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Ener Sea - 1987/88
(Vessel Analysis Computing System)

Paul Pinhorn

Fisheries and Oceans Canada
and
Energy Mines and Resources Canada
and
Dept of Energy
Government of Newfoundland and Labrador

May, 1988

Canadian Technical Report of Fisheries and Aquatic Science
No. 1661

Fisheries and Oceans / Pêches et Océans

Canada

Canadian Technical Report of Fisheries and Aquatic Sciences

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Les rapports techniques contiennent des renseignements scientifiques et techniques qui constituent une contribution aux connaissances actuelles, mais qui ne sont pas normalement appropriés pour la publication dans un journal scientifique. Les rapports techniques sont destinés essentiellement à un public international et ils sont distribués à cet échelon. Il n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques du ministère des Pêches et des Océans, c'est-à-dire les sciences halieutiques et aquatiques.

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Les numéros 1 à 456 de cette série ont été publiés à titre de rapports techniques de l'Office des recherches sur les pêcheries du Canada. Les numéros 457 à 714 sont parus à titre de rapports techniques de la Direction générale de la recherche et du développement, Service des pêches et de la mer, ministère de l'Environnement. Les numéros 715 à 924 ont été publiés à titre de rapports techniques du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 925.

Les rapports techniques sont produits à l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

ENER SEA - 1987/88
(VESSEL ANALYSIS COMPUTING SYSTEM)

PAUL PINHORN

FISHERIES AND OCEANS CANADA

AND

ENERGY MINES AND RESOURCES CANADA

AND

DEPARTMENT OF ENERGY
GOVERNMENT OF NEWFOUNDLAND AND LABRADOR

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CANADIAN TECHNICAL REPORT OF FISHERIES AND
AQUATIC SCIENCES NO. 1661

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Fisheries and Aquatic Sciences No. 1661

MAY, 1988

ENER SEA - 1987/88
(VESSEL ANALYSIS COMPUTING SYSTEM)

BY

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Cat. No. Fs 97-6/1661E 0706-6457

Correct citation for this publication:

Pinhorn, P., 1988. Ener Sea - 1987/88 (Vessel Analysis Computing System)
Can. Tech. Rep. Fish. Aquat. Sci. 1661: vi + 39p

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PREFACE

A contract (FP001-7-2063/01-XAQ) was awarded to Paul Pinhorn to further develop and transfer information relating to the Ener Sea program. An amendment to the contract (FP001-7-2063/02-XAQ) was also awarded to the same consultant. This project was a continuation of a program to develop ways and means for fishermen to reduce their vessel's operating cost.

Funding for this project was provided by the following:

- Fisheries and Oceans / Pêches et Océans
  Hon. Tom Siddon, Minister
- Energy, Mines and Resources Canada / Énergie, Mines and Ressources Canada
  Hon. Marcel Masse, Minister / L'Hon. Marcel Masse, Ministre
- Department of Energy
  Government of Newfoundland and Labrador
  Hon. A. Brian Peckford, Minister

Scientific Authority
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Fisheries Development Division
Fisheries and Habitat Management Branch
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ABSTRACT

Pinhorn, P. May, 1988. Ener Sea - 1987/88 (Vessel Analysis Computing System) Can. Tech. Rep. Fish. Aquat. Sci. 161: vi + 39p.

Three main activities were conducted as part of the Ener Sea Program from June, 1987 to March, 1988. They included propeller analysis, cost reduction/energy efficiency seminars and demonstrations at sea.

A total of 21 fishermen had the propellers on their vessels analyzed and the Vessel Analysis Computing System was demonstrated to 165 fishermen. Nine seminars were held throughout the Newfoundland Region with a total of 141 fishermen in attendance. It was determined from the 23 vessels which had demonstrations conducted at sea that a reduction one knot from maximum speed would result in an average fuel savings of 36%.

The estimated impact of the Ener Sea Program on the Newfoundland fishing fleet from these activities amounts to total savings of approximately $1,235,920.00. It is estimated the projected impact of the Ener Sea Program on the Newfoundland fishing fleet for the next five years will produce savings of approximately $4,134,700.00.

RÉSUMÉ

Pinhorn, P. Mai 1988. Energie en mer, 1987/88 (système d'analyse sur ordinnateur pour les bateaux) Rapport technique canadien des sciences halieutiques et aquatiques.

Trois grandes activités ont été menées dans le cadre du programme "Energie en mer" entre juin 1987 et mars 1988. Elles comportaient l'analyse des hélices, des colloques sur la réduction des coûts et l'efficacité énergétique et des démonstrations en mer.

Un total de 21 pêcheurs ont fait analyser les hélices de leur navire ct 165 pêcheurs ont assisté à une démonstration du systèm informatisé d'analyse des navires. Neuf colloques ont été tenus dans la région de Terre-Neuve auxquels ont assisté 141 pêcheurs. A partir des 23 navires qui ont fait l'objet de démonstration en mer, il a été montré qu'ne réduction d'un noeud de la vitesse maximale entrainerait une économie moyenne de carburant de 36%.

Il a été estimé que les répercussions du programme "Energie en mer" sur toute la flotte de navires de pêche de Terre-Neuve à partir de ces activités permettraient de réaliser des éeconomies totales d'environ 1,235,920 $. On prévoit que les répercussions du programme sur la flotte de pêche de Terre-Neuve au cours des cinq prochaines années permettront de réaliser des économics d'environ 4,134,700 $.

INTRODUCTION

From June 1, 1987, to March 31, 1988, an ongoing program designed to increase vessel efficiency and reduce fishing vessel operating costs was conducted. The Ener Sea van, which houses computer hardware and software, was employed to travel to numerous fishing settlements to conduct seminars and analyze fishing vessels. The computer software enabled the operator to predict vessel fuel savings resulting from propeller change and variation in operational procedure.

The purpose of this program was to transfer to the fishing industry information gathered over the past five years on cost reduction. This was accomplished by: conducting cost reduction/energy efficiency seminars; analyzing (ie: recommending a more efficient propeller) fishing vessels; and carrying out demonstrations at sea to show fishermen the ample fuel savings which result from a small reduction in vessel speed.

This report also outlines an assessment of the actual and projected impact of the Ener Sea program on the Newfoundland inshore fishing fleet.

VESSEL ANALYSIS COMPUTING SYSTEM (VACS)

DESCRIPTION

The Vessel Analysis Computing System (VACS) is a versatile software package offering various recommendations for fuel consumption reduction targeted at Newfoundland fishing vessels from 30' to 65' L.O.A. The VACS package contains five main programs. These are: propeller change; operating profile; operational sheet program; throttle simulation; and the

Ener Sea Data Management System (EDAMS). Each program generates the following output:

Propeller Change

The propeller change program predicts the performance of the present propeller configuration as well as the optimum propeller for the vessel. The optimization portion of the routine either optimizes the torque or thrust (depending on the fishing mode) to determine the most effective propeller.

The output of the propeller change program is presented in tabular form. The computer first outputs the data that was initially entered by the operator. This is followed by a printout of the current propeller performance; thrust, horsepower, torque, percentage of cavitation etc. Next, the program identifies up to three more efficient propellers for the vessel, providing information on their diameter, pitch, percentage of increased efficiency, and percentage of cavitation. From this information, and the propeller cost, the vessel owner is assisted in making a decision as to which propeller in best suited for his vessel. The printout also contains the estimated payback period and the rate of return if the new propeller is retrofitted.

Operational Profile

This program can estimate a vessel's operational profile based on the old or new, more efficient propeller which it selects. By inputting RPM, speed and propeller parameters, the program will provide an estimate of reduction in fuel consumption and speed at various RPM levels. It also generates thrust values for each RPM and speed value.

Operational Sheet Program

The operational sheet program accepts field data collected on vessels tested for fuel consumption and speed at various RPM. It generates graphs and displays and plots operational sheets showing fuel savings from reducing RPM.

Throttle Simulation

The throttle simulation program accepts data from the operational sheet program and shows RPM, speed and fuel consumption at different throttle settings. It also generates speed and fuel consumption curves for each vessel available.

Ener Sea Data Management System (EDAMS)

The EDAMS system is an organizational tool developed specifically for the Ener Sea program. The system contains six individual data base modules encompassing the areas of personnel, industry contacts, project information and fleet data management. The program is highly modular with respect to both procedures and data base modules. It is intended to facilitate any future changes which may become necessary as the requirements of the Ener Sea program expand.

EDAMS was developed in order to allow program personnel immediate access to relevant information when in the office or in the field.

The VACS system output is a combination of screen and printed displayed information. Most of the information can be presented in either table or graph form (Fig. 1).

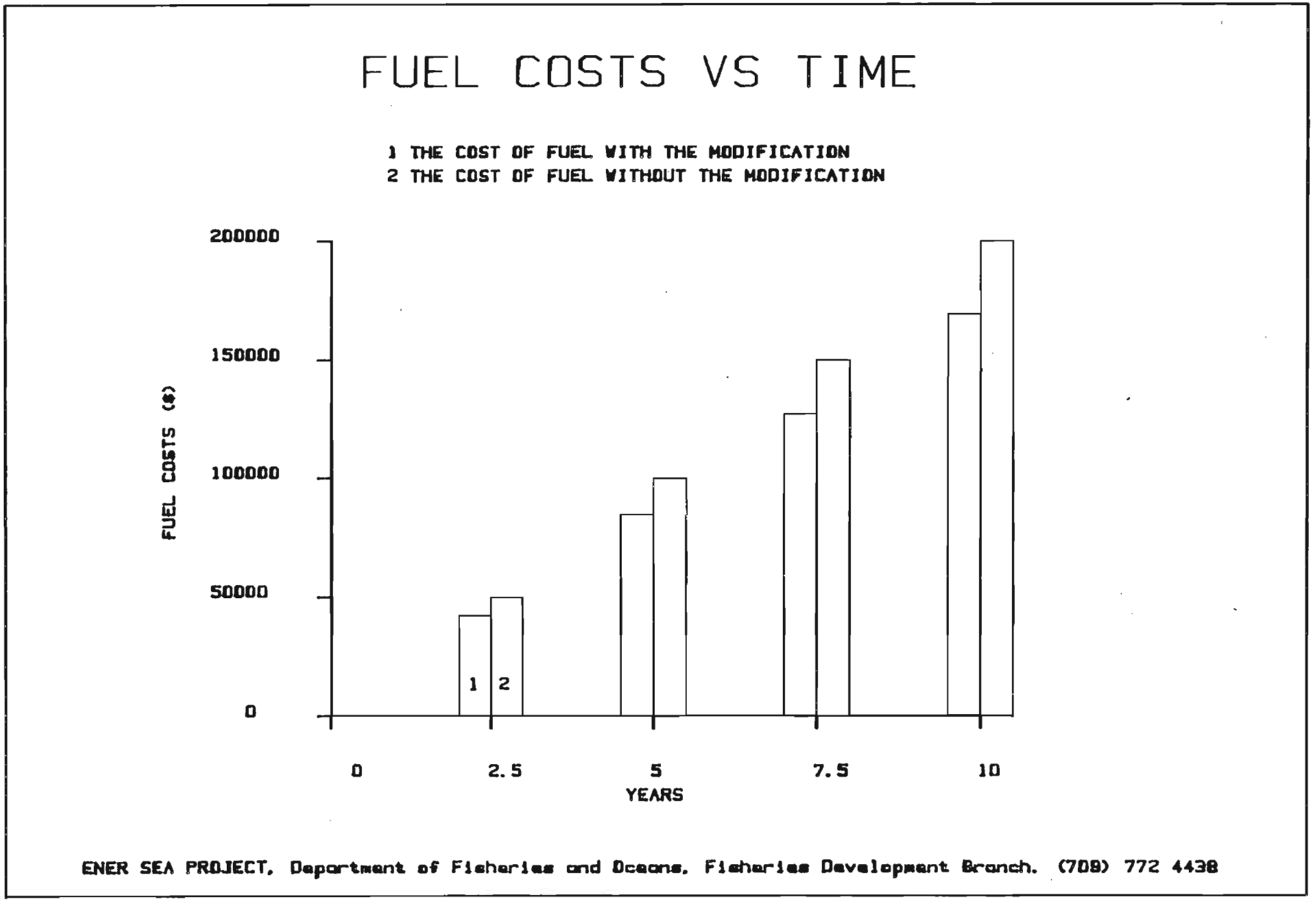
FUEL COSTS VS TIME
1 THE COST OF FUEL WITH THE MODIFICATION
2 THE COST OF FUEL WITHOUT THE MODIFICATION
FUEL COSTS ($)
200000
150000
100000
50000
0
1
2
0
2.5
5
7.5
10
YEARS
ENER SEA PROJECT, Department of Fisheries and Oceans, Fisheries Development Branch. (709) 772 4438

FIG. 1

UPGRADING OF VACS

Recently, the newly developed B.C. trip simulation program was incorporated into the VACS system. This optimization program is a computerized simulation model which can assist fishermen to estimate fuel consumption under varying conditions. Dealers were contacted to obtain engine performance curves for main and auxilliary engines commonly used. These were digitized and integrated into the program. Also, the program was modified to accept Ener Sea field data as another method to predict fuel savings. Effective horsepower (ehp) curves were included as were propeller performance curves, gear ratios and controllable pitch propeller performance values. The program also includes a definition of vessel geometry. The main engine is identified for analysis, propeller dimensions are added, and a fishing scenario is simulated. For this simulation, the user can identify navigation routes used to get to the fishing grounds during actual fishing operations and on the return leg of the trip. The computer calculates mileage and time, based on desired speed and throttle settings, and different fuel saving alternatives are assessed within these parameters. Output takes the form of estimated income for each fishing trip (scenario) and is calculated to indicate the relative importance of fuel to the cost of fish. Because the program will be continuously updated, it will become more comprehensive in the future. Even now it can offer the fishermen important suggestions on how to modify his vessel to realize savings of up to 20% of his total fuel bill.

The VACS software package will be further updated and modified by carrying out sea trials on vessels which have installed a new propeller based on the prediction of the VACS program. This will determine if the predicted is the same as the actual results.

VESSEL ANALYSIS (VACS)

The VACS system consist of computer hardware and software located within a motorized van for easy access to most fishermen. In most cases, the computer program predicts fuel savings by changing to a more efficient propeller and by adjusting the operational profile. The resulting savings can be represented by percentage changes or in chart or table form. Printouts of the information are usually transferred to fishermen during field trips or by mail.

VACS was developed to carry out the difficult calculations involved in vessel analysis and to determine savings that result from vessel modifications. It is the heart of the Ener Sea program.

Many fishermen have been exposed to the VACS system since the beginning of the Ener Sea program. During this contract, 21 fishermen have had their vessel's propeller analyzed by VACS and 165 have had VACS demonstrated to them either through seminars or demonstrations at sea (Table 1).

Since the beginning of this program, 197 vessels have been analyzed for propeller change. It is difficult to determine how many vessel owners are familiar with VACS. However, through information transfer initiatives, it is felt that many fishermen are aware of the program.

In general, most fishermen realized savings from the VACS software package. By using data collected from field and from propeller manufacturers more accurate values of speed, fuel consumption, RPM and B.A.R. could be utilized in the propeller change program. It is proposed to continue collecting field data in order to achieve a data base that is compatable to all vessels within the Newfoundland inshore fishing fleet.

By using data collected on propellers and estimates of fuel savings from fitting a new blade, statistical analysis could be applied to predict fleet savings from vessel analyses (see Table 2, Burry, 1987). From analyzing the savings, it was concluded that the annual fishing fleet savings fleet wide was between $206,934.00 and $329,839.00 with a 95% confidence level. It may be necessary to note that these figures are based on the fact that all vessels will fit new propellers. Since this may not be possible in all cases, these figures may not be totally accurate. However, it does indicate that substantial savings may be realized from fitting a new propeller.

It is intended to continue analyzing vessels since requests are continuously being made by fishermen throughout the region. By maintaining this service more fishermen will achieve savings when operating their vessels.

TABLE 1. VESSELS ANALYZED FOR PROPELLER CHANGE

METHOD OF CONTACT	NUMBER OF VESSELS
SEMINARS	1
TELEPHONE AND MAIL	16
CONSULTING COMPANIES	4
TOTAL	21

TABLE 2. ESTIMATED FLEET SAVINGS FROM VESSEL ANALYSES

CATEGORY	LOWER LIMIT	UPPER LIMIT
30 - 35	$ 79,149.00	$119,760.00
36 - 45	$ 64,278.00	$121,765.00
46 - 55	$ 42,655.00	$ 60,479.00
56 - 65	$ 20,852.00	$ 27,835.00
TOTAL	$206,934.00	$329,839.00

ENERGY EFFICIENCY/COST REDUCTION SEMINARS

Since June, 1987, nine cost reduction/energy efficiency seminars were conducted throughout various locations in the province (see Table 3 and Fig. 2). As a result of these seminars, many fishermen have requested propeller analyses and fuel consumption demonstrations on their vessels.

During the seminars, fishermen were exposed to various fuel cost cutting methods for their vessels. The seminar agenda (Fig. 3) included a choice of five video tapes (Cutting the Cost, Picking a Prop, Engine Efficiency, Propeller Performance and Care of Your Outboard). Fishermen also received information packages containing a complete outline of all material presented during seminars. Following each meeting, it seemed that most fishermen were interested in the propeller program and fuel consumption testing since the majority of requests received were related to these subjects.

To date there have been 31 seminars held in the Newfoundland Region. Figure 2 shows the locations where cost reduction/energy efficiency seminars were conducted.

TABLE 3. SUMMARY OF ENERGY SEMINARS 1987/88

SEMINAR NO.	LOCATION	NO. OF ATTENDANTS	DATE
1	Fortune	9	Nov. 17/87
2	Trepassey	5	Nov. 24/87
3	St. Brides	6	Nov. 26/87
4	Harbour Breton	10	Dec. 17/87
5	Gooseberry Cove	11	Jan. 13/88
6	St. Anthony	34	Jan. 19/88
7	Roddickton	22	Jan. 21/88
8	Holyrood	9	Feb. 4/88
9	Marystown	35	Mar. 15/88
TOTAL		141	

DISTRIBUTION OF COST REDUCTION/ENERGY EFFICIENCY SEMINARS IN THE NFLD REGION

FIG. 2

COST REDUCTION/ENERGY EFFICIENCY SEMINAR

AGENDA

1. General Introduction

2. Sound-On-Slide/Video Tape Cutting the Cost.

3. Demonstrations at sea for fuel consumption, RPM & speed.

   a) Reason for demonstrations
   b) Equipment used in demonstrations
   c) Example of vessels measured
   d) Summary of demonstrations

4. Sound-On-Slide/Video Tape Propeller Performance.

5. ENER SEA Van Program.

6. Propeller Analysis:

   a) Input Parameters,
   b) Present Propeller Conditions and Optimized Blade,
   c) Cost and Benefits.

7. Bottom Cleaning:

   a) Input Parameters,
   b) Cost and Benefits.

8. Operational Profile:

   a) Input Parameters,
   b) Output Profile.

9. Sound-On-Slide/Video Tape Picking a Prop.

10. Appointments for Energy Efficiency Analysis.

11. Closing Remarks.

    Handouts included:

    a) Pamphlet Cutting the Cost.
    b) Operational Profile Sheet.
    c) Pamphlet Picking a Prop.
    d) Summary of ENER SEA Van Program.
    e) Propeller Analysis - Input and Output Parameters.
    f) Bottom Cleaning - Input and Output Parameters.
    g) Operational Profile - Input and Output Parameters.
    h) Pamphlet Engine Efficiency.
    i) Pamphlet Fishing and Fuel Efficiency.
       (How to make more money catching fish.)
    j) Pamphlet Cutting Fuel Costs.
       (Alternatives for commercial fishermen.)

FIG. 3

DEMONSTRATIONS FOR FUEL CONSUMPTION RPM AND SPEED

From the inception of this contract in June, 1987, demonstrations were carried out on 23 vessels from 30' to 65' in length. The demonstrations provided fishermen with information on the relationship between speed, RPM and fuel consumption. Where a slight loss in speed resulted in a high fuel savings refer to (Table 4 and Fig. 4).

A radar gun was used to determine the speed of the vessel relative to a fixed point on shore. This gun is simular to those used by police forces but was modified to accurately record low speeds. It consists of a hand-held radar emitter/receiver interfaced with a digit data display (Fig. 5).

A tachometer was used to measure the RPM of the propeller shaft. It consists of a stroboscope and digital display attached to a 12 volt power source (Fig. 6).

A standpipe composed of one plastic cylinder contained in an aluminum case connected with clear 3/8" hose was used to provide an accurate measurement of fuel consumption. Regularly graduated volume levels were measured and marked on the cylinder. The cylinder was filled through a two-way valve from the bottom with a 25 litre tank mounted on top of the wheelhouse (Fig. 7).

When the equipment was in place, the skipper would steam to a suitable location where the demonstration could be conducted under minimal wind, tide and current conditions.

To begin the demonstration, the vessel steamed straight away from land at an agreed engine RPM. One member of the Ener Sea team would measure fuel consumption while the other monitored RPM and speed. A stopwatch was used

to determine the time required to burn a predetermined amount of fuel. Several readings were taken from each instrument while steaming away from land. The vessel was then brought around without changing the RPM and headed back for another run. By measuring both situations, most of the variations due to wind, tide and current were averaged.

Five to seven runs were conducted at increasing engine revolutions (usually in increments of 200 RPM). The number of runs completed was dictated by the skipper's willingness to operate his engine at high RPM.

After each demonstration, the skipper was presented with a table of his vessel's results. The table showed his engine's fuel consumption at various vessel speeds and RPM (Fig. 8). This data will also be used in predicting resistance in the B.C. trip simulation program which is presently being incorporated into the Ener Sea program.

In future, an effort will be made to test vessels in the weak regions (see Fig. 9). This will ensure an even distribution of data collected.

TABLE 4. SUMMARY OF VESSELS DEMONSTRATED FOR FUEL CONSUMPTION RPM AND SPEED

VESSEL NO.	VESSEL LENGTH (FT)	ENGINE H.P. (MAX)	% FUEL SAVED FROM A DROP OF 1 KNOT FROM MAX. SPEED
1	30	62	19
2	35	140	17
3	32	55	51
4	37	36	33
5	45	117	32
6	33	33	32
7	45	218	46
8	32	55	53
9	35	90	32
10	32	30	42
11	37	135	50
12	52	220	34
13	55	365	24
14	50	117	35
15	50	154	33
16	50	115	26
17	50	230	46
18	52	300	41
19	43	125	34
20	42	154	39
21	42	170	40
22	40	117	35
23	40	105	31
AVG.	42	137	36

DISTRIBUTION OF DEMONSTRATIONS AT SEA WITHIN THE NFLD REGION

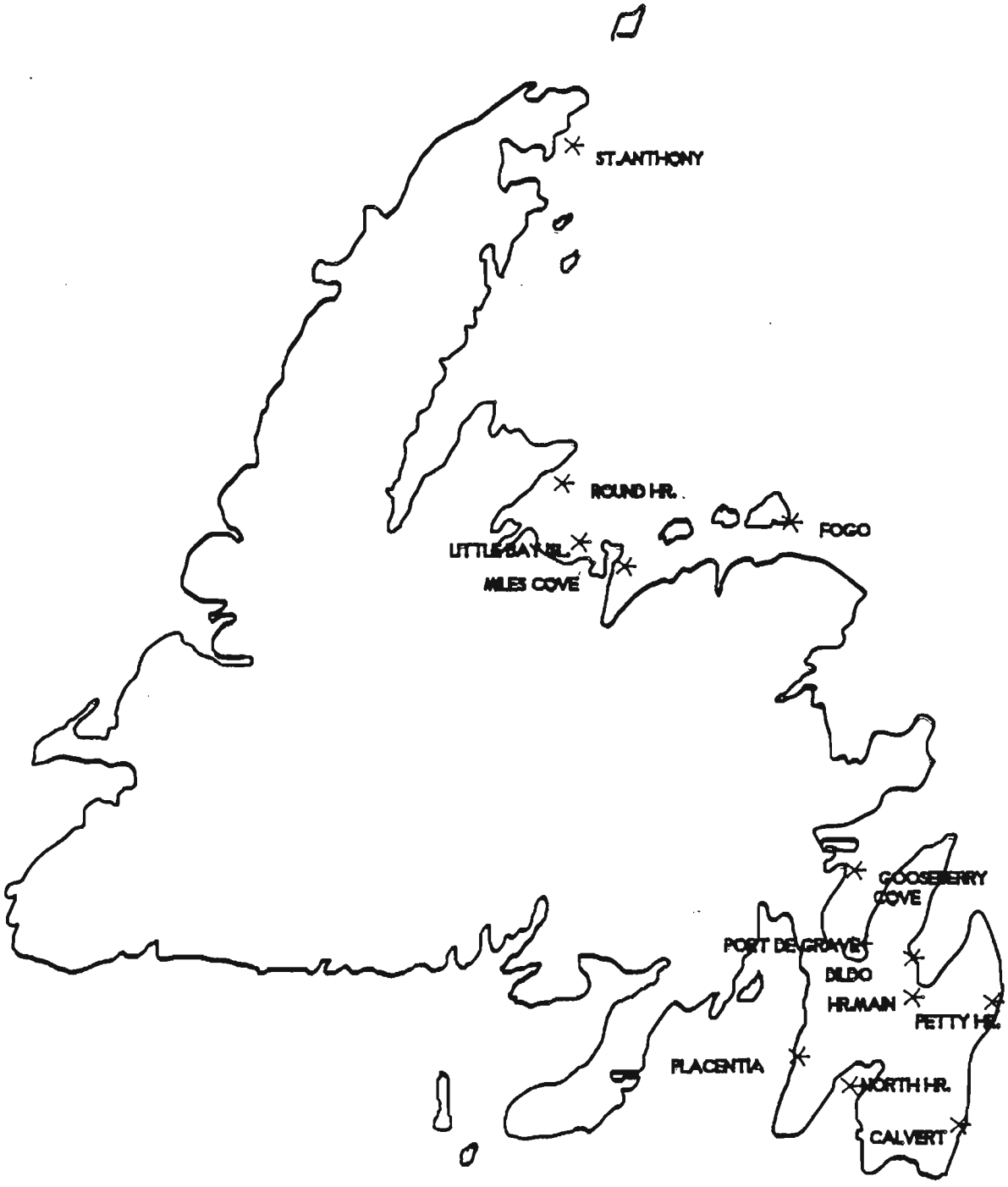

FIG. 4

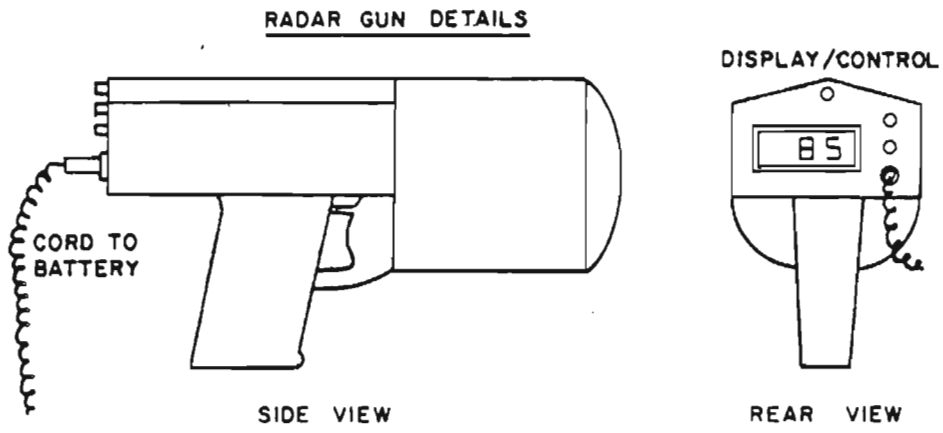
RADAR GUN DETAILS
DISPLAY/CONTROL
85
CORD TO BATTERY
SIDE VIEW
REAR VIEW

FIG. 5

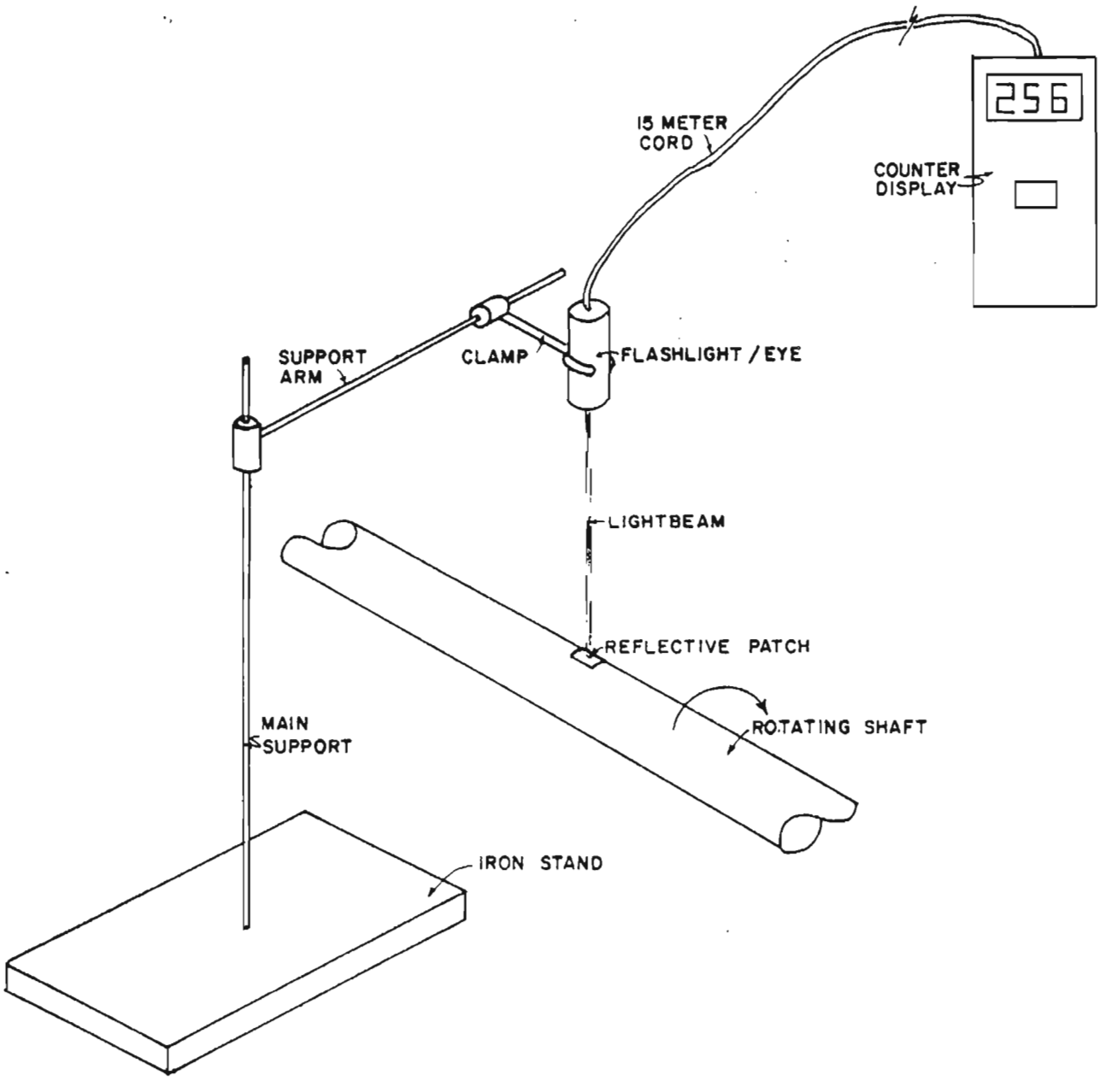
256
15 METER CORD
COUNTER DISPLAY
SUPPORT ARM
CLAMP
FLASHLIGHT / EYE
LIGHTBEAM
REFLECTIVE PATCH
ROTATING SHAFT
MAIN SUPPORT
IRON STAND

FIG. 6

FIG. 7

FUEL MEASURING SYSTEM

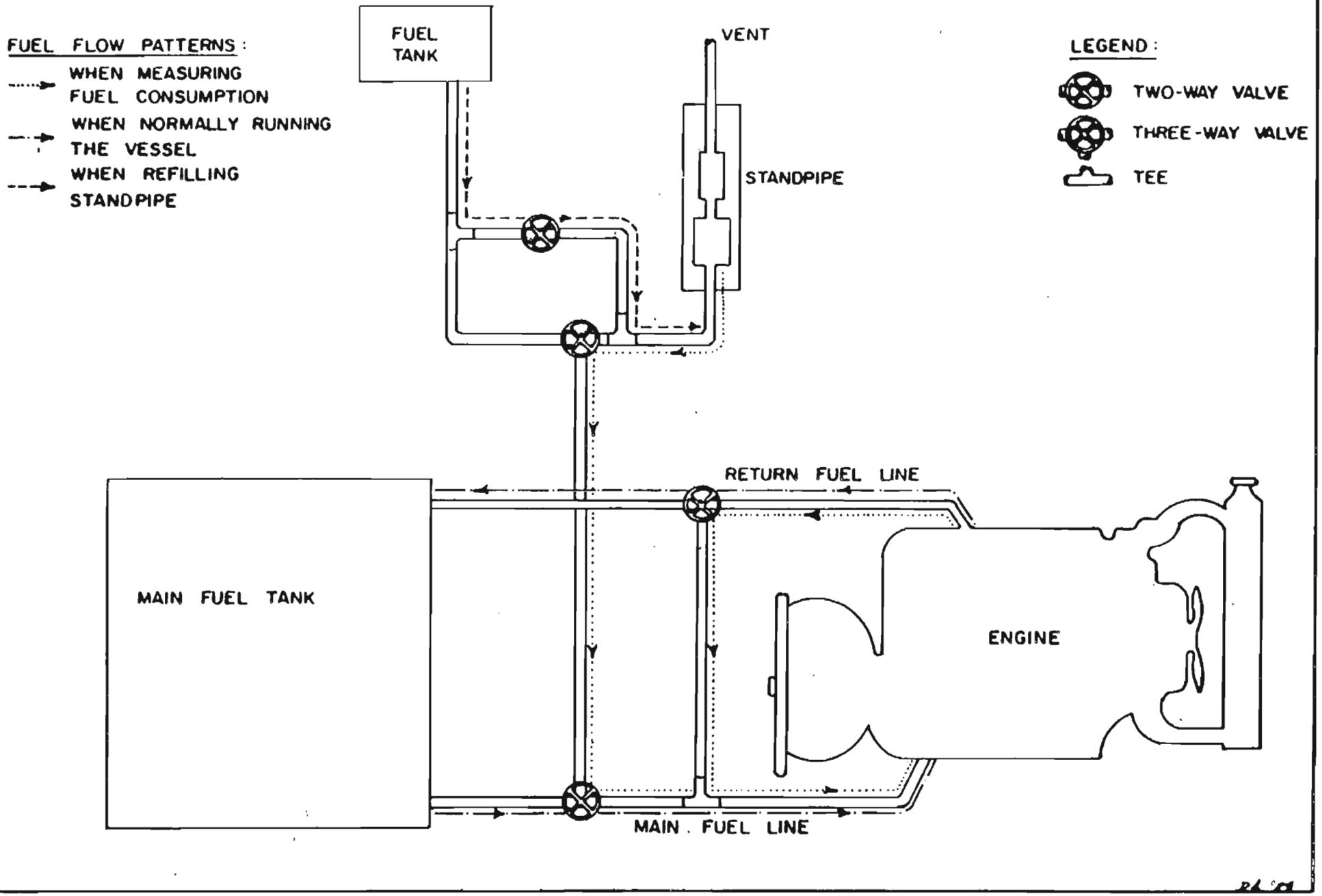

FIG. 8

ENER SEA VESSEL OPERATIONAL GUIDE

M.V.: MARY MARIE LENGTH: 50 ft ENGINE: 230HP CUMMINS DATE: SP/87

RPM (engine)	SPEED (knots)	FUEL CONSUMPTION (gal/hr)	DROP IN SPEED FROM MAX (knots)	DROP IN CONSUMPTION FROM MAX (gal/hr)	FUEL SAVED PER TRIP
3000	9.43	10.20	0.00 (0%)	0.00 (0%)	0%
2800	9.29	8.49	0.14 (1%)	1.71 (17%)	16%
2600	8.97	6.72	0.46 (5%)	3.48 (34%)	31%
2400	8.45	5.07	0.98 (10%)	5.13 (50%)	45%
2200	7.93	4.03	1.50 (16%)	6.17 (60%)	53%
2000	7.61	3.38	1.82 (19%)	6.82 (67%)	59%

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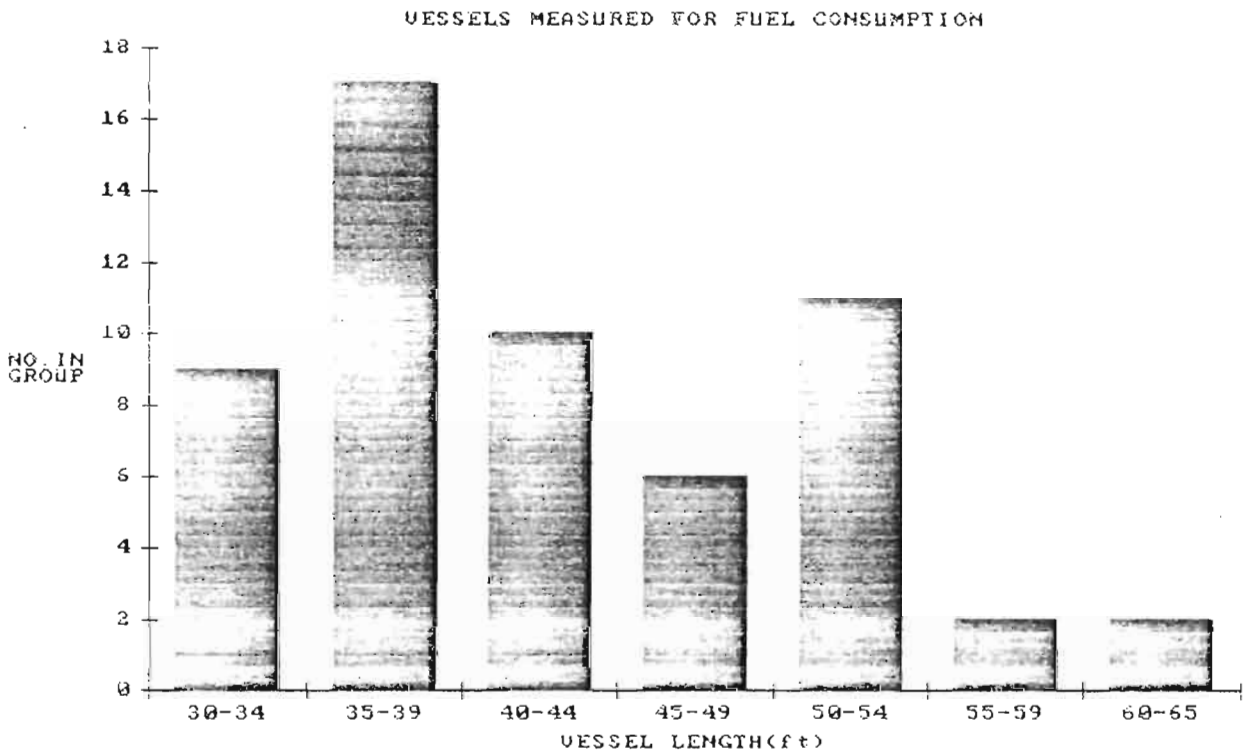
VESSELS MEASURED FOR FUEL CONSUMPTION
NO. IN GROUP
0
2
4
6
8
10
12
14
16
18
30-34
35-39
40-44
45-49
50-54
55-59
60-65
VESSEL LENGTH(ft)

FIG. 9

INVESTIGATION INTO POSSIBLE PROPELLER RELATED SAVINGS AS A RESULT OF ENER SEA

In the past, many fishermen have been educated about propellers through the Ener Sea program. It seemed from speaking with fishermen that problems such as cavitation, corrosion and heavy blades were most common. By transferring information to fishermen and analyzing their vessels it may be possible that many of these problems were or will be remedied.

It was determined from a recent study that fishermen would save an average of 4% fuel by fitting a more efficient propeller.

In addition, savings would be realized by reducing cavitation and eliminating corrosion resulting in a longer propeller life.

By analyzing each of the three benefits it is possible that the following savings could be gained by each fishermen who fitted a new blade:

ANNUAL FUEL SAVINGS FROM INCREASED PROPELLER EFFICIENCY

Annual Fuel Savings = (*average annual fuel consumption per vessel) x (fuel savings from a more efficient propeller)
= (0.04) x ($4,453.00)
= $178.00 per vessel annually

ANNUAL SAVINGS FROM REDUCED CAVITATION

Savings from reducing cavitation by fitting a new propeller would be attained since the life of the new propeller would increase over the old propeller approximately four years to ten years.

Annual Savings = [(*average cost of old propeller x new prop life/old prop life) - (*average cost of new propeller)]/new prop life
= [($847.00 x 10/4) - ($1,027.00)]/10
= $109.00 per vessel annually

ANNUAL SAVINGS FROM ELIMINATION OF CORROSION

Savings from eliminating corrosion would be realized since the life of the propeller could increase from four years to ten years. In certain areas the damage from corrosion may vary such as the St. Brides Area, where fishermen have to replace blades every two years.

Estimated Annual Savings = (*average cost of propeller x new prop life/old prop life)/new prop life
= ($937.00 x 10/4)/10
= $234.00 per vessel annually (excludes cost of sacrificial plates)

TOTAL ANNUAL SAVINGS FROM ALL THREE BENEFITS

Total savings = savings from (more efficient propeller) + (reduced cavitation) + (eliminating corrosion)
= ($178.00) + ($109.00) + ($234.00)
= $521.00 per vessel annually

This saving indicates that it is very feasible for fisherman to learn more about propellers so they may improve their propeller efficiency and increase the life of their blades.

*NOTE: These values were taken from "Analysis of Ener Sea Potential", Burry, 1987 and Columbian Propeller price list effective January, 1987.

ESTIMATED IMPACT ON FISHERMEN THAT HAVE BEEN EXPOSED TO ENER SEA

Over the past four years propeller analysis have been carried out on 197 vessels and the relationship of fuel consumption, RPM and speed was demonstrated at sea on 57 vessels. Also 31, energy efficiency cost /

reduction seminars were held, which informed 477 fishermen of practical ways of reducing operational costs.

Recently, several studies and surveys were conducted in order to assess the impact of these activities (see results of surveys in appendices). Based on these studies and surveys the following conclusions were made:

1. As a result of fishermen being exposed to cost reduction/energy efficiency seminars they have reduced their RPM and saved approximately 19.3% fuel.
2. As a result of fishermen having their vessels measured for fuel consumption, RPM and speed they have reduced their RPM and saved approximately 18.5% fuel.
3. As a result of fishermen having propeller analyses carried out on their vessels they would save approximately 4.0% fuel. In addition, savings would occur from reduced cavitation.

By using financial data from a recent report ("Analyses of Ener Sea Potential", Burry, 1987) and statistical data from Statistics Branch of Department of Fisheries and Oceans, figures of average fuel cost and number of vessels in the fleet between 30' and 65' were used.

The following is an estimate of the impact of Ener Sea based on these figures.

ESTIMATED IMPACT ON FISHERMEN FROM THE THREE PREVIOUS ACTIVITIES

Cost Reduction/Energy Efficiency Seminars

Number of fishermen attending seminars:

1984/85 -	134
1985/86 -	138
1986/87 -	64
1987/88 -	141
TOTAL	477

For 1984/85 to date

Fuel Savings (RPM reduction) = (no. of fishermen) x (average fuel cost) x (savings from seminars) x (no. of years to date)
= (134) x ($4,453) x (.193) x (4)
= $460,654.00

For 1985/86 to date

Fuel Savings (RPM reduction) = (no. of fishermen) x (average fuel cost) x (savings from seminars) x (no. of years to date)
= (138) x ($4,453) x (.193) x (3)
= $355,804.00

For 1986/87 to date

Fuel Savings (RPM reduction) = (no. of fishermen) x (average fuel cost) x (savings from seminars) x (no. of years to date)
= (64) x ($4,453) x (.193) x (2)
= $110,007.00

For 1987/88 to date

Fuel Savings (RPM reduction) = (no. of fishermen) x (average fuel cost) x (savings from seminars) x (no. of years to date)
= (141) x ($4,453) x (.193) x (1)
= $121,180.00

Total savings from seminars since 1984

$	460,654.00
	355,804.00
	110,007.00
	121,180.00
$	1,047,645.00

Demonstrations At Sea

Number of vessels analyzed:

1985/86 - 21
1986/87 - 13
1987/88 - 23

TOTAL 57

For 1985/86 to date

Fuel Savings (RPM reduction) = (no. of vessels measured) x (average fuel cost) x (savings from demonstrations) x (no. of years to date)
= (21) x ($4,453) x (.185) x (3)
= $51,900.00

For 1986/87 to date

Fuel Savings (RPM reduction) = (no. of vessels measured) x (average fuel cost) x (savings from demonstrations) x (no. of years to date)
= (13) x ($4,453) x (.185) x (2)
= $21,419.00

For 1987/88 to date

Fuel Savings (RPM reduction) = (no. of vessels measured) x (average fuel cost) x (savings from demonstrations) x (no. of years to date)
= (23) x ($4,453) x (.185) x (1)
= $18,948.00

Total savings from demonstrations at sea since 1984

$51,900.00
21,419.00
18,948.00
$92,267.00

Propeller Analyses

Number of vessels analyzed:

1984/85 - 66
1985/86 - 43
1986/87 - 58
1987/88 - 30

TOTAL 197

For 1984/85 to date

Fuel Savings (Propeller Change) = (no. of vessels analyzed) x (average fuel cost) x (savings from a more efficient prop.) x (no. of years to date)
= (66) x ($4,453) x (.04) x (4)
= $47,024.00

For 1985/86 to date

Fuel Savings (Propeller Change) = (no. of vessels analyzed) x (average fuel cost) x (savings from a more efficient prop.) x (no. of years to date)
= (43) x ($4,453) x (.04) x (3)
= $22,978.00

For 1986/87 to date

Fuel Savings (Propeller Change) = (no. of vessels analyzed) x (average fuel cost) x (savings from a more efficient prop.) x (no. of years to date)
= (58) x ($4,453) x (.04) x (2)
= $20,662.00

For 1987/88

Fuel Savings (Propeller Change) = (no. of vessels analyzed) x (average fuel cost) x (savings from a more efficient prop.) x (no. of years to date)
= (30) x ($4,453) x (.04) x (1)
= $5,344.00

Total savings from propeller analysis since 1984

$47,024.00
22,978.00
20,662.00
5,344.00
$96,008.00

Total savings from the three previous activities

(RPM reduction) seminars	$1,047,645.00
(RPM reduction) demonstrations	92,267.00
Propeller Analyses	96,008.00
TOTAL	$1,235,920.00

During seminars, vessel owners are presented with information to assist them in making cost reduction changes to their vessels. Savings from propeller cavitation reduction, propeller corrosion elimination, vessel bottom cleaning, stern post fairing, engine tune-up, etc., could not be assessed. However, fishermen have made some of these changes to their vessels as a result of the seminars. In some cases these modifications may have greater benefits to vessel owners than propeller analysis or demonstrations at sea. The impact these changes have had on the fishing industry is very difficult to measure.

Also it is impossible to obtain the number of fishermen that have received information from other fishermen in their communities.

PROJECTED IMPACT OF ENER SEA ON FISHING FLEET

TOTAL PROJECTED SAVINGS FOR FIVE YEARS FROM PREVIOUS ACTIVITIES

The projected impact of Ener Sea for the next five years may be achieved by analyzing savings since 1984.

Cost Reduction/Energy Efficiency Seminars

From previous seminars the following savings may be projected.

Projected Savings = (previous savings) x (projected years/previous years)
= ($1,047,645.00) x (5/4)
= $1,309,556.00

Demonstrations at Sea

From previous demonstrations the following savings may be projected.

Projected Savings = (previous savings) x (projected years/previous years)
= ($92,267.00) x (5/4)
= $115,334.00

Propeller Analyses

From previous propeller analysis the following savings may be projected.

Projected Savings = (previous savings) x (projected years/previous years)
= ($96,008.00) x (5/4)
= $120,010.00

Total Projected Savings from Previous Activities

(RPM reduction) seminars	=	$1,309,556.00
(RPM reduction) demonstrations	=	115,334.00
Propeller Analyses		120,010.00
TOTAL		$1,544,900.00

TOTAL PROJECTED SAVINGS FOR FIVE YEARS FROM FUTURE ACTIVITIES

In the next five years development work on this project will be replaced by information transfer. This will enable more fishermen to be contacted and additional vessels to be analyzed (see Fig. 10 - 12). Assuming that twice as many contacts and analysis will be made in the next five years, the projected future savings will be:

Total Projected Savings from Future Activities

Total Savings = 2 x (projected savings from previous activities)
= 2 x ($1,544,900.00)
= $3,089,800.00

TOTAL PROJECTED SAVINGS FOR THE NEXT FIVE YEARS

Total Savings = (projected savings from previous activities) + (projected savings from future activities)
= ($1,544,900.00) + ($3,089,800.00)
= $4,634,700.00

As seen above, the continuation of this project will increase the savings from $1,235,920.00 to $4,634,700.00 in just five years (see Fig. 13).

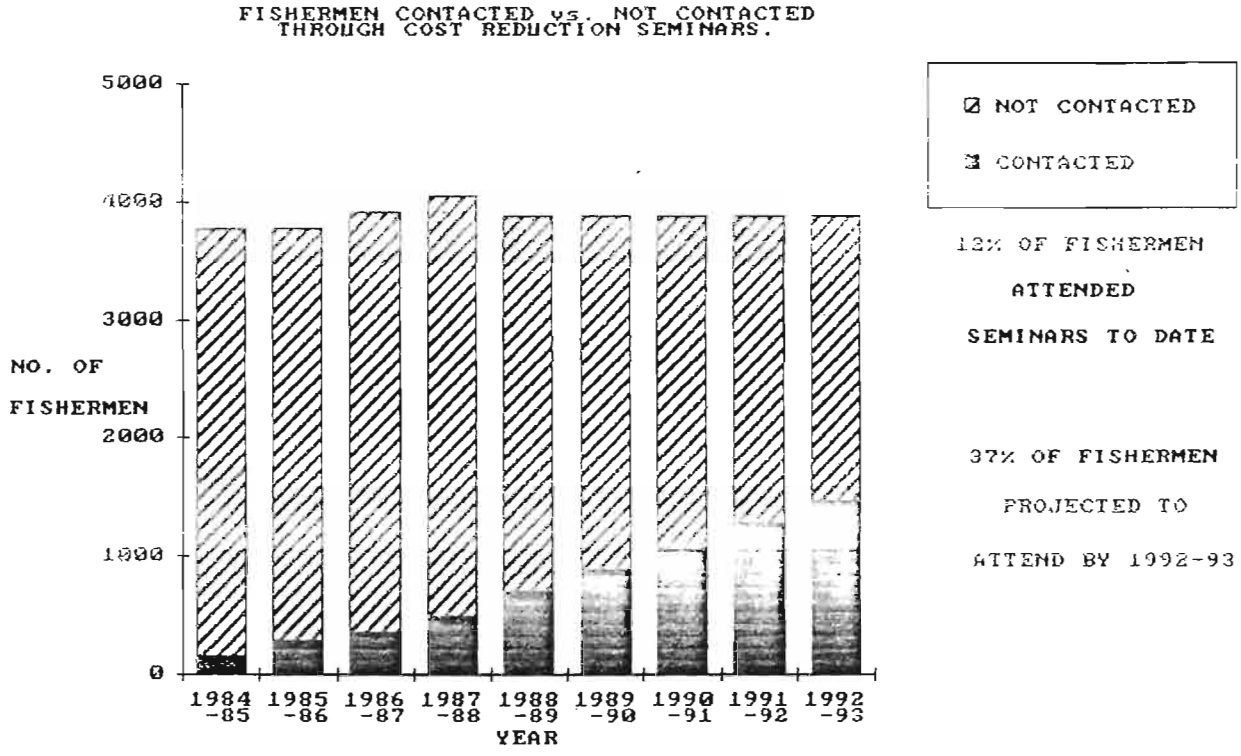
FISHERMEN CONTACTED vs. NOT CONTACTED
THROUGH COST REDUCTION SEMINARS.
5000
4000
3000
2000
1000
0
NO. OF
FISHERMEN
1984 -85
1985 -86
1986 -87
1987 -88
1988 -89
1989 -90
1990 -91
1991 -92
1992 -93
YEAR
NOT CONTACTED
CONTACTED
13% OF FISHERMEN
ATTENDED
SEMINARS TO DATE
37% OF FISHERMEN
PROJECTED TO
ATTEND BY 1992-93

FIG. 10

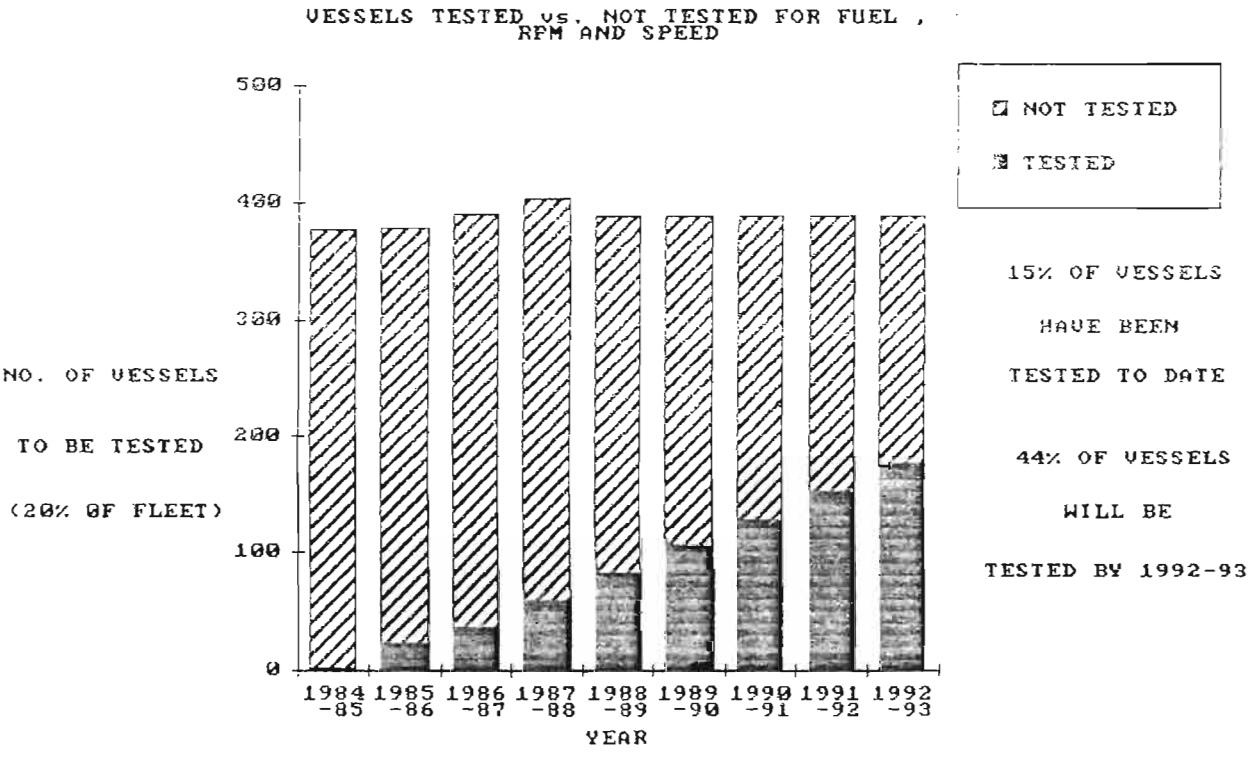
VESSELS TESTED vs. NOT TESTED FOR FUEL ,
RPM AND SPEED
500
400
300
200
100
0
NO. OF VESSELS
TO BE TESTED
(20% OF FLEET)
1984 -85
1985 -86
1986 -87
1987 -88
1988 -89
1989 -90
1990 -91
1991 -92
1992 -93
YEAR
NOT TESTED
TESTED
15% OF VESSELS
HAVE BEEN
TESTED TO DATE
44% OF VESSELS
WILL BE
TESTED BY 1992-93

FIG. 11

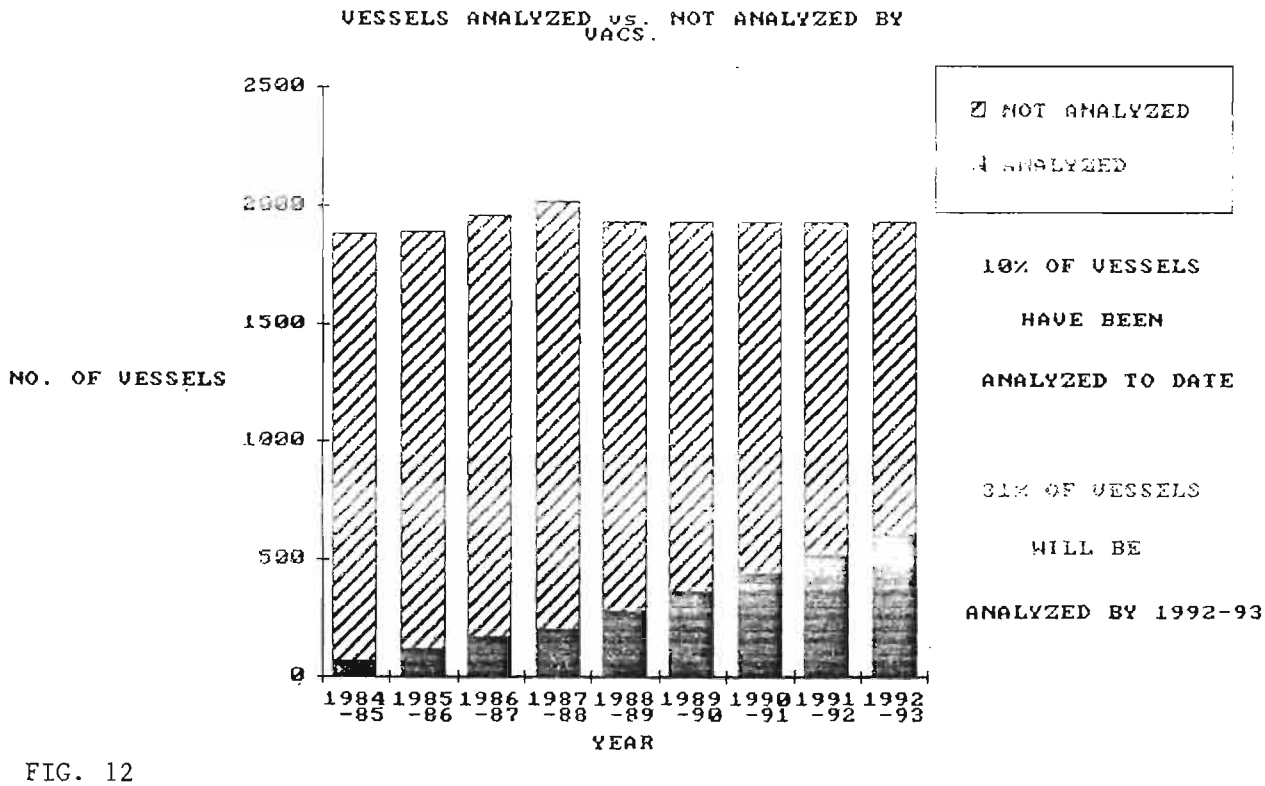
VESSELS ANALYZED VS. NOT ANALYZED BY VACS.
NO. OF VESSELS
2500
2000
1500
1000
500
0
1984-85
1985-86
1986-87
1987-88
1988-89
1989-90
1990-91
1991-92
1992-93
YEAR
NOT ANALYZED
ANALYZED
10% OF VESSELS HAVE BEEN ANALYZED TO DATE
31% OF VESSELS WILL BE ANALYZED BY 1992-93

FIG. 12

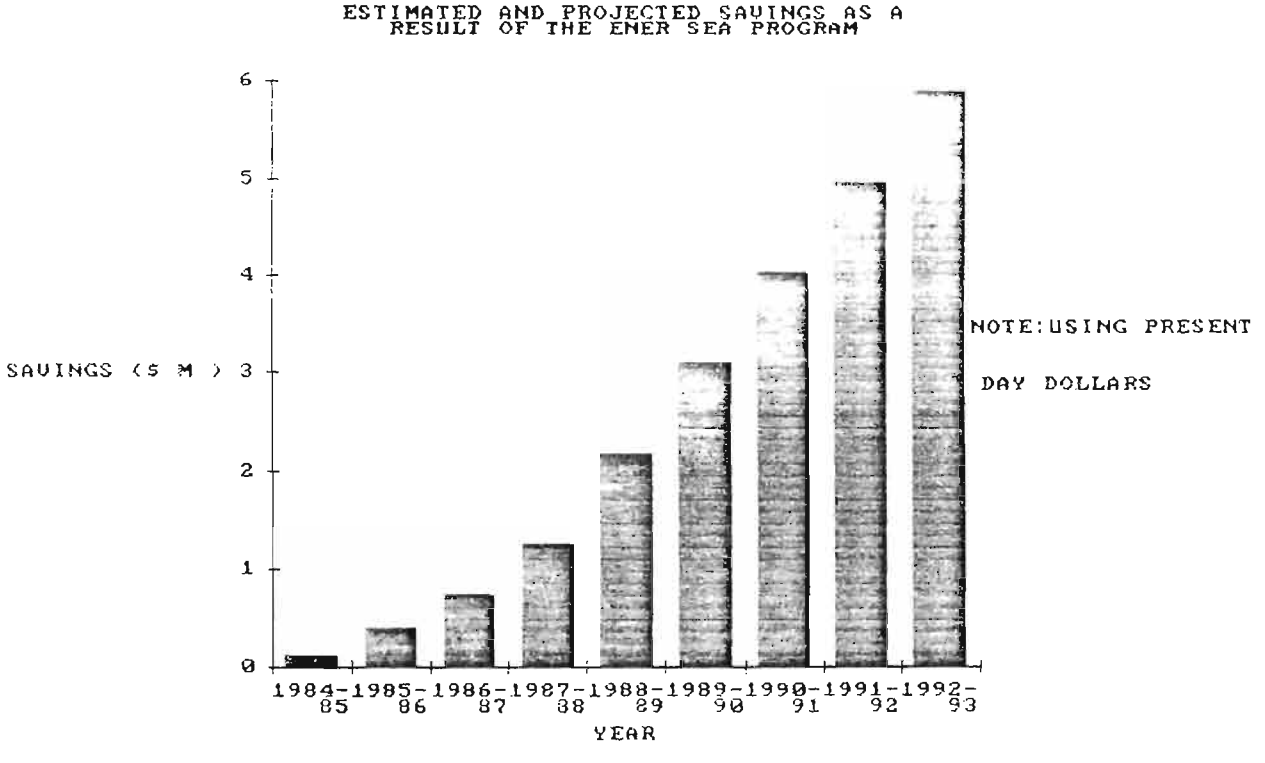
ESTIMATED AND PROJECTED SAVINGS AS A RESULT OF THE ENER SEA PROGRAM
SAVINGS ($ M)
6
5
4
3
2
1
0
1984-85
1985-86
1986-87
1987-88
1988-89
1989-90
1990-91
1991-92
1992-93
YEAR
NOTE: USING PRESENT DAY DOLLARS

FIG. 13

TABLE 5. SUMMARY OF ACTUAL AND PROJECTED SAVINGS FROM ENER SEA

ACTIVITY	ACTUAL SAVINGS	PROJECTED SAVINGS	TOTAL SAVINGS
SEMINARS	$1,047,645.00	$3,928,668.00	$4,976,313.00
DEMONSTRATION AT SEA	92,267.00	346,002.00	438,269.00
PROPELLER ANALYSES	96,008.00	360,030.00	456,038.00
TOTAL	$1,235,920.00	$4,634,700.00	$5,870,620.00

CONCLUSIONS

Since 1984, the Ener Sea program has been successful in reducing operating costs for fishermen in the inshore fishing fleet. By analyzing the previous impact study in this report, it was calculated that an actual savings of $1,235,920.00 had been realized and a total projected savings of $4,634,700.00 would be possible. This could result in total savings of $5,870,620.00 by 1993 if the project would continue on over the next five years.

In addition to the savings stated previously, benefits in reducing cavitation and corrosion were estimated. It was concluded that a fisherman who encountered these problems could save an average of $521.00 per year. This indicated that it would be feasible to educate fishermen about propeller related problems and to assist them in rectifying their problems.

By continuing this program more fishermen who have not been introduced to Ener Sea could take advantage of the useful activities and information available. Since development work will be replaced by information transfer, the number of contacts made through the various activities should increase, thus improving the efficiency of the fleet considerably.

From requests and responses received from fishermen, it is easily realized that Ener Sea has created a positive image in the industry and may be used as a dependable and reliable tool to further enhance the inshore fishing fleet.

RECOMMENDATIONS

Based on the findings in this report it is recommended to:

1. Continue holding cost reduction/energy efficiency seminars. These seminars should be similar to those previously held, except for the incorporation of new material gathered.
2. Continue demonstrating to fishermen the relationship between RPM, speed and fuel consumption. This information will be useful to fishermen in reducing their operating costs and further develop the Ener Sea data base.
3. Continue analyzing propellers on fishing vessels in the Newfoundland fishing fleet. The benefits from this activity will be the same as in the demonstrations at sea.
4. Continue the storing and utilization of data collected from field to further improve the chances of estimating fuel savings on other vessels.
5. Measure fuel consumption, RPM and speed on vessels that have fitted a new propeller and have had a fuel test completed prior to the retrofit. This will accurately verify the VACS software package.
6. Investigate areas which have severe problems in cavitation and corrosion. This will offer a better understanding of the typical causes of these problems within the Newfoundland Region.

APPENDIX

THE IMPACT OF THE ENER SEA PROGRAM ON THE NEWFOUNDLAND FISHING INDUSTRY

Sufficient work was carried out by the Branch during the 1984/85 fiscal year to assess the Ener Sea program's impact on the inshore Newfoundland fishing industry (Carberry, 1986).

IMPACTS DUE TO CONTACT WITH ENER SEA

Information collected at cost reduction/energy efficiency seminars suggest that fishermen in attendance would reduce their operating RPM by 118 on average during the 1985 fishing season. When this average was applied to collected data, potential fleet wide, a 15% fuel savings was possible. With the fuel bills accounting for 65% of operating costs in some instances and fishermen's experiences with low incomes, it was clear these savings would be very significant.

In an attempt to correlate the actual impact Ener Sea has on fishermen (i.e. actual behaviour) rather than the fishermen's prediction at the time of the seminar, a follow-up survey was conducted. As time and resources were restrictive, the statistical validity of the survey was somewhat compromised. (See Tables 8 to 11).

The Tables classify the fishermen into groupings based on the level of contact they had with Ener Sea.

TABLE 8. Summary of Seminar Results

Went to Seminar But Did Not Visit Ener Sea Van				
Respondent	Previous RPM	Current RPM	RPM Reduction	Recommendations/Comments
1	2550	2100	450	Engine tune-up
2	2350	1975	375	Blade Repaired
3	2600	2350	250	
4	2250	2100	150	
5	2000	1850	150	
6	-	-	-	Already Cut Back
7	-	-	-	Already Cut Back
Average	N.A.	N.A.	196	N.A.

TABLE 9. Summary of Seminar Results

Went to Seminar And Visited Ener Sea Van*				
Respondent	Previous RPM	Current RPM	RPM Reduction	Recommendations/Comments
1	3000	2000	1000	
2	2600	2350	250	
3	1750	1550	200	
4	2600	2450	150	
5	2150	2000	150	Will change propeller
6	2000	1850	150	Stern post & propeller
7	—	-	-	Already cut back
8	-	-	-	Already cut back
9	-	-	-	Already cut back
Average	N.A.	N.A.	211	N.A.

*Had their vessel analyzed by VACS.

TABLE 10. Summary of Fuel Consumption Results

Subject to Fuel Consumption Analysis										
Respondent	Previous RPM	Consumption Gal./hr.	Current RPM	Consumption Gal./hr.	RPM* Reduction	% Decrease Consumption	% Fuel** Saved	A	B	C
1	2300	5.50	2000	3.37	300	38.7	34.9	Yes	X	
2	2500	3.10	2000	1.70	500	45.2	31.0	Yes	X	
3	2000	5.80	1875	4.80	125	17.2	15.4	Yes	X	
4	2800	5.78	2600	4.78	200	17.3	13.5	Yes	X	
5	1850	6.95	1750	6.01	100	13.5	10.5	Yes	X	
6	-	-	-	-	0	0.0	0.0	Yes	-	-
7	-	-	-	-	0	0.0	0.0	Yes	-	-
8	2000	6.55	1800	4.56	200	30.4	26.9	Yes		X
9	2100	5.80	1850	4.00	250	31.0	26.5	Yes		X
10	2050	5.98	1950	4.90	100	18.1	17.1	Yes		X
11 ***	2200	5.71	2000	4.40	200	24.3	20.1	Yes	X	
12	2250	5.91	2200	5.55	50	6.9	5.0	No	-	X
13	-	-	-	-	0	0.0	0.0	No	-	-
Average	N.A.	4.39	N.A.	3.39	156	18.7	15.4			

A - Attended a Seminar (Yes/No)

B - Reduced RPM as a result of seminar

C - Reduced RPM as a result of Fuel Consumption Analysis

* Note: Each respondent with 0 RPM Reduction stated "Already cut back"

** Note: This column is adjusted for the extra time the vessel spends steaming at lower speed.

*** Note: Tachometer was not working - Average of other boats which have reduced R.P.M. has been applied (rounded)

TABLE 11. Savings per Contact Grouping

Group	Number	Average RPM Reduction	Fuel Saved (Adjusted)
General Contact	N.A.	N.A.	N.A.
Attended Seminar (Not Van)	73	196	19.3% (Est.)
Attended Seminar (And Van)	60	211	20.8% (Est.)
Fuel Consumption Analysis	18	156	15.4% (Actual)
	TOTAL 151	AVG. 198	AVG. 19.5%

The estimated direct impact of the Ener Sea Program as of September, 1986, with 151 vessels cutting back an average of 198 RPM (weighted) is an average fuel consumption reduction of 19.5% (straight line estimate).

FLEET SAVINGS

RPM Reduction

Maximum potential savings from RPM reduction can be calculated as: 41% savings* multiplied by the total amount of fuel burned by the Newfoundland Nearshore Vessel Fleet. Although, on examination, this estimate appeared reasonable, several refinements are necessary because: a) not all vessels registered were actively fishing, b) the average operator did not run at maximum RPM and, c) many operators believed they'd cut back to a point where additional cuts had a marginal effect on speed (28% of those surveyed above).

*Note: 41% savings estimate came from the speed/fuel consumption testing ie. a one knot reduction from maximum speed.

The number of active vessels (defined by the Economics Branch, Newfoundland Region, as those vessels with landings valued above $43,000, and licensed as a full-time fisherman) were estimated to be 861. (Anon.1985c).

This figure is adjusted for 63 vessels in Labrador (Anon.1985b), not included in this economic survey but included in the Newfoundland Region. Estimating that 11% of the Labrador vessels are inactive (Anon.1985c), the total number of 'active' vessels based in Newfoundland is 917.

When the survey results are applied to the fleet, 917 vessels would cut-back by an average of 198 RPM, (Carberry, 1985), with an average fuel savings of 19.5%. By using fuel cost data from 1984, it was concluded the average fisherman burned $4,260 of fuel in 1984 (Anon.1985a). This meant the fleet savings could be $761,751.90 or 1.93 million litres (approx.) at 39.45¢ per litre.

Propeller Change

Fishermen could avail themselves of several benefits through the Ener Sea program's propeller selection program. The proper selection process led to: a) greater fuel efficiency and; b) lower propeller repair and replacement costs due to cavitation.

Unfortunately, vessel design often dictates the propeller used, not allowing for the optimal prop/vessel match. This led to a third benefit from Ener Sea; the improvement in vessel design as a result of increased awareness by fishermen.

Of the 21 vessels tested for fuel consumption, RPM and speed, there were no underwater measurements available for six of these vessels. Eight vessels had clearances too small to allow installation of larger, more efficient blades. Propeller changes were able to be made on the remaining seven vessels.

The results of the testing on all 21 vessels (Table 7) plus the analysis for fuel savings related to propeller change on seven of the vessels (Table 12) were used to estimate the total fleet savings from both RPM reduction and propeller change.

TABLE 12. Summary of Saving Due to a Propeller Change

Vessel Number	RPM	Gal./ hr.	Old Propeller	New Propeller	% Fuel Saved
1	2,550	2.37	B3, D22, P19	B4, D23, P17	6.97
2	2,178	4.15	B4, D28, P24	B4, D30, P22	5.22
3	1,800	4.56	B3, D24, P16	B3, D25, P15	2.94
4	2,350	2.90	B3, D18, P13	B4, D19, P12	3.41
5	2,250	2.75	B3, D20, P18	B3, D21, P17	4.85
6	1,700	15.60	B3, D54, P30		0
7	1,850	7.00	B3, D36, P25		0
				TOTAL	3.34

The number of vessels in the fleet available for propeller change is 7/15, the six for which no clearance measurements were available being subtracted from the 21 or 47% of the total fleet of 917; thus 917 x .47 = 431.

The fleet savings from a propeller change then becomes = 431 x $4,260 (avg. cost of fuel burned per vessel) x 0.334 (avg. fuel saving per vessel) = $61,324.40 per year.

The total fleet savings over a 10 year period from propeller change and RPM reduction is then =[($761,751.90 (total annual savings from RPM reduction))+($61,324.40 (savings from propeller change))]x10 = $8,231,000 (non adjusted).

TELEPHONE SURVEY

Another survey was undertaken by telephoning a target group of 83 fishermen. Each one was asked 16 questions related to cost reduction. After answering these questions they were asked if the efforts and methods mentioned in the previous questions resulted in lower operating costs. The results were as follows:

Over 75 percent of the respondants said "yes" (Whiteway, 1986) by employing such cost saving methods they were actually able to reduce their operating costs. They were especially positive about the fuel savings gained by "throttling back".

Twelve fishermen said they saved "a great deal"; while nine replied "a little"; two said $200 - "400 a year. Three fishermen reported a fuel cost reduction of 1/2, one a reduction of 1/3 and three a reduction of 1/4. One individual said he never noticed a difference and another said it was "hard to tell".

CONCLUSIONS

The Ener Sea Program has developed substantially since its 1982 inception. This significant achievement results from extensive data collecton enabling the Vessel Analysis Computing System (VACS) to be improved and the

Ener Sea Data Management System (EDAMS) created. These improvements and additions have made the Ener Sea Program more accurate, reliable and organized for the future.

It may also be concluded that the Ener Sea Program has begun to make fishermen more aware of the need to save fuel in order to make their enterprise more viable. This realization has been heightened through seminars, individual vessel analysis, vessel testing and other activities offered through the program.