International Council for the
Exploration of the Sea

C.M.1979/K:8
Shellfish Committee

REPORT OF THE HOMARUS WORKING GROUP

Lowestoft, England, 21-24 May 1979

SUMMARY

A total of 13 lobster stocks were subjected to a cohort analysis by length, and the effects of size limit and fishing mortality changes on yield per recruit assessed. In the main the data analyses indicated the advantages and necessity of increased minimum size limits and for decreased fishing mortality. As well as increasing Y/R such management action would ensure considerable increases in stock biomass, and therefore recruitment potential, which would reduce the severe risk of imminent fishery induced recruitment failure.

Furthermore, the Group recommended that immediate attention must be given to the modelling of lobster growth, with special reference to the effect this has on yield assessment models.

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1. INTRODUCTION

Following the last meeting of the ICES *Homarus* Working Group in May 1977 and in accordance with C. Res. 1977/4:21 ACFM drew attention in its 1978 report to the serious state of many *Homarus* stocks, and recommended that an increase in size at first capture and a reduction in exploitation rate should be given serious consideration in all areas, to reduce the risks of a fishery induced recruitment failure.

At the 66th Statutory Meeting in 1978 the Council decided (C. Res. 1978/2:33) that the *Homarus* Working Group should be convened ...... to make stock assessments with a view to providing management strategies in lobster fisheries.

The following participated:

D B Bennett	- UK (Rapporteur)
K M Bhatnagar	- Ireland
J F Caddy	- Canada
G Y Conan	- France
B I Dybern	- Sweden
G P Ennis	- Canada
F A Gibson	- Ireland (Chairman)
K R Gundersen	- Norway
H Hallback	- Sweden
M Leglise	- France
J G Pope	- UK
R G J Shelton	- UK
S Tveite	- Norway

2. ASSESSMENT INPUTS AND MODELS

The length cohort technique (Jones, 1974) and its extension for considering minimum size and fishing mortality changes (Jones, 1976) is essentially a short cut technique. Its use by the Working Group proved to be an extremely valuable means of providing management advice for the various lobster stocks which were examined (see Section 4).

Short cut techniques imply simplifications which require to be further refined, and the Working Group recognised that this applies equally to lobster stocks. Lobsters have peculiar incremental growth patterns, which all delegates agreed require to be studied in greater detail so that refinements of annual or incremental growth curves can be achieved. One drawback of using the Jones technique for estimating the effects of changes in size limits and fishing mortality is that it only considers changes in the yield of length groups included in the analysis. The exclusion of the infrequent larger animals in small samples may tend to underestimate the long term gains to be made by larger decreases in fishing mortality. This effect can be corrected (as it can be when studying most species of fish and shellfish) by:

(a) better sampling, to include larger categories where this is appropriate, and,

(b) using simulation techniques for estimating yield per recruit.

It would be valuable, perhaps, to introduce the estimates of F obtained from the Jones technique into yield per recruit models to predict the potential impact of regulatory measures more precisely. If methods can be developed which describe the growth rate of each years recruits this would be valuable. Additionally, catch at length data for past years would be of interest in order to see what changes have occurred through time.

Since recruitment overfishing is believed to be an important factor in heavily fished stocks, various aspects of the fecundity of populations also require to be elucidated so that the likely impact of existing or new regulations on the spawning potential of the stock can be assessed.

The Working Group, having fully discussed these matters, decided that member countries should give immediate attention to them, with a view to reconvening at an appropriate date, to examine their effects on further changes in management strategies.

In spite of the fact that short cut techniques have certain limitations, the analyses of various lobster stocks, carried out by the Working Group indicated a high degree of uniform opinions on the expected results which will arise from changes in minimum size limits and/or fishing mortality. Therefore, recognising the need for refinement but at the same time being satisfied that the available data provide a sound basis for management advice, the individual members of the Working Group were able to provide reasoned comment for the appropriate action specific to the stocks with which they are concerned.

3. COHORT AND YIELD PER RECRUIT ANALYSES

3.1. CANADA

3.1.1. ICNAF Area 5Ze

The size frequency data (Stasko, M S, 1977) came from NE George's Bank. The von Bertalanffy growth parameters were taken from the "American Lobster Fishery Management Plan" Table 21 (southern New England offshore stocks) and the terminal F value from Table 22 (mean 1968-71).

Fishing Mortality Fishing mortality rises with size to a plateau of 0.52 at between 115 and 160 mm C.L. before rising to around 1.0 for the larger size groups. The low F for the first 30 mm appears to reflect an unexplained low availability, while the high rate of capture for the very large animals may imply that:- (a) migration from the population, or, (b) reduced entry to the gear at large sizes, or, (c) natural mortality is higher. Whatever the mechanism, these values are regarded as anomalous. The mean estimate of around F = 0.5 is somewhat higher than the inputs of F used but not extra-ordinarily so.

Size Limits Since availability of younger size groups appears to be limited in the population, the effects of small increases in size limit alone have a relatively minor impact on Y/R or spawning stock biomass (Table 5).

Effort Changes Increases in effort are likely to be unproductive and small increases in Y/R may be attained by reducing fishing mortality, particularly in conjunction with an increased size limit (Table 5). Marginal increases in Y/R being predicted up to at least 100 mm C.L. Short-term losses within the limits proposed would not be large, but it would take at least 5 years for the new equilibrium to be attained. The benefits in terms of Y/R are relatively minor in this case, and together with the loss at higher levels of F, suggests that we are not too far from the optimum level.

3.1.2. Southern Gulf of St Lawrence/SE Nova Scotia Stocks

This analysis considers data from inshore fisheries in two different areas, and the conclusions must, therefore, be regarded as tentative. The von Bertalanffy parameters come from Robinson MS 1978 for Gabarus, SE Nova Scotia, and are used to analyse a rather typical size frequency from Richibucto Cape, Southern Gulf of St Lawrence in 1976 (Robinson, MS, 1977), one of the most highly exploited inshore areas. In this case, no independent estimates of von Bertalanffy have been possible, largely because of the very heavy dependence of the fishery on one age group and the small size range available. It seems quite possible that the Gabarus data will underestimate the potential growth rate in the Southern Gulf (which is one of the warmer inshore areas).

The proportion mature at size is estimated (roughly) from Templemann's data for District 8 in the Southern Gulf, where first berried females are approximately 61 mm C.L. and 100% maturity at around 98 mm C.L. Intermediate values were estimated assuming a standard cumulative normal ogive.

Fishing Mortality The mean value of F = 1.5 is lower than predicted for the Southern Gulf from other estimates, and probably somewhat higher than for SE Nova Scotia.

Size Limits Significant increases in Y/R occur with increases in size limit from 64 up to at least 80 mm, ie the largest increase examined, and even more remarkable increases in spawning potential occur (Table 6). These are likely to be of major importance for this kind of stock in which recruitment appears to be very precarious, namely a stock with one of the lowest size limits in the Atlantic (at or around the size at first maturity) and a very intensive fishery.

Fishing Mortality Reductions in fishing mortality of up to 50% would show modest increases in Y/R and significant increases in population fecundity (Table 6). The effects would be somewhat enhanced if taken in conjuction with increases in size limit. Rather surprisingly, although further increases in F slightly improve yield (and more probably spawning potential), further increases in F taken in conjunction with increased minimum size can be sustained and even result in a slight increase in Y/R. This appears to illustrate that size limit changes override the effect of fishing mortality changes at this state of exploitation.

3.1.3. Newfoundland

Y/R assessments have previously been done for 5 Newfoundland stocks (Ennis, 1978 unpublished ms). The general results were similar for each and indicate that quite significant increases in Y/R could be achieved by increasing the minimum legal size above the present 81 mm C.L. and that smaller increases could be achieved by reducing exploitation rates from existing levels even at higher size limits. The model used (Ennis and Akenhead, 1978 unpublished ms) was developed to accommodate certain conditions that exist in the Newfoundland fishery and to use the growth data (molt increment and proportions molting) that were available.

The results presented in this Working Group Report for Newfoundland stocks are similar. However, the predicted long term increases in Y/R for a given fishing regime using the Jones Cohort Model (Tables 7, 8 and 9) are substantially smaller, particularly for females, than those predicted using the former model. Likely reasons for the differences are: (a) in the former model lobsters which do not molt in a given year are subjected to a natural mortality rate of 5% instead of M =0.1 and (b) egg bearing females, of which there are usually fairly large numbers in Newfoundland populations because of the small size at maturity, are not exposed to fishing mortality during the year they carry eggs (berried lobsters are protected) and all molt before the fishing season the following year.

The von Bertalanffy parameters used in the Working Group Report were estimated from annual growth curves produced by combining molt increment and proportions molting data starting from the smallest size (61 mm C.L.) for which these data are available and assigning an age of 6 for males and 7 for females at this size. These assigned ages are rough estimates and if they are off by 1 or 2 years, slight changes in the K and L_∞ values would result.

It is felt that the model developed specifically for Newfoundland lobsters is more applicable to the situation and gives more realistic results than the Jones model, although they both show the benefits from an increase in minimum size and/or decrease in fishing mortality.

3.2. FRANCE

The present analysis of French data is only acceptable for scientific purposes. Knowledge of biological parameters as well as the adequacy of the models used for processing the data does not yet permit any precise recommendations for long term regulations of the French stock considered at this meeting.

In the present state of the lobster fishery at "Le Conquet", it seems reasonable to conclude that the fishing mortality is low ($F \simeq 0.2$). This may be because the fishery is mainly directed towards crabs rather than lobsters. Natural mortality also seems to be low ($M \simeq 0.1$). Increments in legal size, ranging from 80 mm C.L. plus 5 mm to 15 mm do not provide substantial long term increases in Y/R; neither does a reduction of the fishing mortality (Table 10). Such reductions in fishing mortality do result in drastic short-term losses in Y/R (eg 46% in the first year at 50% reduction in effort combined with a +15 mm increase in size limit (Table 10). Increasing fishing effort would tend to lead to slight long term losses in Y/R.

Consequently, changing present conditions of exploitation in this French fishery, either by increasing minimum legal size, or by reducing fishing mortality, would not provide any clear benefit. Increasing fishing mortality, even slightly, should be avoided. The yield per recruit approach in its present form does not appear to provide an efficient way of improving total yield for the fishery. A solution for improving the yield should rather be sought by increasing the biomass, possibly using efficient repopulation techniques.

3.3. IRELAND

Males

A reduction in fishing mortality to 75% of the current level, without increasing the minimum landing size (83 mm C.L.), would result in a loss in catch of 16% in the first year (Table 11). The long-term gain in catch would be about 9% and the biomass would increase by 30%. The result would be similar if the fishing mortality was kept at the current level and the legal minimum size increased by 10 mm to 93 mm. A combination of a 5 mm increase in minimum size to 88 mm and a reduction in fishing mortality to 75% results in 40% increase in biomass, a 20% loss in catch in the first year with a long-term gain of 13%.

Females

There seemed to be no appreciable gains in Y/R of females, either by increasing the present minimum size limit or by reducing fishing mortality (Table 12). Short-term losses in Y/R are greater with reductions in fishing mortality than with increases in minimum size. A combination of 5 mm increase in minimum size and a reduction in fishing mortality to 75% would only give a 5% long-term increase in Y/R but the stock biomass would increase by 38% and fecundity by 71%.

3.4. NORWAY

On the west coast of Norway the lobster stock seems to be sensitive to changes in fishing mortality. If the minimum size is increased by 1 cm (total length) the long-term gain in Y/R will be 3% (Table 13). If at the same time, the fishing effort is reduced by 25%, the gain in yield per recruit will be 11% and this would further increase to 21% if effort were reduced by 50%. Additional increases in minimum size seems to give relatively small increases in Y/R.

On the Skagerak coast the effect of increased minimum size and reduced fishing mortality is smaller in comparison with the West coast, especially for females (Tables 14 and 15). However a larger size and reduced fishing mortality would produce a considerable increase in spawning stock.

The main cause for the serious reduction of the Norwegian stock is considered to be due to poor recruitment. It seems to be advisable to implement management regulations which will increase the spawning stock and at the same time improve Y/R.

The first year losses should not be too big, especially if effort is reduced in stages and carried out by licensing the fishermen and the catch in such a way that those fishermen remaining in the fishery will hardly experience a reduction in their catches.

3.5. SWEDEN

The Swedish participants in the meeting could not present basic material for the yield assessments made by the Group. However, it is reasonable to believe that the data for the Norwegian Skagerak area are, in the main, also applicable to the adjacent Swedish west coast. The Swedish lobster fishery is at present in a critical situation, the official statistics show a considerable decrease in annual landings and available figures for cpue, as a rule, also show a strong decline. This and other evidence make it highly probable that recruitment of the lobster stock should be enhanced mainly by an increase of the minimum size, and that a limitation of the fishing effort in the fishery is necessary.

3.6. UK - ENGLAND AND WALES

Data were available for cohort analysis and yield per recruit modelling from 8 areas (MAFF, 1978). Three of these areas were selected for this Report - Yorkshire, Cornwall and Cardigan Bay. The yield assessments (Tables 16-21) suggest that raising the minimum size and/or decreasing the fishing mortality would increase the Y/R.

In the Yorkshire fishery where mean F was about 0.9 a 10 mm increase in minimum landing size from 80 to 90 mm C.L. would give a 16-23% (♂ - ♀) increase in Y/R with the present effort level (Tables 16 and 17). A 50% reduction in fishing effort could increase this to 23-45%. Considerable increases in stock biomass and egg production would also occur.

The Cardigan Bay fishery had a lower mean F of about 0.5 but a 10 mm increase in minimum size gave similar long term gains (19-22%) (Tables 18 and 19) as for Yorkshire. However, reductions in fishing mortality were not so worthwhile. Stock biomass and egg production would increase considerably.

The exploitation rate in Cornwall is considerably lower than the other two fisheries considered. The long-term gains in Y/R were all less than 10% (Tables 20 and 21). Some increases in stock biomass would occur if the minimum size was increased and fishing mortality reduced.

An increase in minimum landing size to 85 mm C.L. has recently been recommended for England and Wales (MAFF, 1978). Although the long-term increases in Y/R would not be large, there would be a considerable increase in the weight of the stock on the grounds. There would also be an increase in egg production in most areas by well over a third. In the heavily exploited fisheries in Northumberland, Yorkshire and Norfolk, many parts of the south coast, and Cardigan Bay a substantial proportion of the present catch are immature. Although it is not known how large a breeding stock is required for adequate larval production, common sense suggests that in such heavily exploited fisheries the minimum size should be well above the size at first maturity (~80 mm C.L.).

There is thought to have been an increase in fishing effort from full-time, part-time and hobby fishermen in recent years. It is not possible to say exactly what the increase in effort is because available data is incomplete. However, the lobster stocks are only capable of supporting a certain level of fishing effort and the Y/R assessment shows that a reduction in fishing mortality would benefit most fisheries.

3.7. UK - SCOTLAND

Scottish lobster fisheries fall into two main groups. The fisheries on the south east and east coasts have a long hisotry of intensive exploitation (F >1). Catches are dominated by small individuals and cpue is low (Table 4). The northern and western fisheries are less heavily exploited (F 0.3-0.6) and catches include a wider range of size groups. In most of these areas cpue (Table 4) is considerably greater than in the south eastern fisheries but on the north coast and in the Orkney Islands cpue is no greater than in the south east. This is because the northern fisheries are characterised by small numbers of large animals spaced widely over the fishing grounds.

The Y/R assessment suggests that all the main Scottish lobster fisheries are suffering to some extent from growth overfishing. The problem is most acute in the south east where Y/R would benefit considerably from an increase of at least 5 mm in minimum legal landing size (Tables 22 and 23), and a reduction in fishing mortality. It is possible that the accompanying increase in egg production would benefit recruitment but evidence to back this assertion is wanting. Similar management action would also increase Y/R in the less heavily exploited west coast fisheries (Tables 24 and 25) where growth rates appear to be somewhat higher. Short term losses and long term gains would be somewhat less than in the south east however.

It is worth noting that in the more remote offshore fisheries of the west coast, the season is greatly restricted by weather. The continuing economic viability of these fisheries is therefore dependent upon the maintenance of a reasonably high level of cpue. This is a further reason for strengthened conservation measures.

The two assessments reported here have been chosen as typical of the two main categories of Scottish lobster fishery. More detailed assessments of other Scottish fisheries have produced similar results.

4. MANAGEMENT STRATEGIES

4.1. General conclusions

4.1.1. Yield/Recruit

The cohort analyses on length and consequent yield per recruit assessments have shown that in most stocks worthwhile gains in Y/R are possible with an increase in minimum landing size and/or a decrease in fishing mortality. The more heavily exploited stocks (say F >0.5) show the greatest gains (Figure 1). In the less heavily exploited stocks the predicted gains in Y/R are quite small.

In all stocks, except Le Conquet, France, the first priority is to increase the minimum landing size. An increase of up to +10 mm C.L. is possible, but consideration must be given to staging such an increase to reduce the economic impact on fishermen of short-term losses.

Additional gains in Y/R are possible with a decrease in fishing mortality of up to 25% (Figure 2). As well as increasing the Y/R a reduction in fishing mortality would also reduce fishing costs.

4.1.2. Recruitment

Lobsters have a relatively low fecundity (7-14000 eggs) (Hepper and Gough, 1978) and the size at first capture is currently well below the size at which 50% of the stock are mature. The present levels of fishing mortality on many stocks are high and it follows that the risk of recruitment overfishing cannot be discounted for these stocks. Since Y/R would be increased were fishing mortality rates reduced, there is no reason to run this risk. Effort reductions and/or increases in minimum sizes (Figures 3 and 4) should serve to make substantial increases in stock biomasses, particularly those with high fishing mortality.

Although the Group felt that the main priority was to increase the minimum size the potential increases in Y/R and spawning stock will be negated if fishing mortality is allowed to increase. Fishing mortality must be held at its current level and consideration given to a significant reduction in fishing mortality over the next few years in the more heavily exploited fisheries.

4.2. MANAGEMENT RECOMMENDATIONS

4.2.1. Canada

4.2.1.1. ICNAF Area 5Ze

It is recommended that the present status quo in fishing mortality should be maintained. If it could be reduced there would be significant increases in population fecundity and modest increases in Y/R.

Increasing the size limit would be worthwhile, not because of long-term gains, but as a precaution against recruitment declines if fishing effort were to increase in the future.

4.2.1.2. Southern Gulf of St Lawrence/SE Nova Scotia

The overriding importance of increasing the size limit is confirmed by the calculations, because it would both increase Y/R and provide much needed support for additional recruitment which appears to be the main limiting factor in this fishery. Decreasing fishing mortality, which must be secondary to size limit increases, will produce modest increases in Y/R but more importantly larger reproductive potential.

4.2.1.3. Newfoundland

It is recommended that the minimum legal size in the Newfoundland lobster fishery be increased from 81 mm (3 3/16") carapace length to 89 mm (3 1/2"), to increase yield per recruit by approximately 15-20%. Efforts should be made to reduce current fishing mortality rates using trap limits and restricted entry, not so much to increase yield per recruit as to improve the economic efficiency of the fishery.

4.2.2. France - Le Conquet

In the present state of the Le Conquet lobster fishery in France it seems that increments in legal minimum size ranging from 80 mm C.L. plus 5 mm to 15 mm do not provide substantial long term increases in yield per recruit; neither does a reduction in fishing mortality. Consequently changing the present conditions of exploitation in this fishery, either by increasing the minimum legal size or by reducing fishing effort, would not provide any clear benefit. Increasing fishing effort, even slightly should be avoided. A solution for improving the yield should be reached through means of increasing the biomass, possibly by using efficient repopulation techniques.

4.2.3. Ireland

a) Present minimum legal size limit should be strictly enforced.

b) Increase the minimum legal landing size from the present 83 mm to 85 mm C.L.

c) Reduce fishing effort from the present level of exploitation to a level which will produce long-term gains to the fishery.

d) Catch/effort data (at present nil) should be collected to enable better management of the lobster stocks.

4.2.4. Norway

It is recommended that the minimum size be increased to 82 mm C.L. (23 cm total length). A reduction in fishing effort should be considered, preferably by preventing spare-time fishermen from fishing. This would also improve the possibilities for effective enforcement of the increased minimum size.

4.2.5. Sweden

It is recommended that the minimum landing size of lobsters be increased, in the first hand to 23 cm total length or 82 mm C.L. It is also recommended that measures are taken to decrease the fishing mortality rate.

4.2.6. UK - England and Wales

The minimum landing size should be increased to 85 mm C.L. The long-term gains from this measure could be lost if fishing effort is allowed to increase. A limited entry licensing scheme with pot limits would effectively control fishing effort, and this could be applied regionally to reduce the fishing effort on the more heavily exploited stocks.

4.2.7. UK - Scotland

It is recommended that the minimum legal landing size be increased to 85 mm C.L. and a start made upon the reduction of fishing effort on a regional basis through the introduction of a restrictive licensing scheme.

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TABLE 1

EUROPEAN LOBSTER LANDINGS (tonnes) SOURCE: BULLETIN STATISTIQUE - ICES (*Approximate or estimated as available)

	DENMARK	E & W	FRANCE	IRELAND	NORWAY	SCOTLAND	SPAIN	SWEDEN	ALL EUROPEAN COUNTRIES
1950	216	352*	304	170	969	784	19	215	3 074
51	157	346	368	139	862	643	29	252	2 833
52	186	331	449	164	712	635	32	210	2 751
53	145	403	485	200	848	635	37	216	3 006
54	124	450	499	189	648	597	34	188	2 765
55	108	506	497	253	632	662	34	167	2 889
56	101	492	537	308	708	688	32	178	3 074
57	74	528	568	270	655	728	53	148	3 059
58	75	495	625	300	714	704	68	164	3 174
59	72	489	401	347	684	819	57	160	4 159
1960	85	465	497	267	787	890	37	168	3 226
61	76	565	509	180	681	991	26	147	3 211
62	67	469	437	167	551	898	24	120	2 767
63	71	480	318	153	498	805	5	105	2 470
64	50	477	388	217	380	793	23	92	2 470
65	35	398	426	205	410	643	20	86	2 254
66	30	420	446	278	312	586	20	78	2 389
67	30	387	422	279	240	567	161	64	2 412
68	24	371	361	287	313	616	99	66	2 395
69	25	383	340	298	234	568	18	66	1 953
1970	22	491	324	277	202	602	47	72	2 108
71	15	451	310	285	133	678	20	51	1 952
72	16	429	373	221	161	585	16	54	1 893
73	13	455	352	258	142	545	10	45	1 865
74	11	377	336	253	140	600	12	38	1 825
75	14	382	385	330	127	503	14	36	1 826
76	12	383	328	369	121	528	29	41	1 852
77	14	444	353	338	100	541	69	32	1 911
78*		314	400	310	95	516		19	
Averages 1950-59	126	439	573	234	743	690	40	190	3 078
1960-69	49	442	414	233	441	736	43	99	2 555
1970-78	(15)	414	351	294	136	566	(27)	43	

Table 2 Lobster landings (tonnes) from the United States inshore and offshore (traps and trawls) fisheries for 1965-76. *Includes scuba diving and fish pots.

Year	Inshore Traps	Offshore Traps	Offshore Trawls	Other*	Total
1965	11 218	0	2 481	20	13 719
1966	11 609	0	1 776	15	13 400
1967	10 068	0	2 048	15	12 131
1968	12 253	0	2 490	25	14 768
1969	12 165	52	3 086	22	15 325
1970	11 604	666	3 199	23	15 492
1971	11 308	1 480	2 477	16	15 281
1972	10 626	2 890	1 093	17	14 626
1973	10 518	1 945	671	16	13 150
1974	10 398	1 749	940	-	13 087
1975	10 476	1 939	726	-	13 141
1976	11 708	1 914	598	-	14 220

Table 3 Lobster landings (tonnes) in Canada

Year	Maritimes			P.Q.	Nfld	Canada
	Inshore	Offshore (trap)	Total			
1965	15 193	-	15 193	1 494	1 695	18 382
1966	13 584	-	13 584	1 773	1 580	16 937
1967	12 926	-	12 926	1 501	1 414	15 841
1968	13 842	-	13 842	1 274	1 808	16 924
1969	15 406	-	15 406	1 083	1 730	18 219
1970	13 937	-	13 937	1 195	1 463	16 595
1971	14 720	100	14 820	1 108	1 381	17 309
1972	12 471	334	12 805	1 009	1 237	15 051
1973	13 422	481	13 903	981	1 263	16 147
1974	11 496	410	11 906	1 005	1 326	14 237
1975	14 040	547	14 587	1 204	1 663	17 488
1976	11 669	636	12 305	1 247	2 254	15 781
1977	13 582	635	14 217	1 435	2 180	17 832
1978	14 342	675	15 017	1 597	2 471	19 085

Table 4 Lobster cpue (kg per 100 trap hauls) Scotland 1968-1978

Year	Area					
	Orkney	SE Coast	East Coast	Inshore West Coast	Offshore West Coast	Total West Coast
1968	9.3	6.0	No data	16.1	25.7	19.7
1969	8.4	5.3	"	12.3	21.2	17.3
1970	6.8	5.8	"	17.9	33.6	15.4
1971	11.5	5.8	"	17.3	35.9	25.7
1972	10.6	7.5	"	13.3	32.0	20.5
1973	7.2	5.2	"	14.7	18.7*	16.3
1974	7.0	5.9	7.0	13.1	22.9	16.4
1975	5.1	4.9	8.4	13.2	22.7	16.6
1976	5.3	4.2	5.2	11.9	28.5	19.3
1977	5.6	6.1	5.9	11.8	30.4	15.4
1978	7.9	5.7	5.6	10.2	29.6	14.6

* Data only supplied for part of the year.

Table 5 Yield per recruit assessment for ICNAF Area 5Ze, sexes combined

CURRENT MIN.
SIZE (mm CL)

81

MEAN FISHING
MORTALITY (F)

0.5

M 0.1

K 0.098

L∞ 241

Min. Size Increment (mm CL)	% of current fishing mortality	% change in Y/R after 1	3 Years	5	Long-term	% change in Biomass	Eggs
0	125	+12.5	+ 0.3	-3.3	- 4.3	-12.4	-15.7
	75	-16.5	0.0	+1.6	+ 5.0	+19.1	+24.2
	50	-37.9	-17.2	-3.3	+ 8.7	+51.6	+65.5
+ 5	100	0	0	0	+ 0.1	+ 0.1	+ 0.1
	125	+12.5	0	-3.3	- 4.2	-12.3	-15.6
	75	-16.6	- 4.5	-1.6	+ 5.1	+19.2	+24.3
	50	-38.0	-17.2	-3.3	+ 8.8	+51.6	+65.6
+10	100	0	0	0	0.4	+ 0.6	+ 0.6
	125	+12.2	+ 0.3	-3.0	- 3.9	-11.7	-15.0
	75	-16.7	- 4.5	-2.0	+ 5.3	+19.6	+24.8
	50	-38.0	-17.3	-3.2	+ 8.9	+52.0	+66.0
+20	100	- 3.8	- 0.2	+1.9	+ 3.1	+ 6.1	+ 7.3
	75	-19.5	- 5.2	-2.6	+ 7.6	+24.7	+31.0
	50	-40.0	-18.1	-3.1	+10.6	+56.5	+71.6

Table 6 Yield per recruit assessment for S Gulf St Lawrence/SE Nova Scotia, sexes combined

CURRENT MIN. SIZE (mm CL)

64

MEAN FISHING MORTALITY (F)

1.5

M 0.1

K 0.108

L_∞ 159

Min. Size Increment (mm CL)	% of current fishing mortality	% change in Y/R after 1	3 Years	5	Long-term	% change in Biomass	Eggs
0	125	+ 1.8	- 3.6	- 4.5	- 4.5	- 20.6	- 36.0
	75	- 6.3	+ 0.01	+ 6.0	+ 6.0	+ 34.2	+ 75.2
	50	-21.0	+ 7.2	+12.4	+12.4	+ 98.8	+251.8
+ 5	100	- 7.1	+ 7.3	+ 8.6	+ 8.6	+ 42.5	+ 50.5
	125	- 3.6	+ 2.7	+ 3.6	+ 3.6	+ 21.2	+ 5.0
	75	-14.8	+10.1	+14.2	+14.3	+ 77.3	+140.0
	50	-29.7	+10.5	+ 8.6	+19.2	+141.5	+335.6
+10	100	-35.6	+18.8	+23.0	+23.0	+128.9	+203.0
	125	-31.0	+16.4	+18.1	+18.4	+ 47.6	135.8
	75	-42.8	+19.3	+27.8	+27.8	+164.7	+321.1
	50	-54.2	+13.7	+29.3	+29.3	+226.7	+547.4
+15	100	-69.1	+26.1	+36.0	+36.0	+215.6	+428.7
	125	-67.3	+26.4	+31.6	+31.7	+ 47.6	+344.6
	75	-72.4	+19.4	+39.4	+39.4	+249.8	+564.6
	50	-76.4	+13.6	+36.6	+36.6	+306.3	+799.8

Table 7 Yield per recruit assessment for Notre Dame Bay, males

CURRENT MIN.
SIZE (mm CL)

81

MEAN FISHING
MORTALITY (F)

1.12

M 0.1

K 0.2174

L∝ 121.6

Min. Size Increment (mm CL)	% of current fishing mortality	% change in Y/R after 1	2	3 Years	4	5	Long-term	% change in Biomass
0	125	+ 2	-	- 2	-	- 2	- 2	- 16
	75	- 6	-	+ 1	-	-13	+ 3	+ 27
	50	-20	-	- 2	-	+ 4	+ 6	+ 80
+ 5	100	-10	+ 3	- 5	+ 6	+ 6	+ 6	+ 45
	125	- 6	+ 4	+ 4	+ 4	+ 4	+ 4	+ 36
	75	-18	+ 1	+ 5	+ 7	+ 8	+ 9	+ 71
	50	-31	- 9	- 1	+ 4	+ 7	+11	+123
+10	100	-40	+ 1	+10	+12	+14	+15	+125
	125	-36	+ 5	+10	+12	+12	+13	+108
	75	-48	- 6	+ 6	+11	+14	+17	+753
	50	-58	-21	- 5	+ 3	+ 9	+16	+205
+15	100	-87	-45	- 3	+12	+20	+25	+259
	125	-84	-37	+ 4	+17	+22	+24	+239
	75	-89	-53	-14	+ 4	+15	+24	+288
	50	-92	-65	-31	-12	+ 2	+18	+336

Table 8 Yield per recruit assessment for Notre Dame Bay, females

CURRENT MIN.
SIZE (mm CL)

81

MEAN FISHING
MORTALITY (F)

0.66

M 0.1

K 0.1962

L_∞ 117.27

Min. Size Increment (mm CL)	% of current fishing mortality	% change in Y/R after 1	3 Years	5	Long-term	% change in biomass
0	125	+ 4	- 1	- 1	- 1	- 18
	75	- 8	- 1	0	+ 1	+ 31
	50	-24	- 9	- 5	- 2	+ 91
+ 5	100	-18	+ 2	+ 4	+ 4	+ 63
	125	-12	+ 3	+ 4	+ 4	+ 45
	75	-28	- 2	+ 2	+ 4	+ 95
	50	-42	-13	- 7	- 2	+156
+10	100	-74	- 9	+ 2	+ 6	+200
	125	-70	- 2	+ 6	+ 8	+176
	75	-78	-19	- 6	+ 1	+236
	50	-84	-35	-20	-10	+296
+15	100	-94	-45	-14	- 1	+321
	125	-93	-37	- 6	+ 4	+296
	75	-95	-55	-26	-10	+355
	50	-97	-67	-42	-25	+403

Table 9 Yield per recruit assessment of Placentia Bay, females

CURRENT MIN.
SIZE (mm CL)

81

MEAN FISHING
MORTALITY (F)

0.71

M 0.1

K 0.2168

L_∞ 116.15

Min. Size Increment (mm CL)	% of current fishing mortality	% change in Y/R after 1	3 Years	5	Long-term	% change in Biomass	Eggs
0	125	+ 7	0	- 1	- 1	- 7	- 8
	75	-12	- 3	0	+ 1	+ 11	+ 13
	50	-30	-12	- 5	+ 1	+ 32	+ 35
+ 5	100	-17	+ 1	+ 4	+ 4	+ 18	+ 20
	125	- 9	+ 2	+ 3	+ 3	+ 11	+ 13
	75	-28	- 4	+ 2	+ 5	+ 29	+132
	50	-46	-16	- 6	+ 3	+ 49	+ 53
+10	100	-58	- 5	+ 6	+ 9	+ 50	+ 55
	125	-52	0	+ 7	+ 9	+ 43	+ 48
	75	-65	-14	+ 1	+ 8	+ 61	+ 67
	50	-74	-30	-12	+ 4	+ 78	+ 85
+15	100	-85	-28	0	+10	+ 81	+ 89
5	125	-83	-21	+ 5	+11	+ 75	+ 82
	75	-87	-39	- 8	-18	+ 91	+ 99
	50	-91	-53	-24	- 1	+106	+115

Table 10 Yield per recruit assessment for Le Conquet, France, males

CURRENT MIN.
SIZE (mm CL)

80

MEAN FISHING
MORTALITY (F)

0.20

M 0.1

K 0.1

L∝ 200

Min. Size Increment (mm CL)	% of current fishing mortality	% change in Y/R after 1	2 Years	3	Long-term	% change in Biomass
0	125	+19	+14	+ 9	-3	-14
	75	-21	-17	-14	+3	+20
	50	-45	-39	-34	+3	+51
+ 5	100	0	0	0	+1	+ 1
	125	+18	+13	+ 9	-3	-13
	75	-21	-18	-14	+3	+21
	50	-45	-39	-34	+3	+52
+10	100	- 1	- 1	- 1	+1	+ 3
	125	+17	+13	+ 9	-2	-11
	75	-22	-18	-15	+4	+22
	50	-45	-40	-35	+4	+53
+15	100	- 3	- 2	- 2	+3	+ 6
	125	+15	+11	+ 8	+1	- 8
	75	-24	-19	-16	+6	+27
	50	-46	-41	-35	+4	+56

Table 11 Yield per recruit assessment for SE Ireland, males

CURRENT MIN.
SIZE (mm CL)

83

MEAN FISHING
MORTALITY (F)

0.57

M 0.1

K 0.1090

L∝ 197.80

Min. Size Increment (mm CL)	% of current fishing mortality	% change in Y/R after 1	2	3 Years	4	5	Long-term	% change in Biomass
0	125	9	2	- 2	-3	- 4	- 4	-14
	75	-16	- 8	- 1	3	6	9	30
	50	-36	-23	-11	-2	6	19	80
+ 5	100	- 6	- 2	1	3	4	6	13
	125	4	1	0	0	0	12	- 4
	75	-20	- 9	- 1	4	8	13	40
	50	-39	-25	-12	-2	7	23	90
+10	100	-14	- 4	2	6	9	12	30
	125	- 5	0	3	5	6	7	13
	75	-27	-13	- 2	6	12	19	57
	50	-45	-26	-14	-2	8	28	106

Table 12 Yield per recruit assessment for SE Ireland, females

CURRENT MIN.
SIZE (mm CL)

83

MEAN FISHING
MORTALITY (F)

0.41

M 0.1

K 0.1390

L∝ 158.50

Min. Size Increment (mm CL)	% of current fishing mortality	% change in Y/R after 1	2	3 Years	4	5	Long-term	% change in Biomass	Eggs
0	125	12	7	5	3	2	0	-11	- 24
	75	-21	-14	-10	- 7	- 5	2	28	54
	50	-42	-34	-27	-22	-18	-3	66	139
+ 5	100	-10	- 5	- 1	1	2	5	15	20
	125	4	4	5	4	4	4	-13	- 11
	75	-26	-18	-12	- 7	- 4	5	38	71
	50	-47	-37	-29	-23	-19	-2	76	155
+10	100	-20	-10	- 4	0	3	9	30	44
	125	- 8	0	3	6	7	9	15	11
	75	-35	-23	-15	- 9	- 5	8	53	95
	50	-53	-42	-33	-26	-20	-1	89	179

Table 13 Yield per recruit assessment for W Norway, sexes combined

CURRENT MIN.
SIZE (mm CL)

78

MEAN FISHING
MORTALITY (F)

0.95

M 0.1

K 0.15

L_∞ 50 (cm TL)

Min. Size Increment (mm CL)	% of current fishing mortality	% change in Y/R after 1	3 Years	5	Long-term	% change in Biomass	Eggs
+ 5	100	- 2	+2	+ 3	+ 3	+ 6	+ 7
	125	+ 6	-2	- 3	- 3	- 9	- 8
	75	-15	+2	+ 8	+11	+30	+27
	50	-33	-4	+10	+21	+76	+55
+10	100	- 7	+4	+ 7	+ 8	+15	+21
	125	+ 1	+2	+ 3	+ 3	+ 1	+ 8
	75	-19	+4	+12	+16	+40	+40
	50	-37	-4	+12	+25	+86	+65
+15	100	-11	+7	+12	+13	+25	+35
	125	- 4	+5	+ 7	+ 6	+10	+23
	75	-23	+5	+15	+20	+49	+52
	50	-40	-4	+14	+28	+95	+75

Table 14 Yield per recruit assessment for Norway, Skagerak, males

CURRENT MIN.
SIZE (mm CL)

78

MEAN FISHING
MORTALITY (F)

0.88

M 0.1

K 0.15

L∝ 40 (cm, TL)

Min. Size Increment (mm CL)	% of current fishing mortality	% change in Y/R after 1	3 Years	5	Long-term	% change in Biomass
0	125	+ 7	-3	- 5	- 5	- 18
	75	-12	+2	+ 6	+ 7	+ 28
	50	-31	-2	+14	+15	+ 77
+ 5	100	- 6	+2	+ 4	+ 5	+ 15
	125	+ 1	0	0	0	- 2
	75	-17	+3	+10	+11	+ 43
	50	-35	+2	+16	+18	+ 91
+10	100	-20	+5	+13	+13	+ 47
	125	-13	+5	+ 9	+ 9	+ 30
	75	-30	+4	+18	+19	+ 73
	50	-45	-4	+21	+25	+119
+15	100	-35	+7	+20	+20	+ 76
	125	-30	+8	+16	+16	+ 59
	75	-44	+3	+24	+25	+101
	50	-56	-7	+26	+30	+146

Table 15 Yield per recruit assessment for Norway, Skagerak, females

CURRENT MIN.
SIZE (mm CL)

76

MEAN FISHING
MORTALITY (F)

0.70

M 0.1

K 0.33

L∞ 32.5 (cm, TL)

Min. Size Increment (mm CL)	% of current fishing mortality	% change in Y/R after 1	3 Years	5	Long-term	% change in Biomass	Eggs
0	125	+10	0	2	- 3	- 17	- 23
	75	-14	- 4	0	+ 3	+ 26	+ 34
	50	-35	-16	- 7	+ 2	+ 68	+ 89
+ 5	100	- 6	+ 2	+ 3	+ 4	+ 15	+ 17
	125	+ 4	+ 3	+ 2	+ 1	- 1	- 6
	75	-19	- 4	+ 2	+ 6	+ 40	+ 50
	50	-39	-17	- 6	+ 4	+ 81	+104
+10	100	-20	+ 2	+ 8	+10	+ 47	+ 59
	125	-11	+ 6	+ 8	+ 9	+ 31	+ 37
	75	-33	- 5	+ 5	+11	+ 70	+ 91
	50	-50	-20	- 6	+ 7	+108	+141
+15	100	-35	0	+10	+14	+ 73	+ 97
	125	-27	+ 5	+12	+13	+ 58	+ 76
	75	-46	- 9	+ 5	+14	+ 95	+127
	50	-60	-25	- 8	+ 9	+131	+172

Table 16 Yield per recruit assessment for Yorkshire, England, males

CURRENT MIN. SIZE (mm CL)

80

MEAN FISHING MORTALITY (F)

0.93

M 0.1

K 0.0913

L_∞ 209

Min. Size Increment (mm CL)	% of current fishing mortality	% change in Y/R after 1 Years	3	5	Long-term	% change in Biomass
0	125	+ 6	+ 5	- 6	- 6	- 19
	75	-11	+ 7	+ 9	+ 9	+ 32
	50	-29	+ 2	+19	+25	+ 95
+ 5	100	- 8	+ 6	+ 9	+10	+ 27
	125	- 1	+ 3	+ 4	+ 4	+ 8
	75	-19	+ 7	+17	+19	+ 60
	50	-36	+ 2	+25	+33	+123
+10	100	-24	+12	+21	+23	+ 67
	125	-17	+11	+16	+17	+ 46
	75	-34	+10	+27	+31	+100
	50	-48	+ 2	+32	+45	+165
+15	100	-45	+17	+33	+35	+109
	125	-40	+18	+29	+30	+ 88
	75	-52	+12	+37	+44	+143
	50	-62	- 1	+39	+55	+207

Table 17 Yield per recruit assessment for Yorkshire, England, females

CURRENT MIN.
SIZE (mm CL)

80

MEAN FISHING
MORTALITY (F)

0.84

M 0.1

K 0.1088

L∝ 168

Min. Size Increment (mm CL)	% of current fishing mortality	% change in Y/R after 1	2	3 Years	4	5	Long-term	% change in Biomass	Eggs
0	125	7	0	- 2	- 3	- 4	- 4	- 16	- 30
	75	-12	- 4	0	2	4	5	28	59
	50	-30	-16	- 7	- 1	4	12	82	196
+ 5	100	-13	- 1	3	5	6	7	29	42
	125	- 6	1	3	3	4	4	13	7
	75	-24	- 7	1	6	9	12	57	108
	50	-40	-20	- 8	0	7	17	113	255
+10	100	-36	- 6	6	11	14	16	71	117
	125	-30	- 1	7	10	12	12	53	75
	75	-45	-14	1	9	14	20	100	193
	50	-57	-29	-12	- 1	8	23	155	352
+15	100	-60	-19	4	14	19	23	116	216
	125	-56	-13	8	15	19	20	98	168
	75	-65	-29	- 5	9	18	27	146	300
	50	-73	-43	-20	- 4	9	29	202	470

Table 18 Yield per recruit assessment for Cardigan, Wales, males

CURRENT MIN. SIZE (mm CL)

80

MEAN FISHING MORTALITY (F)

0.5

M 0.1

K 0.1105

L∞ 175

Min. Size Increment (mm CL)	% of current fishing mortality	% change in Y/R after 1	3 Years	5	Long-term	% change in Biomass
0	125	+10	0	- 3	- 5	- 24
	75	-15	- 5	0	+ 6	+ 41
	50	-35	-17	- 7	+10	+117
+ 5	100	+ 9	+ 2	+ 5	+ 9	+ 33
	125	+ 1	+ 4	+ 4	+ 4	+ 6
	75	-24	- 5	+ 3	+14	+ 76
	50	-43	-20	- 7	+16	+152
+10	100	-32	+ 1	+11	+22	+ 91
	125	-22	+ 6	+13	+18	+ 62
	75	-44	- 9	+ 6	+26	+127
	50	-59	-26	- 8	+24	+212
+15	100	-53	- 5	+14	+33	+146
	125	-46	+ 3	+18	+30	+115
	75	-61	-17	+ 5	+35	+192
	50	-72	-34	-12	+29	+263

Table 19 Yield per recruit assessment for Cardigan, Wales, females

CURRENT MIN. SIZE (mm CL)

80

MEAN FISHING MORTALITY (F)

0.54

M 0.1

K 0.0947

L∝ 175

Min. Size Increment (mm CL)	% of current fishing mortality	% change in Y/R after 1	2	3 Years	4	5	Long-term	% change in Biomass	Eggs
0	125	10	4	1	- 1	- 2	- 4	- 23	- 32
	75	-14	- 9	- 5	- 3	- 1	4	39	58
	50	-34	-25	-18	-13	- 9	6	107	168
+ 5	100	-14	- 4	0	2	4	7	41	46
	125	- 4	1	3	3	3	4	16	8
	75	-27	-14	- 7	- 3	1	11	81	110
	50	-45	-32	-22	-16	-10	10	149	226
+10	100	-43	-17	- 5	1	6	18	108	135
	125	-36	-10	1	5	8	15	81	90
	75	-53	-29	-16	- 8	- 1	19	149	207
	50	-65	-45	-32	-24	-15	15	213	324
+15	100	-64	-37	-16	- 5	4	25	167	226
	125	-59	-30	- 9	1	9	23	140	177
	75	-71	-47	-28	-16	- 5	25	206	299
	50	-78	-60	-44	-33	-22	17	265	411

Table 20 Yield per recruit assessment for Cornwall, England, males

CURRENT MIN. SIZE (mm CL)

80

MEAN FISHING MORTALITY (F)

0.309

M 0.1

K 0.0914

L∝ 200

Min. Size Increment (mm CL)	% of current fishing mortality	% change in Y/R after 1	3 Years	5	Long-term	% change in Biomass
0	125	+17	+ 7	+ 2	- 5	- 22
	75	-20	-11	- 7	+ 4	+ 33
	50	-42	-30	-21	+ 1	+ 86
+ 5	100	- 6	- 1	+ 2	+ 6	+ 15
	125	+10	+ 7	+ 5	+ 2	- 8
	75	-25	-13	- 6	+ 8	+ 48
	50	-46	-31	-22	+ 4	+ 99
+10	100	-13	- 2	+ 4	+ 8	+ 7
	125	+ 2	+ 6	+ 8	+11	+ 29
	75	-41	-15	- 6	+13	+ 62
	50	-50	-34	-22	+ 6	+113
+15	100	-23	- 5	+ 4	+18	+ 50
	125	- 9	+ 4	+10	+15	+ 27
	75	-39	-19	- 6	+18	+ 83
	50	-56	-38	-24	+ 9	+131

Table 21 Yield per recruit assessment for Cornwall, England, females

CURRENT MIN.
SIZE (mm CL)

80

MEAN FISHING
MORTALITY (F)

0.23

M 0.1

K 0.0689

L∝ 200

Min. Size Increment (mm CL)	% of current fishing mortality	% change in Y/R after 1	2	3 Years	4	5	Long-term	% change in Biomass	Eggs
0	125	17	11	7	3	1	-3	-15	- 19
	75	-20	-15	-11	- 8	- 5	3	21	29
	50	-43	-36	-29	-23	-18	3	55	76
+ 5	100	- 4	- 3	- 2	- 1	- 1	2	6	7
	125	13	8	5	2	1	-1	- 8	- 13
	75	-23	-18	-13	- 9	- 6	5	27	35
	50	-45	-38	-31	-25	-19	4	60	82
+10	100	- 9	- 7	- 5	- 3	- 2	5	15	16
	125	6	3	2	1	0	3	1	- 3
	75	-27	-21	-16	-11	- 7	7	35	44
	50	-48	-40	-33	-26	-20	5	66	90
+15	100	-16	-13	- 9	- 6	- 3	8	25	28
	125	- 2	- 3	- 3	- 2	0	6	11	9
	75	-32	-26	-20	-14	- 9	9	44	55
	50	-52	-44	-36	-29	-22	7	74	100

Table 22 Yield per recruit assessment for SE Scotland, males

CURRENT MIN.
SIZE (mm CL)

80

MEAN FISHING
MORTALITY (F)

1.1

M 0.1

K 0.0913

L∝ 209

Min. Size Increment (mm CL)	% of current fishing mortality	% change in Y/R after 1	3 Years	5	Long-term	% change in Biomass
0*	100	- 1	1	2	2	5
	125	3	- 3	- 4	- 4	- 14
	75	-11	6	10	10	36
	50	-27	5	20	24	101
+ 5	100	- 9	8	12	12	36
	125	- 3	5	6	6	17
	75	-19	10	19	20	69
	50	-35	7	27	33	134
+10	100	-28	16	25	25	82
	125	-22	15	20	20	62
	75	-37	15	31	34	117
	50	-50	7	36	45	183

* Takes account of sub-legal landings at present minimum size.

Table 23 Yield per recruit assessment for SE Scotland, females

CURRENT MIN.
SIZE (mm CL)

80

MEAN FISHING
MORTALITY (F)

1.1

M 0.1

K 0.1088

L∝ 169

Min. Size Increment (mm CL)	% of current fishing mortality	% change in Y/R after 1 Years	3	5	Long-term	% change in Biomass	Eggs
0*	125	3	- 1	- 2	- 2	- 9	- 35
	100	- 3	1	2	2	8	9
	75	-14	1	5	7	37	113
	50	-31	- 5	6	14	96	413
+ 5	100	-17	5	9	10	42	66
	125	-10	5	6	6	24	9
	75	-27	3	11	15	72	192
	50	-43	- 6	8	21	131	532
+10	100	-43	8	16	19	91	186
	125	-37	10	15	16	73	111
	75	-50	3	16	24	123	347
	50	-61	-11	10	28	183	746

* Takes account of sub-legal landings at present minimum size.

Table 24 Yield per recruit assessment for W Scotland, males

CURRENT MIN.
SIZE (mm CL)

80

MEAN FISHING
MORTALITY (F)

0.55

M 0.1

K 0.1200

L∝ 196.60

Min. Size Increment (mm CL)	% of current fishing mortality	% change in Y/R after 1	3 Years	5	Long-term	% change in Biomass
0*	125	8	3	- 5	- 6	- 14
	100	- 1	1	1	2	3
	75	-15	1	9	12	31
	50	-35	-7	14	27	84
+ 5	100	- 6	3	7	8	15
	125	4	<1	- 1	- 1	- 2
	75	-19	2	13	18	43
	50	-38	-7	16	32	95
+10	100	-13	5	13	16	31
	125	- 4	4	8	9	14
	75	-25	2	18	26	60
	50	-43	-8	18	38	111

* Takes account of sub-legal landings at present minimum size.

Table 25 Yield per recruit assessment for W Scotland, females

CURRENT MIN. SIZE (mm CL)

80

MEAN FISHING MORTALITY (F)

0.49

M 0.1

K 0.1700

L∞ 160.30

Min. Size Increment (mm CL)	% of current fishing mortality	% change in Y/R after 1	3 Years	5	Long-term	% change in Biomass	Eggs
0*	125	12	4	2	- 1	- 14	- 34
	100	- 1	< 1	1	1	3	4
	75	-19	- 9	- 4	1	30	71
	50	-40	-24	-16	- 5	75	195
+ 5	100	- 7	1	4	6	15	20
	125	6	6	6	5	- 3	- 21
	75	-24	- 9	- 2	5	42	90
	50	-44	-25	-16	- 3	86	217
+10	100	-16	1	7	11	31	43
	125	- 3	7	10	11	13	- 1
	75	-31	-10	- 1	8	58	118
	50	-50	-28	-17	- 2	101	248

* Takes account of sub-legal landings at present minimum size.

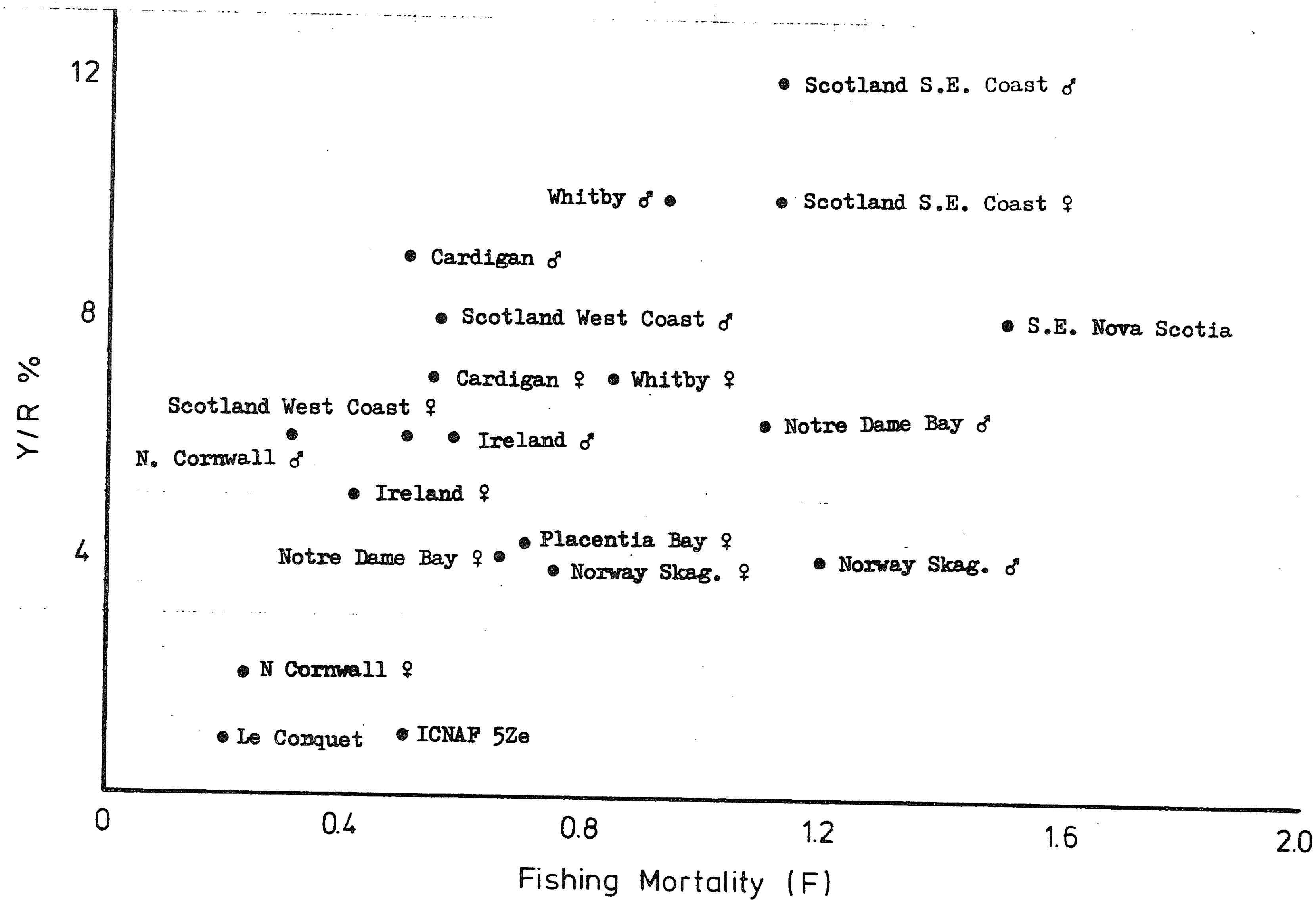

Figure 1 Long term increase in lobster Y/R due to 5mm increase in minimum size.

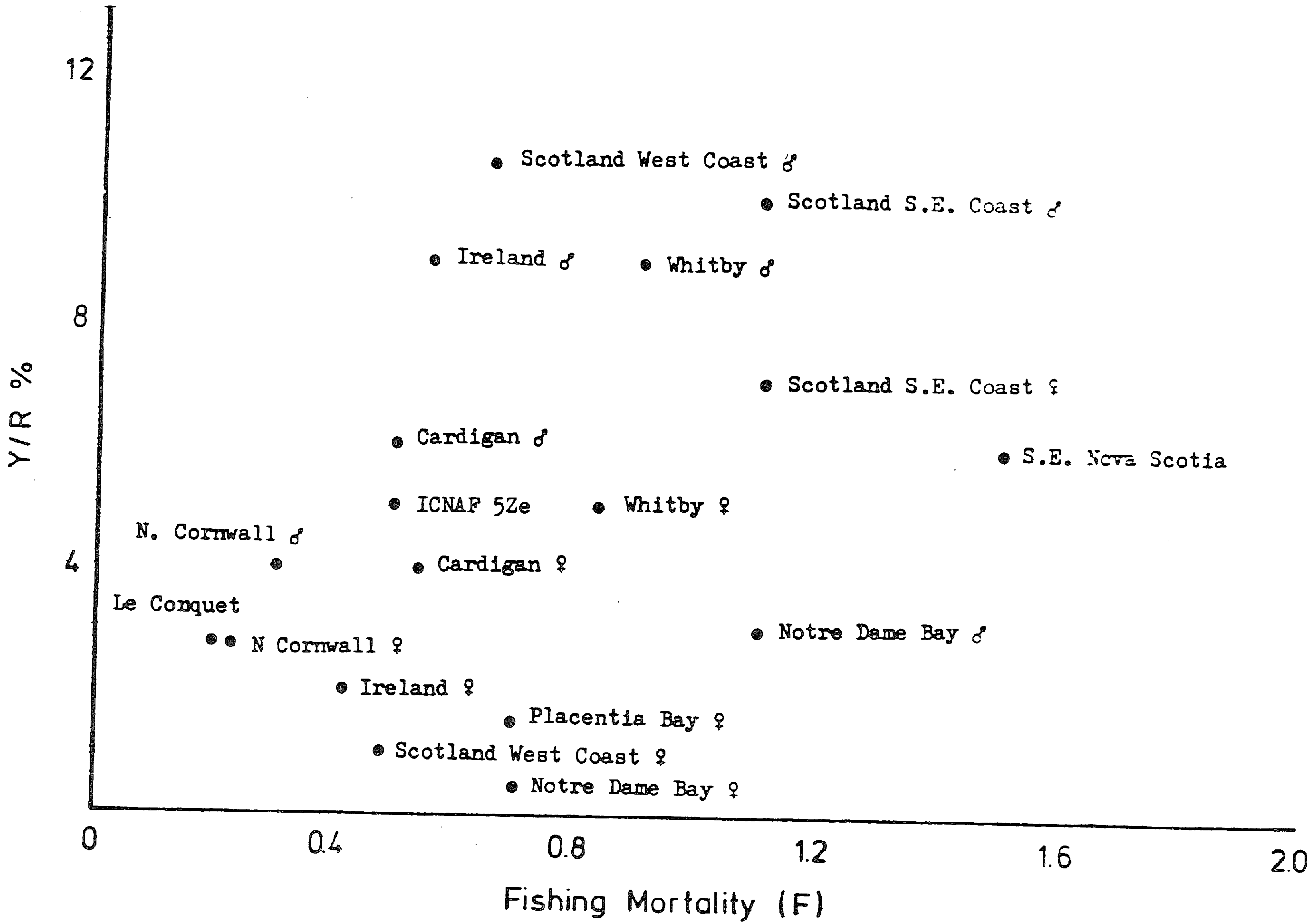

Figure 2 Long term increase in lobster Y/R due to a 25% decrease in effort.

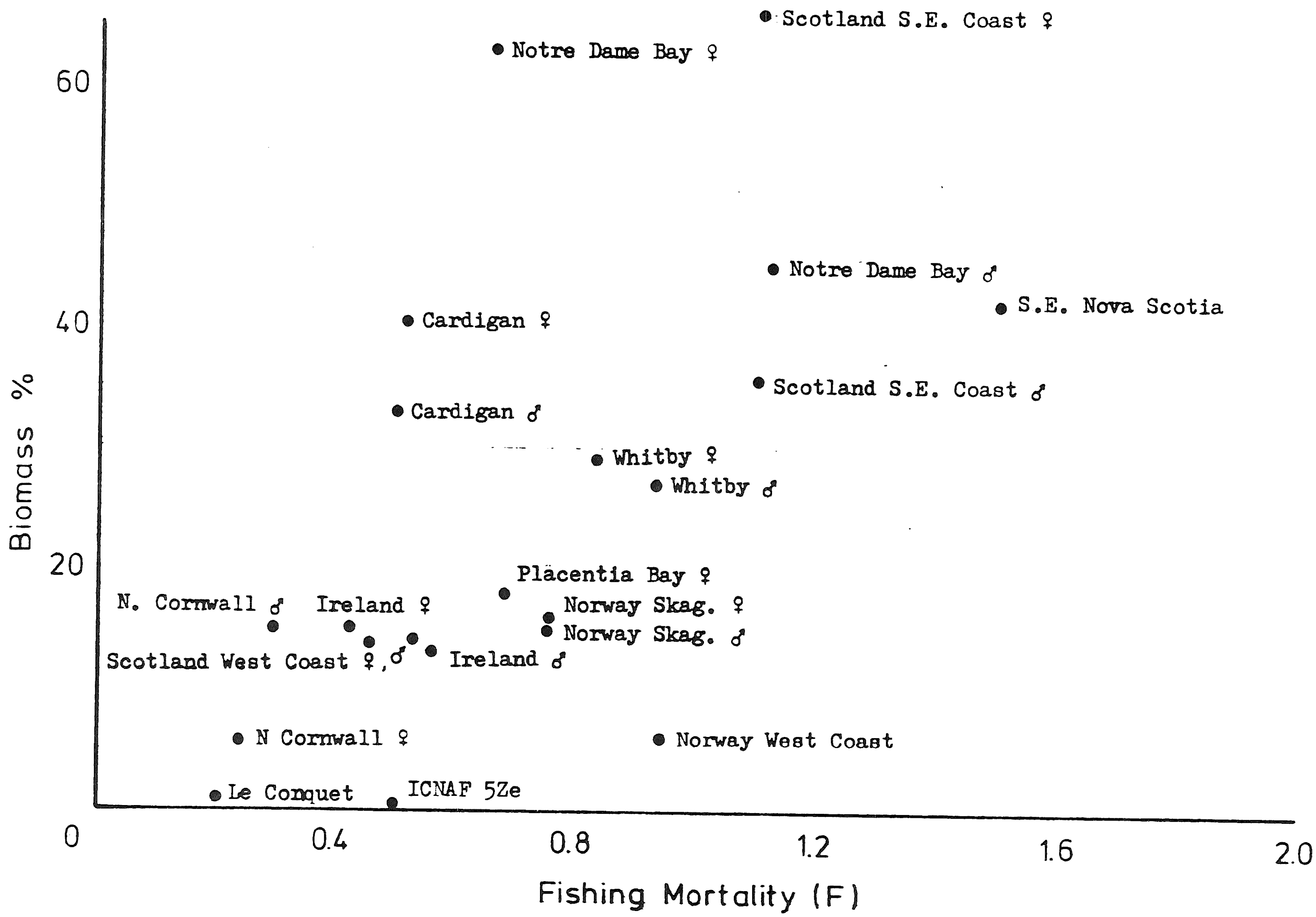

Figure 3 Increase in biomass of lobsters with an increase of 5mm in minimum size.

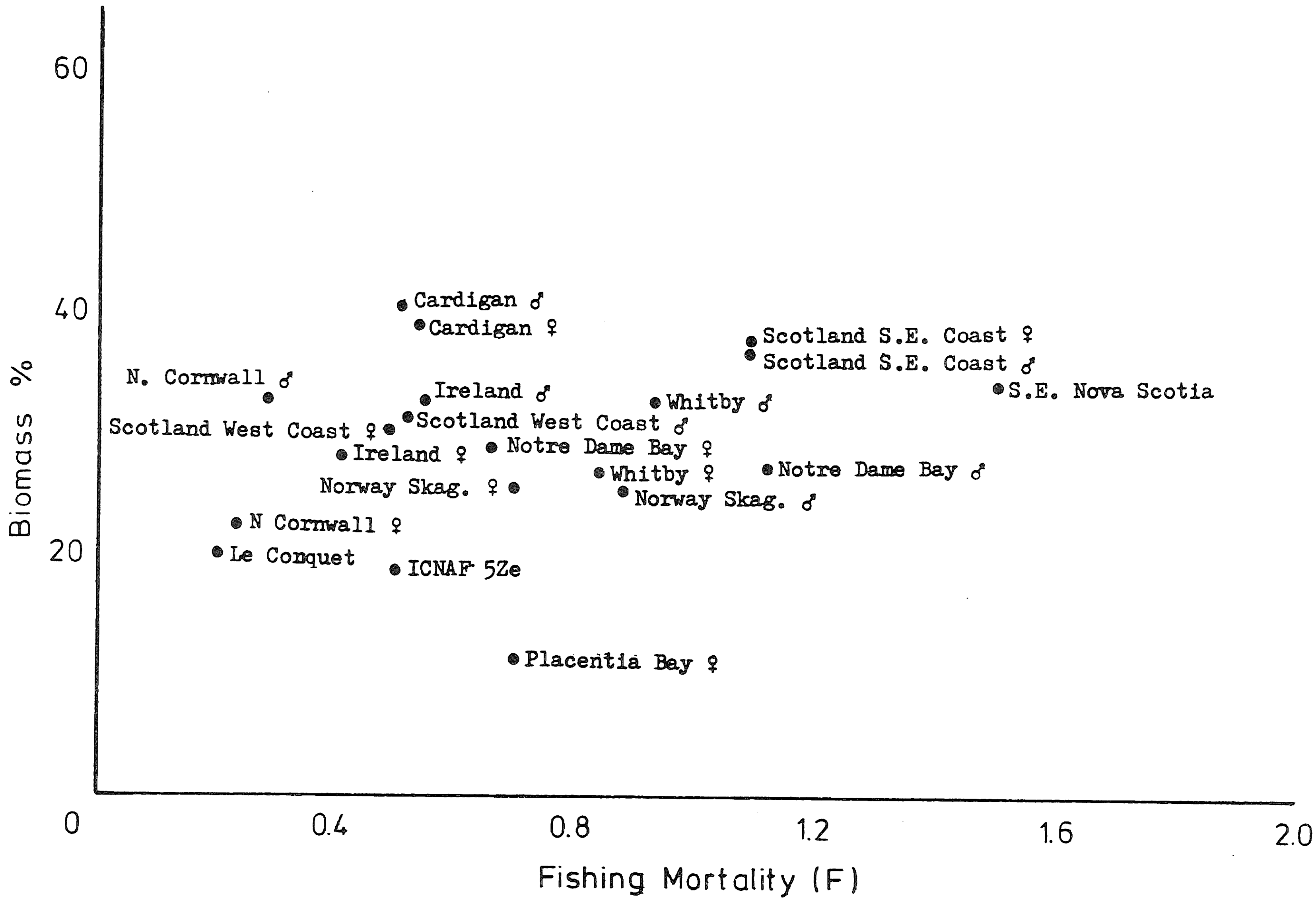

Figure 4 Increase in biomass of lobsters with a decrease of fishing mortality of 25%.

5. DATA APPENDIX

SIZE FREQUENCY DISTRIBUTIONS (NOS/MILLE) USED IN ASSESSMENTS

ICNAF Area 5Ze, ♂ + ♀

CL (mm)	‰
80	1.62
85	7.29
90	19.45
95	20.26
100	45.38
105	87.52
110	94.00
115	139.38
120	117.50
125	108.59
130	96.43
135	70.50
140	52.67
145	45.38
150	28.36
155	23.50
160	11.35
165	12.97
170	10.53
175	3.24
180	2.43
185	1.62

Notre Dame Bay, ♀

CL (mm)	‰
81	217.84
83	219.90
85	206.77
87	172.24
89	98.69
91	35.26
93	17.30
95	14.86
97	6.17
99	4.17
101	2.23
103	2.07
105	.97
107	.00
109	.80
111	.00
113	.00
115	.50
117	.23

S. Gulf St Lawrence/SE Nova Scotia, ♂ + ♀

CL (mm)	‰
65	375.59
70	375.59
75	140.85
80	56.34
85	32.86
90	14.08
95	4.69

Notre Dame Bay, ♂

CL (mm)	‰
81	166.37
83	170.86
85	176.59
87	178.48
89	129.82
91	97.72
93	39.69
95	16.08
97	8.30
99	5.06
101	5.56
103	1.69
105	1.15
107	1.69
109	.24
111	.24
113	.47

Placentia Bay, ♀

CL (mm)	‰
65	.00
67	.00
69	.00
71	.00
73	.00
75	.00
77	.00
79	.00
81	145.45
83	185.76
85	173.89
87	156.79
89	130.45
91	76.34
93	39.44
95	31.40
97	22.34
99	14.60
101	10.37
103	5.47
105	3.33
107	1.33
109	1.30
111	1.13
113	.60

Le Conquet, France, ♂

CL (mm)	°/oo
75	2.95
80	12.54
85	27.56
90	58.28
95	84.41
100	99.17
105	106.07
110	104.38
115	82.31
120	80.99
125	63.44
130	52.43
135	46.00
140	39.26
145	35.88
150	29.72
155	24.82
160	19.92
165	13.28
170	9.22
175	4.06
180	3.06
185	.26

SE Ireland, ♂

CL (mm)	°/oo
76	3.97
81	95.77
86	171.64
91	175.00
96	146.87
101	118.11
106	90.61
111	61.60
116	45.13
121	29.47
126	26.48
131	15.15
136	11.04
141	5.42
146	1.97
151	1.68
156	.00
161	.00
166	.09

SE Ireland, ♀

CL (mm)	°/oo
71	.70
76	14.90
81	124.81
86	172.91
91	157.63
96	166.64
101	127.46
106	73.71
111	54.04
116	31.94
121	29.63
126	19.49
131	12.25
136	6.47
141	3.35
146	2.02
151	.83
156	1.21

W Norway, ♂ + ♀

TL (cm)	°/oo
19	.15
20	1.08
21	12.85
22	60.85
23	76.34
24	102.20
25	114.28
26	121.24
27	107.46
28	87.80
29	89.81
30	61.47
31	48.16
32	34.38
33	27.56
34	21.52
35	11.61
36	7.28
37	5.42
38	2.48
39	2.48
40	2.32
41	.46
42	.15
43	.15
44	.15
45	.15
46	.15

Norway, Skagerak, ♂

TL (cm)	°/oo
22	166.75
23	170.50
24	196.65
25	154.79
26	104.71
27	84.54
28	50.89
29	30.61
30	25.34
31	12.67
32	2.53

Norway, Skagerak, ♀

TL (cm)	°/oo
22	165.24
23	178.32
24	190.67
25	143.57
26	120.45
27	80.26
28	49.39
29	35.48
30	23.02
31	10.46
32	3.14

Yorkshire, England, ♂

CL (mm)	°/oo
75	25.02
80	287.32
85	270.37
90	159.45
95	89.08
100	67.94
105	38.85
110	30.96
115	14.12
120	9.23
125	3.81
130	3.56
135	0.13
140	0.18

Yorkshire, England, ♀

CL (mm)	°/oo
75	47.86
80	305.42
85	291.55
90	164.87
95	99.23
100	46.82
105	21.04
110	11.56
115	7.27
120	2.28
125	1.19
130	0.48
135	0.26
140	0.17

Cardigan, Wales, ♂

CL (mm)	°/oo
80	305.08
85	309.03
90	146.62
95	87.14
100	53.38
105	29.92
110	22.08
115	14.51
120	9.37
125	7.51
130	4.21
135	4.86
140	6.30

Cardigan, Wales, ♀

CL (mm)	°/oo
80	367.70
85	309.27
90	132.36
95	78.36
100	37.99
105	20.97
110	15.54
115	13.26
120	8.60
125	8.76
130	7.19

Cornwall, England, ♂

CL (mm)	‰
80	169.95
85	139.13
90	155.61
95	133.90
100	97.52
105	94.36
110	40.49
115	38.44
120	38.33
125	23.98
130	13.01
135	9.62
140	3.00
145	10.01
150	10.62
155	3.06
160	18.98

Cornwall, England, ♀

CL (mm)	‰
80	91.33
85	111.08
90	115.22
95	125.07
100	113.51
105	84.74
110	79.74
115	60.45
120	78.02
125	55.88
130	27.94
135	28.68
140	16.16
145	6.72
150	5.46

SE Scotland, ♂

CL (mm)	‰
75	56.99
80	313.94
85	271.95
90	155.97
95	68.99
100	63.99
105	27.99
110	22.00
115	11.00
120	5.00
125	1.00
130	1.00
135	.10
140	.10

SE Scotland, ♀

CL (mm)	‰
75	93.80
80	334.85
85	276.35
90	146.24
95	74.63
100	41.35
105	16.14
110	8.07
115	4.03
120	2.72
125	1.21
130	.40
135	.20

W Scotland, ♂

CL (mm)	‰
70	2.00
75	39.03
80	148.10
85	163.11
90	160.11
95	118.08
100	106.07
105	78.05
110	48.03
115	43.03
120	28.02
125	29.02
130	19.01
135	9.01
140	6.00
145	2.00
150	1.00
155	.30

W Scotland, ♀

CL (mm)	‰
70	2.00
75	41.00
80	157.00
85	164.00
90	154.00
95	133.00
100	106.00
105	79.00
110	56.00
115	38.00
120	24.00
125	14.00
130	12.00
135	8.00
140	3.00
145	3.00
150	4.00
155	1.00
160	1.00