GEAR DAMAGE IN THE NOVA SCOTIA INSHORE FISHERY

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May 1984

Canadian Industry Report of Fisheries and Aquatic Sciences No. 156

Gouvernement du Canada
Pêches et Océans

Government of Canada
Fisheries and Oceans

Canadian Industry Report of Fisheries and Aquatic Sciences

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Cat. No. F597-14/0156E ISSN 0704-3694

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FOREWORD

This study was conducted by the Eastern Fishermen's Federation during 1984 to estimate in current dollars the annual damage to fishing gear along Nova Scotia's Atlantic shore that could be attributed to the presence of grey seals and harbour seals along that shore. The study adds information and presents a methodology to the question of the incidence of gear damage.

Opinions, interpretations and conclusions contained in the report are attributable to the authors and do not necessarily reflect those of the Department of Fisheries and Oceans.

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May 1985

ABSTRACT

Farmer, Paula, and Allan Billard. 1985. Gear damage in the Nova Scotia Inshore fishery. Can. Ind. Rep. Fish. Aquat. Sci. 156:43p.

This study has evaluated seal damage for the Nova Scotia inshore fishery. $94,589 in damage and loss of gear was attributed to grey and harbour seals by a survey of slightly less than ten percent of the fisherman population (8.8%). Aggregating total damage values for the population results in a 1983 seal damage estimate of $1,076,430.

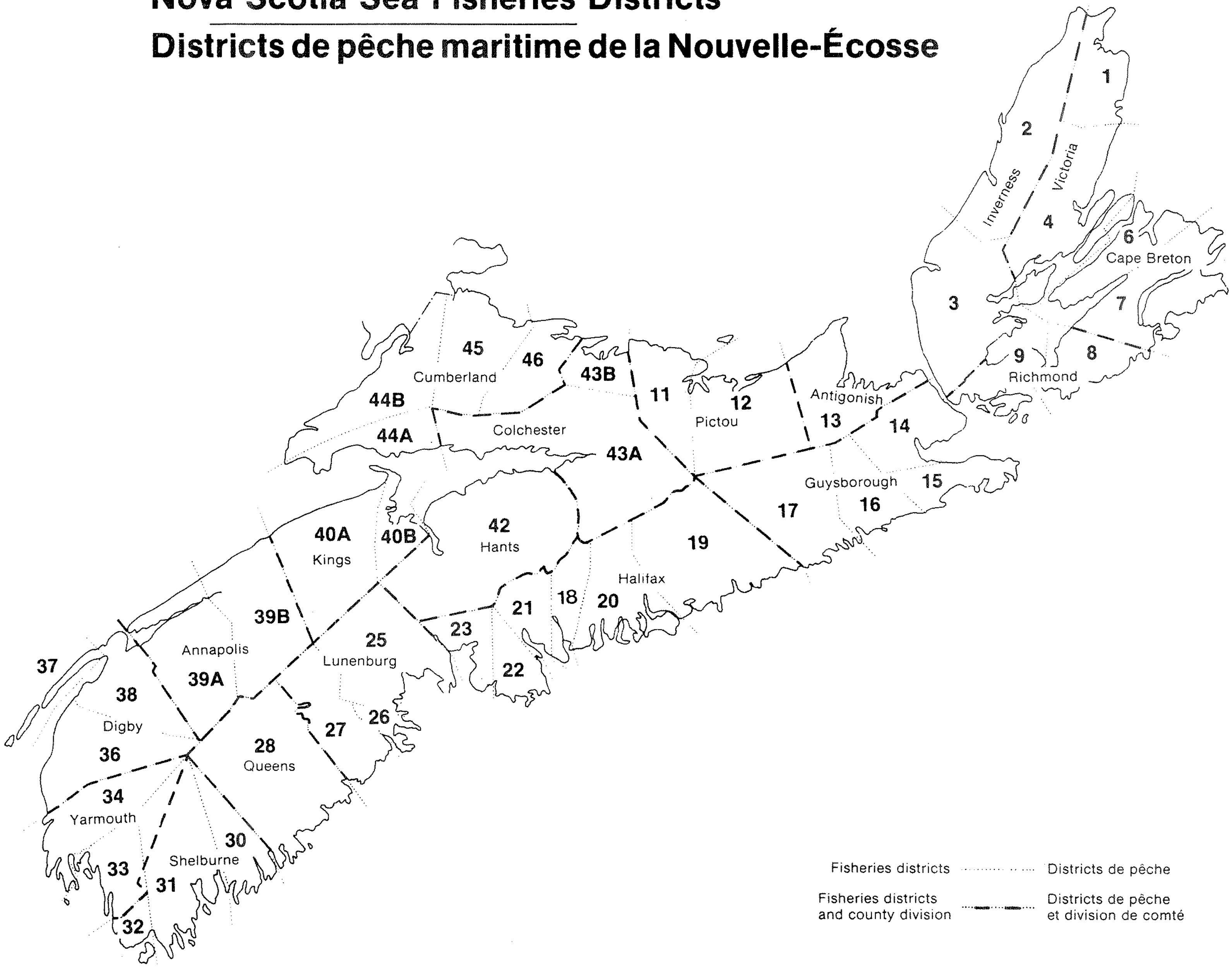
RESUME

Farmer, Paula and Allan Billard. 1985. Gear damage in the Nova Scotia Inshore fishery. Can. Ind. Rep. Fish. Aquat. Sci. 156:43p

Cette étude présente une évaluation des domages subit par la pêche cotière en Nouvelle Ecosse à cause des phoques. Un relevé de juste au dessous de dix pour cent (8.8%) de la population de pêcheur estime à $94,589 les domages et pertes en agrès attribuables aux phoques gris et aux loups marins. Si on rapporte ces estimés de domages à la population, on arrive à un estimé de $1,076,430 pour les domages causés par les phoques en 1983.

Nova Scotia Sea Fisheries Districts

Districts de pêche maritime de la Nouvelle-Écosse



1. INTRODUCTION

For the past several years a controversy has been raging in several areas of the North Atlantic over sealing. Wildlife protectionists feel that the seal hunt is unnecessarily brutal and should be stopped. Other groups argue that the seal hunt and related processing industries have a vested interest in the continuation of an activity which brings employment and revenue to chronically depressed areas.

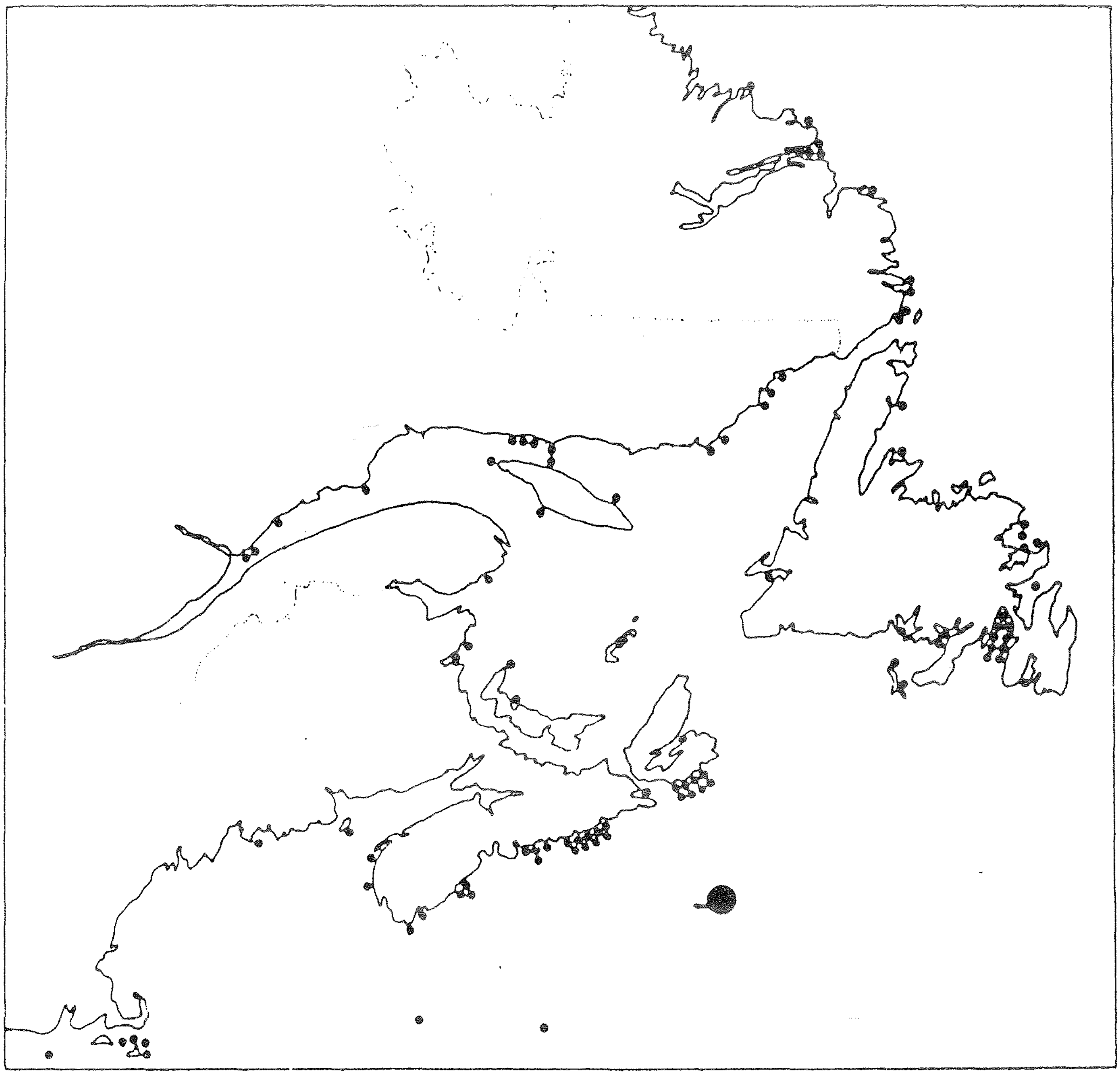
There does exist a common ground toward which the interests of various groups converge. A valid analysis of the manner in which seals of different types interact with their respective environments can do much to clear up the existing misconceptions. Analysis may also provide more realistic and less emotional solutions to seal management. This project attempts to investigate the relationship between seals and gear damage.

Interaction is complex as several types of seals live along the coast of Atlantic Canada. Each species has specific breeding grounds, preys upon certain fish, and migrates within specific coastal waters each year. This study does not deal with damage caused by harp seals (a species which is commonly found off the coast of Newfoundland and is hunted during the sealing season). Instead, this project examines only damage by grey seals (Halichoerus grypus) and harbour seals (Phoca vitulina).

The issue is examined within the context of a predator-prey relationship. Fish stocks are managed by biological assessment which results in a system of continuously fine-tuned regulations and restrictions enforced throughout the various fishing districts. However, managing prey while allowing predators to go uncontrolled is not seen to be effective: predators deplete fish stocks and thereby offer increasing competition to the one controlled predator -- the fisherman.

Sable Island is the single most popular breeding area for grey seals in Nova Scotia. It provides long stretches of sand on a relatively uninhabited bar away from the congested provincial coastline. As a result, the seal population returns to Sable Island each year to whelp. A general rise in this population has been observed both statistically[1], and casually by the fishermen along the Atlantic coast of the province. This increase is troublesome due to the fact that the breeding population disperses in a post-whelp fan from Sable Island toward fishing areas along the coast where inshore gear is encountered. (See Figure 1)

Figure 1
Dispersal of pups from Sable Island[2]
(Each dot represents one seal recaptured or resighted)



2. METHODOLOGY

The species under study have already been defined. This analysis will refer to 'seal' as meaning grey and/or harbour seal interchangeably. It was impossible to ask fishermen to differentiate explicityly between grey seals and harbour seals when citing damage factors because it threatened to reveal the bias during questioning. Also fishermen are not always able to tell whether or not a certain type of seal is responsible.

Respecting gear, this study was confined to the evaluation of damage to fixed inshore gear in physical units. It is hoped that physical-unit analysis will provide more accurate answers from respondents than would a direct request for dollar-value assessments. Physical counts are converted to dollar values in Appendix 3 to facilitate monetary damage conclusions found in the Abstract.

The hypothesis as formulated below suggests that no positive relationship exists between the number of units of gear damage attributed to seals and the dollar value of gear damage:

Let X = independent variable (units damaged by seals)
Let Y = dependent variable (value of total gear damage by all factors)

$$H_o: \frac{dY}{dX} = 0 \qquad H_a: \frac{dY}{dX} \neq 0$$

This form of the null hypothesis is statistically appealing because it seeks to disprove the hypothesis, thereby allowing less likelihood of forming incorrect conclusions. It is hoped that this study will be able to convincingly argue that the null hypothesis should be rejected, and that the relationship between the two variables will be non-negative as well as non-zero.

The survey sample was determined by calculations performed on a Department of Fisheries and Oceans data set comprising well over 4000 candidates in fisheries statistical districts 1-39. The data set listed licenced fishermen alphabetically in each district, and included information on homeport, full-time or part-time status, and an exact breakdown of fishing licences held.

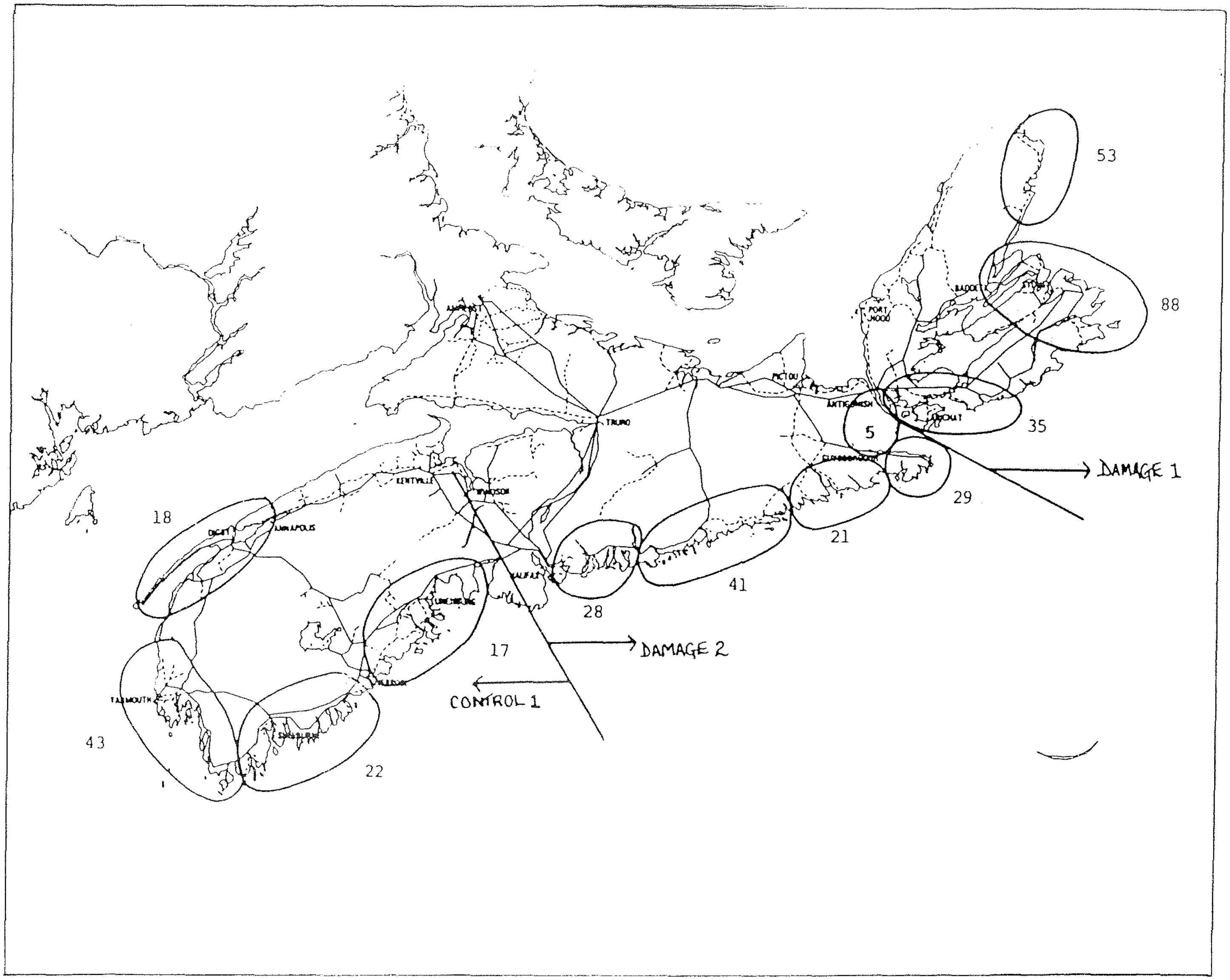
To prepare the data for random selections, districts 2, 3, 10-13, 21-24, and 29 were excluded. Two reasons exist for this Firstly the districts were not geographically located within the boundaries of the investigation area (e.g., district 24 is found on Chignecto Bay and Districts 2, 3, and 10-13 are in the Gulf of St. Lawrence). Other districts were far too urban and it was felt that random sampling would fail to select legitimate candidates (as with districts 21-23 in the Metropolitan Halifax area). This reduced the population to 3736.

Secondly 294 fishermen were rejected from the active population because they fished their licences on an incorporated basis. It was felt that these larger enterprises would grossly exaggerate the incidence of gear damage. The ensuing rejection reduced the effective population size to 3444 candidates.

At this point each fisherman was given a four-digit identification code. The first entry of statistical District 01 became known as 0001 and numbering proceeded to the last alphabetical entry in District 39 who became 3444. The population was then split into two sections. Districts 01-20 (comprising candidates 0001 to 1363) became the damage area because geographical location caused them to receive a large share of the fan of seals dispersing from Sable Island after whelping. Districts 25-39 (comprising candidates 1364 to 3444) became the control area because geographically their areas received significantly less of the post-whelp dispersion.

A control area was employed in order to more accurately gauge the extent of damage along the entire Nova Scotian coast. It was felt that analysis of worst-case regions alone would skew results and render conclusions less dependable. As a result the random draw of candidates was weighted 3:1 (an arbitrary selection of the research team). As a result the damage area possessed a larger number of candidates and was therefore divided into two sub-regions: Damage 1 and Damage 2. The locations of the 300 damage and 100 control respondents selected via the use of random number tables established twelve rough survey clusters: 3 occurring in Damage 1; 5 occurring in Damage 2; 4 occurring in Control 1 (see Figure 2).

<u>Figure 2</u>
<u>Geographical Clusters</u>
(400-draw random sample)



A series of additional random numbers which had been generated during the same draw were retained as alternates because the research team planned to sample with complete replacement in an effort to secure a 100% response rate.

The next stage in preparing the random sample was to determine the population chracteristics and compare these with the damage and control sample trends. For example, if a parent population consists of 35% lobster licence holders but the random sample consists of 70% lobster licence holders then the sample grossly oversamples the lobster trap component of inshore fishing gear under study. This comparative method evaluated the 'goodness' of the random sample by confirming or contradicting the ability of the 10% drawn to approximate general traits of the parent population (see Appendix 1).

The parent population showed that 29.9% of licences held were lobster. Breaking the population into parent-damage and parent-control, 26.3% and 32.6% respectively compare favourably with sample-damage and sample-control figures of 25.5% and 36.1%. The aggregate parent figure for groundfish was 26.8%. Broken down, again comparisons were favourable: parent-damage of 25.1% to sample-damage of 23.6%; parent-control of 28.0% to sample-control of 28.4%. Similar patterns emerged for mackerel-herring licences: aggregate parent figures were 16.1% and 21.5% respectively; parent-damage figures of 18.6% and 18.8% are comparable to sample- damage figures of 19.2% and 18.3%; parent-control figures for mackerel-herring licences of 14.1% and 23.5% respectively also differed from sample-control figures of 13.5% and 19.7% but were nonetheless within a useful range.

The final gear type, crab traps, was found to have a parent representation of 1.5% which divided itself into 3.3% parent-damage and 0% parent-control. Hence it was not surprising that the sample-damage crab figure correlated at 4.4% while the sample- control matched exactly to parent at 0%.

Once satisfied with the validity of the random sample drawn, the research team devised a survey timetable and sent letters on a staggered basis to different areas of the province. Members of the research team then began first-hand data collection in order to conduct the survey in as unbiased a manner as possible.

During the two month survey period one difficulty surfaced repeatedly: fishermen listed as licence-holders for gear types under study were found to have moved, retired, changed occupation, been inaccessible (hospitalized, on duty at remote lighthouses), or ceased fishing with the stated gear types. Two respondents were deceased. Some respondents also refused to participate in the survey because they regarded themselves as part-timers who had little or no information to contribute to the study.

As a result, many of the random numbers generated as alternates were used. This reduced the effective population by an additional 64 respondents, thereby reducing the true parent population to 3380. Even with significant replacement the survey team was only able to achieve a 75% response rate. Nevertheless, contacting nearly 300 fishermen (297) still represents a significant cross-section of the parent group -- almost 10% of the population was surveyed. This falls somewhat short of the 12% to 15% envisaged at the beginning of the study, but it is an acceptable figure nonetheless since the degress of freedom achieved in most of the gear analysis was sufficient.

3. PRELIMINARY GEAR DAMAGE ANALYSIS

The costs of seal damage have been calculated for both repair and replacement from dollar-value listings of the components of the different gear types. Prices for various components of fishing gear were compiled for a separate study made by the Eastern Fishermen's Federation. A brief summary of these values can be found in Appendix 3.

Geographically, lobster traps have some cost variations but none which are significant -- they are mostly adaptations to suit particular lobster grounds. A problem which concerned the research team was differences in trap designs induced by seal damage. For example, some areas use boxes over the bait to keep the seals away while others use bait bags to prevent seals from stealing the bait. Some fishermen use different sized rings: the smaller the ring the less is the likelihood that a seal can get its head into a traps; however, the use of smaller rings may preclude catching 'jumbo' lobsters.

Other modifications that have been made to traps to discourage seals deal mostly with variations to the trap doors. These alterations are significant in terms of the extra time needed to tend 250 such traps every time they are hauled. Unfortunately such time constraints are not verifiable, hence not quantifiable. The variety of structural adaptations were not able to be captured by the research team. As a result, rather than introduce inconsis- tencies into the analysis standard figures were used for all gear types.

Fish traps are very expensive and are used only for large scale fishing, hence loss tends to be large scale as well. Given the relative indivisibility of this gear, damage to part of the trap means that the entire trap must be kept from the water until repairs have been made. Fish traps also hold some attraction for seals because they contain many fish when full -- they may perhaps be more susceptible in theory to seal damage (or at least to seals chasing fish over the head rope of the door). Fishermen have had to sit watch over traps to guard against seals, or make extra trips to their fish traps. This requires extra man hours and additional expenditures on fuel but does not necessarily manifest itself in physical damage picked up during questioning. The alteration of fishing techniques to avoid damage is another problem which is difficult to evaluate for analysis.

Long line gear is set quite a distance offshore in deep water where there are relatively few seals. In these deeper waters seals may not dive to the bottom where they can be a problem to long lines (as evidenced in both preliminary and econometric results since crosstabulations for trawl damage showed seals were not a contributing factor). Seals have been caught in trawl gear, but generally this gear is far more susceptible to damage by draggers and sharks.

The research team also was unable to analytically evaluate the fact that the average fisherman is required to tie up capital in large amounts of inventory. This capital stock is often stored in a garage or shed and is rarely considered when a respondent is asked whether or not he takes specific precautions to guard against gear damage. As a result the value of estimates does not consider the opportunity cost of the foregone use of capital tied up in this inventory -- the sole purpose of which is to enable the fisherman to just maintain the units of gear he chooses to use in that period.

Finally, some fishermen do not value their own labor when they are required to repair gear. They feel that gear maintenance is one of the requisites of the job and that hours spent going over their gear are not a damage cost so much as a continuous maintenance necessity.

Due to the variability of gear use, and regional modifications to various gear types this preliminary analysis forms an ad hoc sensitivity analysis to derive damage estimates. Seal damage is divided into:

1) slight (1-29% of damage/loss attributed to seals)
2) medium (30-89% of damage/loss attributed to seals)
3) heavy (90-100% of damage/loss attributed to seals)

Algebraically weighted calculations were then performed to derive damage value estimates. More rigorous treatment of damage calculations may be found in the econometric analysis (see Section 4).

Table 3-1
Fish Trap Damage Calculations

5 Fishermen set fish traps in 1983
3 cited damage to their traps
0 cited loss of traps

8 fish traps were set in 1983
4 fish traps were damaged
0 fish traps were lost

$12,000.00 represents the cost of replacing a fish trap

225 hours were spent on repair of two seal-damaged fish traps (both in district 15 -- Damage 2)

Assume: 1) Damage to one fish trap was 1/8 damage to the other because one required 200 hours of repair time while the other required 25 hours of repair time.

Assume: 2) Fish traps are large scale investments generally only made by the best full-time fishermen so the wage value used is the high full-time hourly wage in Damage 2 (see Table 2A-8 of Appendix 2, and page 42).

Assume: 3) Buoys, floats, and anchors are damaged more by weather, therefore seal damage involves the following materials for repair:

100 lbs.	bottom net per trap =	$450.00
150 lbs.	lead line per trap =	277.50
150 lbs.	head line per trap =	202.50
1 sheet	of leader per trap =	200.00

Compute: 1) Labor costs:
$7.31 per hour x 225 hours = $1,644.75

Compute: 2) Material costs (weighted):
(450.0 x 1) + (450.0 x .125) = 506.25
(277.5 x 1) + (277.5 x .125) = 312.19
(202.5 x 1) + (202.5 x .125) = 227.81
(200.0 x 1) + (200.0 x .125) = 225.00

TOTAL REPAIR COSTS = $2916.00 = SEAL DAMAGE VALUE

Table 3-2
Mackerel-Herring Gill Net Damage Calculations

90-100% damage attributed to seals
by 68.8% of respondents
respecting 312 damaged nets, 26 lost nets

30-89% damage attributed to seals
by 23.6% of respondents
respecting 68 damaged nets, 14 lost nets

0-29% damage attributed to seals
by 7.7% of respondents
respecting 18 damaged nets, 5 lost nets

Damage Ranges:	68.8/100 = x/321 ==	220.0 nets
	23.6/100 = x/ 68 ==	16.0 nets
	7.7/100 = x/ 18 ==	1.4 nets

Total (weighted) number of nets damaged by seals = 237.4 nets

Loss Ranges:	68.8/100 = x/ 26 ==	18.0 nets
	23.6/100 = x/ 14 ==	3.0 nets
	7.7/100 = x/ 5 ==	0.4 nets

Total (weighted) number of nets lost due to seals = 21 nets

<u>Compute</u>: 1) Repair costs:
$7.81 per hour x 6 hours = $47.22
One sheet of web = $65.00
($47.22 + $65.00) x 237.4 = $26,641.03

<u>Compute</u>: 2) Replacement costs:
$411.00 per net x 21 nets = $8,631.00

REPAIR COST:	$26,641.03
REPLACEMENT COST:	$8,631.00
<u>SEAL DAMAGE VALUE</u>:	$35,272.03

Table 3-3
Groundfish Gill Nets

16 fishermen cited damage to their nets in 1983
9 fishermen cited loss of nets in 1983

597 groundfish gill nets were set in 1983
369 nets were damaged
376 nets were lost

100% damage attributed to seals
by 50% of respondents
respecting 15 damaged nets

50% damage attributed to seals
by 50% of respondents
respecting 5 damaged nets

75% loss attributed to seals
by 100% respondents
respecting 15 lost nets

Assume: 1) 9 men/328 total repair hours = 36.44 avg hours
16 men/369 total nets damaged = 23.06 avg nets
36.44/23.06 = x/1 == 1.58 hours per man per net

Damage Ranges: 75/100 = x/15 == 11.25 nets
100/100 = x/ 5 == 5.00 nets

Total (unweighted) number of nets damaged by seals = 16.25

Compute: 1) Repair Costs:
16.25 nets x 1.58 hours x $7.87 per hour = $202.06
1/3 sheet of web = $19.00
2/9 coil headline = $12.66
12 lbs. leadline = $29.17
Total: ($60.83 x 16.25) + $202.06 = 1190.54

Compute: 2) Replacement Costs (weighted for seals as 75% cause)
($611.75 x .75) x 15 = $6882.19

REPAIR COST:	$1190.54
REPLACEMENT COST:	$6882.19
SEAL DAMAGE VALUE:	$7870.67

Table 3-4
Wooden Lobster Trap Damage Calculations

36,449 traps were set in 1983
 11,064 traps were damaged
 11,192 traps were lost

90-100% damage attributed to seals
 by 4.5% of respondents
 respecting 80 damaged, 12 lost traps

30-89% damage attributed to seals
 by 40.8% of respondents
 respecting 408 damaged, 192 lost traps

0-29% damage attributed to seals
 by 54.7% of respondents
 respecting 485 damaged, 398 lost traps

Damage Ranges: 4.5/100 = x/ 80 == 3.5 traps
 40.8/100 = x/408 == 199 traps
 54.7/100 = x/485 == 265 traps

Total (weighted) number of traps damaged by seals = 467.5 traps

Loss Ranges: 4.5/100 = x/12 == 0.5 traps
 40.8/100 = x/192 == 78.0 traps
 54.7/100 = x/398 == 218.0 traps

Total (weighted) number of traps lost to seal damage = 297 traps

Compute: 1) Repair Costs:

467.5 traps x 1.5 hrs x $7.87 per hr =	$5518.84
3 rings =	1.05
3 sills =	.75
2 latches =	.20
1/16 ball of twine =	.50
1/20 coil of rope =	1.75
Total: ($4.25 x 467.5) + $5518.84 =	$7505.72

Compute: 2) Replacement Costs:
 297 traps x $55.35 = $16,438.95

REPAIR COST:	$ 7,505.72
REPLACEMENT COST:	$16,438.95
SEAL DAMAGE TOTAL:	$23,944.67

Table 3-5
Gear Used by Type
(Units Lost, Units Damaged)

Gear Type	No. Set '83	No. Damaged	No. Lost
Fish Traps	8	3	0
Mackerel-Herring Gill Nets	1322	657	753
Groundfish Gill Nets	597	369	376
Light Longline	1318	107	234
Heavy Longline	453	22	135
Wooden Lobster Traps	36,449	11,064	11,192
Wire Lobster Traps	536	0	0
Wire Crab Traps	993	28	94

Table 3-6
Total Dollar Value of Seal Damage in 1983

Gear Type	Damage
Fish Traps	$2,916.00
Mackerel-Herring Gill Nets	35,272.03
Groundfish Gill Nets	7,870.67
Light longline	N/A
Heavy Longline	N/A
Wooden Lobster Traps	23,944.67
Wire Lobster Traps	N/A
Wooden Crab Traps	N/A
Wire Crab Traps	N/A
Total	$70,003.37

The damages incurred by a sample of 297 respondents totalled $70,003.37. The total (corrected) parent population for this survey is 3380 fishermen. Aggregated upwards for the entire population required multiplication of this damage figure by a factor of approximately 11.38 (3380/297 = 11.38). Thus total seal damage incurred along the Atlantic seaboard is evaluated at $796,638.35. Calculating downwards, the average damage value suffered per fisherman (unweighted for higher damage in certain regions) is $235.69.

4. ECONOMETRIC GEAR DAMAGE ANALYSIS

The next stage in the investigation evaluates the relationship between various contributory damage factors (the explanatory independent variables), other independent variables and the dependent variable of the model known as the dollar value of damage in 1983. This approach attempts to formulate an econometric model and evaluate the regression results.

Since the form the econometric model takes was not theoretically predetermined, and since six gear types emerged during the survey as being frequently used by the sample population, data analysis had to be restricted to one gear type to derive a prototype model and enable statistical fine-tuning.

While investigating whether or not seals are related to gear damage it is also necessary to specify other contributory variables for two reasons: to better define the gear damage function for regression analysis; to make efficient use of the wealth of information gathered during the survey.

An initial test equation was specified as follows:

Y = f(U, F, H, SO, WR, TN); where:

- Y = 1983 dollar value of damage and loss per respondent
- U = number of units used by each respondent in 1983 season
- F = total number of fishermen in the district
- H = total number of hours spent repairing season's damage
- S0 = total units damaged and lost due to seals and other predators
- WR = total units damaged and lost due to weather and wear and tear
- TN = total units damaged and lost due to traffic and theft

However, the number of nets used by each respondent during the 1983 season and the total number of fishermen per region were significant at neither the 98% nor the 95% confidence levels via a two-tailed t-test, and were dropped from the model. The modified model appears below:

Y = f(H, SO, WT, TN)

This model was then run on all six gear types and reported a positive relationship between seal/other predators and the value of gear damage which is significant at the 98% confidence interval for all gear types but wooden lobster traps (see Table 4-1).

It was noted that the standard error rose on Groundfish Gill Nets and Heavy longline gear types, but this is because out of 297 respondents 16 reported damage to the former and 17 reported damage to the latter, thereby limiting the degrees of freedom with which to run regressions.

Table 4-1
Regression Results

$$\hat{Y}_{1i} = \hat{\alpha} + \hat{\beta}_1 X_{1i} + \hat{\beta}_2 X_{2i} + \hat{\beta}_3 X_{3i} + \hat{\beta}_4 X_{4i}$$

where: X_{1i} = hours fix
X_{2i} = seals, oth
X_{3i} = weather, wear & tear
X_{4i} = traffic, theft

Gear Type	Coefficient estimate (Standard Error)					$\bar{R}^2$	α^2	N
	$\hat{\alpha}$	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_3$	$\hat{\beta}_4$			
Mackerel_herring gill nets	12.493	-.81062*	156.73*	267.73*	224.23*	.7637	522.40	140
	(63.329)	(.36441)	(11.451)	(21.077)	(19.745)			
Groundfish gill nets	-918.80	-12.081*	636.30*	118.08***	274.58***	.8321	2150.90	16
	(919.23)	(2.5444)	(84.373)	(61.961)	(152.00			
Light Longline	-637.09	-11.665***	1685.8*	2187.68*	2103.6*	.9464	3078.80	54
	(606.19)	(6.1465)	(81.109)	(145.37)	(145.70)			
Heavy Longline	2959.4	-24.059	1856.6*	2139.5*	2470.7*	.9261	7261.00	17
	(2915.0)	(43.320)	(332.41)	(509.53)	(590.66)			
Wooden Lobster traps	141.77	7.9976*	4.4044	15.984*	22.314*	.8971	638.12	228
	(71.343)	(.32039)	(4.2573)	(.71594)	(2.9481)			
Wire Crab traps	-43.786	-83.327*	1938.7*	289.73*	274.35*	.9989	39.26	15
	(19.050)	(1.6159)	(60.887)	(4.4393)	(3.4153)			

* Significant at the 98.7% confidence level
** Significant at the 95% confidence level
*** Significant at the 90% confidence level

Table 4-2
Mackerel-Herring Gill Net Damage Results

Number reporting damage = 140

GENERAL STATISTICS

	TOTAL	AVERAGE
USED	1107 nets	7.91 nets
DAMAGED	648 nets	4.63 nets
LOST	153 nets	1.09 nets
VALUE	$135,990.40	$971.36
REPAIRS	13,060 hours	93.26 hours

DAMAGE BY FACTOR

	TOTAL	PERCENT	AVERAGE
SEALS	417.4 nets	52.62%	2.98 nets
OTHER PREDATORS	141.9	17.89	1.01
WEATHER	45.9	5.79	0.34
WEAR AND TEAR	57.0	7.19	0.41
TRAFFIC	102.2	12.88	0.73
THEFT	28.8	3.63	0.21

REGIONAL PERCENTAGES

	DAMAGE 1	DAMAGE 2	CONTROL1
SEALS	56.78%	62.45%	0.00%
OTHER PREDATORS	13.12	19.22	34.49
WEATHER	8.63	3.49	1.12
WEAR AND TEAR	5.34	0.29	39.33
TRAFFIC	12.08	11.25	22.14
THEFT	4.05	3.30	2.92
	N = 73	N = 50	N = 17

Table 4-3
Groundfish Gill Net Damage Results

Number reporting damage = 16

GENERAL STATISTICS

	TOTAL	AVERAGE
USED	415 nets	25.94 nets
DAMAGED	259 nets	16.19 nets
LOST	79 nets	4.94 nets
VALUE	$67,300.00	$4206.30
REPAIRS	3481 hours	217.56 hours

DAMAGE BY FACTOR

	TOTAL	PERCENT	AVERAGE
SEALS	26 nets	8.2%	1.62 nets
OTHER PREDATORS	131	41.3	8.18
WEATHER	22	6.9	1.37
WEAR AND TEAR	104	32.7	6.48
TRAFFIC	34	10.7	2.13
THEFT	0	0.0	0.00

REGIONAL PERCENTAGES

	DAMAGE 1*	DAMAGE 2	CONTROL1
SEALS	0.00%	13.77%	0.00%
OTHER PREDATORS	0.00	35.80	49.45
WEATHER	0.00	0.00	17.19
WEAR AND TEAR	0.00	35.12	29.30
TRAFFIC	0.00	15.31	4.06
THEFT	0.00	0.00	0.00
	N = 0	N = 11	N = 5

* those surveyed in Damage 1 reported neither damage nor loss

Table 4-4
Light Longline Damage Results

Number reporting damage = 54

GENERAL STATISTICS

	TOTAL	AVERAGE
USED	780 Tubs	14.44 tubs
DAMAGED	107 tubs	1.98 tubs
LOST	231 tubs	4.28 tubs
VALUE	$592,488.00	$10,972.00
REPAIRS	1340 hours	24.82 hours

DAMAGE BY FACTOR

	TOTAL	PERCENT	AVERAGE
SEALS	0.0 tubs	0.00%	0.00 tubs
OTHER PREDATORS	149.1	45.10	2.76
WEATHER	6.5	1.97	0.12
WEAR AND TEAR	104.9	31.73	1.94
TRAFFIC	70.1	21.20	1.30
THEFT	0.0	0.00	0.00

REGIONAL PERCENTAGES

	DAMAGE 1	DAMAGE 2	CONTROL 1
SEALS	0.00%	0.00%	0.00%
OTHER PREDATORS	41.10	50.30	50.80
WEATHER	3.42	0.00	0.00
WEAR AND TEAR	40.94	17.00	22.75
TRAFFIC	14.54	32.70	26.45
THEFT	0.00	0.00	0.00
	N = 26	N = 16	N = 12

Table 4-5
Heavy Longline Damage Results

Number reporting damage = 17

GENERAL STATISTICS

	TOTAL	AVERAGE
USED	343 tubs	20.18 tubs
DAMAGED	22 tubs	1.31 tubs
LOST	144 tubs	8.47 tubs
VALUE	$373,558.00	$21,974.00
REPAIRS	340 hours	20.00 hours

DAMAGE BY FACTOR

	TOTAL	PERCENT	AVERAGE
SEALS	0.0 tubs	0.00%	0.00 tubs
OTHER PREDATORS	64.6	41.12	3.80
WEATHER	11.0	7.00	0.65
WEAR AND TEAR	40.5	25.78	2.38
TRAFFIC	41.0	26.10	2.41
THEFT	0.0	0.00	0.00

REGIONAL PERCENTAGES

	DAMAGE 1	DAMAGE 2	CONTROL 1
SEALS	0.00%	0.00%	0.00%
OTHER PREDATORS	42.23	0.00	35.79
WEATHER	8.46	0.00	0.00
WEAR AND TEAR	27.54	0.00	17.35
TRAFFIC	21.77	0.00	46.86
THEFT	0.00	0.00	0.00
	N = 11	N = 0	N = 6

Table 4-6
Wooden Lobster Trap Damage Results

Number reporting damage = 228

GENERAL STATISTICS

	TOTAL	AVERAGE
USED	52,590 traps	230.66 traps
DAMAGED	9,309 traps	40.83 traps
LOST	10,217 traps	44.81 traps
VALUE	$498,704.40	$2,187.30
REPAIRS	19,380 hours	85.00 hours

DAMAGE BY FACTOR

	TOTAL	PERCENT	AVERAGE
SEALS	531.24 traps	2.76%	2.33 traps
OTHER PREDATORS	25.08	0.13	0.11
WEATHER	16,698.72	86.80	73.24
WEAR AND TEAR	471.96	2.45	2.07
TRAFFIC	1,370.28	7.13	6.01
THEFT	141.36	0.73	0.62

REGIONAL PERCENTAGES

	DAMAGE 1	DAMAGE 2	CONTROL 1
SEALS	0.10%	11.38%	3.95%
OTHER PREDATORS	0.20	0.00	0.00
WEATHER	92.75	81.30	74.15
WEAR AND TEAR	2.03	1.73	4.13
TRAFFIC	4,15	4.46	17.39
THEFT	0.77	1.13	0.38
	N = 111	N = 59	N = 58

Table 4-7
Wire Crab Trap Damage Results

Number reporting damage = 15

GENERAL STATISTICS

	TOTAL	AVERAGE
USED	448 traps	29.87 traps
DAMAGED	28 traps	1.87 traps
LOST	74 traps	4.93 traps
VALUE	$22,572.00	$1,504.80
REPAIRS	80 hours	5.00 hours

DAMAGE BY FACTOR

	TOTAL	PERCENT	AVERAGE
SEALS	0.00 traps	0.00%	0.00 traps
OTHER PREDATORS	0.90	0.88	0.06
WEATHER	0.00	0.00	0.00
WEAR AND TEAR	16.05	15.74	1.07
TRAFFIC	85.05	83.38	5.67
THEFT	0.00	0.00	0.00

REGIONAL PERCENTAGES

	DAMAGE 1	DAMAGE 2	CONTROL 1
SEALS	0.00%	0.00%	0.00%
OTHER PREDATORS	0.88	0.00	0.00
WEATHER	0.00	0.00	0.00
WEAR AND TEAR	15.74	0.00	0.00
TRAFFIC	83.38	0.00	0.00
THEFT	0.00	0.00	0.00
	N = 15	N = 0	N = 0

Table 4-8
Total Value of Seal Damage

GEAR	CALCULATION	SEAL DAMAGE VALUE
Mackerel-Herring Gill Nets	$135,990.40/52.62%	$71,558.15
Groundfish Gill Nets	$ 67,300.00/82.00%	$ 9,267.21
Wooden Lobster Traps	$498,704.40/ 2.76%	$13,764.24
TOTAL:		$94,589.60

The damages incurred by the sample of 297 respondents totals $94,589.60 via econometric analysis. Aggregated upwards as before, using a corrected parent population figure of 3380, results in a total seal damage value of $1,076,429.60. Calculating downwards, the average damage value suffered per fisherman (unweighted for higher damage in certain regions) is $318.48. Seal damage is particularly high in Damage 1 and higher still in Damage 2, as seen from Tables 4-2 through 4-7.

5. RECOMMENDATIONS

The research team is satisfied that this survey has reported statistically consistent results. Using first-hand data collection techniques, and maintaining a strict line of questions resulted in information which is as unbiased as possible. Experience conducting surveys in the field has also enabled the analysts to gain an intuitive feel for the issue at hand.

The seal damage value achieved via econometric analysis is, although larger than the original value, preferred by the author of this report. It results from a rigorous data streaming process performed by a single individual to preserve consistency of coding and manipulation. As well, the latter method of analysis was performed using econometric tests to ascertain the validity of regression results, and any conclusions arising forthwith.

This study has provided a detailed evaluation of the damage caused to fixed inshore fishing gear by grey and harbour seals. Of importance is the fact that no forecasting can be done to predict future levels of damage. There are two reasons for this:

1) There exist no investigations of seal damage in previous years which are rigorous enough to pool studies to establish a time-series data base.
2) Although the grey seal population is regularly assessed, data on rates of population increase are being continuously revised, and data concerning the number of seals tagged by statistical district is not yet ready for release.

The appeal of this study is that the techniques and processing are easily replicated, and with the appreciation of concerned groups funds might be established to re-evaluate gear damage in later periods to develop a viable time-series data base. Only with accurate time-series conclusions may recommendations as to the continuation of bounty programs or the implementation of a cull be properly achieved.

6. ACKNOWLEDGEMENTS

This report was made possible by the kind consideration and assistance of several people. Notably, the provincial Department of Development (Hon. Roland Thornhill, Minister) and the provincial Department of Fisheries and Oceans (Hon. John Leefe, Minister). As well, appreciation to the federal Department of Fisheries and Oceans for comments and assistance provided by Messrs. P. Sutherland, C. Cormier, and N. Kimber. Thanks are also due to the Canadian Petroleum Association (Ms. Leslie Grattan).

Invaluable assistance was received by members of the Faculty of Economics, Dalhousie University. Notably Dr. Leigh Mazany and Dr. Dan Gordon.

Finally, very special thanks to Mr. R. Clifton Thomson for his expertise in data collection and his enthusiastic dedication to the project.

APPENDICES

Abbreviations

Tables 1A-1 and 2:

Term	Meaning
L	Lobster licence holders
G	Groundfish licence holders
H	Herring licence holders
M	Mackerel licence holders
SW	Swordfish licence holders
CR	Crab licence holders
No. L	Total number of licences

Table 1A-3:

Term	Meaning
Incorp.	Fishing an incorporated business
Scal. seine	Drag scallops, or Danish seines (Gear types inappropriate to survey)
Ret'd	Retired
Other	Trip fishing, ill, moved, away, deceased
No. Rep	Number of replacements used

Appendix 1
Population and Sample Characteristics

Table 1A-1
Parent Population Characteristics

District	Sample Range	L	G	H	M	SW	CR	No. L
1	0001 - 0161	136	117	1	19	86	45	404
4	0162 - 0243	66	25	26	28	26	8	179
6	0244 - 0410	119	102	73	69	46	14	423
7	0411 - 0614	153	135	36	53	57	28	462
8	0615 - 0662	40	19	32	36	4	11	142
9	0663 - 0778	45	64	85	80	26	1	301
14	0779 - 0799	18	3	15	4	0	0	40
15	0800 - 0990	89	132	117	135	3	4	480
16	0991 - 1012	13	16	13	15	4	0	61
17	1013 - 1068	42	30	12	19	7	0	110
18	1069 - 1109	19	37	37	38	1	0	132
19	1110 - 1242	84	92	93	49	6	0	324
20	1243 - 1363	72	83	100	94	0	0	349
	0001 - 1363	896	855	640	639	266	111	3407
	%	26.3	25.1	18.8	18.7	7.8	3.3	100.0
25	1364 - 1539	114	135	119	145	0	0	513
26	1540 - 1681	83	84	98	82	2	0	349
27	1682 - 1767	62	66	78	73	1	0	280
28	1768 - 1911	106	103	82	77	7	0	375
30	1912 - 2016	76	87	53	48	8	0	272
31	2017 - 2223	131	154	120	108	16	0	529
32	2224 - 2663	365	260	73	44	34	0	776
33	2664 - 2911	238	81	123	31	9	0	482
34	2912 - 3093	166	120	146	22	4	0	458
36	3094 - 3165	56	53	50	31	0	0	190
37	3166 - 3294	93	76	87	4	1	0	261
38	3295 - 3382	16	68	36	0	3	0	123
39	3383 - 3444	30	33	41	1	0	0	105
	1363 - 3444	1536	1320	1106	666	85	0	4713
	%	32.6	28.0	23.5	14.1	1.8	0.0	100.0
TOTAL:	0001 - 3444	2432	2175	1746	1305	351	111	8120
	%	29.9	26.8	21.5	16.1	4.3	1.4	100.0

Table 1A-2
Sample Population Characteristics

District	L	G	H	M	SW	CR	No. L
01	34	28	0	5	21	13	101
04	13	4	7	8	7	4	43
06	24	23	17	19	20	3	106
07	39	38	10	14	17	9	127
08	9	7	8	9	0	6	39
09	14	15	18	21	4	1	73
14	7	1	6	0	0	0	14
15	14	22	23	23	1	0	83
16	4	6	6	7	2	0	25
17	11	5	2	2	2	0	22
18	4	3	3	3	0	0	13
19	15	15	18	17	0	0	65
20	22	27	33	30	0	0	112
TOTAL:	210	194	151	158	74	36	823
%:	25.5	23.6	18.3	19.2	9.0	4.4	100.0
25	4	7	5	8	0	0	24
26	6	5	5	5	0	0	21
27	1	1	2	2	0	0	6
28	4	2	2	1	0	0	9
30	4	3	2	1	0	0	11
31	7	5	4	4	2	0	22
32	21	15	6	3	1	0	46
33	16	6	5	2	1	0	30
34	3	3	2	0	0	0	8
36	2	2	2	2	0	0	8
37	3	3	3	0	0	0	9
38	2	5	2	0	0	0	9
39	2	2	1	0	0	0	5
TOTAL:	75	59	41	28	5	0	208
%:	36.0	28.4	19.7	13.5	2.4	0.0	100.0

Table 1A-3
Parent Entries Rejected by Reason

REGION	DRAWN	SURVEYED	REJECTION REASON Incorp.	Scal. Seine	Ret'd	Other	No. Rep
01	38	32	0	0	2	0	2
04	16	11	0	0	0	0	0
06	36	24	7	2	1	5	5
07	51	39	11	2	1	5	7
08	10	18	0	0	1	1	2
09	27	22	6	0	3	3	1
14	7	4	0	0	0	2	0
15	32	24	8	1	3	4	5
16	8	2	0	1	1	0	1
17	13	13	4	2	0	1	3
18	4	3	0	0	0	0	0
19	23	22	1	1	1	1	4
20	35	23	0	0	2	1	3
TOTAL:	300	227	37	9	15	25	33
25	9	6	2	0	1	1	1
26	9	5	69	1	0	3	1
27	2	2	4	0	0	0	0
28	6	3	13	1	0	0	0
30	6	4	12	1	3	0	3
31	9	7	12	1	0	0	1
32	25	19	25	0	1	4	1
33	16	9	22	0	0	0	0
34	3	3	25	0	0	1	2
36	2	2	33	0	0	0	2
37	4	3	23	0	1	1	1
38	6	4	17	0	0	2	2
39	3	3	0	0	0	1	2
TOTAL:	100	70	257	4	6	13	16
	400	297	294	13	21	38	49

Data Set: 3444 Rejected: 64 Corrected Population: 3380

Table 1A-4
Corrected Response Rate

CLUSTER AREA	SAMPLE DRAWN	SAMPLE SURVEYED	% RESPONSE
1. Northern C. B.	53	44	83.02
2. Sydney	88	67	76.14
3. Arichat	35	32	91.43
4. Guysborough	5	4	80.00
5. Canso	29	16	55.17
6. Ecum Secum	21	15	71.43
7. Jeddore	41	25	60.98
8. Eastern Passage	28	23	82.14
9. Lunenburg	17	13	82.35
10. Shelburne	22	15	68.18
11. Yarmouth	43	30	69.77
12. Digby	18	12	66.66

Average Response: 73.94%

Aggregated Response Rates

CLUSTER AREA	SAMPLE DRAWN	SAMPLE SURVEYED	%RESPONSE RATE
Damage 1 (1-3 above)	176	143	81.13
Damage 2 (4-8 above)	124	83	66.69
Control 1 (9-12 above)	100	70	70.00

Average Aggregate Response: 72.61%

Appendix 2
Wage Calculations

In order to realistically evaluate the wages of fishermen throughout the study area, three breakdowns are used which coincide with sectioning wage analysis in the Kirby Report[3]. Specifically, Department of Fisheries and Oceans Statistical Districts 01, 04, 06, 07 and 08 which comprise Damage 1 in this report coincide with North-Eastern Nova Scotia in the Kirby Report. Damage 2 (including Districts 14 through 20) comprises Eastern Shore Nova Scotia. Control 1 (Districts 25 through 39 with previously explained exclusions) makes up Western Shore Nova Scotia.

The Kirby Report[4] states clearly in all wage averages that the incomes of the highliners (i.e., the top 10% of wage earners in all fishing districts of Atlantic Canada) heavily skew the data. As a result, this study employs data from median calculations.

Table 2A-1
Regional Averages of Fishing Incomes
(Median in 1982 Dollars - Adjusted for Highliners)

REGION	F-TIME EARNINGS	NO. F-TIME	P-TIME EARNINGS	NO. P-TIME
Dam 1	$ 9,400	1000	$ 2,000	400
Dam 2	8,100	1200	1,000	500
Con 1	18,700	4700	2,500	1800

Secondly, the number of full and part-time fishermen in each of the three regions is evaluated due to the caveat that 25% of part-time fishermen beahve like full-time fishermen[5]. Results are as follows:

Table 2A-2
Regional Breakdown of Fishermen by Type

REGION	NO. F-TIME	NO. P-TIME
Dam 1	1100	300
Dam 2	1325	375
Con 1	5150	1410

Thirdly, a weighted equation is derived which is based upon an average of the percent of part-time fishermen in the three regions:

Table 2A-3
Percent Breakdown of P-Time Fishermen to Total

REGION	NO. P-TIME	PERCENT
Dam 1	300/1400	22.06
Dam 2	375/1700	22.06
Con 1	1410/6580	21.43
	Average:	21.5

Equation: 100 - 21.50 = 75.80
Let X = No. F-time fishermen
Let Y = No. P-time fishermen

Weighted Equation: 0.79X + 0.22Y = Average earnings per region

At this point the weighted equation is used to determine more accurate regional wages -- based upon the unique breakdown in the numbers of full and part-time fishermen found in the different regions (in addition to being based upon differences in wages).

Kirby's regional median incomes[6] are substituted into the weighted equation to determine the following:

Table 2A-4
Average Regional Wages*
(Full and Part-Time Per Year)

REGION	CALCULATIONS
Dam 1	(0.79 x 9400) + (0.22 x 2000) = $ 7,809.00/yr
Dam 2	(0.79 x 8100) + (0.22 x 1000) = $ 6,573.50/yr
Con 1	(0.79 x 18700) + (0.22 x 2500) = $ 15,217.00/yr

* net revenue after costs

Employing the same weighted variables, and given the data on number of weeks fished as found in the Kirby Report[7], full and part-time fishing information was combined to develop aggregate figures.

Table 2A-5
Average Number of Weeks Worked
(Total Atlantic Provinces)

TYPE	NO. WEEKS
F-time	23.1
P-time	11.8

Calculate average no. of weeks: (0.79 x 23.1) + (0.22 x 11.8)
= 18.13 + 2.54
= 20.67 weeks (avg.)

Table 2A-6
Average Wages Per Week
(Nova Scotia)

REGION	WEEKLY WAGE CALCULATIONS
Dam 1	$ 7,809.00 / 20.67 = $ 377.78
Dam 2	6,573.50 / 20.67 = 318.02
Con 1	15,217.00 / 20.67 = 736.17

However, it is important to derive an idea of what the average wages are for both full and part-time fishermen. Toward this end average wages were split using the number of weeks worked (as found in Table 2A-5) and the yearly wages per region (as found in Table 2A-4):

Table 2A-7
Average Wages Per Week
(Full and Part-time Fishermen)

REGION	AVERAGE WAGES PER YEAR		WEEKS WORKED	AVERAGE WEEKLY WAGES
Dam 1	F-time:	$ 9,400	23.1	$ 506.92
	P-time:	2,000	11.8	169.49
Dam 2	F-time:	8,100	23.1	350.65
	P-time:	1,000	11.8	84.75
Con 1	F-time:	18,700	23.1	809.52
	P-time:	2,500	11.8	211.86

It is interesting to note at this point that the average wage per week in Nova Scotia is $347.91 (averaged from April, August and December values for 1983).[8] This general wage for all sectors throughout Nova Scotia includes overtime but does not reflect the greater number of hours a fisherman may work. To remedy this the research team employs a system which averages best, mid, and worst case scenarios for the number of hours worked. Full and part-time fishermen were evaluated according to the following ranges:

F-time:	Best =	8 hours per day
	Mid =	10 hours per day
	Worst =	12 hours per day
P-time:	Best =	4 hours per day
	Mid =	6 hours per day
	Worst =	8 hours per day

Table 2A-8
Average Wage Cases
(Full-time)

N.E. N.S.: $406.92 per week / 6 days = $67.82 / day

Best:	$67.82 / 8 hrs =	$8.47 / hour
Mid:	67.82 /10 hrs =	6.78
Worst:	67.82 /12 hrs =	5.65

3 case average = $6.96 per hour (Damage 1)

E. Shore N.S.: $350.65 per week / 6 days = $58.44 / day

Best:	$58.44 / 8 hrs =	$7.31 / hour
Mid:	58.44 /10 hrs =	5.84
Worst:	58.44 /12 hrs =	4.87

3 case average = $6.01 per hour (Damage 2)

W. Shore N.S.: $809.52 per week / 6 days = $134.92 / day

Best:	$134.92 / 8 hrs =	$16.87 / hour
Mid:	134.92 /10 hrs =	13.49
Worst:	134.92 /12 hrs =	11.24

3 case average = $13.87 per hour (Control 1)

Table 2A-9
Average Wage Cases
(Part-time)

N.E. N.S.: $169.49 per week / 6 days = $28.25 / day

Best:	$28.25 / 4 hrs =	$7.06 / hour
Mid:	28.25 / 6 hrs =	4.71
Worst:	28.25 / 8 hrs =	3.53

3 case average = $5.10 per hour (Damage 1)

E. Shore N.S.: $ 84.75 per week / 6 days = 14.13 / day

Best:	$14.13 / 4 hrs =	$3.53 / hour
Mid:	14.13 / 6 hrs =	2.36 / hour
Worst:	14.13 / 8 hrs =	1.77

3 case average = $2.55 per hour (Damage 2)

W. Shore N.S.: $211.86 per week / 6 days = $35.31 / day

Best:	$35.31 / 4 hrs =	$8.83 / hour
Mid:	35.31 / 6 hrs =	5.86
Worst:	35.31 / 8 hrs =	4.41

3 case average = $6.37 oer hour (Control 1)

When taking averages of the three sets of full and part-time fishing wages, it is clear that Control 1 heavily skews the results:

Full-time hourly wage average: $6.96 + 6.01 + 13.87 = 26.84
$26.84/3 = 8.94

Part-time hourly wage average: $5.10 + 2.55 + 6.37 = 14.02
$14.02/3 = 4.67

When the full and part-time fishing wages are combined, the following weighted equation adjusts the average wage to a more realistic wage rate:

Weighting: 3/4 full-time, 1/4 part-time

Weighted Equation: (3/4 x $8.94) + (1/4 x $4.67)
= $6.70 + 1.17
= $7.87

$7.87 is accepted by this study as a good approximation of the hourly value of a fisherman's effort. This figure also closely approximates the Nova Scotian general hourly wage of $7.15 (derived from applying the same 3-case analysis to the Statistics Canada hourly wage for Nova Scotia of $347.91[9]).

Hence $7.87 represents the labor value used in all sections of this report except the ad hoc analysis of fish trap damage (which was localized in 1983 in Damage 2, thereby justifying the use of the high-range full-time hourly wage of $7.31 for that area as opposed to the average figure).

Appendix 3

Table 3A-1
1984 Dollar Value of Gear by Type
(Per Unit)

Gear Type		Dollar Value
Fish Traps		$12,000.00
Mackerel-Herring Gill Nets		411.00
Groundfish Gill Nets		611.75
Light Long Lines		4,179.02
Heavy Long Lines		4,460.88
Wooden Lobster Traps		55.35
Wire Lobster Traps	Bought:	376.00
Wire Crab Traps	Made:	266.00

Appendix 4
Endnotes

[1] K. Zwanenberg, An Assessment of the Northwest Atlantic Grey Seal Population for 1983. Bedford Institutue of Oceanography, 1984, p. 10.

[2] A. W. Mansfield and B. Beck, The Grey Seal in Eastern Canada. Fisheries and Marine Services, 1977, p. 38.

[3] Taskforce on the Atlantic Fisheries, Navigating Troubled Waters (The Report of the Kirby Royal Commission). Canada, 1982, p. 11.

[4] Ibid., p. 27.

[5] Ibid., p. 24.

[6] Ibid., p. 28.

[7] Ibid., p. 26.

[8] Statistics Canada, Labor Force Annual Averages, Statscan 71-529, 1975-83.

[9] Statistics Canada, Employment Earnings and Hours. Statscan 72-002, 1983.

Appendix 4
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