems seem to arise because many of the Fisheries College and Vocational School graduates do not gain the necessary "on the job" experience and either take other work in the fishing or other industry, or indeed leave the area totally. In all cases it has been stressed that the absence of suitably qualified persons with experience is critical."

The main question arising from the preceding is: "How did we, as a region with a marine based economy, get into this position and what can we do about it"? Let me assure you that the problem did not occur overnight nor will it be resolved overnight. For example, an examination of the Canadian Marine Industry in 1974-75 led to the publishing of a document entitled "Marine Industry Manpower Inventory and Needs Forecast, 1976-1980". Quoting from this document, It would appear from the results of this study that the amount of training being provided for marine occupations in Fishing and Shipping Industries is glaringly inadequate. Even given insufficiencies in the data, it would seem that the present level of training activity is far from meeting the forecast needs and the quality of expertise in both the fishing and shipping fleets is rapidly deteriorating.

The present reduced level of economic activity may temporarily mask the seriousness of the situation but unless immediate action is taken, new and larger skill shortages will appear as time goes on. These shortages will become especially acute as the rate of economic activity moves to higher levels. The results of the above summary suggest several remedies:

1. that, except for one or two cases, the output of Certified Deck and Engineering Officers should be at least doubled,
2. that more adequate courses should be
developed for non-certified occupations with 3 or 4 times as many enrolled as at present, 3. that the increased training should be accompanied by a stepped-up recruiting campaign combined with a concerted effort on the part of employers to improve working conditions so as to reduce the level of employee turnover. 3

To grasp the magnitude of the problems and potential solutions associated with the training (or lack of training) of marine engineers, we must first understand the type of persons in the fishing industry who are covered by this classification. Essentially, every trawler is required to have on board a chief engineer and a watchkeeping (second) engineer. The sections of the Ministry of Transport "Regulations Relating to the Examination of Marine Engineers" which pertain to these classifications are given in Appendices 1 and 2 respectively. I would also point out that the Ministry of Transport is primarily concerned with safety at sea; that you get to the fishing ground safely and you return safely. They are not concerned with your ability to fish.

In summary, the chief engineer of a motor driven fishing vessel shall be eighteen years of age and have not less than the equivalent of 48 months sea service as an engineer. Similarly, the watchkeeping engineer of a motor driven fishing vessel shall be eighteen years of age and have not less than the equivalent of 12 months sea service as an engineer. You will also note from these regulations that there is no mandatory requirement for completion of any training program by persons seeking certification at either of these two levels. The idea is simply that you will acquire the necessary skills and technical expertise while working on the job—a concept which is complicated by the fact that there are no engine room trainees on trawlers, only two certified engineers. Obviously, the idea of learning while you worked had merit on older ships where the engine and related systems were relatively uncomplicated. However, today's trawlers, with machinery worth in the neighbourhood of $2,500,000, are sophisticated packages of equipment requiring skills in the fields of hydraulics, electronics, mechanics, instrumentation and controls—skills with which people are not born, but which they must learn one way or another. The present method of going to sea and teaching yourself is grossly inefficient, and unless changed, will perpetuate the present problems. Furthermore, any type of on-the-job training can succeed only if the existing supervising work force is itself highly skilled and properly motivated; a poorly trained supervisor/instructor will, at best, maintain the status quo.

Finally, when a person has obtained the required period of sea service for one or more of the marine engineer classifications, he/she is permitted to undertake the appropriate Ministry of Transport examination(s). The preparation for these examinations generally involves a type of academic upgrading which does not include either technical or "hands-on" training. The answers to questions concerning unfamiliar equipment are learned by rote and the ensuing examinations are a function of memory and not of technical knowledge. As often as not, the end result is a marine engineer who is certified but not qualified.

A word of caution: "The dangers associated with attempting to train marine personnel in an isolated school environment are perhaps even greater than those inherent in the present system".

I think that everyone will agree that a major factor in the solution to the present manpower crisis lies in improved training. But what type of training and under what format? There are in fact two separate areas of concern: the first is the upgrading of practising marine engineers; and the second is the development of a suitable training plan for new entrants.

With regard to existing personnel, both certified and uncertified, there is an immediate need for an equipment oriented specialist type of training in hydraulics, electrical/electronics and instrumentation and controls. Such courses can be provided by schools and/or equipment manufacturers, and need only be of a short duration. Historically, the main problem with such programs is the question of "who pays?" Companies are reluctant to spend monies training employees who may leave upon completion of such programs and Canada Manpower allowances are not attractive for personnel in these categories. In addition, candidates for Marine Engineering Certification are reluctant to learn anything not directly related to the Ministry of Transport examinations.

In the case of new entrants, it is my opinion that the only realistic approach is to provide a "Co-operative Training" scheme, whereby the activities best learned at sea and those best learned in school are identified and taught in their respective environments. To successfully implement this scheme, I foresee five components as being essential:

1) Long-term commitments to both funding and berths at sea by the companies and government; it is impossible to implement and operate this type of training program on the basis of commitments for only one fiscal year. In addition, it is not realistic to expect to fill the needs of industry with only one or two graduating classes.

2) The duration of the training program must be sufficient to allow new entrants to reach the first level of certification. For the fishing fleet, this is certification as a watchkeeping engineer of a motor driven fishing vessel. Hence, the minimum program duration is twelve months, with a minimum of 6 months sea service in accordance with the Ministry of Transport regulations. (Appendix 1)

3) Identification and selection of the proper
trainees for such a program is of the utmost importance; experience has shown that students from fishing communities are more likely to enter the fishing industry than are those from large centres.

4) The establishment of realistic academic entrance requirements which are “in tune” with both those persons presently in the industry and those wishing to enter the occupation is essential.

5) Finally, the inclusion of an “at sea” evaluation period very early in the training program is necessary to weed out unsuitable candidates.

The success of this type of training scheme, or in fact the success of any marine training scheme, is dependent upon the active support and mutual trust of its major participants: the fishing companies, the union(s) and both the provincial and federal governments.

CONCLUSION

If the fishing industry of eastern Canada is to obtain maximum benefits in harvesting efficiency and energy conservation from new and improved technology, initially it will require a major effort in the area of marine engineering training. In this regard I offer the following observations:

1) It is incorrect to suggest that a modern trawler requires a lesser breed of marine engineer than the shipping industry. Generally, the only difference is in equipment size and not in equipment sophistication.

2) The present emphasis on certification must be coupled with a more realistic emphasis of qualification.

3) Existing marine engineers must be encouraged, through short specialty courses, to upgrade their skills in the areas of hydraulics, electronics, electrical, automation and instrumentation.

4) It should be mandatory that all new entrants into engine room positions have completed a recognized training program.

5) Finally, offshore oil and gas exploration off eastern Canada will worsen the present situation by attracting the best engineers from the fishing fleet and by directly competing for well trained new entrants.

APPENDIX 1

Schedule B

WATCHKEEPING ENGINEER OF A MOTOR DRIVEN FISHING VESSEL

Qualifications

1. Candidates for examination for a certificate as

Watchkeeping Engineer of a motor driven fishing vessel shall be of the full age of eighteen years.

2. (1) The service required by a candidate for a Watchkeeping certificate is as follows; since reaching the age of 15 years,

(a) not less than 6 months as apprentice machinist, improver machinist or machinist in a machine shop employed in the manufacture or repair of steam, internal combustion engines, or other substantial machinery to the satisfaction of the Board and, in addition, not less than 6 months on regular watch as engineer, oiler or assistant to the engineer on a motor ship of not less than 170 brake horsepower; or

(b) not less than 6 months engaged, or assisting, in the overhaul of the propulsion machinery of motor ships of not less than 170 brake horsepower and, in addition, not less than 6 months on regular watch as engineer, oiler or assistant to the engineer on a motor ship of not less than 170 brake horsepower; or

(c) not less than 12 months on regular watch as engineer on a motor ship of not less than 75 brake horsepower; or

(d) not less than 12 months on regular watch as oiller on a motor ship of not less than 170 brake horsepower; or

(e) any combination of the types of service specified in paragraphs (a) to (d) that totals 12 months and includes not less than 6 months on regular watch at sea as engineer, oiler or assistant engineer.

(2) The time spent at a recognized trade or vocational school on appropriate courses will be recognized as equivalent to machine shop service with a maximum allowance of 6 months.

Schedule of Examination

3. For Watchkeeping certificates for motor driven fishing vessels there shall be an oral examination designed to establish that the candidate has sufficient knowledge to operate with safety the machinery of a motor driven fishing vessel.

Syllabus

4. The engineering knowledge to be shown by a candidate for a certificate as a watchkeeping engineer of a motor driven fishing vessel shall be sufficient to enable him to operate safely the machinery and auxiliaries, including heating boilers, that are normally found in a motor driven fishing vessel.

5. Candidates will be required to take an oral examination consisting of 10 questions.

6. Candidates shall have a satisfactory knowledge of the principles on which internal
combustion engines work and shall be prepared to be examined on the following:

(i) the methods of supplying air, fuel and lubrication to the cylinders and moving parts;
(ii) the attention required by the various parts of the machinery;
(iii) the use of the different valves, cocks, pipes and connections;
(iv) the purpose of the non-return valves fitted in bilge lines;
(v) the chief causes which may make an engine difficult to start and the remedies that should be applied;
(vi) how to make good the results of ordinary wear and tear to the machinery and how to test the fairness of shafting;
(vii) how to remedy the breakdowns that occur to an internal combustion engine;
(viii) the causes of crank-case explosions and the precautions to be taken to lessen the risk of such explosions occurring;
(ix) the operation of small, low pressure heating boilers and the purpose and use of the various boiler mountings;
(x) the operation of air compressors and air receivers and the purpose and use of the various mountings;
(xl) the care and use of the fire extinguishers normally carried on motor driven fishing vessels;
(xii) precautions that should be taken on board ship to minimize the risk of fire; and
(xiii) the precautions to be taken before entering tanks.

APPENDIX 2

Schedule C

CHIEF ENGINEER
OF A MOTOR DRIVEN FISHING VESSEL

Qualifications

1. Candidates for examination for a certificate as Chief Engineer of a motor driven fishing vessel shall be of the full age of eighteen years.

2. The service required by a candidate for a Chief Engineer's certificate is as follows:
   (a) since obtaining the required service for a Watchkeeping certificate, not less than 36 months on regular watch as engineer in a motor ship of not less than 170 brake horsepower; or
   (b) since obtaining the required service for a Fourth Class certificate, not less than 12 months on regular watch as engineer in a motor ship of not less than 170 brake horsepower.

Schedule of Examination

3. For Chief Engineer certificates for motor driven fishing vessels there shall be a written examination followed by an oral examination, in accordance with the following:

<table>
<thead>
<tr>
<th>Number of papers</th>
<th>Engineering Knowledge, Motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

There shall be nine questions in the paper, not more than six of which are to be answered. If more than the required number of questions in the paper are answered, all the solutions will be marked and the six questions with the lowest marks awarded will be taken.

ORAL

The candidate will be examined orally on nine set questions, and in addition will be given the opportunity to elucidate and clarify his answers given to the written questions attempted.

Syllabus

4. The engineering knowledge to be shown by a candidate for a certificate as a Chief Engineer of a motor driven fishing vessel shall be sufficient to enable him to take charge, and to operate safely the machinery and auxiliaries, including the heating boilers, that are normally found in a motor driven fishing vessel.

5. Candidates should be prepared to be examined on the following:

   (a) Engineering Knowledge, Motor
   (i) operation and maintenance of feed, ballast and bilge pumps, steering gear, windlass, and boilers for auxiliary and heating purposes;
   (ii) operation and maintenance of feed, steam and bilge pipelines and fittings;
   (iii) precautions to be taken against fire and explosion due to oil or gas, with reference to oil fuel installations and the burning of oil fuel in internal combustion engines and boilers; action and maintenance of mechanical and chemical fire extinguishers and other fire-fighting appliances;
   (iv) causes of crankcase explosions in internal combustion engines, and in air starting lines. Use of wire gauze diaphragms and the places where fitted;
   (v) precautions against the outbreak of fire in engine rooms;
   (vi) operation and maintenance of internal combustion engines, auxiliary steam machinery, air-starting receivers, and their mountings;
   (vii) general construction of internal combustion engines, auxiliary steam machinery,
air-starting receivers, valves and fittings, and the materials used in the construction of this machinery;

(viii) operation and maintenance of electrical generators and motors, use of voltmeter, ammeter, ground lights and fuses;

(ix) operation and maintenance of air compressors, and their safe operation with respect to the danger inherent in over lubrication; and

(x) elementary construction and action of governors.

(b) Oral

The oral examination will be based on practical knowledge, and will be conducted as indicated in the examination schedule.


TRAINING – THE MANPOWER RESOURCE

by James McLevey, Director
Training & Field Services N.S. Dept. of Fisheries

Coming towards the conclusion of a conference such as this where we have examined the current situation, technical projects and several areas of technology related to energy reminds me of a story told of a visit by a number of industry and government officials to a very modern manufacturing plant.

As the tour progressed the visitors were more and more impressed by the bewildering array of machines, mechanical devices and the overall mystique of automation. Towards the end of the tour the visiting group came across the first plant worker they had seen associated with the manufacturing plant. The worker turned around to greet the group and around his neck hung a sign “The Man Who Presses the Buttons.”

In our industry we have fortunately still many people who press the buttons and despite the advancing and changing technology we still have and fortunately will continue to have people who press buttons and still rank high in our priorities.

The training of fishermen has for over 25 years been an integral part of the policies of the Nova Scotia Department of Fisheries. There is now in the region of $4,000,000.00 invested in plant equipment for the training of fishermen.

By way of statistics on the number of fishermen undertaking training:

1978-79
531 fishermen participated and 53 training courses were conducted.

1979-80
895 fishermen and 64 courses were conducted.

1980-81
1,024 fishermen and 89 programs were conducted.

The current year just ending sees us with the largest number of students ever in our training programs and I am sure that it will also be the highest number of fishermen undertaking training through any fisheries training institute in Canada.

On looking at this fisheries training, just exactly what do we offer by way of fisheries training; where do we do it; when it is done; how is it done and in the light of this conference – what will we be doing?

What
We have six main areas and most of these are associated with fish harvesting:

1) Navigation.
2) Engineering.
3) Business practices.
4) Net and gear technology.
5) Safety – life saving, survival and firefighting.
6) Custom designed programs.

In the field of navigation we prepare fishermen to qualify for Ministry of Transport certification at five levels at certification ranging from Master of Small Craft to Fishing Master Class 1.

Engineering
We prepare fishermen to qualify for M.O.T. certificates at three levels:
1) Fishing watchkeeping engineer.
2) Fishing vessel chief Engineer.
3) Fourth class engineer.

Fishing Gear Technology
Our programs as all others are conducted to serve the needs of both the inshore and offshore fishermen. For offshore fishermen we conduct two courses for which certificates are awarded. Those courses are the deckhand program and trawlerman program. These were produced in collaboration with industry representatives.

For inshore fishermen we conduct a wide range of programs which are custom designed to suit the fishermen in any given area of the province.

The Business Practice Program
Conducted over a period of three weeks, covers the areas of taxation, insurance, recordkeeping and bookkeeping practices. Over 90 per cent of the clients taking this course are the fishermen’s wives.

Safety Programs
We conduct marine emergency duty courses comprising of life saving, survival, fire fighting and first aid. These courses are a pre-requisite for M.O.T. certification as deck officers and engineers.

Custom Designed Programs
We are often requested to produce custom designed programs for individual client needs including engineering programs, training for fisherman overseas E.G. Belize, Central America and special programs for Transport Canada and Federal Fisheries.

Where
Approximately 25 per cent of our training takes place in the Fisheries Training Centre in Pictou. The school is fully equipped with accommodation for 60 students and has a well equipped engineering shop, navigation school, net loft, and a fairly recent addition to the school is a new M.E.D. Centre for life saving and survival exercises where we have two fully equipped 20 foot fibre-glass life boats mounted on sets of gravity and luffing davits.

The remainder of our training takes place in...
fishing communities throughout the province and in the current year we held programs in 54 different locations in the province.

How

Looking at the how in terms of payment, selection of clients, courses, locations and planning.

1) At present, approximately 80 per cent of the training programs are financially sponsored by the Canada Employment and Immigration training program through a joint federal and provincial agreement which is administered by a federal/provincial manpower needs committee. Personally, I feel that that is not the best arrangement. We have been lucky in the last few years to have some highly motivated students. But sometimes when the courses come too free and easy the motivation on the part of the student is not always there — if he comes with a MOT Ticket, fine.

2) Selection of fishermen for the training programs is done jointly through Canada Manpower Centres and the Nova Scotia Fisheries field representatives. We have nine field representatives throughout the province and during the course of our regular meetings the training needs of the fishermen in the various communities are identified. Working in cooperation with local Canada Manpower Centres course schedules are drawn up and revised as the needs change. Fishermen from the offshore fleet are normally referred to our training programs by Canada Manpower Centres.

Planning

In preparation for planning our training programs, we have devised a card system. This covers almost 11,000 fishermen with each card showing the training record of each fisherman.

The cards are set up to correspond to the nine areas represented by our field staff. The system is kept up-to-date manually and by the late fall we hope to switch to a computer system where by pressing the appropriate buttons we can obtain a listing of those fishermen who have not received training in a given area of the province and for any particular discipline e.g. Engineering.

This information can then be used in conjunction with the expressed needs of companies, groups of fishermen, associations, etc. and related to provincial and national polices.

As a further aid to planning we have data on the numbers of fishermen in each county by age distribution, number of vessels by size and a profile on each fishing port.

This statistical data blended with the knowledge of our field representatives and training staff as they keep aware of ongoing changes in the industry facilitates our planning effort.

When

The Fisheries Training Centre in Pictou is open from the first week in September to the end of June. During this period there is a fairly steady flow of clients for navigation, engineering, net and gear technology.

The training in the fishing communities throughout the province normally takes place in a period from late October to early April.

Addressing the question “What are our future prospects” with respect to training our people resources, our strategy for the coming year is:

Engineering

Of our 1024 students this year only 42 students participated in engineering programs.

There is a need for publicity in what is available by way of engineering training and the results that can be expected. This point comes to mind when we consider that in the period April 1, 1980 to February 28, 1981 there was a total of 740 search and rescue incidents, most of which involved fishing vessels due to mechanical breakdown.

Much of this mechanical breakdown was due to poor maintenance and could certainly have been avoided with participation in engineering programs.

By way of a simple illustration, last year we had an incident where a fisherman lost his 40 foot boat through a lack of knowledge on how to bleed the fueling system of his diesel engine.

For our offshore fleet a complete review of the recruitment, selection and training of engineers is required.

In 1979, 87 exemptions were issued for vessels to sail without a qualified engineer.

Navigation

In the field of navigation much more emphasis will be placed on the relationship of speed to fuel consumption and efficient use of electronic equipment such as: Loran C in relationship to plotting of courses.

We will be encouraging all fishermen who own their boats to participate in the Fishing Master Class IV course where knowledge gained in the use of electronic instruments, chartwork, tides and currents will better equip fishermen in this whole question of energy conservation.

Nets and Gear Technology

We will incorporate more information in our net and gear technology courses related to the efficiency of gear with respect to the use of energy.

Business Practices

Our “Record Book for Fishermen” gives an excellent set of data which is particularly helpful around taxation time.

We will attempt to devise a cost control guide related to energy and include this in the program.
Conclusion

The convening of a conference such as this to examine harvesting and energy related problems in the fishing industry assists those in the training business clarify a training need. The challenge posed has then to be taken up by the schools with the co-operation of the fishermen, companies and all levels of government. The dividends in such training are high.
APPENDIX 1
FISHERIES REPRESENTATIVES
Nova Scotia Department of Fisheries

1. Cecil Rankin
   10 Maple Street
   Pictou, N.S.  Tel. 485-6878
   *SEND MAIL TO:
   Fisheries Training Centre
   P.O. Box 700
   Pictou, Nova Scotia
   B0K 1H0  Tel. 485-4525/485-5056

   Region 1 - Cumberland, Colchester, Pictou and
   Antigonish Counties

2. Leslie Tobey
   P.O. Box 131
   Port Hood
   Inverness Co., N.S.
   BOE 2WO  Tel. 787-3470

   Region 2 - Inverness & Victoria Counties

3. Adolphe Kehoe
   P.O. Box 162
   Petit de Grat
   Richmond Co., N.S.
   BOE 2LO  Tel. 226-2787/226-3799

   Region 3 - Cape Breton & Richmond Counties

4. Gerald Boudreau
   Little Dover
   Guysborough Co., N.S.
   BOH 1V0  Tel. 366-2553

   Region 4 - Guysborough County

5. Elliott Pellerin
   15 Wheatstone Heights
   Dartmouth, N.S.
   B2Y 4E1  Tel. 469-1671

   Region 5 - Halifax County

6. Gerald Mossman
   R.R. #1
   Rose Bay
   Lunenburg Co., N.S.
   BOJ 2X0  Tel. 766-4749

   Region 6 - Lunenburg & Queen's Counties

7. Gerald Nickerson
   Lower Clark's Harbour
   Shelburne Co., N.S.
   BOW 1P0  Tel. 745-2224

   Region 7 - Shelburne County

8. Arnold Muise
   P.O. Box 15
   Middle West Pubnico
   Yarmouth Co., N.S.
   B0W 2M0  Tel. 762-2846

   Region 8 - Yarmouth County and portion of
   Digby Co. south of the Sissiboo
   River

9. Richard McDormand
   P.O. Box 56
   Granville Ferry
   Annapolis Co., N.S.
   B0S 1K0  Tel. 532-7039

   Region 9 - Digby Co., north of the Sissiboo
   River including Digby Neck and the
   Counties of Annapolis, King's and
   Hants.
## APPENDIX 2

### ISSUE NO. 5 – TRAINING SCHEDULE

**FISHERIES TRAINING CENTRE, PICTOU, N.S.**

<table>
<thead>
<tr>
<th>Course</th>
<th>Course Number</th>
<th>Dates</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine Engineering Watchkeeper</td>
<td>1</td>
<td>Sept. 2 to Oct. 24/80</td>
<td>Pictou</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Oct. 20 to Dec. 12/80</td>
<td>Pictou</td>
</tr>
<tr>
<td>Marine Engineering F/V Chief Engineer</td>
<td>3</td>
<td>Dec. 1 to Mar. 27/81</td>
<td>Pictou</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Feb. 16 to May 8/81</td>
<td>Pictou</td>
</tr>
<tr>
<td>Able Fisherman</td>
<td>5</td>
<td>Jan. 5 to Feb. 27/81</td>
<td>Pictou (cancelled)</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Mar. 2 to Apr. 24/81</td>
<td>Pictou</td>
</tr>
<tr>
<td>Nets &amp; Gear - Deckhand</td>
<td>7</td>
<td>Sept. 22 to Oct. 17/80</td>
<td>Pictou</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Oct. 20 to Nov. 14/80</td>
<td>Pictou</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Nov. 24 to Dec. 19/80</td>
<td>Pictou</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Jan. 12 to Jan. 23/81</td>
<td>Pictou</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Mar. 2 to Mar. 13/81</td>
<td>Pictou</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>Mar. 16 to Mar. 27/81</td>
<td>Pictou</td>
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<tr>
<td>Navigation - Fishing Master Class III</td>
<td>14</td>
<td>Sept. 8 to Nov. 21/80</td>
<td>Pictou</td>
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<tr>
<td></td>
<td>15</td>
<td>Jan. 5 to Mar. 27/81</td>
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<tr>
<td></td>
<td>16</td>
<td>Apr. 6 to June 19/81</td>
<td>Pictou</td>
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<td>Navigation - Fishing Master Class II</td>
<td>17</td>
<td>Jan. 5 to Mar. 27/81</td>
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<tr>
<td>Navigation - Master Small Craft (40 ton)</td>
<td>18</td>
<td>Nov. 24 to Dec. 19/80</td>
<td>Pictou</td>
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### M.E.D. TRAINING – N.S.N.I., HALIFAX

<table>
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<tr>
<th>Course</th>
<th>Course Number</th>
<th>Dates</th>
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<tbody>
<tr>
<td>M.E.D., Part “B”</td>
<td>1</td>
<td>Dec. 15 to Dec. 19/80</td>
<td>Halifax</td>
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<tr>
<td>Fire Fighting</td>
<td>2</td>
<td>Jan. 26 to Jan. 30/81</td>
<td>Halifax</td>
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<tr>
<td>N.S.N.I.</td>
<td>3</td>
<td>Feb. 9 to Feb. 13/81</td>
<td>Halifax</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Feb. 22 to Feb. 27/81</td>
<td>Halifax</td>
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# OUTPORT TRAINING 1980-1981

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<th>Dates</th>
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<tbody>
<tr>
<td>Marine Emergency Duties</td>
<td>1</td>
<td>Sept. 9 - Sept. 13/80</td>
<td>Pictou</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Oct. 20 - Oct. 24/80</td>
<td>Pictou</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Oct. 27 - Oct. 31/80</td>
<td>Chezzetcook</td>
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<tr>
<td></td>
<td>4</td>
<td>Nov. 3 - Nov. 7/80</td>
<td>Little River, C.B.</td>
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<tr>
<td></td>
<td>5</td>
<td>Nov. 17 - Nov. 21/80</td>
<td>Petit de Grat</td>
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<tr>
<td></td>
<td>6</td>
<td>Nov. 24 - Nov. 28/80</td>
<td>Chezzetcook</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Dec. 8 - Dec. 12/80</td>
<td>Port Hood</td>
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<td>Dec. 15 - Dec. 19/80</td>
<td>Ingonish</td>
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<td></td>
<td>9*</td>
<td>Jan. 5 - Jan. 9/81</td>
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<td>10</td>
<td>Jan. 12 - Jan. 16/81</td>
<td>Cheticamp</td>
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<td>12*</td>
<td>Jan. 26 - Jan. 30/81</td>
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<tr>
<td></td>
<td>13*</td>
<td>Feb. 2 - Feb. 6/81</td>
<td>Tor Bay</td>
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<td>14</td>
<td>Feb. 9 - Feb. 13/81</td>
<td>Yarmouth</td>
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<td>15*</td>
<td>Feb. 16 - Feb. 20/81</td>
<td>Shelburne</td>
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<td>16*</td>
<td>Feb. 23 - Feb. 27/81</td>
<td>Alder Point</td>
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<td>17*</td>
<td>Mar. 2 - Mar. 6/81</td>
<td>Surettes Island</td>
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<td></td>
<td>18</td>
<td>Mar. 9 - Mar. 13/81</td>
<td>Digby Neck</td>
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<tr>
<td></td>
<td>19*</td>
<td>Mar. 16 - Mar. 20/81</td>
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<td>21</td>
<td>Mar. 30 - Apr. 3/81</td>
<td>Bay St. Lawrence</td>
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<td>22</td>
<td>Apr. 6 - Apr. 10/81</td>
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<td>(Federal Fisheries)</td>
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<td>Small Gas &amp; Diesel</td>
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<td>Sept. 8 - Sept. 26/80</td>
<td>West Dublin</td>
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<td>Sept. 29 - Oct. 18/70</td>
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<td>Dec. 1 - Dec. 19/80</td>
<td>Port Hood</td>
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<td>32</td>
<td>Jan. 5 - Jan. 23/81</td>
<td>Harve Boucher</td>
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<td>Louisbourg</td>
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<td>36</td>
<td>Mar. 30 - Apr. 17/81</td>
<td>L’Ardoise</td>
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<td>Business Practices</td>
<td>37</td>
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<td>41</td>
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<tr>
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<td>42</td>
<td>Jan. 5 - Feb. 13/81</td>
<td>Pinkney Point</td>
</tr>
<tr>
<td></td>
<td>43</td>
<td>Jan. 5 - Feb. 13/81</td>
<td>St. Joseph du Moine</td>
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<td>44</td>
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<td>Lismore</td>
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<td></td>
<td>45</td>
<td>Feb. 23 - Apr. 3/81</td>
<td>Clark’s Harbour</td>
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152
### Outport Training - continued

<table>
<thead>
<tr>
<th>Course</th>
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<th>Location</th>
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<tr>
<td>Inshore Fishing Operations ( cont'd)</td>
<td>46</td>
<td>Feb. 16 - Mar. 20/81</td>
<td>Tiverton</td>
</tr>
<tr>
<td>47</td>
<td>Jan. 5 - Feb. 13/81</td>
<td>Cape North</td>
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<tr>
<td>48</td>
<td>Feb. 16 - Mar. 27/81</td>
<td>Inverness</td>
<td></td>
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<tr>
<td>49</td>
<td>Feb. 16 - Mar. 27/81</td>
<td>Morristown</td>
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<td>50</td>
<td>Feb. 16 - Mar. 27/81</td>
<td>Mabou</td>
<td></td>
</tr>
<tr>
<td>Special Programs</td>
<td>51</td>
<td>Oct. 20 - Nov. 14/80</td>
<td>Eskasoni**</td>
</tr>
<tr>
<td>52</td>
<td>Oct. 20 - Nov. 14/80</td>
<td>Eskasoni**</td>
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#### COURSES ADDED

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<td>53</td>
<td>Nov. 10 - Dec. 5/80</td>
<td>Liscombe</td>
</tr>
<tr>
<td>54</td>
<td>Jan. 19 - Feb. 27/81</td>
<td>West Pubnico</td>
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</tr>
<tr>
<td>55</td>
<td>Jan. 5 - Jan. 30/81</td>
<td>Canso</td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>Feb. 2 - Feb. 27/81</td>
<td>Canso</td>
<td></td>
</tr>
<tr>
<td>F/M Class IV</td>
<td>57</td>
<td>Nov. 10 - Dec. 19/80</td>
<td>Little River, C.B.</td>
</tr>
<tr>
<td>58</td>
<td>Mar. 2 - Mar. 27/81</td>
<td>Aulds Cove</td>
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<tr>
<td>Eng. Watchkeeper</td>
<td>59</td>
<td>Jan. 5 - Feb. 20/81</td>
<td>Yarmouth</td>
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<tr>
<td>Fishing V. Master</td>
<td>60</td>
<td>Jan. 5 - Feb. 13/81</td>
<td>Little River, Digby</td>
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<tr>
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<td>Jan. 5 - Feb. 13/81</td>
<td>Yarmouth</td>
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<tr>
<td>Fishing V. Master</td>
<td>62</td>
<td>Jan. 5 - Feb. 13/81</td>
<td>Meteghan</td>
</tr>
<tr>
<td>Fishing V. Master</td>
<td>63</td>
<td>Jan. 12 - Feb. 20/81</td>
<td>Aider Point</td>
</tr>
<tr>
<td>Fishing V. Master</td>
<td>64</td>
<td>Jan. 12 - Feb. 20/81</td>
<td>Lunenburg</td>
</tr>
<tr>
<td>Fishing V. Master</td>
<td>65**</td>
<td>Jan. 12 - Feb. 27/81</td>
<td>Shelburne</td>
</tr>
<tr>
<td>Fishing V. Master</td>
<td>66</td>
<td>Feb. 9 - Mar. 20/81</td>
<td>Tor Bay</td>
</tr>
<tr>
<td>Fishing V. Master</td>
<td>67</td>
<td>Feb. 9 - Mar. 20/81</td>
<td>Cheticamp</td>
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<tr>
<td>Fishing V. Master</td>
<td>68</td>
<td>Feb. 9 - Mar. 20/81</td>
<td>Annapolis Royal</td>
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<tr>
<td>Fishing V. Master</td>
<td>69**</td>
<td>Feb. 16 - Apr. 3/81</td>
<td>Dingwall</td>
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<tr>
<td>Fishing V. Master</td>
<td>70</td>
<td>Feb. 16 - Mar. 27/81</td>
<td>Petit de Grat</td>
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<tr>
<td>Fishing V. Master</td>
<td>71</td>
<td>Feb. 16 - Mar. 27/81</td>
<td>Bay St. Lawrence</td>
</tr>
<tr>
<td>Inshore Fishing Op.</td>
<td>72</td>
<td>Jan. 12 - Feb. 20/81</td>
<td>Lockeport</td>
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<td>Pleasant Bay</td>
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<td>74</td>
<td>Feb. 2 - Feb. 27/81</td>
<td>Meteghan Centre</td>
</tr>
<tr>
<td>Inshore Fishing Op.</td>
<td>75</td>
<td>Feb. 2 - Mar. 13/81</td>
<td>Little Harbour</td>
</tr>
<tr>
<td>F/M Class III</td>
<td>76</td>
<td>Mar. 2 - Mar. 27/81</td>
<td>(Shelburne)</td>
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<tr>
<td></td>
<td>77</td>
<td>Mar. 23 - May 28/81</td>
<td>Meteghan Centre</td>
</tr>
</tbody>
</table>

**PLEASE NOTE:**

- Maximum number of clients for Fishing Vessel Master Class IV and 40 Ton (Small Craft Master) in outports is 12.
- * Change in location.
- **Note that the MED course takes place during the Navigation Program - see courses 15 and 20.
ENERGY, PROPULSION AND SMALL FISHING VESSELS
by D.J. Fraser, Naval Architect
Maritime Marine Consultants Ltd.
Riverside, New Brunswick

1. Introduction
The design of marine propellers and propulsion systems for small fishing vessels has not been treated as a significant economic factor in the recent past because of the relatively high initial cost of customised, as compared to, off the shelf, standard propellers. The situation, however, is rapidly changing because of the rising fuel costs.
In order to obtain the maximum efficiency from the propulsion system the anticipated operational conditions must be clearly established with respect to mode of fishing, type of gear, steering and fishing time at the design stage.

2. Operational Requirements
Fig. 1 shows the envelope of installed power in recent, small fishing vessels on the Canadian East Coast. The circled crosses denote draggers and the crosses other fishing vessels. There is considerable variation in the installed power and there has been a general tendency to increase the power in recent years. An example of this is the steady increase from 280 to 450 bhp installed in the 65 foot steel draggers. Some of the increase has been due to auxiliaries being driven off the front end of the main engine but it is essential that this additional power is economically utilized for propulsion when not required for fishing. A careful analysis of the fishing and sailing operations should establish the actual maximum power requirement.

3. Propeller Options Available
The following options are available to the Owner;
i. Fixed pitch propeller designed for trawling.
ii. Fixed pitch propeller and nozzle designed for trawling.
iii. Controllable pitch propeller.
iv. Controllable pitch propeller with nozzle.
v. Compromise fixed pitch propeller.
vi. Compromise fixed pitch propeller with nozzle.

Energy, Propulsion and Small Fishing Vessels
vii. Fixed pitch propeller designed for cruising.
viii. Fixed pitch propeller with nozzle designed for cruising.
ix. Two speed or multi-gearbox.
x. Two (2) pitch propeller.
For comments see Table I.

4. Propeller Design Parameters
i. Diameter:- Basically as the diameter increases the propeller open efficiency increases. Therefore the propeller diameter should be as large as possible consistent with the required clearances. See Fig. 2. Most vessels less than sixty (60) feet in length cannot fit the optimum diameter of propeller and have to rely on propeller speed, revolutions, to absorb the power. Lack of sufficient clearance between the propeller and the surrounding hull can result in any or all of the following:
a. Cavitation with its erosion of the propeller surface and loss of efficiency.
b. Loss of efficiency due to poor and turbulent flow into the propeller.
c. Vibration due to cavitation or propeller tip induced.

Energy, Propulsion and Small Fishing Vessels
iv. Power:- Basically as power increases efficiency decreases. As mentioned previously most fishing vessels are over propelled. Normally for displacement type vessels the increase in power is proportional to the cube of the speed up to a speed length ratio of 1. (i.e. 10 knots for a 100 foot vessel). Above that value the power per increase in speed rises rapidly to 4th, 5th and even 6th powers of the speed until the planing region is reached at about 2.3 speed length ratio. By careful design the start of the rapid increase in power can be delayed to 1.1 and even 1.15 speed length ratios which are the ratios at which the larger fishing vessels operate. The cost of the delay is paid for by slightly higher power requirements at the lower speeds.
Therefore, most small fishing vessels are seriously overpowered. The Owner is using large amounts of fuel in obtaining very little increase in
speed and as will be illustrated is not transmitting that power very efficiently to the propeller.

5. Propeller Design

From the above parameters and the operational profile a propeller can be designed. Normally this is done by the use of model propeller charts, the most notable of which are the N.S.M.B. series for standard propellers of two, three, four, five and six blades with variations of blade area. From these charts optimum blade area and pitch are obtained.

6. Cavitation

Cavitation is the main propeller disease, but like most diseases can be avoided in the early stages - i.e. the design stage. Cavitation is caused by the reduction of pressure on the back of the blade dropping the pressure below the saturation vapour pressure causing, initially, bubbles of gas to form, normally at the propeller tips and if the pressure is low enough to eventually envelope the back of the propeller blade in a continuous sheet of gas. It causes vibration as the bubbles or sheets breakdown, erosion of the blade due to the explosions and serious loss of propeller efficiency. Its two main cures are sufficient blade area and good propeller shape design.

Energy, Propulsion and Small Fishing Vessels

The thrust developed by a propeller is due to the pressure differential between the face and back of the blade and hence reflects the thrust loading of the blade surface. As a rule of thumb for heavily loaded propellers the thrust per square inch of blade surface should not exceed eight (8) lbs. It is however better to use a cavitation chart such as developed by Burnii to check the area required to avoid cavitation.

Economic Utilisation of Available Power

The general approach to the utilisation of the available power, particularly, in the operation of draggers has been to try variations of propeller design and input. Little has been considered from the prime mover aspect. As stated earlier for a very small reduction in speed a significant reduction can be made in power. The calculations appended illustrate this point and indicate perhaps what can be achieved by sensible use of the throttle and fuel rack.

By reducing the power and revolutions it is possible using the same propeller to significantly reduce fuel consumption. Assuming that the distance to the grounds is about 55 miles, the number of trips per week is 2 and the fishing season is about 6 months; approximately 10% of the fuel spent when sailing can be saved. Added to this, engine is not working heavily loaded at about 87% full load.

In order to refine the operation of the engine, manufacturers could help considerably in providing specific fuel consumption charts giving engine r.p.m., engine bhp, BMEP and specific fuel consumption. Like most naval Architects we find great difficulty in obtaining such information on smaller engines although it surely exists.

Energy, Propulsion and Small Fishing Vessels

8. Stern Design

The more even and steady the flow of water into the propeller the higher the efficiency. Fig. 4 gives the minimum acceptable design clearances for a fishing vessel propeller. Particular attention should be given to the following:

i. Clearances between the hull and the propeller.
ii. Fairing of the shaft log and sternpost.
iii. Recessing of additions to the hull.
iv. Anodes (zincs) fitted to both the hull and the rudder to prevent erosion.
v. Low angles of both run and buttock lines for the after 10% of the hull running into the aperture. Connected with this is a slope maximum of 1.6 on a non-dimensional sectional area curve to ensure that there is no undue breakdown of the flow into the propeller.
vi. Aerofoil shaped, double plate rudder, semi-balanced gives better flow aft of the propeller.
vii. The aperture structure to be heavily constructed and connected to ensure no vibration.
viii. Shafting carefully aligned and checked periodically for alignment and wear-down.
ix. Good fairing between stern tube and forward end of propeller bossing. Rope guard to be fitted.
x. Adequate immersion of the propeller tips, to prevent air being drawn down into the propeller. Immersion should be at least half the diameter of the propeller.
xi. Reasonable slope in either the profile or section of the stern above the propeller to prevent undue slaming in heavy weather conditions.

Energy, Propulsion and Small Fishing Vessels

The above are only estimates based on information from propeller manufacturers. In all cases, the standard propellers available do not have sufficient blade area to avoid significant cavitation and blade erosion due to the heavy blade loadings. The initial column for the special assumes that a suitable mould is available and is purely the cost of the supply and fabrication of the additional material to obtain a reasonable blade area to avoid cavitation. The no mould column assumes that the mould has to be made. This approximately triples the cost of the propeller at 24 ins. diameter and doubles it at the 72 ins. diameter.

It, therefore, pays to shop around for a propeller manufacturer that will have the correct or near correct propeller either off the shelf or with a mould in existence. The costs given are for manganese bronze propeller material.

By purchasing a propeller with sufficient blade area both the efficiency of the propeller and its life
are improved drastically.

Protection
For the inshore fishing vessel protection of the propeller is important. In a dragger this can be achieved by fitting a substantial nozzle for open propellers. Some Owners have fitted a "beaver tail" both for protection and to aid in keeping the net out of the propeller. If it is intended to operate in light ice either stainless steel or a higher tensile material should be considered and if operating in heavy ice, ice fins should be fitted forward of the propeller. Care should be taken to ensure the fins lie more or less in the streamflow line. Aerofoil fins are expensive to fit and heavy steel plate, faired at the edges appear to be more economic to fit.

Conclusions
As a general conclusion the following is suggested for new vessels:

i. The fishing modus operandi should be clearly defined.

9. Approximate Cost of Propellers

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Cost$/Lb Standard</th>
<th>List Price</th>
<th>Special</th>
<th>Special No. Mould</th>
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<tr>
<td>24&quot;</td>
<td>$14</td>
<td>$420</td>
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<tr>
<td>72&quot;</td>
<td>$7</td>
<td>$6636</td>
<td>$9357</td>
<td>$12080</td>
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**PROPELLER OPTIONS AVAILABLE**

**TABLE I**

<table>
<thead>
<tr>
<th>Propeller Option</th>
<th>Operation</th>
<th>Design Speed</th>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed pitch &amp; nozzle.</td>
<td>Dragging.</td>
<td>3-5 knots</td>
<td>Optimun pull propeller protection</td>
<td>Loss free running speed. Medium cost.</td>
</tr>
<tr>
<td>Controllable pitch propeller.</td>
<td>Multi purpose or dragging with long voyage.</td>
<td>7-8 knots</td>
<td>Reasonable pull &amp; free running speed.</td>
<td>Expensive initially.</td>
</tr>
<tr>
<td>Controllable pitch &amp; nozzle.</td>
<td>Mainly dragging.</td>
<td>7-8 knots</td>
<td>Good pull propeller protection.</td>
<td>Some loss in free running speed, very expensive initially.</td>
</tr>
<tr>
<td>Compromise fixed pitch.</td>
<td>Dragging &amp; multi purpose.</td>
<td>7-8 knots</td>
<td>Average pull inexpensive.</td>
<td>Some loss in free running speed.</td>
</tr>
<tr>
<td>Fixed pitch.</td>
<td>Multi purpose.</td>
<td>10-12 knots</td>
<td>Good free running speed, inexpensive.</td>
<td>Low pull.</td>
</tr>
<tr>
<td>Two (2) pitch.</td>
<td>Dragging &amp; multi purpose.</td>
<td>7-8 knots</td>
<td>Reasonable pull &amp; free running.</td>
<td>Medium cost.</td>
</tr>
<tr>
<td>Fixed pitch.</td>
<td>Dragging.</td>
<td>3-5 knots</td>
<td>High pull inexpensive.</td>
<td>Loss free running speed.</td>
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</table>
MAIN ENGINE POWER REQUIREMENTS

![Graph showing main engine power requirements for different types of fishing vessels.](image)
## MAIN DIMENSIONS OF VESSELS

<table>
<thead>
<tr>
<th>Item</th>
<th>Item LOA (Ft.)</th>
<th>Item LBP (Ft.)</th>
<th>Item LWL (Ft.)</th>
<th>Item Beam MLD (Ft.)</th>
<th>Item Depth MLD (Ft.)</th>
<th>Item L/B</th>
<th>Item L/D</th>
<th>Item Steelweight L.T.</th>
<th>Item Fish Hold Lbs.</th>
<th>Item Consumables L.T.</th>
<th>Item Displacments L.T.</th>
<th>Item Draft Loaded Ft.</th>
<th>Item Trial Speed Kts.</th>
<th>Item BHP</th>
<th>Item RPM Propeller</th>
<th>Item Propeller Diameter Ins.</th>
<th>Item Rudder Area Ft²</th>
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<tr>
<td></td>
<td>35.00</td>
<td>50.00</td>
<td>75.00</td>
<td>100.00</td>
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<td>87.50</td>
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<td></td>
<td>3.22</td>
<td>2.93</td>
<td>3.02</td>
<td>3.57</td>
<td>4.00</td>
<td>7.00</td>
<td>11.50</td>
<td>13.50</td>
<td>8.74</td>
<td>6.77</td>
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</table>
NB: PROPELLERS ARE DESIGNED FOR TRAWLING CONDITION @ 4 KNOTS BUT DIAMETER SLIGHTLY REDUCED FROM TRAWLING OPTIMUM TO ACCOMMODATE FREERUNNING CONDITION.
TYPICAL WOODEN VESSEL GOOD STERN ARRANGEMENT

N.B. PROPELLER COULD BE INCREASED IN DIAMETER IF LOWERED BUT IS FITTED TO SUIT ENGINE/GEARBOX CENTRELINE
SUGGESTED MINIMUM CLEARANCES
TOP OF PROPELLER A 0.10D MOST CRITICAL
ART OF PROPELLER B 0.12D @ 0.7 RADIUS
BOTTOM OF PROPELLER C 0.02D
FORWARD OF PROPELLER D 0.15D

ITEMS OF NOTE
i. STERN POST FAIRED
ii. ROPE GUARD FAIRING. IF NOT FITTED AFT END STERN TUBE SAME DIAMETER AS FORWARD END PROPELLER CLEARANCE 1"
iii. STEEL TIE PLATES RECESSED INTO WOOD
iv. RUDDER WELL BALANCED & SUPPORTED

Figure 4
APPENDIX
50.0’ FISHING.....POWERING

BHP CURVES @ 150 BHP & 400 RPM AND 130 BHP & 380 RPM

SPEED 9.33 KNOTS

150 BHP

SPEED 9.23 KNOTS

130 BHP

PITCH RATIO IDENTICAL

PITCH RATIO

0.9

0.8

BHP

V KNOTS

8

9

10
Mr. Callaghan: Before proceeding to the questions, I would like to point out that there are several topics that came up which we haven’t discussed in any length, including the cost-benefit criteria that was suggested as the basis on which we would introduce new technologies to account for the lowering of energy. I think we had very little discussion on the effect of regulations on energy consumption, particularly the suggestion of Peter Matthews that we go to the property rights approach in the division of the fishery. Thirdly, it would be appropriate at this point to emphasize what’s needed in education for the fishery, and the fourth topic, what’s needed in research for the fishery. However, I would not restrict the discussion to these points, but nevertheless we ought to recognize their importance.

David Stewart: I would like to make a general comment about instrumentation, in particular with regard to the small inshore vessel. I think what is needed is a fuel computer similar to the ones that have been developed for the automotive industry, costing a couple of hundred dollars, although for diesel it could be more like a thousand. However, it is something you can mount on a very small vessel so the person operating it has a first hand knowledge of how much fuel he burns.

Wim Plaine, Navigational Electronics: Fuel flow meters are relatively inexpensive, and you can have meters that will monitor up to about 60 gallons for $250. On another point, one of the things I have seen over the last twenty years that I have been in the marine business, is the amount of inefficiency in fishing vessels, and I think one of the biggest problems is legislated inefficiency. Take for example the 65-foot dragger; some are almost as wide as they are long and have tremendously big engines with inadequate propellers. If we were to limit licences by engine horsepower you would be surprised how efficient these boats could become. They could be built a little longer, leaner, and easier to drive.

Allan Boyd, Nova Scotia, Department of Fisheries: Regarding training, I think we have seen an industry in Canada that has not been interested in training their staff. The industry had relied so much in the past on importing trained people from Europe. This is no longer possible: A) because our Department of Immigration won’t allow it; and B) because nobody wants to come to Canada anymore because the wage differential is no longer as great as it used to be. I think the only way that we’re going to get reasonably trained people is to start apprenticeship training programs and here I talk directly to Mr. Peter Matthews, because most large vessel owners do their own maintenance today. It’s no good putting trainees on a boat. They’re not going to learn anything, because unless the vessel breaks down, they’re never going to see the inside of it.

Therefore, our training has got to start in the shop. However, you can’t have this practical training without some vocational and academic training. The operators have to say to a prospective employee: “we will take you in but you have to attend evening classes, at least twice or three times a week and possibly one full day”. I know in Europe, the apprentices have to attend three nights a week and one full day. If they don’t attend, they are dropped from the program. I think this is one facet of the training operation that we lack here in Canada.

Mr. Greenland: I agree with you, but there is one problem in that the current regulations require a minimum of six months at sea. The benefits of that six months again, I’m sure you could comment on. I would add a further comment; under the existing regulation for 4th class engineer you can get a 4th class certificate by serving essentially three years in an apprenticeship or shop program. That will cease sometime in the foreseeable future as soon as Canada requires a minimum of six months sea time for a 4th class certificate. My suggestion is to promote the cooperative training aspect. We must get our students familiar with life at sea; not only the technical aspects of what they have to learn but co-operating with people at sea, that in itself is as much of a problem in the training as what the man learns with regard to his hands. In Newfoundland we have undertaken a nine month diesel program which is accredited for essentially six months of equivalent sea time. The Provincial Government, Canada Manpower, and the four major fishing companies are now participating in the sea program of six months duration. This is strictly an at sea orientation familiarization program.

Gastien Godin, Association Professionnelle des Pêcheurs du Nord-Est du Nouveau-Brunswick: Allow me to return to a previous question, Mr. President. On the one hand, the commentary we were making concerned itself not only with crab, but equally with groundfish. When we quoted an extract from the second letter, it concerned a processor fisherman who had on board a refrigeration unit for groundfish as well. Therefore, as far as it concerns us, it applies to both fisheries. But, I believe that the suggestion made by Mr. Côté, justified the intervention we made; and that before he condemns categorically such an important program, he make the appropriate nuances.

Mr. President, since this is perhaps the last chance, today, to make a few comments at this conference on all the problems raised concerning the energy question, I must tell you that our fishermen’s association is of vested interest to us, because in the end, it is the fishermen who will have to live with this problem in the years to come. That is why we are heavily represented here today. What perhaps leaves something to be desired, as far as the conference
format is concerned, is that it is more of a lecture or perhaps a unilateral discussion with no provision for workshops or, to better advantage, discussion. It's that it has been speeches rather with for the most part, a short time, at the end, reserved for discussion, where there was the possibility of a few interruptions only.

I don't think that we have met the challenge put to us by the Deputy Minister at the beginning of the conference when he said that we should take advantage of these two days in order to confront the energy question and see if we could possibly, in the end, find some answers. I think we have heard a whole stock of very valuable papers. All fishermen here, have benefitted, I think, from this, but at the same time, there was not enough exchange to allow us to try together to find solutions to this energy problem during the next few years.

All the same, I would like to bring up some points here, at the end of this conference. In Mr. Matthews's paper, on page four, where he is criticizing Federal Fisheries Management, he says: “management regimes, which plan to totally deny Nova Scotian and South Coast Newfoundland trawlers, access to prolific fishing grounds (Gulf of St. Lawrence and Sydney Bight) near their home ports, and to "compensate" them with fish on the Labrador grounds, adding four (4) days or more steaming time per trip”. Is that one way Mr. Matthews is suggesting in order to save energy? 

Frankly, I think it's obvious that that's the case. Are you aware, Mr. Matthews, that the logic that recommendation i.e. if the boats over 150 ft. want to fish the Gulf and Sydney Bight stocks, because it would cost too much for them to go and fish off Labrador; does that mean that if they must go into the Gulf; as the Deputy Minister said: "It can't be taken twice”, that if the big trawlers take that fish, then the Gulf fishermen – the mid-water fishermen – will not be able to take it? Does that, then, mean that in order to compensate for the fish they can't take in the Gulf (mid-water fishermen), that we should send them to fish cod off Labrador in order to save energy? Would it be possible for Mr. Matthews to comment on that recommendation?

Mr. Matthews: Yes, Mr. Godin, I guess we go into a lot of detail about that question: i.e. if the boats over 150 feet want to fish the Gulf and Sydney Bight stocks, because it would cost too much for them to go and fish off Labrador; does that mean that if they must go into the Gulf; as the Deputy Minister said: "It can't be taken twice”, That if the big trawlers take that fish, then the Gulf fishermen – the mid-water fishermen – will not be able to take it? Does that, then, mean that in order to compensate for the fish they can't take in the Gulf (mid-water fishermen), that we should send them to fish cod off Labrador in order to save energy? The one question I might ask you is that perhaps you haven't got the right vessels in the Gulf to begin with. The type of vessels that you build there are only suitable for six months of the year operation; therefore there is a tremendous inefficiency in the type of vessel that you are building. What is required in the total operation concept is a vessel that can operate year round, so you can get maximum utilization out of your vessel and the plant facilities.

Gastien Godin, Association Professionnelle des Pêcheurs du Nord-Est du Nouveau Brunswick: Mr. President, it is obvious that I won't enter into a long discussion on that question today. All the same, it is necessary to make a short response to it. It's just that this kind of logic means that ten boats could take all the fish in the Gulf. All the communities which make their living from fishing during the six months . . . because with us, ice is a reality of life with which we must live if the boats cannot come to take fish in the Baie de Chaleurs when it is full of ice in January . . . anyway . . . Therefore if that is the solution, there is no logic in a policy like that.

I think we have to work on the basis of what we have, which is that of an inshore and middle-distance Gulf fleet. The solution is not for ten boats . . . fifteen boats or large trawlers to come and take the main part of what there is in the Gulf, because it can be more profitable. In any case, who is going to go after the cod off Labrador? You are the only ones who can go get it. The comment I would like to make on that is that it is a shame to find energy-saving solutions like those that have been recommended by Mr. Matthews in the official documents. The second comment I would like to make, Mr. President, is that, concerning this conference, there remains some interesting things which have been recommended as short term solutions to the problems facing the industry. Furthermore, in Mr. Matthew's document, you have some interesting things concerning hulls and the consequence of certain methods of hull and boat maintenance on fuel consumption, etc. . . .

I think that what we would like to suggest at this conference is that there be someone from this Department who could lean on the idea of putting out a manual; at the practical level in order to better fuel consumption, which could be provided to the fishermen or distributed through the fishermen's associations, to inform them of the consequences of such and such an action on fuel consumption. In other words to put into layman's language some of the valuable scientific information provided in the speeches of this conference. So, that is one suggestion we would like to make.

The other question was brought up quite forcefully this morning by our friend, a fisherman and representative from Newfoundland, but could not be answered due to the closure of the session. It is that which we have discussed throughout the conference concerning long term solutions to bettering the fuel question. Have we truly addressed the real question being asked today?

The considerable increase in fuel costs expected over the next few years could affect the
survival and profitability of the fishing fleet. On the other hand, the prices paid to the fishermen do not increase and are sometimes reduced. The reason they are reduced is the result of the effect of fuel prices on the operation and profitability of the processing plants. So, finally, it is the fisherman who, in the end, must assume full responsibility. It is he who obtains the primary resource material and brings it ashore creating manpower and employment.

On this question it is certain that the Department and our association have undertaken, along with the government to work on a quality improvement program, as they have also done for example with boat improvement. I think fishermen are ready to make an effort in those directions. They know that in the long run, it could have a beneficial effect on the cost of catching fish.

But what we would ask, and this is our second recommendation, is whether or not it would be possible for the government to put into effect immediately, a commission or committee to find a formula; to work on a way of enabling the fishermen to eventually receive a better price for their fish. In the end the increased prices received by the fishermen for their fish might absorb or compensate for some of the costs incurred with the problems associated with increasing the quality of fish.

Could we seriously work on seeing in what manner, during the transitional years, it would be possible to help fishermen to hold their own, at least for the next few years? Obviously, the way things are going now, there are some fishermen who will not be able to hold their own.

My last point today, Mr. President, is a technical one. There are many points deserving discussion here today. For example the fisherman with previous experience was unable to discuss pair trawling due to the number of interruptions. Generally, the federal Government does things very well at the seminar level. . . . (reference made to previous seminars and their usefulness). . . . but this one has been a majestic failure for us. (Complaint about the inavailability of French versions of session papers). Despite our criticisms, however, we will all return home, at least in our group, enriched with the documents of quality presented here today.
CLOSING COMMENTS

W.F. Scott, P. Eng., Conference Co-ordinator

The assignment given to me at this juncture: to produce a summary of everything that has transpired during the last two days; the presentations, of questions and comments — including the points raised by Mr. Godin — is not an easy task. To make an exact summary is impossible and I'm sure you all appreciate that. First, allow me to give an update on some of the things that we have been doing in our Branch and initiating through our Department to present the energy subject in a finer focus. The most important thing that I would see arising out of a conference such as this is that contacts have been established, people meeting people, and discovering who knows what. That in itself is a major accomplishment. The message taken away by each individual is the summary of the conference. Looking at the composition of our audience, it has been most refreshing for those of us who were involved in the organization of the conference to see that we are not talking to any one particular group; we have several fishermen with us, we have people from the academic circuit, we have specialists in a range of engineering disciplines, all of whom have to be integrated in order that we can understand and react to what is a very, very complex situation. As far as the Department is concerned, I am reiterating Dr. May's words at our opening, when I say that perhaps this conference is the first public initiative that has been taken with respect to energy in the matter of fish harvesting. In order to get a conference of this style and type off the ground there had to be quite a bit of preparatory work; I think it would maybe be appropriate to take two or three minutes to tell you some of the things that we have done in this regard. We have announced publicly the areas concerning energy conservation in which we are involved, including co-ordinating this conference. There are other activities which have a more long-term implication. The first thing that has to be recognized is that we have begun a process to try and develop a technical inventory of the Canadian fleet, and we have attacked the problem from a national perspective. We must remember the fishing industry is competing with agriculture, transport, and others when future energy availability is concerned.

We have the vessel inventory well under way, because you have to have the facts before you can initiate any kind of plans or programs or make any analysis. The second undertaking that we are quite proud of is the initiative that was taken by a local company, Seimac Limited, to develop a data logging system on contract to our Department. The idea is quite simple: we want to have some sort of device which is easily transportable from one type of boat to another and, with the cooperation of the ship personnel concerned, to measure the performance of the ship under two different modes. We measure conventional operations, doing things in the traditional fashion. We then hope to be able to recommend some modifications; be they physical or otherwise. I am thinking of a different process of operation as opposed to physically changing the boat in order to make similar comparisons in before and after situation.

From the Department's point of view we see this conference as a first activity; I'm sure there is no dispute with the fact that this is probably the first time that fishermen, people in industry, people in government and people in academic quarters, have sat down and talked about energy as it relates to fishing. I think we would have been kidding ourselves had we assumed that in the course of two days we were going to solve a problem that is going to be with us for a long time. This is the first action, and there are many things the fishermen in particular could start to do if they are so inclined. I would like to run through some suggestions that have been made and others I feel are important. The first thing to do is to keep some records about your boat. Start to experiment to see what sort of differences in performance you would get if you exchanged your revolutions by a couple of hundred. Make comparisons with your neighbours and the others that share the harbour with you, or even people that are engaged in the same type of fishing. I think Mr. Fraser in his paper touches on a very sad point, and I say this with a lot of feeling, because I have been involved with fishing boats in Canada and elsewhere for a number of years and I can appreciate the dimension of the problem. It is a sad fact of life that there are more fishing vessels in the world than any other type of marine craft and they are the type of vessels which seem to receive the least amount of attention. To put things another way, if a company like Mr. Matthew's is considering getting a new class of trawler built at $12-15 million a piece, we spend a lot of money on the design of the vessel to get things done properly as a total engineered system. The smaller classes of fishing vessels shall we say rather happened as opposed to being designed as a total system. As Mr. Fraser pointed out, there has not been any real regard of the fact that the vessel has to be treated as a complete unit.

In the final analysis, the message I'm going to take away, and I think the rest of you will, too, is that we are beginning an education process for a new style of life. Although some delegates may feel we have been involved in a one-way discussion, I am sure most delegates will leave the conference with a lot more knowledge about fishing vessel energy than when they arrived, and in that regard something has been accomplished. Regarding the idea of creating a process of on-going education; it is one of the things that we have been talking about in our Department. The strategy was that this conference had to take place first, and we take off from here.
Another point I would like to make, keeping in mind the styles of advertising and communication that we now live with, is the parallel between a fishing vessel and a human body: they are both energy conversion systems. You put something in one form and its converted into something else at the other end of the process. You put calories into a marine motor just the same as you put them into your mouth, and they are converted into an end use. I think one of the most important things about our smaller fishing boats is, what shape are they in? Dave Fraser talked at great length about aperture design and the fact that some of these are very inefficient, and I have to agree with him. Water doesn’t like turning corners, and when you look at some of our older types of wooden boats, particularly those that have a stem post this wide and a little propeller that wide; you wonder how the vessel moves in the first place. However, things like that are important, so think about the shape of your boat and occasionally take a good look at it.

Another point to think about, is the current buzz word “Participaction”, and this is what we are going to be talking about as far as trying to get together with everybody on the energy question that relates to harvesting. We are talking about a combined process of participaction and action in which we are all going to get involved. Last but not least, just again to focus on some other buzz words current in the economic and health environments. Health and wealth are nice things to have together, but one without the other is not desirable. Let’s assume that if the boats are in good shape or in good health and if they are operated within an environment that respects the energy situation, in combination with the other factors that have to apply, there can be no bad influence on the wealth of the operations.

On the point of questions; if anyone had a question which was not answered or he didn’t get the chance to ask it, leave a card with one of us, and we will do our best to forward the answers by mail or other means.