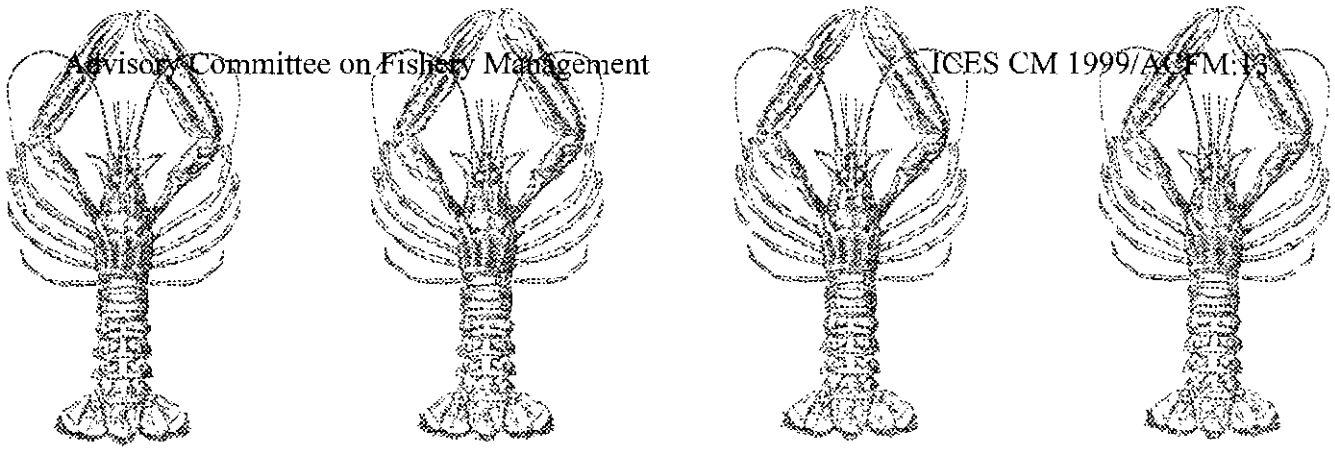
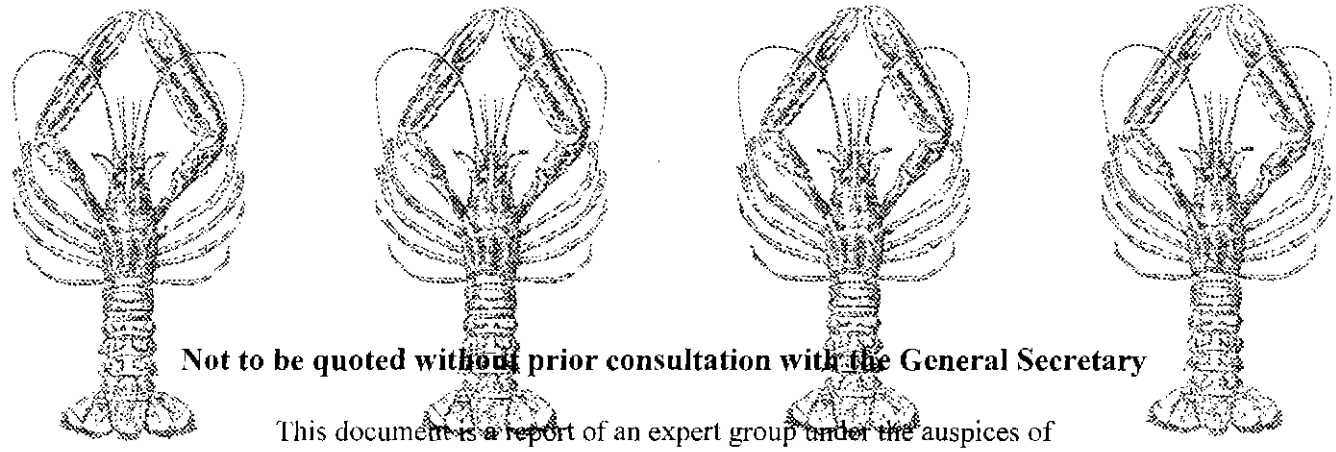


Report of the Working Group on *Nephrops* Stocks

Ostend, Belgium, 15-22 April 1999

Part 1



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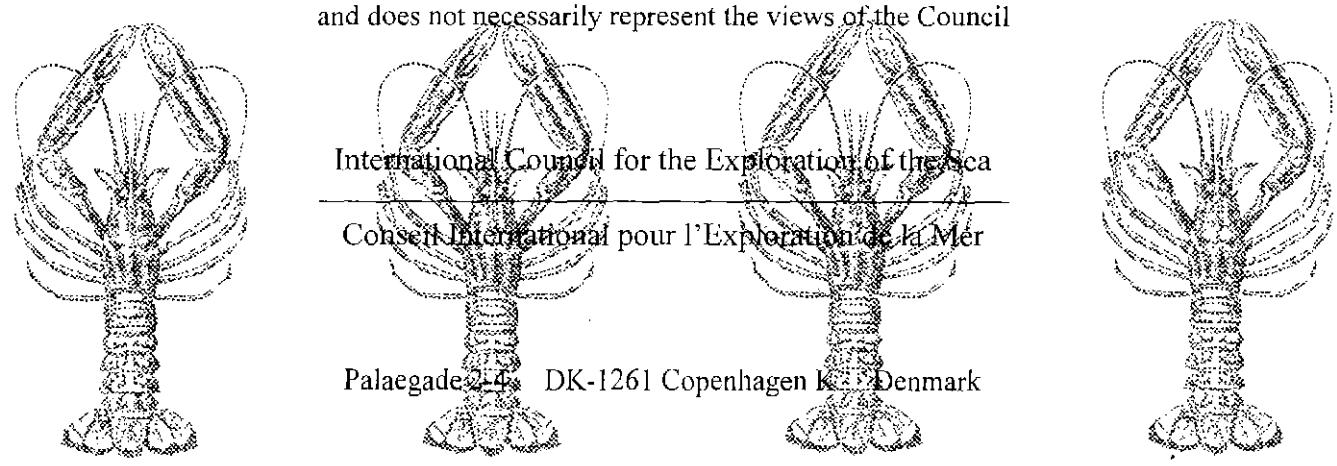


International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palaegade 2-4 DK-1261 Copenhagen K Denmark

Table of contents

1.	**Terms of reference**	**5**
2.	**Participants**	**5**
3.	**Methods employed in the assessment of *Nephrops***	**6**
3.1.	Analysis of trends in fishery data	6
3.2.	Analytical assessments	6
3.3.	Fishery independent data	7
3.4.	Judging the status of a stock	7
3.5.	Catch predictions	8
4.	**Input data and biological parameters used in *Nephrops* assessments**	**9**
4.1.	Fishery data	9
4.2.	Length composition sampling	9
4.3.	Biological input parameters	10
	Tables and graphs	11
5.	**Assessments and management possibilities for *Nephrops***	**13**
5.1.	**General introduction**	**13**
5.1.1.	Functional Units, Management Areas and TAC Areas	13
5.1.2.	Assessments	13
5.1.3.	Management considerations, provision of catch options	14
5.1.4.	Section layout	15
	Tables and graphs	17
	Nephrops stocks in ICES Sub-area III	
5.2.	**Management Area E**	**38**
5.2.1.	Description of the fisheries	38
5.2.2.	Skagerrak (FU 3)	40
5.2.3.	Kattegat (FU 4)	41
5.2.4.	Assessment of the *Nephrops* stocks in the Skagerrak-Kattegat area	42
5.2.5.	Summary for Management Area E	44
	Tables and graphs	45
	Nephrops stocks in ICES Sub-area IV	
5.3.	**Management Area F**	**66**
5.3.1.	Moray Firth (FU 9)	66
5.3.2.	Noup (FU 10)	72
5.3.3.	Summary for Management Area F	73
	Tables and graphs	74
5.4.	**Management Area G**	**96**
5.4.1.	Fladen Ground (FU 7)	96
5.4.2.	Summary for Management Area G	101
	Tables and graphs	102

5.5.	**Management Area S**	**115**
5.5.1.	Norwegian Deep (FU 32)	115
5.5.2.	Summary for Management Area S	116
	Tables and graphs	117
5.6.	**Management Area I**	**120**
5.6.1.	Farn Deeps (FU 6)	120
5.6.2.	Firth of Forth (FU 8)	126
5.6.3.	Summary for Management Area I	130
	Tables and graphs	131
5.7.	**Management Area H**	**164**
5.7.1.	Botney Gut - Silver Pit (FU 5)	164
5.7.2.	Off Horn Reef (FU 33)	170
5.7.3.	Summary for Management Area H	171
	Tables and graphs	172
	Nephrops stocks in ICES Sub-area V	
5.8.	**Management Area A**	**189**
5.8.1.	Iceland (FU 1)	189
5.8.2.	Summary for Management Area A	191
	Tables and graphs	192
5.9.	**Management Area B**	**193**
5.9.1.	Faeroes (FU 2)	193
5.9.2.	Summary for Management Area B	193
	Tables and graphs	194
	Nephrops stocks in ICES Sub-area VI	
5.10.	**Management Area D**	**195**
5.11.	**Management Area C**	**196**
5.11.1.	North Minch (FU 11)	196
5.11.2.	South Minch (FU 12)	201
5.11.3.	Firth of Clyde (FU 13)	204
5.11.4.	Summary for Management Area C	210
	Tables and graphs	211
	Nephrops stocks in ICES Sub-area VII	
5.12.	**Management Area J**	**266**
5.12.1.	Irish Sea East (FU 14)	266
5.12.2.	Irish Sea West (FU 15)	270
5.12.3.	Summary for Management Area J	276
	Tables and graphs	277
5.13.	**Management Area K**	**309**
5.14.	**Management Area L**	**310**
5.14.1.	Porcupine Bank (FU 16)	310
5.14.2.	Aran Grounds (FU 27)	313

5.14.3. Irish coast stocks (FUs 18-19) 315
5.14.4. Summary for Management Area L 315
Tables and graphs 316

5.15. Management Area M 332

5.15.1. Celtic Sea (FUs 20-22) 332
5.15.2. Summary for Management Area M 338
Tables and graphs 339

Nephrops stocks in ICES Sub-area VIII

5.16. Management Area N 357

5.16.1. Bay of Biscay (FUs 23-24) 357
5.16.2. Summary for Management Area N 364
Tables and graphs 365

5.17. Management Area O 385

5.17.1. North Galicia (FU 25) 385
5.17.2. Cantabrian Sea (FU 31) 388
5.17.3. Summary for Management Area O 390
Tables and graphs 391

5.18. Management Area P 405

Nephrops stocks in ICES Sub-areas IX and X

5.19. Management Area Q 406

5.19.1. West Galicia (FU 26) and North Portugal (FU 27) 406
5.19.2. South-West and South Portugal (FUs 28-29) 409
5.19.3. Gulf of Cadiz (FU 30) 413
5.19.4. Summary for Management Area Q 413
Tables and graphs 414

5.20. Management Area R 436

6. Correspondence between state of exploitation indices and outcome of analytical assessments 437

Tables and graphs 439

7. Comparison between analytical assessments and fishery independent data 441

7.1. Biomass estimates from annual larval production 441
7.2. Trends in overall abundance estimated from underwater TV surveys 442
7.3. Incorporation of TV abundance estimates in Integrated Catch Analysis 443
7.4. Conclusions 445
Tables and graphs 446

8. Biological reference points 453

8.1. Biological reference points from age-based analytical assessments 453
8.1.1. Yield BRPs 454
8.1.2. Recruitment BRPs 455

8.1.3. Summary and recommendations for future work 457
8.2. Other sources of information for BRPs and related methodological topics 458
8.2.1. Effort and landings per area 458
8.2.2. Indices of female maturity 458
8.3. Economic considerations in relation to growth overfishing 459
Tables and graphs 461

9. Discards **479**

9.1. *Nephrops* discards 479
9.2. Fish discards 480
9.3. Research on discard reducing devices 481
Tables and graphs 482

10. References **498**

Acronyms and abbreviations **504**

Data appendix (only available on CDRom)

1. Terms of reference

The Working Group on *Nephrops* Stocks met in Oostende, Belgium, from 15-22 April 1999 to (ICES Council Resolution 1998 2:4:14):

(a) Assess the status of those *Nephrops* stocks in the ICES area where new methodology or new data justified a new assessment, revising catch options only where necessary.

(b) Continue the work of the *Nephrops* Study Group on precautionary reference points.

(c) Make comparisons between analytical assessment methods and fishery independent data from, for example, TV surveys.

(d) Update information on quantities of discards by gear type and area for the stocks of *Nephrops* and fisheries considered by this group (OSPAR 1997/5.3).

2. Participants

The following scientists attended the meeting of the WG:

N. Bailey	UK, Scotland
M. Bell	UK, England
R. Briggs	UK, Northern Ireland
J. Elson	UK, England
C. Fariña	Spain
J.P. Hillis	Ireland
S. Munch-Petersen	Denmark
F. Redant	Belgium – Chair
C. Silva	Portugal
C. Talidec	France
I. Tuck	UK, Scotland
S. Tveite	Norway
M. Ulmestrand	Sweden

In addition, written contributions were received from:

H. Eiriksson	Iceland
F. Van Beek	Netherlands
S. Verver	Netherlands

During the meeting, technical and computer assistance was provided by:

C. Vanden Berghe	Belgium

3. Methods employed in the assessment of *Nephrops*

The assessment methods employed by the *Nephrops* Working Group were mainly based on:

(1) The analysis of long-term trends in fishery data (landings, effort, CPUE, LPUE, mean sizes of *Nephrops* in catches and/or landings, etc.).

(2) The use of the length cohort analysis (LCA), and after slicing length compositions into 'age' groups, the VPA.

(3) The results of fishery independent surveys (mostly underwater TV surveys).

The following review summarises the main methods, dealing first with the most basic approaches.

3.1. Analysis of trends in fishery data

The examination of trends in fishery data remains an important element of *Nephrops* assessments, especially for stocks with few biological or sampling data. For a number of stocks, available information now extends over many years, providing good historical perspective, and more attention could be paid to the broad, overall trends rather than to small fluctuations in the most recent years.

Long-term trend plots are provided for landings, effort, CPUE and/or LPUE, and mean size in catches and/or landings. In some cases, the data series provided relate to vessels specifically targeting *Nephrops* (as opposed to vessels that fish for a mixture of species – amongst which *Nephrops* – or that take *Nephrops* as a by-catch, while primarily targeting other species of fish or shellfish). This subset of the overall landings varies in significance, depending on the fishery in question.

For many stocks, CPUEs and LPUEs are now given for size classes below and above a certain 'cut-value' (usually 35 mm carapace length, CL), corresponding to the size that is almost always retained by fishermen for landing, regardless on how liberal discarding may be. This approach has been advocated several years ago (ICES, 1995a), to produce CPUEs and LPUEs for the larger size classes (i.e. the size classes above the 'cut value') which can be regarded as true indices of relative abundance, and to produce CPUEs for the smaller size classes which can be regarded as indices of recruitment.

3.2. Analytical assessments

Length based assessments

There were no changes in the coding or new developments to the LBA3 program, which uses Jones' method to carry out a length based 'cohort analysis' (LCA). The program provides assessments of the yield per recruit (Y/R) type and allows predictions of the short- and long-term effects of changes in fishing effort.

Although ACFM does not require that assessments be repeated every year, it was decided to carry out new length based assessments when there had been some change in the state of exploitation, a change in parameter values, or a revision of the length composition data. As a rule, the LCAs were performed over relatively short reference periods (usually the most recent 3 or 4 years in the data series) to reflect the current state of exploitation of the stock.

Length slicing to produce nominal 'age' groups

The WG continued using the existing L2AGE slicing program (see ICES, 1994a, for a detailed description of this program) to generate nominal 'age' groups that could be used in an age based assessment. This program was modified prior to the 1995 WG meeting, to produce output files in a format suitable for use in the Lowestoft VPA package.

Age based assessments

For all stocks with sufficiently long series of adequate data, an age based assessment was performed, by means of the Lowestoft VPA (version 3.1) suite. This made it possible to make use of a separable model, Extended Survivors Analysis (XSA), and more extensive diagnostics and statistical output to make improved judgements about the performance of the VPA.

3.3. Fishery independent data

The results of fishery independent surveys (usually by means of underwater TV) have become an increasingly useful tool in the assessment of *Nephrops* stocks. Firstly, as a means to obtain fishery independent estimates of stock size and biomass. Secondly, as a means to validate the estimates of total stock biomass (TSB) and recruitment given by the analytical assessments. For some stocks, where landing statistics were believed to be unreliable (due to e.g. under-reporting) or where sampling levels were inadequate for a 'traditional' analytical approach, they have even become the only means for assessing the state of exploitation of the stock and for making predictions on its fisheries potential.

3.4. Judging the status of a stock

As before, it was decided that most attention should be paid to the male component of the stock since (a) in most cases, this was perceived as the most vulnerable component, and (b) most assessments suggested that F on the females was generally low, and that the female stock was not over-exploited.

The full range of information was taken into account in making judgements. For stocks where the VPA appeared to perform well, this was used to give some idea of trends in the stock. In other cases, the shape of the LCA Y/R curve was considered, and trends in fishery data (such as CPUE or LPUE) were also examined. Because of the differences between FUs in biological features and quality of the data available, no attempt was made to use the same pieces of information as a basis for the judgement for *all* stocks. Each one was dealt with on the merits of the assessments applied.

3.5. Catch predictions

At the 1993 WG meeting, three methods were used to make predictions of suitable catch options (ICES, 1993a). These were:

(1) Mean landings over a suitable reference period.

(2) Landings vs. effort plots (when the correlation was particularly good).

(3) A short-term forecast along finfish lines, using average recruitment values from the converged part of the VPA.

The option eventually chosen for each FU depended on the quality of the assessments and the fishery data available (ICES, 1993a). As in the previous assessment rounds, the WG has taken note of ACFM's suggestion that, if the advice on the state of a stock had not changed, there was no reason to 'update' the catch option by the addition of new data points to the series.

4. Input data and biological parameters used in *Nephrops* assessments

4.1. Fishery data

Updated information on landings and effort was provided for all FUs, except for FU 2 (Faeroes). Landings for a number of stocks were slightly revised, to eliminate former errors in the data series. Where available, landings and effort data, together with CPUEs and LPUEs for the last 10 years, are given on both a quarterly and an annual basis, as proposed by the *Nephrops* Study Group (ICES, 1994b).

With the advent of TAC management, and increased fishing effort by finfish vessels switching to *Nephrops*, there are indications that the quality of landing statistics has fallen. Unreported landings are believed to have occurred in recent years, some of which are thought to be substantial. Except for one FU, estimates of these unreported landings were not available, and so could not be incorporated into the assessments. The main concern is that the proportion of unreported landings is probably increasing over time (there is some evidence of this for at least one FU). This could result in the WG under-estimating the current levels of exploitation. In many FUs, current effort is already to the right of F_{max}, particularly for the males, and increases in effort and landings are not desirable, especially when they go unreported. Increases in unreported landings could also bias the length composition samples if particular market categories are more affected than others, and could influence VPA estimated trends in fishing mortality, total stock biomass and recruitment.

Again, the WG expressed its hope that all countries will continue to attempt collecting representative landings and effort statistics. The apparent increase in under-reporting is of particular concern. In some cases, the landings are not recorded by statistical rectangle, and this creates difficulties in allocating landings and effort figures to FUs.

4.2. Length composition sampling

For each FU, a summary table is provided with details on the sampling levels for catches, landings and discards. By quarter for the last two years, and annually for the last 10 years.

For most stocks, sampling levels are assumed to be sufficiently high – with respect to both sampling frequency and sample size – to produce reliable annual length frequency distributions of the removals (i.e. landings plus dead discards). For many stocks, however, there is little statistical evidence that the reliability requirements are actually being achieved.

The *Nephrops* Study Group comprehensively reviewed the sampling procedures used by different countries (ICES, 1996b). The Study Group did not prescribe minimum sampling requirements, acknowledging instead that some of the observed differences in sampling intensity relate to particular features of the stocks and fisheries. Unfortunately, cutbacks in resources seem to be degrading the length sampling programmes, at a time when, with increasing fishing pressure in many *Nephrops* fisheries, there is a need to improve the quality of the assessments.

4.3. Biological input parameters

Biological input parameter (Table 4.1. and relevant tables under Section 5) were reviewed by last year's *Nephrops* Study Group (ICES, 1998b) and again by this year's WG. Few new data were reported, most of which related to the size at 50 % maturity of the females (corresponding to the length at which females switch from an immature growth pattern, with two or more moults per year, to a mature growth pattern, with only one moult per year).

The results of a recently completed, EU-sponsored research programme on the mortality of *Nephrops* discards (also presented at last year's Study Group meeting), suggest that the 25 % discard survival rate used by the WG so far, gives acceptable and rather conservative estimates of the dead discards (ICES, 1998b). At least for those stocks where discarding is taking place on the actual *Nephrops* grounds, and not outside the grounds, as is the case in a number of fisheries (e.g. Farn Deeps, FU 6; Irish Sea East, FU 14; and Irish Sea West, FU 15). For the stocks in question, substantially lower discard survival rates have been used in the assessments (Table 4.1.).

The continuous need for the WG to rely upon biological parameters estimated several years ago is a consequence of the relatively low level of biological research on *Nephrops* in more recent years. The only way to remedy this, is additional funding for *Nephrops* research.

Table 4.1. - Input parameters used in analytical assessments of male and female *Nephrops*. For some Functional Units, growth and natural mortality parameters are given for immature females (above) and mature females (below). New or modified inputs shown in bold.

			Both sexes		**Males**					**Females**					
Management Area	Functional Units	Functional Unit(s)	Grp. Interval	Discard surv.	K	Linf	M	a and b from L-W relationship W = a * L exp b		K	Linf	Transit. length	M	a and b from L-W relationship W = a * L exp b	
A	1	Iceland	No analytical assessments done at WG												
B	2	Faroes	No analytical assessments done at WG												
C	11	North Minch	2	0.25	0.160	70	0.3	0.00028	3.240	0.160	70	**27**	0.3	0.00085	2.910
										0.060	60		0.2	0.00085	2.910
	12	South Minch	2	0.25	0.161	68	0.3	0.00028	3.240	0.161	68	**25**	0.3	0.00089	2.910
										0.060	59		0.2	0.00089	2.910
	13	Clyde	2	0.25	0.160	73	0.3	0.00028	3.240	0.160	73	**27**	0.3	0.00085	2.910
										0.060	62		0.2	0.00085	2.910
E	3	Skagerak	2	0.25	0.160	75	0.3	0.00045	3.113	0.100	65	28	0.2	0.00108	2.847
	4	Kattegat	2	0.25	0.160	75	0.3	0.00045	3.113	0.100	65	28	0.2	0.00108	2.847
F	9	Moray Firth	2	0.25	0.165	62	0.3	0.00028	3.240	0.165	62	**25**	0.3	0.00074	2.910
										0.060	56		0.2	0.00074	2.910
	10	Noup	No analytical assessments done at WG												
G	7	Fladen	2	0.25	0.160	66	0.3	0.00030	3.250	0.160	66	**25**	0.3	0.00074	2.910
										0.100	56		0.2	0.00074	2.910
H	5	Botney Gut	2	0.25	0.165	62	0.3	0.00023	3.320	0.165	62	27	0.3	0.00080	2.950
										0.080	60		0.2	0.00080	2.950
	33	Off Horn Reef	No analytical assessments done at WG												
I	6	Farn Deeps	2	0.00	0.160	66	0.3	0.00038	3.170	0.160	66	24	0.3	0.00091	2.890
										0.060	58		0.2	0.00091	2.890
	8	Firth of Forth	2	0.25	0.163	66	0.3	0.00028	3.240	0.163	66	**26**	0.3	0.00085	2.910
										0.065	58		0.2	0.00085	2.910

Grp. interval = group interval (mm CL) ; Disc. survival = discard survival rate ; Transit. length = size at sexual maturity (mm CL) ; na = not applicable

Table 4.1. - (continued)

Management Area	Functional Units	Functional Unit(s)	Both sexes		Males					Females					
			Grp. Interval	Discard surv.	K	Linf	M	a and b from L-W relationship W = a * L exp b		K	Linf	Transit. length	M	a and b from L-W relationship W = a * L exp b	
J	14	Irish Sea East	2	0.00	0.160	60	0.3	0.00022	3.348	0.160	60	24	0.3	0.00114	2.820
										0.100	56		0.2	0.00114	2.820
	15	Irish Sea West	1	0.10	0.160	60	0.3	0.00032	3.210	0.160	60	**24**	0.3	0.00068	2.960
										0.100	56		0.2	0.00068	2.960
L	16	Porcupine Bank	1	na	0.140	75	0.2	0.00009	3.550	0.100	60	**24**	0.2	0.00009	3.550
	17	Aran Grounds	1	na	**0.150**	**60**	**0.3**	**0.00032**	**3.210**	**0.150**	**60**	**24**	**0.3**	**0.00068**	**2.960**
										0.100	**50**		**0.2**	**0.00068**	**2.960**
	18-19	Irish Coast	No analytical assessments done at WG												
M	20-22	Celtic Sea	1	0.25	0.170	68	0.3	0.00009	3.550	0.170	68	31	0.3	0.00009	3.550
										0.100	49		0.2	0.00009	3.550
N	23-24	Bay of Biscay	1	0.30	0.140	76	0.3	0.00039	3.180	0.140	76	25	0.3	0.00081	2.970
										0.110	56		0.2	0.00081	2.970
O	25	North Galicia	2	na	0.160	70	0.2	0.00043	3.160	0.160	70	28	0.2	0.00043	3.160
										0.080	60		0.2	0.00043	3.160
	31	Cantabrian Sea	5	na	0.150	90	0.2	0.00043	3.160	0.100	70	na	0.2	0.00043	3.160
Q	26-27	West Galicia and North Portugal	1	na	0.150	85	0.2	0.00043	3.160	0.150	85	26	0.2	0.00043	3.160
										0.100	65		0.2	0.00043	3.160
	28-29	SW and S Portugal	2	0.00	0.200	70	0.3	0.00028	3.220	0.200	70	30	0.3	0.00056	3.030
										0.065	65		0.2	0.00056	3.030
	30	Gulf of Cadiz	No analytical assessments done at WG												
S	32	Norwegian Deep	No analytical assessments done at WG												

Grp. interval = group interval (mm CL) ; Disc. survival = discard survival rate ; Transit. length = size at sexual maturity (mm CL) ; na = not applicable

5. Assessments and management possibilities for *Nephrops*

5.1. General introduction

5.1.1. Functional Units, Management Areas and TAC Areas

Functional Units and Management Areas

The Functional Units (FU) are defined by the groupings of ICES statistical rectangles given in Table 5.1.2. and illustrated in Figures 5.1.1., 5.1.2. and 5.1.3. Functional Units are aggregated into Management Areas (MA) (Table 5.1.1.), the level at which the WG recommends management should take place.

In 1997, the definition of several FUs and MAs has been revised, and two new FUs were defined (viz. Norwegian Deep, FU 32, in the NE North Sea; and Off Horn Reef, FU 33, in the SE North Sea) (ICES, 1997a). Nearly all historical sets of landings and effort data have now been reorganised to take these changes into account.

TAC areas

The WG and ACFM have repeatedly pointed out that TACs based on the present large areas defined by ICES boundaries are not satisfactory. They do not allow for a type of management which takes account of the different levels of exploitation in different FUs. The WG wishes to reiterate its view that *Nephrops* are more appropriately managed at a smaller scale and recommends that the Management Areas described be adopted, or that specific management strategies be developed, aiming at the control of fishing effort on a much smaller geographical scale than is the case in the existing quota-based system.

Outstanding examples of actual and potential problems inherent to the current system are the North Sea (where difficulties will continue to arise if the recommended catch option for MA G – which includes the Fladen Ground, FU 7 – continues to be aggregated with those for other areas into a single TAC), and Sub-Area VII (where the TAC covers a large area which offers no opportunity to effectively manage each FU or even each MA according to their individual states of exploitation).

5.1.2. Assessments

Table 5.1.3. summarises the types of assessment that were carried out for the different FUs, and gives some idea of the general 'quality' of these assessments and the state of exploitation of the stocks in terms of F_{bar}, F_{max} and $F_{96\text{-}98}$. To allow easy comparison, a similar table with the results of the 1997 assessments is also included (Table 5.1.4.).

All assessments were conducted on males and females separately, and these frequently gave rather different results. The reasons for adopting this approach have been discussed before (ICES, 1991a) and are based on the greater availability and associated vulnerability of males

in many of the stocks, and on the desirability to accommodate different growth and natural mortality rates for the two sexes.

5.1.3. Management considerations, provision of catch options

For many of the *Nephrops* stocks assessed, there was no change in the assessed state of the stock, and hence the advice on catch options remained unchanged.

For some FUs (Bay of Biscay, FUs 23+24; and S and SW Portugal, FUs 28+29) however, there is serious reason for concern, because there is evidence of declining trends in biomass and recruitment, and a suggestion that management action should be taken (through a reduction in fishing effort and/or TAC, an increase of the minimum mesh size, or the establishment of closed areas) or, at least, that the situation should be carefully monitored.

Concern also remains on the possible impact of effort transfers from the increasingly restricted finfish fisheries to the more lucrative *Nephrops* fisheries. For most *Nephrops* FUs this would be detrimental. Therefore, most catch options of the *status quo* type should be regarded as primarily aiming to constrain effort. It is felt that the style of current ACFM advice, concentrating as it does primarily on stocks in immediate danger, does not give sufficient emphasis to proactive management of stocks where the current state of exploitation is regarded as about right or only 'slightly' over the top.

For two FUs (Norwegian Deep, FU 32; and Off Horn Reef, FU 33), management advice is given for the first time. In both cases, there is evidence of a rapidly expanding fishery, with increasing landings and, rather reassuringly, increasing LPUEs.

In line with ACFM's directions, the WG has offered recommendations for most stocks which are based on collective discussions, made in the light of the quality of the input data, the parameter values and the assessment results, together with any other considerations relevant to the FU in question. In most cases where the *status quo* objective is recommended, no attempt has been made to update the catch options presented previously (ICES, 1991a and 1993a).

Summaries of the past advice given by the WG and by ACFM are shown in Tables 5.1.5. to 5.1.11. for TAC areas IIIa, IV, VIa, VII, VIIIa,b, VIIIc and IXa. The proposed and agreed TACs in these tables are taken from the relevant reports of the WG and of ACFM respectively; the landing figures from this year's WG report (see MA summary tables at the end of Sections 5.2. to 5.20.). With respect to these tables it is worth reminding that:

(a) Up to 1995, management advice was given every year (in 1991 for the year 1992, in 1992 for the year 1993, etc.), and since then every two years (in 1995 for the years 1996 and 1997, in 1997 for the years 1998 and 1999, etc.).

(b) Past advice was based on the landings and effort data as they were available to the WG at the time. Since then, however, many data series have been improved and revised, thus adding to the apparent discrepancy between proposed TACs and actual (read 'revised') landings.

For TAC areas Va, Vb, VIb, VIIId,e, IXb and X, no such summary tables are presented. For Va and Vb, because the *Nephrops* fisheries in these areas are managed by national quota, on which ICES is not expected to give advice. For the other areas, there is no evidence of an exploitable *Nephrops* distribution, and the WG's advice invariably has been for zero TACs, to prevent mis-reporting. Except for VIIId,e (for which the EC has set a TAC of 50 t), this advice has always been followed by both ACFM and the European Commission.

Overviews of the total *Nephrops* landings from the ICES area for the past 10 years, are given in Tables 5.1.12. and 5.1.13. (by MA and by country).

5.1.4. Section layout

The remainder of the stock assessment section (Sections 5.2. to 5.20.) has been organised to list MAs, and then FUs contained within each MA, according to ICES Sub-areas and Divisions. Tables and figures appear at the end of each MA section.

For each FU, there are sections on:

(a) Trends in landings, effort, CPUE and/or LPUE, mean sizes in catches and/or landings.

(b) Data and biological inputs for analytical assessments.

(c) General comments on quality of data and inputs.

(d) Length based assessments (LCA).

(e) Age based assessments (VPA).

(f) Fishery independent data (if any).

(g) Comments on quality of assessments.

(h) Management considerations.

Summaries of the management considerations for the MA as a whole are given at the end of each MA section, together with tables summarising the recent history (1989-98) of landings by FU and by country.

Data on the (trends in) landings, fishing effort, CPUEs and/or LPUEs, and mean sizes in catches or landings for each FU, together with the results of the underwater TV surveys are given in the main body of the report. The presentation of the results from LCA and VPA is limited to:

(a) The output tables of Jones' cohort analysis (source: LCA).

(b) Plots of the short- and long-term changes in Y/R and B/R upon relative changes in effort (source: LCA).

(c) The output table with the Fs-at-age (source: VPA).

(d) Plots of the log-residuals (source: VPA).

(e) Tables and plots of the estimates of landings, fishing mortality (F_{bar}), total stock biomass (TSB) and recruitment (source: VPA).

(f) Plots of F_{bar} vs. effort (source: VPA).

(g) Tables and graphs presenting any other data that are of particular relevance to the stock in question.

References to 'standard' tables and graphs are listed at the beginning of each section or sub-section, but in the text they are restricted to a minimum (in an attempt to improve the flow of the text).

With respect to the fishery related statistics, it is worth reminding that, for several years now, the WG has consistently made the distinction between catches and landings, and between catches per unit effort or CPUEs (which include the discards) and landings per unit effort or LPUEs.

Full sets of the input data tables to LCA and VPA, and of the outputs of the VPA are given in a Data Appendix (available in electronic format only). Copies of the Data Appendix can be obtained from ICES General Secretariat, from the WG Chairman or from the WG Members (see Section 2.).

Table 5.1.1. - Description of Management Areas, together with their Working Group labels and the Functional Units contained within them. New or modified descriptions shown in bold.

WG label	ICES description	Functional Units (FUs) or groupings thereof when treated as one in assessments	
A	Va	1	Iceland
B	Vb (non EC)	2	Faeroe Islands
C	VIa	11	North Minch
		12	South Minch
		13	Clyde
D	Vb (EC) + VIb		None
E	IIIa	3	Skagerrak
		4	Kattegat
F	IVa, rect. 44-48 E6-E7 + 44E8	9	Moray Firth
		10	Noup
G	**IVa, West of 2° E excl. MA F**	7	Fladen
H	**IVb,c, East of 1° E excl. rect. 43F5-F7**	5	Botney Gut
		33	Off Horn Reef
I	IVb,c, West of 1° E	6	Farn Deeps
		8	Firth of Forth
J	**VIIa, North of 53° N**	14	Irish Sea East
		15	Irish Sea West
K	VIId,e		None
L	VIIb,c,j,k	16	Porcupine Bank
		17	Aran Grounds
		18	Ireland NW coast
		19	Ireland SW and SE coast
M	**VIIf,g,h, excl. rect. 31E1 32E1-E2 + VIIa, South of 53° N**	20+21+22	Celtic Sea
N	VIIIa,b	23+24	Bay of Biscay
O	VIIIc	25	North Galicia
		31	Cantabrian Sea
P	VIIId,e		None
Q	IXa	26	West Galicia
		27	North Portugal
		28+29	South-West and South Portugal
		30	Gulf of Cadiz
R	IXb + X		None
S	**IVa, East of 2° E + rect. 43F5-F7**	32	Norwegian Deep

Table 5.1.2. - *Nephrops* Functional Units and descriptions by statistical rectangles. New or modified descriptions shown in bold.

FU no.	Name	ICES area	Statistical rectangles
1	Iceland South coast	Va	55-56 C6-D0; 55-56 D2-D4
2	Faeroe Islands	Vb	55E3
3	Skagerrak	IIIa	**47G0-G1; 46F9-G1; 45F8-G1; 44F7-G0; 43F8-F9**
4	Kattegat	IIIa	**44G1-G2; 42-43G0-G2; 41G1-G2**
5	Botney Gut - Silver Pit	IVb,c	36-37 F1-F4; 35F2-F3
6	Farn Deeps	IVb	38-40 E8-E9; 37E9
7	Fladen Ground	IVa	**44-49 E9-F1; 45-46E8**
8	Firth of Forth	IVb	40-41E7; 41E6
9	Moray Firth	IVa	44-45 E6-E7; 44E8
10	Noup	IVa	47E6
11	North Minch	VIa	44-46 E3-E4
12	South Minch	VIa	41-43 E2-E4
13	Clyde	VIa	39-40 E4-E5
14	Irish Sea East	VIIa	35-38E6; 38E5
15	Irish Sea West	VIIa	36E3; 35-37 E4-E5; 38E4
16	Porcupine Bank	VIIc,k	34D6-D8; 33D5-D8; 32D5-D6
17	Aran Grounds	VIIb	34-35 D9-E0
18	Ireland NW coast	VIIb	37D9-E1; 36D9
19	Ireland SW and SE coast	VIIg,j	**31-33 D9-E0; 31E1; 32E1-E2; 33E2-E3**
20	NW Labadie, Baltimore and Galley	VIIg,j	)
21	Jones and Cockburn	VIIg,h,j	) **27-29 E1-E2; 31E2-E4; 32E3**
22	Smalls	VIIg	)
23	Bay of Biscay North	VIIIa	22-24 E6-E7; 23-24E5
24	Bay of Biscay South	VIIIb	20-21 E7-E8; 19E8
25	North Galicia	VIIIc	15E0-E1; 16E1
26	West Galicia	IXa	13-14 E0-E1
27	North Portugal (N of Cape Espichel)	IXa	6-12E0; 9-12E1
28	South-West Portugal (Alentejo)	IXa	3-5 E0-E1
29	South Portugal (Algarve)	IXa	2E0-E2
30	Gulf of Cadiz	IXa	2-3 E2-E3
31	Cantabrian Sea	VIIIc	16E4-E7
32	Norwegian Deep	IVa	**44-52 F2-F6; 43F5-F7**
33	Off Horn Reef	IVb	**39-41E4; 39-41E5**

Table 5.1.3. - Summary of *Nephrops* assessments carried out by the WG in 1999.

MA	FU	Analytical assessments performed					Quality of assessments					Major ouputs of assessments					
		LCA		VPA		TV survey	LCA		VPA		TV survey	Mean F from LCA		% Effort at Fmax		Fbar from VPA	
		Mal	Fem	Mal	Fem		Mal	Fem	Mal	Fem		Mal	Fem	Mal	Fem	Mal	Fem
A	1	Assessed nationally															
B	2	None															
C	11	X	X	X	X	X	++	++	++	++	++	0.62	0.19	-40	+50	0.77	0.19
	12	X	X	Trial	Trial	X	++	++	?	?	?	0.49	0.15	-20	> +50	(0.72)	(0.21)
	13	X	X	X	X	X	++	?	++	?	?	0.65	(0.03)	-40	(> +50)	0.90	(0.09)
E	3	X	X	Trial	Trial		?	?	?	?		nr	nr	(-40)	(+40)	(0.33)	(0.09)
	4	X	X	Trial	Trial		?	?	?	?		nr	nr	(-60)	(-20)	(0.76)	(0.30)
F	9	X	X	X	X	X	++	++	++	?	?	0.53	0.13	-10	> +50	0.71	(0.11)
	10					X					?						
G	7	X	X			X	?	?			++	(0.38)	(0.23)	(+40)	(+40)		
H	5	X	X	X	X		++	++	?	?		0.21	0.16	+40	+50	(0.27)	(0.18)
	33	None															
I	6	X	X	X	X	X	++	++	++	++	?	0.54	0.09	-40	> +50	0.53	0.18
	8	X	X	X	X	X	++	++	++	++	++	0.85	0.17	-60	> +50	0.85	0.25
J	14	X	X			X	++	++			?	0.44	0.17	0	> +50		
	15	X	X	X	X		++	++	?	?		0.64	0.55	-50	-50	(0.76)	(0.65)
L	16	X	X				++	++				0.43	0.34	-40	+10		
	17	Trial	Trial				?	?				(0.83)	(0.30)	(-20)	(> +50)		
	18-19	None															
M	20-22	X	X	X	X		++	++	?	?		0.41	0.45	-40	-40	(0.50)	(0.46)
N	23-24	X	X	X	X		++	++	?	?		0.77	0.48	-60	-30	(0.99)	(0.42)
O	25	X	X				++	++				0.62	0.11	-30	> +50		
	31	P	P				++	++				0.46	0.31	-30	+30		
Q	26-27	P	P				++	++				1.10	0.50	-60	0		
	28-29	X	X	X	X		?	?	?	?		(0.49)	(0.23)	(0)	(> +50)	(0.46)	(0.26)
	30	None															
S	32	None															

LCA = Length based assessment ; VPA = 'age' based assessment ; TV survey = underwater television survey ; Mal = males ; Fem = females

X = new assessment performed ; P = assessment not repeated, results of previous assessment used ; ++ = acceptable quality ; ? = questionable quality ; nr = not reported

Figures in brackets are from assessments of questionable quality ; Mean F from VPA is for 1996-98

Table 5.1.4. - Summary of *Nephrops* assessments carried out by the WG in 1997.

MA	FU	Analytical assessments performed					Quality of assessments					Major ouputs of assessments					
		LCA		VPA		TV survey	LCA		VPA		TV survey	Mean F from LCA		% Effort at Fmax		Fbar from VPA	
		Mal	Fem	Mal	Fem		Mal	Fem	Mal	Fem		Mal	Fem	Mal	Fem	Mal	Fem
A	1	Assessed nationally															
B	2	None															
C	11	X	X	X	X	X	++	++	++	++	++	0.64	0.10	-40	> +50	0.74	0.14
	12	X	X			X	++	++			?	0.53	0.17	-20	> +50		
	13	X	X	X	X	X	?	?	++	?	?	(0.55)	(0.02)	(-30)	(> +50)	0.78	(0.08)
E	3-4	X	X				?	?				(0.55)	(0.18)	(-50)	(-30)		
F	9	X	X	X	X	X	++	++	++	?	?	0.51	0.07	-25	> +50	0.56	(0.10)
	10					X					?						
G	7					X					++						
H	5	X	X				++	++				0.25	0.10	+35	> +50		
	33	FU established in 1998															
I	6	X	X	X	X		++	++	++	++		0.60	0.12	-40	> +50	0.69	0.25
	8	X	X	X	X	X	++	++	++	++	++	0.86	0.19	-60	+30	0.87	0.19
J	14	X	X				++	++				0.46	0.17	-35	+15		
	15	X	X	X	X		++	++	?	?		0.67	0.50	-40	-40	(0.80)	(0.74)
L	16	None															
	17	None															
	18-19	None															
M	20-22	X	X	X			++	++	++			0.42	0.43	-50	-40	0.57	
N	23-24	X	X	X	X		++	++	?	?		0.69	0.38	-60	-20	(0.76)	(0.44)
O	25	P	P				?	?				(0.56)	(0.13)	(-30)	(> +50)		
	31	X	X				++	++				0.46	0.31	-30	+30		
Q	26-27	X	X				++	++				1.10	0.50	-60	0		
	28-29	X	X	X	X		?	?	?	?		(0.97)	(0.45)	(-30)	(> +50)	(0.83)	(0.21)
	30	None															
S	32	FU established in 1998															

LCA = Length based assessment ; VPA = 'age' based assessment ; TV survey = underwater television survey ; Mal = males ; Fem = females

X = new assessment performed ; P = assessment not repeated, results of previous assessment used ; ++ = acceptable quality ; ? = questionable quality

Figures in brackets are from assessments of questionable quality ; Mean F from VPA is for 1994-96

Table 5.1.5. - Summary of TACs proposed by the WG and by ACFM, agreed TACs, reported landings and percentages of TACs taken, by Management Area (as defined by the WG) and by TAC area (as defined by ICES) - Data for TAC area IIIa.

MA or TAC area	FUs	Year	Kind of advice given	WG proposal (t) (*)	ACFM proposal (t) (**)	Agreed TAC (t)	Reported landings (t)	% taken vs. WG proposal	% taken vs. agreed TAC
TAC area IIIa = MA E	FUs 3 & 4 (single advice for comb. FUs)	1992	Set TAC mostly for allocation purposes	4000	~ 4000	3500	2912	73	83
		1993	Avoid increases in effort - status quo TAC	4000	~ 4300	3500	3209	80	92
		1994	Keep effort constant - decrease TAC to level of 1992 landings	2900	2900	3500	2874	99	82
		1995	Keep effort constant - status quo TAC	2900	2900	4800	3428	118	71
		1996	Keep effort constant - status quo TAC	2900	2900	4800	3981	137	83
		1997	As for the year 1996	2900	2900	4800	4206	145	88
		1998	Avoid increases in effort - increase TAC to level of 1996 landings	4000	4000	4800	5045	126	105
		1999	As for the year 1998	4000	4000	4800			
		2000	Increase TAC to level of 1998 landings Long-term benefits in Y/R if more size selective gears were used	5000	3800				
		2001	As for the year 2000	5000	3800				

(*) All figures rounded to the nearest 5 t ; Figures in brackets are not explicitly mentioned in the WG reports, but follow from the recommended catch options.

(**) Since the final version of the WG report was completed after ACFM's May 1999 meeting, ACFM's proposals for the years 2000 and 2001 could also be included in the tables.

Table 5.1.6. - Summary of TACs proposed by the WG and by ACFM, agreed TACs, reported landings and percentages of TACs taken, by Management Area (as defined by the WG) and by TAC area (as defined by ICES) - Data for TAC area IV.

MA or TAC area	FUs	Year	Kind of advice given	WG proposal (t) (*)	ACFM proposal (t) (**)	Agreed TAC (t)	Reported landings (t)	% taken vs. WG proposal	% taken vs. agreed TAC
MA F	FUs 9 & 10	1992	FU 9: Keep effort at average for 1985-90 - set TAC accordingly FU 10: Set TAC at level of 1990 landings	2360	~ 2400	Part of TAC area IV (see below)	1818	77	Part of TAC area IV (see below)
		1993	FU 9: Keep effort at average for 1985-91 - adjust TAC accordingly FU 10: Status quo advice	2300	2400		2252	98	
		1994	FU 9: 20 % increase in effort acceptable - adjust TAC accordingly FU 10: Status quo advice	2165	2400		2160	100	
		1995	FU 9: Keep effort constant - status quo TAC FU 10: Status quo advice	(2165)	2400		1627	75	
		1996	FU 9: Keep effort constant - status quo TAC FU 10: Status quo advice	(2165)	2400		1896	88	
		1997	As for the year 1996	(2165)	2400		1856	86	
		1998	FU 9: Keep effort constant - status quo TAC FU 10: Status quo advice	(2165)	2400		1358	63	
		1999	As for the year 1998	(2165)	2400				
		2000	FU 9: Reduce effort to 1993-98 level - adjust TAC accordingly FU 10: Adjust TAC to average landings for 1993-98	2000	1850				
		2001	As for the year 2000	2000	1850				
MA G	FU 7	1992	Set TAC at max. historical landings	2670	~ 2700	Part of TAC area IV (see below)	3564	133	Part of TAC area IV (see below)
		1993	Set TAC at max. historical landings	4375	2700		3870	88	
		1994	Stock under-exploited - allow 20 % increase in landings	5225	5000		5445	104	
		1995	Stock under-exploited - status quo TAC	(5225)	5000		7099	136	
		1996	Stock under-exploited - no TAC proposed		5000		6323		
		1997	As for the year 1996		5000		7028		
		1998	Stock under-exploited - no TAC proposed		7000		6090		
		1999	As for the year 1998		7000				
		2000	Stock under-exploited - increase TAC by approx. 2000 t	9000	9000				
		2001	As for the year 2000	9000	9000				

(*) All figures rounded to the nearest 5 t ; Figures in brackets are not explicitly mentioned in the WG reports, but follow from the recommended catch options.

(**) Since the final version of the WG report was completed after ACFM's May 1999 meeting, ACFM's proposals for the years 2000 and 2001 could also be included in the tables.

Table 5.1.6. - (continued).

MA or TAC area	FUs	Year	Kind of advice given	WG proposal (t) (*)	ACFM proposal (t) (**)	Agreed TAC (t)	Reported landings (t)	% taken vs. WG proposal	% taken vs. agreed TAC
MA S	FU 32 (defined in 1999)	1992	Included in 'other rectangles' within MA G	Included in advice for MA G	Included in advice for MA G	Part of TAC area IV (see below)	Included in figures for MA G	Included in figures for MA G	Part of TAC area IV (see below)
		1993	Included in 'other rectangles' within MA G						
		1994	Included in 'other rectangles' within MA G						
		1995	Included in 'other rectangles' within MA G						
		1996	Included in 'other rectangles' within MA G						
		1997	Included in 'other rectangles' within MA G						
		1998	Included in 'other rectangles' within MA G						
		1999	Included in 'other rectangles' within MA G						
		2000	Stock under-exploited - avoid increases in effort - no TAC proposed						
		2001	As for the year 2000						
MA I	FUs 6 & 8	1992	FU 6: Keep effort constant - set TAC at average landings for 1986-89 FU 8: Reduce effort to average for 1981-90 - set TAC accordingly	4595	~ 4600	Part of TAC area IV (see below)	3475	76	Part of TAC area IV (see below)
		1993	FU 6: Keep effort constant - set TAC at average landings for 1986-90 FU 8: Reduce effort by 20 % - adjust TAC accordingly	4270	~ 4170		5654	132	
		1994	FU 6: Reduce effort by 20 % - adjust TAC accordingly FU 8: Reduce effort by 20 % - adjust TAC accordingly	3760	~ 4170		5955	158	
		1995	FU 6: Reduce effort by 20 % - status quo TAC FU 8: Reduce effort by 20 % - status quo TAC	(3760)	~ 4170		4702	125	
		1996	FU 6: Avoid further increases in effort - no TAC proposed FU 8: Avoid further increases in effort - no TAC proposed		~ 4170		4562		
		1997	As for the year 1996		~ 4170		4722		
		1998	FU 6: Avoid further increases in effort - no TAC proposed FU 8: Avoid further increases in effort - no TAC proposed		4170		4674		
		1999	As for the year 1998		4170				
		2000	FU 6: Avoid further increases in effort - status quo TAC FU 8: Avoid further increases in effort - status quo TAC	4170	4170				
		2001	As for the year 2000	4170	4170				

(*) All figures rounded to the nearest 5 t ; Figures in brackets are not explicitly mentioned in the WG reports, but follow from the recommended catch options.

(**) Since the final version of the WG report was completed after ACFM's May 1999 meeting, ACFM's proposals for the years 2000 and 2001 could also be included in the tables.

Table 5.1.6. - (continued).

MA or TAC area	FUs	Year	Kind of advice given	WG proposal (t) (*)	ACFM proposal (t) (**)	Agreed TAC (t)	Reported landings (t)	% taken vs. WG proposal	% taken vs. agreed TAC
MA H	FUs 5 & 33 (FU 33 defined in 1999)	1992	FU 5: Avoid increases in effort - set TAC at level of 1990 landings FU 33: Included in 'other rectangles' within MA H	875	870	Part of TAC area IV (see below)	859	98	Part of TAC area IV (see below)
		1993	FU 5: Keep effort at 1990-91 level - adjust TAC accordingly FU 33: Included in 'other rectangles' within MA H	920	870		1071	116	
		1994	FU 5: Keep effort at 1989-92 level - adjust TAC accordingly FU 33: Included in 'other rectangles' within MA H	900	870		841	93	
		1995	FU 5: Keep effort constant - adjust TAC to match revised Belgian landings FU 33: Included in 'other rectangles' within MA H	(~ 950)	870		1241	131	
		1996	FU 5: Keep effort constant - adjust TAC to match revised Belgian landings FU 33: Included in 'other rectangles' within MA H	(~ 950)	870		917	97	
		1997	As for the year 1996	(~ 950)	870		1521	160	
		1998	FU 5: Status quo advice - adjust TAC to include historical Dutch landings FU 33: Included in 'other rectangles' within MA H	(~ 1000)	1000		1616	162	
		1999	As for the year 1998	(~ 1000)	1000				
		2000	FU 5: Keep effort constant - adjust TAC to level of 1998 landings FU 33: Set TAC at a level not exceeding 500 t	1600-1750	1600				
		2001	As for the year 2000	1600-1750	1600				
TAC area IV = MA F + MA G + MA S + MA I + MA H	FUs 5 to 10 plus FUs 32 & 33	1992	See above	10500	10570	12000	9716	93	81
		1993	See above	11865	10140	12000	12847	108	107
		1994	See above	12050	12440	13000	14401	120	111
		1995	See above	(12100)	12440	15200	14669	121	97
		1996	See above	(12100)	12440	15200	13698	113	90
		1997	See above	(12100)	12440	15200	15127	125	100
		1998	See above	(13925)	14570	15200	13737	99	90
		1999	See above	(13925)	14570	15200			
		2000	See above	16770	16620				
		2001	See above	16770	16620				

(*) All figures rounded to the nearest 5 t ; Figures in brackets are not explicitly mentioned in the WG reports, but follow from the recommended catch options.

(**) Since the final version of the WG report was completed after ACFM's May 1999 meeting, ACFM's proposals for the years 2000 and 2001 could also be included in the tables.

Table 5.1.7. - Summary of TACs proposed by the WG and by ACFM, agreed TACs, reported landings and percentages of TACs taken, by Management Area (as defined by the WG) and by TAC area (as defined by ICES) - Data for TAC area VI.

MA or TAC area	FUs	Year	Kind of advice given	WG proposal (t) (*)	ACFM proposal (t) (**)	Agreed TAC (t)	Reported landings (t)	% taken vs. WG proposal	% taken vs. agreed TAC
TAC area VIa = MA C	FUs 11 to 13	1992	FU 11: Keep effort constant - set TAC accordingly FU 12: Keep effort constant or reduce by 20 % - set TAC accordingly FU 13: Keep effort at 1990 level - set TAC accordingly	11360 - 11735	~ 11400	12000	10795	95	90
		1993	FU 11: Keep effort constant - adjust TAC accordingly FU 12: Keep effort constant or reduce by 20 % - set TAC accordingly FU 13: Keep effort at 1990 level - set TAC accordingly	11205 - 11575	~ 11300	12000	11337	101	94
		1994	FU 11: Keep effort constant - adjust TAC accordingly FU 12: State of stock improved - adjust TAC accordingly FU 13: Reduce effort - adjust TAC accordingly	10165	11300	12600	11101	109	88
		1995	All FUs: Status quo advice - status quo TAC	(10165)	11300	12600	12783	126	101
		1996	All FUs: Status quo advice - no TAC proposed		11300	12600	11155		89
		1997	As for the year 1996		11300	12600	11222		89
		1998	All FUs: Status quo advice - no TAC proposed		11300	12600	11098		88
		1999	As for the year 1998		11300	12600			
		2000	All FUs: Keep effort at current levels - status quo TAC FUs 11 & 12: Avoid effort increases in creel fishery	(11300)	11300				
		2001	As for the year 2000	(11300)	11300				

(*) All figures rounded to the nearest 5 t ; Figures in brackets are not explicitly mentioned in the WG reports, but follow from the recommended catch options.

(**) Since the final version of the WG report was completed after ACFM's May 1999 meeting, ACFM's proposals for the years 2000 and 2001 could also be included in the tables.

Table 5.1.8. - Summary of TACs proposed by the WG and by ACFM, agreed TACs, reported landings and percentages of TACs taken, by Management Area (as defined by the WG) and by TAC area (as defined by ICES) - Data for TAC area VII.

MA or TAC area	FUs	Year	Kind of advice given	WG proposal (t) (*)	ACFM proposal (t) (**)	Agreed TAC (t)	Reported landings (t)	% taken vs. WG proposal	% taken vs. agreed TAC
MA J	FUs 14 & 15	1992	FU 14: Keep effort at 1985-90 level - set TAC accordingly FU 15: Keep effort constant - set TAC at level of 1987-90 landings	9395	8900	Part of TAC area VII (see below)	7997	85	Part of TAC area VII (see below)
		1993	FU 14: Keep effort at 1985-91 level - adjust TAC accordingly FU 15: Keep effort constant - set TAC at level of 1987-91 landings	9305	9400		8729	94	
		1994	FU 14: Keep effort at 1985-92 level - adjust TAC accordingly FU 15: Keep effort constant - set TAC at level of 1987-90 landings	9095	9400		8142	90	
		1995	FU 14: Status quo advice - no TAC proposed FU 15: Status quo advice - no TAC proposed		9400		9321		
		1996	FU 14: Status quo advice - no TAC proposed FU 15: Status quo advice - no TAC proposed		9400		7756		
		1997	As for the year 1996		9400		10509		
		1998	FU 14: Status quo advice - no TAC proposed FU 15: Status quo advice - no TAC proposed		9400		9422		
		1999	As for the year 1998		9400				
		2000	FU 14: Avoid increases in effort - status quo TAC FU 15: Avoid increases in effort - status quo TAC	9400	9400				
		2001	As for the year 2000	9400	9400				
MA K	None	1992	Zero TAC to prevent mis-reporting	0	0	Part of TAC area VII (see below)			Part of TAC area VII (see below)
		1993	Zero TAC to prevent mis-reporting	0	0				
		1994	Zero TAC to prevent mis-reporting	0	0				
		1995	Zero TAC to prevent mis-reporting	0	0				
		1996	Zero TAC to prevent mis-reporting	0	0				
		1997	As for the year 1996	0	0				
		1998	Zero TAC to prevent mis-reporting	0	0				
		1999	As for the year 1998	0	0				
		2000	Zero TAC to prevent mis-reporting	0	0				
		2001	As for the year 2000	0	0				

(*) All figures rounded to the nearest 5 t ; Figures in brackets are not explicitly mentioned in the WG reports, but follow from the recommended catch options.

(**) Since the final version of the WG report was completed after ACFM's May 1999 meeting, ACFM's proposals for the years 2000 and 2001 could also be included in the tables.

Table 5.1.8. - (continued).

MA or TAC area	FUs	Year	Kind of advice given	WG proposal (t) (*)	ACFM proposal (t) (**)	Agreed TAC (t)	Reported landings (t)	% taken vs. WG proposal	% taken vs. agreed TAC
MA L	FUs 16 to 19	1992	FU 16: Keep effort at 1986-91 level - set TAC accordingly FU 17: Avoid increases in effort - set TAC at level of recent landings FUs 18 & 19: Set TAC at max. landings over 1981-90	3760 - 4022	3800	Part of TAC area VII (see below)	3723	93-99	Part of TAC area VII (see below)
		1993	FU 16: Keep effort at 1987-91 level - adjust TAC accordingly FU 17: Avoid increases in effort - set TAC at level of recent landings FUs 18 & 19: Set TAC at max. landings over 1982-91	4055	~ 4000		3598	89	
		1994	FU 16: Adjust TAC to match decreases in effort FU 17: Avoid increases in effort - set TAC at level of recent landings FUs 18 & 19: Adjust TAC to match revised landing figures	3745	~ 4000		4326	116	
		1995	All FUs: Status quo advice - no TAC proposed		~ 4000		4990		
		1996	All FUs: Status quo advice - no reason to revise TAC	4000	4000		4137	103	
		1997	As for the year 1996	4000	4000		3680	92	
		1998	All FUs: Status quo advice - no reason to revise TAC	4000	4000		4556	114	
		1999	As for the year 1998	4000	4000				
		2000	FU 16 : Avoid increases in F - no reason to revise TAC FUs 17, 18 & 19: Status quo advice - no reason to revise TAC	4000	4000				
		2001	As for the year 2000	4000	4000				
MA M	FUs 20 to FU 22 (single advice for comb. FUs)	1992	Keep effort constant - set TAC accordingly	3760	~ 3800	Part of TAC area VII (see below)	4252	113	Part of TAC area VII (see below)
		1993	Adjust TAC to match improved landings vs. effort relationship	3500	3800		4678	134	
		1994	Keep effort constant - set TAC accordingly	3620	3800		5188	143	
		1995	Status quo advice - leave TAC unchanged	(3620)	3800		6048	167	
		1996	Status quo advice - leave TAC unchanged	(3620)	3800		4531	125	
		1997	As for the year 1996	(3620)	3800		3862	107	
		1998	Status quo advice - no reason to revise TAC	(3800)	3800		3547 (***)		
		1999	As for the year 1998	(3800)	3800				
		2000	Status quo advice - no reason to revise TAC	3800	3800				
		2001	As for the year 2000	3800	3800				

(*) All figures rounded to the nearest 5 t ; Figures given in brackets are not explicitly mentioned in the WG reports, but follow from the recommended catch options.

(**) Since the final version of the WG report was completed after ACFM's May 1999 meeting, ACFM's proposals for the years 2000 and 2001 could also be included in the tables.

(***) Highly provisional.

Table 5.1.8. - (continued).

MA or TAC area	FUs	Year	Kind of advice given	WG proposal (t) (*)	ACFM proposal (t) (**)	Agreed TAC (t)	Reported landings (t)	% taken vs. WG proposal	% taken vs. agreed TAC
TAC area VII = MA J + MA K + MA L + MA M	FUs 14 to 22	1992	See above	16915	16500	20000	15972	94	80
		1993	See above	16860	17200	20000	17005	101	85
		1994	See above	16460	17200	20000	17656	107	88
		1995	See above	(17020)	17200	20000	20359	120	102
		1996	See above	(17020)	17200	23000	16424	96	71
		1997	See above	(17020)	17200	23000	18051	106	78
		1998	See above	(17200)	17200	23000	17525	102	76
		1999	See above	(17200)	17200	23000			
		2000	See above	17200	17200				
		2001	See above	17200	17200				

(*) All figures rounded to the nearest 5 t ; Figures in brackets are not explicitly mentioned in the WG reports, but follow from the recommended catch options.

(**) Since the final version of the WG report was completed after ACFM's May 1999 meeting, ACFM's proposals for the years 2000 and 2001 could also be included in the tables.

Table 5.1.9. - Summary of TACs proposed by the WG and by ACFM, agreed TACs, reported landings and percentages of TACs taken, by Management Area (as defined by the WG) and by TAC area (as defined by ICES) - Data for TAC area VIIIa,b.

MA or TAC area	FUs	Year	Kind of advice given	WG proposal (t) (*)	ACFM proposal (t) (**)	Agreed TAC (t)	Reported landings (t)	% taken vs. WG proposal	% taken vs. agreed TAC
TAC area VIIIa,b = MA N	FUs 23 & 24 (single advice for comb. FUs)	1992	Exploitation pattern likely to improve - set TAC at max. over 1985-89	6675	~ 6800	6800	5728	86	84
		1993	Status quo advice - TAC adjusted to include landings taken outside FUs	6885	6800	6800	4965	72	73
		1994	Keep effort at 1989-91 level - set TAC accordingly	5575	6800	6800	4082	73	60
		1995	Status quo effort and TAC	(5575)	6800	6800	4453	80	65
		1996	Status quo effort and TAC	(5575)	6800	6800	4308	77	63
		1997	As for the year 1996	(5575)	6800	6800	3641	65	54
		1998	Evidence of decreasing trend in male and female recruitment Mesh increase to 70 or 80 mm recommended Constrain effort - adjust TAC accordingly (no figure proposed)		4200	5500	2214 (***)		
		1999	As for the year 1998		4200	5500			
		2000	Appreciation of stock less pessimistic than in 1997 assessment Evidence of decreasing trend in male stock biomass Mesh increase to 70 or 80 mm recommended - no TAC proposed		4200				
		2001	As for the year 2000		4200				

(*) All figures rounded to the nearest 5 t ; Figures in brackets are not explicitly mentioned in the WG reports, but follow from the recommended catch options.

(**) Since the final version of the WG report was completed after ACFM's May 1999 meeting, ACFM's proposals for the years 2000 and 2001 could also be included in the tables.

(***) Highly provisional.

Table 5.1.10. - Summary of TACs proposed by the WG and by ACFM, agreed TACs, reported landings and percentages of TACs taken, by Management Area (as defined by the WG) and by TAC area (as defined by ICES) - Data for TAC area VIIIc.

MA or TAC area	FUs	Year	Kind of advice given	WG proposal (t) (*)	ACFM proposal (t) (**)	Agreed TAC (t)	Reported landings (t)	% taken vs. WG proposal	% taken vs. agreed TAC
TAC area VIIIc = MA O	FUs 25 & 31	1992	FU 25: Keep effort constant - set TAC at level of 1984-90 landings FU 31: Keep effort constant - set TAC at level of 1988-90 landings	510	510	800	522	102	65
		1993	FU 25: Status quo advice - adjust TAC to match revised landings FU 31: Status quo advice - adjust TAC to match revised landings	570	510	1000	365	64	37
		1994	All FUs: Keep effort at current levels - status quo TAC	570	510	1000	393	69	39
		1995	All FUs: Keep effort at current levels - status quo TAC	570	510	1000	367	64	37
		1996	All FUs: Keep effort at current levels - status quo TAC Expl. pattern of Nephrops largely defined by TACs for other species		510	1000	338		34
		1997	As for the year 1996		510	1000	317		32
		1998	All FUs: Keep effort at current levels - status quo TAC Expl. pattern of Nephrops largely defined by TACs for other species		510	1000	171		17
		1999	As for the year 1998		510	1000			
		2000	All FUs: Keep effort at current levels - status quo TAC Expl. pattern of Nephrops largely defined by TACs for other species	(510)	510				
		2001	As for the year 2000	(510)	510				

(*) All figures rounded to the nearest 5 t ; Figures in brackets are not explicitly mentioned in the WG reports, but follow from the recommended catch options.

(**) Since the final version of the WG report was completed after ACFM's May 1999 meeting, ACFM's proposals for the years 2000 and 2001 could also be included in the tables.

Table 5.1.11. - Summary of TACs proposed by the WG and by ACFM, agreed TACs, reported landings and percentages of TACs taken, by Management Area (as defined by the WG) and by TAC area (as defined by ICES) - Data for TAC area IXa.

MA or TAC area	FUs	Year	Kind of advice given	WG proposal (t) (*)	ACFM proposal (t) (**)	Agreed TAC (t)	Reported landings (t)	% taken vs. WG proposal	% taken vs. agreed TAC
TAC area IXa = MA Q	FUs 26 to 30	1992	FU 26: Provisional TAC corresponding to level of 1989-91 landings FU 27: Insuff. data - provisional TAC corresponding to 1990 landings FUs 28 & 29: Recent landings unreliable - set TAC at 1984-85 level FU 30: Insuff. data - provisional TAC at max. historic landings	1315	1300	2500	1349	103	54
		1993	FU 26: Status quo advice - status quo TAC FU 27: Adjust TAC to match improved landing figures FUs 28 & 29: Adjust TAC to match improved landing figures FU 30: Status quo TAC	1335	1300	2500	1059	79	42
		1994	FU 26: Keep effort constant - adjust TAC to level of 1991-92 landings FU 27: Status quo advice - adjust TAC to level of 1987-92 landings FU 28 & 29: Assessment improved - no reason to revise TAC FU 30: Status quo TAC	1390	1300	2500	792	57	32
		1995	All FUs: Status quo advice - status quo TAC	(1390)	1300	2500	916	66	37
		1996	FU 26: Status quo advice - status quo TAC FU 27: Insuff. data - no advice given FUs 28 & 29: Reduce F - avoid effort increases - no TAC proposed FU 30: Insuff. data - no advice given MA as a whole: No reason to revise TAC proposed by ACFM	1300	1300	2500	512	39	20
		1997	As for the year 1996	1300	1300	2500	570	44	23
		1998	FUs 26 & 27: No particular advice given Expl. pattern of Nephrops largely defined by TACs for other species FUs 28 & 29: Strong evidence of decreases in TSB and recruitment Drastically reduce overall fishing pressure - no TAC proposed FU 30: Insuff. data - no advice given		500	2500	595		24
		1999	As for the year 1998		500	2000			

(*) All figures rounded to the nearest 5 t ; Figures in brackets are not explicitly mentioned in the WG reports, but follow from the recommended catch options.

(**) Since the final version of the WG report was completed after ACFM's May 1999 meeting, ACFM's proposals for the years 2000 and 2001 could also be included in the tables.

Table 5.1.11. - (continued).

MA or TAC area	FUs	Year	Kind of advice given	WG proposal (t) (*)	ACFM proposal (t) (**)	Agreed TAC (t)	Reported landings (t)	% taken vs. WG proposal	% taken vs. agreed TAC
TAC area IXa = MA Q	FUs 26 to 55	2000	FUs 26 & 27: No particular advice given Expl. pattern of Nephrops largely defined by TACs for other species FUs 28 & 29: Strong evidence of decreases in TSB and recruitment Drastically reduce overall fishing pressure, either by effort reduction, mesh size increase or establishment of closed area FU 30: Insuff. data - no advice given MA as a whole: Maintain TAC at 500 t	500	500				
		2001	As for the year 2000	500	500				

(*) All figures rounded to the nearest 5 t ; Figures in brackets are not explicitly mentioned in the WG reports, but follow from the recommended catch options.

(**) Since the final version of the WG report was completed after ACFM's May 1999 meeting, ACFM's proposals for the years 2000 and 2001 could also be included in the tables.

Table 5.1.12. - Summary of *Nephrops* landings from the ICES area, by Management Area, 1989-98.

ICES sub-area	IIIa	IV					Va	Vb
MA	E	F	G	S	I	H	A	B
1989	3880	2705	2330	32	5140	778	1866	74
1990	4342	2324	2560	160	4561	945	1692	62
1991	4251	1778	4274	177	3820	1019	2157	56
1992	2912	1818	3402	162	3475	859	2230	57
1993	3209	2252	3532	338	5654	1071	2381	63
1994	2874	2160	4686	759	5955	841	2238	73
1995	3428	1627	6605	494	4702	1241	1027	76
1996	3981	1896	5361	962	4562	917	1633	na
1997	4206	1856	6266	762	4722	1521	1229	na
1998 *	5045	1358	5230	860	4674	1616	1418	na

* provisional na = not available

ICES sub-area	VIa	VII			VIII		IXa	Overall total
MA	C	J	L	M	N	O	Q	All MAs
1989	10981	8522	3988	3846	5372	515	1351	51380
1990	10068	8922	3101	4386	5049	457	1193	49822
1991	10544	10327	3405	3278	4808	562	1307	51763
1992	10795	7997	3723	4252	5728	522	1349	49281
1993	11337	8729	3598	4678	4965	365	1059	53231
1994	11101	8142	4326	5188	4082	393	792	53610
1995	12783	9321	4990	6048	4453	367	916	58078
1996	11155	7756	4137	4531	4308	338	512	52049
1997	11222	10509	3680	3862	3641	317	570	54363
1998 *	11098	9422	4556	3547	2214	171	595	51803

* provisional na = not available

Table 5.1.13. - Summary of *Nephrops* landings from the ICES area, by country, 1989-98.

Country	Iceland	Faeroe Islands	Norway	Sweden	Denmark	Netherlands	Belgium	Rep. of Ireland
1989	1866	74	72	799	3314	na	677	5095
1990	1692	62	187	1097	3671	na	736	4312
1991	2157	56	303	1230	3627	na	712	5586
1992	2230	57	224	749	2599	133	593	4492
1993	2381	63	205	859	2926	130	707	4837
1994	2238	73	233	764	3176	158	518	4942
1995	1027	76	166	919	3596	253	661	7759
1996	1633	na	188	1034	4154	421	293	4466
1997	1229	na	183	1131	4261	591	498	6136
1998 *	1418	na	291	1322	4978	669	384	7532

* provisional na = not available

Country	UK Scotland	UK Engl & Wal	UK N. Ireland	UK Isle of Man	France	Spain	Portugal	Overall total
1989	17877	3624	5580	8	8941	2898	557	51380
1990	16772	3209	5535	25	9354	2602	572	49822
1991	17874	3069	6024	61	7972	2562	533	51763
1992	17614	2384	5112	14	10009	2553	522	49281
1993	19523	3857	5356	32	9809	2121	427	53231
1994	19811	4479	5836	16	9086	2022	259	53610
1995	22696	3456	5543	23	9837	1781	283	58078
1996	20200	3390	5683	10	8839	1591	149	52049
1997	21645	3263	6598	7	7335	1343	143	54363
1998 *	19931	3083	6026	25	4760	1218	169	51803

* provisional na = not available

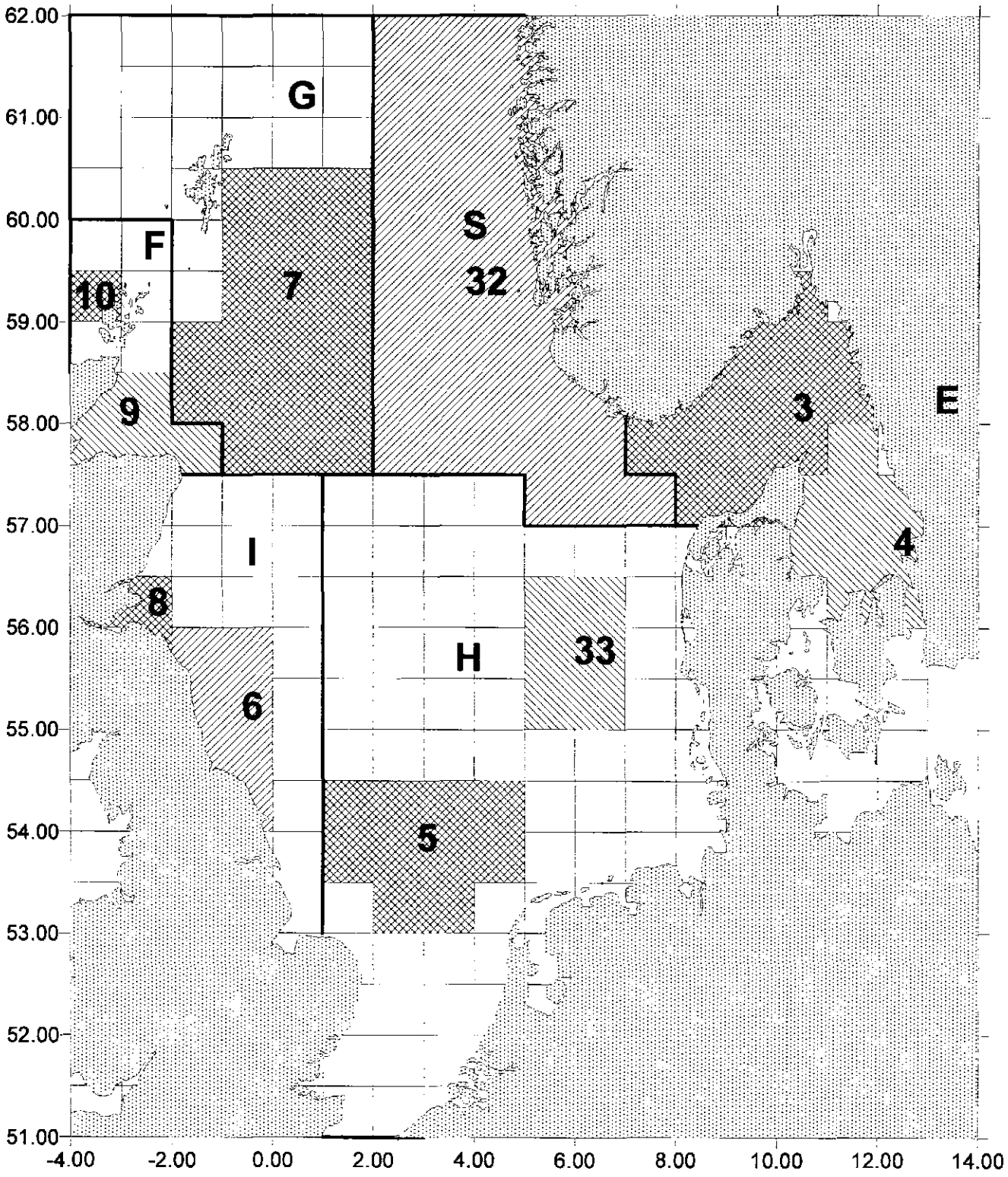


Figure 5.1.1. - *Nephrops* Management Areas and Functional Units as defined and used by the *Nephrops* Working Group - ICES Sub-areas IIIa and IV.

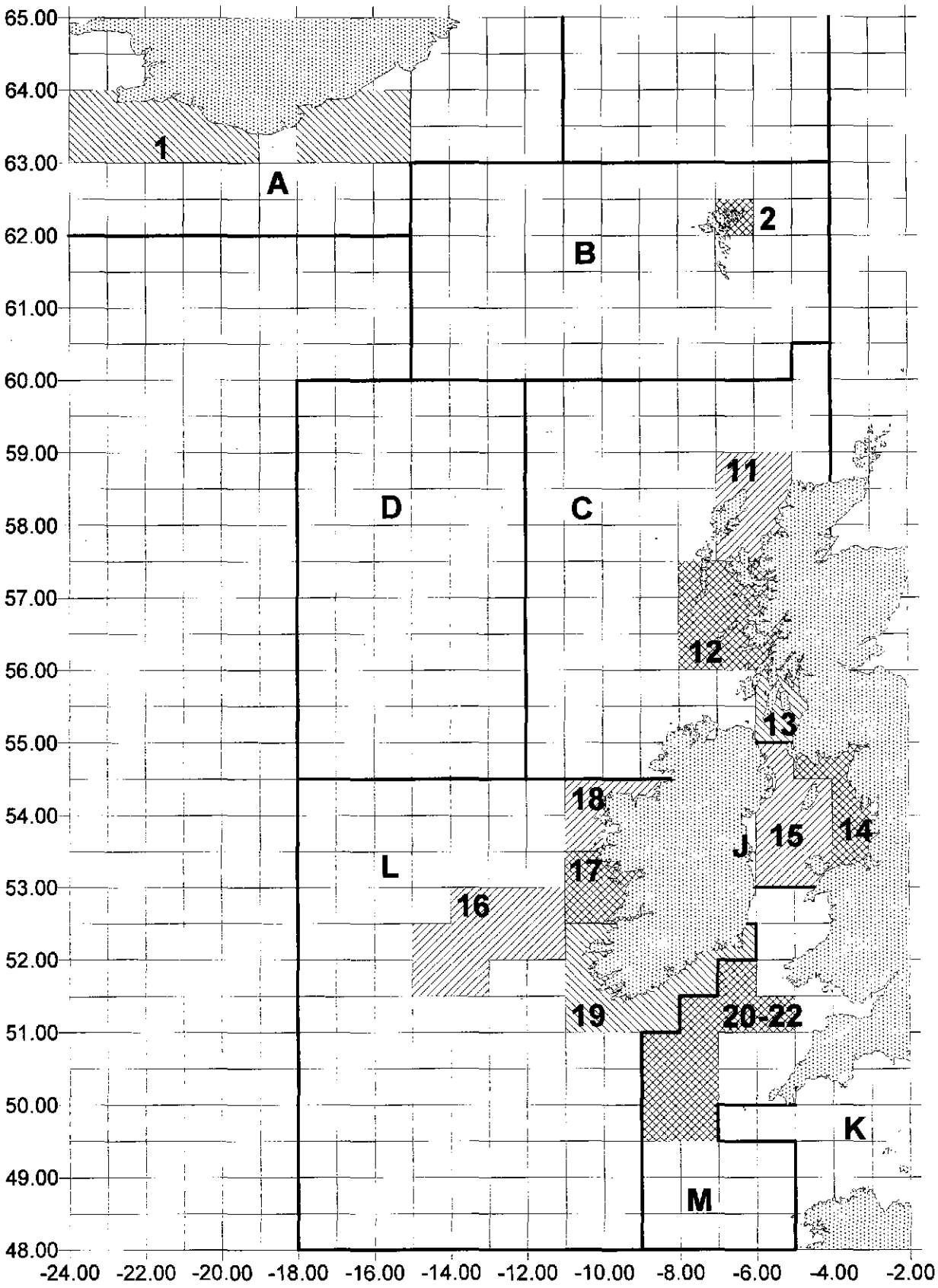


Figure 5.1.2. - *Nephrops* Management Areas and Functional Units as defined and used by the *Nephrops* Working Group - ICES Sub-areas V, VI and VII.

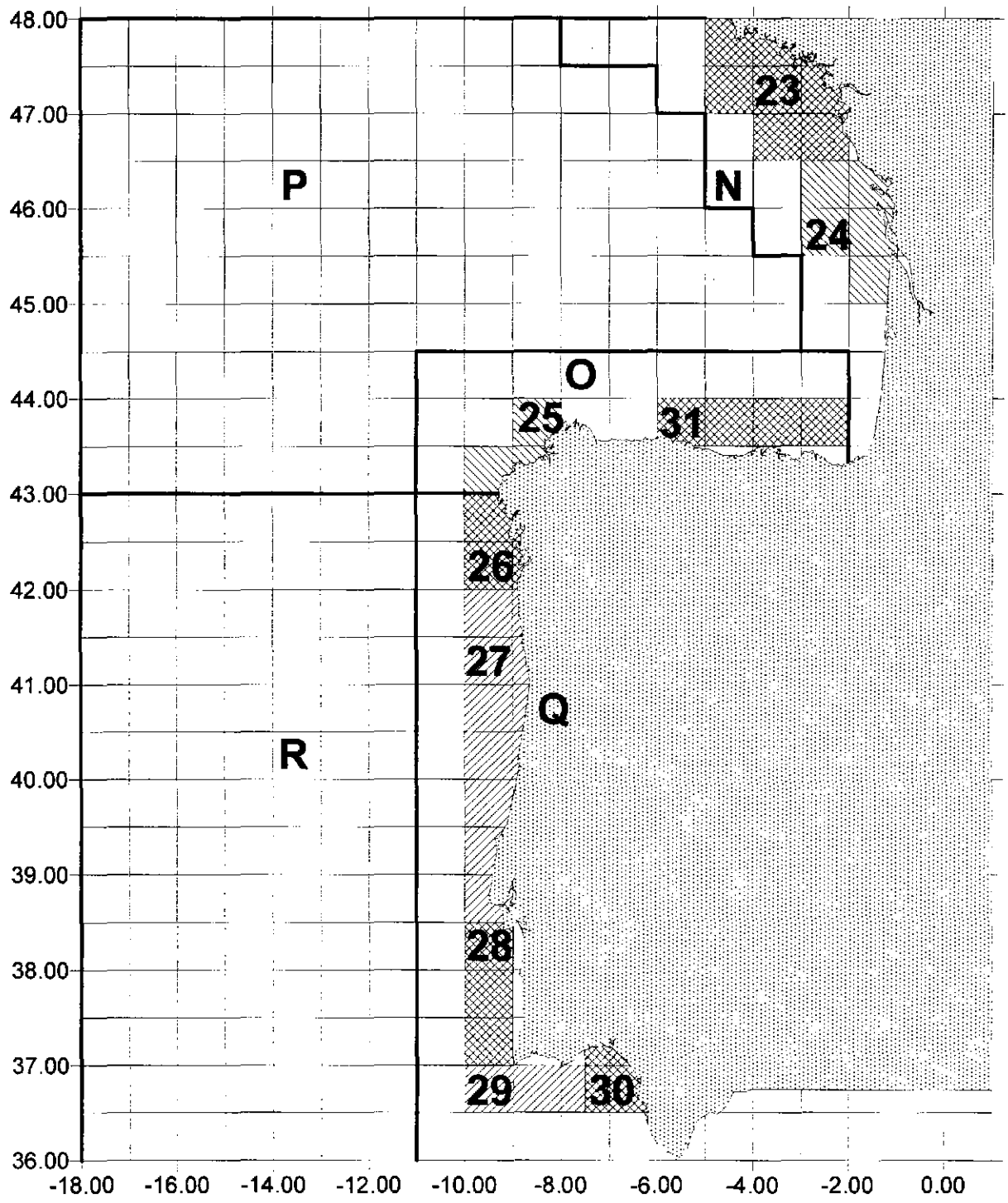


Figure 5.1.3. - *Nephrops* Management Areas and Functional Units as defined and used by the *Nephrops* Working Group - ICES Sub-areas VIII, IX and X.

5.2. Management Area E

ICES description **IIIa**

Functional Units **Skagerrak (FU 3)**
Kattegat (FU 4)

The statistical rectangles comprised in this Management Area and its constituent Functional Units are shown in Figure 5.1.1.

5.2.1. Description of the fisheries

Since vessels fishing for *Nephrops* in the Skagerrak and Kattegat are not confined to either of the two FUs, the descriptions of the fisheries are given for FUs 3 and 4 combined. The description of the Danish fisheries also comprises information on the *Nephrops* directed fisheries in ICES Sub-area IV.

Denmark

Over the past decades, the Danish *Nephrops* fishery has increased in importance. While up to 1997, it had ranked third in economic importance (landings of species for human consumption), it has now become the second most important fishery, only to be surpassed by cod. The market demand for *Nephrops* has increased and most of the landings are exported. So far, the regulatory measures for the *Nephrops* fisheries in the Skagerrak, the Kattegat and the North Sea have not put any constraints on the fisheries. This has resulted in an increasing number of vessels switching to *Nephrops*, whenever and for whatever reason the fisheries for other species are less profitable.

The following overview of the Danish *Nephrops* fisheries is based on logbook data for the years 1997 and 1998.

Traditionally, most of the Danish *Nephrops* landings have been taken within ICES Sub-area IIIa, and this is still the case (approximately 70 % of the total landings in 1998). In the North Sea, the Danish fishery is exploiting the *Nephrops* stocks on the Fladen Ground (FU 7), the Norwegian Deeps (FU 32), the Botney Gut and the Silver Pit (FU 5), and in recent years also Off Horn Reefs (FU 33) (also see Sections 5.4., 5.5. and 5.7.).

The gears in use are bottom trawls with various mesh sizes in the codends. According to the information available from the logbooks (for 1998), the majority of the *Nephrops* trawlers in the Skagerrak and the Kattegat uses a 70 mm mesh '*Nephrops* trawl'. In the North Sea fisheries however, the picture differs. According to the logbooks, almost 60 % of the North Sea *Nephrops* is taken by 100 mm mesh 'fish trawls', while on the Fladen, significant amounts of *Nephrops* are taken as a by-catch of the *Pandalus* fishery.

The table below gives the total number of Danish vessels which have been fishing for *Nephrops* in 1997 and 1998. The table also includes the shrimp vessels taking *Nephrops* as a by-catch. Note that the majority of the vessels are rather small.

Year	< 20 GRT	20-49 GRT	>= 50 GRT
1997	194	78	92
1998	192	69	96

Further details on the distribution of the Danish *Nephrops* fishery are given in the table below. The duration of fishing trips depends on the distance between landing harbour and fishing ground, and also on the size of the vessels. The fishing grounds in the Skagerrak and the Kattegat are closest to the ports.

Number of fishing trips and average days at sea per trip in the Danish *Nephrops* fisheries in 1998. Data by vessel class and fishing area (~ FU).

	< 20 GRT		20-49 GRT		>= 50 GRT	
Fishing area	trips	days/trip	trips	days/trip	trips	days/trip
Kattegat	6514	2	1121	2	288	3
Skagerrak	5013	2	2415	2	1580	3
Norwegian Deep (FU 32)	72	6	52	7	369	10
Fladen Ground (FU 7)	-	-	-	-	181	12
Off Horn Reefs (FU 33)	-	-	62	7	207	8
Botney Gut (FU 5)	-	-	1	8	25	10

Some of the larger *Nephrops* vessels fishing in the North Sea have started to pack the *Nephrops* (whole) in boxes, so that they are ready for export when landed.

Sweden

Vessel data are available from the 1995 logbooks. In total about 180 trawlers reported *Nephrops* landings. Of these, 71 landed 5 tonnes or more and account for about 75 % of the total *Nephrops* landings. In addition, approximately 25 creelers reported *Nephrops* landings.

The average size of the trawlers was 16 meters (length over all; range 11-23 m), with an engine power of 240 kJ (range 75-400) and a GRT of 45 (range 11-129). The average age of the vessels was 30 years (range 7-70). The newer vessels (< 20 year old) are stern trawlers, while most of the older vessels are side trawlers.

Since 1989, trawlers have been shifting from single to twin rigs. Nowadays, 54 % of the trawl caught *Nephrops* comes from twin rigs and 43 % from single rigs. The remaining 3 % of the *Nephrops* landings are taken as by-catches from finfish and shrimp (*Pandalus*) directed trawlers. The trawls currently used have 70 mm diamond meshes in the codend. About 15-20 trawler voluntarily use 70 mm square mesh codends in order to reduce the by-catches of small fish and *Nephrops*, thereby simplifying the sorting of their catches. The smaller vessels are usually more specialised on *Nephrops* than the larger ones, which are more dependent on the by-catches of fish (particularly cod, haddock and whiting), and which also tend to fish on

other grounds. A by-catch rule prohibits the use of *Nephrops* trawls if the by-catch of protected fish species exceeds 70 % by weight.

The Swedish *Nephrops* directed trawl fishery is mainly a one day fishery, on grounds within one hour sailing from port. Average trawling duration is about 7 hours/day, usually with 2 hauls per day.

Creeling for *Nephrops* was introduced in 1984. Since then, the number of boats participating in this fishery has remained quite stable at about 25-30 units. The creel fishery is mainly carried out inside the trawling border

Nephrops smaller than the MLS (40 mm CL) are discarded, together with freshly moulted (soft) or damaged animals. All *Nephrops* are landed fresh and whole. Trawl caught *Nephrops* are generally landed iced, while creel landings are live. On landing, the *Nephrops* are separated in trawl- and creel-caught. Prices are about 25 % higher for creel-caught *Nephrops*. Most of the creel-caught *Nephrops* are sold to the Swedish market, while the majority of trawl-caught *Nephrops* are exported to Denmark.

The economic value of the *Nephrops* fishery has increased in recent years and has amounted to about 10 10^6 Euro in 1998, making the *Nephrops* fishery the second most valuable in Sweden.

5.2.2. Skagerrak (FU 3)

Trends in landings, effort, LPUE and mean size

Table	5.2.1.	Landings by country, 1989-98
Table	5.2.2.	Catches, landings, effort, CPUEs and LPUEs Swedish fleet, 1989-98
Table	5.2.3.	Effort and LPUEs Danish fleet, 1989-98
Table	5.2.4.	Mean sizes of *Nephrops* in catches, Swedish data, 1989-98
Figure	5.2.1.	Long-term trends in landings, effort, LPUE and mean size, Swedish and Danish data
Figure	5.2.2.	Landings by sex + Quarterly plots of effort and LPUEs by sex, Swedish data, single trawl, 1989-98
Figure	5.2.3.	Idem: Data for twin trawl

Landings, effort CPUE and LPUE

Denmark, Sweden and Norway exploit this FU. Since 1987, the *Nephrops* landings have fluctuated between 1900 and 3249 t, with the lowest landings being recorded in 1992-94 (Table 5.2.1.). Since 1994, the landings have increased for all three countries, and peak landings (the highest on record) were observed in 1998. Denmark and Sweden still dominate in this fishery (with 63 % and 31 % by weight of the 1998 landings), whereas the Norwegian landings yielded 6 % of the total. Landings from the Swedish creel fishery too have substantially increased in 1998 compared to previous years.

Effort data for the Swedish fleet are available for 1978-98 (Figure 5.2.1.), with the last 9 years being separated into single and twin trawl (also see Figures 5.2.2. and 5.2.3.). Total Swedish trawling effort has decreased since 1993, and has been at a relative low level in the last three years. At the same time, however, the LPUEs have been at a very high level (Figure 5.2.1.). In

1998 the highest overall LPUE for the whole period was observed (the same trend as in Danish figures, see below). The CPUE, especially for single trawlers, has increased even more than the LPUE (Table 5.2.2.). This could be interpreted as an indication of high recruitment for this period.

Danish effort figures for the Skagerrak (Table 5.2.3. and Figure 5.2.1.) were estimated from logbook data. For the whole period, it is assumed that effort is exerted mainly by vessels using twin trawls. The overall trend in effort for the Danish fleet is similar to that in the Swedish fishery, with a low level of effort in 1994, and an increase in 1997 and 1998. The trend in LPUEs too is similar to that in the Swedish fishery, with very high LPUEs in the last 3-4 years (Table 5.2.3.).

At the time of the meeting, no effort data were available for the Norwegian *Nephrops* fishery in the Skagerrak. Fishermen fishing for *Nephrops* are supposed to fill in catch records in logbooks, but these logbook data are not entered into the fisheries database.

5.2.3. Kattegat (FU 4)

Trends in landings, effort, LPUE and mean size

Table 5.2.5. Landings by country, 1989-98
Table 5.2.6. Catches, landings, effort, CPUEs and LPUEs Swedish fleet, 1989-98
Table 5.2.7. Effort and LPUEs Danish fleet, 1989-98
Table 5.2.8. Mean sizes of *Nephrops* in catches, Swedish data, 1989-98
Figure 5.2.4. Long-term trends in landings, effort, LPUE and mean size, Swedish and Danish data

Landings, effort and LPUE

Denmark and Sweden both have *Nephrops* directed fisheries in the Kattegat. In 1998, Denmark accounted for 83 % of total landings, while Sweden took 17 %. Since the low observed in 1994, total landings have increased every year. This trend has been similar for both countries. In 1998, total landings of approximately 1800 t were recorded. This is more than twice of the landings in 1994 (Table 5.2.5.).

Swedish standardised total effort has been relatively stable over the period 1978-90. An increase to a high level is noted in 1993 and 1994, followed by a decrease in recent years (Figure 5.2.4.).

Figures for total Danish effort are based on logbook records since 1987. Effort decreased up to 1995, then increased again to 1998, probably reflecting an expanding *Nephrops* fishery in the southern Kattegat (Table 5.2.7.; Figure 5.2.4.).

The Swedish and Danish annual LPUEs show similar trends. The LPUEs were at their lowest in 1989-94, but have increased again since then (Tables 5.2.6. and 5.2.7.; Figure 5.2.4.). The higher LPUEs during recent years may reflect increasing stock size due to strong recruitment in 1994-96 (see below). The marked increase in Danish effort in 1998 may in part be due to an expanding Danish fishery conducted in the southern part of the Kattegat in 1998.

Combined LPUEs for FUs 3 and 4

Also the combined LPUEs for the Skagerrak and the Kattegat (FUs 3 and 4 combined) for both the Swedish and the Danish fleet show a marked increasing trend since 1992 (Figure 5.2.5.). The corresponding overall effort (all areas and all fleets combined) has remained at roughly the same level during the last five years.

5.2.4. Assessment of the *Nephrops* stocks in the Skagerrak-Kattegat area (FUs 3 and 4 combined)

Analysis of fishery statistics and fishery related indices

The WG considered the following fisheries related data for *Nephrops* in FUs 3 and 4:

- Trends or fluctuations in total (estimated) effort and corresponding LPUE by Denmark and Sweden during the period 1990-98.
- The total amounts of discards in the fisheries as estimated from the samples.

Trends in effort and LPUE

Changes in LPUE may reflect changes in either stock size or catchability. However, since LPUE has increased in the last three years, it is likely that the exploitable stock biomass has increased somewhat (by experience, high LPUEs due to sudden changes in catchability caused by e.g. poor oxygen conditions, usually are of much shorter duration). From the discard data (Figure 5.2.6.), it can be seen that in both the Skagerrak and the Kattegat, the period of 1993-95 was one with high amounts of discards and relatively low LPUEs, whereas in 1996-98 the LPUEs were high and the amounts of discards low.

Quantities and size composition of the discards

For the Skagerrak, length frequency data are available from Sweden for 1990-98 and from Denmark for 1991-97. Of these, the Swedish data series can be considered as having been the most regular, since sampling took place regularly throughout the time period and usually covered the whole year. However, the Swedish discard samples are obtained by agreement with selected fishermen, and this might tempt the fishermen to bias the samples. Geographically, the samples from the Swedish Skagerrak fishery mainly cover the north-eastern part of the Skagerrak. Since 1991, a biological sampling programme of the Danish *Nephrops* fishery has been carried out on board the fishing vessels, in order to also cover the discards in this fishery. At present, Norway does not sample its *Nephrops* fishery in the area, but length samples are taken on research vessel surveys in the Skagerrak.

Figure 5.2.7. gives an idea of the high amounts of discards in the *Nephrops* fisheries in the Skagerrak, and of the differences between the Danish and Swedish fishery. These are probably due to geographical differences in the main fishing grounds visited by the two fleets. However, due to its high cost and the lack of manpower, sampling intensity has in general not been satisfactory, and seasonal variations have often not been adequately covered.

For the Kattegat, length frequency data are available from Sweden for 1990-1992 and from Denmark for 1992-98. Again, however, sampling intensity has not been satisfactory, in the sense that not all seasons and grounds were fully covered. Nevertheless, the Danish results show very high amounts of discards in the Kattegat fishery.

Figure 5.2.8. shows the overall size composition of the catches in the Skagerrak and the Kattegat. There is a difference in size of the *Nephrops* between the two areas, the Kattegat *Nephrops* being smaller. This difference holds for the whole period covered by the data (see also Tables 5.2.4. and 5.2.8., which give the mean sizes of *Nephrops* in the catches).
Since the discard data may also be regarded as indices of recruitment, they can be used to further explain the current developments in the stocks. The strong recruitments, which boosted the amounts of discards in 1993-95, have contributed significantly to the landings in 1996-98. Following this line of arguments, one could put forward that the relatively low amounts of discards seen in both the Skagerrak and the Kattegat in the past three years, are indicative of much lower recruitment levels, and that a decline in stock size and LPUE could be expected in the coming years.

Data and biological inputs for analytical assessments

Table 5.2.9. Sampling data and input parameters

For *Nephrops*, length compositions are the basic biological data sets for assessing the state of exploitation of the stocks. Length composition data can be used directly as indicators of recruitment (see above) and stock condition, and for length based assessments, or they may be sliced into artificial age groups as an input to age based assessment techniques. Both the length- and the age-based method however, require reliable growth data, and these are still lacking for the stocks in the Kattegat-Skagerrak area.

Length based assessments (LCA)

Figures 5.2.9. and 5.2.10. show a series of LCA outputs for *Nephrops* in the Skagerrak and the Kattegat, primarily to demonstrate the impact of the changes in size composition of the catches since 1991-95 on the LCA results. For each stock and sex three runs were made: one with the length data for the entire period 1993-98, one for 1993-95 (the years with high amounts of discards) and one for 1996-98 (the years with low amounts of discards).

Age based assessments (VPA)

Table 5.2.10. Skagerrak: Output XSA males: Long-term trends in landings, Fbar, TSB and recruitment
Table 5.2.11. Skagerrak: Output XSA females: Long-term trends in landings, Fbar, TSB and recruitment
Table 5.2.12. Kattegat: Output XSA males: Long-term trends in landings, Fbar, TSB and recruitment
Table 5.2.13. Kattegat: Output XSA females: Long-term trends in landings, Fbar, TSB and recruitment

Trial VPAs were run for both the Skagerrak and the Kattegat stock. The length compositions of the catches were split into 10 nominal 'age' groups (slicing was done with the von Bertalanffy growth parameters given in Table 5.2.9.). The analysis was seen primarily as an attempt to quantify the indices of and the trends in recruitment.

Comments on quality of assessments

The uncertainty on the biological parameters for the Skagerrak and the Kattegat stocks as used in the LCAs and in the length-to-age conversions, makes the results of the analytical assessments somewhat speculative, and therefore limits their usefulness for management purposes.

Management considerations

On the basis of the evidence on the trends in (a) landings, effort and LPUE, (b) discard composition, and (c) size compositions of and mean sizes of *Nephrops* in the catches, the WG is of the opinion that both FUs have been at a relatively high level in 1996-98, yielding increasing landings. In this connection it can be mentioned that towards the end of 1998, the LPUEs in both the Danish and the Swedish *Nephrops* fishery had reached such a level that the fishing industry requested a revision of the agreed 1998 TAC for Sub-area IIIa.

The relatively low amounts of discards in both FUs in 1996-98, however, may be indicative of lower recruitment levels in these years.

5.2.5. Summary for Management Area E

Table 5.2.14. Landings by FU and from Other rectangles, 1989-98
Table 5.2.15. Landings by country, 1989-98

The assessments of the state of the stocks in MA E suggest:

- Increasing stock sizes for the years 1996-1998.
- Relatively low recruitment levels in the same period.

Obviously, the assessments do not provide a sufficient basis to formulate catch options based on various effort levels. Instead, and following a precautionary approach, the WG recommends that the total landings from Sub-area IIIa in the coming years be maintained at the 1998 level.

Recommendation on more size selective Nephrops trawls

As on previous occasions, the WG wishes to point out that the large amounts of *Nephrops* discarded in Sub-area IIIa, reflect the fact that the legal minimum landing size (40 mm CL) does not correspond to the L_{50} of the current legal mesh size of 70 mm (with standard diamond shape). Previous years' mesh assessments (see e.g. ICES, 1997a), together with selectivity and survival experiments (see ICES, 1998b for more details), have shown that the introduction of square meshes in the *Nephrops* trawls will have a positive effect on the survival of undersized *Nephrops*, and that it would increase long-term yield. Therefore, the WG recommends a change to more size selective types of gear in the Skagerrak and the Kattegat area (such as trawls with a 70 mm square mesh, which already are successfully used by 15-20 Swedish *Nephrops* trawlers).

Table 5.2.1. - Skagerrak (FU 3): Landings (tonnes) by country, 1989-98.

Year	Denmark	Norway	Sweden		Total
			Trawl	Creel	
1989	1795	64	643	65	2567
1990	1749	148	860	110	2867
1991	1639	197	949	151	2936
1992	1151	111	524	114	1900
1993	1485	100	577	123	2285
1994	1298	62	531	90	1981
1995	1569	91	659	111	2430
1996	1772	103	708	113	2696
1997	1687	117	690	118	2612
1998 *	2055	185	864	145	3249

* provisional na = not available

Table 5.2.2. - Skagerrak (FU 3): Catches and landings (tonnes), effort ('000 hours trawling), CPUE and LPUE (kg/hour trawling) of Swedish *Nephrops* trawlers, 1989-98 (data presented for single and twin trawls separately).

Single trawl					
Year	Catches	Landings	Effort	CPUE	LPUE
1989	na	555	97.1	na	5.7
1990	729	490	73.5	9.9	6.7
1991	676	401	71.4	9.5	5.6
1992	360	231	73.7	4.9	3.1
1993	614	279	72.6	8.4	3.8
1994	441	246	60.1	7.3	4.1
1995	501	336	60.8	7.8	5.2
1996	754	488	51.1	14.8	9.6
1997	643	437	44.4	14.4	9.8
1998 *	794	557	49.7	16.0	11.2

* provisional na = not available

Twin trawl					
Year	Catches	Landings	Effort	CPUE	LPUE
1989	0	0	0.0	na	na
1990	302	203	17.1	17.7	11.9
1991	740	439	39.5	18.7	11.1
1992	370	238	34.1	10.9	7.0
1993	568	258	35.9	15.8	7.2
1994	444	248	34.1	13.1	7.3
1995	403	270	32.9	12.2	8.2
1996	187	121	13.0	14.4	9.3
1997	219	149	17.5	12.5	8.5
1998 *	254	178	16.7	15.1	10.6

* provisional na = not available

Table 5.2.3. - Skagerrak (FU 3): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching *Nephrops* with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1989-98.

Year	Logbook data		Estimated effort
	Effort	LPUE	
1989	12759	82.4	21642
1990	16969	76.4	22791
1991	17136	73.3	22158
1992	12183	70.4	16239
1993	11073	104.8	14068
1994	10672	109.8	1187
1995	10494	131.6	11935
1996	11885	137.6	12793
1997	11791	139.7	12075
1998 *	12501	155.4	13038

* provisional na = not available

Table 5.2.4. - Skagerrak (FU 3): Mean sizes (mm CL) of male and female *Nephrops* in catches of Swedish trawlers, 1989-98.

Year	Catches					
	Undersized		Full sized		All	
	Males	Females	Males	Females	Males	Females
1989	na	na	na	na	na	na
1990	34.5	34.1	44.6	43.9	39.8	38.5
1991	30.2	30.9	41.6	41.2	32.4	34.4
1992	33.3	32.3	43.4	44.7	36.0	37.4
1993	33.0	31.5	42.2	43.6	35.3	34.7
1994	31.7	29.6	41.8	43.7	34.1	31.2
1995	29.5	26.5	41.6	42.1	32.8	28.1
1996	32.8	31.6	42.7	43.6	37.4	36.5
1997	35.4	34.0	44.1	43.6	39.5	38.5
1998 *	35.1	34.5	45.7	43.9	41.2	38.0

* provisional na = not available

Table 5.2.5. - Kattegat (FU 4): Landings (tonnes) by country, 1989-98.

Year	Denmark	Sweden	Total
1989	1222	91	1313
1990	1349	127	1476
1991	1185	130	1315
1992	901	111	1012
1993	765	159	924
1994	751	142	893
1995	850	144	994
1996	1072	213	1285
1997	1272	322	1594
1998 *	1486	310	1796

* provisional na = not available

Table 5.2.6. - Kattegat (FU 4): Catches and landings (tonnes), effort ('000 hours trawling), CPUE and LPUE (kg/hour trawling) of Swedish *Nephrops* trawlers, 1989-98 (data presented for single and twin trawls separately).

Single trawl					
Year	Catches	Landings	Effort	CPUE	LPUE
1989	na	67	19.6	na	3.4
1990	114	77	14.2	8.0	5.4
1991	66	39	10.3	6.4	3.7
1992	44	28	11.6	3.8	2.4
1993	128	58	14.9	8.6	3.9
1994	95	53	16.2	5.7	3.2
1995	79	53	9.6	7.8	5.5
1996	207	134	13.7	15.1	9.8
1997	269	183	18.0	15.0	10.2
1998 *	181	127	13.1	13.8	9.7

* provisional na = not available

Twin trawl					
Year	Catches	Landings	Effort	CPUE	LPUE
1989	0	0	0.0	na	na
1990	25	17	1.9	13.2	9.1
1991	93	55	8.8	10.6	6.2
1992	101	65	14.2	7.1	4.6
1993	187	85	17.8	10.6	4.8
1994	138	77	14.2	9.7	5.4
1995	125	84	11.0	12.2	7.7
1996	97	63	7.5	13.0	8.4
1997	183	124	12.7	14.3	9.7
1998 *	215	151	15.0	14.4	10.1

* provisional na = not available

Table 5.2.7. - Kattegat (FU 4): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching *Nephrops* with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1989-98.

Year	Logbook data		Estimated effort
	Effort	LPUE	
1989	9725	65.2	18858
1990	12042	79.0	17109
1991	13494	68.7	17175
1992	12126	65.4	13627
1993	8815	74.9	10195
1994	9403	77.3	9802
1995	9039	91.2	9357
1996	9872	95.7	11209
1997	10028	112.2	11348
1998 *	10388	122.3	12144

* provisional na = not available

Table 5.2.8. - Kattegat (FU 4): Mean sizes (mm CL) of male and female *Nephrops* in catches of Swedish trawlers, 1989-98.

Year	Catches					
	Undersized		**Full sized**		**All**	
	Males	Females	Males	Females	Males	Females
1989	na	na	na	na	na	na
1990	na	na	na	na	na	na
1991	30.1	30.6	41.9	42.1	31.9	32.4
1992	32.5	32.4	44.0	42.4	36.2	34.2
1993	30.0	28.8	41.8	42.7	30.8	29.6
1994	29.2	27.5	40.4	39.7	30.7	28.1
1995	30.4	30.1	41.9	43.5	33.2	33.3
1996	32.0	30.6	41.4	43.5	36.1	36.6
1997	33.0	32.8	44.5	44.0	36.6	34.6
1998 *	33.0	32.7	44.5	43.7	36.6	36.2

* provisional na = not available

Table 5.2.9. - Skagerrak and Kattegat (FUs 3-4): Input data and parameters.

FU	3 & 4	MA	E
FLEET	Sweden	GEAR	Trawl

	1998					1997				
	Number of samples				Mean no. per sample	Number of samples				Mean no. per sample
	Qtr 1	Qtr 2	Qtr 3	Qtr 4		Qtr 1	Qtr 2	Qtr 3	Qtr 4	
Catch	1	0	0	0	3136	1	0	0	1	1646
Landings	7	10	10	4	296	7	5	6	6	301
Discards	8	10	9	5	282	6	6	5	7	289

	Number of samples									
Year	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989
Catch	1	2	3	4	0	0	0	0	0	0
Landings	31	24	35	27	12	7	8	8	6	0
Discards	32	24	32	29	12	7	8	8	6	0

FU	3 & 4	MA	E
FLEET	Denmark	GEAR	Trawl

	1998					1997				
	Number of samples				Mean no. per sample	Number of samples				Mean no. per sample
	Qtr 1	Qtr 2	Qtr 3	Qtr 4		Qtr 1	Qtr 2	Qtr 3	Qtr 4	
Catch	0	0	0	0		0	0	0	0	
Landings	0	2	2	2	327	1	1	3	3	200
Discards	0	2	2	2	218	1	1	3	3	190

	Number of samples									
Year	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989
Catch	0	0	4	16	8	5	1	0	0	0
Landings	6	8	4	16	8	5	4	0	0	0
Discards	6	8	4	16	8	5	4	0	0	0

FU	3 & 4	MA	E
FLEET	Norway	GEAR	Trawl

	1998					1997				
	Number of samples				Mean no. per sample	Number of samples				Mean no. per sample
	Qtr 1	Qtr 2	Qtr 3	Qtr 4		Qtr 1	Qtr 2	Qtr 3	Qtr 4	
Catch	1	0	0	1	307	1	0	1	1	331
Landings	0	0	0	0		0	0	0	0	
Discards	0	0	0	0		0	0	0	0	

	Number of samples									
Year	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989
Catch	2	3	0	0	2	0	0	0	0	0
Landings	0	0	0	0	0	0	0	0	0	0
Discards	0	0	0	0	0	0	0	0	0	0

Continued on next page

Table 5.2.9. - (continued).

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival	0.25	borrowed from stocks in IVa
MALES		
Growth - K	0.160	borrowed from stocks in IVa
Growth - L(inf)	75	"
Natural mortality - M	0.3	"
Length/weight - a	0.00045	Swedish observations (unpublished data)
Length/weight - b	3.113	"
FEMALES		
Immature Growth		
Growth - K	---	all length groups assumed to be mature
Growth - L(inf)	---	"
Natural mortality - M	---	"
Size at maturity	28	Swedish observations (unpublished data)
Mature Growth		
Growth - K	0.100	borrowed from stocks in IVa
Growth - L(inf)	65	"
Natural mortality - M	0.2	"
Length/weight - a	0.00108	Swedish observations (unpublished data)
Length/weight - b	2.847	"

Table 5.2.10. - Skagerrak (FU 3): VPA output males.

Year	Recruits Age 1	Total Biomass	TSB	Landings	Yield/SSB	Fbar 3-8
	'000	tonnes	tonnes	tonnes		
1990	221436	12019	12019	2119	0.176	0.776
1991	234140	12471	12471	2600	0.209	0.817
1992	232994	10348	10348	986	0.095	0.553
1993	230688	12660	12660	1392	0.110	0.541
1994	249072	13894	13894	1520	0.109	0.449
1995	228186	14830	14830	1925	0.130	0.356
1996	132029	15253	15253	1978	0.130	0.273
1997	138862	15254	15254	1965	0.129	0.286
1998	120271	14887	14887	2650	0.178	0.416
Average 96-98						0.325

Table 5.2.11. - Skagerrak (FU 3): VPA output females.

Year	Recruits Age 1	Total Biomass	TSB	Landings	Yield/SSB	Fbar 3-13
	'000	tonnes	tonnes	tonnes		
1990	148031	12037	12037	748	0.062	0.116
1991	159374	11179	11179	336	0.030	0.080
1992	183670	14368	14368	914	0.064	0.137
1993	208014	14558	14558	893	0.061	0.187
1994	162600	14700	14700	461	0.031	0.127
1995	87560	13436	13436	505	0.038	0.121
1996	34927	13909	13909	718	0.052	0.083
1997	22660	12961	12961	647	0.050	0.076
1998	2640	11997	11997	599	0.050	0.096
Average 96-98						0.085

Table 5.2.12. - Kattegat (FU 4): VPA output males.

Year	Recruits Age 1	Total Biomass	TSB	Landings	Yield/SSB	Fbar 3-8
	'000	tonnes	tonnes	tonnes		
1991	108522	4371	4371	665	0.152	0.828
1992	144413	4746	4746	673	0.142	1.500
1993	160194	6142	6142	489	0.080	0.931
1994	137139	5787	5787	746	0.129	0.605
1995	99160	5340	5340	537	0.101	0.725
1996	104252	6473	6473	852	0.132	0.578
1997	98068	7072	7072	1202	0.170	0.882
1998	82381	6577	6577	1400	0.213	0.834
Average 96-98						0.764

Table 5.2.13. - Kattegat (FU 4): VPA output females.

Year	Recruits Age 1	Total Biomass	TSB	Landings	Yield/SSB	Fbar 3-13
	'000	tonnes	tonnes	tonnes		
1991	126241	7353	7353	650	0.088	0.411
1992	108798	6866	6866	339	0.049	0.228
1993	94231	6896	6896	435	0.063	0.596
1994	71804	4887	4887	147	0.030	0.279
1995	35576	5104	5104	461	0.090	0.247
1996	19492	4686	4686	433	0.092	0.134
1997	15430	3888	3888	392	0.101	0.448
1998	3522	2907	2907	396	0.136	0.327
Average 96-98						0.303

Table 5.2.14. - Management Area E (IIIa): Total *Nephrops* landings (tonnes) by Functional Unit plus other rectangles, 1989-98.

Year	FU 3	FU 4	Other	Total
1989	2567	1313	0	***3880***
1990	2867	1475	0	***4342***
1991	2936	1315	0	***4251***
1992	1900	1012	0	***2912***
1993	2285	924	0	***3209***
1994	1981	893	0	***2874***
1995	2430	998	0	***3428***
1996	2696	1285	0	***3981***
1997	2612	1594	0	***4206***
1998 *	3249	1796	0	***5045***

* provisional na = not available

Table 5.2.15. - Management Area E (IIIa): Total *Nephrops* landings (tonnes) by country, 1989-98.

Year	Denmark	Norway	Sweden	Total
1989	3017	64	799	***3880***
1990	3097	148	1097	***4342***
1991	2824	197	1230	***4251***
1992	2052	111	749	***2912***
1993	2250	100	859	***3209***
1994	2049	62	763	***2874***
1995	2419	91	918	***3428***
1996	2844	103	1034	***3981***
1997	2959	117	1130	***4206***
1998 *	3541	185	1319	***5045***

* provisional na = not available

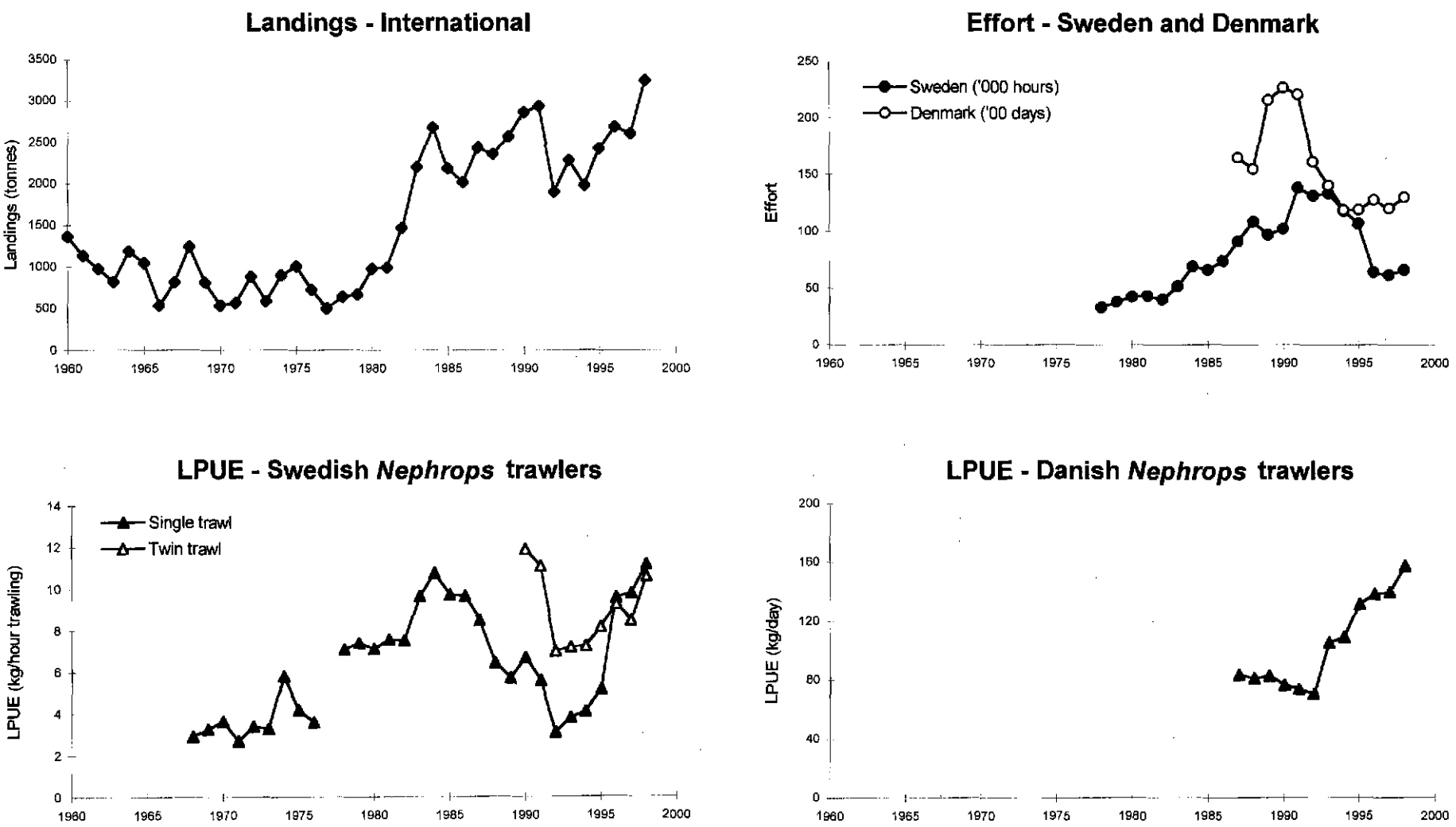


Figure 5.2.1. - Skagerrak (FU 3): Long-term trends in landings, effort, LPUEs and mean sizes of *Nephrops* in catches and/or landings.

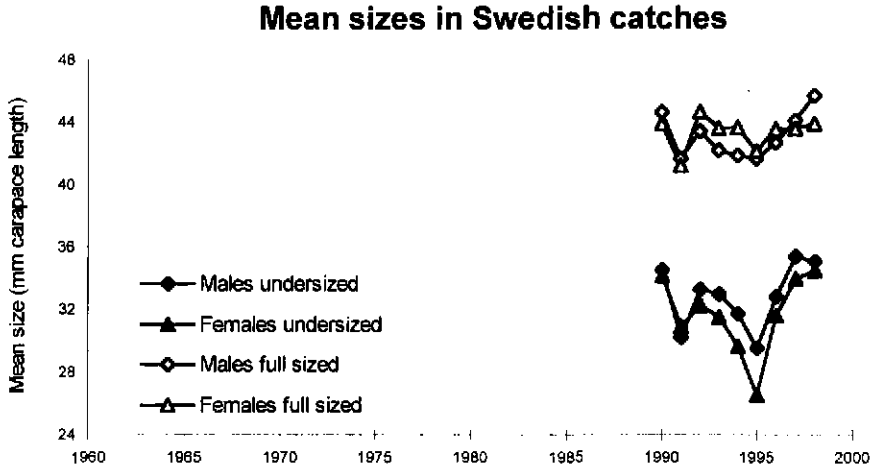


Figure 5.2.1. - (continued).

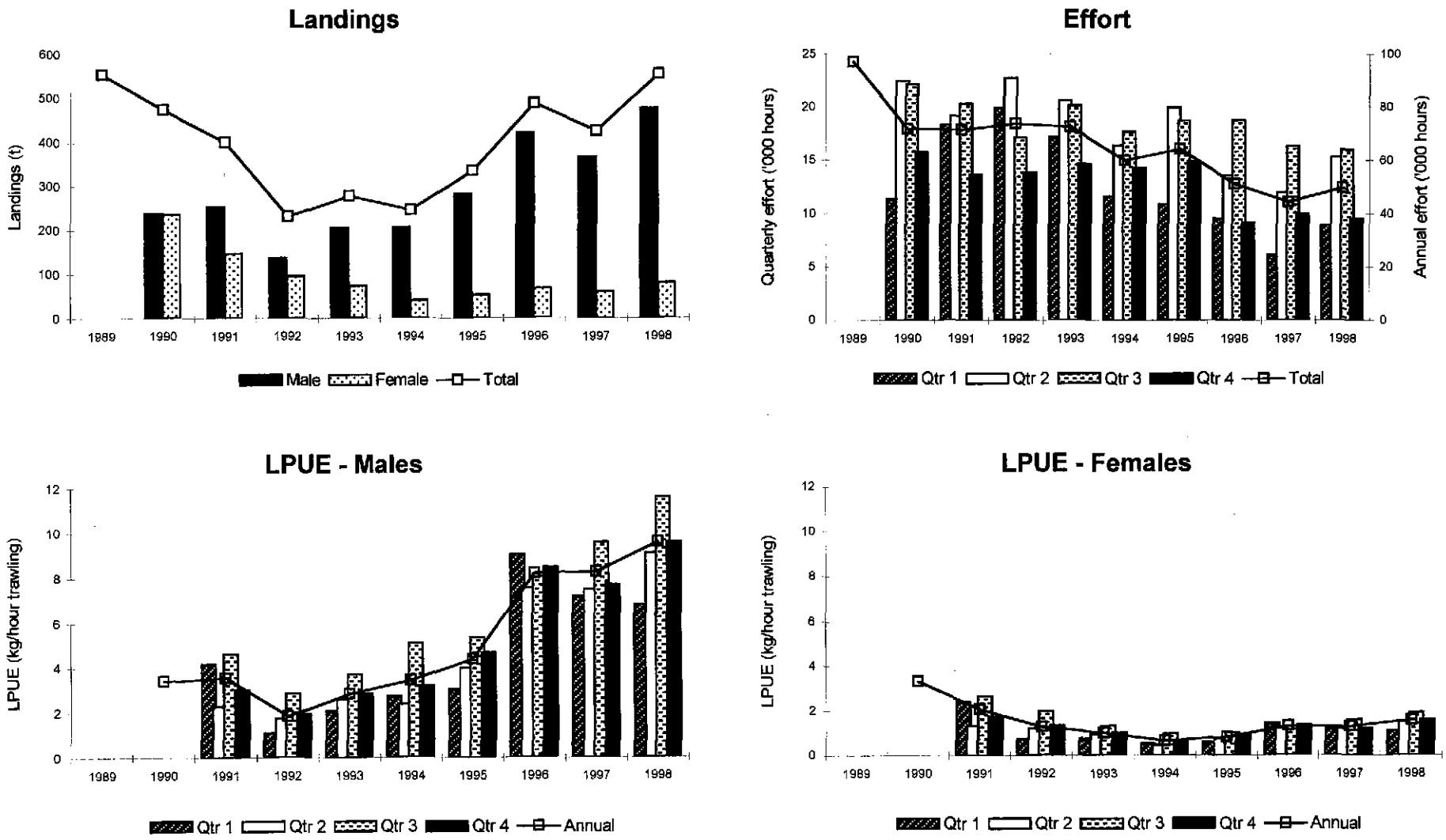


Figure 5.2.2. - Skagerrak (FU 3): Landings, effort and LPUEs by quarter and sex from Swedish *Nephrops* trawlers - Single trawl.

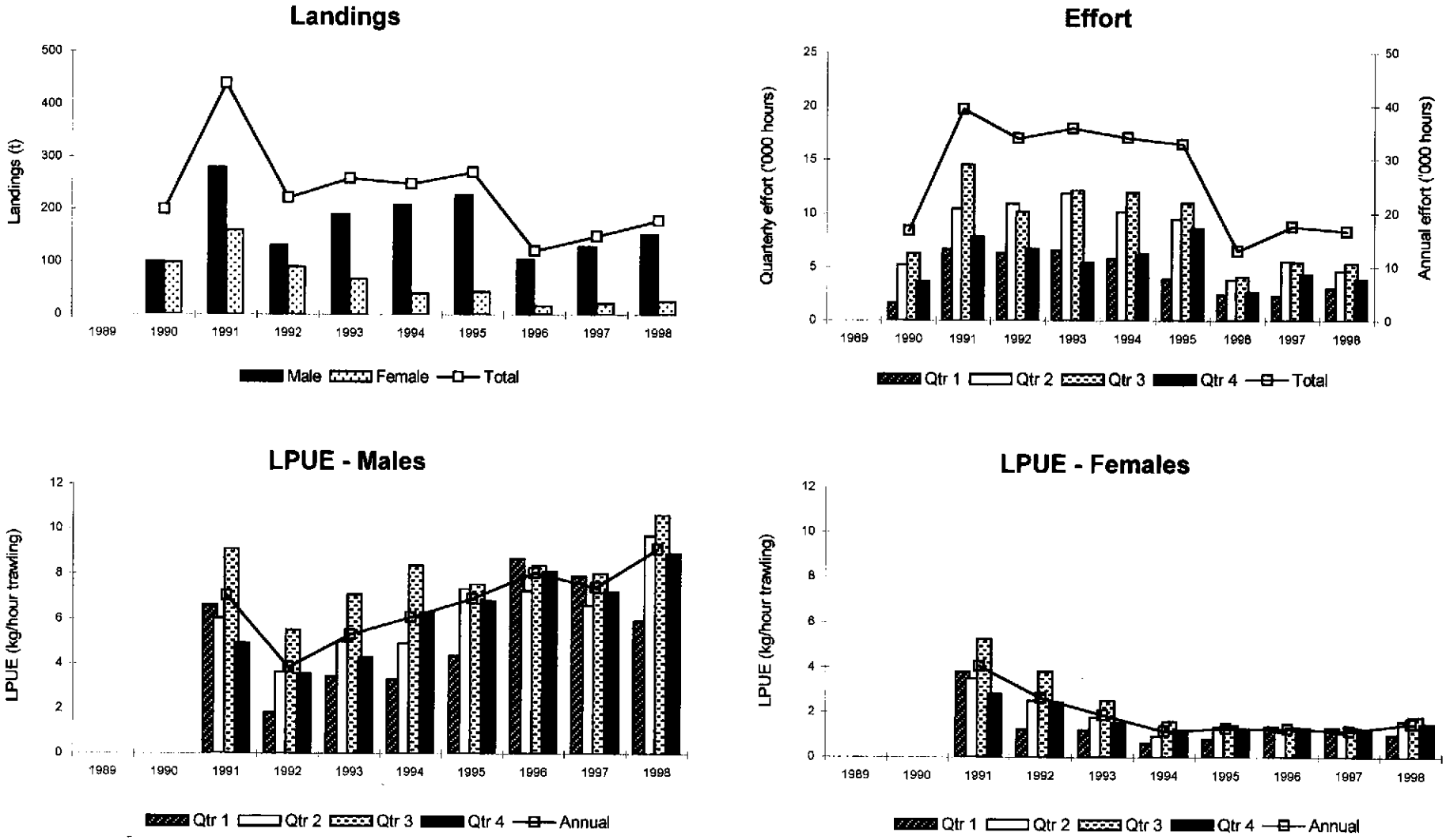


Figure 5.2.3. - Skagerrak (FU 3): Landings, effort and LPUEs by quarter and sex from Swedish *Nephrops* trawlers - Twin trawl.

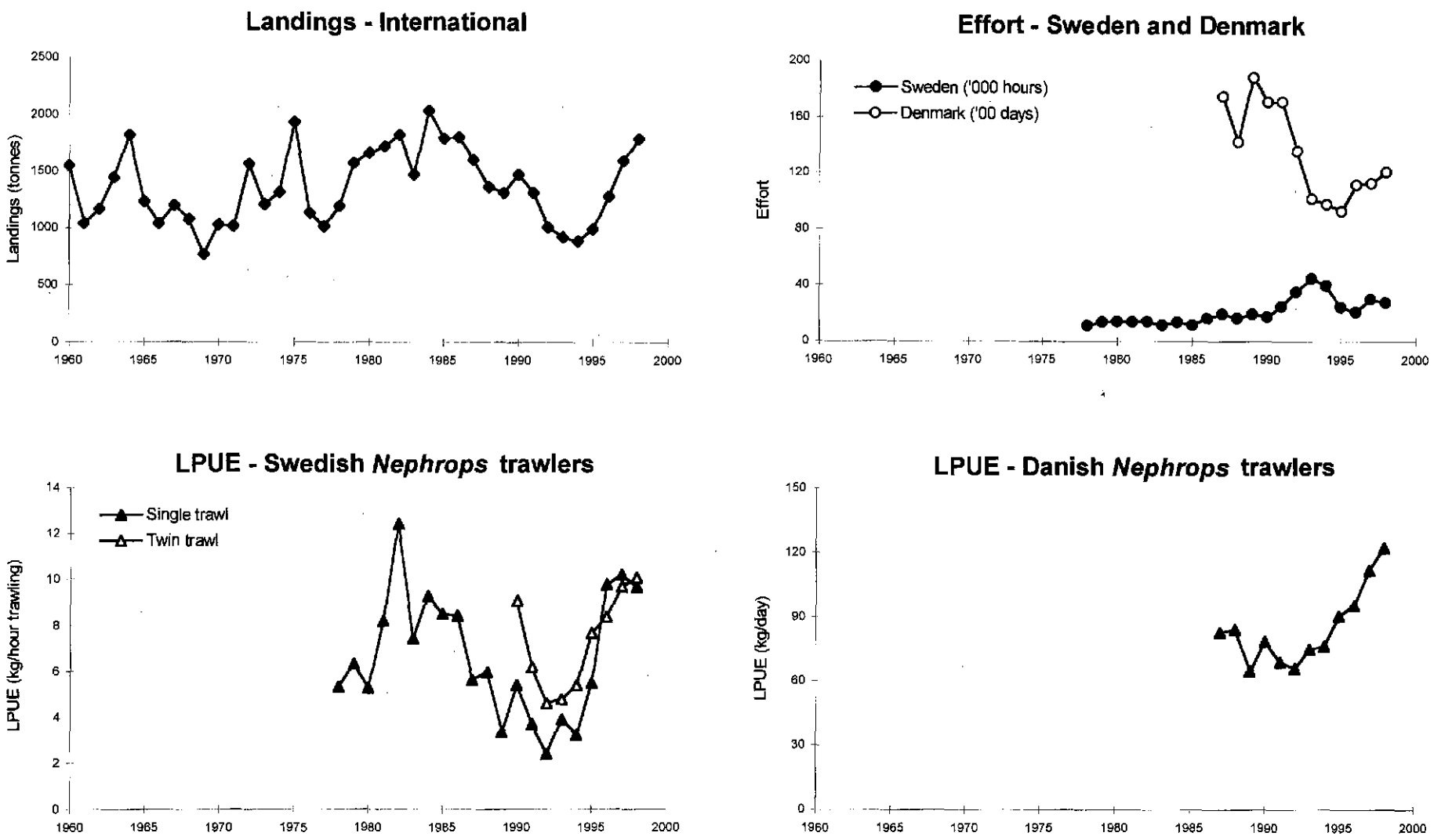


Figure 5.2.4. - Kattegat (FU 4): Long term trends in landings, effort, LPUEs and mean sizes of *Nephrops* in catches and/or landings.

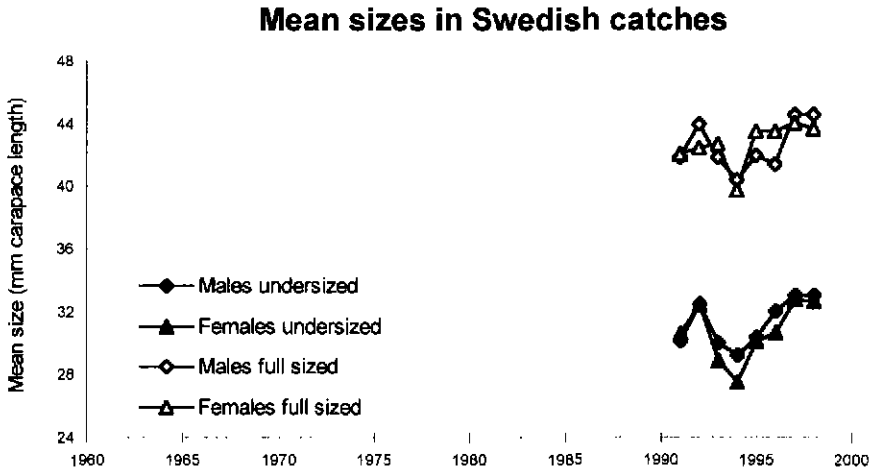
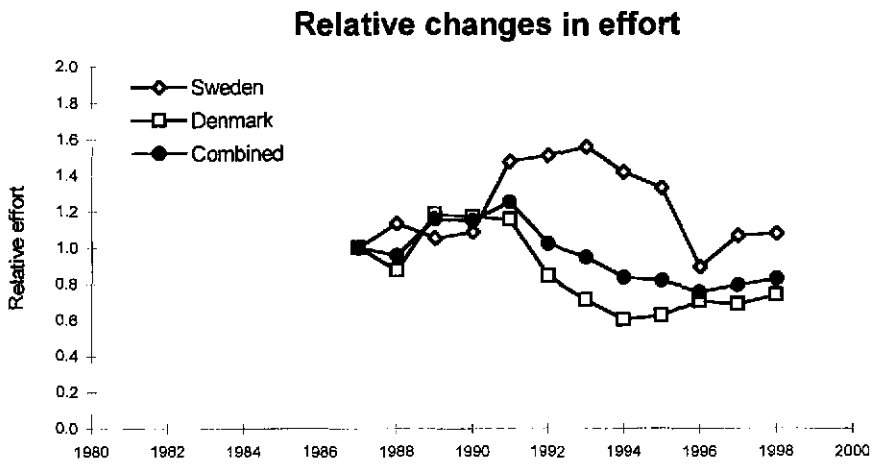


Figure 5.2.4. - (continued).



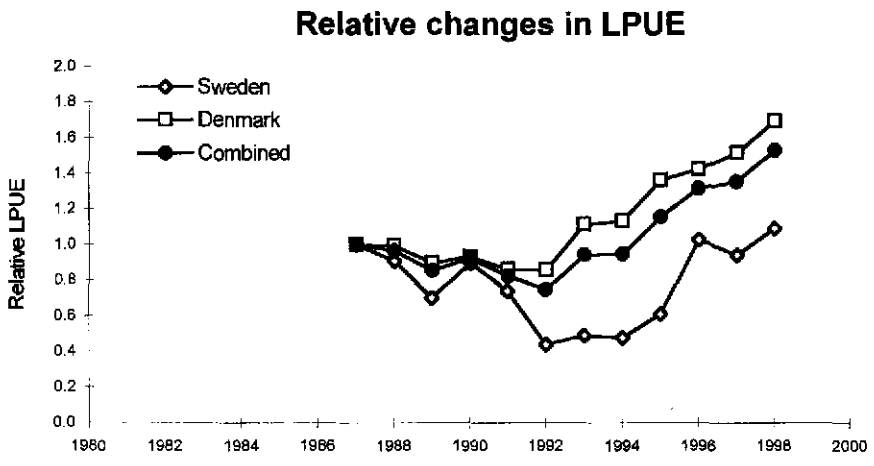


Figure 5.2.5. - Skagerrak and Kattegat (FUs 3 and 4 combined) - Relative changes in effort and LPUE, 1987-98.

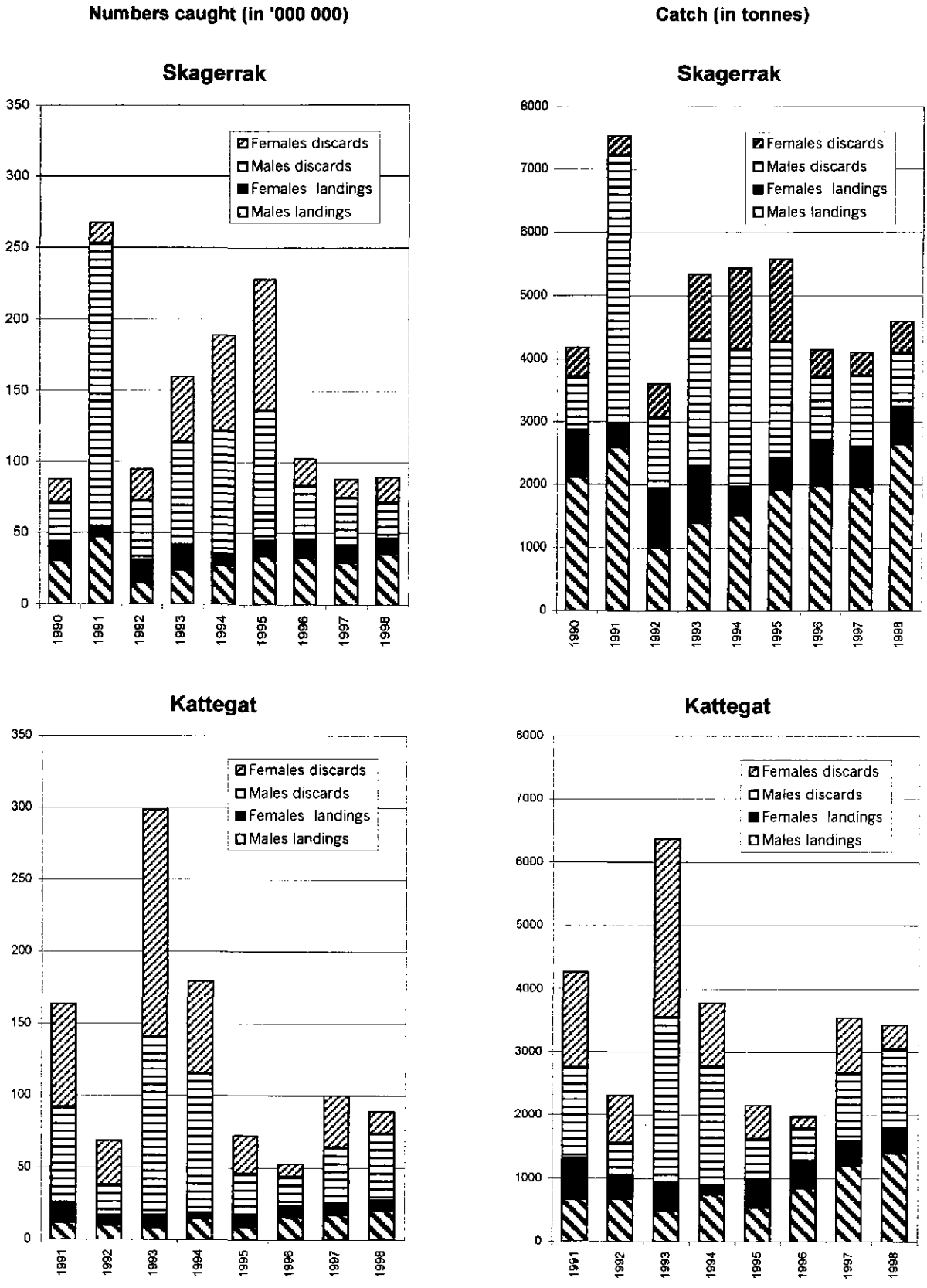


Figure 5.2.6. - Skagerrak (FU 3) and Kattegat (FU 4): Composition of *Nephrops* catches, split by catch fraction (landings and discards) and by sex, 1990-98 and 1991-98.

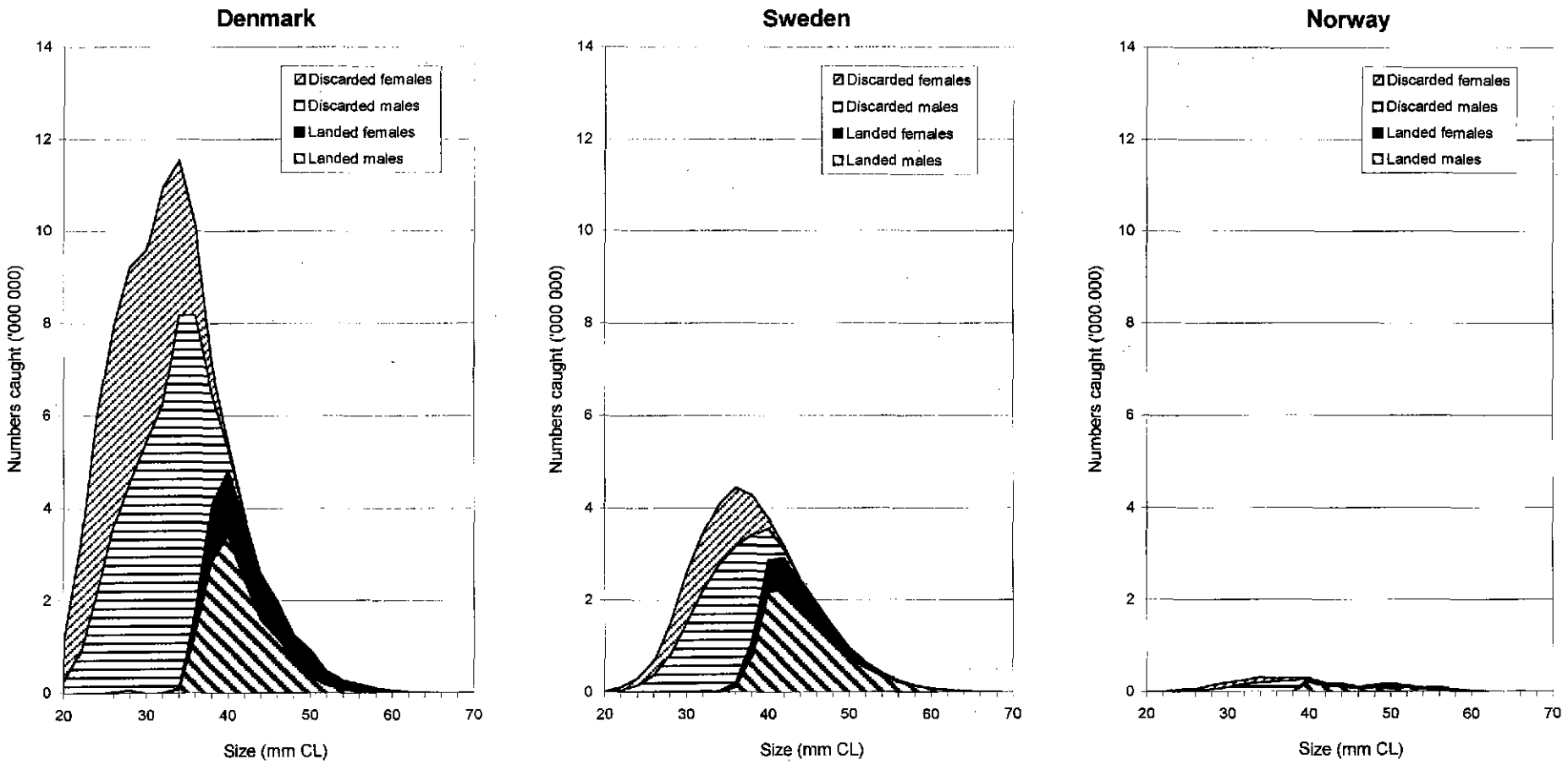


Figure 5.2.7. - Skagerrak (FU 3): Length frequency distributions of *Nephrops* catches, split by catch fraction (landings and discards) and sex. Data for Denmark, Sweden and Norway shown separately.

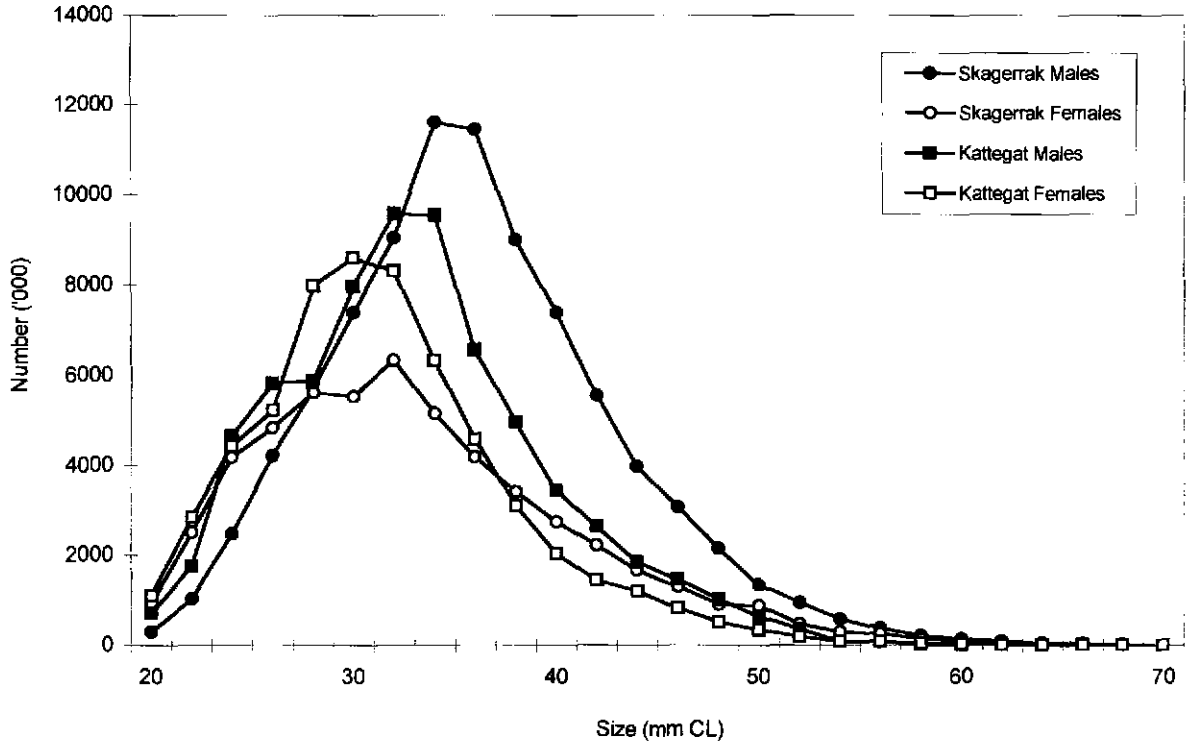


Figure 5.2.8. - Skagerrak (FU 3) and Kattegat (FU 4): Average length frequency distributions (averaged across the years 1990-98) of male and female *Nephrops*.

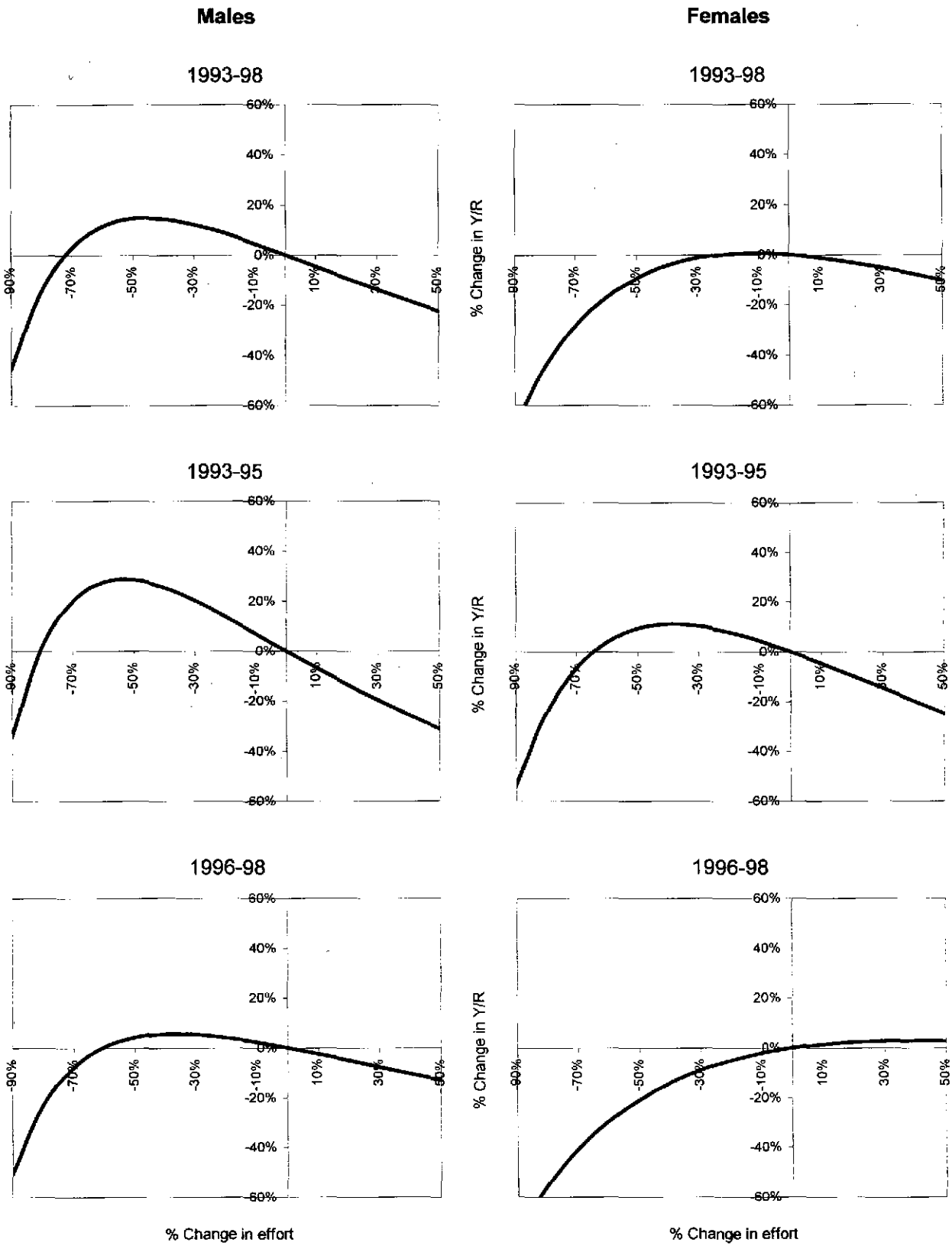


Figure 5.2.9. - Skagerrak (FU 3): Output LCA: Relative changes in long-term yield upon relative changes in effort, for different reference periods. Males and females shown separately.

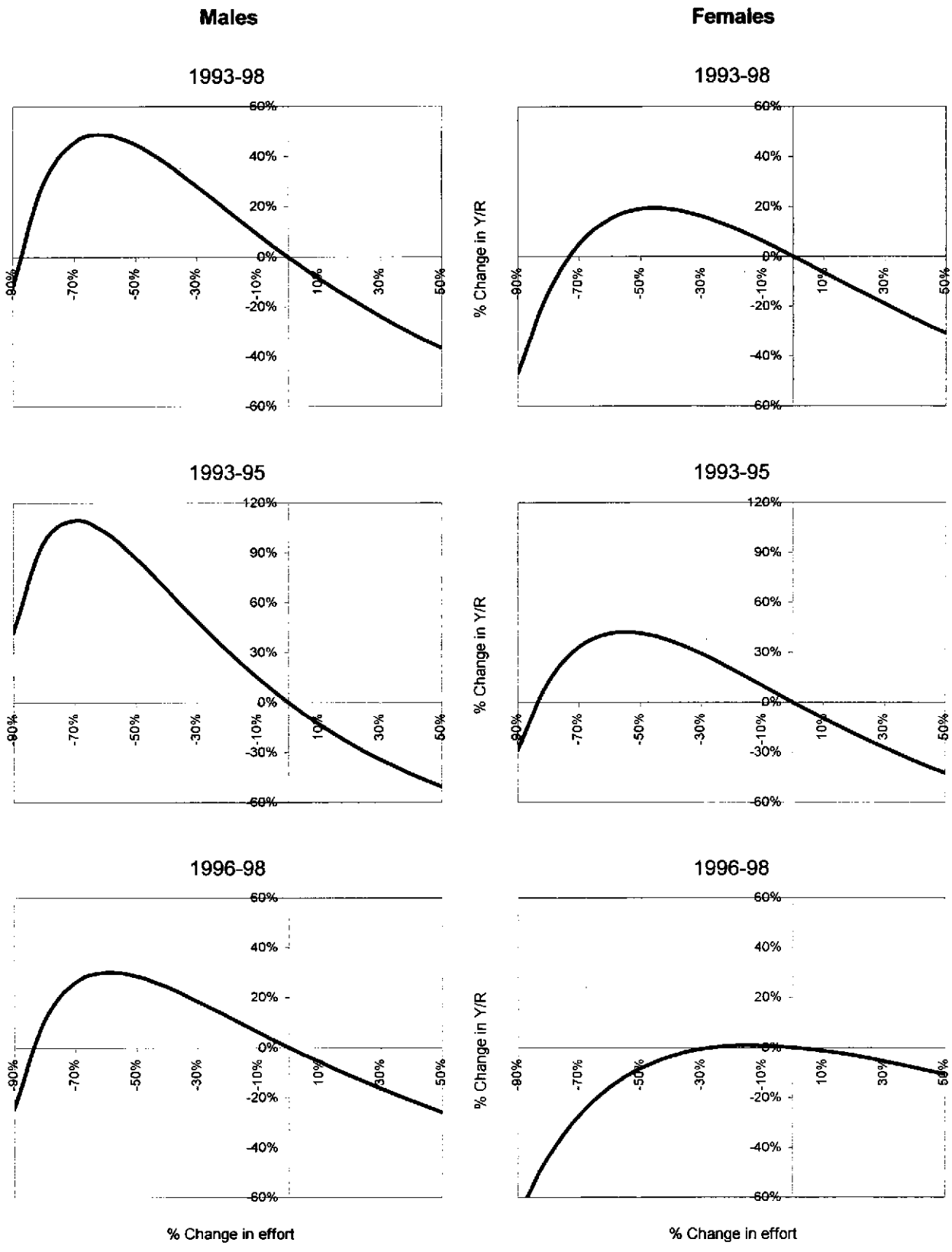


Figure 5.2.10. - Kattegat (FU 4): Output LCA: Relative changes in long-term yield upon relative changes in effort, for different reference periods. Males and females shown separately.

5.3. Management Area F

ICES description **IVa rectangles 44-48 E6-E7 + 44E8**

Functional Units **Moray Firth (FU 9)**
Noup (FU 10)

The statistical rectangles comprised in this Management Area and its constituent Functional Units are shown in Figure 5.1.1.

5.3.1. Moray Firth (FU 9)

Description of the fisheries

UK – Scotland

An extensive description of the Scottish fisheries in this area will be given in the next WG Report.

Trends in landings, effort, CPUE, LPUE and mean size

Table	5.3.1.	Landings by country, 1989-98
Table	5.3.2.	Effort and LPUEs Scottish fleet, 1989-98
Table	5.3.3.	Mean sizes of *Nephrops* in catches and landings, Scottish data, 1989-98
Figure	5.3.1.	Long-term trends in landings, effort, LPUE and mean size, Scottish data
Figure	5.3.2.	Landings by sex + Quarterly plots of effort and LPUEs by sex, 1989-98
Figure	5.3.3.	Quarterly plots of CPUEs for selected size groups, 1989-98
Figure	5.3.11.	Fishing intensity indices

Landings, effort, CPUE and LPUE

Landings data were reported for UK vessels landing in Scotland only (Table 5.3.1.). After the very low figure in 1995, the slight recovery in landings in 1996 was maintained in 1997. Provisional figures for 1998, however, suggest a further decline to a new low of just over 1000 t, well below half the peak landings of 1989. *Nephrops* trawlers accounted for 1102 t in 1997 (76.3 % of the total) and 737 t in 1998 (71.6 % of the total). The remaining landings were made mainly by other types of trawler and by creel fishing (< 5 t). Fishing effort also increased in 1996 and 1997 from a low in 1995, but provisional figures for 1998 suggest that it has dropped back to 34.2 10^3 hours, just under 50 % of the level in the peak year 1989 (Table 5.3.2.).

In 1997, there was a marked decline in overall *Nephrops* trawl LPUE followed by a further decline in 1998 (Table 5.3.2.). These values are the lowest in the recent time series and are similar to the values observed in the 60s, when the fishery was in its early stages of development (Figure 5.3.1.). Given that there are likely to have been changes in gear efficiency over this time scale, the recent low values give cause for concern. Declines are

most obvious in the single *Nephrops* trawl data series but are also evident since 1996 in the multi-rig data. Following low levels of effort by multi-rig trawls in 1996, there has been an increase in the use of larger mesh versions of these gears (the use of 70 mm multi-rig gear in this area is subject to a UK national ban).

Figure 5.3.2. shows that the decline in landings has affected both males and females but particularly the males. This is perhaps not surprising since there have been subtle changes in the pattern of effort through the year with the 1st, 2nd and 3rd quarters (when males are generally more abundant than females) becoming relatively more important (Figure 5.3.2.).

Plots of annual LPUEs by sex show declines in both sexes for 1997 and 1998 (Figure 5.3.2). The seasonal pattern of LPUE in females has tended to exhibit the unusual pattern of 1995 when LPUE was high throughout the year instead of showing a seasonal pattern with a peak in the 3rd quarter.

For the first time, CPUE was also calculated for size groups unaffected by discarding and recruitment (> 35 mm CL) and for smaller animals (< 35 mm CL) (Figure 5.3.3.). For both males and females, CPUE of the smaller animals peaked in 1995, whereas the CPUE for larger animals was more stable. Results also suggest that most of the recent decline in overall CPUE can be explained by declines in the smaller components of the catches. This may point to a reduction in recruitment.

Mean size

The mean size of males and females was also calculated for categories < 35 mm CL and > 35 mm CL in the landings, and for < 35 mm CL in the catch (Figure 5.3.1.). There was little evidence of any trend in the larger size category but the mean size in the catch of small animals showed a marked dip in 1995, followed by a return to higher values since then. Taken together with the CPUE data, this observation is not inconsistent with the suggestion of strong recruitment in 1995 followed by a decline since then.

Fishing intensity indices

Landings per area and fishing effort per area for the Moray Firth are shown in Figure 5.3.11. These suggest quite low values in comparison with some other Scottish stocks.

Data and biological inputs for analytical assessments

Table 5.3.6. Sampling data and input parameters

Adequate sampling of commercial trawl landings was achieved in this fishery in 1997 and 1998. Discard sampling on board commercial fishing vessels was carried out in all quarters during both 1997 and 1998. The landing and discard samples were raised to fleet level and combined to estimate total removals, assuming a discard survival of 25 %. In the absence of reliable discard data before 1990, an average was estimated from the combined 1990-91 data, and this was applied retrospectively to estimate the removals in earlier years.

Input parameters were mostly unchanged from previous years. A new size at first maturity in females (25 mm CL) was adopted, in line with the findings of the 1998 *Nephrops* Study Group (ICES, 1998b).

General comments on quality of data and inputs

There is no detailed information on the accuracy of the landings statistics. There may have been some under-reporting of landings towards the end of each year but it is not thought to be important in this area.

In general, there is a disproportionately large number of samples collected for a stock of this size (apart from the discards prior to 1990). Compared to some other Scottish grounds, there appears to be less biological variation in growth and other parameters (see ICES, 1993a).

Length based assessments (LCA)

Table 5.3.7. Output table LCA males, with mean F
Table 5.3.8. Output table LCA females, with mean F
Figure 5.3.4. Changes in Y/R and B/R upon changes in F, for males and females separately

In view of the addition of length composition data for 1997 and 1998, it was considered appropriate to update the LCA. The reference period chosen was 1996-98, during which fishing effort was reasonably stable (Figure 5.3.1.). Input F values were the same as in previous assessments of this type (0.05 and 0.025 for males and females respectively).

For males, the LCA resulted in a fairly flat-topped Y/R curve with current F slightly above F_{max}, essentially similar to that given in the 1997 WG Report (ICES, 1997a). For females, the long-term Y/R relationship was markedly curved, giving a more pessimistic impression than in the previous assessment. Current F was, however, still below F_{max}. Annualised fishing mortalities (averaged across the inter-quartile length range) were 0.53 and 0.13 for males and females respectively, slightly higher than the 1997 assessment (ICES, 1997a).

Age based assessments (VPA)

A single fleet assessment was carried out using Scottish data from 1981-98. The Lowestoft VPA program was used on nominal 'age' groups generated by slicing the length distributions. Tuning of the VPA was carried out using Scottish *Nephrops* trawl effort data, raised by the ratio of landing of all trawls to *Nephrops* trawls.

Males

Table 5.3.9. Output XSA males: Fs-at-age
Table 5.3.11. Output XSA males: Long-term trends in landings, Fbar, TSB and recruitment
Figure 5.3.5. Output XSA males: Log catchability residuals
Figure 5.3.7. Output XSA males: Long-term trends in landings, Fbar, TSB and recruitment
Figure 5.3.9. Output XSA males: Plots of Fbar vs. effort

The slicing procedure generated 9 nominal 'age' groups (9 = plus group). Tuning of the VPA was carried out using the XSA option. Tuning was performed over the whole 18 year period, over ages 1-8, with a tricubic time taper but without shrinkage. For the catchability analysis, catchability was dependent on stock size for ages < 3, with estimates shrunk to the population mean; and independent of age for ages > 4. Survivor estimates were shrunk towards mean F. The tuning converged after 15 iterations.

For the young ages, there was no evidence of trends in the log catchability residuals, but for age 1 there were large fluctuations in the most recent years (Figure 5.3.5.). The residuals for the older age groups showed strong year effects, particularly prior to 1989, but have become more stable in recent years.

Trends in the estimates of yield, F_{bar}, TSB and recruitment are plotted in Figure 5.3.6. F_{bar} was high in 1989, but has remained relatively constant in more recent years, fluctuating between about 0.4 and 0.8. TSB apparently increased during the mid- and late 80s, but has since declined and is now at its lowest level in the time series. Recruitment has fallen from the relatively high levels of the mid-80s and has become more variable. In common with a number of other areas, recruitment improved in 1994 although this did not appear to have lead to improved biomass.

The correlation coefficient between F_{bar} and effort is significant ($r = 0.62$; $p < 0.01$), indicating that the VPA has taken account of the pattern of fishing mortality reasonably well.

Females

Table 5.3.10. Output XSA females: Fs-at-age
Table 5.3.12. Output XSA females: Long-term trends in landings, Fbar, TSB and recruitment
Figure 5.3.6. Output XSA females: Log catchability residuals
Figure 5.3.8. Output XSA females: Long-term trends in landings, Fbar, TSB and recruitment
Figure 5.3.9. Output XSA females: Plots of Fbar vs. effort

The slicing procedure gave 16 nominal 'age' groups (16 = plus group). Different values of M were chosen for immature and mature females (Table 5.3.6.). XSA tuning choices were the same as for males. The tuning had not converged to the program criteria after 30 iterations but examination of the final year F values from the last two iterations showed that convergence had occurred to 2 decimal places.

With the exception of age 1, the log catchability residuals for the youngest ages were reasonable (Figure 5.3.8.). In the ages 6-15, there was a declining trend through the 80s and some year effects at most ages.

Trends in yield, F_{bar}, TSB and recruitment estimated by the VPA are shown in Figure 5.3.9. Mean F values are generally low and show no particular trends. The estimates of TSB show an increasing trend through the 80s, followed by a decline in the 90s. Values are generally higher in females than males. Recruitment showed a similar trend to the males, being relatively high in the late 80s, declining in the 90s, but with a peak in 1994. Again, there is little evidence that this led to a significant increase in biomass.

The correlation between F_{bar} and effort is not quite significant ($r = 0.46$; $p = 0.055$) but the very low F values suggest that the VPA may not be very reliable in the case of females (see ICES, 1995a).

Comparison between the two sexes of the TSB series and the recruitment estimates shows greater values in females (by a factor of between 2 and 3) than in males. This is regarded as unrealistic, although the discrepancy is not so pronounced as in the 1997 assessment (ICES, 1997a).

Catch predictions

In view of the declining biomass and recruitment identified by the VPA and supported by the TV results (see below), and taking into account the recent fall in effort and landings, it was felt that a prediction of likely catches and landings at current effort and stock levels was appropriate.

Catch predictions for 1999 (Table 5.3.13.) were made, based on stock size rolled forward from the VPA, recruitment averaged over the previous four years, a recent effort pattern (Fs-at-age averaged over the last three years) and status quo effort. Under these conditions, the predicted catch was 895 t for males and 530 t for females, giving a total catch of 1425 t. Applying discard proportions by weight to these figures gave total landings of 773 t and 415 t for males and females respectively, and a total of 1188 t.

Catch predictions were also made for 2000 (Table 5.3.13.), rolling on the numbers-at-age in the stock a further year, and using the same assumptions, but making no allowance for recruits that year. With the same allowances for discards, total catch for 2000 was predicted to be 1274 t and total landings 1058 t. This prediction suggests that if effort is maintained at current levels, landings too can be expected to remain close to present levels.

Fishery independent methods – Underwater TV surveys

Table 5.3.4. Results of 1997 and 1998 underwater TV surveys
Table 5.3.5. Overview results of underwater TV surveys, 1993-98

Combined TV camera and trawl surveys of this stock have been carried out between 1993 and 1998. New data reported to the WG cover the surveys in June 1997 and September 1998.

Estimates of mean burrow density in different strata varied from 0 to 0.26 per m^2 in 1997, and from 0 to 0.36 per m^2 in 1998. The estimates for 1997, raised to the total ground area (2195 km^2), gave an overall abundance estimate of 317 10^6 burrows (95 % confidence interval 66 10^6) with an estimated stock biomass in the range 4.8-7.3 10^3 t. This represents a decrease on the results from the 1996 survey to the lowest level in the series. Some of this decline may be the result of having to use a different research vessel than in the earlier surveys. The chartered vessel was unable to control speed over the bottom quite so well and this made estimation of the TV track areas more difficult. The estimates for 1998, however, tend to confirm that the stock size has fallen since 1994, with abundance estimated at 391 10^6 animals (95 % confidence interval 115 10^6) and a biomass in the range 5.3-7.5 10^3 t. Allowing for the fact that this survey was slightly later in the year (by adding in an estimate for the number of

removals taken by fishing between June and early September) made little difference to the picture.

The TV trends are in broad agreement with the trends in biomass estimated from the VPA and tend to confirm a steady decline in the size of the stock in recent years, which gives cause for concern. At the 1997 WG (ICES, 1997a), it was pointed out that the TV method includes rather more information on recruiting sizes of *Nephrops*. The 1994 estimate of improved recruitment from the VPA was also observed in the TV abundance data. This is discussed more fully in the sections covering the use of independent methods (Section 7) and the correspondence between methods (Section 6).

Comments on quality of assessments

The VPA appears to have performed reasonably well in males but less in females, for which fishing mortalities were so low that the tuning failed to converge. Trends in recruitment for the two sexes are encouragingly similar. There was good agreement between the trends shown in direct TV estimates of abundance and those derived from the VPA. While the biomass trends from the TV surveys are similar to those of the VPA, the absolute values differ to some extent. This may be due to the use of inappropriate mean weights in the TV data. Increased numbers of trawl samples during the survey, the use of data from discard sampling trips, or direct measurement of the animals on the TV screen may offer ways of improving the biomass estimates.

Management considerations

The LCA results for the males suggest that exploitation was marginally above the optimum but, owing to its flat-topped appearance, little is to be gained from a reduction in effort to F_{max}. From the Y/R curve, females are apparently under-exploited, with current F below F_{max}. These results tend to suggest that the stock is not suffering from growth overfishing, a situation which has been described previously (see e.g. ICES, 1997a). Other aspects of the Moray Firth assessment, however, do not provide the same optimistic picture and it is recommended that less attention is paid to the Y/R findings. Y/R does not provide any information about recruitment or biomass trends and relies on the assumption that recruitment is stable. Other indicators, however, suggest that there may be a downward trend in biomass and rather erratic recruitment in recent years.

These indications of declining stock biomass and erratic recruitment suggest that the stock will require careful monitoring in the future and that effort should not be allowed to increase to the levels observed in the late 80s. It also raises the question of whether the previous management advice (ICES, 1997c) remains suitable. The existing Moray Firth recommendation was derived in 1991 from average landings for the period 1985-90. Examination of the long-term trends (Figure 5.3.1.) shows that this was a period of unusually high landings and LPUE, which appear not to be sustainable. It is suggested that a TAC based on a recent mean, closer to the current levels of exploitation, would be more appropriate. Mean landings for the period 1993-98 were 1424 t and are associated with effort levels somewhat below those in 1985-90. The catch prediction in the assessment section above resulted in even lower expected landings in the next couple of years than the average calculated above. In view of

the uncertainties in some of the inputs to the assessments and the catch predictions, however, such a large reduction in TAC is not advisable without further information.

5.3.2. Noup (FU 10)

Description of the fisheries

UK – Scotland

An extensive description of the Scottish fisheries in this area will be given in the next WG Report.

Trends in landings, effort, LPUE and mean size

Table 5.3.14. Landings by country, 1989-98
Table 5.3.15. Effort and LPUEs Scottish fleet, 1989-98
Figure 5.3.10. Long-term trends in landings, effort and LPUE, Scottish data
Figure 5.3.11. Fishing intensity indices

Landings, effort and LPUE

Landings data were reported for UK vessels landing in Scotland only (Table 5.3.14). Landings from the Noup have been fluctuating without obvious trend with values for 1997 and 1998 amounting to 316 t and 254 t respectively. In the last three years, landings by *Nephrops* trawlers have been stable at around 180 t and have accounted for over half of the (52-72 %) of the total. Other trawlers contribute the remaining part of the landings.

Following a peak in effort by *Nephrops* trawlers in 1994, effort has fallen back to earlier levels but LPUE remains high and is fluctuating without trend at a level above many other Scottish stocks (Table 5.3.15.). Most of the *Nephrops* trawl activity is by single trawls (the use of multi-rig gear accounts for only 4-6 % of *Nephrops* directed trawl effort) and is mainly by vessels using larger mesh sizes. No mean size data are available for this stock.

Fishing intensity indices

A measure of the relative fishing pressure on the stock is provided by landings per area and effort per area indices. Using the 1997 and 1998 landings and equivalent effort gave indices of 0.464 t per km^2 and 0.013 * 1000 hours per km^2 for 1997, and 0.468 t per km^2 and 0.008 * 1000 hours per km^2 for 1998 (Figure 5.3.11.). As reported in earlier years, these values are relatively low compared to the indices for some other Scottish grounds.

Data and biological inputs for analytical assessments

Sampling of the landings in this small fishery has been very limited to date. Between 1991 and 1992, three samples were taken each year, and between 1997 and 1998, four samples

were taken. No discard sampling has taken place. Biological parameters for the stock are largely unknown.

A TV survey of the ground was conducted by Scotland in June 1994, providing estimates of burrow density and abundance of the stock. There have been no surveys in this area in subsequent years.

Assessments

As noted previously, the limited availability of length composition data and biological information precludes stock assessments by analytical methods. There have been no new estimates of stock size from TV surveys since 1994. The survey in 1994, based on tows at 10 stations, gave a mean density estimate of 0.63 burrows per m^2, a mean stock abundance estimate of 250 10^6 burrows (95 % confidence interval 160-340 10^6), and stock biomass estimates in the range 4-8 10^3 t.

Management considerations

In the absence of analytical assessment, conclusions on the state of the Noup stock can only be based on LPUE and landings per area trends, and a preliminary TV survey. Comparisons with other Scottish stocks in terms of the landings per area and effort per area indices suggest that current levels of fishing effort are acceptable for this small FU. Maintenance of effort at this level would be an appropriate measure at this time.

5.3.3. Summary for Management Area F

Table 5.3.16. Landings by FU and from Other rectangles, 1989-98
Table 5.3.17. Landings by country, 1989-98

The recent landings from the Moray Firth (FU 9) and the Noup (FU 10) and from Other rectangles forming MA F show that there has been a marked reduction in landings, particularly in the most recent years. Taking into account the results from the VPA and the TV surveys, particularly for the Moray Firth (which suggest reduced biomass and recruitment), and the catch predictions (which suggest that landings will remain at a low level), the WG advises that there is a need to restrict effort. Since much of the reduction is associated with declines in the Moray Firth, it is suggested that the previous advice of a landing of 2076 t for this FU be reduced to about 1500 t (the average for 1993-98). With allowances of 400 t for the Noup and of 100 t for Other squares outside the FUs (averages for 1993-98), the total recommended figure for the MA is 2000 t.

Since this MA area is located within the larger North Sea TAC, there is a risk of effort rising to inappropriate levels by transfers from other areas. While the WG recognises that there may be practical difficulties in managing *Nephrops* by a series of smaller units, it recommends that management initiatives be taken to ensure that effort can be appropriately controlled in different areas within the overall TAC area.

Table 5.3.1. - Moray Firth (FU 9): Landings (tonnes) by gear, all UK, 1989-98.

Year	UK			
	Nephrops trawl	Other trawl	Creel	Total
1989	2102	474	0	2576
1990	1700	338	0	2038
1991	1284	233	0	1517
1992	1282	305	0	1587
1993	1505	302	0	1807
1994	1178	358	0	1536
1995	967	312	0	1279
1996	1084	366	1	1451
1997	1102	344	0	1446
1998 *	737	289	4	1030

* provisional na = not available

Table 5.3.2. - Moray Firth (FU 9): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1989-98 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	**All *Nephrops* gears combined**		
	Landings	Effort	LPUE
1989	2102	69.6	30.2
1990	1700	58.4	29.1
1991	1284	47.1	27.3
1992	1282	41.5	30.9
1993	1505	48.6	30.9
1994	1178	47.5	24.8
1995	967	30.6	31.6
1996	1084	38.2	28.4
1997	1102	47.7	23.1
1998 *	737	34.2	21.5

Year	**Single rig**			**Multirig**		
	Landings	Effort	LPUE	Landings	Effort	LPUE
1989	na	na	na	na	na	na
1990	na	na	na	na	na	na
1991	571	25.1	22.7	713	22.0	32.5
1992	617	24.8	24.8	651	16.1	40.4
1993	783	28.1	27.9	722	20.6	35.1
1994	1023	42.0	24.2	155	5.5	28.1
1995	857	27.0	31.8	110	3.6	30.0
1996	1057	37.4	28.3	27	0.8	33.7
1997	960	42.5	22.6	142	5.1	27.8
1998 *	574	27.9	20.6	163	6.3	25.9

* provisional na = not available

Table 5.3.3. - Moray Firth (FU 9): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish catches and landings, 1989-98.

Year	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
	Males	Females	Males	Females	Males	Females
1989	na	na	29.8	28.8	40.1	39.4
1990	28.8	28.1	30.4	29.1	38.4	38.7
1991	28.4	27.4	30.1	28.7	38.2	38.2
1992	29.4	28.6	31.0	30.5	38.3	38.0
1993	29.8	29.9	31.3	30.9	38.6	37.7
1994	28.9	30.1	30.8	31.0	39.5	37.5
1995	25.8	25.0	29.9	29.3	39.1	38.0
1996	29.3	28.4	30.6	29.7	38.5	38.0
1997	28.5	27.9	29.5	28.9	38.8	38.2
1998 *	28.7	28.2	30.1	29.3	38.8	38.2
* provisional na = not available						

Table 5.3.4. - Moray Firth (FU 9): Results by stratum of the 1997 and 1998 TV surveys. Note that stratification was based on a series of arbitrary rectangles.

Stratum	Area (km^2)	Number of Stations	Mean burrow density ($no./m^2$)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
1997 TV survey							
P	690	12	0.261	0.018	180	727	0.670
Q	655	10	0.117	0.007	77	288	0.264
R	728	10	0.083	0.001	60	72	0.066
S	122	2	0.000		0		
Total	2195	34			317	1087	1
1998 TV survey							
P	690	12	0.359	0.068	248	2708	0.819
Q	655	10	0.111	0.006	73	254	0.077
R	728	8	0.096	0.005	70	346	0.104
S	122	1	0.000		0		
Total	2195	31			391	3308	1

Table 5.3.5. - Moray Firth (FU 9): Results of the 1993-98 TV surveys.

Year	Mean density	Abundance	95% confidence interval	Biomass
	burrows/m²	millions	millions	'000 tonnes
1993	0.19	418	94	6.7-10.5
1994	0.39	850	213	15.1-25.1
1995	No survey			
1996	0.26	563	109	8.7-12.8
1997	0.14	317	66	4.8-7.3
1998	0.18	391	115	5.3-7.5

Table 5.3.6. - Moray Firth (FU 9): Input data and parameters.

FU	**9**	**MA**	**F**
FLEET	**UK Scotland**	**GEAR**	***Nephrops* and light trawl**

	1998					**1997**				
	Number of samples				Mean no. per sample	Number of samples				Mean no. per sample
	Qtr 1	Qtr 2	Qtr 3	Qtr 4		Qtr 1	Qtr 2	Qtr 3	Qtr 4	
Catch	0	0	0	0		0	0	0	0	
Landings	6	3	12	8	542	15	15	13	8	513
Discards	1	2	2	2	706	4	6	4	2	751

	Number of samples									
Year	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989
Catch	0	0	0	0	0	0	0	0	0	0
Landings	29	51	49	33	37	52	49	46	78	44
Discards	7	16	15	5	11	8	7	9	8	0

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival	0.25	Gueguen and Charuau, 1975
MALES		
Growth - K	0.165	adapted from Bailey and Chapman, 1983
Growth - L(inf)	62	"
Natural mortality - M	0.3	Morizur, 1982
Length/weight - a	0.00028	Howard and Hall, 1983
Length/weight - b	3.240	"
FEMALES		
Immature Growth		
Growth - K	0.165	adapted from Bailey and Chapman, 1983
Growth - L(inf)	62	"
Natural mortality - M	0.3	Morizur, 1982
Size at maturity	25	ICES, 1998b
Mature Growth		
Growth - K	0.060	adapted from Bailey and Chapman, 1983
Growth - L(inf)	56	"
Natural mortality - M	0.2	based on Morizur, 1982 ; assuming lower rate for mature females
Length/weight - a	0.00074	Howard and Hall, 1983
Length/weight - b	2.910	"

Table 5.3.7. - Moray Firth (FU 9): LCA output males.

Reference period	1996-98		
Linf (mm CL)	62.0	K	0.165

Size (mm CL)	Removals ('000)	M	DT (years)	F*DT	F	Z	Nos. attaining aver. size ('000)	Average nos. in the sea ('000)	Average biomass (kg)
17	70	0.3	0.276	0.001	0.002	0.302	114273	30210	100127
19	261	0.3	0.289	0.003	0.009	0.309	105140	29035	135388
21	1376	0.3	0.303	0.015	0.050	0.350	96169	27656	175615
23	3325	0.3	0.319	0.041	0.129	0.429	86495	25791	217107
25	5952	0.3	0.337	0.087	0.257	0.557	75431	23163	252707
27	6664	0.3	0.357	0.119	0.335	0.635	62523	19954	276780
29	7728	0.3	0.379	0.179	0.473	0.773	49862	16378	284092
31	7666	0.3	0.404	0.247	0.611	0.911	37204	12579	268930
33	5372	0.3	0.433	0.252	0.582	0.882	25740	9266	241105
35	4612	0.3	0.466	0.331	0.709	1.009	17570	6537	204700
37	2878	0.3	0.505	0.333	0.658	0.958	10975	4397	164037
39	1883	0.3	0.551	0.360	0.653	0.953	6764	2901	127785
41	1068	0.3	0.607	0.346	0.570	0.870	3999	1885	97250
43	541	0.3	0.674	0.293	0.434	0.734	2359	1254	75251
45	274	0.3	0.759	0.240	0.317	0.617	1438	871	60373
47	154	0.3	0.867	0.217	0.250	0.550	901	621	49418
49	99	0.3	1.012	0.230	0.227	0.527	559	439	39828
51	44	0.3	1.216	0.177	0.145	0.445	328	308	31751
53	26	0.3	1.523	0.190	0.125	0.425	191	214	24929
55	8	0.3	2.039	0.115	0.056	0.356	100	145	18977
57	7	0.3			0.050	0.350	48	145	18977
					Totals, including lengths above + group			213748	2865125

Mean F, calculated across inter-quartile range	0.534

Table 5.3.8. - Moray Firth (FU 9): LCA output females.

Reference period	1996-98		
Linf immatures (mm CL)	62.0	K immatures	0.165
Linf matures (mm CL)	56.0	K matures	0.060
Transition length (mm CL)	25.0		

Size (mm CL)	Removals ('000)	M	DT (years)	F*DT	F	Z	Nos. attaining aver. size ('000)	Average nos. in the sea ('000)	Average biomass (kg)
13	1	0.3	0.253	0.000	0.000	0.300	140518	34178	54655
15	14	0.3	0.264	0.000	0.000	0.300	130264	33007	77846
17	56	0.3	0.276	0.001	0.002	0.302	120348	31818	105722
19	206	0.3	0.289	0.002	0.007	0.307	110747	30593	138124
21	1207	0.3	0.303	0.013	0.041	0.341	101363	29187	173891
23	3202	0.3	0.319	0.037	0.117	0.417	91400	27303	209543
25	5716	0.2	0.337	0.077	0.228	0.428	80005	25093	243091
27	7767	0.2	1.191	0.135	0.113	0.313	69267	68850	827520
29	6359	0.2	1.283	0.164	0.128	0.328	47691	49929	733537
31	4274	0.2	1.390	0.171	0.123	0.323	31306	35058	621459
33	2734	0.2	1.516	0.173	0.114	0.314	19991	24109	509842
35	1856	0.2	1.668	0.194	0.117	0.317	12412	16085	401698
37	1290	0.2	1.854	0.239	0.129	0.329	7320	10162	297018
39	704	0.2	2.086	0.246	0.118	0.318	3980	6071	206002
41	337	0.2	2.385	0.234	0.098	0.298	2051	3502	136963
43	130	0.2	2.784	0.187	0.067	0.267	1008	1980	88658
45	52	0.2	3.345	0.163	0.049	0.249	479	1088	55465
47	21	0.2	4.189	0.168	0.040	0.240	209	551	31792
49	7	0.2	5.608	0.183	0.033	0.233	76	239	15530
51	2	0.2			0.025	0.225	21	239	15530
					Totals, including lengths above + group			429042	4943886

Mean F, calculated across inter-quartile range	0.132

Table 5.3.9. - Moray Firth (FU 9): VPA Fs-at-age males.

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.000	0.000	0.001	0.010	0.000	0.000	0.001
2	0.047	0.040	0.032	0.043	0.096	0.112	0.093	0.099	0.096	0.079	0.116	0.093	0.045	0.033	0.303	0.069	0.138	0.068
3	0.442	0.190	0.166	0.258	0.413	0.500	0.398	0.390	0.540	0.323	0.383	0.455	0.385	0.189	0.306	0.521	0.494	0.324
4	0.734	0.443	0.305	0.463	0.641	0.562	0.604	0.643	0.904	0.699	0.532	0.698	0.803	0.503	0.504	0.769	0.776	0.545
5	0.644	0.574	0.402	0.489	0.809	0.518	0.626	0.535	1.128	0.892	0.597	0.896	1.033	0.755	0.613	0.733	1.063	0.658
6	0.566	0.619	0.493	0.716	0.596	0.701	0.534	0.562	1.808	0.963	0.578	0.785	0.939	0.830	0.718	0.717	1.194	0.714
7	0.500	0.454	0.381	0.655	0.666	0.388	0.982	0.264	1.690	0.922	0.591	0.701	0.697	0.764	0.604	0.660	0.829	0.651
8	0.582	0.455	0.342	0.465	0.623	0.598	0.824	0.659	1.434	0.848	0.640	0.734	0.809	0.733	0.533	0.641	0.831	0.594
+ grp	0.582	0.455	0.342	0.465	0.623	0.598	0.824	0.659	1.434	0.848	0.640	0.734	0.809	0.733	0.533	0.641	0.831	0.594

Table 5.3.10. - Moray Firth (FU 9): VPA Fs-at-age females.

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0.001	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.000	0.001	0.013	0.000	0.000	0.001
2	0.069	0.047	0.035	0.028	0.071	0.105	0.075	0.063	0.058	0.073	0.101	0.047	0.026	0.033	0.182	0.051	0.092	0.046
3	0.082	0.048	0.028	0.028	0.074	0.119	0.067	0.053	0.062	0.085	0.097	0.061	0.054	0.047	0.046	0.076	0.088	0.051
4	0.104	0.081	0.045	0.043	0.119	0.148	0.091	0.086	0.104	0.118	0.118	0.065	0.097	0.085	0.075	0.134	0.107	0.069
5	0.106	0.095	0.060	0.057	0.138	0.158	0.100	0.102	0.105	0.128	0.118	0.072	0.129	0.137	0.083	0.142	0.115	0.070
6	0.086	0.116	0.075	0.059	0.156	0.149	0.118	0.121	0.103	0.141	0.109	0.084	0.161	0.195	0.083	0.148	0.121	0.086
7	0.083	0.112	0.096	0.066	0.163	0.149	0.135	0.145	0.107	0.155	0.095	0.108	0.192	0.269	0.091	0.130	0.128	0.104
8	0.101	0.104	0.091	0.081	0.174	0.136	0.148	0.161	0.099	0.153	0.089	0.113	0.222	0.323	0.130	0.108	0.096	0.099
9	0.091	0.125	0.081	0.059	0.169	0.143	0.131	0.169	0.092	0.171	0.079	0.110	0.201	0.319	0.154	0.114	0.089	0.085
10	0.087	0.143	0.109	0.061	0.142	0.178	0.146	0.177	0.106	0.208	0.083	0.130	0.216	0.338	0.213	0.134	0.108	0.086
11	0.084	0.083	0.113	0.077	0.122	0.134	0.123	0.149	0.123	0.242	0.057	0.081	0.210	0.203	0.192	0.131	0.112	0.066
12	0.114	0.156	0.132	0.105	0.214	0.169	0.116	0.211	0.172	0.310	0.085	0.109	0.285	0.281	0.219	0.165	0.163	0.087
13	0.092	0.119	0.143	0.066	0.141	0.198	0.081	0.127	0.219	0.249	0.070	0.094	0.160	0.161	0.157	0.111	0.126	0.067
14	0.135	0.171	0.199	0.138	0.167	0.278	0.170	0.165	0.201	0.430	0.094	0.130	0.259	0.205	0.214	0.164	0.146	0.089
15	0.099	0.112	0.095	0.066	0.111	0.132	0.123	0.129	0.168	0.171	0.080	0.086	0.137	0.129	0.092	0.086	0.091	0.071
+ grp	0.099	0.112	0.095	0.066	0.111	0.132	0.123	0.129	0.168	0.171	0.080	0.086	0.137	0.129	0.092	0.086	0.091	0.071

Table 5.3.11. - Moray Firth (FU 9): VPA output males.

Year	Recruits Age 1	Total Biomass	TSB	Landings	Yield/SSB	Fbar 3-8
	'000	tonnes	tonnes	tonnes		
1981	112066	3577	3577	1004	0.281	0.597
1982	137925	3441	3441	676	0.196	0.456
1983	173092	4068	4068	598	0.147	0.342
1984	191273	4680	4680	895	0.191	0.481
1985	178524	5139	5139	1341	0.261	0.615
1986	189246	5100	5100	1272	0.250	0.570
1987	181725	5266	5266	1344	0.255	0.541
1988	155948	5111	5111	1263	0.247	0.532
1989	157754	5249	5249	1938	0.369	1.095
1990	117423	3985	3985	1099	0.276	0.719
1991	75394	3833	3833	919	0.240	0.523
1992	84346	3521	3521	1127	0.320	0.708
1993	110544	2981	2981	966	0.324	0.790
1994	131449	2811	2811	569	0.202	0.569
1995	92584	2996	2996	659	0.220	0.535
1996	73895	3011	3011	854	0.284	0.685
1997	82045	2630	2630	894	0.340	0.882
1998	97908	2310	2310	567	0.246	0.561
Average 96-98						0.709

Table 5.3.12. - Moray Firth (FU 9): VPA output females.

Year	Recruits Age 1	Total Biomass	TSB	Landings	Yield/SSB	Fbar 3-13
	'000	tonnes	tonnes	tonnes		
1981	189354	6371	4903	412	0.084	0.094
1982	203248	6749	5157	444	0.086	0.107
1983	221730	7166	5448	342	0.063	0.089
1984	247916	7692	5799	275	0.047	0.064
1985	250932	8330	6292	740	0.118	0.147
1986	250147	8617	6567	871	0.133	0.153
1987	257202	8699	6631	646	0.097	0.114
1988	236459	8893	6852	695	0.101	0.136
1989	215538	8978	7107	630	0.089	0.117
1990	189489	8979	7294	936	0.128	0.178
1991	158407	8271	6815	597	0.088	0.091
1992	169393	8255	6809	462	0.068	0.093
1993	187314	8078	6513	837	0.129	0.175
1994	228661	8005	6209	964	0.155	0.214
1995	149799	7346	5881	551	0.094	0.131
1996	128834	7134	5871	497	0.085	0.127
1997	166918	6776	5607	517	0.092	0.114
1998	155541	6721	5389	408	0.076	0.079
Average 96-98						0.107

Table 5.3.13. - Moray Firth (FU 9): Catch predictions for 1999 and 2000, based on estimated stock size in 1999 rolled forward from the VPA, mean recruitment over last four years, current effort pattern (mean for 1996-98), and status quo effort.

Calculation of catches in numbers and in weight

Age	Stock no.	F	M	Catch numbers	Weight at age (g)	Catch weight (t)	Stock no.	Catch numbers	Catch weight (t)
	1999			1999		1999	2000	2000	2000
Males									
1	86608	0.001	0.3	75	0.003	0	*	*	*
2	72433	0.126	0.3	7420	0.008	59	64097	6566	53
3	42082	0.633	0.3	17322	0.014	243	47317	19476	273
4	18926	0.992	0.3	10538	0.023	242	16552	9216	212
5	9113	1.150	0.3	5533	0.035	194	5200	3157	111
6	3064	1.225	0.3	1926	0.047	91	2137	1343	63
7	1021	1.022	0.3	579	0.061	35	667	378	23
8	375	0.980	0.3	207	0.073	15	272	150	11
+ group	309	0.980	0.3	171	0.096	16	190	105	10
Totals				43770		895		40393	755
Females									
1	150273	0.001	0.3	65	0.003	0	*	*	*
2	115488	0.063	0.3	6092	0.007	43	111269	5870	41
3	87716	0.072	0.2	5507	0.010	55	80340	5044	50
4	50313	0.103	0.2	4479	0.012	54	66847	5951	71
5	44353	0.109	0.2	4152	0.014	58	37154	3478	49
6	44690	0.119	0.2	4535	0.016	73	32570	3305	53
7	30657	0.120	0.2	3158	0.018	57	32500	3348	60
8	20500	0.101	0.2	1791	0.021	38	22253	1944	41
9	13781	0.096	0.2	1144	0.023	26	15169	1259	29
10	11687	0.109	0.2	1100	0.025	27	10251	965	24
11	9432	0.103	0.2	836	0.029	24	8577	760	22
12	6637	0.138	0.2	779	0.030	23	6969	818	25
13	4525	0.101	0.2	396	0.034	13	4732	414	14
14	2822	0.133	0.2	320	0.034	11	3348	380	13
15	2032	0.083	0.2	146	0.039	6	2022	146	6
+ group	6730	0.083	0.2	485	0.045	22	6604	476	21
Totals				34985		530		34157	519
Total (males + females)									
Totals						**1426**			**1274**

* - No account is made for recruits in year 2000

Conversion of catches to landings

	% Catch discarded (by weight)	**1999** Landings (t)	**2000** Landings (t)
Males	13.7	773	652
Females	21.7	415	407
Total		**1188**	**1058**

Table 5.3.14. - Noup (FU 10): Landings (tonnes) by gear, all UK, 1989-98.

Year	UK		
	Nephrops trawl	Other trawl	Total
1989	24	61	85
1990	101	116	217
1991	110	86	196
1992	58	130	188
1993	200	176	376
1994	308	187	495
1995	162	118	280
1996	180	164	344
1997	185	131	316
1998 *	183	71	254

* provisional na = not available

Table 5.3.15. - Noup (FU 10): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1989-98 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	**All *Nephrops* gears combined**		
	Landings	Effort	LPUE
1989	24	0.9	25.8
1990	101	2.9	34.6
1991	110	4.8	23.1
1992	58	1.9	30.0
1993	200	4.8	41.3
1994	308	8.4	36.7
1995	162	3.9	42.1
1996	180	4.5	40.0
1997	185	5.3	34.9
1998 *	183	3.2	57.2

Year	**Single rig**			**Multirig**		
	Landings	Effort	LPUE	Landings	Effort	LPUE
1989	na	na	na	na	na	na
1990	na	na	na	na	na	na
1991	23	0.9	25.3	87	3.9	22.6
1992	33	1.4	23.0	23	0.4	53.9
1993	152	3.6	42.0	48	1.2	39.0
1994	273	7.6	36.0	35	0.8	42.1
1995	139	3.5	39.9	23	0.4	63.2
1996	174	4.2	41.4	6	0.2	30.0
1997	172	4.9	35.1	13	0.4	32.5
1998 *	171	3.0	57.0	12	0.2	60.0

* provisional na = not available

Table 5.3.16. - Management Area F (IVa, rect. 44-48 E6-E7 + 44E8): Total *Nephrops* landings (tonnes) by Functional Unit plus other rectangles, 1989-98.

Year	FU 9	FU 10	Other	Total
1989	2576	85	44	***2705***
1990	2038	217	69	***2324***
1991	1517	196	65	***1778***
1992	1587	188	43	***1818***
1993	1807	376	69	***2252***
1994	1536	495	129	***2160***
1995	1279	280	68	***1627***
1996	1451	344	101	***1896***
1997	1446	316	94	***1856***
1998 *	1030	254	74	***1358***
* provisional na = not available				

Table 5.3.17. - Management Area F (IVa, rect. 44-48 E6-E7 + 44E8): Total *Nephrops* landings (tonnes) by country, 1989-98.

Year	UK	Other	Total
1989	2705	0	***2705***
1990	2324	0	***2324***
1991	1778	0	***1778***
1992	1818	0	***1818***
1993	2252	0	***2252***
1994	2160	0	***2160***
1995	1627	0	***1627***
1996	1896	0	***1896***
1997	1856	0	***1856***
1998 *	1358	0	***1358***
* provisional na = not available			

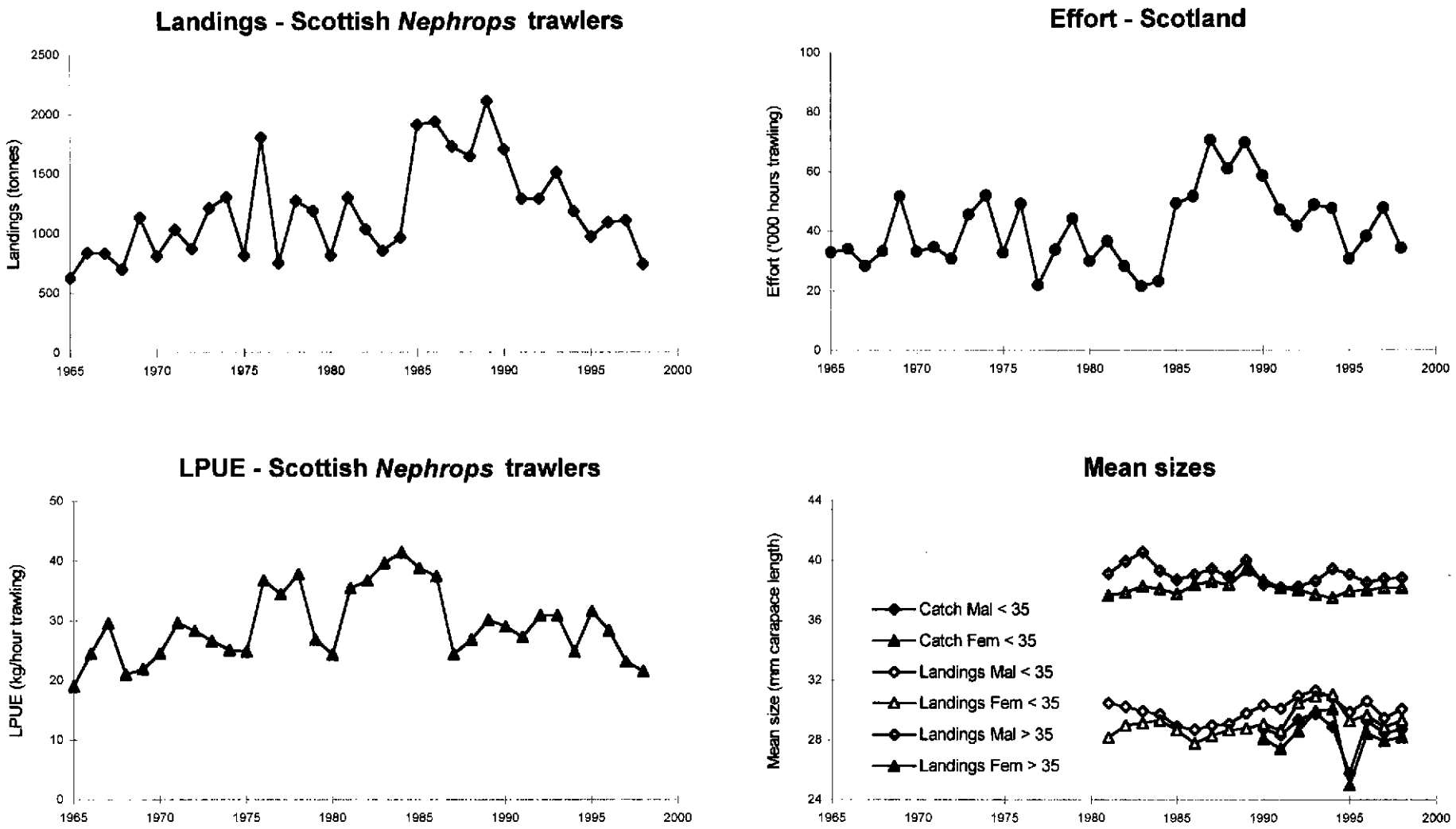


Figure 5.3.1. - Moray Firth (FU 9): Long-term trends in landings, effort, LPUEs and mean sizes of *Nephrops* in catches and landings.

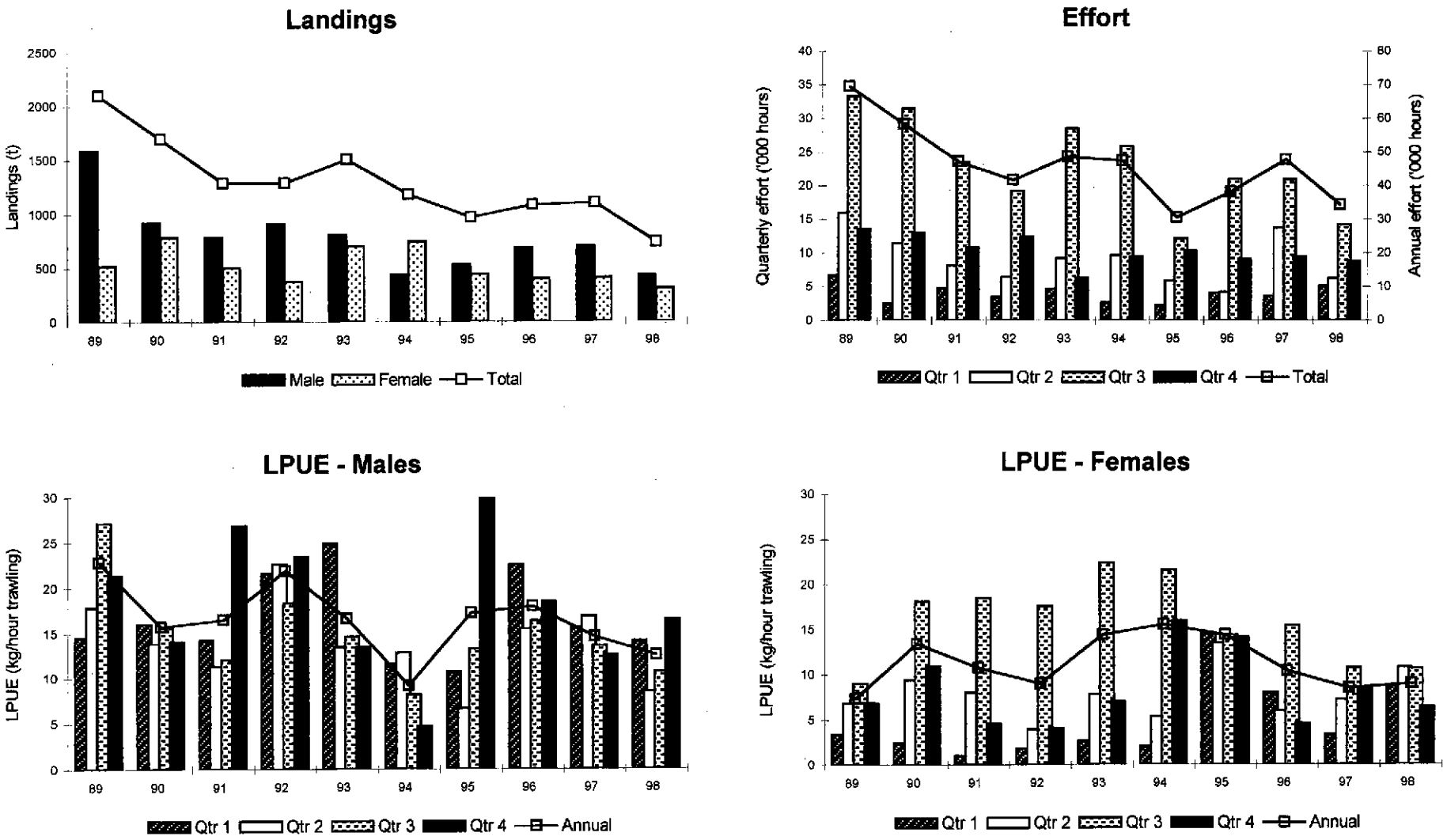


Figure 5.3.2. - Moray Firth (FU 9): Landings, effort and LPUEs by quarter and sex from Scottish *Nephrops* trawlers.

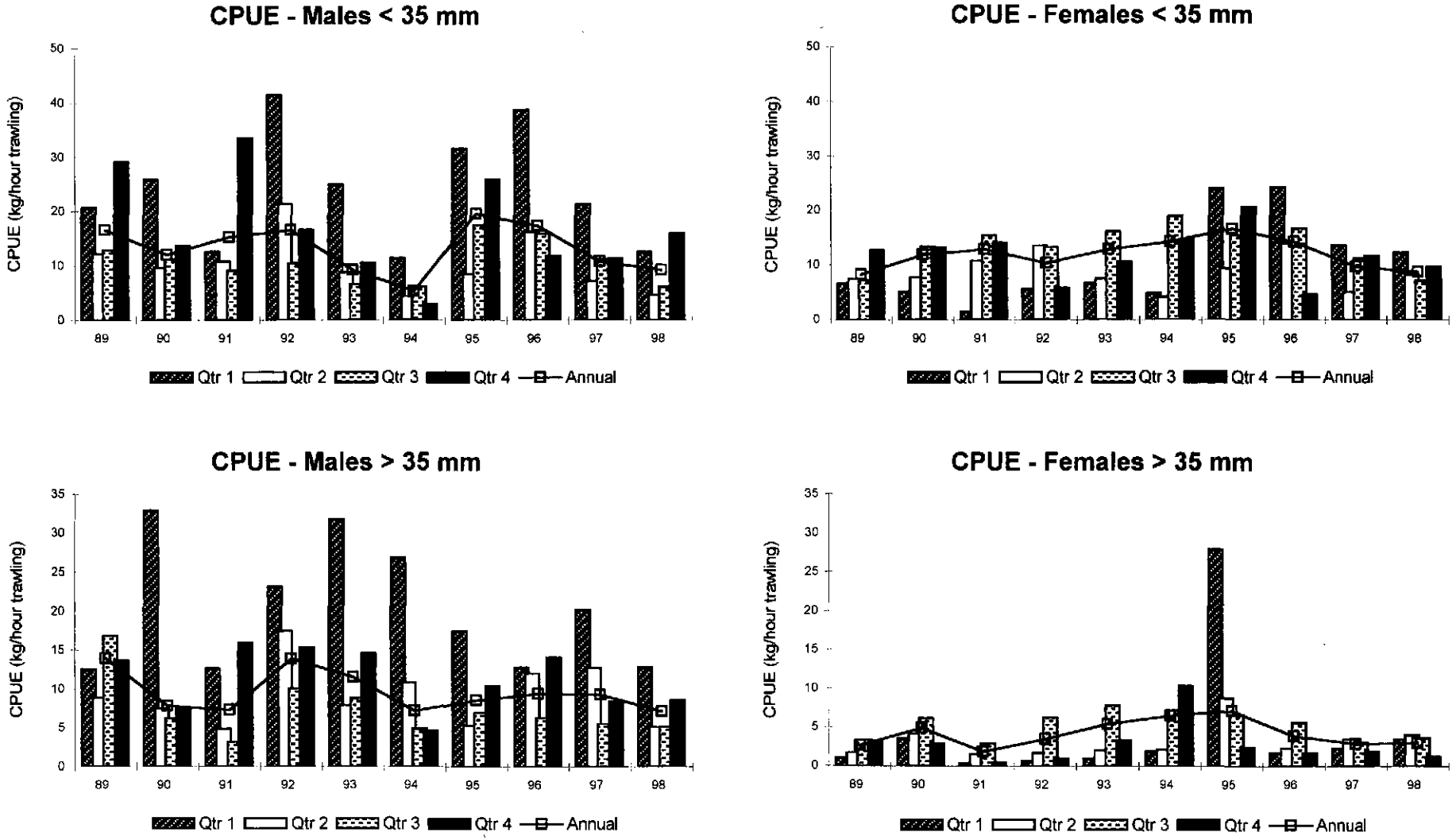
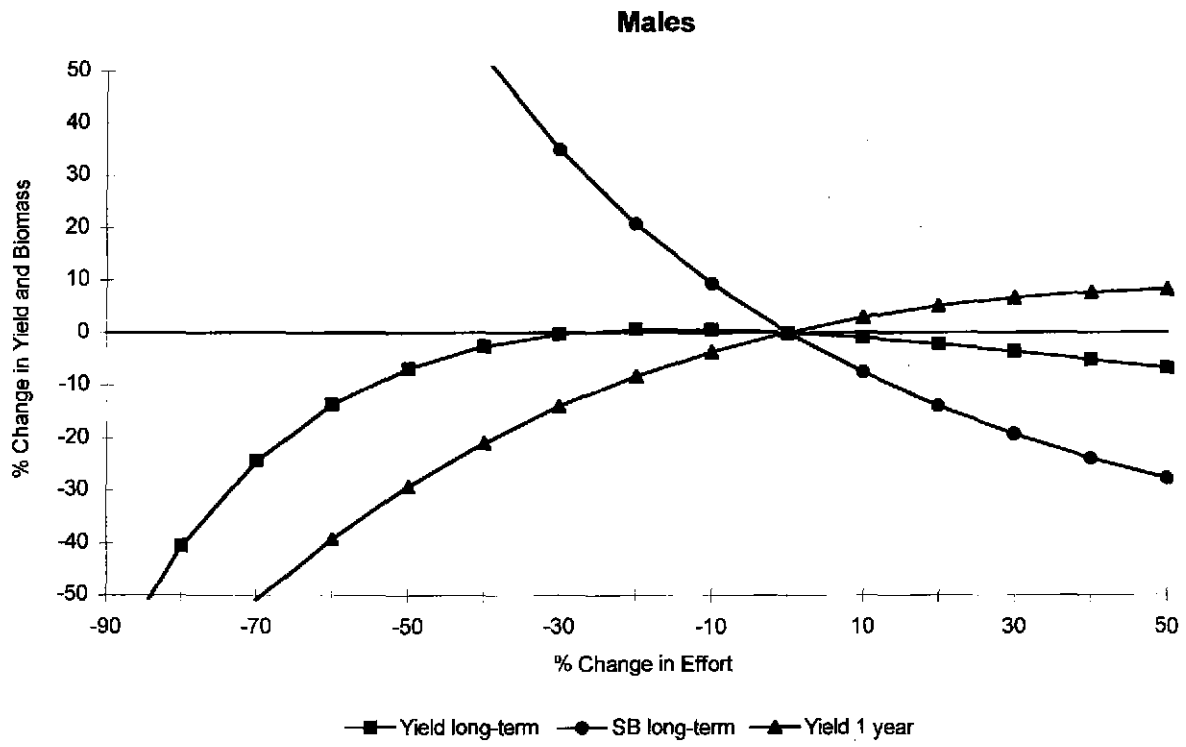


Figure 5.3.3. - Moray Firth (FU 9): CPUEs by sex and quarter, for selected size groups.



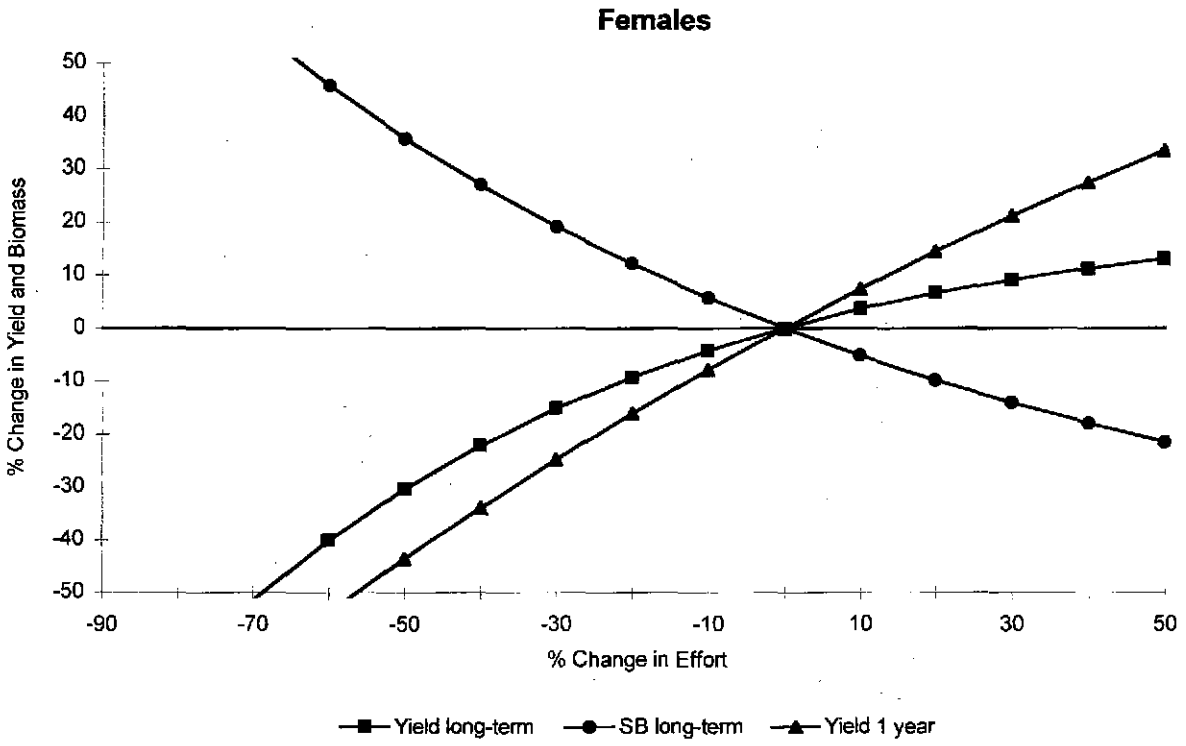


Figure 5.3.4. - Moray Firth (FU 9): Output LCA: Relative changes in short-term yield (ie after 1 year), long-term yield and long-term biomass upon relative changes in effort. Males and females shown separately.

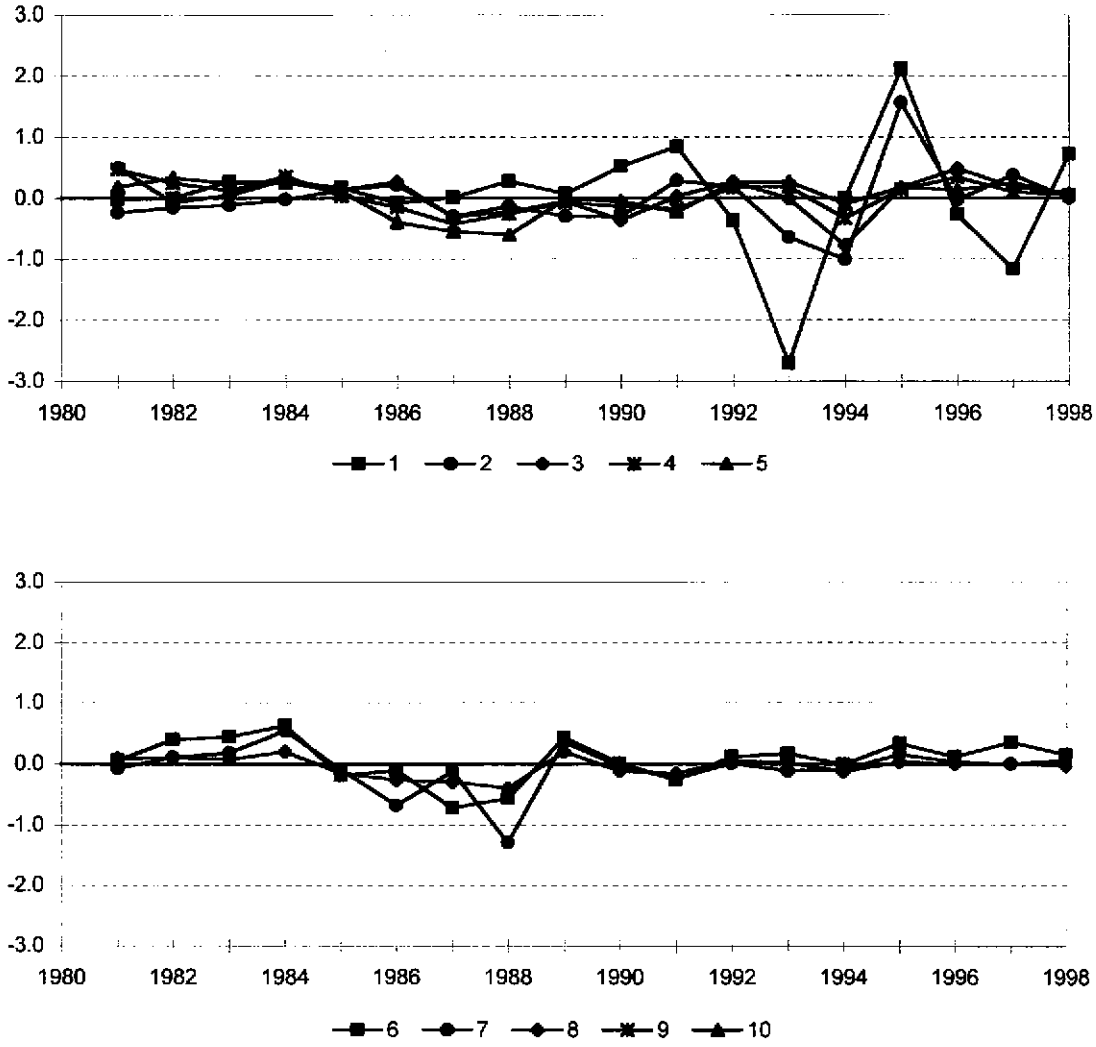
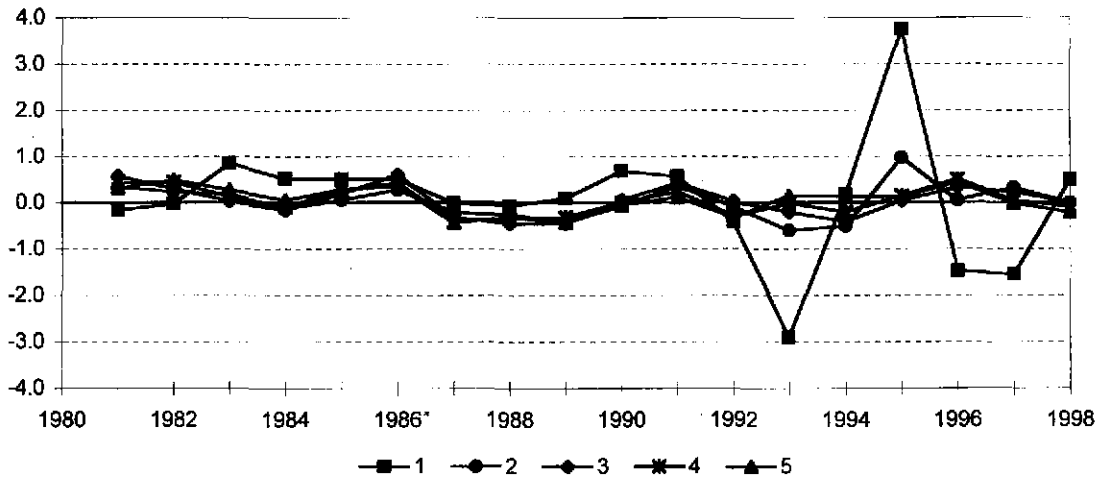
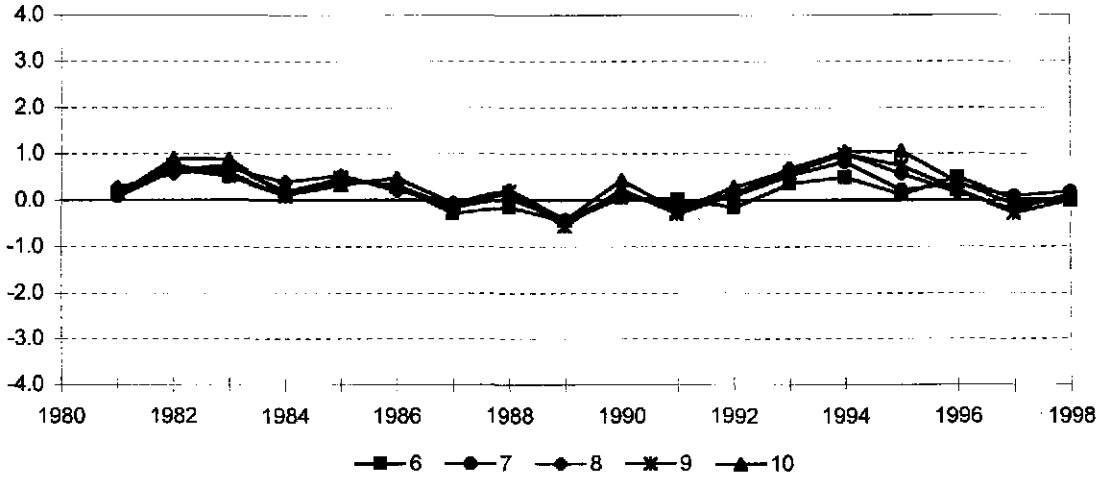


Figure 5.3.5. - Moray Firth (FU 9): Output VPA males: Log catchability residuals.





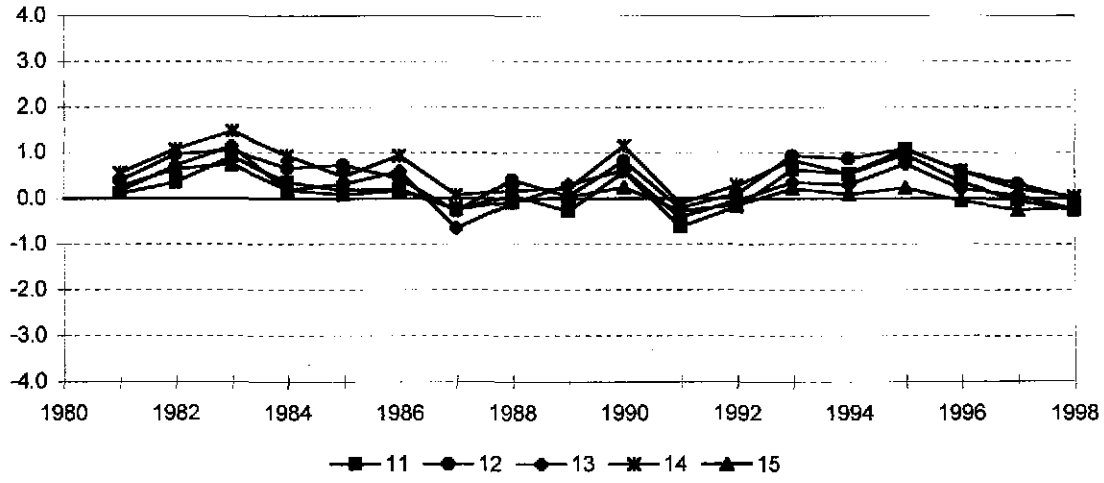


Figure 5.3.6. - Moray Firth (FU 9): Output VPA females: Log catchability residuals.

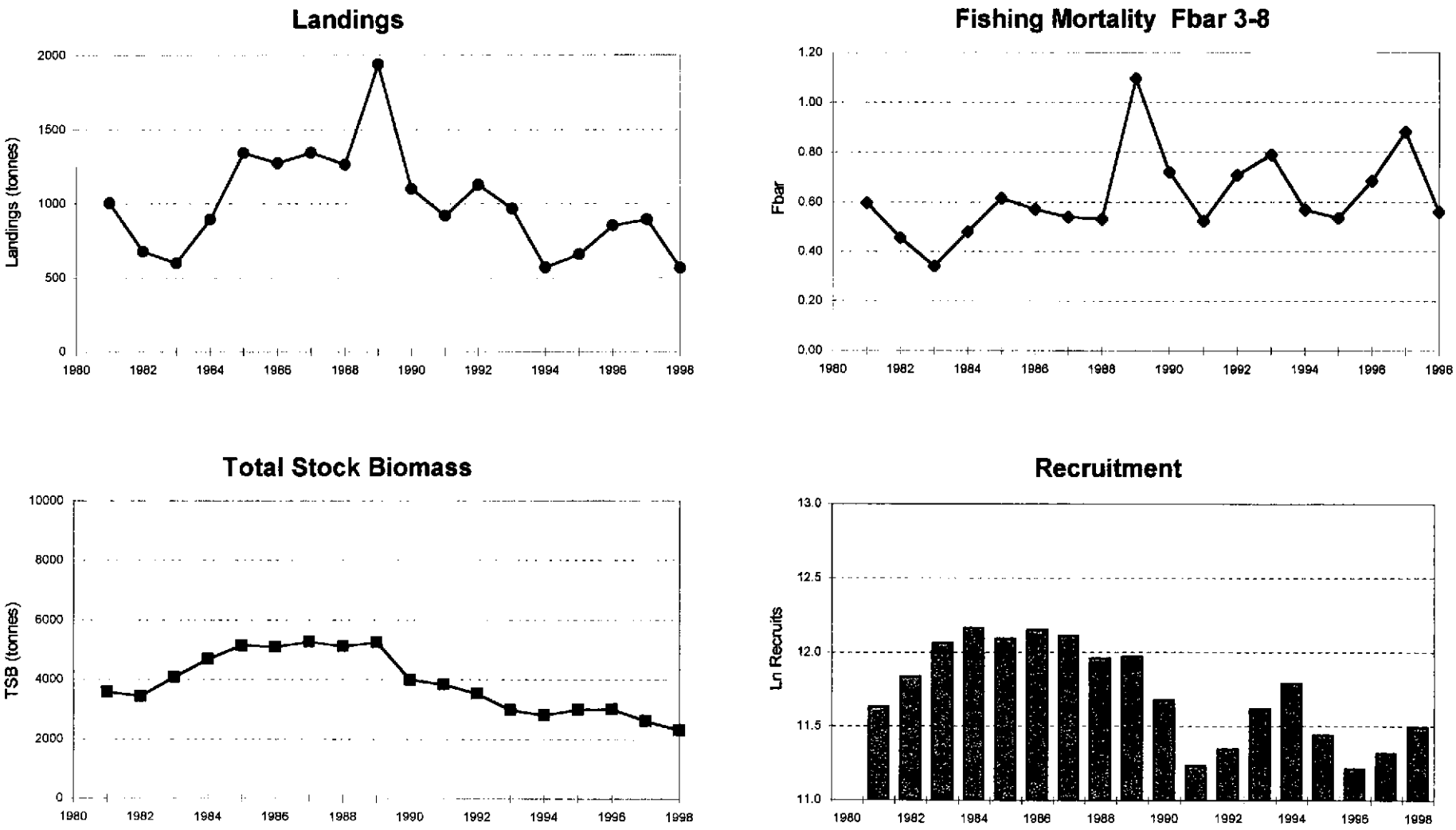


Figure 5.3.7. - Moray Firth (FU 9): Output VPA males: Trends in Landings, Fbar, TSB and Recruitment.

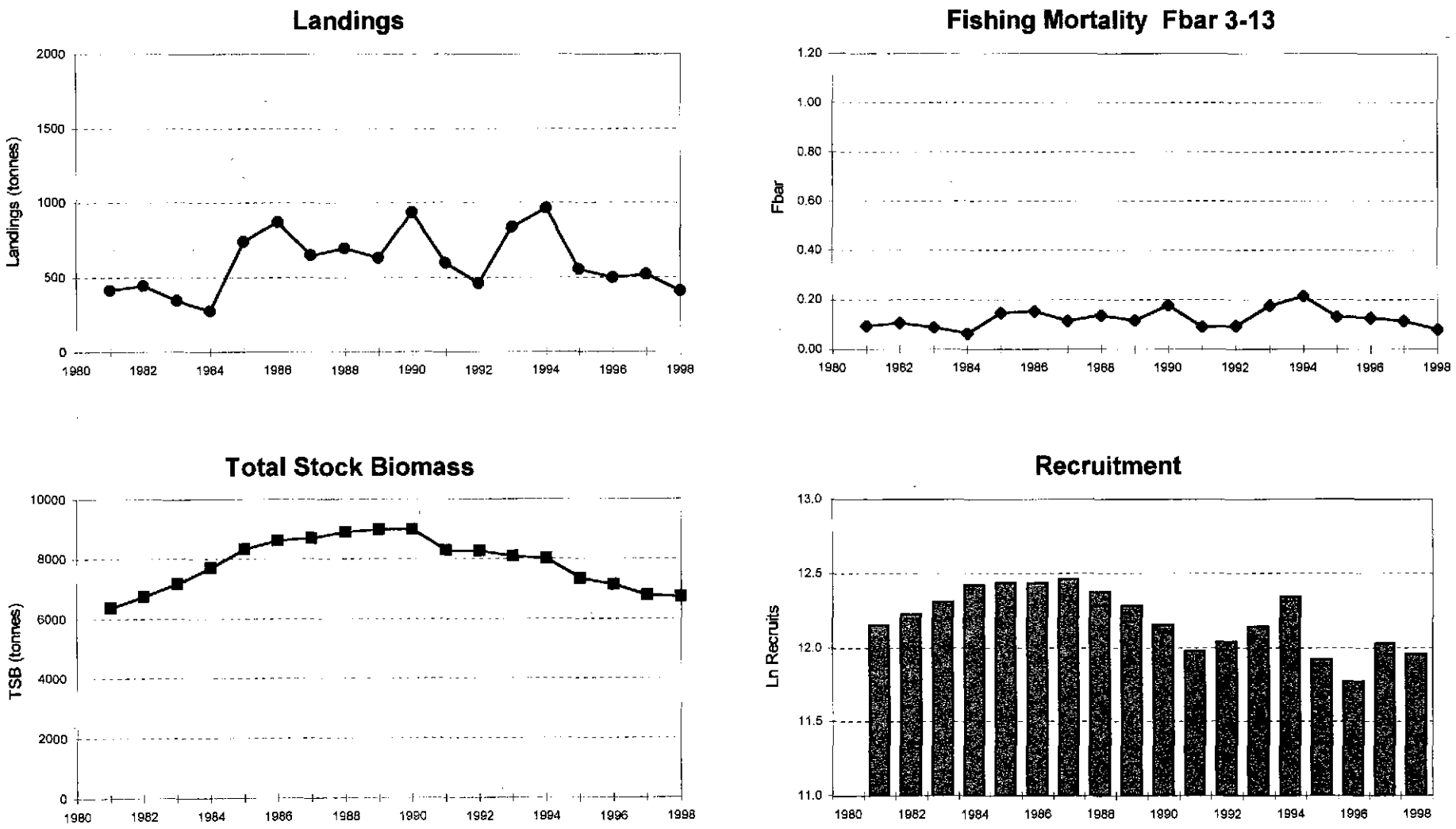


Figure 5.3.8. - Moray Firth (FU 9): Output VPA females: Trends in Landings, Fbar, TSB and Recruitment.

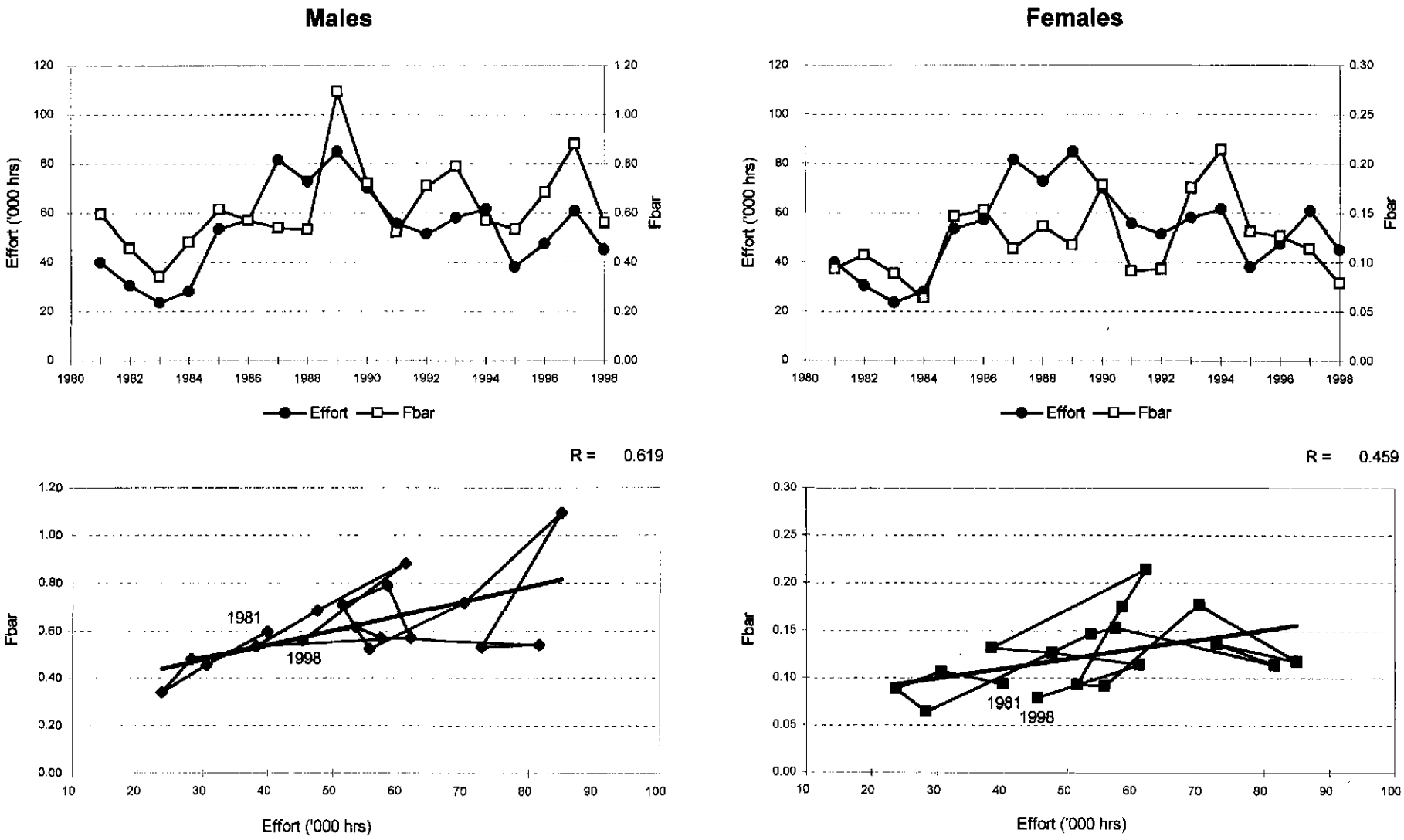


Figure 5.3.9. - Moray Firth (FU 9): Effort and Fbar, and relationship between them, for males and females.

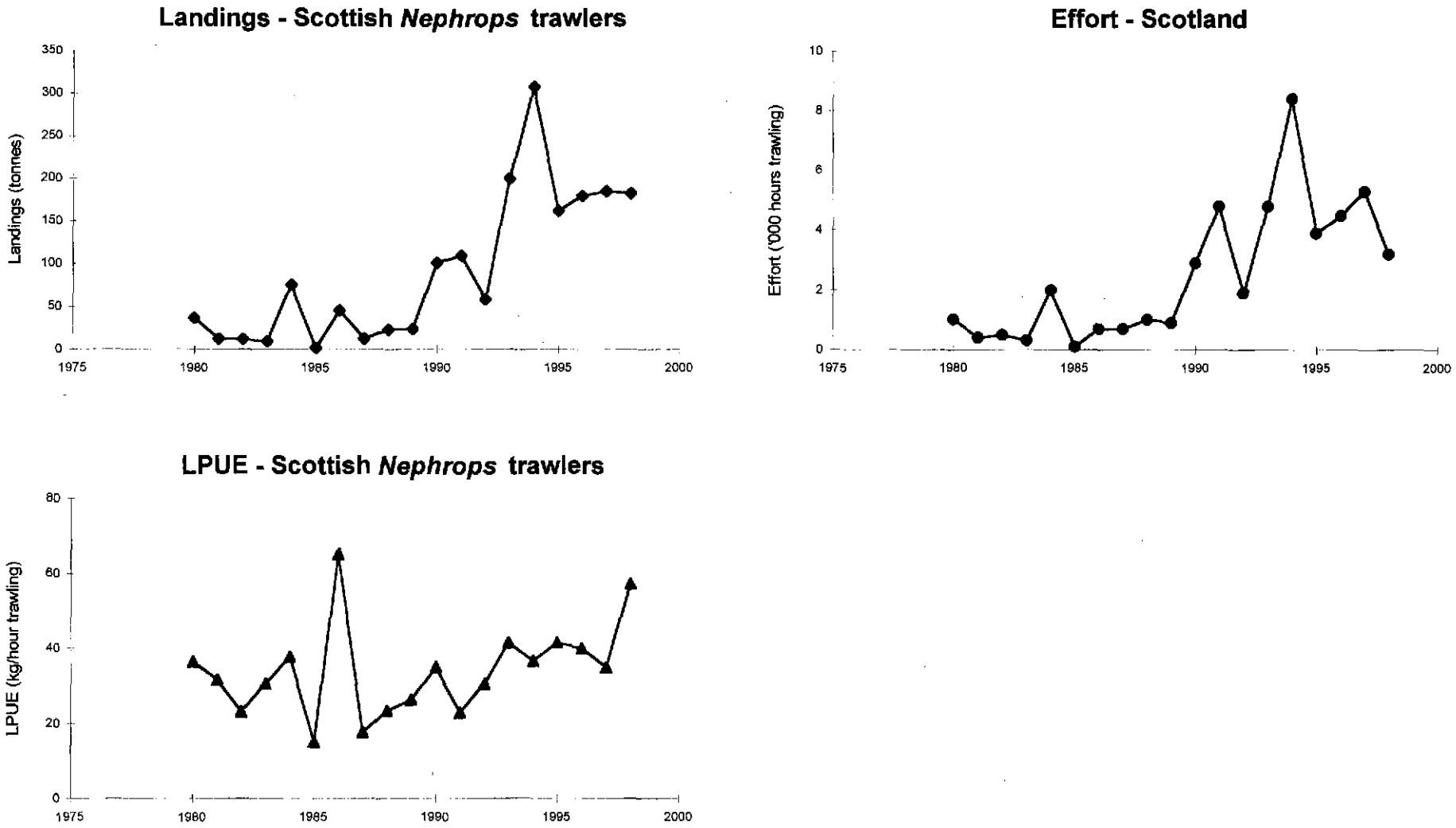


Figure 5.3.10. - Noup (FU 10): Long-term trends in landings, effort and LPUEs.

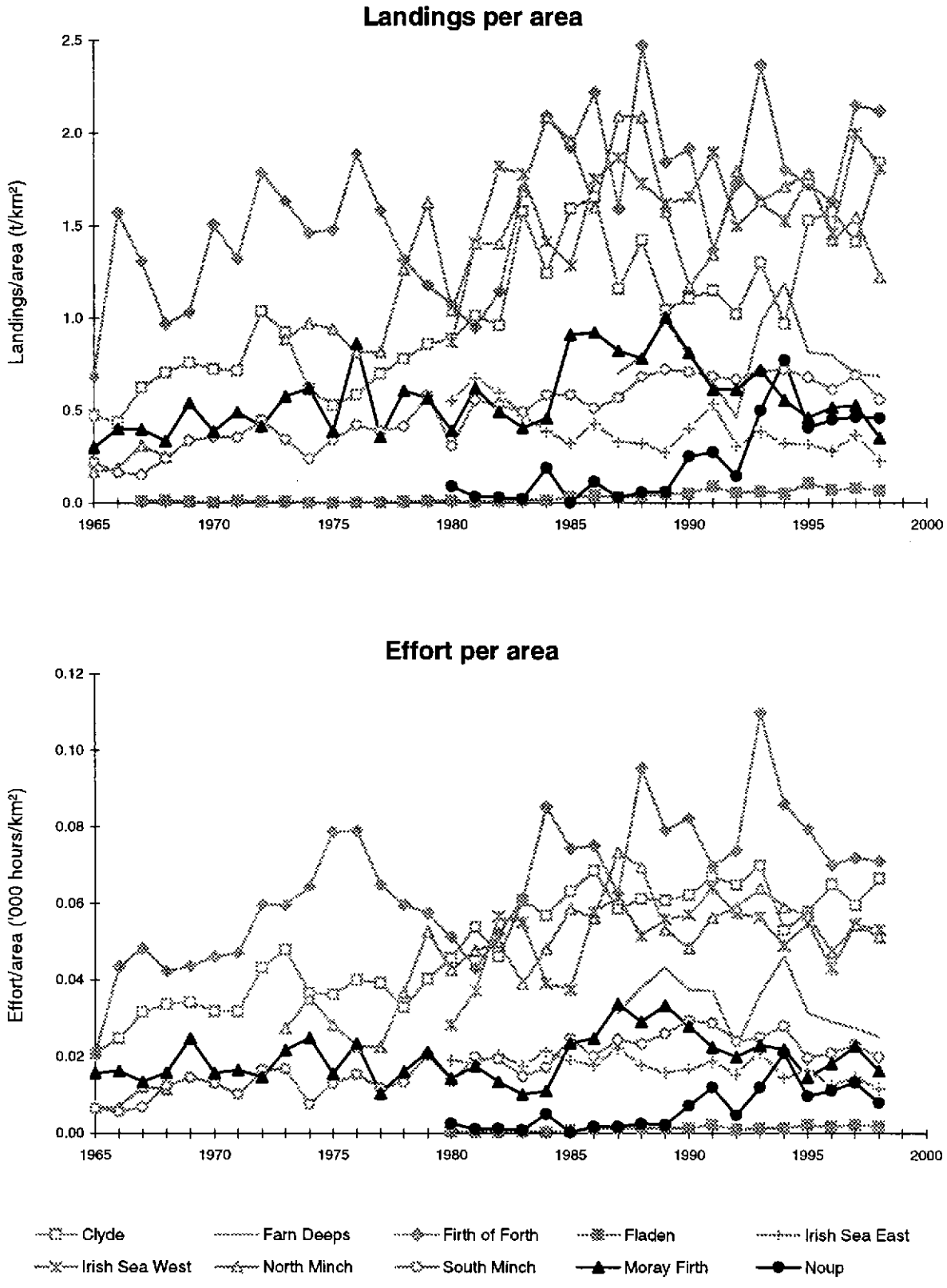


Figure 5.3.11. - *Nephrops* trawl landings per unit area (t/km²) and trawl effort per unit area ('000 hours trawling/km²) on various grounds.
Data relevant to this section of the report are shown in black.

5.4. Management Area G

ICES description **IVa West of 2° E, excluding MA F**

Functional Units **Fladen Ground (FU 7)**

The statistical rectangles comprised in this Management Area and its constituent Functional Units are shown in Figure 5.1.1.

A decision on the revision of the ICES statistical rectangles making up this MA was taken at the 1997 WG meeting (ICES, 1997a), with all rectangles East of 2° E being re-allocated to the new MA S (see Section 5.5.). Reorganisation of the database was made prior to this WG meeting.

5.4.1. Fladen Ground (FU 7)

Description of the fisheries

UK – Scotland

An extensive description of the Scottish fisheries in this area will be given in the next WG Report.

Denmark

A description of the Danish *Nephrops* fisheries in Sub-areas IIIa and IV (including the one on the Fladen Ground) is given in Section 5.2.

Trends in landings, effort, CPUE, LPUE and mean size

Table 5.4.1. Landings by country, 1989-98
Table 5.4.2. Effort and LPUEs Scottish fleet, 1989-98
Table 5.4.3. Effort and LPUEs Danish fleet, 1989-98
Table 5.4.4. Mean sizes of *Nephrops* in landings, Scottish data, 1989-98
Figure 5.4.1. Long-term trends in landings, effort, LPUE and mean size, Scottish data
Figure 5.4.2. Landings by sex + Quarterly plots of effort and LPUEs by sex, 1989-98
Figure 5.4.3. Quarterly plots of CPUEs for selected size groups, 1989-98
Figure 5.4.5. Fishing intensity indices

Landings, effort, CPUE and LPUE

Landings data, reorganised according to the new description of the FU, were reported by Belgium, Denmark, the Netherlands, Norway and the UK.

The change in the magnitude of the landings from the Fladen Ground, arising from the reorganisation of statistical rectangles, was quite small – of the order of a few tonnes. Total

landings in 1997 were 6171 t and provisional total landings in 1998 showed a decline to 5136 t (Table 5.4.1.). UK landings make up > 97 % of the total in each year, with virtually all the remainder landed by Denmark. There is, however, considerable concern over the quality of the Scottish landings figures and – although not accurately known – the extent of under-reporting is thought to be relatively large compared to a number of other stocks. This is partly because a high proportion of the *Nephrops* are sold by contract (and hence do not appear on fish markets) and partly because recent landings have begun to push TAC limits and quota allocations.

Of the Scottish landings, the *Nephrops* trawl component is relatively small compared to other areas, and light trawl and other otter trawls are also important. Effort by *Nephrops* trawls was fairly high in 1997 (76.5 10^3 hours) but dropped back to 60 10^3 hours in 1998 (Table 5.4.2.). Overall *Nephrops* trawl LPUE shows no obvious trends and is currently around the average levels for the long-term series. Effort by single *Nephrops* trawls remained fairly constant between 1995 and 1997, but dropped to 39.6 10^3 hours in 1998. The fall in effort was matched by lower landings for this gear, resulting in only slight changes in LPUE – in fact the series has been fairly stable since 1991.

Landings and effort by multi-rig *Nephrops* trawls have fluctuated more widely, and figures for both measures have increased in 1997 and 1998 from the extraordinarily low values of 1996 (Table 5.4.2.). It is thought that the 1996 figures were affected by a change in the data recording system in that year, which may have led to mis-classification between *Nephrops* directed and other multi-rig gears. Recent LPUEs for the multi-rigs (32.1 kg/hour in 1997, and 34.2 kg/hour in 1998) are lower than in previous years. It is unclear why these have dropped or why the values are below those of single trawls. One explanation might be that increasing numbers of vessels are using larger meshed multi-rig gears despite the fact that the Fladen Ground is exempted from the UK legislation that bans 70 mm mesh multi-rigs in other *Nephrops* fisheries.

The Danish LPUE data showed a somewhat different pattern to that of the Scottish trawlers, with peaks of 341 kg/day and 346 kg/day in 1995 and 1997 respectively (Table 5.4.3.). Provisional data for 1998 suggest a decline to pre-1995 levels. The effort series shows a dramatic fall in Danish activity at the Fladen, as vessels have moved elsewhere.

Improved sampling provided an opportunity for a slightly more detailed analysis of seasonal trends in LPUE split by sex (Figure 5.4.2.). Landings are predominantly of males, particularly in the last three years. With the exception of 1998, effort has usually been higher in the latter part of the year with the 3rd quarter predominating. Male LPUEs are distributed fairly evenly throughout the year (a pattern similar to most other stocks), while female LPUEs are generally high in the second half of the year and sometimes highest in the 4th quarter. This is different from many other stocks, and may indicate a later spawning period at the Fladen Ground. CPUEs are reasonably stable in both size categories (< 35 and > 35 mm CL) of males and females (Figure 5.4.3.).

Mean size

The mean size of larger male *Nephrops* (> 35 mm CL) in trawl landings fell by almost 2 mm CL in the early days of the fishery, but has since been more stable with a slight increasing

trend since 1993. Females > 35 mm CL exhibit very stable mean sizes, as do the smaller animals (< 35 mm CL) of both sexes.

Fishing intensity indices

Fishing pressure on the stock, in terms of landings per area and effort per area, is very low in comparison with other Scottish stocks (Figure 5.4.5.). This arises from the vastness of the area of mud encompassed by the Fladen Ground on the one hand, and the relatively low levels of effort on the other. Local concentrations of effort would lead to higher fishing intensities on parts of the stock, but at present it is not possible to estimate the extent of this.

Data and biological inputs for analytical assessments

Table 5.4.7. Sampling data and input parameters

In 1997, landings were sampled in the 1st, 2nd and 4th quarter. In 1998, sampling was carried out in all quarters. Numbers sampled have improved in recent years. As in previous years, it was not possible to sample the discards.

Input parameters used in the assessments are shown in Table 5.4.7., although it should be pointed out that information on biological parameter values for this FU is limited and that a number of these parameters are borrowed from other stocks.

General comments on quality of data and inputs

An LCA assessment was carried out at this WG, using the sample data from the commercial fleet. While the increased sampling level has probably improved the length compositions of the landings, the discards remain unsampled, and data from the Moray Firth were used instead.

Additional combined underwater TV and trawl surveys were carried out by Scotland in June 1997 and September 1998. Good coverage was achieved and the quality of the video images was good. This extends the series of such surveys to six. The stratified survey technique has been described previously (BAILEY *et al.*, 1993; ICES, 1993a and 1994a).

Length based assessments (LCA)

Table 5.4.8. Output table LCA males, with mean F
Table 5.4.9. Output table LCA females, with mean F
Figure 5.4.4. Changes in Y/R and B/R upon changes in F, for males and females separately

Additional market sample data in recent years warranted an attempt at the LCA approach, but an insufficiently long series of reliable data precluded the use of the VPA method.

The reference period for the LCA was 1996-98, during which fishing effort was reasonably stable (Figure 5.4.1.). No discard data were available for this stock but a discard length distribution was derived from Moray Firth discard data, in order to give some idea of the

effect on the Y/R curves. Input F values were 0.05 and 0.025 for males and females respectively.

For males, the LCA without discard data resulted in a flat-topped Y/R curve with current F slightly below F_{max} (Figure 5.4.4.). For females, the long-term Y/R relationship was curved with current F well below F_{max}. Annualised fishing mortalities (averaged across the inter-quartile length range) were 0.38 and 0.23 for males and females respectively (Tables 5.4.8. and 5.4.9.). The addition of discard data produced curves with slightly more evidence of exploitation beyond F_{max} in males, but the differences were only marginal and the results are not reported here. Based on these data, there is no cause for concern in this stock.

Fishery independent methods - TV surveys

Table 5.4.5. Results of 1997 and 1998 underwater TV surveys
Table 5.4.6. Overview results of underwater TV surveys, 1992-98

In previous reports, the WG drew attention to the difficulties of sampling and assessing this widely distributed stock (see e.g. ICES, 1992a). Between 1992 and 1998, as an alternative assessment method for this stock, an annual survey has been undertaken during a summer cruise of the RV '*Scotia*', using an underwater TV camera and an otter trawl. In this section, details of new data for 1997 and 1998 are provided, together with a presentation of the longer term trends.

The surveys continue to confirm the widespread distribution of *Nephrops* on the ground which covers an estimated area of about 28.2 10^3 km^2. Estimates of the mean burrow density in different strata varied from 0.06 to 0.29 per m^2 in 1997, and from 0.09 to 0.41 per m^2 in 1998. The estimates for 1997, raised to the total ground area, gave an overall abundance estimates of 3736 10^6 burrows (95 % confidence interval 689 10^6) with an estimated stock biomass in the range 71-104 10^3 t. This represents a decrease on the results from the 1996 survey to the lowest level observed in the series. As in the case of the Moray Firth, however, some of this decline may have been the result of having to use a different research vessel than in the earlier surveys. The chartered vessel was unable to control speed over the bottom quite so well and this made estimation of the TV track area more difficult.

The abundance estimate for 1998 was 5181 10^6 animals (95 % confidence interval 968 10^6) with a biomass in the range 99-144 10^3 t. An allowance for the fact that the 1998 survey was slightly later in the year (by adding in an estimate for the number of removals taken by the fishery between June and early September) made only a small difference to the overall value.

Examination of the trend in overall abundance at the Fladen Ground shows that abundance peaked in 1994 (Table 5.4.6.) – a year when various abundance indices in a number of other Scottish stocks were also high. Earlier discussions of TV data (see e.g. ICES, 1997a) have pointed out that TV surveys probably provide reasonable estimates of recruiting year classes, so that the 1994 peak may have represented a particularly strong recruitment. Abundance declined in 1995 and 1997 but has increased again in 1998 to a level comparable to the first estimates made in 1992.

Overall, the results point to a continuing large stock which does not show signs of over-exploitation and which, for the time being, is not giving cause for concern.

Comments on quality of assessments

The LCA probably suffers from poorly known parameter values.

Several factors which may affect the accuracy of the TV survey assessments have been discussed before (see e.g. BAILEY *et al.*, 1993; ICES, 1997a). The biomass estimate is obviously dependent on the value for the mean weights of *Nephrops* in each stratum. These are derived from trawl samples and may not be fully representative of the whole area and/or population. It should also be noted that the abundance estimates make no allowance for the fact that a proportion of the burrows may be unoccupied.

Management considerations

The evidence from the TV surveys of a large stock abundance and biomass, the low values of the fishing pressure indices (compared to other stocks), the relatively high LPUEs, and the LCA results all suggest that the Fladen Ground stock is currently under-exploited.

Previous advice for the Fladen Ground was largely based on historical landings data, and precautionary recommendations of 5000 t (prior to 1998) and 7000 t (1998-99) were suggested by ACFM (Table 5.1.6.). Given the large size and extensive distribution of the Fladen stock, it is perhaps not surprising that the fishery has expanded rapidly, that landings from the area have sometimes exceeded the recommendation, and that quota restrictions (under the overall North Sea *Nephrops* TAC) are leading to likely high levels of under-reporting.

The question arises as to whether the use of landings data is a reliable way of providing a guide for management recommendations on this stock, and whether other methods would provide more realistic estimates.

The results from the TV survey offer an independent estimate of stock abundance and this has been used to estimate a likely landings level, given 'harvest ratios' (defined here as catch in numbers/stock abundance) which lie at the lower end of the harvest ratios observed across a range of other *Nephrops* stocks, as calculated during the 1998 *Nephrops* Study Group (ICES, 1998b).

Details of the estimation procedure are given in Table 5.4.10. Average length distributions (1996-98) for the two sexes from Fladen Ground market samples were raised to annual removals (landings + dead discards), using discard estimates from the Moray Firth raised to the level of the Fladen landings. This assumes a similar discarding pattern in the two areas. The total weight of the current landings corresponding to the number of removals (216 10^6 animals) amounted to about 5300 t. The TV abundance figure (5181 10^6) was multiplied by two harvest ratios (0.07 and 0.10), to estimate suitable limits on the numbers of animals removed. These limits were then divided by the estimated current removals to provide a raising factor by which to adjust the estimated current landings.

Based on harvest ratios of 7 % and 10 %, the expected landings would be about 8900 and 12700 t respectively. Adopting the lower ratio (which is below the lowest values calculated

previously) (ICES, 1998b) would offer a precautionary option, while still providing some margin for the further development of the fishery.

5.4.2. Summary for Management Area G

Table 5.4.11. Landings by FU and from Other rectangles, 1989-98
Table 5.4.12. Landings by country, 1989-98

In 1995, revised total landings for the MA as a whole reached 6605 t, which was greater than the ACFM recommendation for that year (5000 t). The departure from recommended levels was also evident in 1996 (5361 t) and 1997 (6266 t). Provisional total international landings in 1998 amounted to 5230 t, which is considered to be an under-estimate due to mis-reporting.

Based on the available data and the observations in many of the *Nephrops* fisheries in inshore Scottish waters, this stock is almost certainly capable of supporting a larger fishery, and current trends suggest that this is happening. The WG considers that recent landings figures are compromised by under-reporting and that, in reality, an increasing proportion of the overall North Sea TAC is probably being taken from the Fladen Ground stock.

The WG considers that a recommendation for this MA for the years 2000 and 2001, based on the TV estimate of stock size and a fairly conservative and precautionary harvest ratio, is appropriate. Hence, an overall TAC of 9000 t is suggested for this MA. This figure is based on a harvest ratio of 7 % for the Fladen Ground FU, plus an allowance for landings taken in squares outside this FU (which have varied between 20 and 184 tonnes).

MA G lies within a TAC management area covering the whole North Sea and including a number of other FUs exhibiting various states of exploitation. On numerous occasions (see e.g. ICES, 1997a), the WG has pointed out the difficulties of managing *Nephrops* stocks in this way, and suggested that some subdivision of the TAC area would be desirable. While maintaining the view that *Nephrops* stocks are most appropriately managed at a smaller scale, the WG recognises that this may not be possible or practical for other reasons. The WG feels however, that attempts should be made to find ways of ensuring that effort is allocated appropriately at a more local level than is possible under the current overall TAC approach. Under the present system, the risk of unacceptably high effort levels on vulnerable grounds, or of a rapid uptake of the North Sea TAC in areas with expanding fisheries (such as the Fladen Ground) will remain.

Table 5.4.1. - Fladen (FU 7): Landings (tonnes) by country, 1989-98.

Year	Belgium	Denmark	Netherl.	Norway	UK	Total
1989	0	165	na	0	2134	2299
1990	2	236	na	1	2301	2540
1991	0	424	na	5	3793	4222
1992	3	359	0	28	2973	3363
1993	0	224	0	3	3266	3493
1994	0	390	0	6	4173	4569
1995	0	439	0	1	5981	6421
1996	0	286	1	1	4923	5211
1997	0	235	0	0	5936	6171
1998 *	0	173	0	0	4963	5136

* provisional na = not available

Table 5.4.2. - Fladen (FU 7): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1989-98 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	**All *Nephrops* gears combined**		
	Landings	Effort	LPUE
1989	1724	47.2	36.5
1990	1702	43.4	39.2
1991	3021	78.5	38.5
1992	1810	39.5	46.3
1993	2033	49.9	40.7
1994	1817	48.8	37.2
1995	3569	75.3	47.4
1996	2338	57.2	40.9
1997	2713	76.5	35.5
1998 *	2291	60.0	38.2

Year	**Single rig**			**Multirig**		
	Landings	Effort	LPUE	Landings	Effort	LPUE
1989	na	na	na	na	na	na
1990	na	na	na	na	na	na
1991	409	11.4	35.8	2612	67.1	39.0
1992	345	9.4	36.7	1465	29.4	49.8
1993	388	9.6	40.3	1645	40.3	40.8
1994	301	8.4	35.6	1516	40.4	37.5
1995	2457	52.3	48.7	1022	23.0	44.4
1996	2089	51.4	40.6	249	5.8	42.9
1997	2013	54.7	36.8	700	21.8	32.1
1998 *	1594	39.6	40.2	697	20.4	34.2

* provisional na = not available

Table 5.4.3. - Fladen (FU 7): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching Nephrops with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1989-98.

Year	Logbook data		Estimated effort
	Effort	LPUE	
1989	1998	123	1462
1990	2529	89	2702
1991	3115	116	3601
1992	2447	127	2858
1993	857	130	1851
1994	1289	239	1620
1995	846	341	1604
1996	595	243	1187
1997	400	346	1100
1998 *	284	160	1323
* provisional na = not available			

Table 5.4.4. - Fladen (FU 7): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish landings, 1989-98.

Year	**Landings**			
	< 35 mm CL		**> 35 mm CL**	
	Males	Females	Males	Females
1989	na	na	na	na
1990	31.4	30.5	40.5	38.8
1991	30.9	30.1	39.0	38.4
1992	30.8	29.3	39.8	39.2
1993	30.4	29.6	38.7	38.2
1994	30.0	28.9	39.2	37.8
1995	30.6	29.8	39.9	38.1
1996	30.4	29.1	40.6	38.8
1997	30.2	29.1	40.9	38.8
1998 *	30.8	29.4	40.7	38.4
* provisional na = not available				

Table 5.4.5. - Fladen (FU 7): Results by stratum of the 1997 and 1998 TV surveys. Note that stratification was based on sediment .

Stratum (ranges of % silt clay)	Area (km^2)	Number of Stations	Mean burrow density (no./m^2)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
1997 TV survey							
>80	3248	13	0.294	0.006	954	4890	0.041
55<80	4967	16	0.247	0.007	1226	10560	0.089
40<55	4304	17	0.143	0.009	618	10199	0.086
<40	15634	9	0.060	0.003	938	93016	0.784
Total	28153	55			3736	118665	1
1998 TV survey							
>80	3248	13	0.406	0.018	1319	14588	0.062
55<80	4967	17	0.295	0.008	1464	12045	0.051
40<55	4304	17	0.239	0.024	1030	25826	0.110
<40	15634	12	0.088	0.009	1368	181881	0.776
Total	28153	59			5181	234340	1

Table 5.4.6. - Fladen (FU 7): Results of the 1992-98 TV surveys.

Year	Mean density	Abundance	95% confidence interval	Biomass
	burrows/m^2	millions	millions	'000 tonnes
1992	0.17	4942	508	110-135
1993	0.21	6007	768	132-171
1994	0.30	8329	1099	176-230
1995	0.24	6733	1209	130-186
1996	No survey			
1997	0.13	3736	689	71-104
1998	0.18	5181	968	99-144

Table 5.4.7. - Fladen Ground (FU 7): Input data and parameters.

FU	7	MA	G
FLEET	UK Scotland	GEAR	*Nephrops* and light trawl

	1998					1997				
	Number of samples				Mean no. per sample	Number of samples				Mean no. per sample
	Qtr 1	Qtr 2	Qtr 3	Qtr 4		Qtr 1	Qtr 2	Qtr 3	Qtr 4	
Catch	0	0	0	0		0	0	0	0	
Landings	10	1	3	2	405	5	3	0	9	357
Discards	0	0	0	0		0	0	0	0	

	Number of samples									
Year	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989
Catch	0	0	0	0	0	0	0	0	0	0
Landings	16	17	7	4	14	6	4	12	9	11
Discards	0	0	0	0	0	0	0	0	0	0

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival	0.25	Gueguen and Charuau, 1975
MALES		
Growth - K	0.160	adapted from Bailey and Chapman, 1983
Growth - L(inf)	66	"
Natural mortality - M	0.3	Morizur, 1982
Length/weight - a	0.00030	after Howard and Hall, 1983
Length/weight - b	3.250	"
FEMALES		
Immature Growth		
Growth - K	0.160	adapted from Bailey and Chapman, 1983
Growth - L(inf)	66	"
Natural mortality - M	0.3	Morizur, 1982
Size at maturity	25	adapted from Bailey, 1984
Mature Growth		
Growth - K	0.100	adapted from Bailey and Chapman, 1983
Growth - L(inf)	56	"
Natural mortality - M	0.2	based on Morizur, 1982 ; assuming lower rate for mature females
Length/weight - a	0.00074	after Howard and Hall, 1983
Length/weight - b	2.910	"

Table 5.4.8. - Fladen (FU 7): LCA output males.

Reference period	1996-98		
Linf (mm CL)	66.0	K	0.160

Size (mm CL)	Removals ('000)	M	DT (years)	F*DT	F	Z	Nos. attaining aver. size ('000)	Average nos. in the sea ('000)	Average biomass (kg)
17	0	0.3	0.261	0.000	0.000	0.300	355845	89153	832355
19	43	0.3	0.272	0.000	0.001	0.301	329099	85888	1128133
21	813	0.3	0.284	0.003	0.010	0.310	303289	82492	1475538
23	2053	0.3	0.298	0.008	0.026	0.326	277728	78787	1868235
25	5529	0.3	0.313	0.023	0.074	0.374	252039	74344	2284795
27	8407	0.3	0.329	0.040	0.122	0.422	224204	68874	2691160
29	13570	0.3	0.347	0.076	0.219	0.519	195128	62013	3030004
31	15911	0.3	0.368	0.109	0.296	0.596	162940	53808	3240575
33	13336	0.3	0.391	0.114	0.293	0.593	130862	45646	3345649
35	13777	0.3	0.417	0.152	0.365	0.665	103810	37788	3333229
37	11985	0.3	0.447	0.178	0.398	0.698	78666	30184	3172234
39	10584	0.3	0.481	0.220	0.457	0.757	57594	23217	2881207
41	8702	0.3	0.521	0.268	0.515	0.815	40008	16989	2469431
43	5635	0.3	0.569	0.267	0.470	0.770	26170	12050	2036401
45	4105	0.3	0.626	0.311	0.496	0.796	16892	8322	1624234
47	2662	0.3	0.695	0.339	0.488	0.788	10264	5493	1230693
49	1426	0.3	0.782	0.315	0.403	0.703	5934	3571	913113
51	909	0.3	0.894	0.362	0.405	0.705	3424	2272	659695
53	421	0.3	1.044	0.314	0.301	0.601	1823	1414	463923
55	181	0.3	1.254	0.255	0.203	0.503	973	905	334189
57	73	0.3	1.571	0.197	0.126	0.426	518	593	245330
59	38	0.3	2.103	0.219	0.104	0.404	265	376	173515
61	16	0.3			0.050	0.350	113	376	192963
					Totals, including lengths above + group			784555	39626601

Mean F, calculated across inter-quartile range	0.377

Table 5.4.9. - Fladen (FU 7): LCA output females.

Reference period	1996-98		
Linf immatures (mm CL)	66.0	K immatures	0.160
Linf matures (mm CL)	56.0	K matures	0.100
Transition length (mm CL)	25.0		

Size (mm CL)	Removals ('000)	M	DT (years)	F*DT	F	Z	Nos. attaining aver. size ('000)	Average nos. in the sea ('000)	Average biomass (kg)
13	1	0.3	0.240	0.000	0.000	0.300	183662	42600	68214
15	26	0.3	0.250	0.000	0.001	0.301	170881	41160	97206
17	100	0.3	0.261	0.001	0.003	0.303	158507	39699	132086
19	374	0.3	0.272	0.003	0.010	0.310	146497	38185	172633
21	2121	0.3	0.284	0.017	0.058	0.358	134668	36381	217048
23	5869	0.3	0.298	0.052	0.174	0.474	121631	33769	259514
25	10774	0.2	0.313	0.111	0.356	0.556	105628	30307	294000
27	14848	0.2	0.715	0.198	0.277	0.477	88785	53761	647037
29	11864	0.2	0.770	0.227	0.295	0.495	63137	40411	594497
31	7095	0.2	0.834	0.197	0.236	0.436	43145	30159	535343
33	4931	0.2	0.910	0.199	0.218	0.418	29990	22692	480524
35	3309	0.2	1.001	0.197	0.196	0.396	20499	16935	423515
37	2283	0.2	1.112	0.205	0.184	0.384	13786	12479	365255
39	1310	0.2	1.252	0.180	0.144	0.344	8994	9146	310795
41	777	0.2	1.431	0.167	0.116	0.316	5847	6729	263527
43	395	0.2	1.671	0.134	0.080	0.280	3718	4959	222385
45	216	0.2	2.007	0.120	0.060	0.260	2328	3640	185736
47	110	0.2	2.513	0.108	0.043	0.243	1382	2599	150108
49	64	0.2	3.365	0.126	0.038	0.238	750	1739	113099
51	38	0.2			0.025	0.225	338	1739	126773
					Totals, including lengths above + group			469089	5659296

Mean F, calculated across inter-quartile range	0.231

Table 5.4.10. - Fladen (FU 7): Predicted landings potential based on abundance estimates using TV surveys, current landings length distributions for the Fladen Ground (with discards data from the Moray Firth raised appropriately), and conservative harvest ratio's (taken from ICES, 1998b).

Males		
Weight = a*CL^b	a =	0.0003
	b =	3.25

Females		
Weight = a*CL^b	a =	0.0007
	b =	2.91

CL	Landings ('000)	Discards ('000)	Removals ('000)	Wgth (g)	Landings (t)
17	0	279	209	4	0
19	43	1014	804	5	0
21	813	3091	3131	7	6
23	2053	7466	7652	9	19
25	5529	11761	14349	12	66
27	8407	9017	15170	15	127
29	13570	5375	17601	19	257
31	15911	1512	17044	23	372
33	13336	176	13468	28	380
35	13777	2	13778	34	472
37	11985	1	11985	41	490
39	10584	0	10584	48	511
41	8702	0	8702	57	492
43	5635	0	5635	66	371
45	4105	0	4105	76	312
47	2662	0	2662	87	232
49	1426	0	1426	100	142
51	909	0	909	113	103
53	421	0	421	128	54
55	181	0	181	144	26
57	73	0	73	162	12
59	38	0	38	180	7
61	11	0	11	201	2
63	5	0	5	222	1
65	0	0	0	246	0
Total			**149946**		**4455**

CL	Landings ('000)	Discards ('000)	Removals ('000)	Wgth (g)	Landings (t)
13	0	1	1	2	0
15	0	35	26	2	0
17	0	133	100	3	0
19	19	473	373	5	0
21	818	1738	2121	6	5
23	2765	4139	5869	8	21
25	5745	6704	10773	10	56
27	10104	6326	14848	12	122
29	10093	2361	11864	15	148
31	6719	501	7095	18	119
33	4907	32	4931	21	104
35	3309	0	3309	25	83
37	2283	0	2283	29	67
39	1310	0	1310	34	45
41	777	0	777	39	30
43	395	0	395	45	18
45	216	0	216	51	11
47	110	0	110	58	6
49	64	0	64	65	4
51	12	0	12	73	1
53	9	0	9	81	1
55	17	0	17	90	2
Total			**66376**		**842**

Total (males + females)	**216322**		**5297**

TV abundance (thousands)	5181000
Landings potential with 10 % removals (ratio = 0.10)	**12687**
Landings potential with 7 % removals (ratio = 0.07)	**8881**
Landings potential = Current landings * TV abundance * Harvest Ratio / Current removals	

Table 5.4.11. - Management Area G (IVa, West of 2° E excl. Management Area F): Total *Nephrops* landings (tonnes) by Functional Unit plus other rectangles, 1989-98.

Year	FU 7	Other	Total
1989	2299	31	***2330***
1990	2540	20	***2560***
1991	4222	52	***4274***
1992	3363	39	***3402***
1993	3493	39	***3532***
1994	4569	117	***4686***
1995	6421	184	***6605***
1996	5211	150	***5361***
1997	6171	95	***6266***
1998 *	5136	94	***5230***

* provisional na = not available

Table 5.4.12. - Management Area G (IVa, West of 2° E excl. Management Area F): Total *Nephrops* landings (tonnes) by country, 1989-98.

Year	Belgium	Denmark	Netherl.	Norway	UK	Total
1989	0	175	na	0	2155	***2330***
1990	2	240	na	1	2317	***2560***
1991	0	427	na	5	3842	***4274***
1992	3	364	0	28	3007	***3402***
1993	0	228	0	3	3301	***3532***
1994	0	395	0	6	4285	***4686***
1995	0	441	0	1	6163	***6605***
1996	0	287	1	1	5072	***5361***
1997	0	235	0	0	6031	***6266***
1998 *	0	173	0	0	5057	***5230***

* provisional na = not available

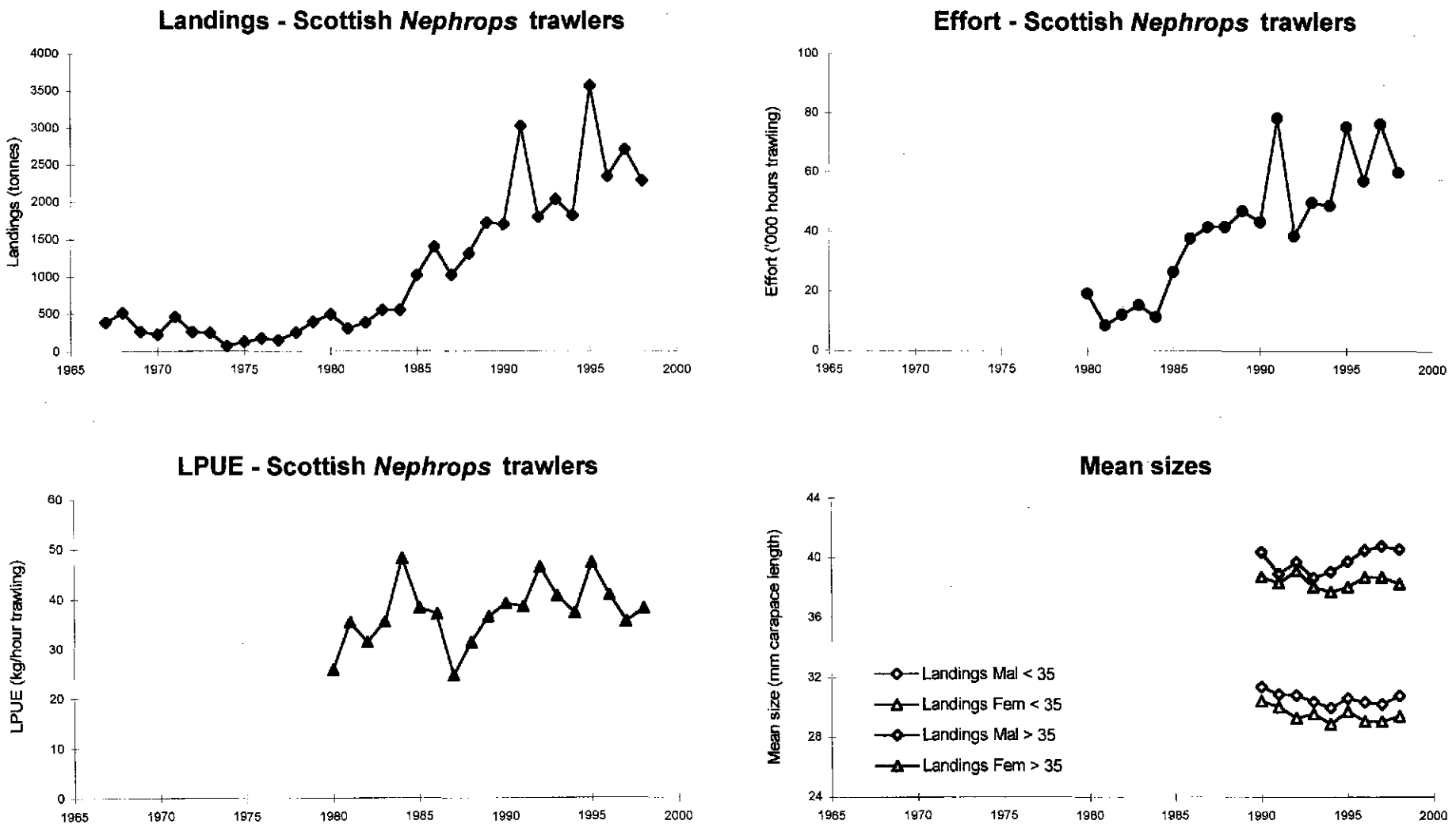


Figure 5.4.1. - Fladen (FU 7): Long-term trends in landings, effort, LPUEs and mean sizes of *Nephrops* in landings.

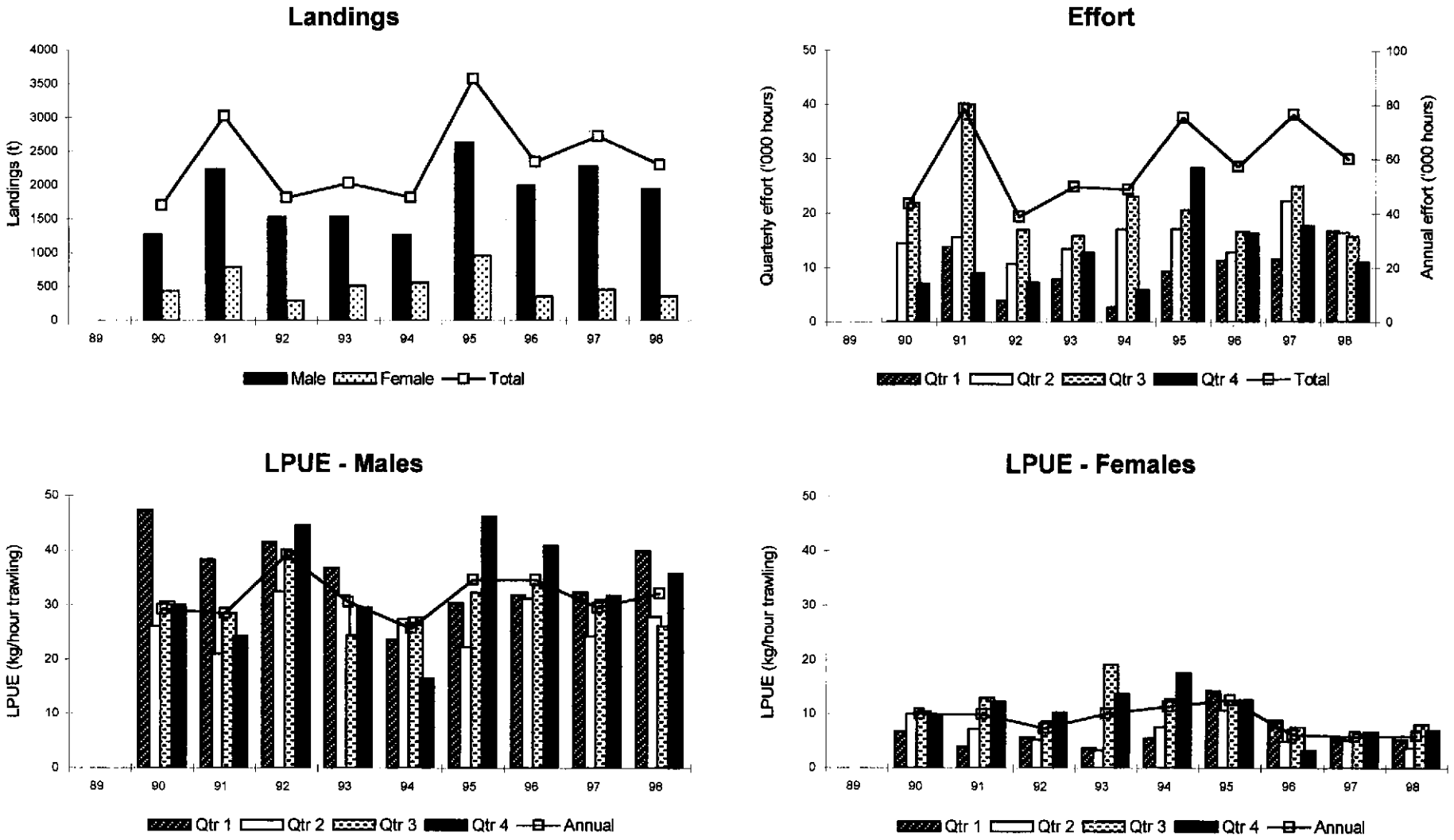


Figure 5.4.2. - Fladen (FU 7): Landings, effort and LPUEs by quarter and sex from Scottish *Nephrops* trawlers.

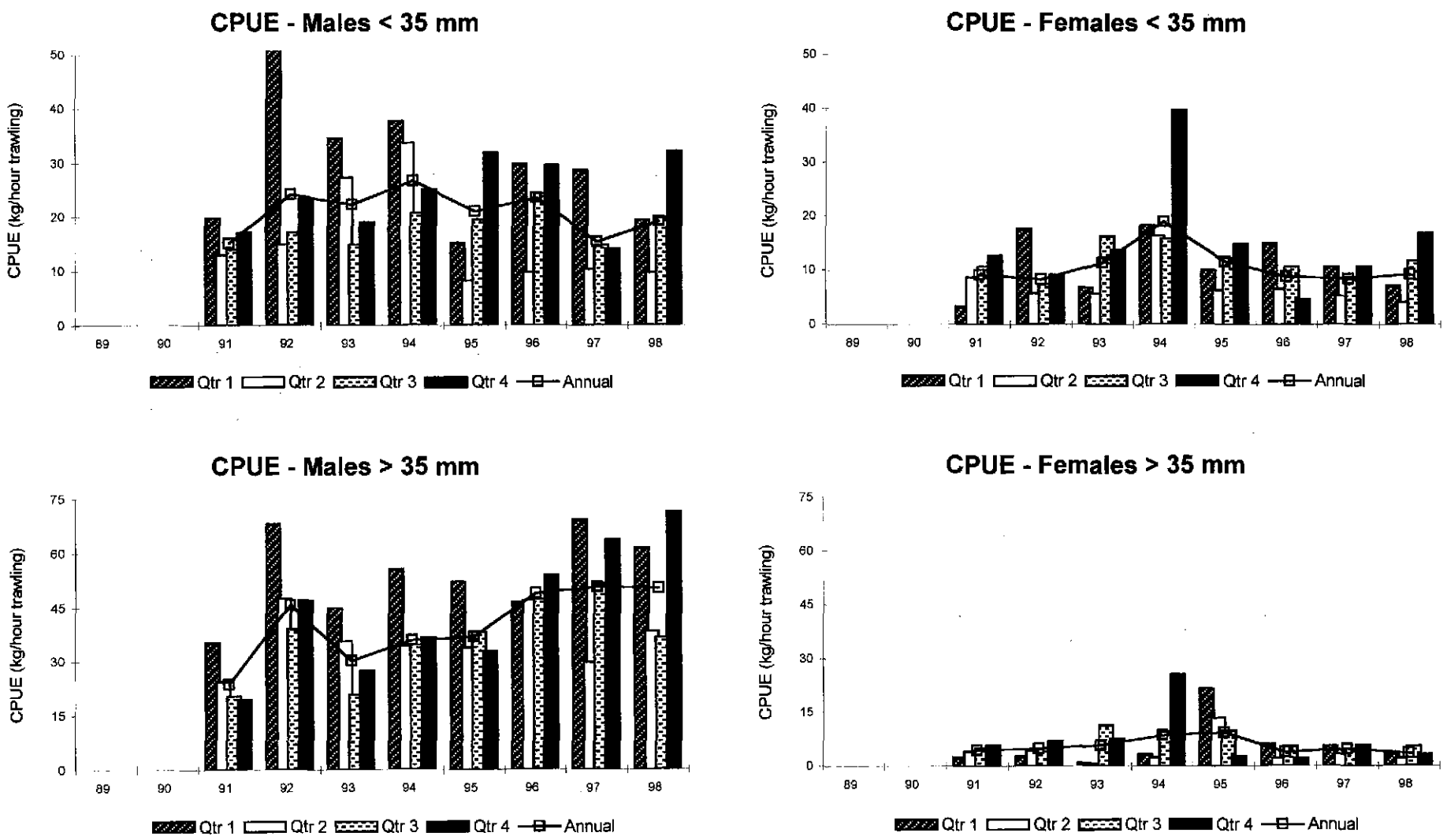
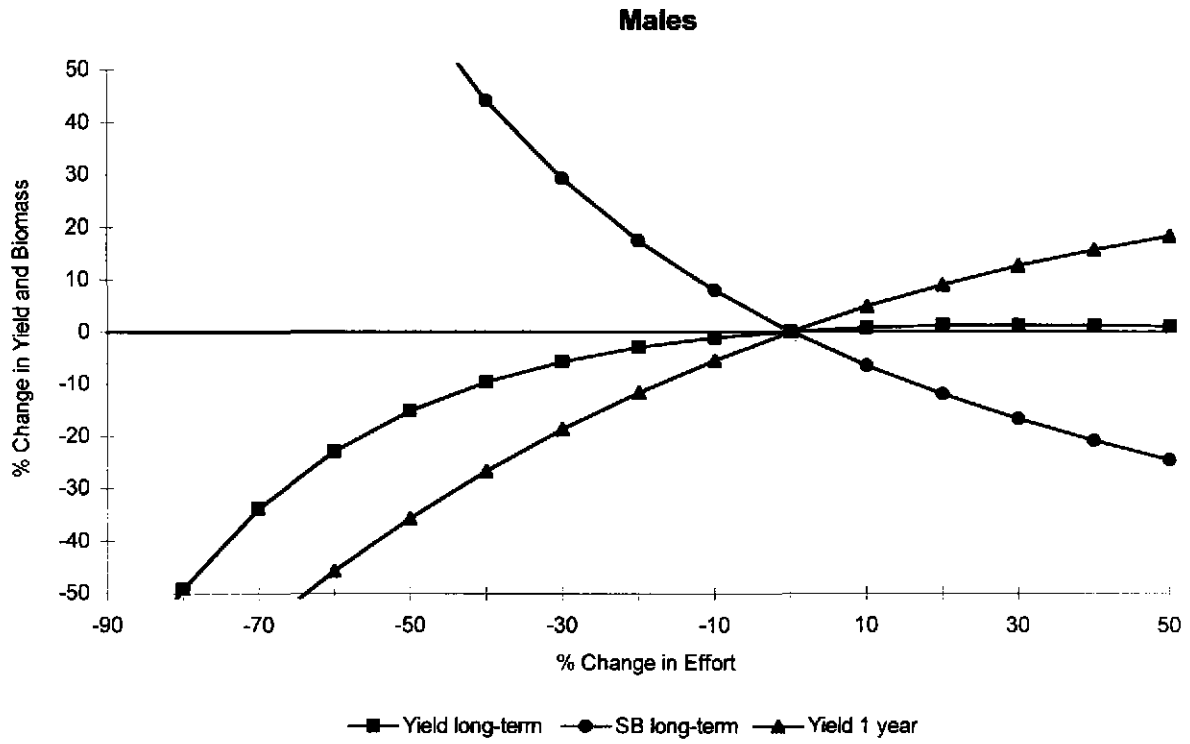


Figure 5.4.3. - Fladen (FU 7): CPUEs by sex and quarter, for selected size groups.



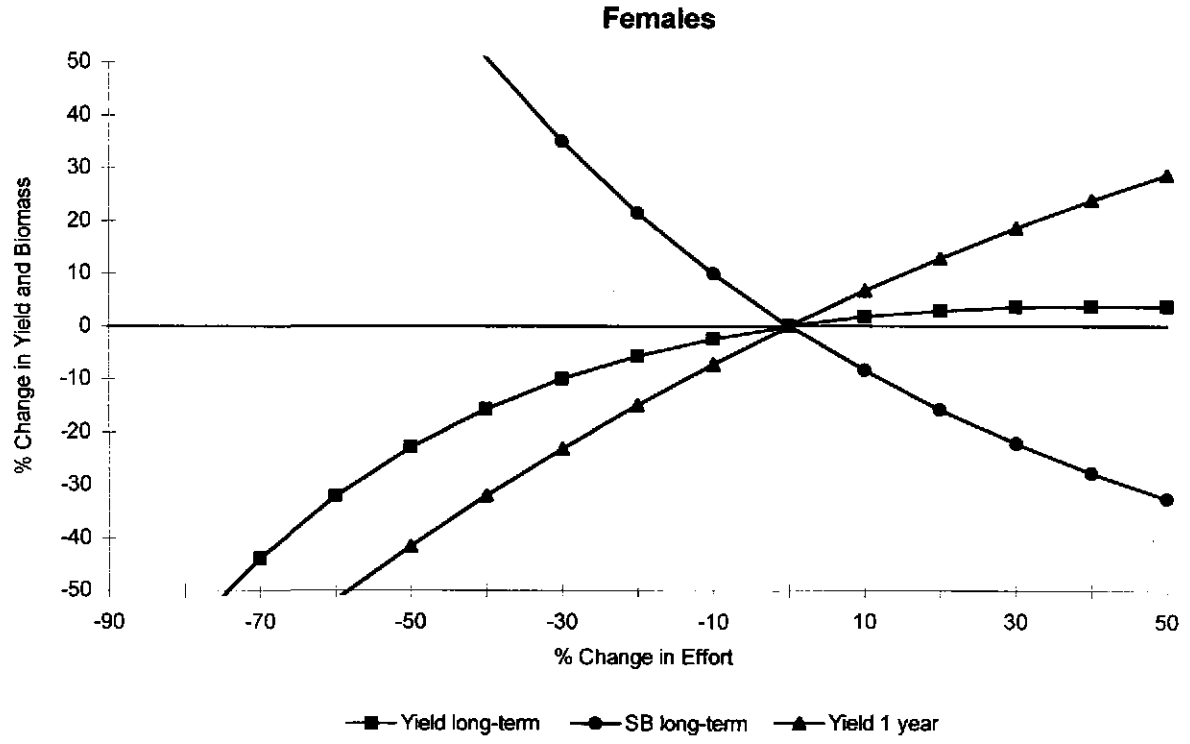


Figure 5.4.4. - Fladen (FU 7): Output LCA: Relative changes in short-term yield (ie after 1 year), long-term yield and long-term biomass upon relative changes in effort. Males and females shown separately.

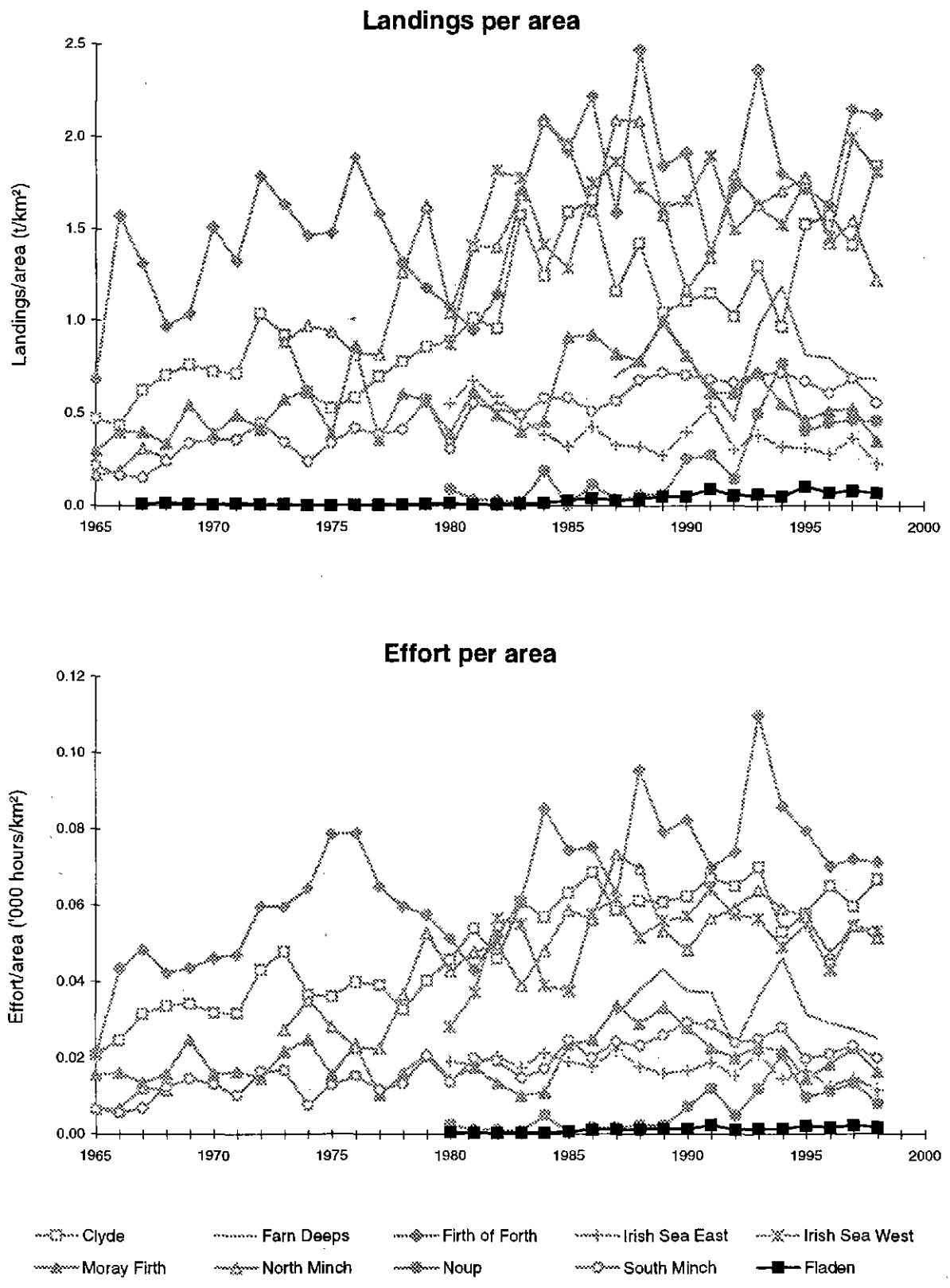


Figure 5.4.5. - *Nephrops* trawl landings per unit area (t/km²) and trawl effort per unit area ('000 hours trawling/km²) on various grounds.
Data relevant to this section of the report are shown in black.

5.5. Management Area S

ICES description **IVa East of 2° E, plus rectangles 43F5-F7**

Functional Units **Norwegian Deep (FU 32)**

The statistical rectangles comprised in this Management Area and its constituent Functional Units are shown in Figure 5.1.1.

5.5.1. Norwegian Deep (FU 32)

Description of the fisheries

Denmark

A description of the Danish *Nephrops* fisheries in Sub-areas IIIa and IV (including the one in the Norwegian Deep) is given in Section 5.2.

Norway

The Norwegian catch of *Nephrops* is largely a by-catch from *Pandalus* trawlers. Due to restrictions in the landings of *Pandalus*, the shrimp trawlers might fish for *Nephrops* for shorter periods of time. A small number of boats (< 10) is targeting *Nephrops* year round, making one week trips and landing their catches in Denmark.

Average length and tonnage of the vessels are 15 m and 25 t respectively. In 1998, 238 vessels were reported to have landed > 50 kg of *Nephrops* each. Most of these vessels make one day trips. Vessels fishing more specifically for *Nephrops* (and demersal fish) are frequently using 100 mm mesh trawls.

Trends in landings, effort, LPUE and mean size

Table 5.5.1. Landings by country, 1989-98
Table 5.5.2. Effort and LPUEs Danish fleet, 1989-98
Table 5.5.3. Mean sizes of *Nephrops* in catches, Norwegian data, 1989-98

Landings, effort and LPUE

Landings from FU 32 increased from 32 t in 1987 to 962 t in 1996, the highest figure in the time series. Danish vessels take about 90 % of the landings.

The only LPUE figures available so far are from Danish logbooks. The logbooks from Norwegian *Nephrops* trawlers are not entered in the official database, and those that could be investigated cover only 2-13 % of the total catch. Bigger vessels having joined the Danish *Nephrops* fleet contributed to a considerable increase in LPUE, especially from 1993 onwards.

Mean size

Unfortunately, there are no good length data from the period with less fishing in the area. Samples from selectivity experiments, carried out in the early 90s, could be worked up to give an idea on the trends in mean size since the beginning of the fishery. Danish length measurements of the discards are available for 1997.

The mean size of *Nephrops* as recorded in Norwegian research vessel catches in 1997 and 1998, using an ordinary 70 mm *Nephrops* trawl, are high compared to those recorded in neighbouring areas (Table 5.5.3.; Figure 5.5.1.; also see Section 5.2.).

Analytical assessments

The data available were not considered suitable for analytical assessment.

Management considerations

The large mean size in the catches, together with the upward trend in the Danish LPUE figures, indicate that the *Nephrops* stock in FU 32 is not fully exploited and that there might be scope for a further increase in catches. However, as a precautionary measure it is recommended that effort should not increase much beyond the present level. The stock should be monitored more closely.

5.5.2. Summary for Management Area S

Table 5.5.4. Landings by FU and from Other rectangles, 1989-98
Table 5.5.5. Landings by country, 1989-98

Since this MA comprises one FU only, the management considerations for this Unit equally apply to the MA as a whole, i.e. not to let effort increase much beyond the present level.

Table 5.5.1. - Norwegian Deep (FU 32): Landings (tonnes) by country, 1989-98.

Year	Denmark	Norway	Sweden	UK	Others **	Total
1989	23	8	0	1	0	32
1990	121	38	0	1	0	160
1991	70	101	0	6	0	177
1992	66	85	0	11	0	162
1993	220	102	0	16	0	338
1994	584	165	1	10	0	759
1995	418	74	1	2	0	494
1996	868	84	0	10	0	962
1997	689	66	1	7	0	762
1998 *	743	106	3	4	4	860

* provisional na = not available

Table 5.5.2. - Norwegian Deep (FU 32): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching *Nephrops* with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1989-98.

Year	Logbook data		Estimated effort
	Effort	LPUE	
1989	131	58	424
1990	1109	74	1694
1991	802	59	1196
1992	638	52	1538
1993	1317	121	1990
1994	2414	208	2649
1995	1792	198	2126
1996	3139	235	3708
1997	3189	218	3866
1998 *	2707	214	3147

* provisional na = not available

Table 5.5.3. - Norwegian Deep (FU 32): Mean sizes (mm CL) of male and female *Nephrops* in Norwegian catches, 1989-98.

Year	**Catches**	
	Males	Females
1989	na	na
1990	na	na
1991	na	na
1992	na	na
1993	na	na
1994	na	na
1995	na	na
1996	na	na
1997	42.6	37.6
1998 *	42.7	37.7

* provisional na = not available

Table 5.5.4. - Management Area S (IVa, East of 2° E + rect. 43F5-F7): Total *Nephrops* landings (tonnes) by Functional Unit plus other rectangles, 1989-98.

Year	FU 32	Other	Total
1989	32	0	***32***
1990	160	0	***160***
1991	177	0	***177***
1992	162	0	***162***
1993	338	0	***338***
1994	759	0	***759***
1995	494	0	***494***
1996	962	0	***962***
1997	762	0	***762***
1998 *	860	0	***860***
* provisional na = not available			

Table 5.5.5. - Management Area S (IVa, East of 2° E + rect. 43F5-F7): Total *Nephrops* landings (tonnes) by country, 1989-98.

Year	Denmark	Norway	Sweden	UK	Others	Total
1989	23	8	0	1	0	***32***
1990	121	38	0	1	0	***160***
1991	70	101	0	6	0	***177***
1992	66	85	0	11	0	***162***
1993	220	102	0	16	0	***338***
1994	584	165	1	10	0	***759***
1995	418	74	1	2	0	***494***
1996	868	84	0	10	0	***962***
1997	689	66	1	7	0	***762***
1998 *	743	106	3	4	4	***860***
* provisional na = not available						

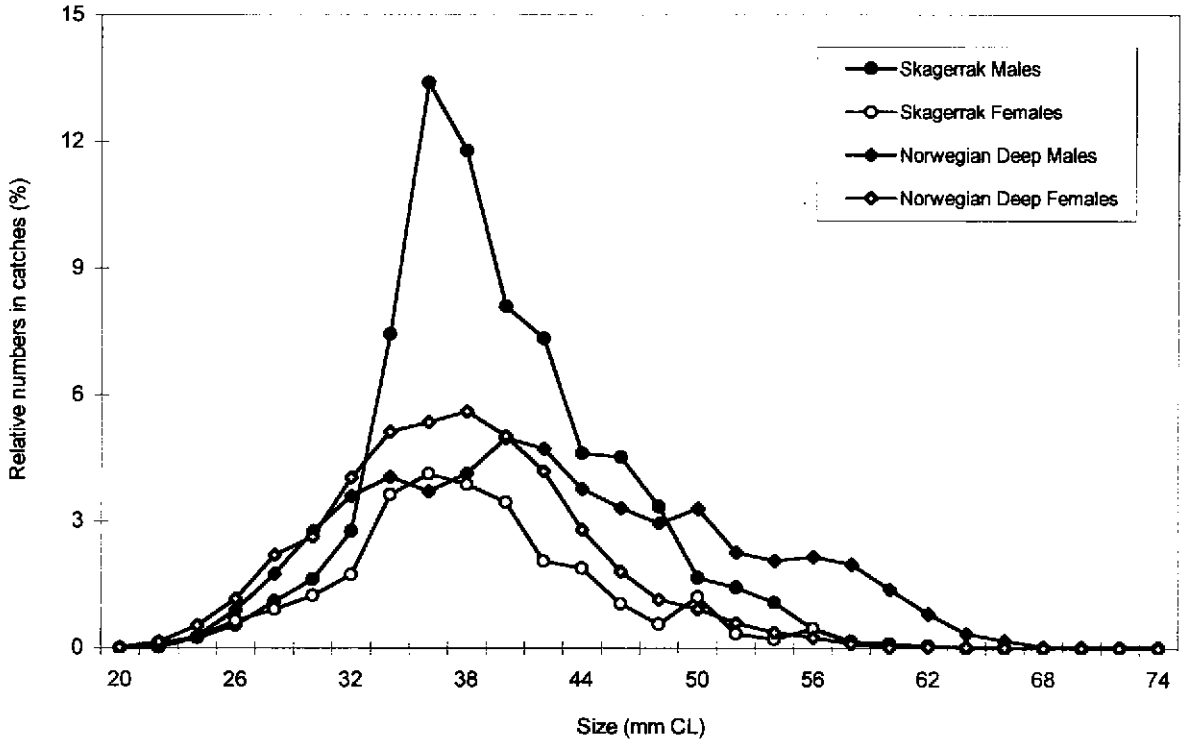


Figure 5.5.1. - Norwegian Deep (FU 32): LFDs of male and female *Nephrops* in Norwegian research vessel catches, compared to Skagerrak (FU 3). Data collected in 1997.

5.6. Management Area I

ICES description	**IVb,c West of 1° E**
Functional Units	**Farn Deeps (FU 6)** **Firth of Forth (FU 8)**

The statistical rectangles comprised in this Management Area and its constituent Functional Units are shown in Figure 5.1.1.

5.6.1. Farn Deeps (FU 6)

Description of the fisheries

UK – England

Approximately 100 boats are involved in the Farn Deeps *Nephrops* fishery. These comprise 50-60 ft side-trawlers, fishing mainly single otter trawls with a 70 mm mesh codend. A small number of twin-rigged trawlers using 80 mm mesh codends has joined the fishery since 1997. All nets have square mesh escape panels. The regular fleet is mostly English but also includes some visiting Scottish boats. Major landing ports are North Shields, Blythe, Amble, Seahouses and Hartlepool. The average duration of *Nephrops* directed fishing trips is one day, with 2 hauls of 4-5 hours duration per day.

Almost all *Nephrops* caught are now landed. There is some discarding at sea, but it is difficult to get reliable data on this. Much of the total catch is brought ashore before sorting. Some very small animals are discarded ashore, so that no viable part of the catch is returned to the grounds. Landings are fresh, by categories large, medium and small whole *Nephrops* and the smallest animals in the catch are landed as tails.

The major season of the *Nephrops* fishery is from October to March. At other times of the year, the vessels fish for various other species, usually on other grounds and with other gear. *Nephrops* is the prime target in the Farn Deeps fishery, with other species being a valued extra. The most important by-catch species are cod, haddock, lemon sole, anglerfish, whiting and plaice. Their catches and value in relation to *Nephrops* are very variable. At present, 'black' landings of *Nephrops* do not appear to be a problem, but there have been some problems in the past.

The fishing season of winter 1998-99 was generally poor. There was a late start to the season owing to good cod catches, and fishing for *Nephrops* was hindered by poor weather conditions over much of the rest of the season. The best catches were to the North of the fishery, off Dunstonborough Head.

Trends in landings, effort, CPUE, LPUE and mean size

Table 5.6.1. Landings by country, 1989-98
Table 5.6.2. Effort, CPUEs and LPUEs UK fleet, 1989-98
Table 5.6.3. Mean sizes of *Nephrops* in catches and landings, English data, 1989-98
Figure 5.6.1. Long-term trends in landings, effort, CPUE, LPUE and mean size, English data
Figure 5.6.2. Landings by sex + Quarterly plots of effort and LPUEs by sex, 1989-98
Figure 5.6.18. Fishing intensity indices

Landings and effort

In 1997 and 1998, landings from the Farn Deeps were entirely made by UK vessels. Total landings were 2189 t in 1997, and 2249 t in 1998, continuing the reduced landings since the peak of 3697 t in 1994 (Table 5.6.1.). Males predominate over females in the landings, ranging from 50 % (1990) to 76 % (1993) of the total.

Fishing effort recorded for UK trawlers has followed a similar trend to landings since the mid-80s (Table 5.6.2.). Peak effort of 143 10^3 hours trawling corresponded to the peak of landings in 1994. Effort had reduced by 45 % to 78 10^3 hours in 1998. Effort in this winter fishery is concentrated in the 4th the and the 1st quarter (Figure 5.6.2.). In 1998, however, the proportion of effort in the 4th quarter was reduced compared with previous years, owing to a late start to the fishing season (see above).

CPUE and LPUE

CPUE data (available from 1985) are calculated mainly from discard sampling during the winter fishing season (October-March). CPUE has fluctuated without obvious trend between 27 and 48 kg/hour trawling (Figure 5.6.1.). In 1997 and 1998, CPUE appears low compared with previous years, but this decline is likely to be an artefact of poor discard sampling in these years.

LPUE has remained stable since 1993, at a relatively high level of 25-27 kg/hour trawling (Figure 5.6.1.). The increase from the low value of 18 kg/hour trawling in 1991 could have been due to a reduction in discarding, although this is not apparent from the trend in mean size in the landings. High current LPUEs are apparent in both sexes (Figure 5.6.2.). The LPUE of males (which has been fairly stable since 1993, at an average of 18 kg/hour trawling) has consistently been twice that of females (on average 9 kg/hour trawling).

Trends in quarterly LPUEs are more variable than the annual trends, but overall the same pattern appears. LPUEs of both sexes are typically highest in the 4th and the 1st quarter, although in some years (such as 1994) the LPUE showed less seasonal variation. In females, higher LPUEs in winter presumably reflect a concentration of *Nephrops* directed effort, rather than increased availability.

Mean size

The increasing trend in mean size in the landings has continued (Table 5.6.3.). Mean sizes of *Nephrops* landed in 1998 were 34.9 mm CL in males and 33.7 mm CL in females, the highest figures for over a decade. The decline in mean size in the landings between 1984 and 1993 (Figure 5.6.1.) is thought to be due to increased retention of small individuals. It is unclear whether or not the present increasing trend reflects a new change in discarding practice. Most

likely, the apparent increase in mean size is a result of biased sampling, with the smallest *Nephrops* not being available for measuring.

Since 1991, the trend in mean size in the catches has been the inverse of that in the landings. The means of 28.9 mm CL in males and 27.3 mm CL in females are likely to be overestimates, owing to poor discard sampling. Thus it appears likely that the mean size of males has declined since the peak of 31.6 mm CL in 1993, although it is still within the range of historical variation.

Data and biological inputs for analytical assessments

Table 5.6.5. Sampling data and input parameters

Landings and effort statistics, and length compositions of landings, catches and discards were available for 1997 and 1998. As in 1997 (ICES, 1997a), discard survival (previously set at 25 %) was changed to zero, to account for suspected unreported landings of small *Nephrops*. This is a conservative approach to estimate the removals by the fishery but it is thought to be essentially correct. Other input parameters (for growth, sexual maturity, length-weight relationships and natural mortality) were also unchanged from those used before.

General comments on quality of data and inputs

The overall quality of statistics collection was poorer in 1997 and 1998 than in previous years. However, landings were well sampled at the major ports in NE England during the main season of the fishery, with an average of 26 samples being taken in quarters 1 and 4.

Owing to staff sickness, catch and particularly discard sampling was very poor. When discard samples were combined with landings samples (using the same method as in previous years), the estimated size distribution under-represented the numbers of very small individuals in the catch. For the purposes of the analytical assessments, the discard size distribution and proportions for 1997 and 1998 were estimated from the 1995 and 1996 discard data, which are based on much larger numbers of samples. It was assumed that the size distribution and proportion by the weight of discards in the catch was the same in 1997 and 1998 as the average for 1995 and 1996.

The biological input parameters are either based directly on Farn Deeps observations (length-weight relationships, size at maturity), derived from other FUs (natural mortality) or determined from Farn Deeps data with reference to estimates for other FUs (growth).

Length based assessments (LCA)

Table 5.6.6. Output table LCA males, with mean F
Table 5.6.7. Output table LCA females, with mean F
Figure 5.6.3. Changes in Y/R and B/R upon changes in F, for males and females separately

Length cohort analysis requires an assumption of steady state with respect to effort and stock recruitment. This assumption was clearly not met for the Farn Deeps stocks in recent years. The reference period chosen was 1994-98, during which the LPUEs remained stable. However, there were marked downward trends in both landings and effort during these five years.

The shapes of the Y/R and B/R curves are essentially unchanged compared to the previous length-based assessments (see e.g. ICES, 1997a). Current effort appears to be higher than that required to maximise Y/R in males, but the Y/R curve is very flat-topped so that the gains from such an effort reduction would be less than 10 %. According to the Y/R curve, females are exploited at a much lower level than males, with current F well below F_{max}. Larger gains in B/R than Y/R would be expected to result from an effort reduction, but with B/R at approximately 60 % of the virgin level in females, there is nothing to suggest that the spawning stock size is compromised at current levels of exploitation.

Annualised mean F values for the inter-quartile range of lengths were 0.54 for the males and 0.09 for the females – slightly lower than the values obtained in 1997, based on the 1990-96 reference period.

Age based assessments (VPA)

The age-based assessment was re-worked with the addition of a further two years of length data and a revision of the database for the years 1985-98. In line with the approach used in 1997, the size distributions and quantities of removals were calculated assuming a discard survival of zero from 1991 onwards. Inputs on growth, length-weight relationships and natural mortality, used to estimate the distribution and mean weight of the removals at age (using the 'slicing' procedure) were also the same as the ones used in 1997. As over 99 % of the historical landings were made by the UK fleet, the assessment was tuned using directed trawl catch and effort data from this fleet.

Males

Table	5.6.8.	Output XSA males: Fs-at-age
Table	5.6.10.	Output XSA males: Long-term trends in landings, Fbar, TSB and recruitment
Figure	5.6.4.	Output XSA males: Log catchability residuals
Figure	5.6.6.	Output XSA males: Long-term trends in landings, Fbar, TSB and recruitment
Figure	5.6.8.	Output XSA males: Plots of Fbar vs. effort

Slicing gave 11 nominal 'ages' (the last one being a plus group). The tuning diagnostics from the XSA indicated that the input parameters used in 1997 remained satisfactory for this year's assessment. Standard errors of log catchability indicated that catchability was best modelled as being dependent on year class strength for ages 1-3 and constant for ages 7 and above. As in 1997 and before, the default option of shrinkage to the mean F was not selected. Previous analyses found that F shrinkage exaggerated the bias in average fishing mortality. In preliminary analyses for this WG, using the inadequate discard data for 1997 and 1998 to estimate removals, it was further found that F shrinkage produced spurious trends of declining recruitment over recent years. This was a result of inflated estimates of F for the poorly represented youngest age classes.

Catchability residuals were noisy, particularly for the oldest age classes. Strong year effects are apparent, but no trends over time. Nevertheless, standard errors on the log catchability and the terminal population estimates indicates that the quality of the assessment was not compromised.

The summary outputs from XSA show a slight decrease in F_{bar} to 0.46 in 1997 and 0.52 in 1998, well below the 1985-98 average of 0.65. Trends in fishing mortality show a close correspondence to landings, owing to the stability of estimated TSB. During 1985-98, TSB has varied by ± 10 % around an overall mean of 8460 t. Recruitment has also remained stable since 1991. Recruitments of 267 10^6 in 1997, and 261 10^6 in 1998 were slightly higher than the 1991-98 mean of 257 10^6.

There is a strong correlation between F_{bar} and effort ($r = 0.84$; $p < 0.001$), which also supports the satisfactory quality of the assessment.

Females

Table 5.6.9. Output XSA females: Fs-at-age
Table 5.6.11. Output XSA females: Long-term trends in landings, Fbar, TSB and recruitment
Figure 5.6.5. Output XSA females: Log catchability residuals
Figure 5.6.7. Output XSA females: Long-term trends in landings, Fbar, TSB and recruitment
Figure 5.6.8. Output XSA females: Plots of Fbar vs. effort

The L2AGE programme produced 14 nominal 'age' classes. As in males, XSA tuning options selected in the 1997 assessment proved to be satisfactory for the 1999 assessment. Catchability was modelled as dependent on year class strength for ages 1-2 and held constant for ages > 12. F shrinkage was not used owing to increased retrospective bias in fishing mortality and the danger of spurious recruitment trends.

The analysis was less well-determined than for males, owing to fewer constraints on catchability. Consequently, the log catchability residuals were slightly noisier, although there were no very large values. There are some year effects but no overall trends in residuals are apparent. In the light of tuning diagnostics, the assessment is considered satisfactory. Standard errors on log catchability and terminal populations were relatively small.

The summary outputs from the XSA show that F_{bar} has been relatively stable, at 0.17 in 1997 and 0.19 in 1998. Both landings and F_{bar} were variable before 1995, showing some similarities in trend. TSB remained relatively stable during 1985-98, varying within about 13 % of the long-term mean of 9725 t. Female recruitment was very similar to that of the males, in terms of both trends and absolute numbers. Recruitments in 1997 and 1998 were 247 10^6 and 255 10^6 respectively, close to the 1985-98 mean of 259 10^6.

F_{bar} showed a good correlation with effort ($r = 0.72$; $p < 0.01$).

Fishery independent methods – TV surveys

Table 5.6.4. Overview results of underwater TV surveys, 1996-98

TV and trawl surveys of the Farn Deeps grounds were conducted in 1996, 1997 and 1998. Abundance and biomass estimates were much more variable than those from the XSA. Estimated abundance declined by a third between 1996 and 1997, and by almost two thirds between 1997 and spring 1998. By autumn 1998, estimated abundance had recovered to about half the level of spring 1996. Further analysis of burrow count data and a review of count

methodology are needed before this trend can be considered real. Moreover, the time series is as yet too short for meaningful comparison of trends with analytical assessment estimates.

The most recent stock biomass estimate of 19.1 - 20.7 10^3 t for 1998 is very close to the combined male and female TSB of 18.6 10^3 t estimated from the XSA. In general, one would expect that the biomass estimate from burrow counts would be higher than that from the XSA, due to the upward bias in estimating mean size from trawl samples (see Section 7) and the counting of burrows of individuals that are too small to appear in the catches. Thus, although the similarity of XSA and burrow count estimates of biomass in 1998 is encouraging, it is too early to conclude that there is agreement between the two assessment methods.

Comments on quality of assessments

Data collection and research efforts in the Farn Deeps were maintained at a reasonably high level before 1997. Landings and effort statistics are considered reasonably reliable until about 1994. Since that time, some under-reporting of landings is suspected.

Length distributions have been sampled intensively since 1983, particularly in the landings. Due to uncertainty about discarding at sea in the presence of observers, and possibly biased on-shore sampling of the landings length composition, discard mortality was set at zero – the worst case scenario. As noted above, very few samples of catches and particularly discards were taken in 1997 and 1998. Catch and discard length distributions were estimated using 1995-96 data. This is not considered to have introduced serious biases into the assessment data for these years. Assessments using length distributions raised from raw catch data gave very similar results to those presented here, albeit with poorer XSA diagnostics. Current prospects are for a return to high sampling levels.

Some of the biological inputs are dependent upon estimates from other FUs. However, given the flat-topped nature of the Y/R curves and the stability of the estimated trends in F_{bar}, TSB and recruitment, only major changes to the biological inputs would be likely to change the perception of the state of exploitation and the appropriate management requirements. The analytical assessments presented here are all considered to be satisfactory in quality and comparable to previous assessments.

Management considerations

The short-term trends in F_{bar}, TSB and recruitment, together with the results of the recent LCAs and the trends in CPUE, LPUE and mean size, can be taken to provide guidance on the state of exploitation of this FU.

The length-based Y/R analyses show that effort would need to be reduced by 35 % to achieve F_{max} for males, but this would result in only small increases in Y/R. Current effort is well below F_{max} for females. In line with changes in landings and effort, the age-based assessments show that F_{bar} for both sexes has declined from the high level of 1994 and is now at or around the lowest values observed since 1985 – the beginning of the assessment period. TSB and recruitment estimates have been stable over recent years.

Although the *Nephrops* stock in the Farn Deeps is at least fully exploited, it is nevertheless concluded that the stock is in a satisfactory state. Concern was previously expressed that this FU could not sustain the high level of effort seen in the late 80s and particularly in 1994. Effort has fallen from these high levels, but the WG continues to recommend that effort should be prevented from exceeding current levels. Landings can be projected for 1999 and 2000, based on F_{bar} at age for 1996-98, constant recruitment at the 1998 level, and proportions by weight of discards equal to the average of the 1995 and 1996 estimates (the most recent years of good discard sampling). Projected landings are 2330 t in 1999 and 2564 t in 2000. These figures are higher than the 1979 t recommended by the 1993 WG under a 20 % effort reduction (ICES, 1993a), but in line with previous recommendations of around 2500 t (ICES, 1991a and 1992a).

5.6.2. Firth of Forth (FU 8)

Description of the fisheries

UK – Scotland

An extensive description of the Scottish fisheries in this area will be given in the next WG Report.

Trends in landings, effort, CPUE, LPUE and mean size

Table 5.6.12. Landings by country, 1989-98
Table 5.6.13. Effort and LPUEs Scottish fleet, 1989-98
Table 5.6.14. Mean sizes of *Nephrops* in catches and landings, Scottish data, 1989-98
Figure 5.6.9. Long-term trends in landings, effort, LPUE and mean size, Scottish data
Figure 5.6.10. Landings by sex + Quarterly plots of effort and LPUEs by sex, 1989-98
Figure 5.6.11. Quarterly plots of CPUEs for selected size groups, 1989-98
Figure 5.6.18. Fishing intensity indices

Landings, effort, CPUE and LPUE

Landings were reported by UK vessels only. In the most recent years, 97-98 % of the landings were made by Scottish *Nephrops* trawlers.

In 1997, reported landings were 2192 t, up by almost 500 t compared to 1996 (Table 5.6.12.). The preliminary landings figure for 1998 indicates a maintenance of the high landings at 2142 t, reversing the trend of the previous years. The increase in landings occurred despite effort remaining at about the same level (around 70 10^3 hours) and reflects a pronounced increase in LPUE to the highest values in the data series since the mid-70s (Figure 5.6.9.). Following the UK ban, no 70 mm multi-rig gears have been used in this fishery since 1993.

The male contribution to the annual landings is usually much greater than the female one (Figure 5.6.10.). Higher female contributions to the landings in some years (e.g. 1988, 1989 and 1997) appear to relate to a change in fishing pattern, with increased effort in the 3rd

quarter and reduced effort in the 4th. Effort is generally greater in the 2nd half of the year. Catch rates of females were surprisingly consistent throughout 1995, unlike other years when the pattern is more typical with peak emergence in the 3rd quarter.

Data on CPUE are for the first time presented for different size groups of animals (Figure 5.6.11.). This tends to suggest an increase in CPUE of the smaller animals, particularly males, while the CPUEs of the larger animals are generally more stable.

Mean size

The mean size of the larger animals (> 35 mm CL) of both sexes in trawl landings has remained very stable in recent years (Table 5.6.14.; Figure 5.6.9.). On the other hand, the mean size of landed *Nephrops* < 35 mm CL shows some evidence of a dip in 1993 which is even more pronounced in the catches (which include discarded animals). This dip corresponds to other indicators which suggest an unusually good recruitment (see further).

Fishing intensity indices

Landings per area and effort per area are currently very high (Figure 5.6.18.), but while effort per area has remained more or less constant, landings per area have increased. Both are higher in the Firth of Forth than for any of the other Scottish grounds.

Data and biological inputs for analytical assessments

Table 5.6.5. Sampling data and input parameters

Sampling of commercial trawl landings is carried out regularly at the Scottish ports of Pittenweem and Eyemouth. Trawl discards were sampled each quarter (except for the 3rd quarter 1998) on board commercial fishing vessels. Additional sampling on a roughly monthly basis has been continued through an EU funded project. The trawl landings and discard samples were raised to fleet level and combined to estimate total removals, as described for the Moray Firth (see Section 5.3.1.).

With the exception of size at first maturity, which was increased from 25 to 26 mm CL, input parameter values remained the same as in previous years.

General comments on quality of data and inputs

Adequate sampling of the landings was achieved in this fishery. The level of discard sampling has increased considerably in the last two years although this still may be below optimum, bearing in mind the high temporal variability in discard rates. The uniform sedimentary environment in the area probably means that the input parameters used in the assessments are more widely relevant for this stock than for some others in the Scottish waters (ICES, 1993a).

Length based assessments (LCA)

Table 5.6.18. Output table LCA males, with mean F

Table 5.6.19. Output table LCA females, with mean F
Figure 5.6.12. Changes in Y/R and B/R upon changes in F, for males and females separately

Following revision of the length composition data, an LCA was carried out for the most recent three years' reference period (1996-98), to check whether any changes had occurred. Input F choices were unchanged from previous analyses (0.1 and 0.05 in males and females respectively).

The dome shaped long-term Y/R curve for males was almost identical to the analysis of 1997, and suggested that current F was well above F_{max}. For females, the Y/R curve was almost flat-topped. Annualised fishing mortalities (averaged over the inter-quartile length range) were 0.85 and 0.17 for males and females respectively. Results for the males suggest evidence of growth overfishing.

Age based assessments (VPA)

A single fleet assessment was carried out using Scottish data from 1981-98. The Lowestoft VPA program was used on nominal 'age' groups, generated by slicing the length distributions. Tuning of the VPA was carried out using Scottish *Nephrops* trawl effort data, adjusted to total trawl effort. Effort data were derived as for the Moray Firth (see Section 5.3.1.).

Males

Table 5.6.20. Output XSA males: Fs-at-age
Table 5.6.22. Output XSA males: Long-term trends in landings, Fbar, TSB and recruitment
Figure 5.6.13. Output XSA males: Log catchability residuals
Figure 5.6.15. Output XSA males: Long-term trends in landings, Fbar, TSB and recruitment
Figure 5.6.17. Output XSA males: Plots of Fbar vs. effort

The slicing procedure generated 11 nominal 'age' groups (11 = plus group). XSA was used to tune the VPA. Tuning was performed over the whole 18 year period, over ages 1-10, with a tricubic time taper but without shrinkage. For the catchability analysis, catchability was dependent on stock size for ages < 3, with estimates shrunk to the population mean. Catchability was independent of age for ages > 5. Tuning converged after 17 iterations.

The log catchability residuals seem reasonably trend-free, apart from the erratic fluctuations for nominal age 1 in recent years, and evidence of year effects in the older age groups (> 5).

Trends in the VPA estimates of yield, F_{bar}, TSB and recruitment are plotted in Figure 5.6.15. F_{bar} has fluctuated around a generally rising trend up to 1991, but has been fairly stable in recent years. TSB has been reasonably stable, and recruitment showed a peak in 1993 followed by a period of generally high values.

There is a good fit between F_{bar} and fishing effort trends, and the correlation of F_{bar} over effort is highly significant ($r = 0.89$; $p < 0.001$).

Females

Table 5.6.21. Output XSA females: Fs-at-age
Table 5.6.23. Output XSA females: Long-term trends in landings, Fbar, TSB and recruitment

Figure 5.6.14. Output XSA females: Log catchability residuals
Figure 5.6.16. Output XSA females: Long-term trends in landings, Fbar, TSB and recruitment
Figure 5.6.17. Output XSA females: Plots of Fbar vs. effort

The slicing procedure gave 16 nominal 'age' groups (16 = plus group). For females, M is assumed to decrease at the onset of sexual maturity. The catchability analysis was similar to that of the males, except that catchability was independent of age for ages > 4. Tuning had not converged to the criteria set by the program after 30 iterations, though examination of the final year Fs-at-age from the last two iterations suggested that convergence had occurred to 3 decimal places.

As for the males, the log catchability residuals for age 1 were erratic in recent years. There were also marked year effects for most other ages.

Trends in the VPA estimates of female yields, F_{bar}, TSB and recruitment are plotted in Figure 5.6.16. F_{bar} has increased gradually over the last 16 years, with relatively high values in 1988-90 and also 1997. Fishing mortality estimates were much lower than for males. TSB has been relatively stable and is currently at a relatively high level. There is evidence of good recruitment in 1993 and 1994, and continued reasonable recruitment since then. Comparison between Figures 5.6.15. and 5.6.16. shows that annual estimates of TSB and recruitment are reasonably consistent between the sexes.

Plots showing trends and the degree of correlation between them are shown in Figure 5.6.17. The correlation between F_{bar} and fishing effort is poorer than for males, but is still statistically significant ($r = 0.56$; $p < 0.05$).

Fishery independent methods - TV surveys

Table 5.6.15. Results of 1998 underwater TV surveys
Table 5.6.16. Overview results of underwater TV surveys, 1993-98

A TV camera and trawl survey of the Firth of Forth grounds was conducted in 1998 using RV '*Scotia*'. Estimates of mean burrow density across different strata varied from 0.27 to 0.49 per m^2. Abundance and biomass estimates raised to the total ground area (915 km^2) were about 345 10^6 burrows (95 % confidence limit 95 10^6) and the corresponding biomass estimates were in the range 4.2-7.5 10^3 t.

Comparison with the earlier survey results (not corrected for unoccupied burrows) suggests a continued fall in abundance and biomass of the stock. This decline does not correspond well to the trends in the VPA, which indicate improved biomass and recruitment. While VPA estimated recruitment was high in 1993, corresponding to a high TV estimate, the recent estimates of recruitment from the VPA are not reflected in the TV surveys. This may have occurred for two reasons. Firstly, there was no TV survey in 1997, and secondly, the visibility during the 1998 survey was generally poor, making burrow counting more difficult and reducing the number of stations.

Comments on the quality of the assessments

In general, this stock is considered to provide reliable assessment results in comparison to most other Scottish stocks. The VPA on sliced 'age' groups has been used for several years and it has invariably performed consistently well, particularly on males. The uniformity of the sedimentary environment, good sampling coverage (at least of the landings) and the even distribution of fishing effort, probably contribute to the quality of the data used in the assessments.

Early signs of good agreement between the direct TV estimates of trends in abundance and the VPA estimates have not been repeated in the last couple of years. This is thought to be related to water clarity and a gap in the TV data series. The comparison of TV and VPA biomass estimates is complicated by the same difficulties in applying mean weights as was the case for the Moray Firth (see Section 5.3.1.), and are discussed in Section 7.

Management considerations

The available evidence from the LCA suggests that the Firth of Forth stock could derive some long-term benefit from a reduction in fishing effort. The Y/R curve for males suggests that an effort reduction of 60 % should generate an increase in long-term yield of about 20 %, though this would be offset to some extent by a reduction in the yield from females.

Despite the evidence of growth overfishing, there are no signs of recruitment problems and the stock looks remarkably stable. Both the LCA and VPA suggest that fishing mortality on males has remained relatively stable, and is higher than on other stocks in Scottish waters. The VPA showed an increasing trend in F, particularly in males, though TSB and recruitment appeared to be reasonably stable with signs of good recruitment in recent years. The opposite trend in the TV estimates gives some cause for concern, but it is felt this is due to technical difficulties rather than to real reductions in biomass.

5.6.3. Summary for Management Area I

Table 5.6.24. Landings by FU and from Other rectangles, 1989-98
Table 5.6.25. Landings by country, 1989-98

The WG again recommends that the main management objective should be to prevent increases in fishing effort above recent levels in both FUs. This is unlikely to be achieved, however, under the present TAC arrangement in the North Sea. A *status quo* TAC for this MA would be 4170 t.

Table 5.6.1. - Farn Deeps (FU 6): Landings (tonnes) by country, 1989-98.

Year	Belgium	Denmark	Netherl.	UK	Total
1989	0	1	0	3098	3098
1990	0	0	0	2498	2498
1991	1	1	0	2061	2063
1992	0	0	0	1463	1463
1993	0	0	0	3030	3030
1994	0	1	0	3696	3697
1995	0	0	0	2568	2568
1996	0	0	5	2482	2487
1997	0	0	0	2189	2189
1998 *	0	0	0	2249	2249

* provisional na = not available

Table 5.6.2. - Farn Deeps (FU 6): Catches and landings (tonnes), effort ('000 hours trawling), CPUE and LPUE (kg/hour trawling) of UK *Nephrops* trawlers, 1989-98.

Year	Catches	Landings	Effort	CPUE	LPUE
1989	4639	3076	133.5	34.7	23.0
1990	4096	2471	116.2	35.3	21.3
1991	3075	2020	114.7	26.8	17.6
1992	2287	1437	69.5	32.9	20.7
1993	3568	3011	111.8	31.9	26.9
1994	5190	3684	143.4	36.2	25.7
1995	3152	2539	97.0	32.5	26.2
1996	3587	2475	90.5	41.6	27.4
1997	2620	2154	85.3	31.4	25.2
1998 *	2265	2129	78.3	29.3	27.2

* provisional na = not available

Table 5.6.3. - Farn Deeps (FU 6): Mean sizes (CL mm) of male and female *Nephrops* in English catches and landings, 1989-98.

Year	**Catches**		**Landings**	
	Males	Females	Males	Females
1989	28.5	27.7	31.9	31.4
1990	26.6	26.9	31.3	30.8
1991	28.4	26.6	33.0	32.6
1992	30.3	28.5	32.5	31.4
1993	31.6	28.2	32.9	29.6
1994	30.4	27.4	33.8	30.5
1995	29.7	28.2	33.9	31.7
1996	28.0	27.1	34.5	32.1
1997	28.6	29.4	33.5	32.1
1998 *	28.9	27.3	34.9	33.7

* provisional na = not available

Table 5.6.4. - Farn Deeps (FU 6): Results from TV surveys carried out in 1996-98, giving estimates of stock abundance and biomass.

Year	Season	Mean density	Abundance	95% confidence interval	Biomass
		burrows/m²	millions	millions	'000 t
1996	Spring	0.793	2452	168	34.8 - 40.0
	Autumn	No survey			
1997	Spring	0.566	1750	96	25.2 - 28.1
	Autumn	0.582	1799	118	25.8 - 29.4
1998	Spring	0.232	717	18	10.7 - 11.2
	Autumn	0.420	1298	52	19.1 - 20.7

Table 5.6.5. - Farn Deeps (FU 6): Input data and parameters.

FU	6	MA	I
FLEET	UK England	GEAR	Trawl

	1998					1997				
	Number of samples				Mean no. per sample	Number of samples				Mean no. per sample
	Qtr 1	Qtr 2	Qtr 3	Qtr 4		Qtr 1	Qtr 2	Qtr 3	Qtr 4	
Catch	3	0	0	13	457	5	0	0	2	326
Landings	27	1	1	22	212	29	8	15	25	195
Discards	0	0	0	2	337	3	0	0	0	406

	Number of samples									
Year	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989
Catch	16	7	43	36	29	22	3	10	21	31
Landings	51	77	68	103	55	66	13	54	50	83
Discards	2	3	43	36	29	22	3	10	21	31

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival	0	assumed (based on Evans et al., 1994)
MALES		
Growth - K	0.160	Macer (unpublished data) and comparison with Scottish stocks
Growth - L(inf)	66	"
Natural mortality - M	0.3	Morizur, 1982
Length/weight - a	0.00038	Farn Deeps observations (Macer, unpublished data)
Length/weight - b	3.170	"
FEMALES		
Immature Growth		
Growth - K	0.160	Macer (unpublished data) and comparison with Scottish stocks
Growth - L(inf)	66	"
Natural mortality - M	0.3	Morizur, 1982
Size at maturity	24	corresponding to CL with 50 % berried
Mature Growth		
Growth - K	0.060	Macer (unpublished data) and comparison with Scottish stocks
Growth - L(inf)	58	"
Natural mortality - M	0.2	based on Morizur, 1982 ; assuming lower rate for mature females
Length/weight - a	0.00091	Farn Deeps observations (Macer, unpublished data)
Length/weight - b	2.890	"

Table 5.6.6. - Farn Deep (FU 6): LCA output males.

Reference period	1994-98		
Linf (mm CL)	66.0	K	0.160

Size (mm CL)	Removals ('000)	M	DT (years)	F*DT	F	Z	Nos. attaining aver. size ('000)	Average nos. in the sea ('000)	Average biomass (kg)
16	198	0.3	0.255	0.001	0.004	0.304	225196	55287	171601
18	1012	0.3	0.266	0.005	0.019	0.319	208411	53150	234835
20	5252	0.3	0.278	0.029	0.104	0.404	191454	50311	305441
22	11572	0.3	0.291	0.073	0.252	0.552	171109	45964	372495
24	13575	0.3	0.305	0.103	0.336	0.636	145747	40400	426627
26	11397	0.3	0.321	0.105	0.327	0.627	120052	34866	470101
28	12086	0.3	0.338	0.138	0.410	0.710	98196	29504	499107
30	9724	0.3	0.357	0.142	0.398	0.698	77259	24428	510689
32	10286	0.3	0.379	0.199	0.525	0.825	60206	19591	499505
34	9059	0.3	0.403	0.246	0.609	0.909	44043	14872	457081
36	6847	0.3	0.431	0.272	0.632	0.932	30522	10839	397390
38	4947	0.3	0.463	0.299	0.646	0.946	20424	7660	331928
40	3481	0.3	0.500	0.333	0.666	0.966	13179	5229	265560
42	2322	0.3	0.544	0.368	0.677	0.977	8129	3429	202616
44	1385	0.3	0.596	0.378	0.635	0.935	4778	2183	148988
46	764	0.3	0.659	0.365	0.554	0.854	2739	1379	108089
48	393	0.3	0.736	0.327	0.444	0.744	1561	885	79120
50	189	0.3	0.835	0.269	0.322	0.622	902	588	59669
52	98	0.3	0.963	0.234	0.243	0.543	537	403	46229
54	65	0.3	1.140	0.274	0.240	0.540	318	271	34953
56	27	0.3	1.395	0.212	0.152	0.452	172	178	25726
58	18	0.3	1.798	0.289	0.161	0.461	92	112	18061
60	16	0.3			0.200	0.500	40	0	0
					Totals, including lengths above + group			401527	5665810

Mean F, calculated across inter-quartile range	0.543

Table 5.6.7. - Farn Deeps (FU 6): LCA output females.

Reference period	1994-98		
Linf immatures (mm CL)	66.0	K immatures	0.160
Linf matures (mm CL)	58.0	K matures	0.060
Transition length (mm CL)	24.0		

Size (mm CL)	Removals ('000)	M	DT (years)	F*DT	F	Z	Nos. attaining aver. size ('000)	Average nos. in the sea ('000)	Average biomass (kg)
14	114	0.3	0.245	0.000	0.001	0.301	350101	82727	190517
16	169	0.3	0.255	0.001	0.002	0.302	325169	79846	264176
18	1074	0.3	0.266	0.004	0.014	0.314	301046	76825	350730
20	4789	0.3	0.278	0.018	0.066	0.366	276924	73159	446234
22	8975	0.3	0.291	0.038	0.131	0.431	250186	68366	542627
24	12728	0.2	0.305	0.061	0.201	0.401	220701	63349	640073
26	12616	0.2	1.076	0.074	0.069	0.269	195303	182399	2302858
28	11351	0.2	1.150	0.091	0.079	0.279	146207	143826	2233152
30	9742	0.2	1.235	0.109	0.088	0.288	106091	110241	2076196
32	8584	0.2	1.334	0.141	0.105	0.305	74301	81411	1837418
34	5764	0.2	1.450	0.144	0.099	0.299	49435	58166	1556562
36	3254	0.2	1.589	0.126	0.079	0.279	32037	41106	1292005
38	1643	0.2	1.756	0.099	0.057	0.257	20562	29070	1064121
40	926	0.2	1.963	0.089	0.045	0.245	13105	20416	863755
42	467	0.2	2.226	0.074	0.033	0.233	8096	14056	682567
44	237	0.2	2.569	0.065	0.025	0.225	4818	9398	520574
46	139	0.2	3.039	0.071	0.023	0.223	2701	5959	374366
48	48	0.2	3.719	0.051	0.014	0.214	1370	3516	249227
50	17	0.2	4.795	0.044	0.009	0.209	619	1874	149166
52	11	0.2	6.758	0.092	0.014	0.214	227	813	72287
54	7	0.2			0.030	0.230	54	0	0
					Totals, including lengths above + group			1146522	17708612

Mean F, calculated across inter-quartile range	0.086

Table 5.6.8. - Farn Deeps (FU 6): VPA Fs-at-age males.

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0.003	0.002	0.015	0.014	0.021	0.028	0.015	0.002	0.008	0.015	0.001	0.005	0.003	0.003
2	0.259	0.103	0.264	0.367	0.294	0.312	0.223	0.086	0.116	0.269	0.225	0.259	0.256	0.226
3	0.739	0.329	0.560	0.809	0.849	0.444	0.353	0.410	0.468	0.538	0.323	0.468	0.384	0.309
4	0.731	0.504	0.646	0.795	1.022	0.688	0.656	0.431	0.676	0.802	0.593	0.679	0.468	0.484
5	0.610	0.589	0.638	0.885	0.902	0.702	0.969	0.350	0.797	0.972	0.628	0.703	0.487	0.510
6	0.500	0.543	0.574	0.856	0.810	0.955	1.053	0.359	0.707	1.005	0.559	0.640	0.498	0.552
7	0.434	0.610	0.611	0.859	0.787	1.111	1.206	0.581	0.505	0.935	0.497	0.698	0.467	0.575
8	0.410	0.511	0.646	0.877	0.544	0.863	1.425	0.660	0.426	0.787	0.367	0.430	0.444	0.665
9	0.449	0.564	0.509	1.409	0.463	0.866	0.902	0.819	0.225	1.086	0.340	0.450	0.391	0.664
10	0.595	0.630	0.702	0.885	0.875	0.876	0.807	0.457	0.674	1.119	0.664	0.789	0.711	0.657
+ grp	0.595	0.630	0.702	0.885	0.875	0.876	0.807	0.457	0.674	1.119	0.664	0.789	0.711	0.657

Table 5.6.9. - Farn Deeps (FU 6): VPA Fs-at-age females.

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0.005	0.002	0.028	0.024	0.021	0.027	0.020	0.001	0.007	0.020	0.004	0.004	0.004	0.004
2	0.193	0.095	0.335	0.413	0.304	0.341	0.234	0.074	0.110	0.385	0.217	0.255	0.236	0.199
3	0.112	0.073	0.171	0.177	0.158	0.118	0.051	0.043	0.055	0.257	0.090	0.112	0.104	0.066
4	0.119	0.101	0.206	0.160	0.188	0.168	0.060	0.054	0.082	0.233	0.131	0.121	0.116	0.071
5	0.145	0.115	0.188	0.169	0.202	0.283	0.118	0.067	0.104	0.205	0.190	0.125	0.136	0.077
6	0.156	0.134	0.180	0.212	0.262	0.409	0.195	0.108	0.111	0.242	0.189	0.140	0.166	0.112
7	0.151	0.161	0.170	0.226	0.300	0.459	0.242	0.123	0.139	0.286	0.199	0.159	0.168	0.152
8	0.161	0.180	0.176	0.263	0.337	0.474	0.324	0.129	0.197	0.303	0.221	0.213	0.189	0.179
9	0.172	0.219	0.191	0.290	0.360	0.517	0.437	0.157	0.194	0.187	0.200	0.199	0.177	0.233
10	0.185	0.269	0.203	0.295	0.422	0.513	0.445	0.174	0.221	0.225	0.213	0.232	0.215	0.282
11	0.196	0.329	0.234	0.350	0.429	0.553	0.466	0.169	0.203	0.310	0.218	0.282	0.234	0.368
12	0.208	0.305	0.275	0.333	0.358	0.437	0.555	0.210	0.224	0.484	0.215	0.262	0.243	0.313
13	0.272	0.508	0.423	0.536	0.550	0.636	0.647	0.421	0.355	0.815	0.344	0.480	0.371	0.483
14	0.421	0.557	0.464	0.600	0.660	0.631	0.549	0.287	0.354	0.747	0.454	0.504	0.462	0.519
+ grp	0.421	0.557	0.464	0.600	0.660	0.631	0.549	0.287	0.354	0.747	0.454	0.504	0.462	0.519

Table 5.6.10. - Farn Deeps (FU 6): VPA output males.

Year	Recruits Age 1	Total Biomass	TSB	Landings	Yield/SSB	Fbar 3-8
	'000	tonnes	tonnes	tonnes		
1985	213131	8372	8372	2473	0.295	0.571
1986	314389	7720	7720	1554	0.201	0.514
1987	308728	8839	8839	2266	0.256	0.612
1988	239289	8622	8622	2995	0.347	0.847
1989	340841	7843	7843	2542	0.324	0.819
1990	350936	7574	7574	1709	0.226	0.794
1991	260839	8178	8178	1904	0.233	0.944
1992	260111	8942	8942	1699	0.190	0.465
1993	252891	9904	9904	2647	0.267	0.596
1994	264190	9290	9290	2927	0.315	0.840
1995	246194	8080	8080	1907	0.236	0.494
1996	244439	8500	8500	2320	0.273	0.603
1997	267387	8057	8057	1765	0.219	0.458
1998	261370	8535	8535	1867	0.219	0.516
Average 96-98						0.526

Table 5.6.11. - Farn Deeps (FU 6): VPA output females.

Year	Recruits Age 1	Total Biomass	TSB	Landings	Yield/SSB	Fbar 3-12
	'000	tonnes	tonnes	tonnes		
1985	211703	9572	7087	1008	0.142	0.161
1986	257350	9698	7265	916	0.126	0.189
1987	272052	10124	7322	1471	0.201	0.199
1988	231454	9697	7008	1673	0.239	0.248
1989	286439	9290	6638	1583	0.239	0.302
1990	306600	9204	6108	1569	0.257	0.393
1991	278021	8520	5639	979	0.174	0.289
1992	255882	9076	6235	520	0.083	0.123
1993	277761	10286	7471	766	0.103	0.153
1994	243818	10954	7935	1936	0.244	0.273
1995	247837	9887	7302	1192	0.163	0.186
1996	255616	9862	7193	1153	0.160	0.184
1997	246713	9949	7265	1121	0.154	0.175
1998	254297	10027	7372	988	0.134	0.185
Average 96-98						0.181

Table 5.6.12. - Firth of Forth (FU 8): Landings (tonnes) by gear, all UK, 1989-98.

Year	UK			
	Nephrops trawl	Other trawl	Creel	Total
1989	1833	52	0	1885
1990	1901	30	0	1931
1991	1359	43	0	1402
1992	1714	41	0	1755
1993	2349	20	0	2369
1994	1833	17	0	1850
1995	1710	53	0	1763
1996	1621	67	1	1688
1997	2137	57	0	2194
1998 *	2105	39	0	2144

* provisional na = not available

Table 5.6.13. - Firth of Forth (FU 8): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1989-98 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	**All *Nephrops* gears combined**		
	Landings	Effort	LPUE
1989	1833	78.7	23.3
1990	1901	81.8	23.1
1991	1359	69.4	19.6
1992	1714	73.1	23.4
1993	2349	100.2	23.4
1994	1827	87.6	21.0
1995	1708	78.9	21.6
1996	1621	69.7	23.3
1997	2137	71.6	29.8
1998 *	2105	70.7	29.8

Year	**Single rig**			**Multirig**		
	Landings	Effort	LPUE	Landings	Effort	LPUE
1989	na	na	na	na	na	na
1990	na	na	na	na	na	na
1991	1231	63.9	19.3	128	5.5	23.2
1992	1480	63.3	23.4	198	8.5	23.3
1993	2340	100.1	23.4	9	0.2	52.9
1994	1827	87.6	21.0	0	0.0	na
1995	1708	78.9	21.6	0	0.0	na
1996	1621	69.7	23.3	0	0.0	na
1997	2137	71.6	29.8	0	0.0	na
1998 *	2105	70.7	29.8	0	0.0	na

* provisional na = not available

Table 5.6.14. - Firth of Forth (FU 8): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish catches and landings, 1989-98.

Year	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
	Males	Females	Males	Females	Males	Females
1989	na	na	29.2	28.9	38.7	38.9
1990	28.5	27.5	29.8	28.6	38.3	38.8
1991	28.7	27.5	29.8	28.7	38.3	38.7
1992	29.5	28.0	30.2	28.7	38.0	38.7
1993	28.7	28.0	30.3	29.5	39.0	38.6
1994	25.7	25.1	29.1	28.5	38.8	37.8
1995	27.9	27.1	29.4	28.9	38.7	37.9
1996	28.0	27.4	29.8	28.8	38.6	38.6
1997	27.3	27.0	29.2	28.7	38.8	38.2
1998 *	27.4	26.1	29.0	27.9	38.6	38.4
* provisional na = not available						

Table 5.6.15. - Firth of Forth (FU 8): Results by stratum of the 1998 TV survey. Note that stratification was based on a series of arbitrary rectangles.

Stratum	Area (sq. km)	Number of stations	Mean burrow density (no./sq. m)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
1998 TV survey							
W	291	6	0.270	0.044	77	623	0.274
X	423	11	0.396	0.068	168	1108	0.487
Y	201	6	0.493	0.081	99	543	0.239
Total	915	23			345	2275	1

Table 5.6.16. - Firth of Forth (FU 8): Results of the 1993-98 TV surveys.

Year	Mean density	Abundance	95% confidence interval	Biomass
	burrows/m²	millions	millions	'000 tonnes
1993	0.72	655	167	9.9-16.7
1994	0.58	529	92	7.6-10.8
1995	No survey			
1996	0.48	443	104	5.8-9.3
1997	No survey			
1998	0.38	345	95	4.2-7.5

Table 5.6.17. - Firth of Forth (FU 8): Input data and parameters.

FU	8	MA	I
FLEET	UK Scotland	GEAR	*Nephrops* and light trawl

	1998					1997				
	Number of samples				Mean no. per sample	Number of samples				Mean no. per sample
	Qtr 1	Qtr 2	Qtr 3	Qtr 4		Qtr 1	Qtr 2	Qtr 3	Qtr 4	
Catch	0	0	0	0		0	0	0	0	
Landings	17	19	8	21	533	27	17	19	25	540
Discards	5	6	0	8	713	9	4	6	3	699

	Number of samples									
Year	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989
Catch	0	0	0	0	0	0	0	0	0	0
Landings	65	88	71	54	74	52	69	62	71	44
Discards	19	22	58	37	16	11	12	6	7	0

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival	0.25	Gueguen and Charuau, 1975
MALES		
Growth - K	0.163	adapted from Bailey and Chapman, 1983
Growth - L(inf)	66	"
Natural mortality - M	0.3	Morizur, 1982
Length/weight - a	0.00028	Howard and Hall, 1983
Length/weight - b	3.240	"
FEMALES		
Immature Growth		
Growth - K	0.163	adapted from Bailey and Chapman, 1983
Growth - L(inf)	66	"
Natural mortality - M	0.3	Morizur, 1982
Size at maturity	26	ICES, 1998b
Mature Growth		
Growth - K	0.065	adapted from Bailey and Chapman, 1983
Growth - L(inf)	58	"
Natural mortality - M	0.2	based on Morizur, 1982 ; assuming lower rate for mature females
Length/weight - a	0.00085	Howard and Hall, 1983
Length/weight - b	2.910	"

Table 5.6.18. - Firth of Forth (FU 8): LCA output males.

Reference period	1996-98		
Linf (mm CL)	66.0	K	0.163

Size (mm CL)	Removals ('000)	M	DT (years)	F*DT	F	Z	Nos. attaining aver. size ('000)	Average nos. in the sea ('000)	Average biomass (kg)
15	74	0.3	0.245	0.001	0.002	0.302	161330	38164	86057
17	616	0.3	0.256	0.004	0.017	0.317	149807	36790	121507
19	1843	0.3	0.267	0.014	0.052	0.352	138154	35177	163450
21	5155	0.3	0.279	0.044	0.157	0.457	125757	32934	208388
23	9479	0.3	0.292	0.094	0.321	0.621	110720	29588	248190
25	13085	0.3	0.307	0.161	0.523	0.823	92355	25040	272227
27	14214	0.3	0.323	0.233	0.722	1.022	71738	19734	272763
29	12180	0.3	0.341	0.286	0.838	1.138	51571	14572	251871
31	9607	0.3	0.361	0.342	0.948	1.248	34985	10167	216601
33	6569	0.3	0.384	0.374	0.975	1.275	22294	6763	175342
35	4277	0.3	0.409	0.405	0.989	1.289	13669	4346	135623
37	2547	0.3	0.438	0.411	0.938	1.238	8067	2729	101465
39	1414	0.3	0.472	0.391	0.829	1.129	4688	1716	75320
41	925	0.3	0.512	0.451	0.882	1.182	2751	1056	54303
43	484	0.3	0.558	0.431	0.772	1.072	1503	631	37735
45	281	0.3	0.614	0.466	0.759	1.059	826	373	25751
47	142	0.3	0.682	0.454	0.665	0.965	431	216	17085
49	68	0.3	0.768	0.421	0.548	0.848	223	126	11399
51	40	0.3	0.878	0.491	0.559	0.859	117	72	7374
53	12	0.3	1.025	0.295	0.288	0.588	55	42	4894
55	13	0.3	1.231	0.704	0.572	0.872	30	23	2956
57	4	0.3	1.542	0.726	0.471	0.771	10	9	1353
59	1	0.3	2.064	0.742	0.360	0.660	3	4	575
61	0	0.3			0.100	0.400	1	4	575
					Totals, including lengths above + group			260273	2492802

Mean F, calculated across inter-quartile range	0.847

Table 5.6.19. - Firth of Forth (FU 8): LCA output females.

Reference period	1996-98		
Linf immatures (mm CL)	66.0	K immatures	0.163
Linf matures (mm CL)	58.0	K matures	0.065
Transition length (mm CL)	26.0		

Size (mm CL)	Removals ('000)	M	DT (years)	F*DT	F	Z	Nos. attaining aver. size ('000)	Average nos. in the sea ('000)	Average biomass (kg)
15	90	0.3	0.245	0.001	0.002	0.302	194659	46048	124476
17	512	0.3	0.256	0.003	0.012	0.312	180755	44420	169162
19	2021	0.3	0.267	0.013	0.048	0.348	166918	42528	220069
21	5103	0.3	0.279	0.036	0.128	0.428	152137	40000	273143
23	11190	0.3	0.292	0.091	0.310	0.610	135031	36140	317894
25	15026	0.3	0.307	0.150	0.489	0.789	112988	30791	341879
27	13485	0.2	1.026	0.185	0.180	0.380	88703	75374	1038331
29	10113	0.2	1.099	0.208	0.189	0.389	60077	53731	904748
31	5947	0.2	1.184	0.188	0.158	0.358	39159	37784	767671
33	3463	0.2	1.283	0.167	0.130	0.330	25619	26793	649390
35	2341	0.2	1.400	0.175	0.125	0.325	16776	18865	539969
37	1328	0.2	1.540	0.157	0.102	0.302	10645	13107	439079
39	752	0.2	1.711	0.143	0.084	0.284	6685	9062	352470
41	392	0.2	1.926	0.123	0.064	0.264	4114	6212	278449
43	198	0.2	2.202	0.105	0.048	0.248	2476	4201	215626
45	108	0.2	2.570	0.102	0.040	0.240	1435	2753	160814
47	61	0.2	3.087	0.113	0.037	0.237	775	1697	112216
49	30	0.2	3.866	0.127	0.033	0.233	373	951	70824
51	16	0.2	5.177	0.191	0.037	0.237	152	452	37755
53	9	0.2			0.050	0.250	45	452	37755
					Totals, including lengths above + group			491360	7051718

Mean F, calculated across inter-quartile range	0.169

Table 5.6.20. - Firth of Forth (FU 8): VPA Fs-at-age males.

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0.002	0.005	0.004	0.009	0.006	0.007	0.005	0.012	0.006	0.005	0.002	0.002	0.001	0.061	0.010	0.006	0.024	0.019
2	0.089	0.119	0.147	0.238	0.173	0.284	0.238	0.422	0.266	0.256	0.162	0.187	0.293	0.647	0.327	0.290	0.304	0.417
3	0.258	0.272	0.378	0.568	0.608	0.771	0.624	0.882	0.720	0.777	0.495	0.697	0.894	0.877	0.869	0.857	0.725	0.778
4	0.460	0.470	0.553	0.887	0.858	0.825	0.733	1.245	0.988	1.050	0.612	0.777	1.269	0.906	0.857	0.949	0.895	0.894
5	0.490	0.558	0.640	1.056	1.011	0.906	0.765	1.478	1.123	1.106	0.597	0.644	1.496	0.955	0.926	0.856	0.899	0.920
6	0.474	0.659	0.818	1.119	1.120	0.877	0.723	1.454	1.031	1.160	0.712	0.456	1.554	1.024	0.923	0.780	0.857	0.942
7	0.469	0.602	1.059	1.227	1.155	0.827	0.848	1.896	1.477	1.371	0.832	0.569	1.616	1.160	0.754	0.790	0.918	0.976
8	0.329	0.498	1.234	0.918	1.033	0.700	0.714	1.161	1.340	1.067	0.866	0.440	1.274	0.650	0.468	0.787	0.699	0.807
9	0.490	0.490	1.502	0.758	0.887	0.830	0.743	1.294	2.014	1.228	1.015	0.384	1.357	1.044	0.411	0.876	1.063	0.981
10	0.461	0.577	1.038	1.027	1.034	0.859	0.772	1.426	1.297	1.122	0.813	0.652	1.495	1.028	0.817	0.978	0.927	0.896
+ grp	0.461	0.577	1.038	1.027	1.034	0.859	0.772	1.426	1.297	1.122	0.813	0.652	1.495	1.028	0.817	0.978	0.927	0.896

Table 5.6.21. - Firth of Forth (FU 8): VPA Fs-at-age females.

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0.003	0.004	0.005	0.008	0.005	0.007	0.005	0.017	0.008	0.007	0.003	0.003	0.002	0.068	0.012	0.007	0.024	0.023
2	0.097	0.114	0.144	0.207	0.180	0.361	0.235	0.448	0.334	0.335	0.250	0.197	0.244	0.637	0.287	0.304	0.414	0.485
3	0.047	0.047	0.077	0.111	0.099	0.253	0.153	0.250	0.210	0.217	0.143	0.159	0.191	0.238	0.182	0.207	0.252	0.181
4	0.063	0.046	0.106	0.137	0.117	0.273	0.174	0.255	0.235	0.228	0.165	0.176	0.234	0.234	0.236	0.236	0.278	0.169
5	0.093	0.071	0.129	0.162	0.135	0.261	0.186	0.287	0.241	0.246	0.202	0.166	0.277	0.236	0.263	0.219	0.300	0.161
6	0.112	0.087	0.160	0.142	0.131	0.241	0.179	0.324	0.299	0.248	0.185	0.133	0.202	0.216	0.212	0.187	0.276	0.163
7	0.133	0.100	0.145	0.145	0.102	0.215	0.161	0.302	0.310	0.270	0.174	0.125	0.247	0.248	0.216	0.215	0.309	0.174
8	0.154	0.117	0.151	0.161	0.101	0.191	0.163	0.330	0.354	0.316	0.185	0.119	0.310	0.296	0.218	0.256	0.352	0.189
9	0.188	0.139	0.178	0.150	0.104	0.206	0.144	0.361	0.478	0.359	0.177	0.117	0.346	0.249	0.189	0.277	0.337	0.185
10	0.155	0.190	0.161	0.119	0.083	0.167	0.099	0.339	0.420	0.310	0.151	0.104	0.206	0.181	0.151	0.261	0.316	0.169
11	0.208	0.207	0.244	0.138	0.092	0.183	0.111	0.445	0.414	0.352	0.201	0.124	0.220	0.186	0.161	0.321	0.451	0.211
12	0.127	0.147	0.147	0.178	0.054	0.141	0.096	0.231	0.353	0.278	0.182	0.109	0.263	0.150	0.118	0.243	0.307	0.174
13	0.157	0.171	0.209	0.179	0.102	0.180	0.115	0.308	0.384	0.390	0.183	0.144	0.418	0.207	0.152	0.276	0.352	0.222
14	0.137	0.111	0.136	0.145	0.081	0.203	0.070	0.272	0.241	0.213	0.190	0.091	0.326	0.161	0.104	0.169	0.220	0.180
15	0.154	0.162	0.180	0.183	0.133	0.227	0.156	0.403	0.335	0.289	0.202	0.160	0.346	0.224	0.198	0.277	0.309	0.212
+ grp	0.154	0.162	0.180	0.183	0.133	0.227	0.156	0.403	0.335	0.289	0.202	0.160	0.346	0.224	0.198	0.277	0.309	0.212

Table 5.6.22. - Firth of Forth (FU 8): VPA output males.

Year	Recruits Age 1	Total Biomass	TSB	Landings	Yield/SSB	Fbar 3-8
	'000	tonnes	tonnes	tonnes		
1981	140045	4035	4035	688	0.170	0.413
1982	139978	4627	4627	900	0.195	0.510
1983	143070	5044	5044	1267	0.251	0.780
1984	152279	5083	5083	1622	0.319	0.963
1985	148755	4546	4546	1500	0.330	0.964
1986	138994	4316	4316	1312	0.304	0.818
1987	169056	4135	4135	1091	0.264	0.735
1988	166685	4367	4367	1496	0.343	1.353
1989	168417	3901	3901	1033	0.265	1.113
1990	171534	4137	4137	1179	0.285	1.088
1991	137379	4262	4262	906	0.213	0.686
1992	143409	4675	4675	1319	0.282	0.597
1993	219542	4853	4853	1678	0.346	1.351
1994	168068	4194	4194	1103	0.263	0.929
1995	170580	3936	3936	1092	0.278	0.799
1996	188931	4130	4130	1039	0.252	0.837
1997	190158	4392	4392	1167	0.266	0.832
1998	169205	4568	4568	1433	0.314	0.886
Average 96-98						0.852

Table 5.6.23. - Firth of Forth (FU 8): VPA output females.

Year	Recruits Age 1	Total Biomass	TSB	Landings	Yield/SSB	Fbar 3-13
	'000	tonnes	tonnes	tonnes		
1981	109956	4930	3652	317	0.087	0.131
1982	122884	5245	3819	293	0.077	0.120
1983	133725	5589	4014	455	0.113	0.155
1984	129429	5786	4153	512	0.123	0.148
1985	130567	5852	4248	469	0.110	0.102
1986	113894	6097	4469	951	0.213	0.210
1987	133194	5601	4014	580	0.145	0.144
1988	123582	5599	3999	1032	0.258	0.312
1989	127683	5029	3490	851	0.244	0.336
1990	122127	4797	3155	749	0.237	0.292
1991	123505	4537	3021	497	0.165	0.177
1992	136047	4814	3130	435	0.139	0.134
1993	211456	5557	3394	687	0.202	0.265
1994	185123	5642	3310	739	0.223	0.222
1995	171148	5551	3414	649	0.190	0.191
1996	174066	5925	3677	639	0.174	0.245
1997	180630	5944	3761	1015	0.270	0.321
1998	158581	5713	3614	695	0.192	0.182
Average 96-98						0.249

Table 5.6.24. - Management Area I (IVb,c, West of 1° E): Total *Nephrops* landings (tonnes) by Functional Unit plus other rectangles, 1989-98.

Year	FU 6	FU 8	Other	Total
1989	3098	1885	157	***5140***
1990	2498	1931	132	***4561***
1991	2063	1402	354	***3820***
1992	1463	1755	256	***3475***
1993	3030	2369	255	***5654***
1994	3697	1850	408	***5955***
1995	2568	1763	371	***4702***
1996	2487	1688	387	***4562***
1997	2189	2194	339	***4722***
1998 *	2249	2144	281	***4674***

* provisional na = not available

Table 5.6.25. - Management Area I (IVb,c, West of 1° E): Total *Nephrops* landings (tonnes) by country, 1989-98.

Year	Belgium	Denmark	Netherl.	UK	Total
1989	0	2	0	5138	***5140***
1990	5	1	0	4555	***4561***
1991	3	1	0	3815	***3820***
1992	0	3	0	3471	***3475***
1993	1	0	0	5654	***5654***
1994	0	1	0	5954	***5955***
1995	0	0	0	4702	***4702***
1996	0	3	5	4554	***4562***
1997	0	1	1	4719	***4722***
1998 *	0	2	1	4671	***4674***

* provisional na = not available

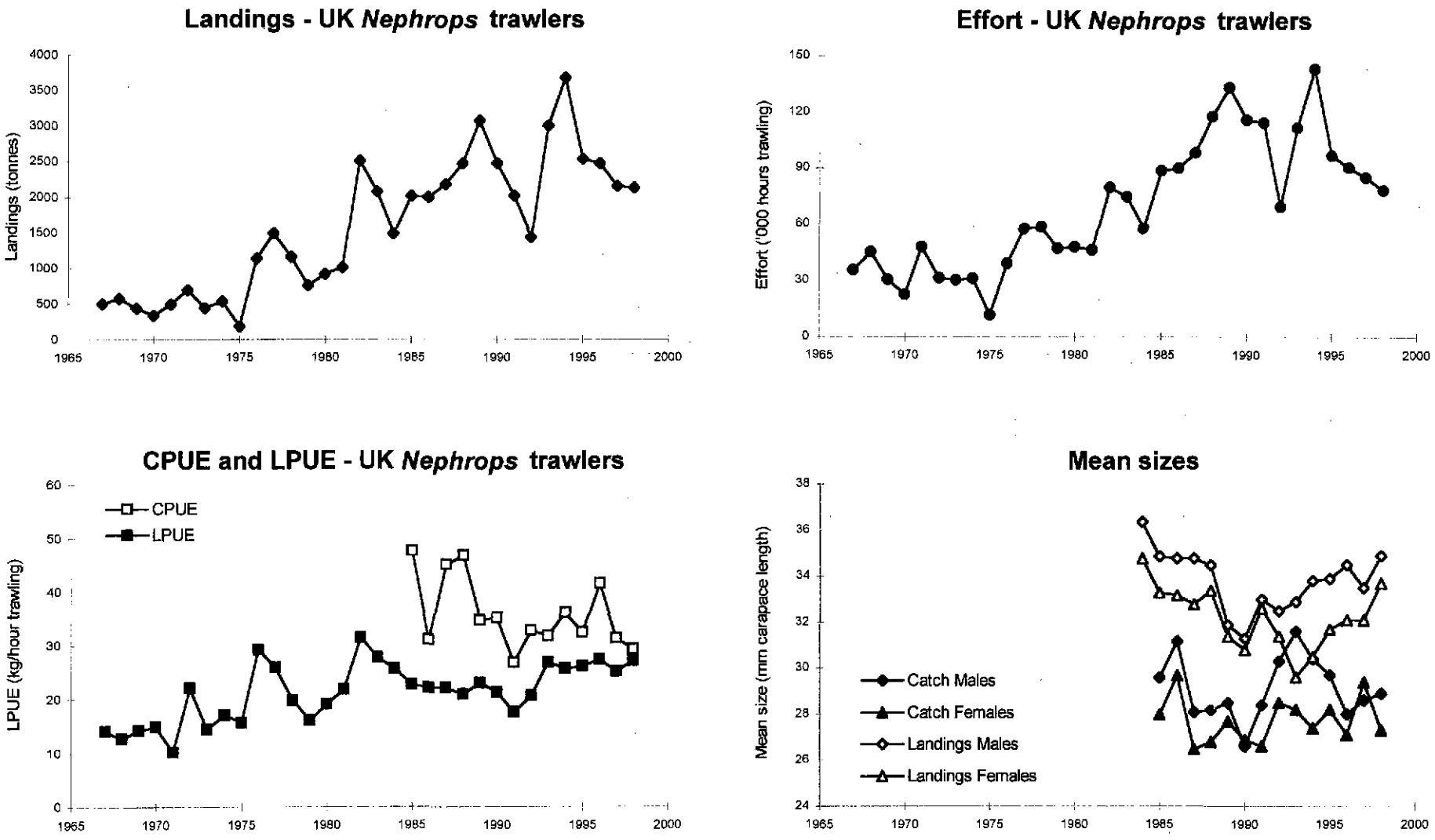


Figure 5.6.1. - Farn Deeps (FU 6): Long-term trends in landings, effort, CPUEs, LPUEs and mean sizes of *Nephrops* in catches and landings.

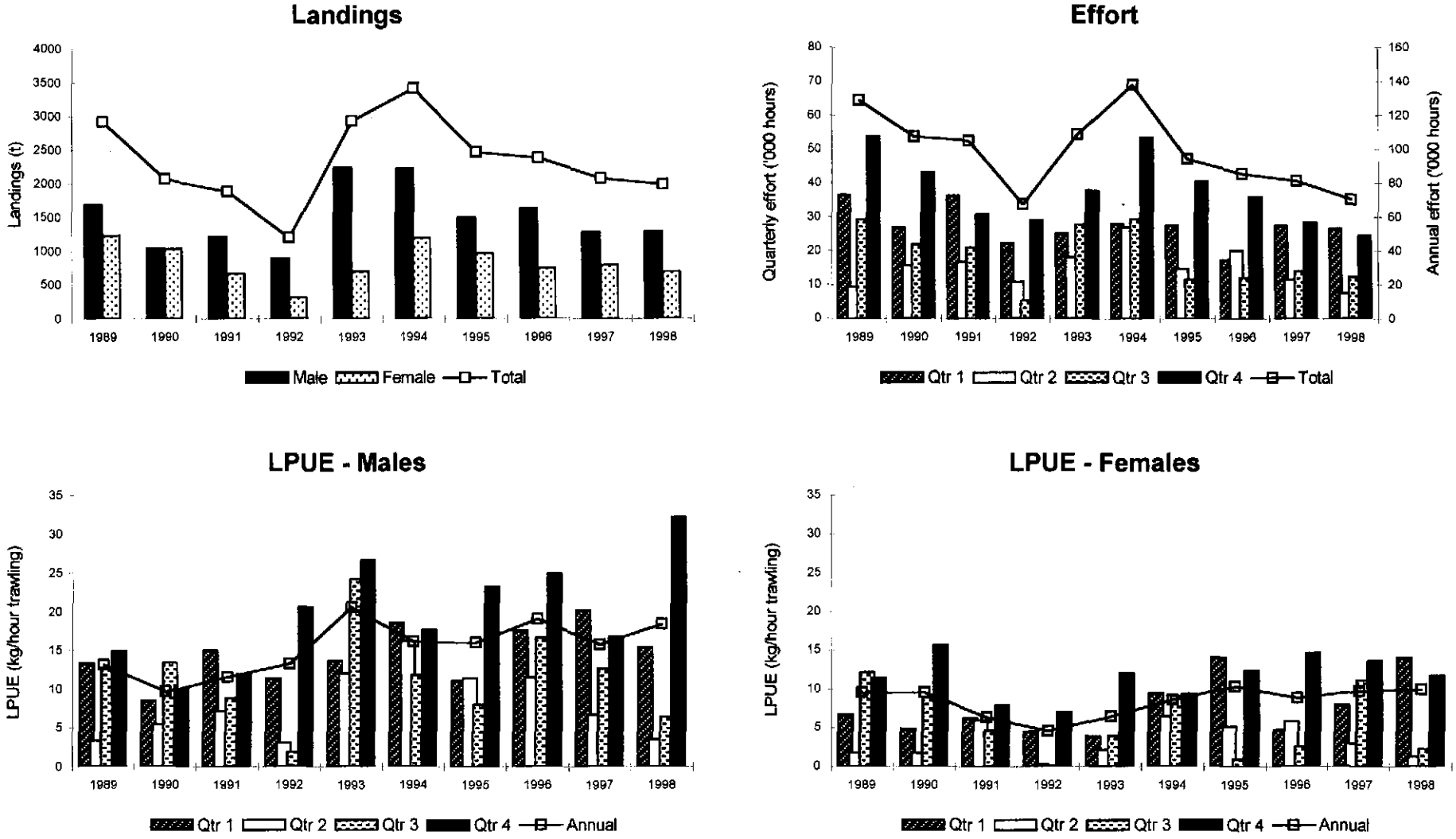
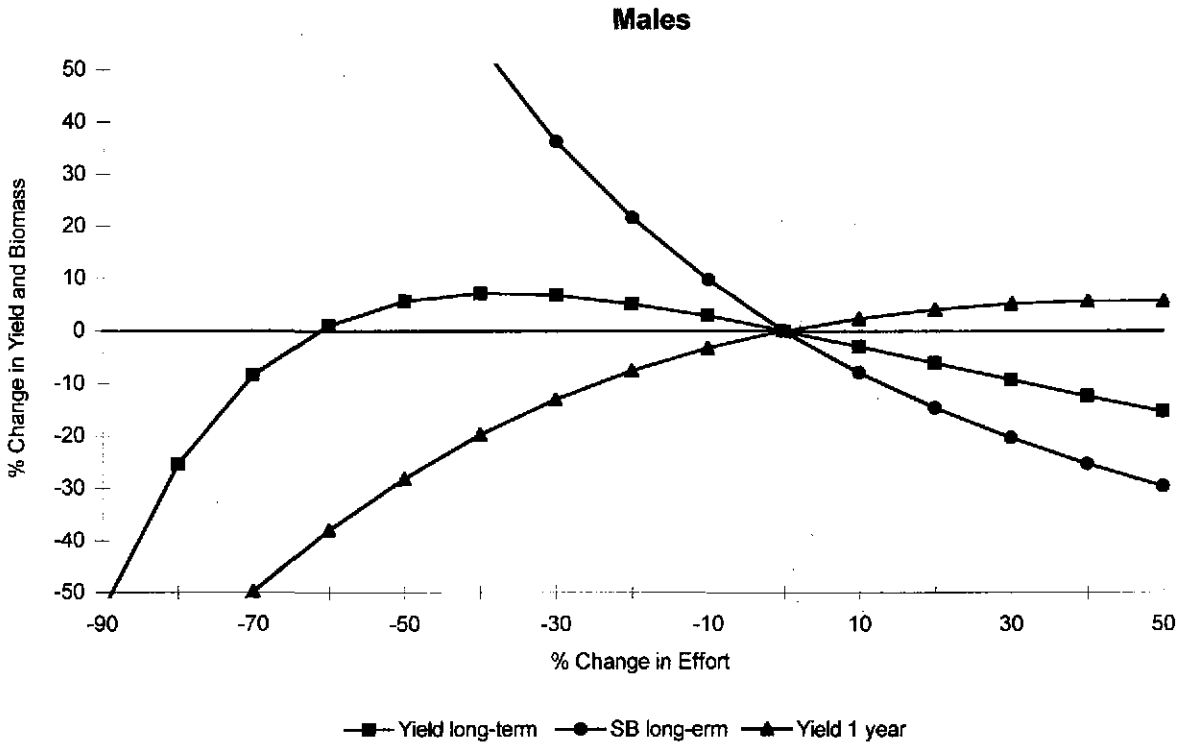


Figure 5.6.2. - Farn Deeps (FU 6): Landings, effort and LPUEs by quarter and sex from English *Nephrops* trawlers.



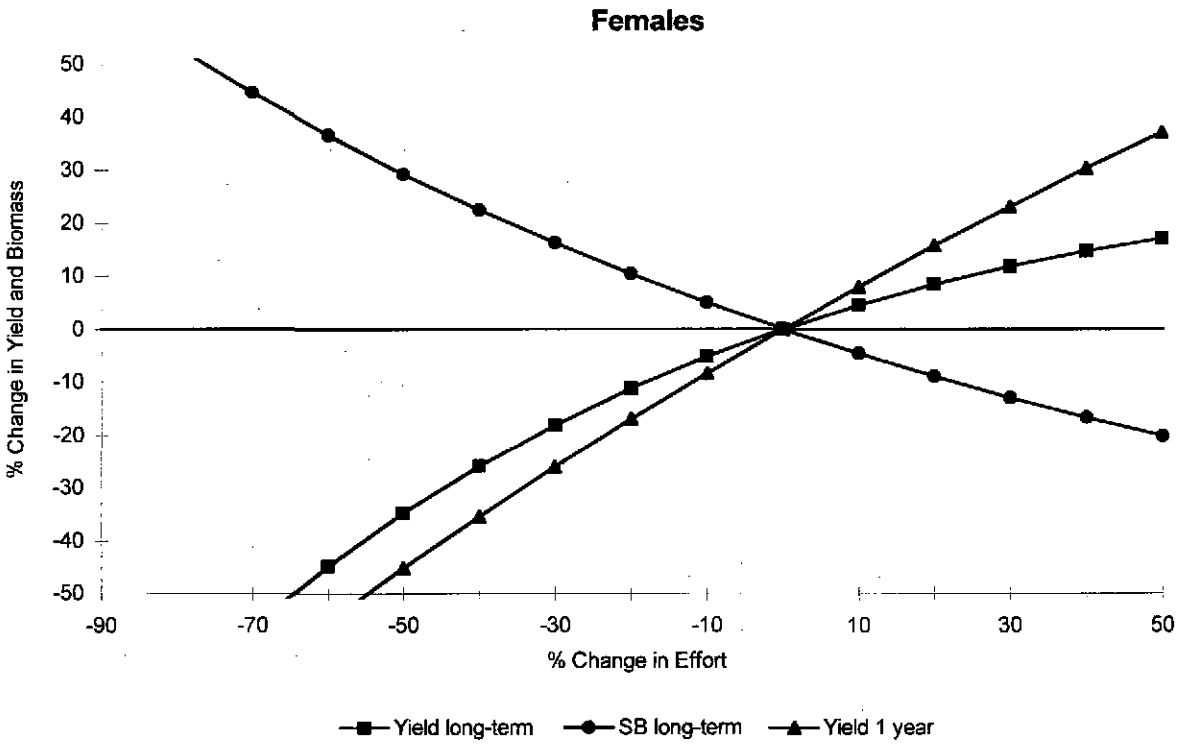


Figure 5.6.3. - Farn Deeps (FU 6): Output LCA: Relative changes in short-term yield (ie after 1 year), long-term yield and long-term biomass upon relative changes in effort. Males and females shown separately.

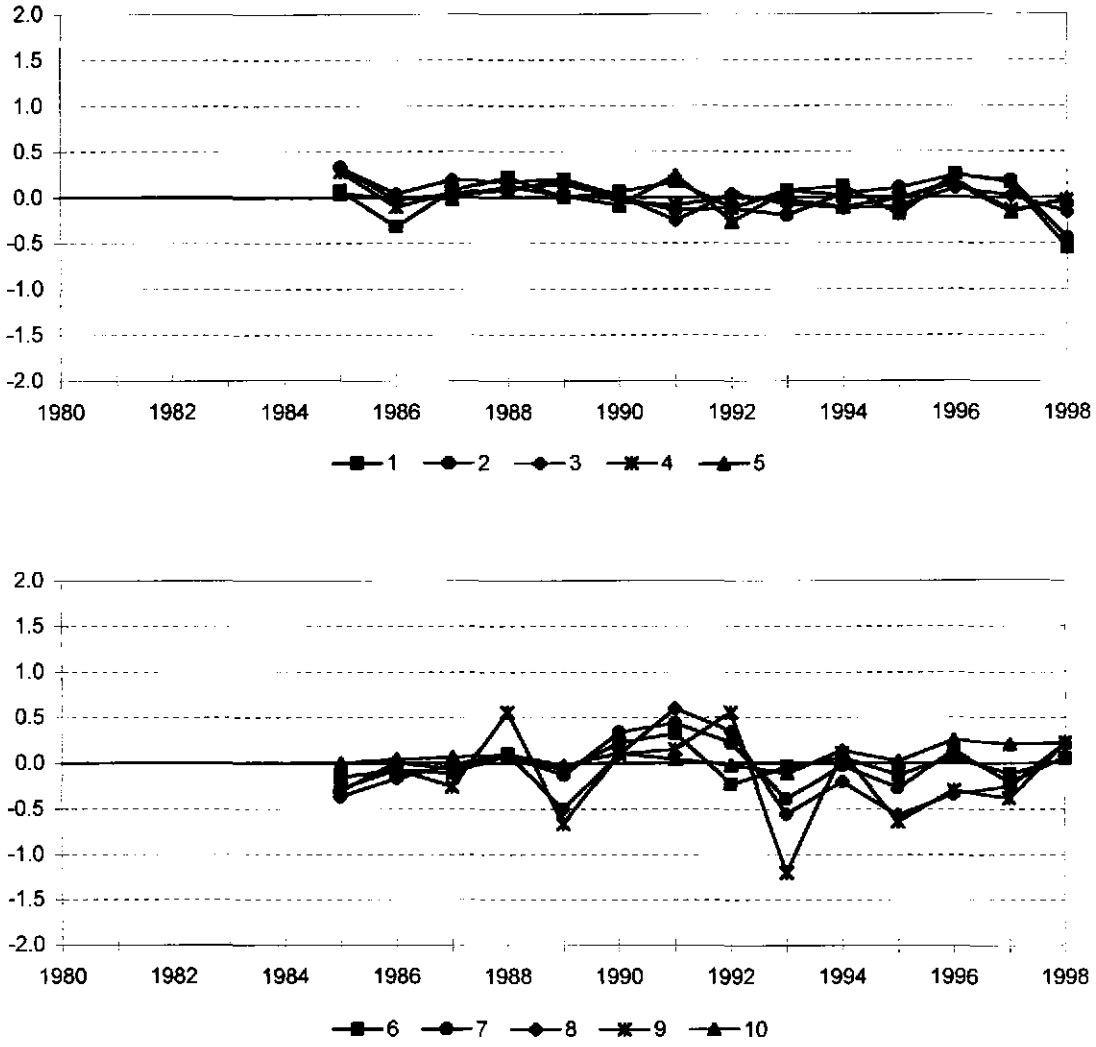
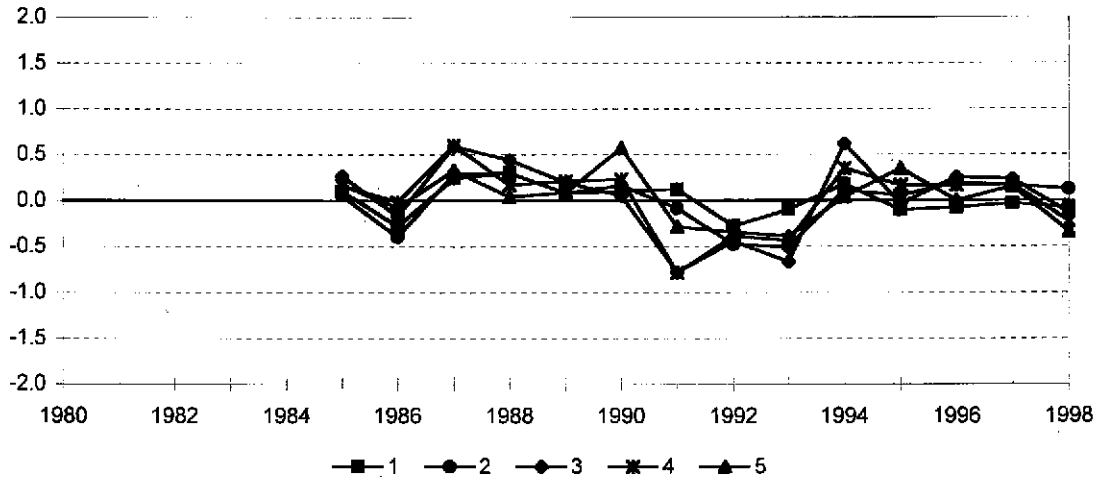
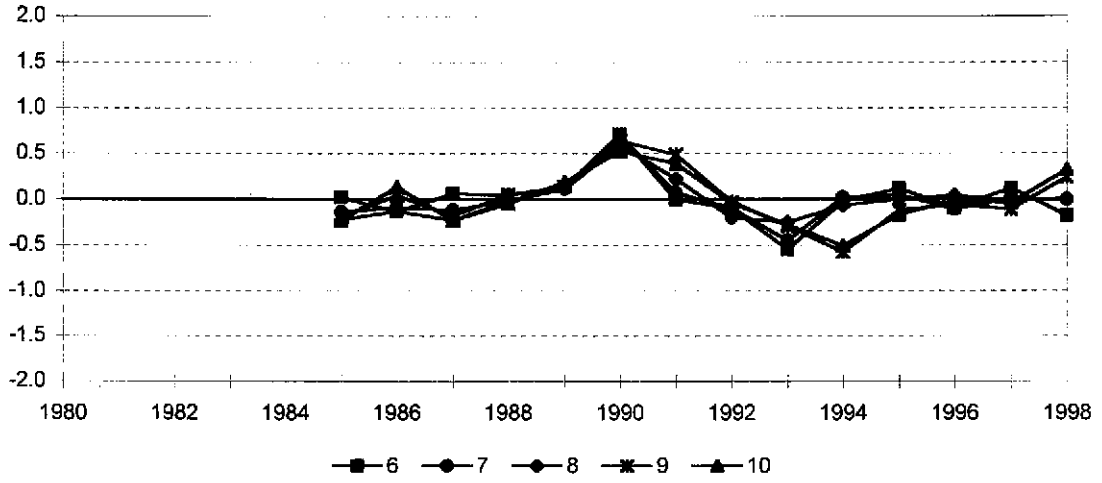


Figure 5.6.4. - Farn Deeps (FU 6): Output VPA males: Log catchability residuals.





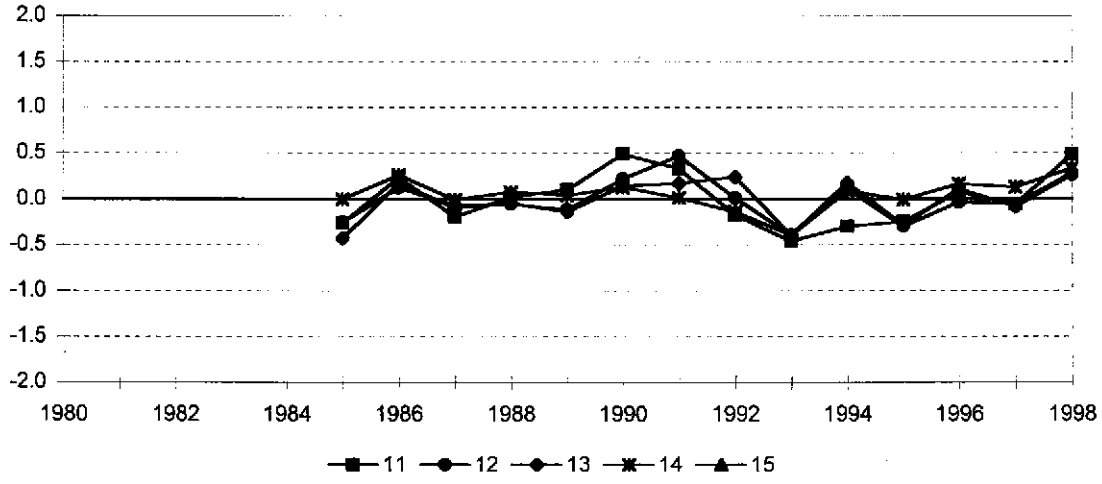


Figure 5.6.5. - Farn Deeps (FU 6): Output VPA females: Log catchability residuals.

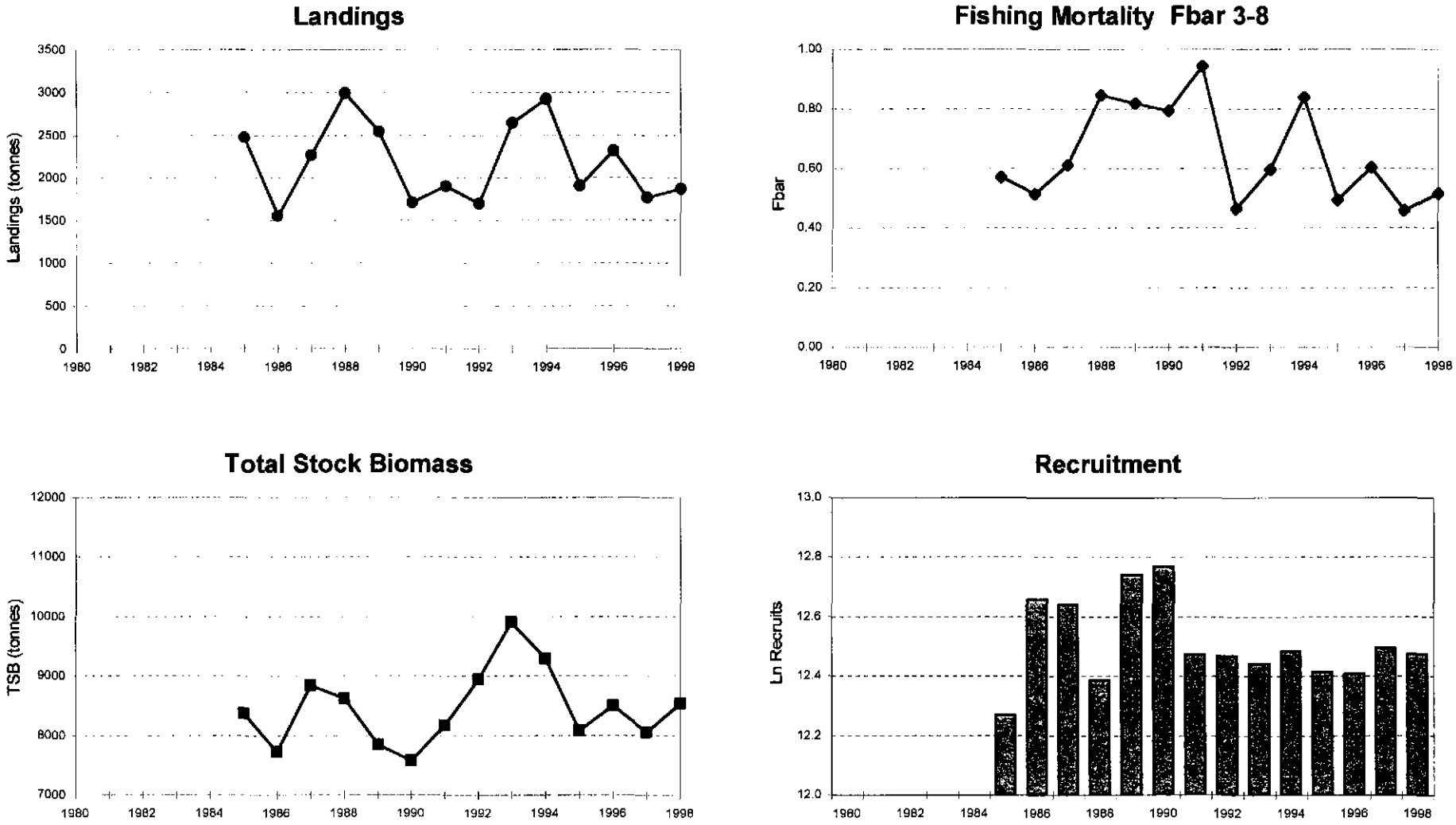


Figure 5.6.6. - Farn Deeps (FU 6): Output VPA males: Trends in Landings, Fbar, TSB and Recruitment.

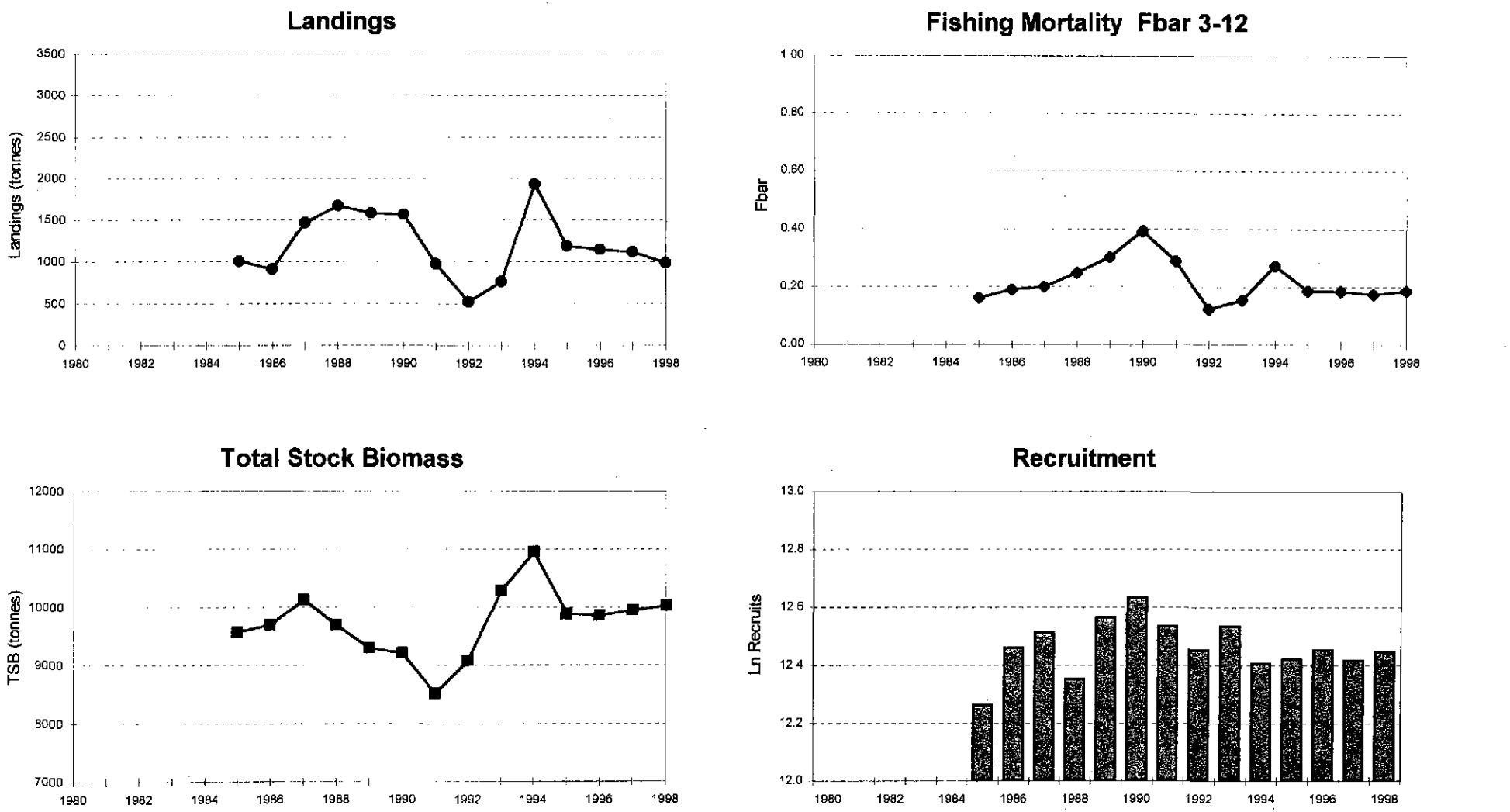


Figure 5.6.7. - Farn Deeps (FU 6): Output VPA females: Trends in Landings, Fbar, TSB and Recruitment.

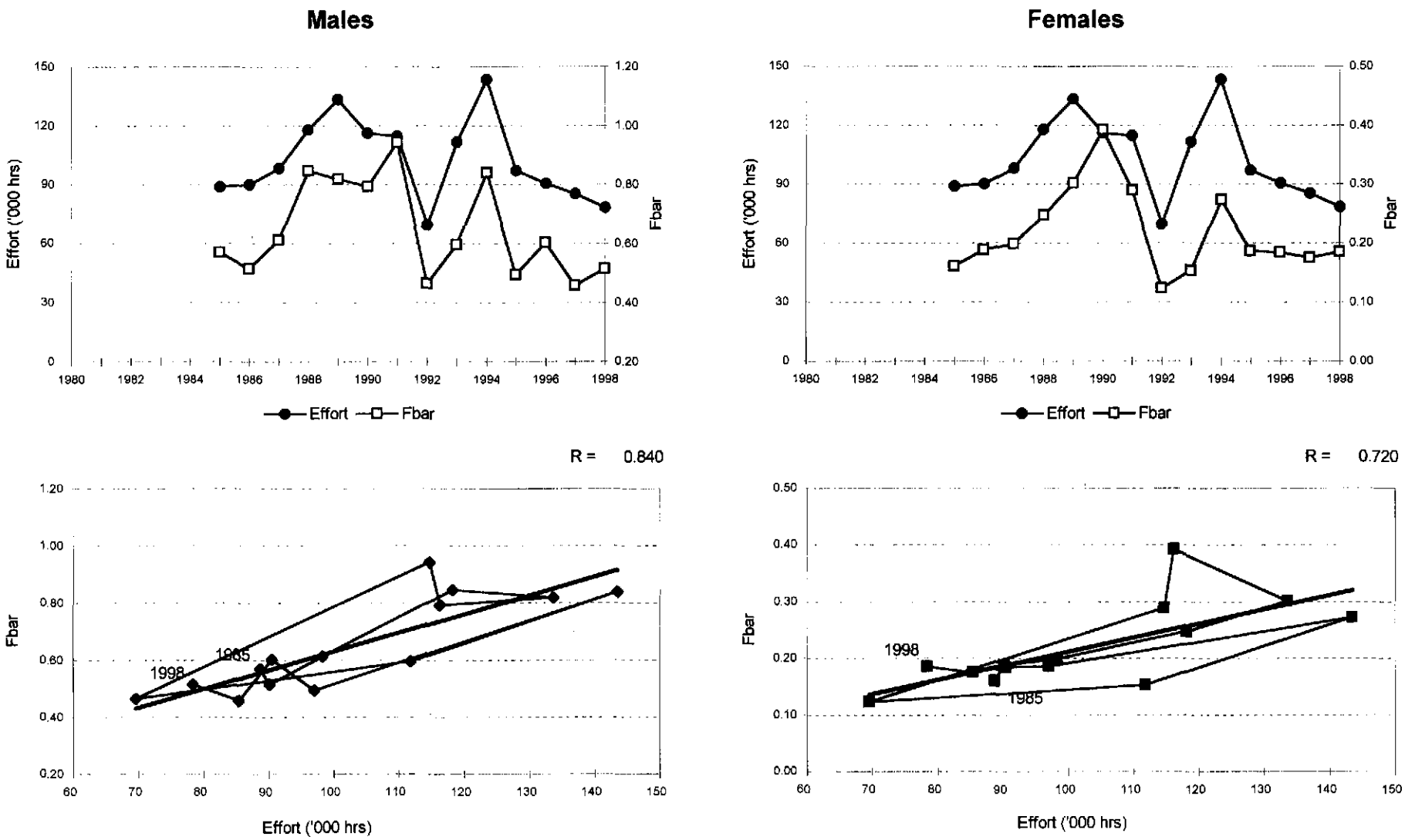


Figure 5.6.8. - Farn Deeps (FU 6): Effort and Fbar, and relationship between them, for males and females.

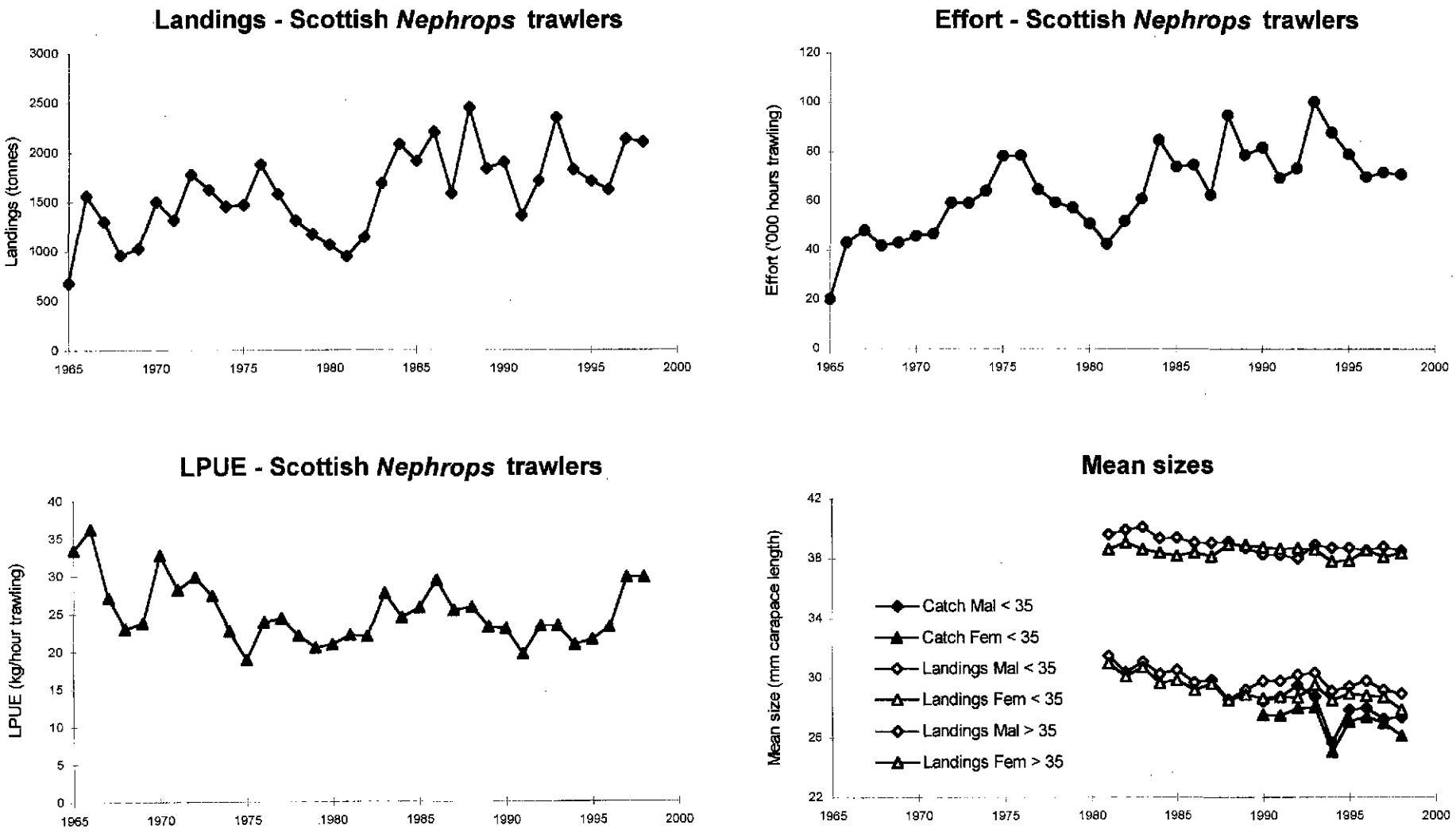


Figure 5.6.9. - Firth of Forth (FU 8): Long-term trends in landings, effort, LPUEs and mean sizes of *Nephrops* in catches and landings.

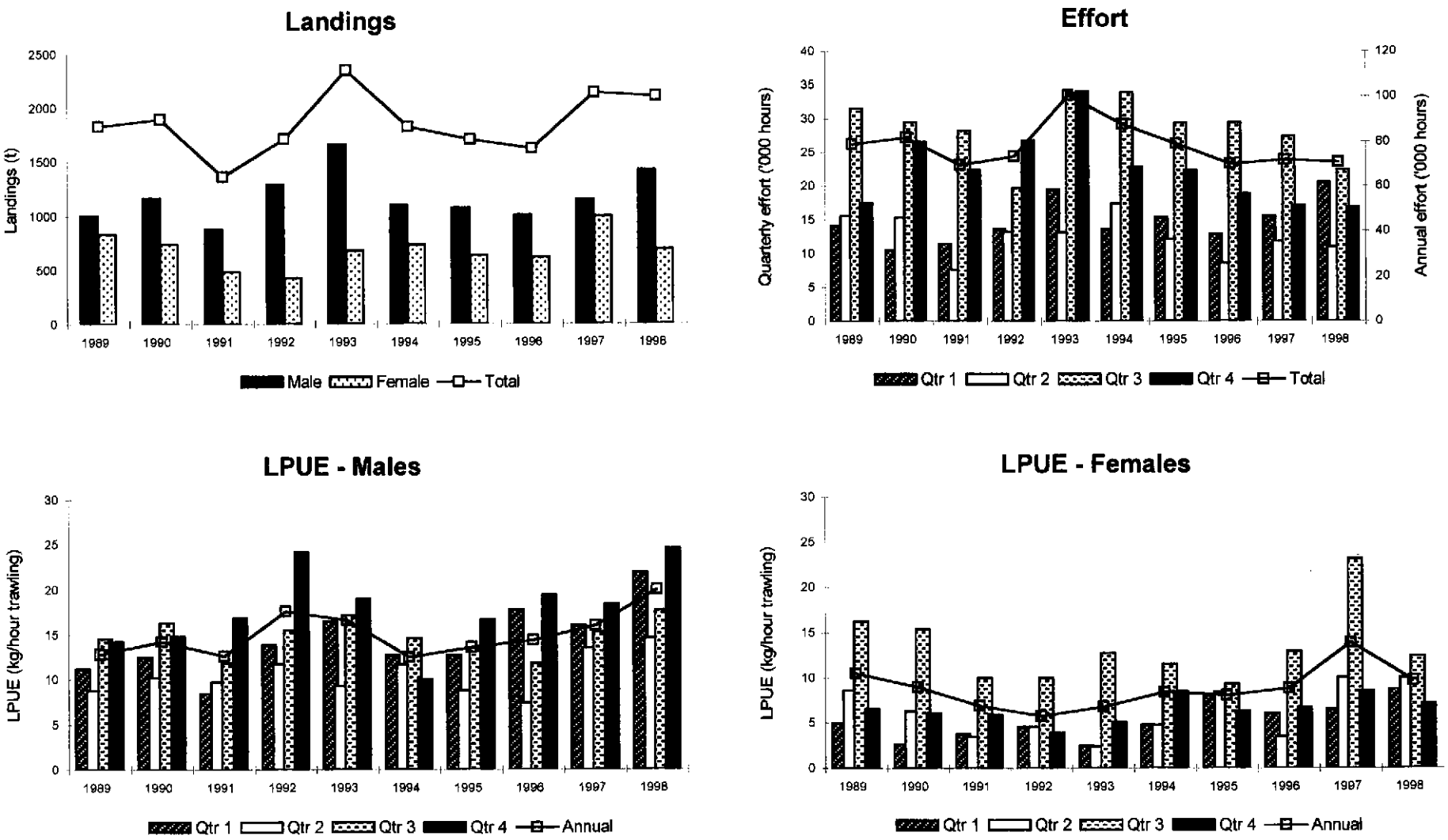


Figure 5.6.10. - Firth of Forth (FU 8): Landings, effort and LPUEs by quarter and sex from Scottish *Nephrops* trawlers.

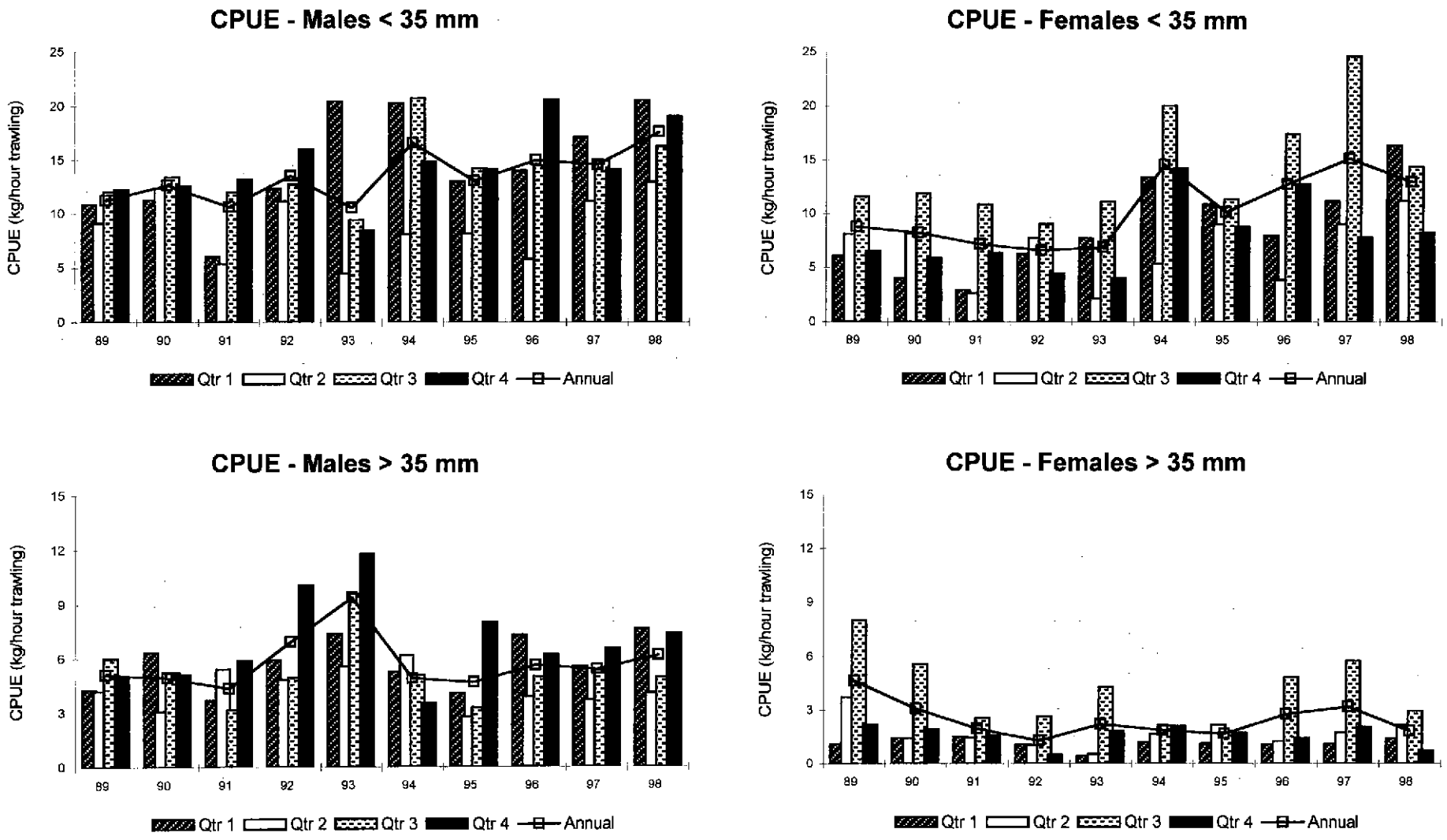
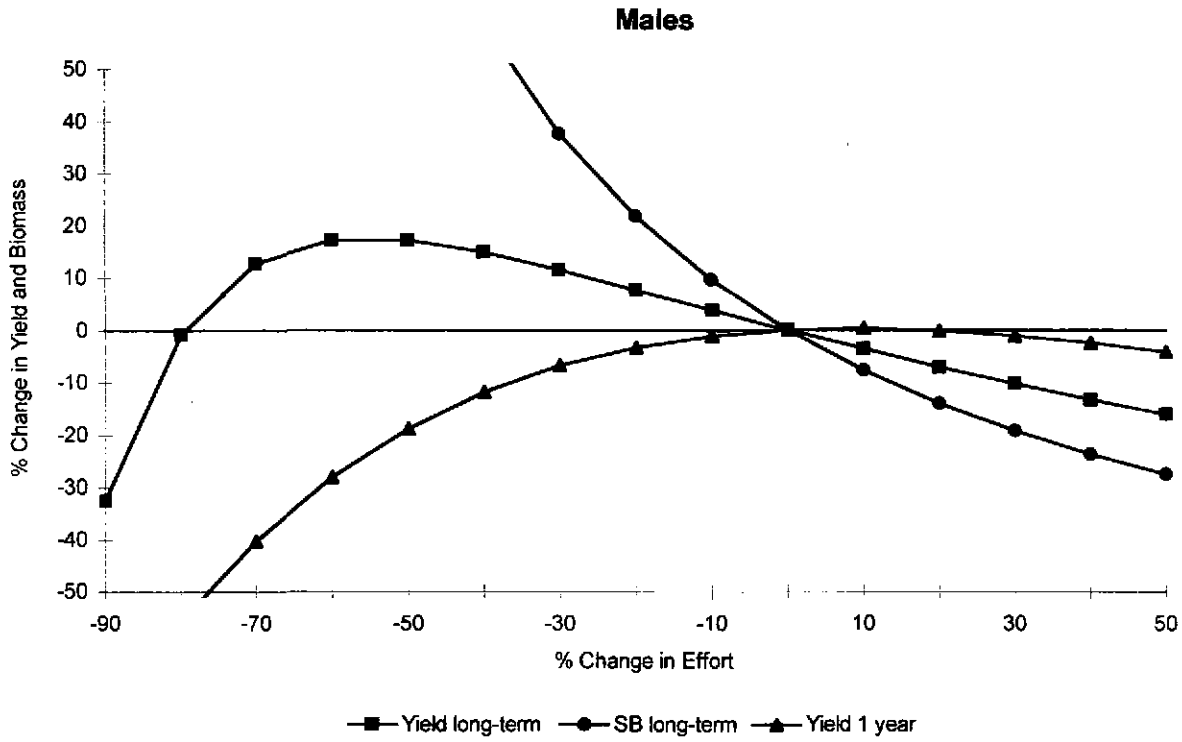


Figure 5.6.11. - Firth of Forth (FU 8): CPUEs by sex and quarter, for selected size groups.



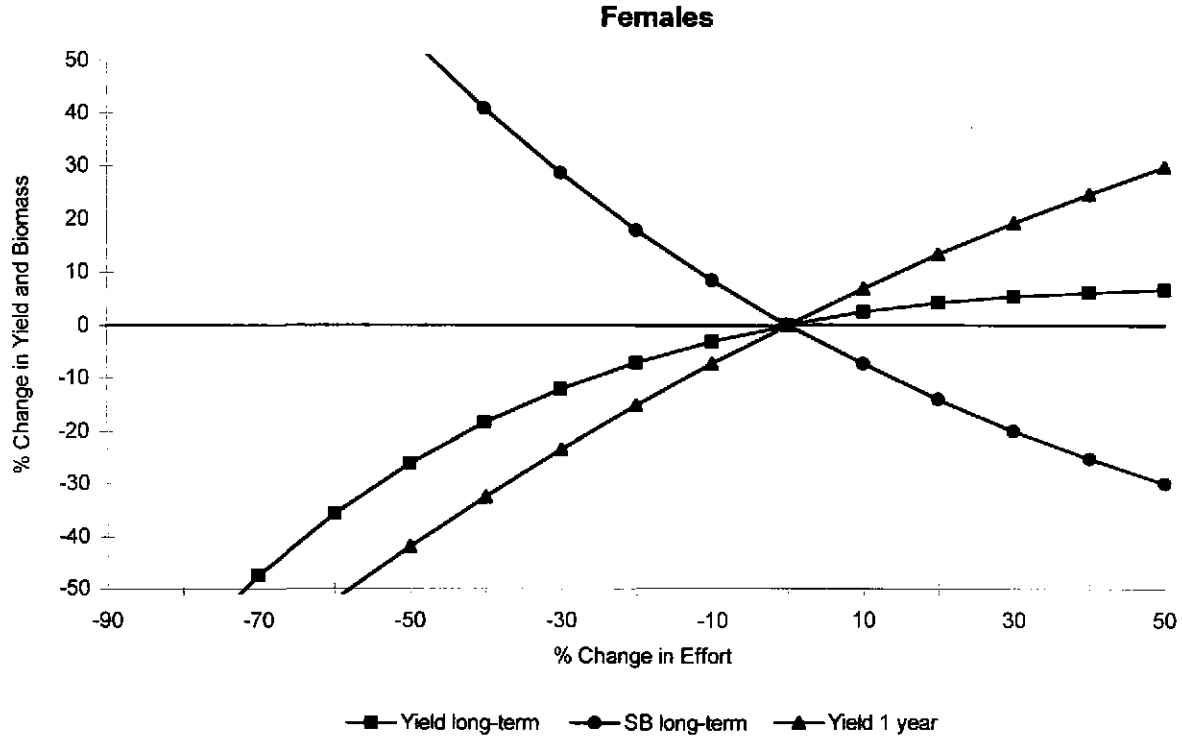


Figure 5.6.12. - Firth of Forth (FU 8): Output LCA: Relative changes in short-term yield (ie after 1 year), long-term yield and long-term biomass upon relative changes in effort. Males and females shown separately.

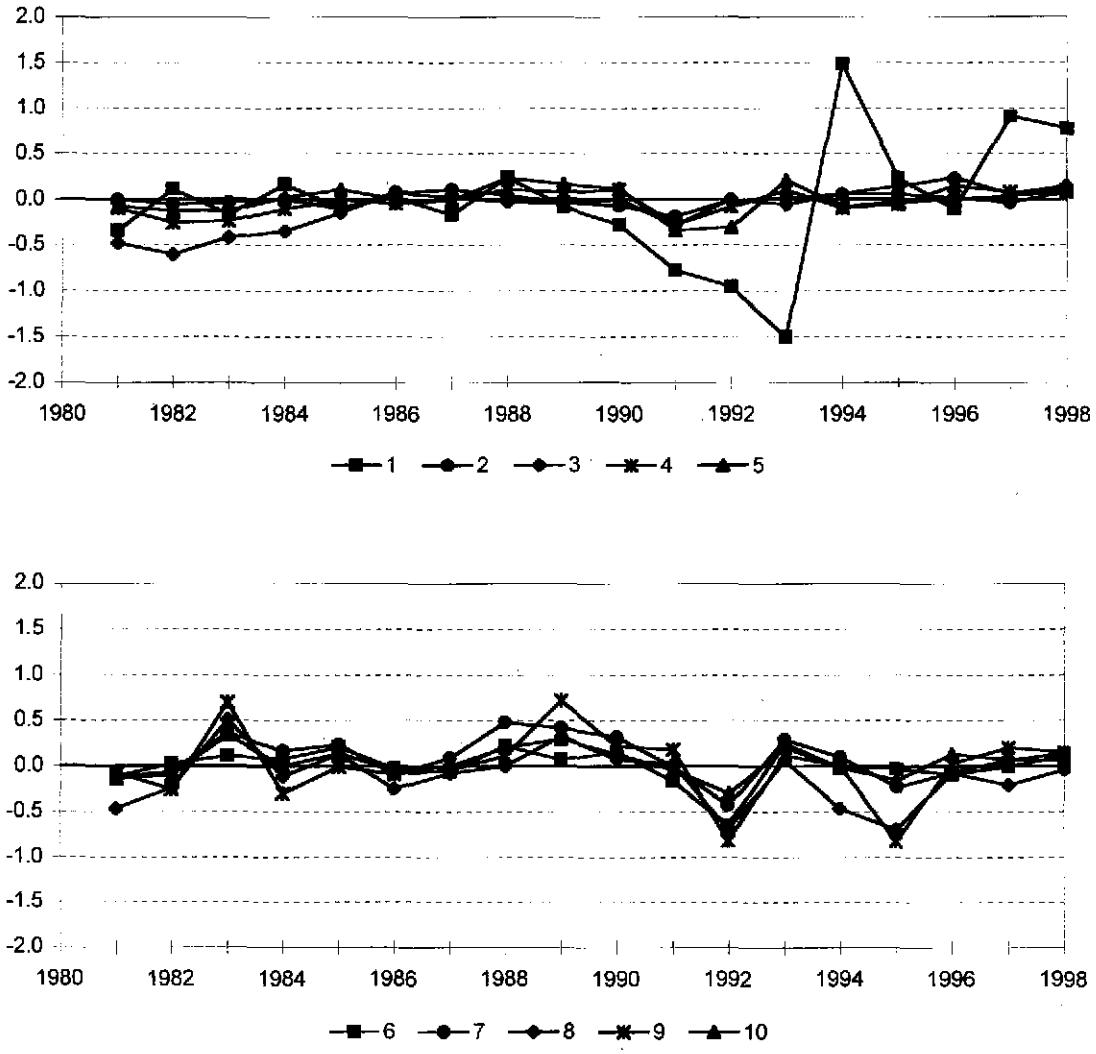
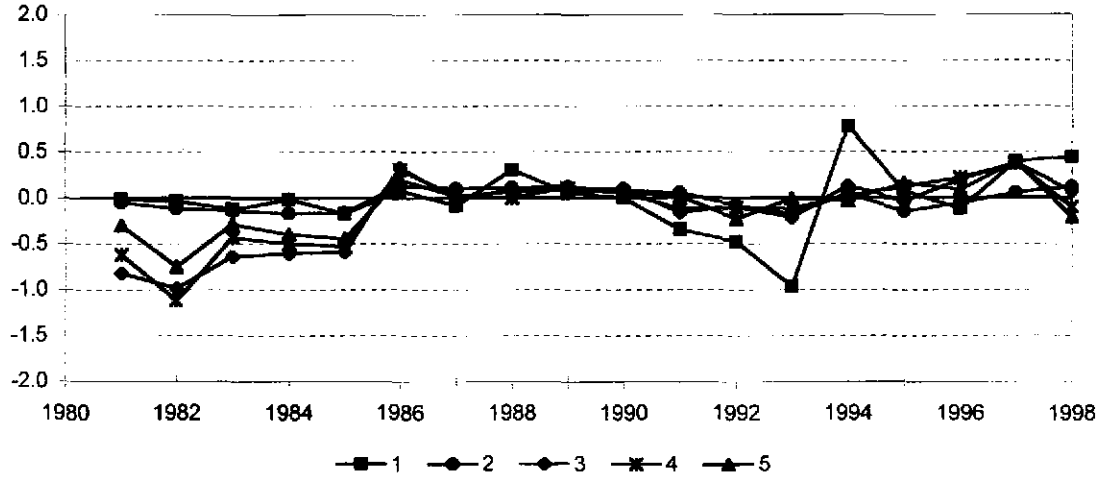
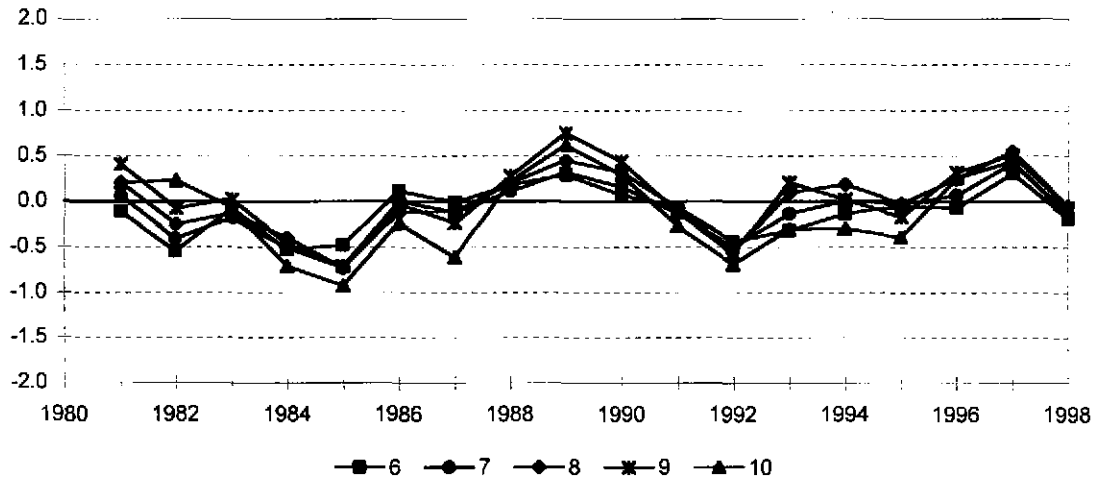


Figure 5.6.13. - Firth of Forth (FU 8): Output VPA males: Log catchability residuals.





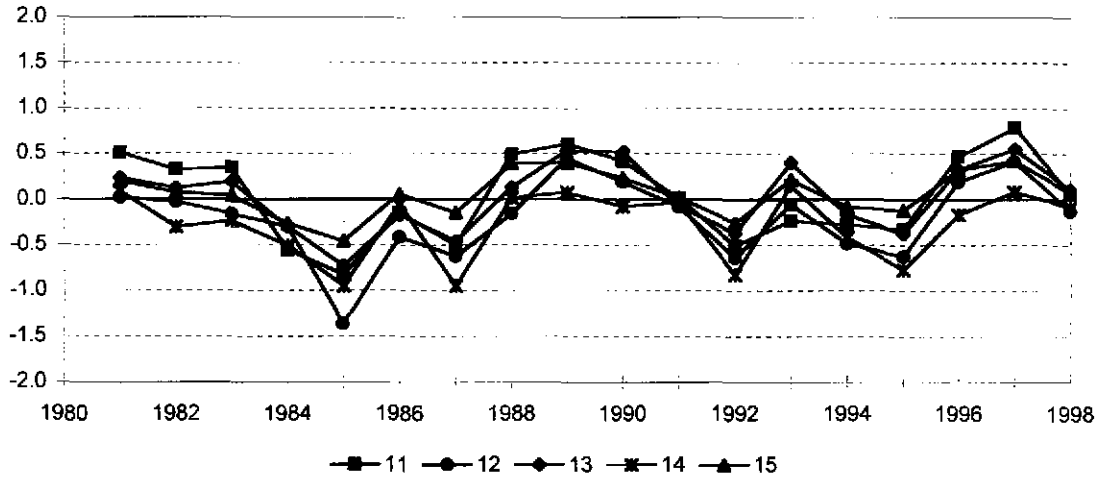


Figure 5.6.14. - Firth of Forth (FU 8): Output VPA females: Log catchability residuals.

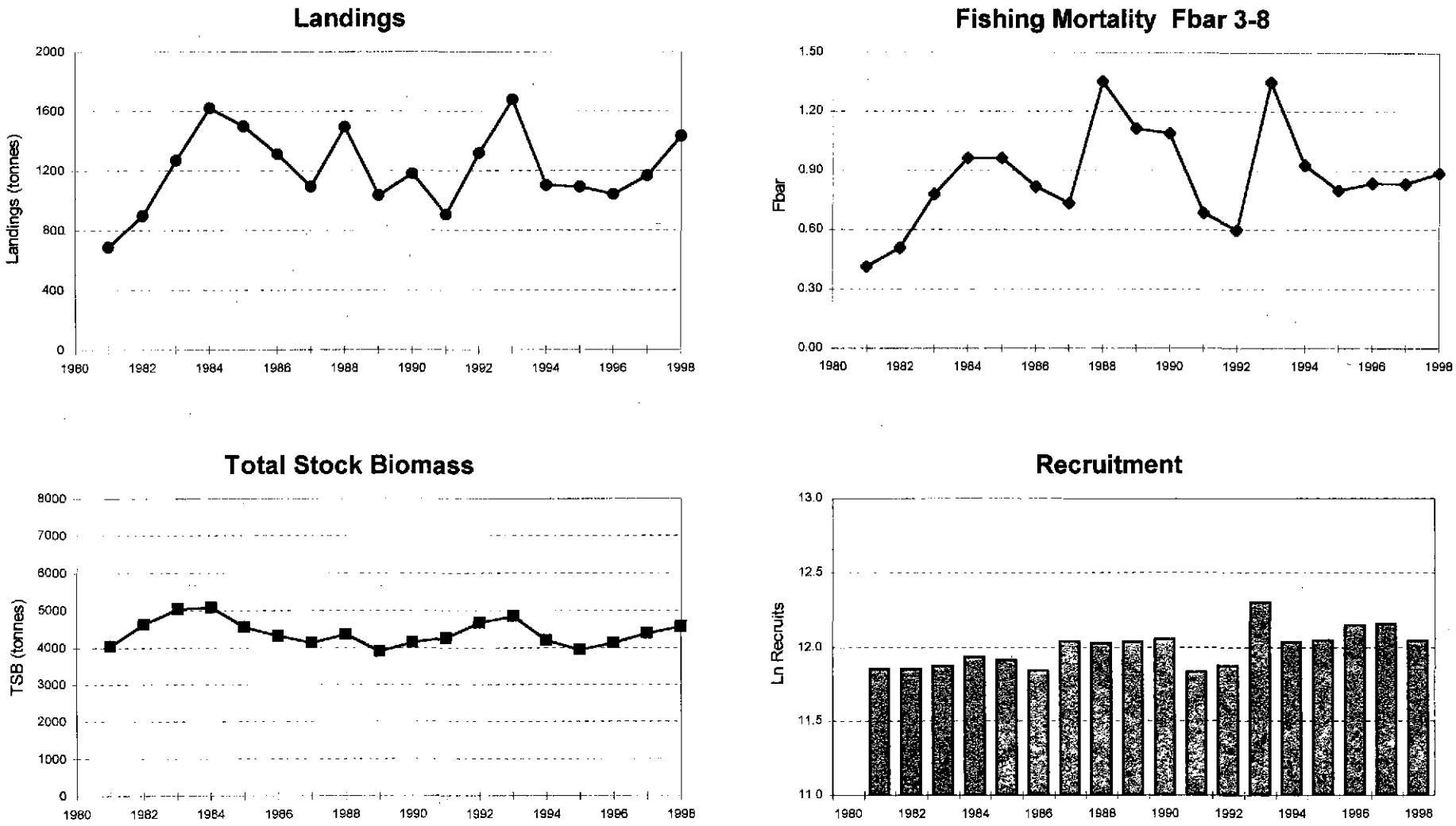


Figure 5.6.15. - Firth of Forth (FU 8): Output VPA males: Trends in Landings, Fbar, TSB and Recruitment.

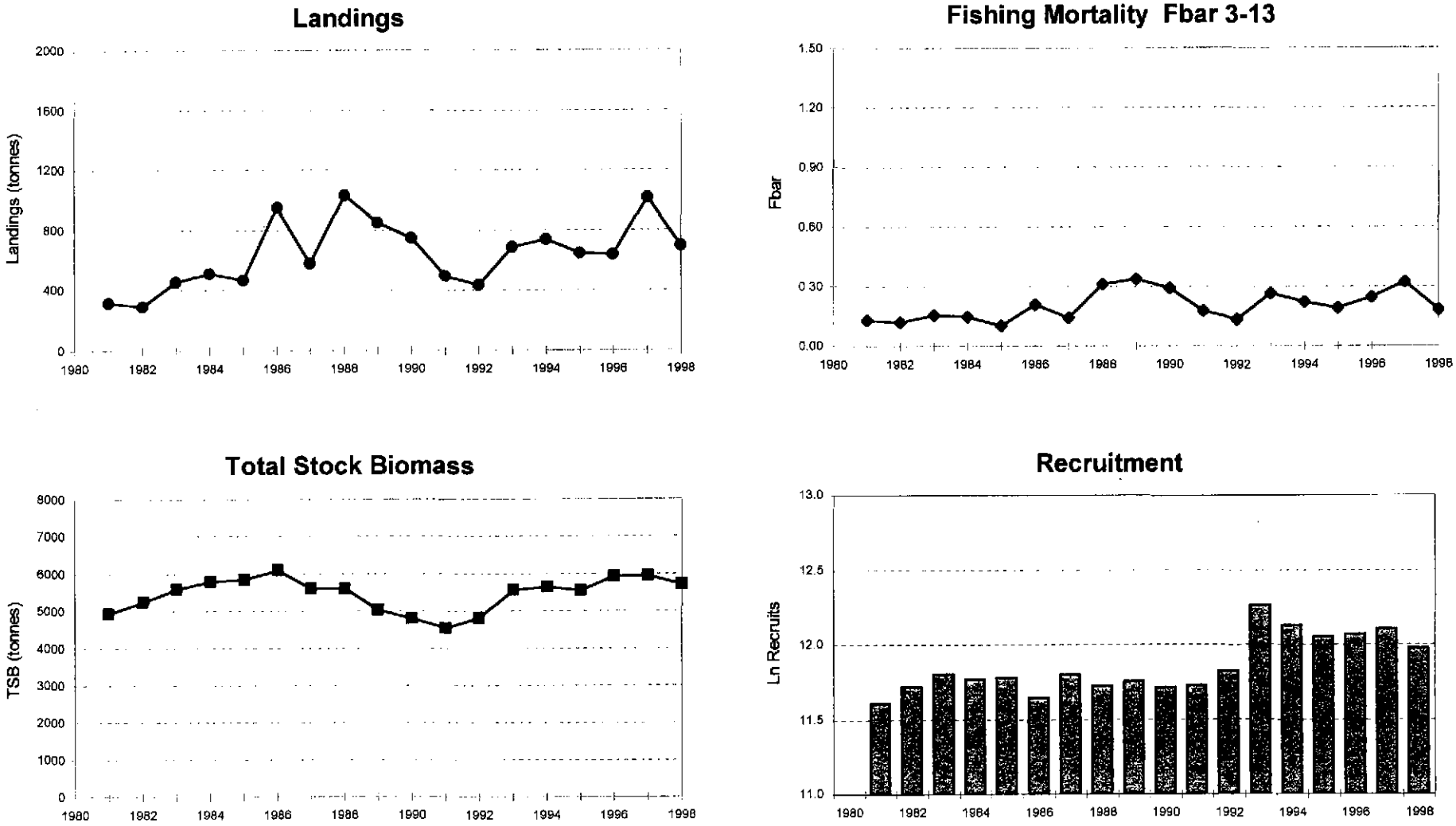


Figure 5.6.16. - Firth of Forth (FU 8): Output VPA females: Trends in Landings, Fbar, TSB and Recruitment.

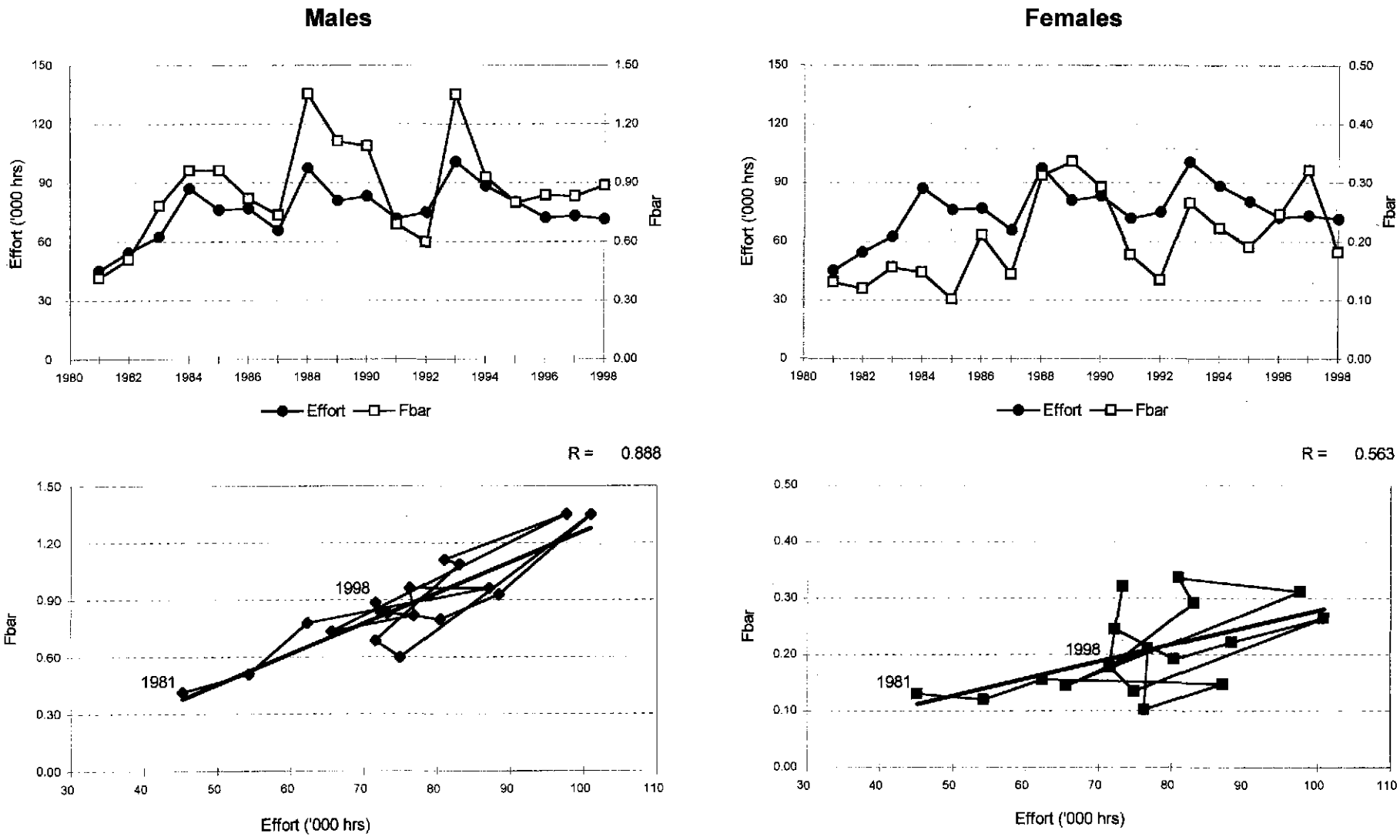


Figure 5.6.17. - Firth of Forth (FU 8): Effort and Fbar, and relationship between them, for males and females.

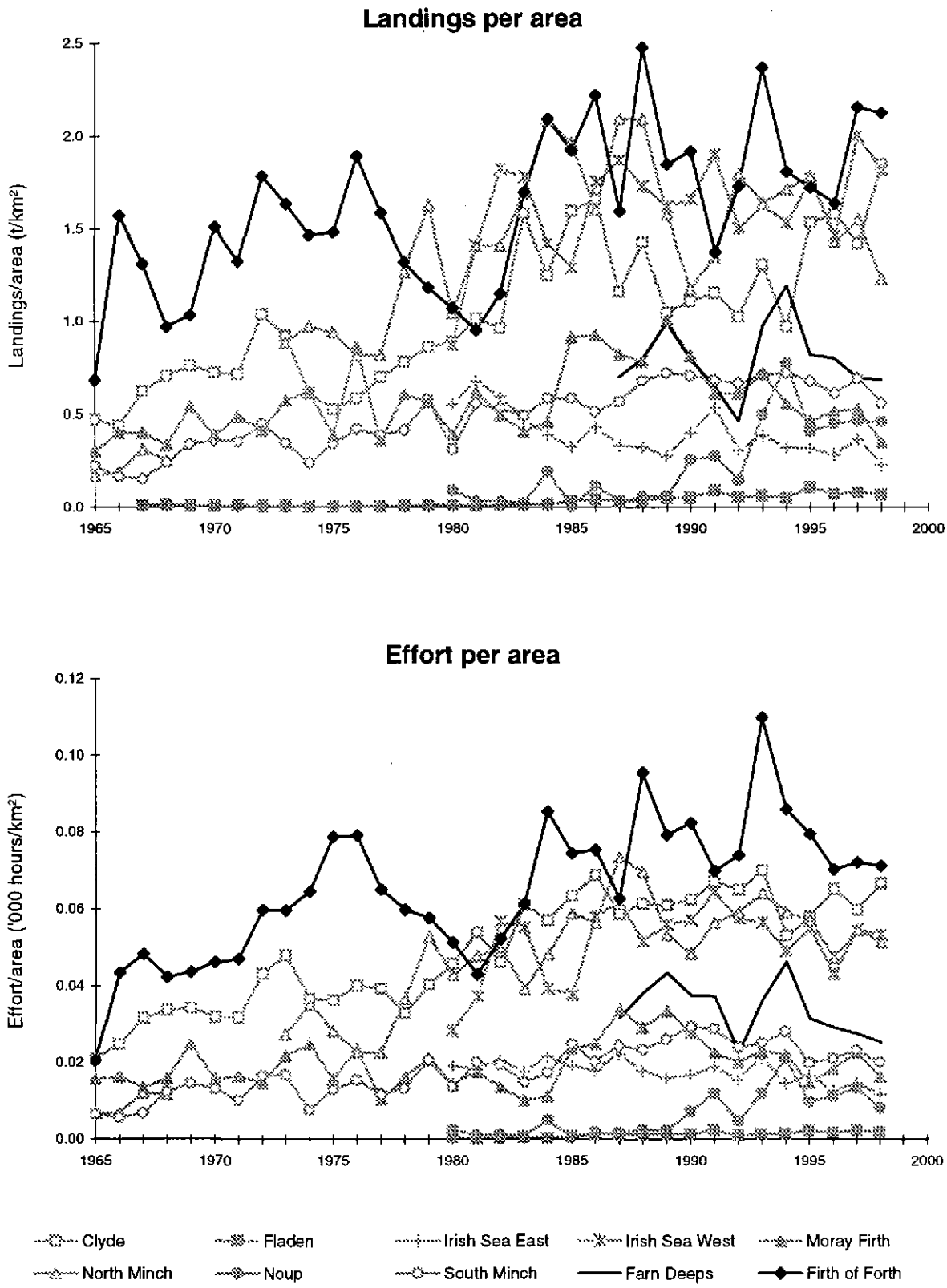


Figure 5.6.18. - *Nephrops* trawl landings per unit area (t/km²) and trawl effort per unit area ('000 hours trawling/km²) on various grounds.
Data relevant to this section of the report are shown in black.

5.7. Management Area H

ICES description	**IVb,c East of 1° E, excluding rectangles 43F5-F7**
Functional Units	**Botney Gut - Silver Pit (FU 5)** **Off Horn Reef (FU 33)**

The statistical rectangles comprised in this Management Area and its constituent Functional Units are shown in Figure 5.1.1.

5.7.1. Botney Gut – Silver Pit (FU 5)

Description of the fisheries

Belgium

Until recently, the Belgian *Nephrops* directed fleet operating in the Botney Gut - Silver Pit area almost entirely consisted of mid-class otter trawlers (mostly side-trawlers), with engine powers ranging from 300 to 500 hp. During summer and autumn, when the catch rates of *Nephrops* are highest, they use single or twin-rig '*Nephrops* trawls' with 70 mm mesh codends, but during winter they change to whitefish trawls, with 100 mm mesh codends.

In the late 80s and early 90s, when the *Nephrops* fishery reached an all-time peak in terms of hours fished, the Belgian fleet comprised 15-20 *Nephrops* specialist trawlers (vessels fishing for *Nephrops* during at least 10 months a year), together with a varying number of so-called 'occasional' *Nephrops* trawlers (vessels fishing for *Nephrops* during the summer months only). Between 1992 and 1994, over half of the Belgian *Nephrops* trawler fleet was decommissioned, in compliance with the EU's Multi-Annual Guidance Programme (MAGP), aiming at an overall reduction of the fishing capacity of the European fishing fleets. As a result, the number of *Nephrops* specialist trawlers went down from 21 units in 1991 to 10 units in 1994. Since then, it has further decreased to 7 in 1998.

Fishing trips to the Botney Gut usually last 10-12 days, and tend to be shorter in the summer than in winter. Nowadays, the specialist trawlers fish for *Nephrops* 'round the clock', with 6 hauls of 3 ½ hours each per day. In former days however, they often shifted to fishing for whitefish during night-time (when the *Nephrops* catch rates are at their lowest) on the higher grounds in the vicinity of the Botney Gut and the Silver Pit. Shifting towards other target species (such as cod and whiting, or flatfish) is still taking place, but when it happens it is for longer periods of time (several days to several weeks) and most often on other grounds (southern North Sea, English Channel, etc.).

At sea, the catches are sorted into *Nephrops* to be landed whole, and *Nephrops* to be landed as tails. Discarding is considerable, the more so since there hardly is a market for small *Nephrops* (< 30 mm CL) in Belgium. Fishermen's selection is much more liberal during the summer months, when the catch rates are generally high and when most of the younger

females are mature (REDANT and POLET, 1994). On board, the *Nephrops* are kept on crushed ice, and stored in bulk in the fish holds.

In the auction, the whole *Nephrops* are hand-sorted and graded into three market categories, viz. small (usually < 35 mm CL), medium (usually 30-45 mm CL) and large (usually > 40 mm CL). Over the past 10 years, there has been a marked shift in the way the *Nephrops* are brought to the auction. In the mid- and late 80s, a large part of the smaller *Nephrops* were landed as 'smalls' whereas nowadays they are mostly landed as tails. As a consequence, the share of the market category small in the landings gradually decreased from 3-4 % (by weight) in the mid-80s to around 0.5 % in the late 90s.

65-85 % (by weight) of the *Nephrops* are landed in the port of Zeebrugge, and 15-35 % in Oostende. In most recent years, some landings were made in foreign ports (up to 5 % of all *Nephrops* landed by Belgian boats), particularly in the Netherlands. The main reason for this being the shorter distance between fishing grounds and auction, and the associated gains in steaming time and fuel consumption.

The by-catches of round- and flatfish are of critical value to the *Nephrops* trawlers. In the late 80s, the top-five of the most important species in the landings of '*Nephrops* directed' trawlers consisted of plaice (with 37 % on average of the total landings by weight), *Nephrops* (25 %), whiting (12 %), cod (8 %) and sole (5 %). In terms of revenues, *Nephrops* ranked first (with 47 % on average of the total value of the landings), followed by plaice (17 %), sole (14 %), turbot (7 %) and cod (5 %). With the decline of the round- and flatfish stocks in the North Sea, the share of *Nephrops* has gone up, and it now ranks first in terms of both quantities landed and revenues (with 34 % on average of the landings by weight and 48 % of their value). The decrease in the round- and flatfish by-landings has caused a substantial loss of 'extra' income to the boats. Moreover, their increased dependence on *Nephrops* as the major source of their revenues has made them much more vulnerable to changes in the market.

As with many other fisheries, there is a problem with under-reporting of the *Nephrops* landings. The phenomenon is not quota-related (there have been problems with under-reporting long before the *Nephrops* quota were introduced), but has everything to do with tax evasion. Since the early 90s however, the port sampling programme is set up in such a way that information on the volume of the 'black' landings can be collected, and these data (which are obtained on strict conditions of confidentiality) are then used to correct the official landings figures.

In 1997 and 1998, two Belgian Eurocutters (small beam trawlers, with a maximum engine power of 300 hp), successfully tried out a Dutch *Nephrops* trawl that can be rigged on their shrimp beams (8-9 m beams of much lighter construction than the ones used for flatfish). Except for cod, the performance of the Eurocutters was comparable to that of the 'traditional' *Nephrops* trawlers, for both landings and revenues per hour trawling (REDANT, 1998). The higher cod LPUEs of the otter trawlers can be attributed to the herding effect of the trawl doors, which makes that the swept area for typically demersal species such as cod, is larger than the area actually swept by the groundrope. In view of the success of these trials, it can be expected that more Eurocutters may shift towards *Nephrops* in the years to come, especially if the catch rates of round- and flatfish in the southern North Sea, and of brown shrimp in the Belgian and Dutch coastal waters, remain at the present low levels.

Netherlands

In recent years, a rapidly expanding *Nephrops* directed fishery has developed in the Netherlands. This development was driven by the reduction of the North Sea finfish quota, which forced part of the Dutch trawler fleet towards alternative target species such as *Nephrops*. At present, some 10-15 vessels are participating in the *Nephrops* directed fishery in the Botney Gut - Silver Pit area. The gear used is a modified (shrimp) beam trawl, with tall shoes.

The Dutch *Nephrops* directed fishery is a typical peak season fishery, with most of the effort being concentrated in summer and early autumn. Roughly 60 % of the Dutch *Nephrops* landings (all areas and all gears combined) are made in the port of Urk, and another 30 % in the port of Wieringen.

As for now, there is no information on fishing and discarding practices, directedness of the fishery, volume and economic importance of the by-catches, etc., but it is hoped that at least some data on these aspect of the fishery can be collected for the next WG meeting.

Denmark

A description of the Danish *Nephrops* fisheries in Sub-areas IIIa and IV (including the one in the Botney Gut - Silver Pit area) is given in Section 5.2.

Trends in landings, effort, LPUE and mean size

Table	5.7.1.	Landings by country, 1989-98
Table	5.7.2.	Effort and LPUEs Belgian fleet, 1989-98
Table	5.7.3.	Effort and LPUEs Danish fleet, 1989-98
Table	5.7.4.	Mean sizes of *Nephrops* in catches and landings, Belgian data, 1989-98
Figure	5.7.1.	Long-term trends in landings, effort, LPUE and mean size, Belgian data
Figure	5.7.2.	Landings by sex + Quarterly plots of effort and LPUEs by sex, 1989-98

Landings, effort and LPUE

International landings from FU 5 have considerably increased since 1996, mainly as a result of the expanding Dutch *Nephrops* fishery in the area. Landings data by FU for the Netherlands are lacking for the years prior to 1996, but judging from the quantities taken in the southern North Sea as a whole in 1992-95, the landings from FU 5 must have been marginal. The more so since most *Nephrops* landed by Dutch vessels prior to 1996 were taken as a by-catch of flatfish directed beam trawling on fishing grounds other than the Botney Gut and the Silver Pit.

Directed effort by 'traditional' Belgian *Nephrops* trawlers has decreased from almost 75 10^3 hours in 1991-92 to around 30 10^3 hours in 1996-98 (Table 5.7.2.). Effort by the Danish fleet was highest in 1989-91, but has since dropped to much lower values (roughly equivalent to that of one full-time Belgian *Nephrops* trawler) (Table 5.7.3.). Effort data for the Dutch fleet are lacking, but the sharp increase in landings between 1996 and 1998 suggests that effort must have sharply increased as well.

LPUEs have varied a great deal throughout the time series, with generally lower values in the earlier years (in both the Belgian and the Danish data series), and higher values in the most

recent years (Figure 5.7.1.). The dip in LPUE in 1996 (which is equally apparent in the two data sets - Tables 5.7.2. and 5.7.3.) was attributed by fishermen to the bad weather conditions which prevailed during the first half of the year, and which resulted in much lower LPUEs during winter and spring than in 'normal' years.

Mean size

Over the past 7-8 years, the mean size of males in the landings (calculated for the size classes > 35 mm CL only, to reduce the noise caused by variations in recruitment strength and discarding) has remained fairly stable, whereas that of the females has declined by almost 2 mm CL (Figure 5.7.2.).

Data and biological inputs for analytical assessments

Table 5.7.5. Sampling data and input parameters

Landings and effort statistics are available for Belgium (landings and effort by vessel class and gear type since 1986), Denmark (landings and effort since 1988), the Netherlands (landings only since 1996) and the UK (landings only).

The Belgian landings data for all years in the data series were adjusted for non-reported landings, following the procedure described in the 1994 WG Report (ICES, 1994a). It is worth noticing that the proportions of *Nephrops* landed on the 'grey' market have hardly changed over the years.

Length frequency data are collected from market samples of the landings by Belgian *Nephrops* directed trawlers only. A routine port sampling programme has been in operation since 1986. Details on this programme can be found in the 1996 Report of the *Nephrops* Study Group (ICES, 1996b). Except for 1993, there are no data on the length composition of catches or discards.

The length frequency distributions for the analytical assessments were derived from the Belgian sampling data, under the assumption that (a) the length compositions of the landings by the Danish and Dutch fleets were identical to that of the Belgian fleet, and (b) the fishermen's selection curve that was derived from the 1993 discard data, was equally valid for the other years in the time series. *Nephrops* directed effort by the Dutch fleet was back-calculated from the landings, using the LPUE values for the Belgian fleet. This approach is justified by the findings of the 1998 comparative study on the performance of the Dutch *Nephrops* directed beam trawling system vs. traditional *Nephrops* directed otter trawling (REDANT, 1998).

General comments on quality of data and inputs

The problems associated with under-reporting of the landings are believed to be adequately resolved, at least as far as the Belgian fleet is concerned. For the other fleets no such corrections could be made, since there is no verifiable information on the importance of their 'black' landings.

Frequency and sample sizes of the Belgian port sampling programme are assumed to be sufficient to produce reliable estimates of the numbers-at-length in the landings of the Belgian fleet. The lack of discard samples in general, and of port samples of the Dutch fleet (which nowadays is taking over half of the landings from the area), puts serious constraints to the reliability of the assessments. There is little hope that this may be remedied in the near future.

Length based assessments (LCA)

Table 5.7.6. Output table LCA males, with mean F
Table 5.7.7. Output table LCA females, with mean F
Figure 5.7.3. Changes in Y/R and B/R upon changes in F, for males and females separately

The LCA for the Botney Gut - Silver Pit was updated, using Belgian length composition data for the years 1996-98 (i.e. the years for which landing figures for all countries were available). Length frequencies were raised to total international landings, assuming that the LFDs of the Danish, Dutch and UK landings were identical to those of the Belgian landings.

All input parameters were the same as the ones used in the 1997 LCA. After tuning, the input Fs were set at 0.3 for the males, and at 0.1 for the females.

The Y/R analysis shows that current F is at 30-40 % below F_{max} for both males and females. Annualised fishing mortalities (averaged across the inter-quartile length range) were 0.21 and 0.16 for males and females respectively. Compared with the previous LCAs (which were re-run, using improved estimates for the discards) mean F has decreased for males, and increased for females.

Age based assessments (VPA)

A single fleet assessment was carried out using raised length frequency data (derived from Belgian samples) and international effort for 1989-98. The Lowestoft VPA suite was used on nominal 'age' groups, generated by slicing the length distributions. Sexes were assessed separately.

Males

Table 5.7.8. Output XSA males: Fs-at-age
Table 5.7.10. Output XSA males: Long-term trends in landings, Fbar, TSB and recruitment
Figure 5.7.4. Output XSA males: Log catchability residuals
Figure 5.7.6. Output XSA males: Long-term trends in landings, Fbar, TSB and recruitment
Figure 5.7.8. Output XSA males: Plots of Fbar vs. effort

The slicing procedure generated 8 nominal 'age' groups (the last one being a plus group). Tuning of the VPA was carried out using the XSA option. Tuning was performed over the whole 10 year period, with a tricubic time taper but without shrinkage. For the catchability analysis, catchability was set to be dependent on age and year class strength for ages < 3 and to be independent of age for ages > 6.

The log catchability residuals are generally small (compared to most other FUs) and show no marked age or year effects.

Trends in the estimates of yield, F_{bar}, TSB and recruitment are given in Figure 5.7.6. F_{bar} (calculated for ages 3-6) decreased with decreasing effort from 1991 to 1995-96, then increased to the highest level in the time series. TSB has slightly increased, while recruitment estimates were remarkably stable throughout the time series.

Estimates of F_{bar} correlate well with effort ($r = 0.68$), although not so well as for females.

Females

Table	5.7.9.	Output XSA females: Fs-at-age
Table	5.7.11.	Output XSA females: Long-term trends in landings, Fbar, TSB and recruitment
Figure	5.7.5.	Output XSA females: Log catchability residuals
Figure	5.7.7.	Output XSA females: Long-term trends in landings, Fbar, TSB and recruitment
Figure	5.7.8.	Output XSA females: Plots of Fbar vs. effort

The slicing procedure generated 12 nominal 'age' groups (the last one being a plus group). Other than for the males, different values of M were chosen for immature and mature animals. General XSA tuning choices were the same as for males. For the catchability analysis, catchability was set to be dependent on age and year class strength for ages < 3 and to be independent of age for ages > 10.

As for males, the catchability residuals are generally small (compared to most other FUs) and show no marked age or year effects.

Trends in yield, F_{bar}, TSB and recruitment are shown in Figure 5.7.7. F_{bar} for the females is generally low, with annual fluctuations matching those in the effort. TSB and recruitment remained almost constant throughout the time series.

Annual mean Fs were calculated over age groups 3-10 and are plotted against fishing effort in Figure 5.7.8. F_{bar} correlates well with fishing effort ($r = 0.75$).

Comments on quality of assessments

As already stated above, the absence of effort and sampling data for the Dutch fleet puts a constraint on the analytical assessments. This is particularly true for the most recent years in the data series, when the Dutch fleet took 45-55 % of the *Nephrops* landings from the area. The back-calculations of the Dutch effort partly resolved the problem, but if the basic assumptions on which these calculations were founded are wrong, the resulting figures may have been wrong too. The same holds for the way the Belgian length frequencies were raised to removals-at-length by the international fleet.

The use of a single fishermen's selection curve to calculate the LFDs of the discards over a period of several years, tends to produce size distributions and numbers-at-age for the discards which hardly differ from one year to another. This involves a serious risk of also levelling the estimates of recruitment in the time series (particularly for the most recent years), which could give a misleading impression of stability.

Management considerations

In view of the results from the analytical assessments, which show that the stock is generally stable in terms of biomass and recruitment, the WG recommends that the TAC for this FU be maintained at a level corresponding to the current level of fishing effort, i.e. at 1100 t. The recent increase in F stresses the need to closely monitor this stock, but is not of such a nature that a restriction of the fisheries need to be envisaged.

5.7.2. Off Horn Reef (FU 33)

Description of the fisheries

Denmark

A description of the Danish *Nephrops* fisheries in Sub-areas IIIa and IV (including the one in the Off Horn Reef area) is given in Section 5.2.

Trends in landings, effort, LPUE and mean size

Table 5.7.12. Landings by country, 1989-98
Table 5.7.13. Effort and LPUEs Danish fleet, 1989-98

Landings, effort and LPUE

Except for landings and effort (Denmark only), there are no data on this fishery. Landings from this FU have been marginal for many years. Since the mid-90s however, they have rapidly increased to a provisional all times' high of 350 t in 1998. The LPUEs too have gone up, from 75-85 kg/day in 1989-92 to just over 200 kg/day in 1998. There are no mean size data for this stock.

Data and biological inputs for analytical assessments

Since there are no length frequency data for this stock, no analytical assessments were made.

Management considerations

FU 33 is a new Functional Unit, the landings from which were previously included in the landings from 'Other rectangles' in MA H, and for which no specific advice has been given in the past.

The overall increase in LPUE (despite a two-fold increase in fishing effort) shows that the stock in this area is giving no reason for concern, and that there might be sufficient margin to let effort increase. If the general principles of the Precautionary Approach are to be applied to this FU, the WG would suggest to set the TAC at a level corresponding to the maximum landings in the time series, i.e. at 350 t. A more optimistic option could be to assume that higher sustainable yields be

possible (taking the steady increase in LPUE in previous years into account), and to set the TAC at a higher level. For the time being however, and pending further information on the extent of this stock and its fisheries potential, it would seem unwise to set the TAC at a level exceeding 500 t.

5.7.3. Summary for Management Area H

Table 5.7.14. Landings by FU and from Other rectangles, 1989-98
Table 5.7.15. Landings by country, 1989-98

The WG draws ACFM's attention to the fact that the current TAC for this MA was calculated from historical landings figures for the late 80s (ICES, 1991a, and amended after ICES, 1997a), i.e. well before the fishery in FU 33 had started to expand. In view of the results from the analytical assessments for FU 5, and the recent upward trends in LPUE in FU 33, the WG proposes to set the TAC for this MA to a value between 1600 and 1750 t (viz. 1100 t for FU 5, 350 or 500 t for FU 33, and 150 t for catches taken outside these FUs but within MA H), depending on whether a precautionary or a more permissive approach is adopted with respect to the fishery in FU 33.

Table 5.7.1. - Botney Gut - Silver Pit (FU 5): Landings (tonnes) by country, 1989-98.

Year	Belgium	Denmark	Netherl.	UK	Total **
1989	670	60	na	1	731
1990	717	113	na	1	831
1991	682	176	na	2	860
1992	571	22	na	12	605
1993	694	20	na	4	718
1994	494	0	na	9	503
1995	641	77	na	3	721
1996	266	41	324	54	685
1997	486	67	537	56	1147
1998 *	372	88	585	28	1072
* provisional na = not available					
** totals for 1989-95 exclusive of landings by the Netherlands					

Table 5.7.2. - Botney Gut - Silver Pit (FU 5): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Belgian *Nephrops* directed trawlers, 1989-98 (data presented for *Nephrops* specialist trawlers and Eurocutters separately).

Year	***Nephrops* specialist trawlers ****			**Eurocutters *****		
	Landings	Effort	LPUE	Landings	Effort	LPUE
1989	631	60.2	10.5	0	0	na
1990	643	66.6	9.6	0	0	na
1991	566	74.0	7.7	0	0	na
1992	524	74.5	7.0	0	0	na
1993	672	58.3	11.5	0	0	na
1994	453	35.5	12.7	0	0	na
1995	559	32.5	17.2	0	0	na
1996	245	30.1	8.1	0	0	na
1997	399	31.8	12.5	30	1.6	18.9
1998 *	309	28.6	10.8	26	1.5	17.4
* provisional na = not available						
** otter trawlers targeting *Nephrops* 10-12 months per year						
*** small beamers (max. 300 hp) targeting *Nephrops* during the summer months						

Table 5.7.3. - Botney Gut - Silver Pit (FU 5): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching *Nephrops* with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1989-98.

Year	Logbook data		Estimated effort
	Effort	LPUE	
1989	496	200	295
1990	520	208	543
1991	501	296	596
1992	128	161	136
1993	108	206	97
1994	0	na	0
1995	111	611	126
1996	132	261	158
1997	59	412	67
1998 *	174	447	196

* provisional na = not available

Table 5.7.4. - Botney Gut - Silver Pit (FU 5): Mean sizes of *Nephrops* > 35 mm CL landed by Belgian *Nephrops* specialist trawlers, 1989-98.

Year	**Landings**	
	Males	Females
1989	42.3	40.3
1990	41.5	40.9
1991	40.8	41.3
1992	40.9	40.9
1993	41.0	40.9
1994	40.3	40.6
1995	40.7	39.8
1996	41.3	39.4
1997	41.2	39.0
1998 *	41.0	39.2

* provisional na = not available

Table 5.7.5. - Botney Gut - Silver Pit (FU 5): Input data and parameters.

FU	5	MA	H
FLEET	Belgium	GEAR	Trawl (*Nephrops* + otter trawl)

	1998					1997				
	Number of samples				Mean no. per sample	Number of samples				Mean no. per sample
	Qtr 1	Qtr 2	Qtr 3	Qtr 4		Qtr 1	Qtr 2	Qtr 3	Qtr 4	
Catch	0	0	0	0		0	0	0	0	
Landings	6	6	6	6	(*)	5	6	6	6	(*)
Discards	0	0	0	0		0	0	0	0	

(*) 200 for all market categories (ie 600 in total) in the 1st and 2nd quarter ; 300 for market categories 'medium' and 'tails', and 200 for market category 'large' (ie 800 in total) in the 3rd and 4th quarter

	Number of samples									
Year	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989
Catch	0	0	0	0	0	0	0	0	0	0
Landings	24	23	23	24	24	22	24	24	24	24
Discards	0	0	0	0	0	0	0	0	0	0

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival	0.25	Gueguen and Charuau, 1975 ; Redant and Polet, 1994
MALES		
Growth - K	0.165	taken from Scottish stocks
Growth - L(inf)	62	"
Natural mortality - M	0.3	Morizur, 1982
Length/weight - a	0.00023	Redant (unpublished data)
Length/weight - b	3.320	"
FEMALES		
Immature Growth		
Growth - K	0.165	taken from Scottish stocks
Growth - L(inf)	62	"
Natural mortality - M	0.3	Morizur, 1982
Size at maturity	27	Redant, 1994
Mature Growth		
Growth - K	0.080	taken from Scottish stocks
Growth - L(inf)	60	"
Natural mortality - M	0.2	based on Morizur, 1982 ; assuming lower rate for mature females
Length/weight - a	0.00080	Redant (unpublished data)
Length/weight - b	2.950	"

Table 5.7.6. - Botney Gut - Silver Pit (FU 5): LCA output males.

Reference period	1996-98		
Linf (mm CL)	62.0	K	0.165

Size (mm CL)	Removals ('000)	M	DT (years)	F*DT	F	Z	Nos. attaining aver. size ('000)	Average nos. in the sea ('000)	Average biomass (kg)
16	5	0.3	0.269	0.000	0.000	0.300	92275	23881	66813
18	10	0.3	0.282	0.000	0.000	0.300	85106	23007	93120
20	23	0.3	0.296	0.000	0.001	0.301	78194	22123	124834
22	50	0.3	0.311	0.001	0.002	0.302	71535	21225	161997
24	115	0.3	0.328	0.002	0.006	0.306	65117	20304	204393
26	261	0.3	0.346	0.005	0.014	0.314	58911	19339	251349
28	612	0.3	0.367	0.012	0.034	0.334	52848	18275	301127
30	1459	0.3	0.391	0.034	0.086	0.386	46754	16974	348999
32	2330	0.3	0.418	0.064	0.152	0.452	40201	15316	387553
34	2808	0.3	0.449	0.095	0.211	0.511	33274	13355	410833
36	3065	0.3	0.485	0.133	0.274	0.574	26454	11201	414376
38	2840	0.3	0.527	0.167	0.316	0.616	20021	9015	397206
40	2282	0.3	0.578	0.189	0.327	0.627	14468	7012	364753
42	1851	0.3	0.639	0.226	0.354	0.654	10074	5259	320425
44	1383	0.3	0.714	0.264	0.370	0.670	6636	3766	266817
46	941	0.3	0.809	0.299	0.369	0.669	4114	2571	210486
48	602	0.3	0.934	0.341	0.366	0.666	2394	1666	156597
50	334	0.3	1.105	0.366	0.331	0.631	1286	1023	109816
52	186	0.3	1.352	0.440	0.325	0.625	640	584	71258
54	92	0.3	1.744	0.571	0.327	0.627	275	291	40174
56	46	0.3			0.300	0.600	92	291	45232
					Totals, including lengths above + group			236474	4748159

Mean F, calculated across inter-quartile range	0.214

Table 5.7.7. - Botney Gut - Silver Pit (FU 5): LCA output females.

Reference period	1996-98		
Linf immatures (mm CL)	62.0	K immatures	0.165
Linf matures (mm CL)	60.0	K matures	0.080
Transition length (mm CL)	27.0		

Size (mm CL)	Removals ('000)	M	DT (years)	F*DT	F	Z	Nos. attaining aver. size ('000)	Average nos. in the sea ('000)	Average biomass (kg)
16	5	0.3	0.269	0.000	0.000	0.300	47775	12364	42176
18	11	0.3	0.282	0.000	0.001	0.301	44062	11910	56408
20	23	0.3	0.296	0.001	0.002	0.302	40478	11450	72854
22	53	0.3	0.311	0.002	0.005	0.305	37020	10980	91366
24	120	0.3	0.328	0.004	0.011	0.311	33673	10490	111629
26	270	0.3	0.346	0.009	0.027	0.327	30406	9958	132985
28	634	0.2	0.807	0.026	0.032	0.232	27149	19976	329365
30	1216	0.2	0.862	0.061	0.070	0.270	22519	17323	347718
32	1830	0.2	0.926	0.119	0.129	0.329	17836	14243	343801
34	1949	0.2	1.001	0.179	0.179	0.379	13152	10953	314506
36	1808	0.2	1.088	0.253	0.233	0.433	9004	7810	264207
38	1283	0.2	1.191	0.297	0.250	0.450	5622	5186	204918
40	834	0.2	1.317	0.341	0.259	0.459	3291	3253	148965
42	431	0.2	1.472	0.326	0.221	0.421	1798	1973	103991
44	219	0.2	1.669	0.311	0.187	0.387	967	1190	71714
46	100	0.2	1.927	0.272	0.141	0.341	508	717	49101
48	40	0.2	2.279	0.212	0.093	0.293	263	437	33869
50	28	0.2	2.789	0.321	0.115	0.315	135	250	21818
52	9	0.2	3.596	0.262	0.073	0.273	56	128	12532
54	7	0.2			0.100	0.300	21	128	13979
					Totals, including lengths above + group			150721	2767901

Mean F, calculated across inter-quartile range	0.155

Table 5.7.8. - Botney Gut - Silver Pit (FU 5): VPA Fs-at-age males.

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0.002	0.003	0.003	0.001	0.001	0.001	0.001	0.000	0.001	0.001
2	0.034	0.042	0.040	0.012	0.017	0.015	0.009	0.006	0.016	0.021
3	0.185	0.176	0.227	0.081	0.096	0.084	0.081	0.059	0.133	0.186
4	0.215	0.227	0.267	0.196	0.187	0.180	0.224	0.168	0.315	0.365
5	0.271	0.310	0.314	0.285	0.240	0.196	0.269	0.192	0.404	0.425
6	0.346	0.387	0.291	0.289	0.259	0.161	0.253	0.200	0.417	0.376
7	0.309	0.429	0.323	0.326	0.324	0.137	0.250	0.202	0.408	0.358
8	0.301	0.340	0.339	0.394	0.333	0.160	0.196	0.215	0.339	0.320
+ grp	0.301	0.340	0.339	0.394	0.333	0.160	0.196	0.215	0.339	0.320

Table 5.7.9. - Botney Gut - Silver Pit (FU 5): VPA Fs-at-age females.

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0.004	0.004	0.005	0.001	0.001	0.002	0.001	0.001	0.002	0.003
2	0.064	0.069	0.084	0.020	0.018	0.031	0.015	0.013	0.028	0.044
3	0.113	0.119	0.148	0.036	0.043	0.047	0.038	0.029	0.061	0.099
4	0.133	0.130	0.173	0.060	0.094	0.064	0.081	0.071	0.107	0.188
5	0.141	0.128	0.177	0.097	0.157	0.083	0.107	0.117	0.153	0.230
6	0.153	0.148	0.190	0.120	0.239	0.099	0.120	0.151	0.196	0.265
7	0.185	0.181	0.218	0.163	0.267	0.108	0.128	0.163	0.202	0.275
8	0.187	0.228	0.247	0.201	0.286	0.103	0.137	0.165	0.221	0.261
9	0.214	0.251	0.314	0.197	0.287	0.100	0.143	0.163	0.278	0.258
10	0.161	0.343	0.264	0.167	0.239	0.100	0.170	0.160	0.221	0.214
11	0.171	0.232	0.347	0.124	0.273	0.084	0.161	0.164	0.190	0.236
12	0.204	0.259	0.318	0.176	0.274	0.102	0.136	0.166	0.207	0.296
+ grp	0.204	0.259	0.318	0.176	0.274	0.102	0.136	0.166	0.207	0.296

Table 5.7.10. - Botney Gut - Silver Pit (FU 5): VPA output males.

Year	Recruits Age 1	Total Biomass	TSB	Landings	Yield/SSB	Fbar 3-6
	'000	tonnes	tonnes	tonnes		
1989	80068	4535	4535	478	0.105	0.254
1990	82189	4643	4643	536	0.115	0.275
1991	85985	4821	4821	544	0.113	0.275
1992	89181	5005	5005	453	0.091	0.213
1993	89370	5377	5377	467	0.087	0.195
1994	82510	5762	5762	393	0.068	0.155
1995	75546	6114	6114	577	0.094	0.207
1996	70837	6180	6180	509	0.082	0.155
1997	79763	6246	6246	923	0.148	0.317
1998	81300	5652	5652	791	0.140	0.338
Average 96-98						0.270

Table 5.7.11. - Botney Gut - Silver Pit (FU 5): VPA output females.

Year	Recruits Age 1	Total Biomass	TSB	Landings	Yield/SSB	Fbar 3-10
	'000	tonnes	tonnes	tonnes		
1989	42914	3229	2509	253	0.101	0.161
1990	44890	3172	2414	295	0.122	0.191
1991	45353	3124	2343	316	0.135	0.216
1992	45681	2977	2189	152	0.069	0.130
1993	44724	3170	2384	251	0.105	0.201
1994	43907	3127	2357	110	0.047	0.088
1995	38974	3152	2425	144	0.059	0.116
1996	36892	3185	2523	176	0.070	0.127
1997	42044	3146	2469	224	0.091	0.180
1998	42498	3103	2370	281	0.119	0.224
Average 96-98						0.177

Table 5.7.12. - Off Horn Reef (FU 33): Landings (tonnes) by country, 1989-98.

Year	Belgium	Denmark	Netherl.	UK	Total **
1989	0	16	na	0	16
1990	0	47	na	0	47
1991	2	69	na	3	74
1992	1	75	na	1	77
1993	0	159	na	1	160
1994	0	137	na	1	138
1995	3	158	na	1	162
1996	1	74	2	1	78
1997	0	274	2	1	277
1998 *	4	333	13	1	350
* provisional na = not available					
** totals for 1989-95 exclusive of landings by the Netherlands					

Table 5.7.13. - Off Horn Reef (FU 33): Logbook recorded effort (days fishing) and LPUE (kg/day) for bottom trawlers catching *Nephrops* with codend mesh sizes of 70 mm or above, and estimated total effort by Danish trawlers, 1989-98.

Year	Logbook data		Estimated effort
	Effort	LPUE	
1989	262	78	200
1990	573	87	552
1991	705	76	897
1992	812	87	858
1993	975	170	971
1994	739	165	761
1995	724	194	816
1996	370	157	469
1997	925	161	1078
1998 *	1442	208	1094
* provisional na = not available			

Table 5.7.14. - Management Area H (IVb,c, East of 1° E excl. rect. 43F5-F7): Total *Nephrops* landings (tonnes) by Functional Unit plus other rectangles, 1989-98.

Year	FU 5	FU 33	Other	Total
1989	731 **	16 **	31 **	***778*** **
1990	831 **	47 **	67 **	***945*** **
1991	860 **	74 **	86 **	***1019*** **
1992	605 **	77 **	178 ***	***859***
1993	718 **	160 **	192 ***	***1071***
1994	503 **	138 **	199 ***	***841***
1995	721 **	162 **	358 ***	***1241***
1996	685	78	154	***917***
1997	1147	277	96	***1521***
1998 *	1072	350	194	***1616***

* provisional na = not available

** exclusive of landings by the Netherlands

*** inclusive of landings by the Netherlands from IVb,c but not allocated to FUs

Table 5.7.15. - Management Area H (IVb,c, East of 1° E excl. rect. 43F5-F7): Total *Nephrops* landings (tonnes) by country, 1989-98.

Year	Belgium	Denmark	Netherl.	UK	Total
1989	677	97	na	4	***778*** **
1990	728	212	na	5	***945*** **
1991	704	305	na	10	***1019*** **
1992	589	114	133	23	***859***
1993	706	228	130	7	***1071***
1994	515	147	158	21	***841***
1995	657	318	253	12	***1241***
1996	290	152	415	60	***917***
1997	491	377	590	63	***1521***
1998 *	380	519	664	52	***1616***

* provisional na = not available

** exclusive of landings by the Netherlands

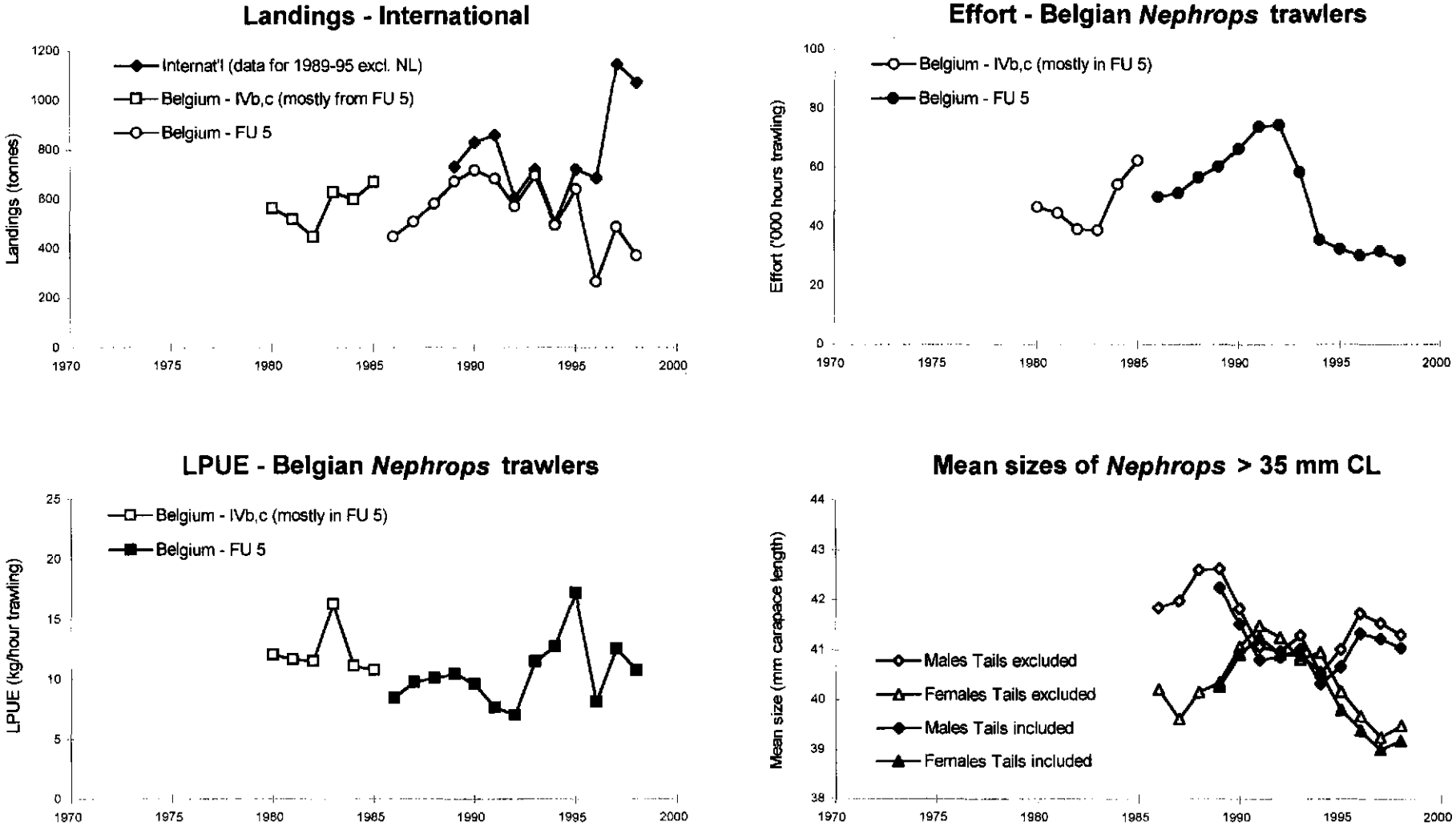


Figure 5.7.1. - Botney Gut - Silver Pit (FU 5): Long-term trends in landings, effort, LPUEs and mean sizes of *Nephrops* in landings.

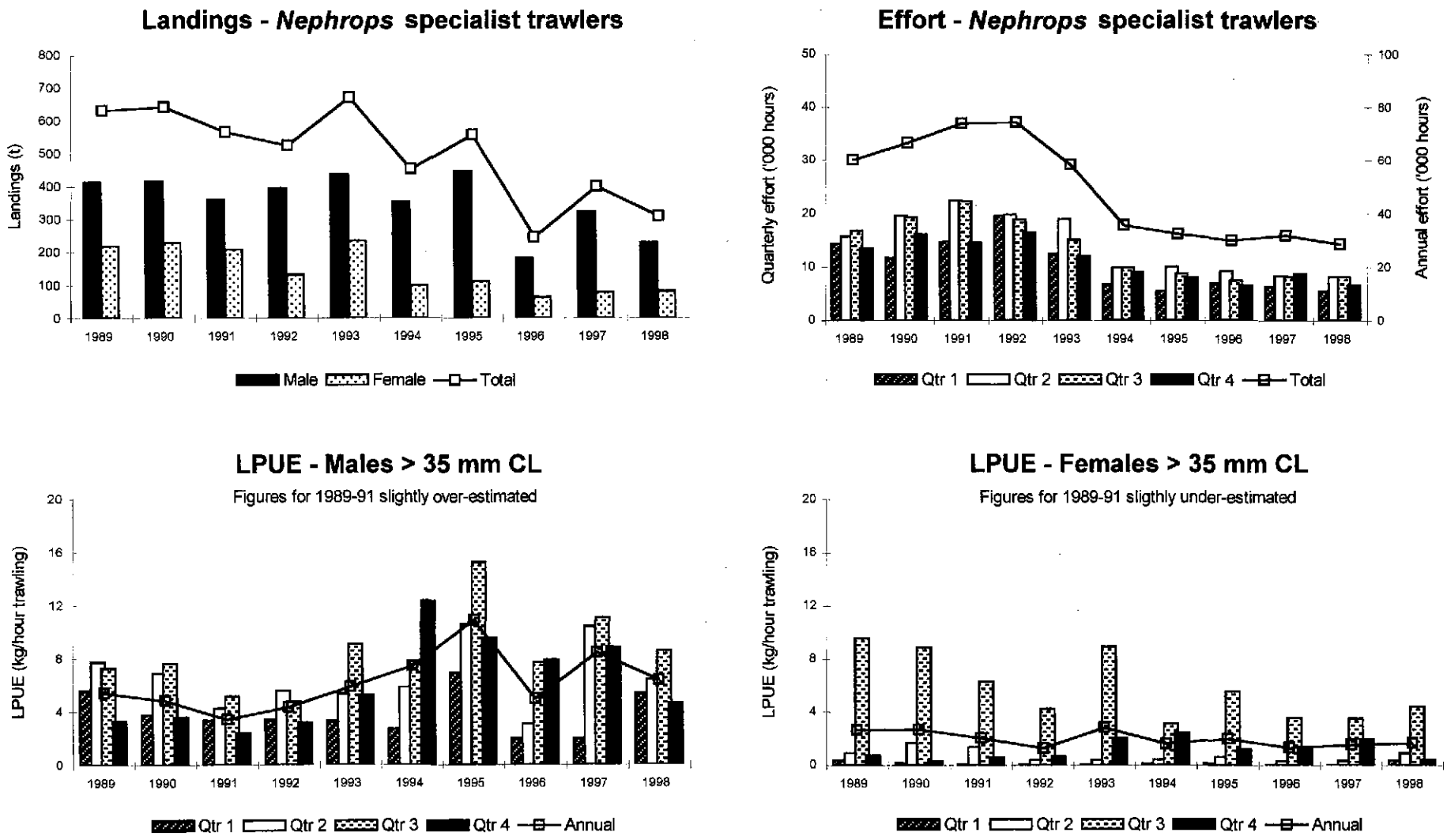
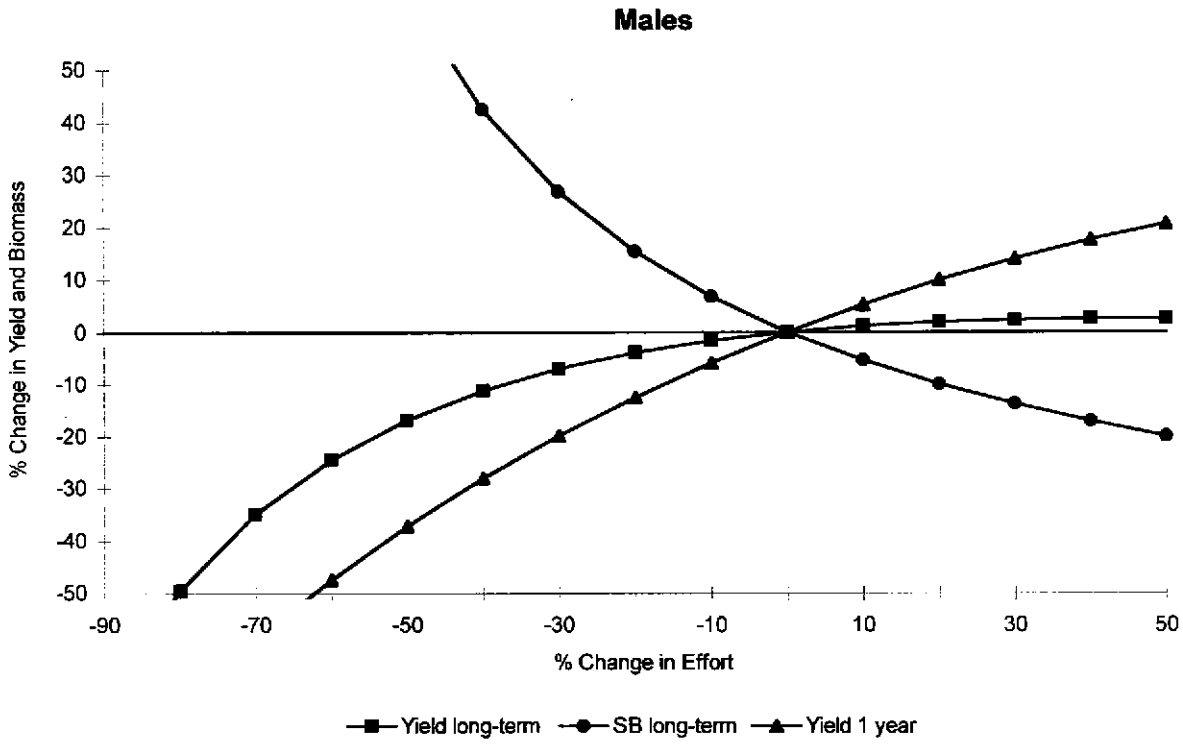


Figure 5.7.2. - Botney Gut - Silver Pit (FU 5): Landings, effort and LPUEs by quarter and sex from Belgian *Nephrops* trawlers.



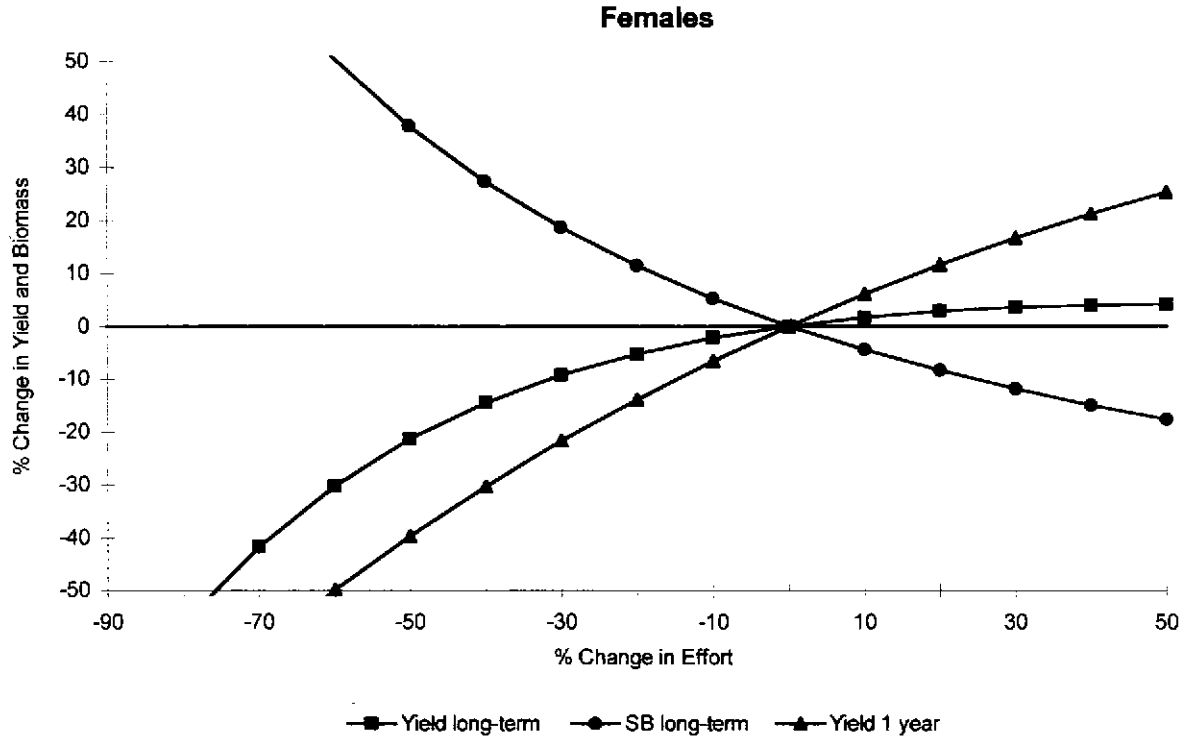


Figure 5.7.3. - Botney Gut - Silver Pit (FU 5): Output LCA: Relative changes in short-term yield (ie after 1 year), long-term yield and long-term biomass upon relative changes in effort. Males and females shown separately.

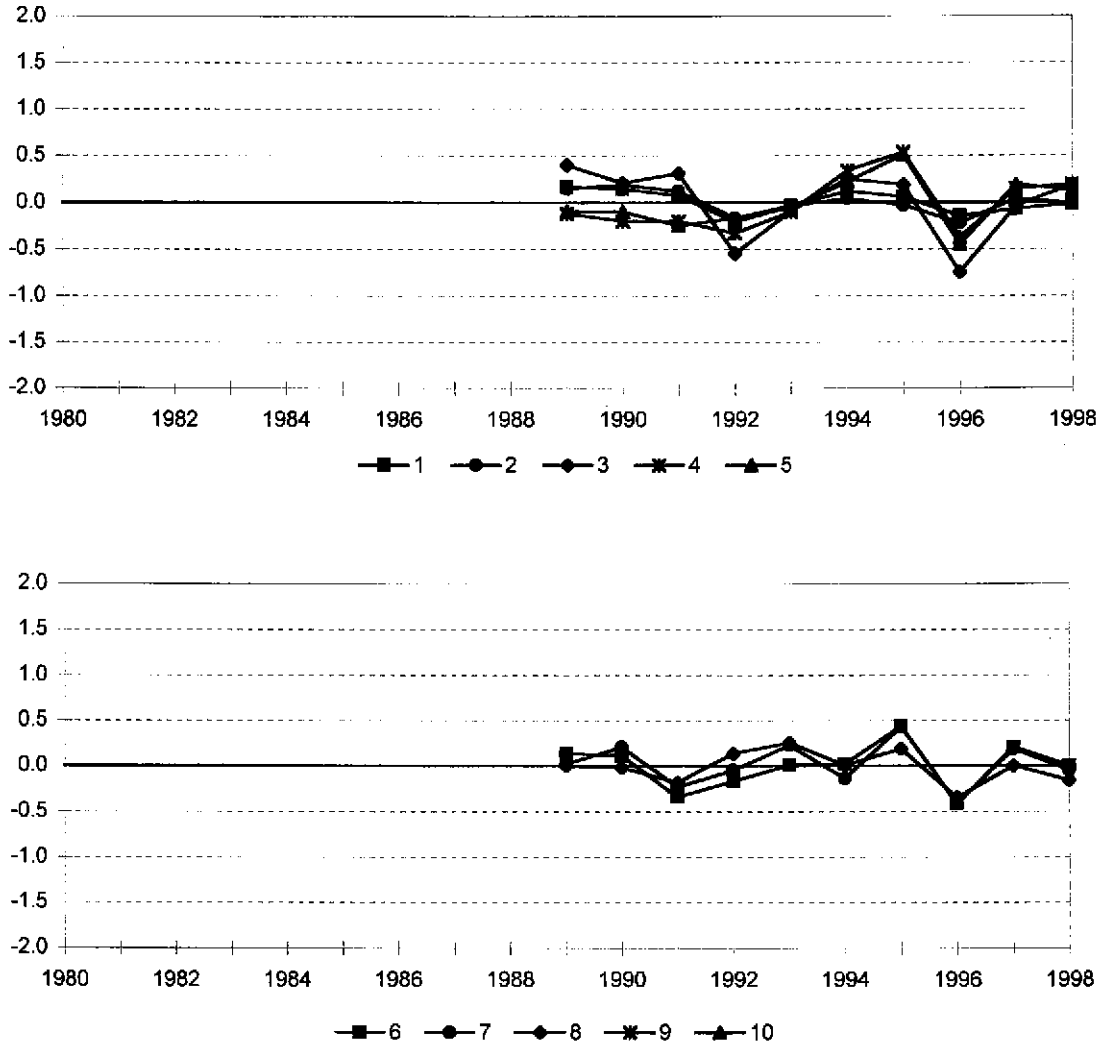
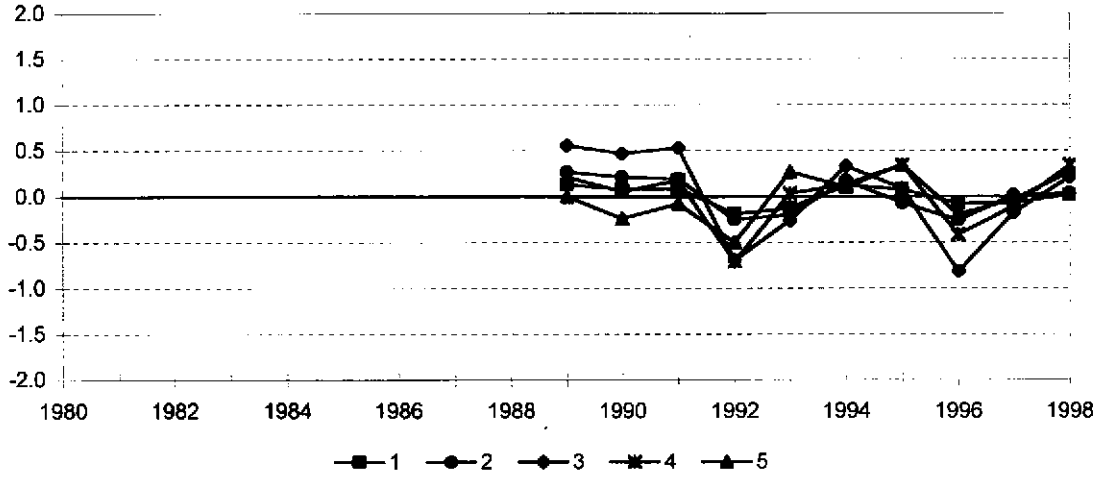
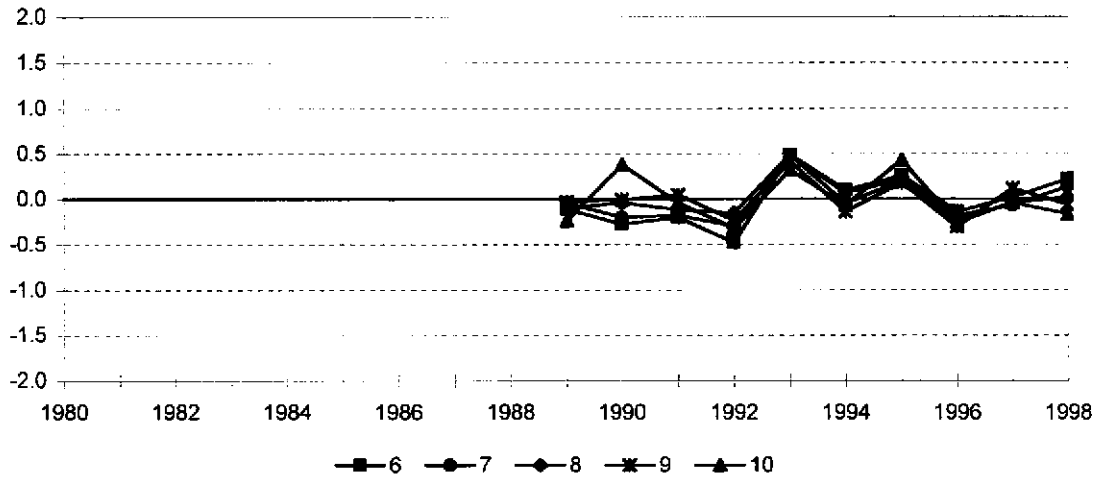


Figure 5.7.4. - Botney Gut - Silver Pit (FU 5): Output VPA males: Log catchability residuals.





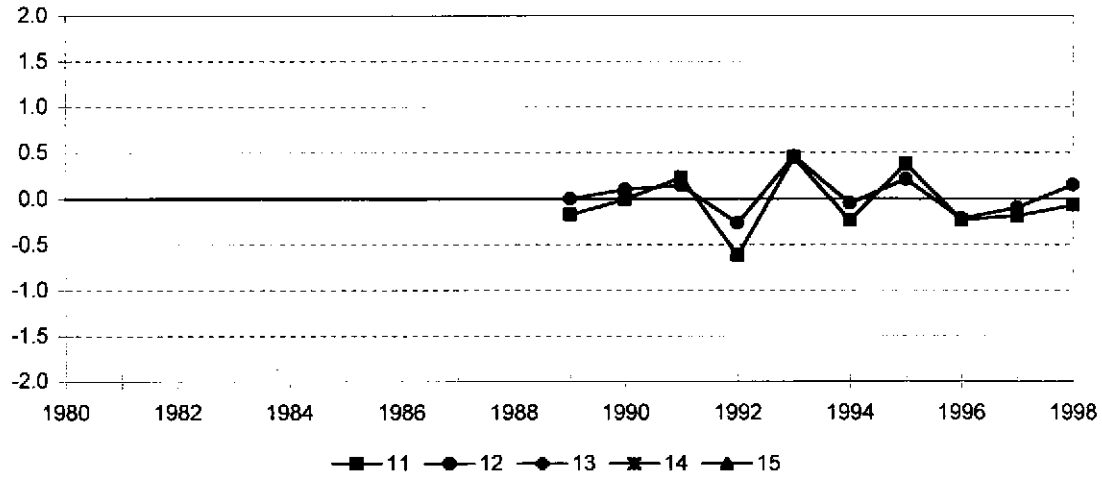


Figure 5.7.5. - Botney Gut - Silver Pit (FU 5): Output VPA females: Log catchability residuals.

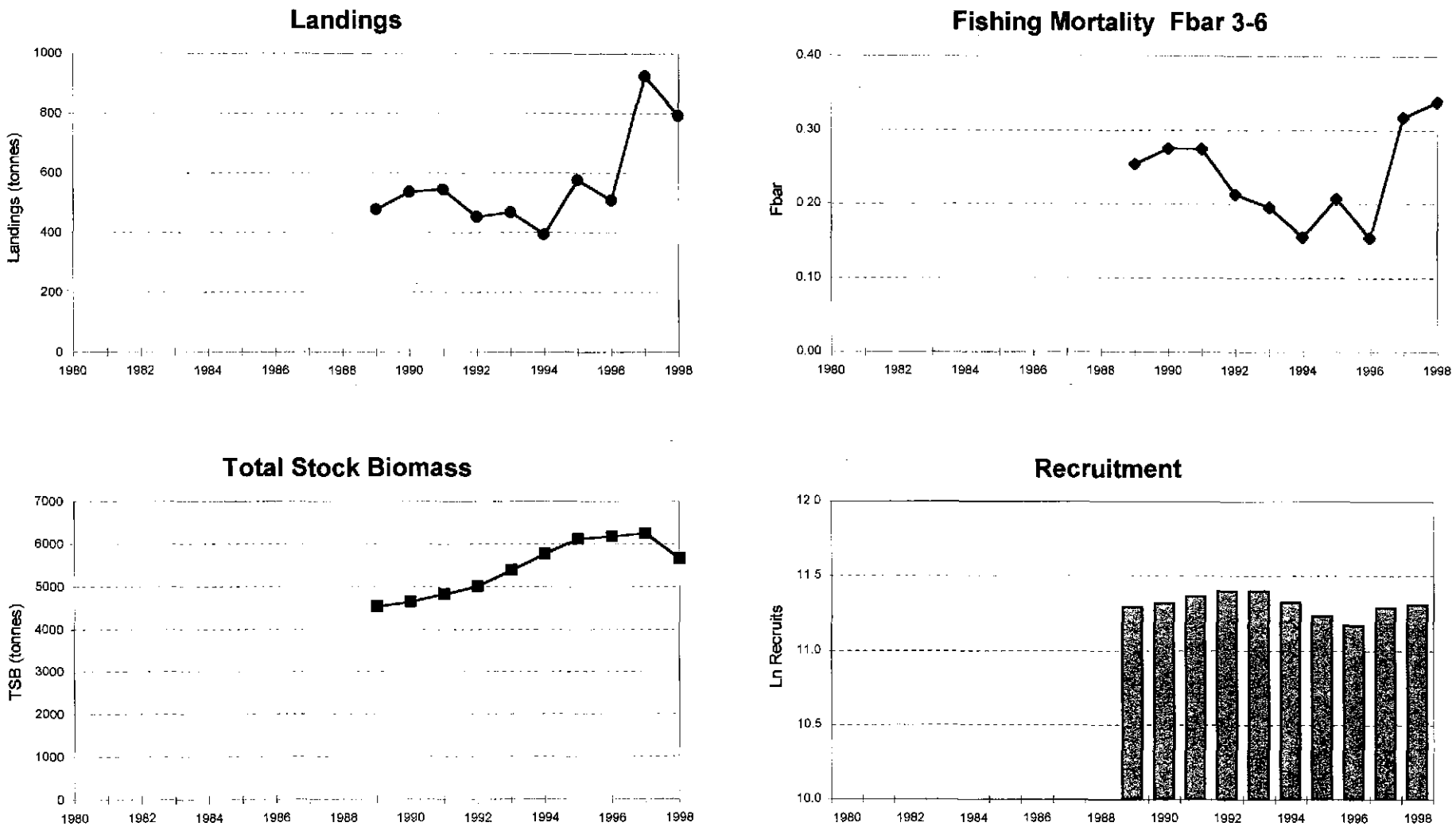


Figure 5.7.6. - Botney Gut - Silver Pit (FU 5): Output VPA males: Trends in Landings, Fbar, TSB and Recruitment.

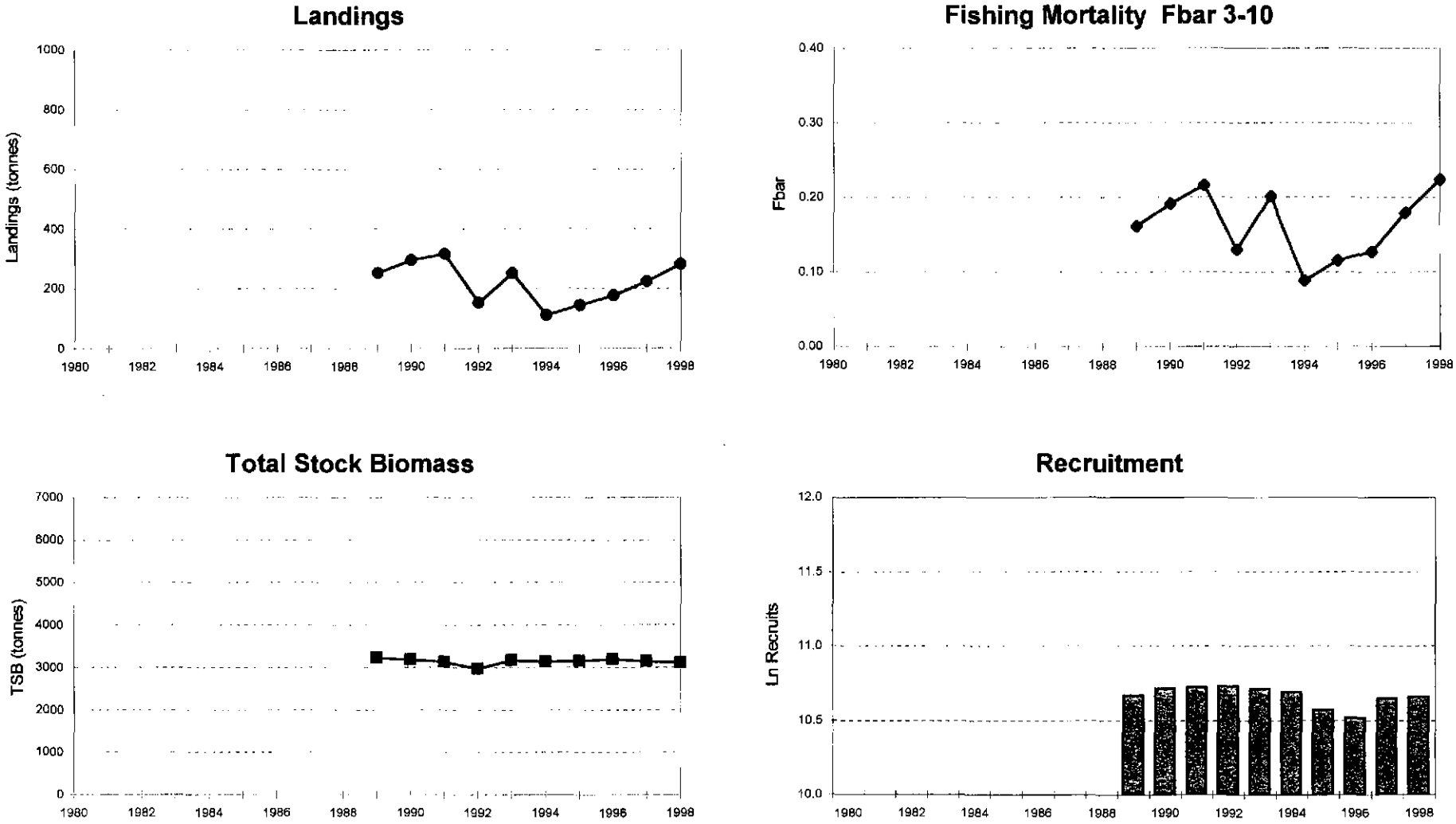


Figure 5.7.7. - Botney Gut - Silver Pit (FU 5): Output VPA females: Trends in Landings, Fbar, TSB and Recruitment.

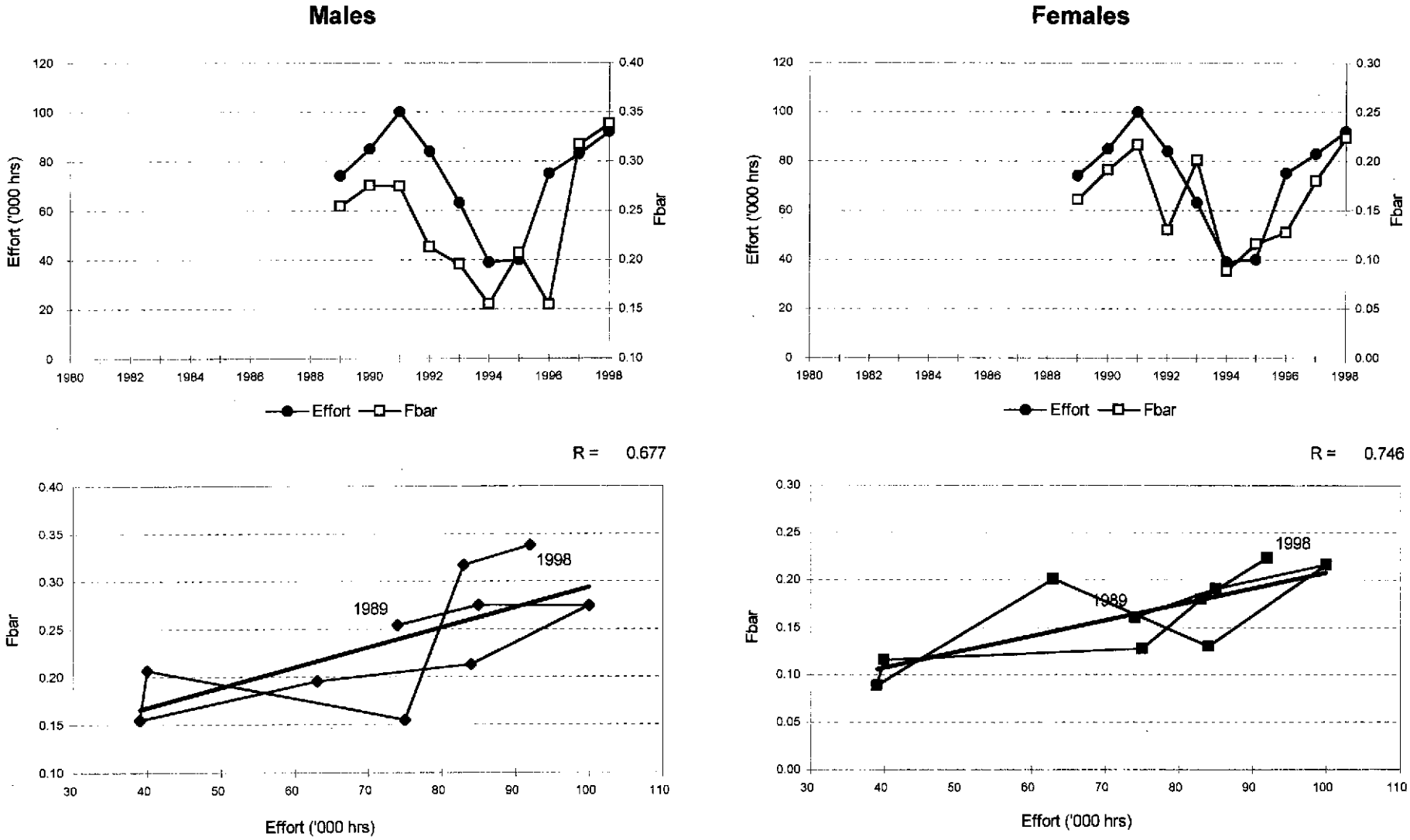


Figure 5.7.8. - Botney Gut - Silver Pit (FU 5): Effort and Fbar, and relationship between them, for males and females.

5.8. Management Area A

ICES description **Va (non-EC)**

Functional Units **Iceland (FU 1)**

The statistical rectangles comprised in this Management Area and its constituent Functional Units are shown in Figure 5.1.2.

5.8.1. Iceland (FU 1)

Description of the fisheries

Around 40-50 boats have been involved in the Icelandic *Nephrops* fishery in recent years, ranging in size from 50-150 GRT and 400-1200 hp. The boats are a mixture of stern trawlers and former side trawlers fitted for stern trawling. All boats are part-time *Nephrops* trawlers, fishing for *Nephrops* during the peak season (May-August), and for other species (with bottom trawls, Danish seine, gill net or long-line) outside the main *Nephrops* season.

The average size of *Nephrops* trawls has increased considerably in the past decade, with increasing headline lengths, and increasing headline heights for added efficiency in catching demersal fish. Nowadays, gears have a headline of 130-220 m, a wire-rope or rockhopper groundrope, and a minimum mesh size of 80 mm. Rockhoppers were introduced in the mid-90s, which has enabled an extension of the fishery into more peripheral *Nephrops* grounds. Twin-trawls came into operation in the early 90s but are still limited to 4-6 boats. Square mesh windows have been legalised for increased escapement of young haddock.

Major landing ports are Grindavik, Thorlakshofn, Vestmannaeyjar (on the Vestman Islands) and Hornafjordur, all on the South coast of Iceland. A small creel fishery was operated in 1989-91, but discontinued in 1992.

Nephrops directed fishing trips last from 2-5 days, with 4-5 hauls of 4-5 hours each per day. Discarding is mainly for economic reasons. The price per kg normally increases four-fold from the size category of 30 mm CL (the minimum legal landing size) to the size category of 50 mm CL and above. All *Nephrops* are landed iced, either whole or tailed. The major part of the landings is subject to direct 'vessel-to-factory' sales agreements, and a small fraction only is sold in the auction.

In a 'good' *Nephrops* season, the value of *Nephrops* can amount to 2/3 of the total landings. In recent years however, fish by-catches have on average increased to 2/3 of the total landed value, due to a combination of less discarding, falling *Nephrops* prices, increased landings of flatfish species and increasing prices of demersal fish. Thus, the fishery has turned into a truly mixed fishery in the 90s. The most important by-catch species, both by weight and value, are cod, haddock, redfish, monkfish and witch.

Unreported landings of *Nephrops* have most likely increased in the last decade. The price of *Nephrops* has become more acceptable to the consumer, and home and restaurant demand (style 'to take the fiancée out for lobster and wine') have increased. This has lead to an increased overall demand on the domestic market and to an increase in the 'black' landings.

The Icelandic *Nephrops* fleet has had a relatively bad time to survive, at least since the mid-90s. CPUEs of *Nephrops* have decreased, coinciding with declining market prices. Moreover, important by-catch species of flatfish (e.g. witch) are on the decline, and the proportions of demersal species in the catches are now playing an increasing role in the economy of the fishery.

Trends in catches, landings, effort, LPUE and mean size

Table 5.8.1. Catches, landings, effort, CPUE and LPUE, Icelandic trawl fishery, 1989-98
Table 5.8.2. Landings, effort and CPUE, Icelandic creel fishery, 1989-98
Table 5.8.3. Mean sizes of *Nephrops* in catches, Icelandic data, 1989-98

The Icelandic *Nephrops* fishery has been managed by overall TACs from 1973-83 and by ITQ since 1984. Also, the fishing season has been limited to the months of May-August, although on occasions exceptions have been made for trial winter fisheries.

Landings, effort and LPUE

With decreasing TACs, landings of *Nephrops* in Iceland have remained low in the period 1995-98 (Table 5.8.1.). The very low landings of 1027 t in 1995 were partly influenced by a fishermen's strike during four weeks in May-June, when CPUEs and landings are normally at their best. However, the principal reason for the most recent decline in the Icelandic *Nephrops* fishery can be related to historically low recruitment levels, although some improvement was observed in certain areas at SE Iceland in 1997-98. The reason for the overall downward trend in recruitment (roughly - 50 % from the mid-70s to the mid-90s) still remains speculative. An apparent recruitment failure observed on the most westerly fishing grounds in recent years, is causing growing concern and further precautionary measures are being considered.

The LPUEs have shown considerable fluctuations over the past decade, from around 51 kg/hour trawling in 1992 and 1993, down to 27 kg/hour in 1995 (Table 5.8.1.). Trends in LPUE are clearly related to recruitment and biomass as indicated by the annual *Nephrops* survey indices for 1985-98, as well as by the results of analytical assessments (VPA, XSA) dating back to 1978. However, catchability has at times been influenced considerably by other than stock-related factors, which can be partly explained by the northerly distribution of *Nephrops* around Iceland.

Mean size

Mean size of especially male *Nephrops* has shown considerable fluctuations following the rapid decline that was observed in the pristine years of the fishery (early 60s). During the period 1989-98, the mean size of males has ranged from 41.6 to 45.4 mm CL (Table 5.8.3.). The trends in mean size are most often thought to reflect variability in recruiting year classes, although periodically lower catch rates do often coincide with larger mean sizes of the catches.

Discard practices studied by fishery inspectors in 1996-98 revealed a wide range of discarding rates, of up to 70 % by numbers, depending on the size composition of the catches. On average, nearly all *Nephrops* < 25 mm CL were discarded, 90 % within the size range of 25-29 mm CL, 65 % between 30-34 mm CL, 35 % within the sizes 35-38 mm CL and about 10 % of individuals of 39-42 mm CL. All undamaged *Nephrops* of 43 mm CL and above were seemingly retained during the sorting process.

Analytical assessments

The Icelandic *Nephrops* stocks are currently being assessed by means of age based assessment techniques (VPA and XSA), the results of which are used to set national TACs. In the absence of details on these assessments, the WG was unable to evaluate their quality, or to give advice on these stocks.

Management considerations

In view of the marked differences in recruitment levels and fishing mortality rates between the *Nephrops* stocks in the south-western and south-eastern Icelandic waters, there seems to be a case to split FU 1 into two sub-units and to develop appropriate management strategies (including separate catch quota) for each of them (EIRIKSSON, pers. comm. via correspondence). According to the most recent assessments, the stock at SW Iceland is declining, with no signs of improving recruitment, whereas at SE Iceland the stock is showing signs of recovery due to increasing recruitment. Pending further information on the issue, the WG suggests to defer a decision on these matters to the next meeting of the WG or the *Nephrops* Study Group, where it can be discussed in more detail, hopefully in the presence of the Icelandic representative to the WG.

5.8.2. Summary for Management Area A

Managed by national TACs, further advice not given.

Table 5.8.1. - Iceland (FU 1): Catches and landings (tonnes), effort ('000 hours trawling), CPUE and LPUE (kg/hour) of Icelandic *Nephrops* trawlers, TAC (tonnes), 1989-98.

Year	Catches	Landings	Effort	CPUE	LPUE	TAC
1989	2100	1866	51.8	41.1	36.0	2100
1990	1939	1692	42.3	46.7	40.0	2100
1991	na	2157	51.2	na	42.1	2100
1992	na	2230	43.5	na	51.3	2100
1993	na	2381	46.3	na	51.4	2200
1994	na	2238	58.9	na	38.0	2200
1995	1127	1027	38.0	29.7	27.0	2200
1996	1888	1633	46.4	40.7	35.2	1500
1997	1492	1229	39.3	38.0	31.3	1200
1998 *	1576	1418	36.4	43.3	38.9	1200

* provisional na = not available

Table 5.8.2. - Iceland (FU 1): Landings (tonnes), effort ('000 creel hauls) and LPUE (g/creel haul) of creel caught *Nephrops*, 1989-98.

Year	Landings	Effort	LPUE
1989	25	113.1	221
1990	31	103.0	301
1991	8	35.2	227
1992	0	0	na
1993	0	0	na
1994	0	0	na
1995	0	0	na
1996	0	0	na
1997	0	0	na
1998 *	0	0	na

* provisional na = not available

Table 5.8.3. - Iceland (FU 1) : Mean sizes (CL mm) of male and female *Nephrops* in catches, 1989-98.

Year	Catches	
	Males	Females
1989	44.0	35.7
1990	41.6	35.3
1991	42.1	36.5
1992	43.5	35.6
1993	45.0	na
1994	45.2	na
1995	45.4	na
1996	43.7	na
1997	43.6	na
1998 *	45.1	na

* provisional na = not available

5.9. Management Area B

ICES description **Vb (non-EC)**

Functional Units **Faeroes (FU 2)**

The statistical rectangles comprised in this Management Area and its constituent Functional Units are shown in Figure 5.1.2.

5.9.1. Faeroes (FU 2)

Trends in landings, effort, LPUE and mean size

Table 5.9.1. Landings by country, 1989-98

No new information on the landings, effort and LPUEs of the Faeroe creel fishery was available to the WG.

5.9.2. Summary for Management Area B

Managed by national TACs, further advice not given.

Table 5.9.1. - Faeroes (FU 2): Landings (tonnes), effort ('000 creel days) and LPUE (g/creel day) of creel caught *Nephrops*, seasons 1988/89 - 1987/98.

Season	Landings	Effort	LPUE
1988/89	74	628	117
1989/90	62	650	96
1990/91	56	624	90
1991/92	57	785	73
1992/93	63	889	71
1993/94	73	1162	63
1994/95	76	na	na
1995/96	na	na	na
1996/97	na	na	na
1997/98	na	na	na

* provisional na = not available

5.10. Management Area D

ICES description **Vb (EC) and VIb**

Functional Units **none**

The statistical rectangles comprised in this Management Area are shown in Figure 5.1.2.

5.10.1. Summary for Management Area D

Zero TAC to prevent mis-reporting.

5.11. Management Area C

ICES description **VIa**

Functional Units **North Minch (FU 11)**
South Minch (FU 12)
Firth of Clyde (FU 13)

The statistical rectangles comprised in this Management Area and its constituent Functional Units are shown in Figure 5.1.2.

5.11.1. North Minch (FU 11)

Description of the fisheries

UK – Scotland

An extensive description of the Scottish fisheries in this area will be given in the next WG Report.

Trends in landings, effort, CPUE, LPUE and mean size

Table 5.11.1. Landings by country, 1989-98
Table 5.11.2. Effort and LPUEs Scottish fleet, 1989-98
Table 5.11.3. Mean sizes of *Nephrops* in catches and landings, Scottish data, 1989-98
Figure 5.11.1. Long-term trends in landings, effort, LPUE and mean size, Scottish data
Figure 5.11.2. Landings by sex + Quarterly plots of effort and LPUEs by sex, 1989-98
Figure 5.11.3. Quarterly plots of CPUEs for selected size groups, 1989-98
Figure 5.11.29. Fishing intensity indices

Landings, effort, CPUE, LPUE and mean size

Landings data were reported from UK vessels alone. In 1997, total landings were 3046 t (representing a slight increase over the 1996 figure), but in 1998 they declined by over 600 t to 2428 t. *Nephrops* trawlers accounted for 83 % of the landings. Landings by creel (which account for 13-14 % of the total) showed a pattern similar to total landings.

Effort by *Nephrops* trawlers rose in 1997, but fell slightly in 1998, and shows an overall declining trend since 1993. The long-term data series shows that effort has been relatively stable in the last few years (Figure 5.11.1.).

Nephrops trawl LPUE appears to have been fairly stable since 1986 (Figure 5.11.1.), although the value for 1998 is at the lower end of the range. The use of 70 mm mesh multi-rig gear by *Nephrops* trawlers has now been eliminated in this fishery, following the UK national ban, but fishing with larger mesh multi-rig gears is now increasing.

In general, males make the largest contribution to the landings and the LPUEs, though in some years (e.g. 1989-90) the contributions from the two sexes were more equal (Figure 5.11.2.). This appears to be associated with reduced fishing effort in the 1st quarter. There appears to have been a decline in male LPUE since 1996, but the value for females has remained stable.

CPUE data for each sex, for *Nephrops* above and below 35 mm CL, are shown in Figure 5.11.3. This size was chosen for all the Scottish stocks examined as the general size limit for discarded animals. The data show a peak in CPUE for smaller individuals in 1994 (and for females in 1995), with values declining to the longer term average after this. The CPUEs for larger males also increased in 1994 (albeit to a lesser extent than the ones for the smaller individuals), and have gradually declined since then. Examination of these data in conjunction with the changes in mean size of the two size categories, leads to the suggestion that a strong year class entered the fishery in 1994, since mean size dropped in the < 35 mm CL category but was stable in the larger animals. The progression of this year class through the fishery may have led to the increase and then decrease in CPUE of the larger individuals.

Fishing intensity indices

Fishing intensity indices derived from estimates of ground area (see ICES, 1993a) are shown in Figure 5.11.29. These suggest that landings per area and effort per area in the North Minch are high compared to some other Scottish stocks, but have slightly declined since 1995. The indices are over-estimates, however, because some areas of muddy substrate are not taken into account.

Data and biological inputs for analytical assessments

Table 5.11.6. Sampling data and input parameters

The length compositions of commercial landings were obtained by port sampling during most months of the year in both 1997 and 1998, with between 2 and 18 samples collected in any one quarter. Sampling of the discards took place on board commercial trawlers during the 3rd and 4th quarter of 1997, and during the 1st, 2nd and 4th quarter of 1998. The trawl landings and discard sample data were raised to fleet level. An average of discard data for the years 1990-91 was used to estimate the removals in earlier years.

Sampling of the creel landings was achieved in each quarter of 1997, and in the 1st, 3rd and 4th quarter of 1998. While there is some overlap in the spatial distribution of the creel and trawl fisheries, the former is mostly limited to sealochs and inshore areas, sometimes exploiting different populations than the trawl fishery.

The assessments were run using the same input parameters as before, except for female size at maturity, which was increased from 25 to 27 mm CL, following results presented at the 1998 *Nephrops* Study Group (ICES, 1998b).

General comments on quality of data and inputs

There are no details on the accuracy of the landing figures in this fishery. The rapid uptake of the TAC, highlighted in earlier years, has not been repeated, and with the reduction in landings from this stock, under-reporting is not thought to be a problem.

A reasonable level of port sampling is achieved for the trawl fishery, usually on a monthly basis, but sampling of the discards has only been possible since 1990, and there are gaps in the quarterly discard sampling. The choice of biological inputs is based on observations from other Scottish areas (see discussion in ICES, 1993a).

Sampling of the creel fishery has been limited to a few samples in most years. A VPA assessment for the creel fishery was attempted in 1993 but has not been repeated because of the paucity of data.

Length based assessments (LCA)

In the recent past, only the trawl fishery in this area has been assessed (ICES, 1997a). At this WG, an LCA was also carried out for the creel fishery.

LCA Trawl fishery

Table	5.11.7.	Output table LCA males, with mean F
Table	5.11.8.	Output table LCA females, with mean F
Figure	5.11.4.	Changes in Y/R and B/R upon changes in F, for males and females separately

LCA was carried out using length composition data for the most recent three years' reference period (1996-98). The same input F choices were used as previously (0.15 and 0.03 for males and females respectively).

The results were very similar to those obtained in 1997 (ICES, 1997a). The long-term Y/R curve for the males is fairly flat-topped, with current F above F_{max}, while the relationship for females is curvi-linear, with current F well below F_{max}. Annualised fishing mortalities (averaged across the inter-quartile length range) are 0.62 and 0.19 for males and females respectively.

LCA Creel fishery

Table	5.11.9.	Output table LCA males, with mean F
Table	5.11.10.	Output table LCA females, with mean F
Figure	5.11.5.	Changes in Y/R and B/R upon changes in F, for males and females separately

An LCA was carried out using creel length composition data for the most recent three years (1996-98). The same input F choices were used as for the trawl fishery LCA (0.15 and 0.03 for males and females respectively).

The creel LCA shows that the long-term Y/R curve was fairly flat-topped for males, with current F below F_{max}, and curvi-linear for females, with current F well below F_{max}. Annualised

fishing mortalities (averaged across the inter-quartile length range) were 0.41 and 0.03 for males and females respectively, i.e. lower than for the trawl fishery.

Age based assessments (VPA)

A single fleet assessment was carried out using Scottish data from 1981-98. The Lowestoft VPA program was used on nominal 'age' groups, generated by slicing the length distributions. Tuning of the VPA was carried out using Scottish *Nephrops* trawl effort data, adjusted in the same way as for the Moray Firth (see Section 5.3.1.). Landings from the creel fishery (which are generally taken from the more inshore regions) were excluded from the VPA. The sexes were assessed separately.

Males

Table 5.11.11. Output XSA males: Fs-at-age
Table 5.11.13. Output XSA males: Long-term trends in landings, Fbar, TSB and recruitment
Figure 5.11.6. Output XSA males: Log catchability residuals
Figure 5.11.8. Output XSA males: Long-term trends in landings, Fbar, TSB and recruitment
Figure 5.11.10. Output XSA males: Plots of Fbar vs. effort

The slicing procedure generated 11 nominal 'age' groups (11 = plus group). Preliminary calculations showed that SOP discrepancies were small in relation to the landed weights, and since the analysis included a proportion of discards, no corrections were applied. Tuning of the VPA was carried out using the XSA option. Tuning was performed over the whole 18 year period and over ages 1-10, with a tricubic time taper but without shrinkage. For the catchability analysis, catchability was dependent on stock size for ages < 3 (with estimates shrunk to the population mean) and independent of age for ages > 4. Survivor estimates were shrunk towards mean F. The tuning converged after 16 iterations.

For the younger ages there was no evidence of trends in the log catchability residuals, but for age 1 there were large fluctuations. There were also large fluctuations for age 9 in some years. Other ages showed some year effects.

Trends in the estimates of yield, mean F, TSB and recruitment are plotted in Figure 5.11.8. Although F_{bar} has fluctuated, it remained relatively constant throughout the time series. TSB and recruitment estimates reveal a similar picture of fluctuation without trend - apparently declining in the late 80s, increasing again thereafter, and then declining in the most recent years. Current values of TSB and recruitment are at the lower end of the range.

The correlation between F_{bar} and effort is not significant ($r = 0.33$; $p = 0.17$), indicating that the VPA has not taken good account of the pattern in fishing mortality.

Females

Table 5.11.12. Output XSA females: Fs-at-age
Table 5.11.14. Output XSA females: Long-term trends in landings, Fbar, TSB and recruitment
Figure 5.11.7. Output XSA females: Log catchability residuals
Figure 5.11.9. Output XSA females: Long-term trends in landings, Fbar, TSB and recruitment
Figure 5.11.10. Output XSA females: Plots of Fbar vs. effort

The slicing procedure gave 16 nominal 'age' groups (16 = plus group). As for the males, mean catch weights-at-age were assumed to represent stock weights and no SOP corrections were applied. Different values of M were chosen for immature and mature females. XSA tuning choices were the same as for males. The tuning had not converged to the program criteria after 30 iterations, but examination of the final year F values from the last two iterations suggests that convergence had occurred to 3 decimal places.

For young ages, there was no evidence of trends in the log catchability residuals, but for age 1 there were large fluctuations throughout the time period. Older ages show strong year effects.

Trends in yield, mean F, TSB and recruitment estimated by the VPA are shown in Figure 5.11.9. F_{bar} values are low, but higher than for the females in some other Scottish stocks (e.g. Moray Firth, FU 9; see Section 5.3.1.). The estimates of TSB show a slight increase in the early 80s, and much more stable values in later years. Recruitment declined in the early 80s, and rose again to a peak in 1993 and 1994, but has been lower again in recent years. Comparison of the TSB and recruitment estimates for the two sexes shows marginally greater values in females than in males.

As for the males, the correlation between F_{bar} and effort is not significant ($r = 0.16$; $p > 0.05$), indicating that the VPA has not taken good account of the pattern in fishing mortality.

Fishery independent methods - TV surveys

Table 5.11.4. Results of 1998 underwater TV survey
Table 5.11.5. Overview results of underwater TV surveys, 1994-98

A TV camera and trawl survey of the North Minch grounds was conducted during a cruise of RV '*Scotia*' in 1998. Estimates of mean burrow density across different strata varied from 0.32-0.68 per m^2, with an overall mean density of 0.41 per m^2, the highest observed at this ground to date. Abundance estimates raised to the total ground area (1775 km^2) increased from 439 10^6 burrows in 1996 to 728 10^6 in 1998, and the corresponding biomass estimates were in the range 8.3-11.1 10^3 and 13.8-18.4 10^3 t in 1996 and 1998 respectively. The results suggest an increase in abundance and biomass of the stock since the last survey. This increase is not matched by the VPA estimated stock biomass, but it may reflect recruitment of very small animals that will appear in the fishery in the year(s) to come. A longer time series of surveys without gaps will improve the usefulness of this approach

Comments on quality of assessments

The trawl fishery LCA gave results similar to previous analyses (ICES, 1997a). There was reasonable agreement between male and female population numbers in the recruiting age classes, suggesting some consistency between the two analyses. The creel fishery LCA estimated four times as many female recruits as male recruits, suggesting a lack of consistency between assessments. This is probably related to the very low F values estimated for the females in this analysis.

Although the relationships between F_{bar} and effort from the VPA were not significant for either sex, and F was low for females, estimated recruits were similar for both sexes and comparison of the biomasses suggests that the results are not unrealistic.

TV survey coverage is considered reasonable in each year, although the gaps in the series are unfortunate.

Management considerations

The LCA results for males suggest that the stock is overexploited, though the Y/R curve is fairly flat-topped. The potential yield gain upon a reduction of effort to F_{max} would be very small. The long-term trend plots suggest that fishing effort has been reasonably stable in the last six years, and the VPA suggests that F is stable for both sexes. Although biomass may have declined in recent years, the TV survey suggests that a larger recruitment may enter this fishery next year. The WG therefore concluded that the advice given before (ICES, 1997a) is still appropriate, namely that fishing effort should be maintained at the current level.

While the LCA results suggest that the creel fishery is exploited at a lower level than the trawl fishery, examination of the catch compositions shows that creeling may have a disproportionate effect on the ovigerous females. For females > 35 mm CL, the proportion of the female creel catch that is berried, is considerably higher overall than for the trawl fishery (Figure 5.11.11.). Also, a different seasonal pattern is shown by the fisheries, with creel landings including a large proportion of berried females in the first three quarters of the year. While the overall numbers of females removed are far greater for the trawl fishery (Figure 5.11.12.), the numbers of berried females removed are more similar, particularly in recent years, and the numbers of larger berried females removed are greater for the creel fishery. The WG suggests that it may not be appropriate to expand effort in a fishery that exploits the female spawning stock in such a way, since it has been argued before that the self-protection of the berried females in their burrows has ensured adequate recruitment in most fisheries.

5.11.2. South Minch (FU 12)

Description of the fisheries

UK – Scotland

An extensive description of the Scottish fisheries in this area will be given in the next WG Report.

Trends in landings, effort, CPUE, LPUE and mean size

Table 5.11.15. Landings by country, 1989-98
Table 5.11.16. Effort and LPUEs Scottish fleet, 1989-98
Table 5.11.17. Mean sizes of *Nephrops* in catches and landings, Scottish data, 1989-98
Figure 5.11.13. Long-term trends in landings, effort, LPUE and mean size, Scottish data
Figure 5.11.14. Landings by sex + Quarterly plots of effort and LPUEs by sex, 1989-98

Figure 5.11.15. Quarterly plots of CPUEs for selected size groups, 1989-98
Figure 5.11.29. Fishing intensity indices

Landings, effort, CPUE, LPUE and mean size

Landings data were reported from UK vessels alone. In 1997, total landings were 4342 t, an increase of 400 t on the previous year, but in 1998 total landings were down to 3710 t, the lowest figure in over a decade. 76 % of the landings are by *Nephrops* trawl, 14 % by other trawls, and 10 % by creel.

Landings and effort remained fairly stable between 1988 and 1994, but have declined slightly over the last four years (Figure 5.11.13.). LPUEs have fluctuated without obvious trend, and mean sizes of the size categories < 35 and > 35 mm CL in catches and landings have remained fairly stable.

Males contribute more to the landings and the LPUEs than females (Figure 5.11.14.). The contribution of females seems to be greater in years when fishing effort is relatively high during the 2nd and 3rd quarter, for example in 1989 and 1990. The CPUEs for males have remained stable for the size ranges above and below 35 mm, while those for the larger females appear to have been slightly higher in the most recent years than earlier in the time series (Figure 5.11.15.).

Fishing intensity indices

Trends in landings per area and effort per area indices for the South Minch are shown in Figure 5.11.29. The data suggest that recent fishing intensity on this stock is moderate in comparison to some other stocks in the Scottish waters.

Data and biological inputs for analytical assessments

Table 5.11.20. Sampling data and input parameters

Length compositions of commercial trawl landings were obtained by port sampling on a monthly basis. Discard sampling on board commercial trawlers took place in each quarter of 1997 and 1998. Large numbers of samples have been achieved through an EU funded project. Landing and discard samples were raised to trawl fleet level in the same way as for the North Minch (FU 11).

In both 1997 and 1998, sampling of the landings was achieved in the creel fishery in each quarter. As in the North Minch, the creel fishery mostly takes place in inshore areas, and generally exploits a different population to that of the trawl fishery.

All input parameters remained the same as previously (see e.g. ICES, 1997a), except for female size at maturity, which decreased from 26 to 25 mm CL.

General comments on quality of data and inputs

As for the North Minch, the biological variability and the heterogeneous nature of the *Nephrops* grounds within the stock makes the choice of parameters difficult.

Length based assessments (LCA)

In the recent past, only the trawl fishery in this area has been assessed (ICES, 1997a). At this WG, an LCA was also carried out for the creel fishery.

LCA Trawl fishery

Table 5.11.21. Output table LCA males, with mean F
Table 5.11.22. Output table LCA females, with mean F
Figure 5.11.16. Changes in Y/R and B/R upon changes in F, for males and females separately

The LCA was carried out using the most recent four years (1995-98) as the reference period. Input F choices were the same as in previous assessments (0.3 and 0.25 for males and females respectively). Output results too were similar to previous years. The Y/R curve for the males is very flat-topped, with current F above F_{max}, while that for the for females is curvi-linear, with current F well below F_{max}. Annualised fishing mortalities (averaged over the inter-quartile length range) were 0.49 and 0.15 for males and females respectively.

LCA Creel fishery

Table 5.11.23. Output table LCA males, with mean F
Table 5.11.24. Output table LCA females, with mean F
Figure 5.11.17. Changes in Y/R and B/R upon changes in F, for males and females separately

LCA was carried out using length composition data for the most recent three years (1996-98). Input F choices were the same as for the trawl fishery LCA (0.3 and 0.25 for males and females respectively).

The results show that the long-term Y/R curve for males is fairly flat-topped, with current F slightly above F_{max}, while the relationship for females is curvi-linear, with current F well below F_{max}. Annualised fishing mortalities were 0.20 and 0.03 for males and females respectively, i.e. lower than for the trawl fishery.

Age based assessments (VPA)

VPA assessments have been carried out previously for this FU (ICES, 1992a and 1993a) and failed to give conclusive results. The approach was attempted again this year, but it was decided not to report the results as they were considered misleading. Tuning diagnostics indicated that the VPA had performed poorly, with downward trends in catchability and no relationship between F_{bar} and effort.

Fishery independent methods - TV surveys

Table 5.11.18. Results of 1997 and 1998 underwater TV surveys
Table 5.11.19. Overview results of underwater TV surveys, 1995-98

TV camera and trawl surveys of the South Minch grounds were conducted during cruises of RV '*Clupea*' in 1997 and 1998. Estimates of mean burrow density across different sediment strata varied from 0.26-0.29 per m^2 in 1997, and from 0.32-0.66 per m^2 in 1998. Abundance

estimates raised to the total ground area (5071 km^2) fell from the 1996 estimate of 1945 10^6 burrows, to 1434 10^6 in 1997, then increased again to 1916 10^6 in 1998. The corresponding biomass estimates were in the range 25.8-36.5 10^3 t and 35.0-48.3 10^3 t in 1997 and 1998 respectively. Over the four years of surveys to date, the abundance has shown no trend, remaining relatively stable. A longer time series of surveys will improve the usefulness of this assessment technique.

Comments on quality of assessments

As for the North Minch (FU 11), the updated trawl fishery LCA gave consistent results in terms of male and female numbers in the recruiting age classes. Reservations on the accuracy of the TV results arising from survey coverage and mean weights applied, suggest that the biomass estimates should be treated cautiously. The creel fishery LCA estimated female recruitment to be three times higher than males. As with the North Minch, this may be due to very low F values for the females.

Management considerations

This year's LCA results broadly confirm those given in the 1997 WG Report (ICES, 1997a). The Y/R curve for the males was very flat-topped with current F above F_{max}. The potential long-term gains from an effort reduction would, however, be very small. Fishing effort appears to have been fairly stable since 1987 and fishing pressure is not particularly high in comparison with other stocks when related to the area of muddy sediments available (Figure 5.11.29.). The long-term data series shows that LPUE has fluctuated without obvious trend, and TV estimates of abundance are fairly stable. The WG concluded that maintaining effort at current levels would be appropriate for this stock.

While the LCA results suggest that the creel fishery is exploited at a lower level than the trawl fishery, catches of berried females are high (Figures 5.11.18. and 5.11.19.). As for the North Minch (FU 11), the WG therefore suggests that it may not be appropriate to expand effort in a fishery that exploits the female spawning stock in such a way.

5.11.3. Firth of Clyde (FU 13)

Description of the fisheries

UK – Scotland

An extensive description of the Scottish fisheries in this area will be given in the next WG Report.

Trends in landings, effort, CPUE, LPUE and mean size

Table 5.11.25. Landings by country, 1989-98
Table 5.11.26. Effort and LPUEs Scottish fleet, 1989-98

Table 5.11.27. Mean sizes of *Nephrops* in catches and landings, Scottish data, 1989-98
Figure 5.11.20. Long-term trends in landings, effort, LPUE and mean size, Scottish data
Figure 5.11.21. Landings by sex + Quarterly plots of effort and LPUEs by sex, 1989-98
Figure 5.11.22. Quarterly plots of CPUEs for selected size groups, 1989-98
Figure 5.11.29. Fishing intensity indices

Landings, effort, CPUE and LPUE

Landings data were reported from UK vessels alone. Table 5.11.25. shows the overall annual landings for the FU, and the results of partitioning the data by area and by gear. In 1997, overall landings were 3556 t, a decrease of almost 500 t on the previous year. In 1998, the provisional landings were 4658 t, an increase of over 1000 t and the highest value recorded so far. The proportion of the total uptake in MA C landed from FU 13 was considerably higher than in the years before (also see Table 5.11.38.). Over 95 % of the landings in 1997 and 1998 were made by *Nephrops* trawlers, with creel landings making up less than 1 %. When split by area, it becomes clear that the greater proportion of the landings is taken in the Firth of Clyde. In recent years, only about 11 % of the landings were taken from the Sound of Jura.

Landings, fishing effort and LPUE data attributed to *Nephrops* trawlers are given separately in Table 5.11.26. for the Firth of Clyde and Sound of Jura. In the Sound of Jura, the LPUEs are consistently higher than in the Firth of Clyde, although catch rates have increased in the Firth of Clyde in recent years and the difference has reduced.

Multi-rig trawls contribute a high proportion of fishing effort in both the Sound of Jura and the Firth of Clyde. The large increase in landings cannot be explained by increased effort, which has been fairly stable in recent years. Increased LPUEs seem the most likely explanation. Taking the FU as a whole, there are large fluctuations in LPUE, with relatively low values between 1989 and 1994, and an increase in the last four years, back to the levels recorded in the mid-80s (Figure 5.11.20.).

Figure 5.11.21. shows landings, effort and LPUE data apportioned between the sexes. These data refer to the Firth of Clyde only, and suggest that females contribute a fairly high proportion of the landings in some years (e.g. 1989, 1990 and 1994), though males generally have higher LPUEs. The recent increase in overall LPUE appears to follow a recent increase in LPUE of both sexes.

CPUEs were also calculated for animals above and below 35 mm CL, the general size limit for discarding in Scottish stocks. While the CPUEs of both sexes have increased for the smaller animals in recent years (Figure 5.11.22.), the CPUEs for the larger animals have remained relatively stable throughout the time period, except for a dip in 1991 and 1992.

Mean size

The mean sizes of animals > 35 mm CL in the landings have fluctuated without obvious trend (Figure 5.11.20.), but the mean size of the smaller individuals in the catches fell in 1993-94 and also in 1998. Considering this information in conjunction with the CPUEs for the two size ranges, it would appear that the increase in LPUE and landings in recent years has been due to large numbers of smaller individuals entering the fishery.

Fishing intensity indices

On the basis of landings and effort per unit area of ground (Figure 5.11.29.), fishing pressure on the Clyde stock is quite high compared to other stocks.

Data and biological inputs for analytical assessments

Table 5.11.30. Sampling data and input parameters

Length compositions of the commercial landings were obtained by sampling at the main ports during most months of the year. Discard sampling was carried out on board commercial trawlers during the 2nd, 3rd and 4th quarter of 1997 and 1998. The landings and discard samples were raised to fleet level, as described for the North Minch (FU 11) (see Section 5.11.1.). So far, nearly all sampling of landings and discards has been done in the Firth of Clyde fishery (East of Kintyre), and very little sampling in the Sound of Jura (West of Kintyre). No sampling of the (small) creel fishery has been carried out. Input parameters were the same as in previous years.

General comments on quality of data and inputs

Data for this FU have been separated to show fishery statistics for each side of the Kintyre Peninsula. This enables the Firth of Clyde population to be assessed using a more appropriate set of biological parameters. Sampling in the Sound of Jura has not improved sufficiently to permit separate assessments for this area.

No details are available concerning the accuracy of the landing figures in this fishery. In recent years, catch rates have been very high in the Clyde, and under-reporting may have re-occurred.

Previous WG Reports (ICES, 1997a) commented on the high prevalence of the parasitic dinoflagellate *Hematodinium* in Clyde *Nephrops* (FIELD et al., 1992; ICES, 1994b), but this was not taken into account in the choice of the input parameters. Recent surveys have shown current prevalence to be considerably lower than the high rates identified in the early 90s.

Length based assessments (LCA)

Table 5.11.31. Output table LCA males, with mean F
Table 5.11.32. Output table LCA females, with mean F
Figure 5.11.23. Changes in Y/R and B/R upon changes in F, for males and females separately

The years 1996-98 (during which effort was reasonably stable) were used as the reference period for the LCA. Input F choices were the same as in previous assessments (0.2 and 0.025 for males and females respectively) (ICES, 1997a). Results too were similar to the previous assessments, although males appear slightly more overexploited, with F further above F_{max} than before. For females, the Y/R relationship was virtually linear. Annualised fishing mortalities (averaged across the inter-quartile length range) were 0.65 and 0.03 for males and females respectively.

Age based assessments (VPA)

A single fleet assessment was carried out, using Scottish trawl data for 1981-98. Tuning of the VPA was carried out with Scottish *Nephrops* trawl effort, raised by the ratio of the *Nephrops* landings by all trawl gears to the *Nephrops* landings by *Nephrops* trawls. This procedure excludes the creel fishery, but this is not considered a problem owing to the very small size of the latter. Sexes were assessed separately.

Males

Table 5.11.33. Output XSA males: Fs-at-age
Table 5.11.35. Output XSA males: Long-term trends in landings, Fbar, TSB and recruitment
Figure 5.11.24. Output XSA males: Log catchability residuals
Figure 5.11.26. Output XSA males: Long-term trends in landings, Fbar, TSB and recruitment
Figure 5.11.28. Output XSA males: Plots of Fbar vs. effort

The slicing procedure gave 11 nominal 'age' groups (11 = plus group). Weights-at-age were assumed to be equivalent to stock weights and no SOP corrections were made. The XSA tuning was carried out over the whole 16 year period, and over ages 1-10, using a tricubic taper with shrinkage. Catchability was taken as dependent on stock sizes for ages < 3 and independent of age for ages > 5. Survivor estimates were shrunk towards the mean F. Tuning converged after 25 iterations.

Large and variable log catchability residuals were found for age 1. For ages 2-5, the residuals were variable but there was little indication of trend or year effects. For the older ages, the residual plots revealed strong year effects but trends were not apparent.

Trends in yield, F_{bar}, TSB and recruitment are plotted in Figure 5.11.26. F_{bar} has fluctuated, with relatively high values in 1988-89, lower levels in the early 90s, and evidence of a rising trend since then. TSB has been fairly steady, but fell in the late 80s and early 90s (perhaps as a result of mortality due to *Hematodinium* infection), but has increased again since 1994. Recruitment has fluctuated throughout the time series to a greater extent than in other Scottish stocks. Peaks are evident in 1985, 1989, 1994 and the most recent years.

The correlation coefficient between fishing effort and F_{bar} is not statistically significant ($r = 0.17$; $p > 0.05$). It is worth noting that the effort records in this fishery may be unreliable (particularly in recent years), since there has been a deterioration over a number of years in the correlation between landings and effort (ICES, 1997a). Possible under-reporting may also have had an effect.

Females

Table 5.11.34. Output XSA females: Fs-at-age
Table 5.11.36. Output XSA females: Long-term trends in landings, Fbar, TSB and recruitment
Figure 5.11.25. Output XSA females: Log catchability residuals
Figure 5.11.27. Output XSA females: Long-term trends in landings, Fbar, TSB and recruitment
Figure 5.11.28. Output XSA females: Plots of Fbar vs. effort

The slicing procedure generated 16 nominal 'age' groups (16 = plus group). As for males, catch mean weights were assumed to be equivalent to stock weights and no SOP corrections were applied. As for the other stocks, M is assumed to decline in mature females. Tuning

choices were the same as for the males. The tuning had not converged after 30 iterations, but convergence criteria differences were at the third decimal place.

For the younger ages, the log catchability residuals show little evidence of trend, although the age 1 residuals were noisier than those for the other ages. There were strong year effects for the older age groups.

As in other Scottish stocks, fishing mortality estimates for the females are much lower than for the males. F_{bar} appears to have been relatively stable around a low value of 0.1. TSB shows a marked upward trend, reaching values of over 20 10^3 tonnes in 1998. Recruitment has fluctuated, but to a lesser extent than in the males, and shows an increasing trend in recent years.

Comparison between the two sexes reveals some inconsistencies, in the sense that the TSB estimates for females are more than twice the ones for the males, and that recruitment appears to be about 50 % higher in females. The trends in recruitment, however, are similar for the two sexes, but there is doubt about the reliability of the female estimates, in view of the poor convergence of the VPA and the low levels of F compared to M.

There is no relationship between F_{bar} and trawl fishing effort ($r = 0.14$; $p > 0.05$). As already mentioned above, the effort figures may be unreliable.

In view of the increasing proportion of the total uptake in the MA landed from this FU, and the indications of high recruitment, it was felt there may be implications for the potential landings over the next few years. A catch prediction was made for the Firth of Clyde (Table 5.11.37.), based on stock size in 1999 rolled forward from the VPA, recruitment averaged over the previous four years, the current effort pattern, and *status quo* effort. Under these conditions, the predicted catch for 1999 was 2709 t for males, and 1788 t for females, giving a total of 4497 t. Applying discard proportions by weight to these figures, gave total predicted landings of 2378 t and 1468 t for males and females respectively, and a total of 3847 t.

Catch predictions were also made for 2000 (Table 5.11.37.), rolling on the numbers-at-age in the stock a further year and using the same assumptions, but making no allowance for recruits in that year. Making the same allowances for discards, the total catch for 2000 was predicted to be 4410 t, and the total landings 3781 t.

Fishery independent methods - TV surveys

Table 5.11.28. Results of 1997 and 1998 underwater TV surveys
Table 5.11.29. Overview results of underwater TV surveys, 1995-98

TV camera and trawl surveys of the Firth of Clyde grounds were conducted during cruises of RV '*Clupea*' in 1997 and 1998. Estimates of mean burrow density across different sediment strata varied from 0.56-0.82 per m^2 in 1997, and from 0.71-0.74 per m^2 in 1998. Abundance estimates raised to the total ground area (2080 km^2) increased from the 1996 estimate of 1113 10^6 burrows to 1426 10^6 in 1997, and 1502 10^6 in 1998. Corresponding biomass estimates were in the range 24.6-38.4 10^3 t and 27.6-38.8 10^3 t in 1997 and 1998 respectively (Table 5.11.29.). Although TV data are only available for four years, the increase in abundance matches the increase in biomass and recruitment shown in the VPA trends. For

this FU, the coverage during the surveys was reasonably good and results suggest an increase in the size of the stock. The magnitude of the increase in biomass over four years of TV surveys, however, appears excessive in relation to the VPA. It is possible that the increased numerical abundance was associated with good recruitment and the presence of many small animals, which is implied from the VPA recruitment trend, and also with changes in CPUE and mean size of the animals < 35 mm CL. Application of an inappropriately high mean individual weight to these numbers would artificially elevate the biomass estimates from the TV surveys. Refinements in the collection and application of mean weights should improve the estimates.

Comments on quality of assessments

By splitting off the Sound of Jura from the assessment for the Firth of Clyde, it was hoped that the analyses would show some improvement on those reported previously. The fact that separation of LPUE data (Table 5.11.26.) suggested large differences in abundance provided some justification for taking this step.

The large discrepancy between numbers of males and females in the recruiting age classes suggests that the LCA results should be treated with caution, particularly in the case of the females. Similarly, the VPA results for the females are considered unreliable because of the low F values (less than the values chosen for M) and the fact that the XSA tuning did not converge. One of the problems is that effort data used in the tuning may be unreliable, since it correlates poorly with *Nephrops* trawl landings (also see ICES, 1995a). Furthermore, patchiness in the distribution of a stock, and hence in its biological features (as is the case in the Clyde area), may compromise assessments when one set of parameter values is applied to the area as a whole.

The apparent increase in female stock biomass, estimated from the VPA, may also be unrealistic. While TV results suggest biomass increases, the uncertainty on the appropriate mean weights to apply to the numbers observed, means that the estimates must be treated cautiously. However, several indicators point towards increasing recruitment in this stock, and it would appear that discrepancies between male and female VPA results are reducing.

Management considerations

The LCA applied to the Firth of Clyde produced results which are similar to the previous analysis for the whole FU (ICES, 1995a). For the males, the Y/R curve indicated current F was to the right of F_{max}, whereas the females appear to be only lightly exploited. Long-term trend plots show that the LPUEs have increased again in the most recent years to the levels of the mid-80s. Although it has been pointed out before that these LPUEs may not be fully reliable (because of possible inaccuracies in the recording of fishing effort) (ICES, 1997a), increased abundance in recent years is also suggested by the TV surveys. Taken at face value, the VPA results for the males suggest that fishing mortality is slowly increasing, although stock biomass has increased from the low levels of the early 90s, and recruitment too appears to be increasing.

The WG concluded that, for the time being, maintaining fishing effort around current levels is acceptable for this stock. The prediction carried out in the assessments section indicated that landings over the next few years are likely to be maintained around the high 1998 level. It is likely however, that under-reporting has been taking place, so that the basis of the assessments and the prediction can be questioned, and that true realised landings may be even higher.

The possibility that the *Hematodinium* disease, which was prevalent in the early 90s, will return cannot be ignored. Therefore, and despite the improved stock condition, maintenance of current effort is considered advisable.

5.11.4. Summary for Management Area C

Table 5.11.38. Landings by FU and from Other rectangles, 1989-98
Table 5.11.39. Landings by country, 1989-98

Landings from MA C have fluctuated without any obvious trend. For the MA as a whole, it is suggested that fishing effort should be held at current levels.

In recent years, biomass and landings have increased in the Firth of Clyde (FU 13), while remaining more stable or falling in the other FUs of the MA (North Minch, FU 11; and South Minch, FU 12). A catch prediction for FU 13 based on *status quo* effort suggested that landings may continue to increase in this area, due to recent good recruitment. The proportion of the landings for the MA taken in FU 13 has increased markedly in the last year, and this is likely to be maintained. The current TAC for the MA is based on the sum of advice for FUs 11, 12 and 13, plus Other rectangles, from 1992 (ICES, 1992a). At the time, the proportion of the total landed from FU 13 was lower, and landings were more evenly distributed between the three FUs than nowadays. While the WG would not want fishing effort or the TAC to increase, it is felt that the allocation of the TAC to FUs should better match the current landings pattern and stock conditions.

This situation emphasises again the difficulties of controlling effort and quota uptake within *Nephrops* TACs applied over large areas. The WG re-iterates its view that efforts should be made to allocate internal quota to FUs at appropriate levels.

Table 5.11.1. - North Minch (FU 11): Landings (tonnes) by gear, all UK, 1989-98.

Year	UK			
	Nephrops trawl	Other trawl	Creel	Total
1989	2603	112	490	3205
1990	1941	133	469	2543
1991	2221	130	438	2789
1992	2964	150	434	3548
1993	2699	85	408	3192
1994	2916	246	454	3616
1995	2940	184	532	3656
1996	2355	147	369	2871
1997	2553	102	391	3046
1998 *	2020	66	342	2428

* provisional na = not available

Table 5.11.2. - North Minch (FU 11): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1989-98 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	**All *Nephrops* gears combined**		
	Landings	Effort	LPUE
1989	2603	87.9	29.6
1990	1941	79.8	24.3
1991	2221	93.1	23.9
1992	2964	98.9	30.0
1993	2699	105.4	25.6
1994	2916	100.8	28.9
1995	2940	94.2	31.2
1996	2355	78.0	30.2
1997	2553	90.0	28.4
1998 *	2020	84.8	23.8

Year	**Single rig**			**Multirig**		
	Landings	Effort	LPUE	Landings	Effort	LPUE
1989	na	na	na	na	na	na
1990	na	na	na	na	na	na
1991	2116	90.2	23.5	105	2.9	36.7
1992	2755	93.2	29.6	167	3.7	45.6
1993	2657	104.4	25.4	42	1.0	43.4
1994	2916	100.8	28.9	0	0.0	na
1995	2937	94.1	31.2	3	0.1	60.0
1996	2354	78.0	30.2	1	0.0	na
1997	2510	88.8	28.3	43	1.2	35.8
1998 *	1971	83.3	23.7	50	1.5	33.3

* provisional na = not available

Table 5.11.3. - North Minch (FU 11): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish catches and landings, 1989-98.

Year	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
	Males	Females	Males	Females	Males	Females
1989	na	na	29.2	29.2	40.1	38.9
1990	29.3	28.6	29.8	28.9	39.1	38.1
1991	30.3	29.1	30.6	29.5	39.4	39.1
1992	29.3	28.0	29.7	28.3	39.6	38.3
1993	29.4	27.9	29.5	28.0	38.7	38.3
1994	28.1	27.0	29.4	28.3	39.5	38.8
1995	27.7	27.7	28.6	29.0	40.0	38.2
1996	29.5	29.4	30.2	30.2	40.0	38.7
1997	29.1	28.4	29.9	28.8	39.4	38.0
1998 *	29.8	28.8	30.6	29.4	39.6	38.4

* provisional na = not available

Table 5.11.4. - North Minch (FU 11): Results by stratum of the 1998 TV surveys. Note that stratification was based on a series of arbitrary rectangles.

Stratum	Area (km^2)	Number of Stations	Mean burrow density (no./m^2)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
1998 TV survey							
U	656	12	0.353	0.021	231	760	0.289
V	425	11	0.536	0.057	228	929	0.353
W	563	10	0.319	0.016	180	501	0.190
X	131	5	0.680	0.129	89	443	0.168
Total	1775	38			728	2633	1

Table 5.11.5. - North Minch (FU 11): Results of the 1994-98 TV surveys.

Year	Mean density	Abundance	95% confidence interval	Biomass
	burrows/m^2	millions	millions	'000 tonnes
1994	0.38	665	99	12.5-16.9
1995	No survey			
1996	0.25	439	62	8.3-11.1
1997	No survey			
1998	0.41	728	103	13.8-18.4

Table 5.11.6. - North Minch (FU 11): Input data and parameters.

FU	11	MA	C
FLEET	UK Scotland	GEAR	*Nephrops* and light trawl

	1998					1997				
	Number of samples				Mean no. per sample	Number of samples				Mean no. per sample
	Qtr 1	Qtr 2	Qtr 3	Qtr 4		Qtr 1	Qtr 2	Qtr 3	Qtr 4	
Catch	0	0	0	0		0	0	0	0	
Landings	5	19	15	11	590	2	12	12	18	646
Discards	4	7	0	3	616	0	0	7	2	717

	Number of samples									
Year	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989
Catch	0	0	0	0	0	0	0	0	0	0
Landings	50	44	19	38	55	39	47	57	53	42
Discards	14	9	4	15	13	11	13	14	13	0

FU	11	MA	C
FLEET	UK Scotland	GEAR	Creel

	1998					1997				
	Number of samples				Mean no. per sample	Number of samples				Mean no. per sample
	Qtr 1	Qtr 2	Qtr 3	Qtr 4		Qtr 1	Qtr 2	Qtr 3	Qtr 4	
Catch	0	0	0	0		0	0	0	0	
Landings	1	0	1	1	391	2	2	2	3	414
Discards	0	0	0	0		0	0	0	0	

	Number of samples									
Year	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989
Catch	0	0	0	0	0	0	0	0	0	0
Landings	3	9	10	10	9	9	4	4	10	4
Discards	0	0	0	0	0	0	0	0	0	0

INPUT PARAMETERS (trawl assessments) (*)		
Parameter	Value	Source
Discard Survival	0.25	Gueguen and Charuau, 1975
MALES		
Growth - K	0.160	adapted from Bailey and Chapman, 1983
Growth - L(inf)	70	"
Natural mortality - M	0.3	Morizur, 1982
Length/weight - a	0.00028	Howard and Hall, 1983
Length/weight - b	3.240	"
FEMALES		
Immature Growth		
Growth - K	0.160	adapted from Bailey and Chapman, 1983
Growth - L(inf)	70	"
Natural mortality - M	0.3	Morizur, 1982
Size at maturity	27	ICES, 1998b
Mature Growth		
Growth - K	0.060	adapted from Bailey and Chapman, 1983
Growth - L(inf)	60	"
Natural mortality - M	0.2	based on Morizur, 1982 ; assuming lower rate for mature females
Length/weight - a	0.00085	Howard and Hall, 1983
Length/weight - b	2.910	"
(*) For creel assessment inputs see Clyde, except for discard survival which is assumed 100 %		

Table 5.11.7. - North Minch (FU 11): LCA output males - Trawl fishery.

Reference period	1996-98		
Linf (mm CL)	70.0	K	0.160

Size (mm CL)	Removals ('000)	M	DT (years)	F*DT	F	Z	Nos. attaining aver. size ('000)	Average nos. in the sea ('000)	Average biomass (kg)
15	3	0.3	0.232	0.000	0.000	0.300	137940	30850	68828
17	38	0.3	0.240	0.000	0.001	0.301	128681	29843	97518
19	305	0.3	0.250	0.003	0.011	0.311	119691	28794	132373
21	1220	0.3	0.261	0.012	0.044	0.344	110747	27589	172722
23	2573	0.3	0.272	0.027	0.099	0.399	101250	26079	216441
25	4352	0.3	0.284	0.051	0.181	0.481	90852	24130	259555
27	5997	0.3	0.298	0.082	0.277	0.577	79258	21679	296470
29	6491	0.3	0.313	0.108	0.344	0.644	66752	18899	323197
31	7660	0.3	0.329	0.160	0.485	0.785	54584	15828	333632
33	6886	0.3	0.347	0.189	0.544	0.844	42162	12693	325624
35	6873	0.3	0.368	0.263	0.714	1.014	31454	9655	298091
37	5359	0.3	0.391	0.304	0.779	1.079	21664	6908	254090
39	3673	0.3	0.417	0.322	0.772	1.072	14214	4778	207529
41	2473	0.3	0.447	0.344	0.770	1.070	9092	3229	164247
43	1441	0.3	0.481	0.321	0.667	0.967	5639	2169	128291
45	973	0.3	0.521	0.353	0.676	0.976	3541	1446	98802
47	679	0.3	0.569	0.427	0.750	1.050	2129	911	71461
49	376	0.3	0.626	0.435	0.695	0.995	1172	546	48830
51	236	0.3	0.695	0.538	0.774	1.074	629	308	31297
53	94	0.3	0.782	0.438	0.560	0.860	298	170	19491
55	40	0.3	0.894	0.358	0.400	0.700	152	101	13064
57	22	0.3	1.044	0.389	0.372	0.672	81	61	8832
59	12	0.3	1.254	0.455	0.363	0.663	40	34	5547
61	4	0.3	1.571	0.340	0.217	0.517	18	19	3394
63	4	0.3			0.300	0.600	8	19	3394
					Totals, including lengths above + group			266738	3582718

Mean F, calculated across inter-quartile range	0.623

Table 5.11.8. - North Minch (FU 11): LCA output females - Trawl fishery.

Reference period	1996-98		
Linf immatures (mm CL)	70.0	K immatures	0.160
Linf matures (mm CL)	60.0	K matures	0.060
Transition length (mm CL)	27.0		

Size (mm CL)	Removals ('000)	M	DT (years)	F*DT	F	Z	Nos. attaining aver. size ('000)	Average nos. in the sea ('000)	Average biomass (kg)
15	3	0.3	0.232	0.000	0.000	0.300	144965	32421	87433
17	98	0.3	0.240	0.001	0.003	0.303	135236	31356	119131
19	361	0.3	0.250	0.003	0.012	0.312	125731	30242	156124
21	1911	0.3	0.261	0.017	0.066	0.366	116298	28891	196818
23	3357	0.3	0.272	0.034	0.124	0.424	105718	27140	238163
25	6265	0.3	0.284	0.072	0.253	0.553	94218	24773	274420
27	9250	0.2	0.298	0.126	0.423	0.623	80516	21876	300644
29	9190	0.2	1.112	0.167	0.150	0.350	66884	61588	1034614
31	7198	0.2	1.191	0.197	0.166	0.366	45328	43770	887196
33	5080	0.2	1.283	0.219	0.171	0.371	29331	29937	723886
35	3298	0.2	1.390	0.233	0.168	0.368	18225	19831	566286
37	2104	0.2	1.516	0.254	0.167	0.367	10933	12711	424817
39	1177	0.2	1.668	0.251	0.151	0.351	6265	7913	307043
41	521	0.2	1.854	0.198	0.107	0.307	3492	4936	220761
43	334	0.2	2.086	0.234	0.112	0.312	1977	3031	155219
45	213	0.2	2.385	0.304	0.128	0.328	1031	1707	99469
47	75	0.2	2.784	0.234	0.084	0.284	472	909	59934
49	35	0.2	3.345	0.255	0.076	0.276	214	468	34729
51	7	0.2	4.189	0.130	0.031	0.231	85	228	19001
53	1	0.2	5.608	0.062	0.011	0.211	32	106	9874
55	1	0.2			0.025	0.225	10	106	9874
					Totals, including lengths above + group			383941	5925434

Mean F, calculated across inter-quartile range	0.187

Table 5.11.9. - North Minch (FU 11): LCA output males - Creel fishery.

Reference period	1996-98		
Linf (mm CL)	70.0	K	0.160

Size (mm CL)	Removals ('000)	M	DT (years)	F*DT	F	Z	Nos. attaining aver. size ('000)	Average nos. in the sea ('000)	Average biomass (kg)
25	4	0.3	0.284	0.000	0.001	0.301	15807	4305	46303
27	32	0.3	0.298	0.002	0.008	0.308	14511	4128	56450
29	173	0.3	0.313	0.014	0.044	0.344	13241	3924	67105
31	439	0.3	0.329	0.040	0.120	0.420	11891	3654	77021
33	677	0.3	0.347	0.071	0.206	0.506	10355	3299	84618
35	964	0.3	0.368	0.125	0.339	0.639	8688	2847	87901
37	921	0.3	0.391	0.154	0.393	0.693	6868	2351	86481
39	873	0.3	0.417	0.195	0.468	0.768	5239	1869	81163
41	667	0.3	0.447	0.208	0.465	0.765	3804	1439	73202
43	472	0.3	0.481	0.208	0.432	0.732	2703	1096	64810
45	326	0.3	0.521	0.206	0.394	0.694	1900	831	56763
47	246	0.3	0.569	0.226	0.397	0.697	1323	621	48709
49	181	0.3	0.626	0.253	0.405	0.705	890	450	40305
51	120	0.3	0.695	0.264	0.380	0.680	573	317	32251
53	73	0.3	0.782	0.259	0.331	0.631	357	220	25317
55	54	0.3	0.894	0.333	0.373	0.673	218	147	18924
57	21	0.3	1.044	0.234	0.224	0.524	119	96	13901
59	14	0.3	1.254	0.287	0.229	0.529	69	63	10233
61	7	0.3	1.571	0.291	0.185	0.485	36	39	7026
63	8	0.3			0.300	0.600	17	39	7787
					Totals, including lengths above + group			31734	986270

Mean F, calculated across inter-quartile range	0.408

Table 5.11.10. - North Minch (FU 11): LCA output females - Creel fishery.

Reference period	1996-98		
Linf immatures (mm CL)	70.0	K immatures	0.160
Linf matures (mm CL)	60.0	K matures	0.060
Transition length (mm CL)	27.0		

Size (mm CL)	Removals ('000)	M	DT (years)	F*DT	F	Z	Nos. attaining aver. size ('000)	Average nos. in the sea ('000)	Average biomass (kg)
25	3	0.3	0.284	0.000	0.000	0.300	63535	17304	191683
27	61	0.2	0.298	0.001	0.004	0.204	58341	16851	231583
29	193	0.2	1.112	0.004	0.004	0.204	54910	54622	917589
31	432	0.2	1.191	0.011	0.009	0.209	43792	46161	935666
33	738	0.2	1.283	0.025	0.019	0.219	34127	38154	922562
35	885	0.2	1.390	0.040	0.029	0.229	25756	30656	875420
37	772	0.2	1.516	0.049	0.032	0.232	18736	23942	800163
39	588	0.2	1.668	0.054	0.033	0.233	13171	18212	706663
41	354	0.2	1.854	0.049	0.026	0.226	8938	13532	605169
43	214	0.2	2.086	0.046	0.022	0.222	5875	9810	502298
45	128	0.2	2.385	0.045	0.019	0.219	3697	6871	400384
47	75	0.2	2.784	0.046	0.017	0.217	2194	4588	302595
49	37	0.2	3.345	0.044	0.013	0.213	1201	2871	213222
51	17	0.2	4.189	0.044	0.011	0.211	588	1637	136308
53	8	0.2	5.608	0.060	0.011	0.211	244	801	74440
55	8	0.2			0.025	0.225	75	801	82750
					Totals, including lengths above + group			286812	7898496

Mean F, calculated across inter-quartile range	0.026

Table 5.11.11. - North Minch (FU 11): VPA Fs-at-age males.

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0.007	0.006	0.022	0.055	0.060	0.020	0.020	0.023	0.021	0.012	0.006	0.020	0.017	0.059	0.072	0.014	0.020	0.014
2	0.233	0.225	0.291	0.440	0.367	0.279	0.327	0.410	0.258	0.200	0.171	0.228	0.216	0.588	0.445	0.206	0.342	0.144
3	0.730	0.674	0.601	0.833	0.629	0.780	0.874	1.193	0.585	0.470	0.625	0.573	0.542	0.822	0.606	0.526	0.645	0.542
4	0.824	0.838	0.699	0.880	0.767	0.862	1.122	1.262	0.685	0.574	0.828	0.838	0.737	1.002	0.842	0.832	0.957	0.796
5	0.693	0.853	0.673	0.839	0.832	0.665	1.021	0.966	0.757	0.428	0.755	0.758	0.437	0.844	0.763	0.886	0.863	0.665
6	0.604	0.833	0.803	0.730	0.872	0.552	1.077	0.814	0.761	0.478	0.731	0.734	0.421	0.779	0.811	1.024	0.779	0.664
7	0.702	0.719	1.090	0.511	0.869	0.481	0.976	0.709	0.794	0.392	0.628	0.740	0.472	0.829	0.856	1.058	0.609	0.673
8	0.623	0.934	0.672	0.468	0.718	0.227	0.707	0.716	0.591	0.381	0.531	1.094	0.455	0.622	1.294	0.922	0.612	0.733
9	0.413	0.539	4.124	0.179	1.791	0.113	0.586	0.925	0.642	0.672	0.489	1.534	0.683	0.296	1.433	0.502	0.659	0.682
10	0.617	0.775	1.402	0.570	0.993	0.517	0.973	0.915	0.720	0.563	0.695	0.948	0.650	0.754	1.017	0.758	0.711	0.664
+ grp	0.617	0.775	1.402	0.570	0.993	0.517	0.973	0.915	0.720	0.563	0.695	0.948	0.650	0.754	1.017	0.758	0.711	0.664

Table 5.11.12. - North Minch (FU 11): VPA Fs-at-age females.

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0.008	0.006	0.032	0.042	0.076	0.026	0.027	0.018	0.057	0.027	0.009	0.041	0.027	0.059	0.059	0.010	0.034	0.023
2	0.195	0.204	0.438	0.419	0.569	0.311	0.333	0.372	0.392	0.329	0.248	0.467	0.372	0.617	0.552	0.202	0.497	0.263
3	0.155	0.098	0.155	0.194	0.209	0.130	0.166	0.241	0.258	0.148	0.127	0.184	0.129	0.171	0.200	0.132	0.186	0.156
4	0.210	0.120	0.144	0.222	0.188	0.144	0.185	0.278	0.334	0.202	0.133	0.207	0.143	0.169	0.231	0.154	0.199	0.150
5	0.230	0.118	0.135	0.226	0.186	0.131	0.235	0.311	0.400	0.263	0.163	0.253	0.183	0.197	0.271	0.171	0.204	0.178
6	0.201	0.111	0.051	0.152	0.115	0.124	0.185	0.258	0.365	0.278	0.137	0.252	0.148	0.157	0.279	0.166	0.164	0.171
7	0.211	0.116	0.055	0.152	0.134	0.121	0.217	0.246	0.389	0.299	0.139	0.288	0.182	0.167	0.294	0.186	0.181	0.202
8	0.306	0.084	0.066	0.143	0.133	0.136	0.235	0.290	0.378	0.340	0.147	0.294	0.224	0.202	0.314	0.199	0.205	0.256
9	0.208	0.075	0.046	0.108	0.077	0.093	0.142	0.216	0.387	0.217	0.142	0.250	0.202	0.168	0.182	0.178	0.150	0.209
10	0.335	0.095	0.069	0.101	0.102	0.108	0.165	0.280	0.413	0.288	0.133	0.301	0.216	0.183	0.241	0.193	0.174	0.233
11	0.223	0.152	0.056	0.089	0.076	0.111	0.139	0.234	0.379	0.209	0.166	0.192	0.196	0.159	0.213	0.134	0.151	0.217
12	0.247	0.183	0.105	0.095	0.101	0.085	0.197	0.224	0.346	0.241	0.175	0.255	0.123	0.152	0.228	0.205	0.155	0.222
13	0.551	0.188	0.130	0.164	0.096	0.087	0.192	0.246	0.270	0.207	0.252	0.211	0.137	0.071	0.288	0.321	0.126	0.228
14	0.505	0.863	0.131	0.213	0.195	0.095	0.316	0.217	0.438	0.191	0.273	0.304	0.136	0.163	0.175	0.510	0.142	0.233
15	0.353	0.271	0.107	0.151	0.153	0.155	0.318	0.311	0.360	0.216	0.251	0.242	0.195	0.230	0.240	0.310	0.164	0.210
+ grp	0.353	0.271	0.107	0.151	0.153	0.155	0.318	0.311	0.360	0.216	0.251	0.242	0.195	0.230	0.240	0.310	0.164	0.210

Table 5.11.13. - North Minch (FU 11): VPA output males.

Year	Recruits Age 1	Total Biomass	TSB	Landings	Yield/SSB	Fbar 3-8
	'000	tonnes	tonnes	tonnes		
1981	198158	7178	7178	2054	0.286	0.696
1982	234376	7346	7346	2053	0.280	0.808
1983	238332	7745	7745	2067	0.267	0.756
1984	247116	8063	8063	2599	0.322	0.710
1985	227724	7558	7558	2147	0.284	0.781
1986	224800	7653	7653	2120	0.277	0.595
1987	166970	7406	7406	2584	0.349	0.963
1988	163351	6338	6338	2408	0.380	0.943
1989	180755	5425	5425	1274	0.235	0.695
1990	191434	5999	5999	1208	0.201	0.454
1991	209588	7179	7179	1781	0.248	0.683
1992	204899	7427	7427	2009	0.270	0.790
1993	223798	7616	7616	1924	0.253	0.511
1994	181832	7857	7857	2376	0.302	0.816
1995	140531	6141	6141	1939	0.316	0.862
1996	127069	5452	5452	1733	0.318	0.875
1997	117187	5069	5069	1631	0.322	0.744
1998	138605	4721	4721	1220	0.259	0.679
Average 96-98						0.766

Table 5.11.14. - North Minch (FU 11): VPA output females.

Year	Recruits Age 1	Total Biomass	TSB	Landings	Yield/SSB	Fbar 3-13
	'000	tonnes	tonnes	tonnes		
1981	144703	4461	2316	429	0.185	0.261
1982	199740	5502	2721	366	0.135	0.122
1983	200318	6605	3438	808	0.235	0.092
1984	224009	7555	4118	1010	0.245	0.150
1985	179081	7632	4469	1203	0.269	0.129
1986	150719	7361	4708	721	0.153	0.115
1987	140475	7498	5100	1016	0.199	0.187
1988	135478	7214	4949	1190	0.241	0.257
1989	137422	6823	4718	1441	0.306	0.356
1990	126957	5863	3820	867	0.227	0.245
1991	155001	6082	3807	573	0.150	0.156
1992	154164	6434	3988	1120	0.281	0.244
1993	193987	6541	3867	860	0.222	0.171
1994	184335	7191	4221	784	0.186	0.163
1995	141487	6828	4292	1067	0.249	0.249
1996	145116	6373	4073	712	0.175	0.185
1997	132918	6549	4235	992	0.234	0.172
1998	143949	6265	4164	839	0.201	0.202
Average 96-98						0.187

Table 5.11.15. - South Minch (FU 12): Landings (tonnes) by gear, all UK, 1989-98.

Year	UK			
	Nephrops trawl	Other trawl	Creel	Total
1989	3846	338	561	4745
1990	3732	262	436	4430
1991	3597	341	503	4442
1992	3479	208	549	4237
1993	3608	197	649	4454
1994	3743	268	404	4415
1995	3442	740	496	4678
1996	3108	419	468	3995
1997	3519	334	492	4345
1998 *	2848	343	519	3710

* provisional na = not available

Table 5.11.16. - South Minch (FU 12): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1989-98 (data for all *Nephrops* gears combined, and for single and multirigs separately).

Year	**All *Nephrops* gears combined**		
	Landings	Effort	LPUE
1989	3846	138.3	27.8
1990	3732	153.5	24.3
1991	3597	150.5	23.9
1992	3479	127.3	27.3
1993	3608	126.5	28.5
1994	3743	144.4	25.8
1995	3442	100.4	34.3
1996	3108	106.4	29.2
1997	3519	117.5	29.9
1998 *	2848	101.4	28.1

Year	**Single rig**			**Multirig**		
	Landings	Effort	LPUE	Landings	Effort	LPUE
1989	na	na	na	na	na	na
1990	na	na	na	na	na	na
1991	3109	134.6	23.1	488	15.8	30.8
1992	3092	115.0	26.9	387	12.3	31.5
1993	3441	122.5	28.1	167	4.0	41.5
1994	3650	141.4	25.7	93	3.0	31.3
1995	3407	99.6	34.2	35	0.8	39.8
1996	3036	104.1	29.2	71	2.4	29.6
1997	3345	112.1	29.8	174	5.4	32.2
1998 *	2790	99.4	28.1	59	1.9	31.1

* provisional na = not available

Table 5.11.17. - South Minch (FU 12): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish catches and landings, 1989-98.

Year	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
	Males	Females	Males	Females	Males	Females
1989	na	na	29.8	29.4	39.5	38.4
1990	na	na	29.3	29.0	39.4	38.5
1991	29.4	27.5	29.9	27.9	39.0	38.5
1992	29.6	28.6	31.0	29.8	39.5	38.0
1993	29.0	27.8	30.0	28.5	39.5	38.0
1994	29.8	28.0	30.8	29.2	39.3	38.1
1995	29.5	28.2	30.0	28.4	39.4	38.0
1996	28.9	28.5	30.4	29.8	39.9	38.1
1997	29.3	28.7	30.6	29.6	39.8	37.8
1998 *	28.9	27.7	30.4	28.7	39.1	38.0

* provisional na = not available

Table 5.11.18. - South Minch (FU 12): Results by stratum of the 1997 and 1998 TV surveys. Note that stratification was based on a series of sediment strata.

Stratum	Area (km^2)	Number of Stations	Mean burrow density (no./m^2)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
1997 TV survey							
M	303	5	0.264	0.028	80	520	0.035
SM	2741	15	0.288	0.012	789	6239	0.418
MS	2028	20	0.279	0.040	565	8151	0.066
Total	5072	40			1434	14910	1
1998 TV survey							
M	303	7	0.659	0.196	200	2576	0.110
SM	2741	15	0.323	0.018	886	9125	0.390
MS	2028	14	0.409	0.040	830	11721	0.500
Total	5072	36			1916	23422	1

Table 5.11.19. - South Minch (FU 12): Results of the 1995-98 TV surveys.

Year	Mean density	Abundance	95% confidence interval	Biomass
	burrows/m^2	millions	millions	'000 tonnes
1995	0.30	1520	331	25.8-40.2
1996	0.38	1945	700	27.1-57.5
1997	0.28	1434	244	25.8-36.5
1998	0.38	1916	306	35.0-48.3

Table 5.11.20. - South Minch (FU 12): Input data and parameters.

FU	12	MA	C
FLEET	UK Scotland	GEAR	*Nephrops* and light trawl

	1998					1997				
	Number of samples				Mean no. per sample	Number of samples				Mean no. per sample
	Qtr 1	Qtr 2	Qtr 3	Qtr 4		Qtr 1	Qtr 2	Qtr 3	Qtr 4	
Catch	0	0	0	0		0	0	0	0	
Landings	11	11	15	12	815	10	12	9	11	827
Discards	9	16	15	5	668	6	17	13	14	641

	Number of samples									
Year	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989
Catch	0	0	0	0	0	0	0	0	0	0
Landings	49	42	56	46	62	72	49	66	56	40
Discards	45	50	54	38	20	15	15	8	13	0

FU	12	MA	C
FLEET	UK Scotland	GEAR	Creel

	1998					1997				
	Number of samples				Mean no. per sample	Number of samples				Mean no. per sample
	Qtr 1	Qtr 2	Qtr 3	Qtr 4		Qtr 1	Qtr 2	Qtr 3	Qtr 4	
Catch	0	0	0	0		0	0	0	0	
Landings	6	9	8	3	385	5	5	4	8	377
Discards	0	0	0	0		0	0	0	0	

	Number of samples									
Year	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989
Catch	0	0	0	0	0	0	0	0	0	0
Landings	26	22	23	8	10	25	8	10	14	5
Discards	0	0	0	0	0	0	0	0	0	0

INPUT PARAMETERS (trawl assessments) (*)		
Parameter	Value	Source
Discard Survival	0.25	Gueguen and Charuau, 1975
MALES		
Growth - K	0.161	adapted from Bailey and Chapman, 1983
Growth - L(inf)	68	"
Natural mortality - M	0.3	Morizur, 1982
Length/weight - a	0.00028	Howard and Hall, 1983
Length/weight - b	3.240	"
FEMALES		
Immature Growth		
Growth - K	0.161	adapted from Bailey and Chapman, 1983
Growth - L(inf)	68	"
Natural mortality - M	0.3	Morizur, 1982
Size at maturity	25	ICES, 1998b
Mature Growth		
Growth - K	0.060	adapted from Bailey and Chapman, 1983
Growth - L(inf)	59	"
Natural mortality - M	0.2	based on Morizur, 1982 ; assuming lower rate for mature females
Length/weight - a	0.00089	Howard and Hall, 1983
Length/weight - b	2.910	"
(*) For creel assessment inputs see Clyde, except for discard survival which is assumed 100 %		

Table 5.11.21. - South Minch (FU 12): LCA output males - Trawl fishery.

Reference period	1995-98		
Linf (mm CL)	68.0	K	0.161

Size (mm CL)	Removals ('000)	M	DT (years)	F*DT	F	Z	Nos. attaining aver. size ('000)	Average nos. in the sea ('000)	Average biomass (kg)
13	10	0.3	0.230	0.000	0.000	0.300	241437	53673	77690
15	51	0.3	0.239	0.000	0.001	0.301	225326	51945	115891
17	347	0.3	0.249	0.002	0.007	0.307	209691	50167	163930
19	1186	0.3	0.259	0.006	0.025	0.325	194294	48236	221751
21	2565	0.3	0.270	0.015	0.056	0.356	178638	46003	288002
23	4520	0.3	0.282	0.030	0.104	0.404	162271	43302	359374
25	6503	0.3	0.296	0.048	0.163	0.463	144758	40022	430499
27	8822	0.3	0.311	0.076	0.245	0.545	126243	36076	493361
29	10727	0.3	0.327	0.112	0.342	0.642	106590	31439	537658
31	12768	0.3	0.345	0.169	0.490	0.790	86417	26107	550291
33	11541	0.3	0.366	0.205	0.561	0.861	65793	20631	529248
35	10902	0.3	0.388	0.275	0.709	1.009	48035	15434	476485
37	7685	0.3	0.414	0.290	0.701	1.001	32467	11010	404996
39	5387	0.3	0.444	0.313	0.704	1.004	21451	7682	333673
41	3394	0.3	0.478	0.309	0.645	0.945	13737	5283	268769
43	2078	0.3	0.518	0.297	0.573	0.873	8742	3642	215420
45	1330	0.3	0.565	0.301	0.533	0.833	5561	2506	171197
47	780	0.3	0.622	0.283	0.455	0.755	3473	1723	135085
49	497	0.3	0.691	0.293	0.424	0.724	2172	1181	105660
51	296	0.3	0.777	0.291	0.375	0.675	1317	797	80982
53	177	0.3	0.889	0.300	0.337	0.637	780	529	60767
55	87	0.3	1.038	0.262	0.253	0.553	443	350	45156
57	57	0.3	1.246	0.323	0.259	0.559	249	224	32408
59	19	0.3	1.561	0.211	0.135	0.435	124	141	22742
61	8	0.3	2.090	0.191	0.091	0.391	63	90	16155
63	14	0.3			0.300	0.600	28	90	16155
					Totals, including lengths above + group			498280	6153345

Mean F, calculated across inter-quartile range	0.494

Table 5.11.22. - South Minch (FU 12): LCA output females - Trawl fishery.

Reference period	1995-98		
Linf immatures (mm CL)	68.0	K immatures	0.161
Linf matures (mm CL)	59.0	K matures	0.060
Transition length (mm CL)	25.0		

Size (mm CL)	Removals ('000)	M	DT (years)	F*DT	F	Z	Nos. attaining aver. size ('000)	Average nos. in the sea ('000)	Average biomass (kg)
13	13	0.3	0.230	0.000	0.000	0.300	254633	56606	108770
15	57	0.3	0.239	0.000	0.001	0.301	237638	54783	155256
17	369	0.3	0.249	0.002	0.007	0.307	221146	52907	211237
19	1206	0.3	0.259	0.006	0.024	0.324	204905	50876	276007
21	3618	0.3	0.270	0.020	0.075	0.375	188435	48404	346533
23	7111	0.3	0.282	0.045	0.158	0.458	170295	45109	415997
25	11463	0.2	0.296	0.082	0.278	0.478	149646	41283	480570
27	15508	0.2	1.076	0.143	0.133	0.333	129921	117483	1696750
29	15528	0.2	1.150	0.213	0.185	0.385	90847	84399	1489962
31	11791	0.2	1.235	0.260	0.210	0.410	58342	56533	1204211
33	7364	0.2	1.334	0.274	0.205	0.405	35150	36225	920509
35	4001	0.2	1.450	0.256	0.177	0.377	20474	22879	686573
37	2178	0.2	1.589	0.242	0.153	0.353	11859	14423	506584
39	1092	0.2	1.756	0.213	0.122	0.322	6773	9088	370574
41	484	0.2	1.963	0.166	0.085	0.285	3851	5793	272242
43	243	0.2	2.226	0.149	0.067	0.267	2203	3698	198985
45	135	0.2	2.569	0.155	0.060	0.260	1217	2280	139641
47	48	0.2	3.039	0.110	0.036	0.236	624	1352	93734
49	29	0.2	3.719	0.146	0.039	0.239	304	749	58488
51	9	0.2	4.795	0.116	0.024	0.224	125	367	32116
53	4	0.2	6.758	0.204	0.030	0.230	43	146	14269
55	1	0.2			0.025	0.225	9	146	14269
					Totals, including lengths above + group			705530	9693277

Mean F, calculated across inter-quartile range	0.153

Table 5.11.23. - South Minch (FU 12): LCA output males - Creel fishery.

Reference period	1996-98		
Linf (mm CL)	68.0	K	0.161

Size (mm CL)	Removals ('000)	M	DT (years)	F*DT	F	Z	Nos. attaining aver. size ('000)	Average nos. in the sea ('000)	Average biomass (kg)
13	8	0.3	0.230	0.000	0.001	0.301	51952	11549	16716
15	41	0.3	0.239	0.001	0.004	0.304	48480	11173	24927
17	277	0.3	0.249	0.006	0.026	0.326	45087	10762	35167
19	867	0.3	0.259	0.022	0.085	0.385	41582	10244	47096
21	1623	0.3	0.270	0.046	0.170	0.470	37641	9548	59772
23	2310	0.3	0.282	0.076	0.267	0.567	33152	8650	71790
25	2456	0.3	0.296	0.095	0.322	0.622	28245	7632	82092
27	1745	0.3	0.311	0.081	0.261	0.561	23497	6698	91605
29	919	0.3	0.327	0.050	0.153	0.453	19741	5999	102593
31	479	0.3	0.345	0.030	0.087	0.387	17021	5499	115916
33	478	0.3	0.366	0.035	0.094	0.394	14892	5069	130027
35	661	0.3	0.388	0.056	0.144	0.444	12893	4599	141987
37	748	0.3	0.414	0.076	0.184	0.484	10852	4073	149832
39	672	0.3	0.444	0.084	0.190	0.490	8881	3542	153860
41	702	0.3	0.478	0.112	0.233	0.533	7145	3015	153357
43	622	0.3	0.518	0.129	0.250	0.550	5536	2495	147587
45	473	0.3	0.565	0.132	0.233	0.533	4164	2032	138783
47	370	0.3	0.622	0.142	0.228	0.528	3081	1633	128035
49	280	0.3	0.691	0.151	0.218	0.518	2220	1289	115345
51	198	0.3	0.777	0.155	0.199	0.499	1551	1000	101581
53	144	0.3	0.889	0.170	0.192	0.492	1052	758	87027
55	110	0.3	1.038	0.210	0.203	0.503	680	550	71014
57	62	0.3	1.246	0.206	0.165	0.465	404	382	55246
59	37	0.3	1.561	0.230	0.147	0.447	226	254	41015
61	20	0.3	2.090	0.271	0.130	0.430	112	155	27859
63	23	0.3			0.300	0.600	46	155	30877
					Totals, including lengths above + group			118753	2321106

Mean F, calculated across inter-quartile range	0.200

Table 5.11.24. - South Minch (FU 12): LCA output females - Creel fishery.

Reference period	1996-98		
Linf immatures (mm CL)	68.0	K immatures	0.161
Linf matures (mm CL)	59.0	K matures	0.060
Transition length (mm CL)	25.0		

Size (mm CL)	Removals ('000)	M	DT (years)	F*DT	F	Z	Nos. attaining aver. size ('000)	Average nos. in the sea ('000)	Average biomass (kg)
13	10	0.3	0.230	0.000	0.000	0.300	167357	37204	71488
15	47	0.3	0.239	0.000	0.001	0.301	156186	36005	102038
17	284	0.3	0.249	0.002	0.008	0.308	145338	34766	138805
19	946	0.3	0.259	0.007	0.028	0.328	134625	33406	181233
21	1808	0.3	0.270	0.015	0.057	0.357	123656	31840	227947
23	2519	0.3	0.282	0.024	0.084	0.384	112295	30051	277135
25	3016	0.2	0.296	0.031	0.106	0.306	100760	28499	331750
27	2341	0.2	1.076	0.029	0.027	0.227	92043	87858	1268896
29	1247	0.2	1.150	0.020	0.017	0.217	72125	73397	1295720
31	538	0.2	1.235	0.011	0.009	0.209	56196	61181	1303214
33	547	0.2	1.334	0.015	0.011	0.211	43421	50490	1282997
35	763	0.2	1.450	0.027	0.019	0.219	32773	40725	1222119
37	704	0.2	1.589	0.035	0.022	0.222	23862	31939	1121770
39	557	0.2	1.756	0.040	0.023	0.223	16767	24362	993403
41	405	0.2	1.963	0.045	0.023	0.223	11334	18024	847074
43	325	0.2	2.226	0.057	0.026	0.226	7321	12808	689204
45	196	0.2	2.569	0.059	0.023	0.223	4431	8666	530719
47	105	0.2	3.039	0.059	0.019	0.219	2499	5543	384239
49	37	0.2	3.719	0.043	0.012	0.212	1284	3304	257937
51	16	0.2	4.795	0.044	0.009	0.209	584	1769	154773
53	10	0.2	6.758	0.096	0.014	0.214	214	765	74742
55	6	0.2			0.025	0.225	50	765	83086
					Totals, including lengths above + group			653369	12840289

Mean F, calculated across inter-quartile range	0.032

Table 5.11.25. - Clyde (FU 13): Landings (tonnes) by area and by gear type, and FU total, all UK, 1989-98.

Year	UK					
	By area		**By gear type**			**Total**
	Firth of Clyde	Sound of Jura	*Nephrops* trawl	Other trawl	Creel	All areas all gears
1989	2579	217	2578	182	36	2796
1990	2559	319	2732	122	24	2878
1991	2631	384	2744	249	22	3015
1992	2332	395	2471	247	9	2727
1993	2738	577	3207	102	5	3315
1994	2094	535	2502	99	28	2629
1995	3690	299	3767	196	26	3989
1996	3674	387	3881	152	28	4061
1997	3132	487	3486	108	25	3619
1998 *	4369	471	4538	265	37	4840

* provisional na = not available

Table 5.11.26. - Clyde (FU 13): Landings (tonnes), effort ('000 hours trawling), and LPUE (kg/hour trawling) of Scottish *Nephrops* trawlers, 1989-98 (data presented for the Firth of Clyde and Sound of Jura separately).

Firth of Clyde

Year	**All *Nephrops* gears combined**		
	Landings	Effort	LPUE
1989	2394	144.3	16.6
1990	2435	142.8	17.0
1991	2489	152.9	16.3
1992	2091	144.6	14.5
1993	2650	156.8	16.9
1994	1999	118.0	16.9
1995	3500	133.8	26.2
1996	3522	150.1	23.5
1997	3019	131.9	22.9
1998 *	4103	150.7	27.2

Year	**Single rig**			**Multirig**		
	Landings	Effort	LPUE	Landings	Effort	LPUE
1989	na	na	na	na	na	na
1990	na	na	na	na	na	na
1991	1594	113.5	14.0	895	39.4	22.7
1992	1317	102.2	12.9	774	42.4	18.3
1993	1771	113.7	15.6	879	43.1	20.4
1994	1484	90.4	16.4	515	27.6	18.7
1995	2582	102.3	25.2	918	31.5	29.1
1996	2474	112.0	22.1	1048	38.1	27.5
1997	2158	98.0	22.0	861	33.9	25.4
1998 *	2962	110.2	26.9	1141	40.5	28.2

* provisional na = not available

Table 5.11.26. - (continued).

Sound of Jura

Year	All *Nephrops* gears combined		
	Landings	Effort	LPUE
1989	184	5.7	32.2
1990	297	10.7	27.7
1991	355	13.1	27.2
1992	380	14.3	26.6
1993	557	15.2	36.7
1994	505	15.4	32.8
1995	266	8.6	30.9
1996	359	10.0	35.9
1997	467	15.1	30.9
1998 *	435	13.5	32.2

Year	Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE
1989	na	na	na	na	na	na
1990	na	na	na	na	na	na
1991	191	7.6	25.1	164	5.5	30.0
1992	210	8.7	24.1	169	5.5	30.6
1993	331	10.2	32.6	226	5.0	44.8
1994	270	8.6	31.4	235	6.9	34.1
1995	161	5.5	29.3	105	3.1	33.9
1996	212	6.3	33.7	147	3.7	39.7
1997	191	7.0	27.3	276	8.1	34.1
1998 *	195	6.7	29.1	240	6.8	35.3

* provisional na = not available

Table 5.11.27. - Firth of Clyde (FU 13): Mean sizes (CL mm) above and below 35 mm of male and female *Nephrops* in Scottish catches and landings, 1989-98.

Year	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
	Males	Females	Males	Females	Males	Females
1989	na	na	30.2	30.0	41.6	39.8
1990	27.4	26.2	30.4	29.5	40.1	39.8
1991	28.6	27.1	29.2	28.2	39.3	40.3
1992	29.6	28.8	30.1	29.2	39.9	41.1
1993	29.6	29.7	31.4	30.9	40.4	39.9
1994	26.4	27.0	29.4	29.4	40.8	39.2
1995	27.2	25.8	28.7	27.6	40.3	39.8
1996	28.8	28.0	30.0	29.1	38.6	40.4
1997	27.9	26.9	30.0	29.2	40.0	40.3
1998 *	26.0	25.4	28.4	27.9	38.9	39.1

* provisional na = not available

Table 5.11.28. - Firth of Clyde (FU 13): Results by stratum of the 1997 and 1998 TV surveys. Note that stratification was based on a series of sediment strata.

Stratum	Area (km^2)	Number of Stations	Mean burrow density (no./m^2)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
1997 TV survey							
M	717	13	0.558	0.046	400	1827	0.075
SM	699	12	0.823	0.168	575	6827	0.281
MS	665	6	0.678	0.213	451	15646	0.644
Total	2081	31			1426	24300	1
1998 TV survey							
M	717	13	0.711	0.119	509	4714	0.291
SM	699	14	0.740	0.163	517	5668	0.350
MS	665	11	0.716	0.145	476	5814	0.359
Total	2081	38			1502	16196	1

Table 5.11.29. - Firth of Clyde (FU 13): Results of the 1995-98 TV surveys.

Year	Mean density	Abundance	95% confidence interval	Biomass
	burrows/m^2	millions	millions	'000 tonnes
1995	0.33	689	210	10.6-19.9
1996	0.54	1113	288	18.2-30.9
1997	0.68	1426	312	24.6-38.4
1998	0.72	1502	254	27.6-38.8

Table 5.11.30. - Firth of Clyde (FU 13): Input data and parameters.

FU	13	MA	C
FLEET	UK Scotland	GEAR	*Nephrops* and light trawl

	1998					1997				
	Number of samples				Mean no. per sample	Number of samples				Mean no. per sample
	Qtr 1	Qtr 2	Qtr 3	Qtr 4		Qtr 1	Qtr 2	Qtr 3	Qtr 4	
Catch	0	0	0	0		0	0	0	0	
Landings	13	19	11	10	559	13	11	13	13	613
Discards	0	7	3	3	815	0	6	5	6	786

	Number of samples									
Year	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989
Catch	0	0	0	0	0	0	0	0	0	0
Landings	53	50	46	53	49	37	57	76	53	44
Discards	13	17	13	17	18	19	13	18	13	0

INPUT PARAMETERS		
Parameter	Value	Source
Discard Survival	0.25	Gueguen and Charuau, 1975
MALES		
Growth - K	0.160	Bailey and Chapman, 1983
Growth - L(inf)	73	"
Natural mortality - M	0.3	Morizur, 1982
Length/weight - a	0.00028	Howard and Hall, 1983
Length/weight - b	3.240	"
FEMALES		
Immature Growth		
Growth - K	0.160	Bailey and Chapman, 1983
Growth - L(inf)	73	"
Natural mortality - M	0.3	Morizur, 1982
Size at maturity	27	Bailey, 1984
Mature Growth		
Growth - K	0.060	Bailey and Chapman, 1983
Growth - L(inf)	62	"
Natural mortality - M	0.2	based on Morizur, 1982 ; assuming lower rate for mature females
Length/weight - a	0.00085	Howard and Hall, 1983
Length/weight - b	2.910	"

Table 5.11.31. - Firth of Clyde (FU 13): LCA output males.

Reference period	1996-98		
Linf (mm CL)	73.0	K	0.160

Size (mm CL)	Removals ('000)	M	DT (years)	F*DT	F	Z	Nos. attaining aver. size ('000)	Average nos. in the sea ('000)	Average biomass (kg)
13	35	0.3	0.212	0.000	0.001	0.301	241771	49630	71838
15	87	0.3	0.219	0.000	0.002	0.302	226847	48141	107405
17	902	0.3	0.227	0.004	0.019	0.319	212318	46549	152109
19	4906	0.3	0.236	0.026	0.111	0.411	197451	44390	204071
21	9900	0.3	0.245	0.059	0.241	0.541	179227	41147	257597
23	12451	0.3	0.255	0.086	0.337	0.637	156977	36965	306785
25	15541	0.3	0.266	0.129	0.486	0.786	133427	32028	344505
27	15134	0.3	0.278	0.158	0.567	0.867	108260	26729	365538
29	15338	0.3	0.291	0.209	0.718	1.018	85086	21415	366229
31	13093	0.3	0.305	0.244	0.800	1.100	63296	16397	345632
33	10437	0.3	0.321	0.277	0.864	1.164	45255	12108	310619
35	7848	0.3	0.338	0.308	0.911	1.211	31158	8641	266767
37	5696	0.3	0.357	0.343	0.960	1.260	20694	5953	218961
39	3430	0.3	0.379	0.322	0.850	1.150	13192	4052	176007
41	2167	0.3	0.403	0.314	0.779	1.079	8534	2791	141983
43	1152	0.3	0.431	0.252	0.584	0.884	5522	1980	117111
45	754	0.3	0.463	0.241	0.521	0.821	3772	1454	99295
47	507	0.3	0.500	0.238	0.476	0.776	2580	1070	83862
49	355	0.3	0.544	0.248	0.457	0.757	1750	780	69813
51	186	0.3	0.596	0.193	0.324	0.624	1159	577	58620
53	117	0.3	0.659	0.176	0.268	0.568	800	439	50444
55	97	0.3	0.736	0.219	0.298	0.598	550	328	42329
57	58	0.3	0.835	0.204	0.244	0.544	354	238	34406
59	36	0.3	0.963	0.205	0.213	0.513	225	171	27638
61	22	0.3	1.140	0.208	0.182	0.482	137	120	21625
63	16	0.3	1.395	0.295	0.211	0.511	79	79	15738
65	7	0.3	1.798	0.287	0.160	0.460	39	48	10458
67	7	0.3			0.200	0.500	17	48	10458
					Totals, including lengths above + group			404266	4277843

Mean F, calculated across inter-quartile range	0.648

Table 5.11.32. - Firth of Clyde (FU 13): LCA output females.

Reference period	1996-98		
Linf immatures (mm CL)	73.0	K immatures	0.160
Linf matures (mm CL)	62.0	K matures	0.060
Transition length (mm CL)	27.0		

Size (mm CL)	Removals ('000)	M	DT (years)	F*DT	F	Z	Nos. attaining aver. size ('000)	Average nos. in the sea ('000)	Average biomass (kg)
13	34	0.3	0.212	0.000	0.000	0.300	1074954	220675	403498
15	121	0.3	0.219	0.000	0.001	0.301	1008718	214099	577378
17	1009	0.3	0.227	0.001	0.005	0.305	944368	207384	787909
19	6211	0.3	0.236	0.007	0.031	0.331	881144	199933	1032141
21	11738	0.3	0.245	0.015	0.061	0.361	814951	191175	1302380
23	14022	0.3	0.255	0.020	0.077	0.377	745857	181423	1592078
25	15621	0.3	0.266	0.024	0.091	0.391	677402	171127	1895599
27	14586	0.2	0.278	0.025	0.090	0.290	610437	162952	2239478
29	11691	0.2	1.042	0.023	0.022	0.222	563257	523882	8800624
31	8760	0.2	1.112	0.022	0.020	0.220	446764	440548	8929698
33	6171	0.2	1.191	0.020	0.017	0.217	349873	367232	8879752
35	4369	0.2	1.283	0.019	0.015	0.215	270238	303040	8653616
37	3897	0.2	1.390	0.022	0.016	0.216	205248	246423	8235845
39	2241	0.2	1.516	0.017	0.011	0.211	152052	197243	7653361
41	1428	0.2	1.668	0.015	0.009	0.209	110353	155385	6948971
43	832	0.2	1.854	0.013	0.007	0.207	77841	119840	6136265
45	556	0.2	2.086	0.013	0.006	0.206	53035	89911	5239572
47	417	0.2	2.385	0.015	0.007	0.207	34493	64962	4284785
49	284	0.2	2.784	0.018	0.006	0.206	21079	44638	3315634
51	221	0.2	3.345	0.026	0.008	0.208	11864	28595	2380722
53	128	0.2	4.189	0.033	0.008	0.208	5919	16551	1537951
55	67	0.2	5.608	0.049	0.009	0.209	2477	8187	845722
57	85	0.2			0.025	0.225	769	8187	845722
					Totals, including lengths above + group			4163392	92518700

Mean F, calculated across inter-quartile range	0.028

Table 5.11.33. - Firth of Clyde (FU 13): VPA Fs-at-age males.

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0.020	0.020	0.035	0.042	0.053	0.058	0.038	0.036	0.023	0.040	0.033	0.009	0.002	0.021	0.050	0.013	0.016	0.084
2	0.244	0.231	0.478	0.347	0.497	0.435	0.352	0.368	0.160	0.260	0.339	0.272	0.200	0.197	0.456	0.368	0.270	0.587
3	0.680	0.604	0.904	0.609	0.804	0.658	0.705	0.721	0.405	0.639	0.725	0.638	0.663	0.391	0.698	0.978	0.683	0.763
4	0.670	0.541	0.758	0.547	0.668	0.686	0.465	0.948	0.861	0.690	0.686	0.771	1.074	0.743	0.879	1.134	1.040	0.894
5	0.544	0.408	0.689	0.440	0.444	0.501	0.291	0.971	0.858	0.546	0.411	0.681	0.935	0.796	0.882	0.702	1.189	0.770
6	0.431	0.310	0.640	0.394	0.325	0.448	0.194	0.795	0.838	0.506	0.293	0.527	0.715	0.722	0.996	0.436	1.461	0.777
7	0.338	0.266	0.638	0.468	0.347	0.468	0.176	0.763	0.939	0.472	0.328	0.376	0.624	0.663	0.952	0.438	1.475	0.798
8	0.237	0.194	0.590	0.525	0.484	0.410	0.125	0.598	1.104	0.618	0.415	0.264	0.504	0.492	1.054	0.405	1.477	0.764
9	0.187	0.233	0.461	0.576	0.472	0.813	0.128	0.557	0.986	0.918	0.475	0.320	0.734	0.527	1.051	0.544	1.666	0.871
10	0.365	0.312	0.630	0.525	0.487	0.596	0.318	0.849	0.963	0.669	0.529	0.593	0.824	0.663	0.915	0.602	1.201	0.760
+ grp	0.365	0.312	0.630	0.525	0.487	0.596	0.318	0.849	0.963	0.669	0.529	0.593	0.824	0.663	0.915	0.602	1.201	0.760

Table 5.11.34. - Firth of Clyde (FU 13): VPA Fs-at-age females.

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0.257	0.303	0.328	1.081	0.781	0.983	0.633	0.432	0.247	0.347	0.321	0.061	0.012	0.144	0.548	0.093	0.213	0.831
2	2.202	1.932	2.942	8.941	6.833	6.411	5.119	3.024	1.246	1.704	2.894	1.858	0.865	1.552	3.598	2.230	2.282	3.834
3	0.930	0.796	1.181	2.200	1.763	1.472	1.428	1.294	0.486	0.752	1.011	1.028	0.613	0.513	0.964	0.992	0.758	0.916
4	1.021	0.922	1.027	2.028	1.551	1.204	1.209	1.277	0.689	0.808	1.091	1.150	0.846	0.706	0.833	1.022	0.903	0.981
5	1.087	0.708	0.888	1.315	1.180	1.153	1.082	1.223	1.126	0.821	1.122	1.005	1.015	0.924	0.862	0.945	0.985	0.812
6	0.870	0.579	0.881	0.740	0.949	1.065	1.019	0.812	1.133	0.985	0.894	1.129	1.007	1.141	0.895	0.725	1.125	0.825
7	0.956	0.610	0.818	0.649	0.874	1.048	0.956	0.806	1.148	1.026	0.947	0.993	1.247	1.265	1.024	0.713	1.058	1.333
8	1.149	0.783	0.790	0.667	0.801	1.066	0.879	0.921	1.251	0.996	1.049	0.894	1.242	1.588	1.172	0.831	0.952	1.732
9	1.090	0.979	0.863	0.503	0.717	0.771	0.834	0.951	1.062	0.927	0.914	0.877	1.078	1.275	1.280	0.968	0.651	1.126
10	1.059	1.132	0.927	0.551	0.656	0.723	0.758	0.952	0.995	1.150	0.889	0.843	1.001	1.021	1.143	1.307	0.796	0.984
11	1.019	1.544	1.003	0.713	0.805	0.798	0.789	1.007	1.114	1.475	1.024	0.996	0.996	0.957	1.150	1.393	1.289	1.038
12	0.974	1.333	1.199	0.669	0.734	0.678	0.818	0.782	0.906	0.938	0.907	0.893	0.841	0.718	0.799	0.970	1.181	0.580
13	0.846	1.616	1.424	0.965	0.969	1.023	1.229	0.976	1.090	1.123	1.151	1.193	1.114	0.891	0.878	1.134	1.302	0.675
14	0.655	0.881	1.147	0.611	0.897	0.797	1.363	0.774	0.933	0.855	1.038	1.259	0.949	0.740	0.677	0.940	0.962	0.531
15	0.896	1.193	0.963	0.752	1.113	1.232	1.899	1.276	1.457	1.137	1.281	1.598	1.275	0.994	0.946	1.221	1.122	0.635
+ grp	0.896	1.193	0.963	0.752	1.113	1.232	1.899	1.276	1.457	1.137	1.281	1.598	1.275	0.994	0.946	1.221	1.122	0.635

Table 5.11.35. - Firth of Clyde (FU 13): VPA output males.

Year	Recruits Age 1	Total Biomass	TSB	Landings	Yield/SSB	Fbar 3-8
	'000	tonnes	tonnes	tonnes		
1981	184591	5643	5643	1385	0.245	0.483
1982	197423	6023	6023	1362	0.226	0.387
1983	214628	6816	6816	2211	0.324	0.703
1984	237601	6517	6517	1647	0.253	0.497
1985	252031	7157	7157	2112	0.295	0.512
1986	176312	6796	6796	1901	0.280	0.528
1987	120060	6292	6292	1535	0.244	0.326
1988	145981	6180	6180	2219	0.359	0.799
1989	184098	5166	5166	1472	0.285	0.834
1990	174968	5529	5529	1388	0.251	0.579
1991	119847	5702	5702	1717	0.301	0.476
1992	101843	5251	5251	1615	0.308	0.543
1993	175409	5234	5234	1618	0.309	0.752
1994	244427	5148	5148	1061	0.206	0.634
1995	212330	6333	6333	2053	0.324	0.910
1996	233944	6546	6546	2115	0.323	0.682
1997	278621	6644	6644	1925	0.290	1.221
1998	367319	7489	7489	2334	0.312	0.794
Average 96-98						0.899

Table 5.11.36. - Firth of Clyde (FU 13): VPA output females.

Year	Recruits Age 1	Total Biomass	TSB	Landings	Yield/SSB	Fbar 3-13
	'000	tonnes	tonnes	tonnes		
1981	221314	10698	7890	875	0.111	0.101
1982	270590	11222	8112	605	0.075	0.078
1983	292598	12617	9000	1165	0.130	0.109
1984	311857	13528	9357	940	0.100	0.040
1985	278280	14114	10011	1373	0.137	0.070
1986	222929	13701	10216	1013	0.099	0.060
1987	208229	13542	10789	687	0.064	0.047
1988	226983	13990	11207	1078	0.096	0.087
1989	256241	14117	11055	1101	0.100	0.105
1990	270514	14238	10850	1160	0.107	0.115
1991	241027	14388	11065	912	0.082	0.066
1992	239948	15629	12092	708	0.059	0.051
1993	288681	16364	12217	1156	0.095	0.104
1994	379932	16913	12284	977	0.080	0.087
1995	366966	18184	13291	1480	0.111	0.088
1996	355998	18949	13705	1449	0.106	0.098
1997	372251	20291	15183	1109	0.073	0.070
1998	416944	20879	15388	1804	0.117	0.095
Average 96-98						0.088

Table 5.11.37. - Firth of Clyde (FU 13): Catch predictions for 1999 and 2000, based on estimated stock size in 1999 rolled forward from the VPA, mean recruitment over last four years, current effort pattern (mean for 1996-98), and status quo effort.

Calculation of catches in numbers and in weight

Age	Stock no.	F	M	Catch numbers	Weight at age (g)	Catch weight (t)	Stock no.	Catch numbers	Catch weight (t)
	1999			1999		1999	2000	2000	2000
Males									
1	273054	0.038	0.3	8736	0.005	44	*	*	*
2	250181	0.408	0.3	73208	0.010	732	194799	57002	570
3	83663	0.808	0.3	40867	0.021	858	123197	60178	1264
4	33411	1.023	0.3	18950	0.037	701	27624	15668	580
5	8700	0.887	0.3	4516	0.055	248	8902	4621	254
6	2084	0.892	0.3	1086	0.076	83	2655	1383	105
7	533	0.904	0.3	280	0.097	27	633	333	32
8	147	0.882	0.3	76	0.118	9	160	83	10
9	56	1.027	0.3	32	0.139	4	45	26	4
10	15	0.854	0.3	8	0.158	1	15	8	1
+ group	10	0.854	0.3	5	0.185	1	8	4	1
Totals				147763		2709		139305	2820
Females									
1	273054	0.034	0.3	7984	0.006	48	*	*	*
2	286086	0.248	0.3	54544	0.011	600	195443	37263	410
3	140155	0.079	0.2	9674	0.017	164	165454	11420	194
4	124251	0.086	0.2	9242	0.020	185	106022	7886	158
5	89544	0.080	0.2	6210	0.024	149	93392	6477	155
6	65080	0.076	0.2	4322	0.028	121	67710	4497	126
7	44711	0.090	0.2	3500	0.032	112	49384	3866	124
8	29209	0.104	0.2	2627	0.034	89	33449	3008	102
9	21368	0.083	0.2	1536	0.039	60	21546	1549	60
10	16943	0.092	0.2	1357	0.042	57	16109	1291	54
11	12034	0.108	0.2	1123	0.045	51	12647	1180	53
12	8035	0.078	0.2	544	0.051	28	8840	599	31
13	4577	0.089	0.2	353	0.052	18	6087	469	24
14	3669	0.070	0.2	225	0.058	13	3429	210	12
15	3117	0.086	0.2	233	0.059	14	2801	210	12
+ group	13605	0.086	0.2	1019	0.078	80	12561	941	73
Totals				104494		1788		80864	1590
Total (males + females)									
Totals						**4497**			**4410**

* - No account is made for recruits in year 2000

Conversion of catches to landings

	% Catch discarded (by weight)	**1999** Landings (t)	**2000** Landings (t)
Males	12.2	2378	2476
Females	17.9	1468	1305
Total		**3847**	**3781**

Table 5.11.38. - Management Area C (VIa): Total *Nephrops* landings (tonnes) by Functional Unit plus other rectangles, 1989-98.

Year	FU 11	FU 12	FU 13	Other	Total
1989	3205	4745	2796	235	***10981***
1990	2543	4430	2878	217	***10068***
1991	2789	4442	3015	298	***10544***
1992	3548	4237	2727	283	***10795***
1993	3192	4454	3315	376	***11337***
1994	3616	4415	2629	441	***11101***
1995	3656	4678	3989	460	***12783***
1996	2871	3995	4061	228	***11155***
1997	3046	4345	3619	212	***11222***
1998 *	2428	3710	4840	120	***11098***

* provisional na = not available

Table 5.11.39. - Management Area C (VIa): Total *Nephrops* landings (tonnes) by country, 1989-98.

Year	Rep. of Ireland	Spain	UK	Total
1989	na	7	10974	***10981***
1990	na	1	10067	***10068***
1991	33	19	10492	***10544***
1992	10	18	10767	***10795***
1993	7	0	11330	***11337***
1994	3	0	11098	***11101***
1995	13	0	12770	***12783***
1996	8	0	11147	***11155***
1997	0	4	11218	***11222***
1998 *	0	11	11087	***11098***

* provisional na = not available

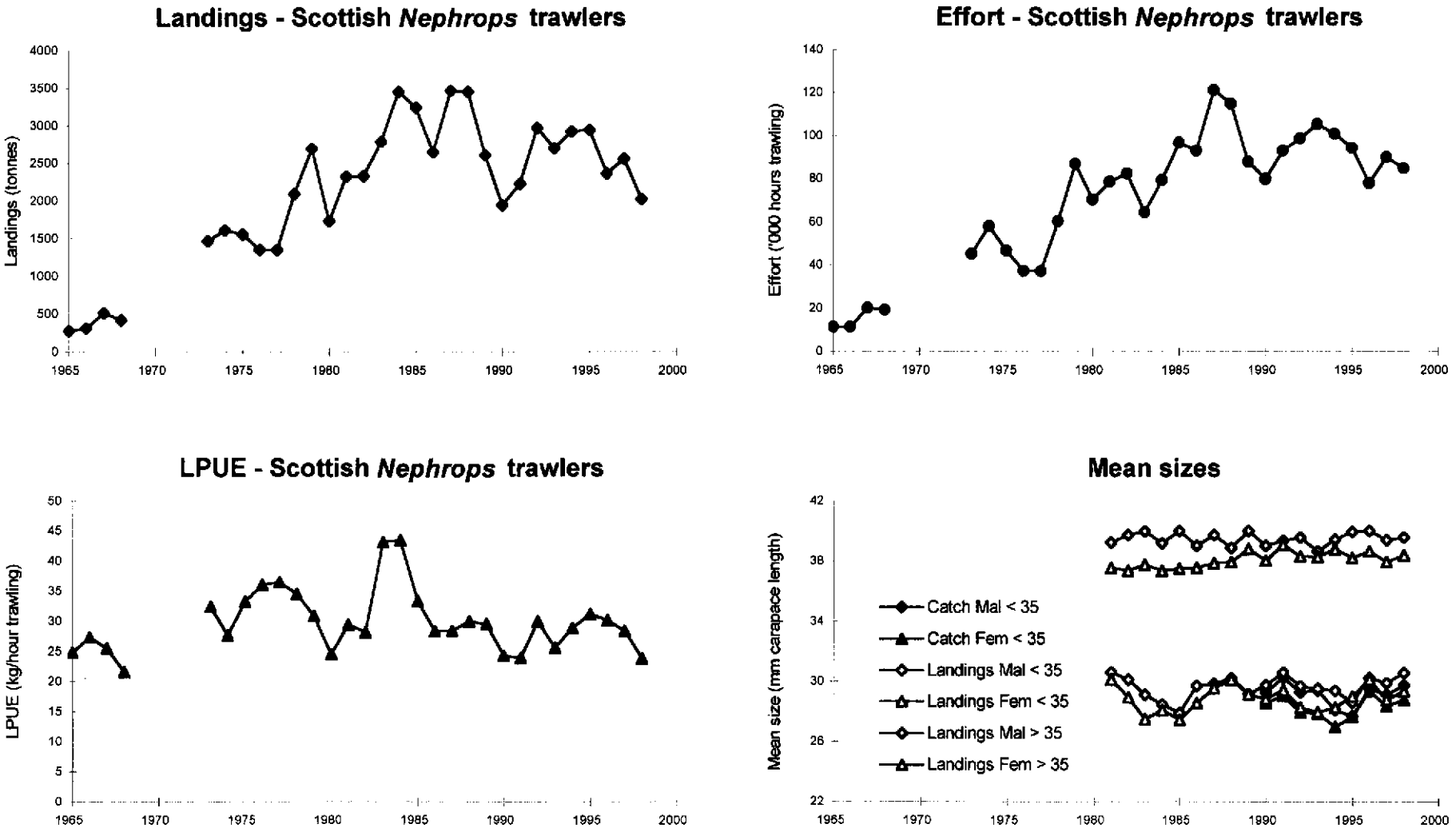


Figure 5.11.1. - North Minch (FU 11): Long-term trends in landings, effort, LPUEs and mean sizes of *Nephrops* in catches and landings.

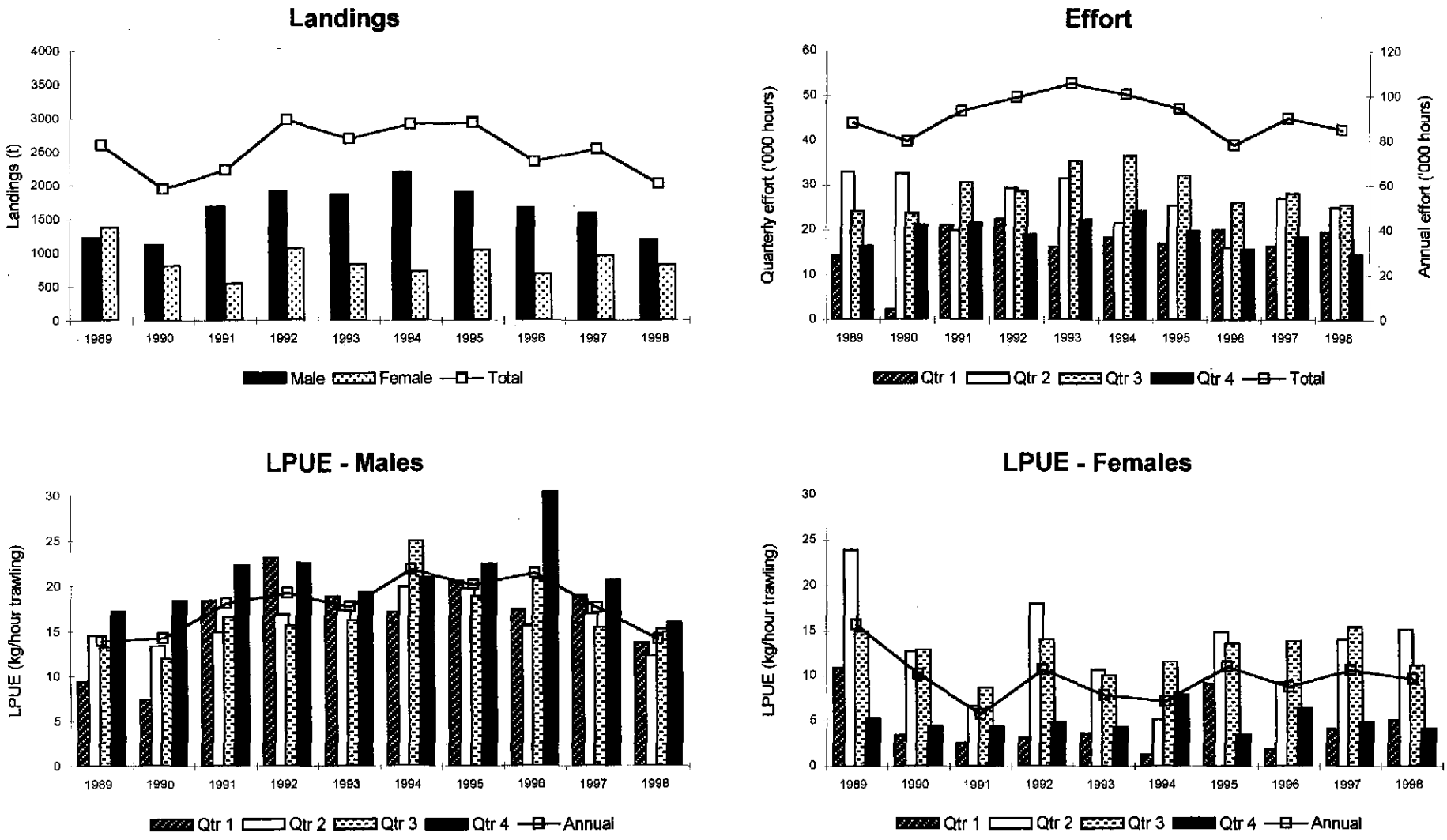


Figure 5.11.2. - North Minch (FU 11): Landings, effort and LPUEs by quarter and sex from Scottish *Nephrops* trawlers.

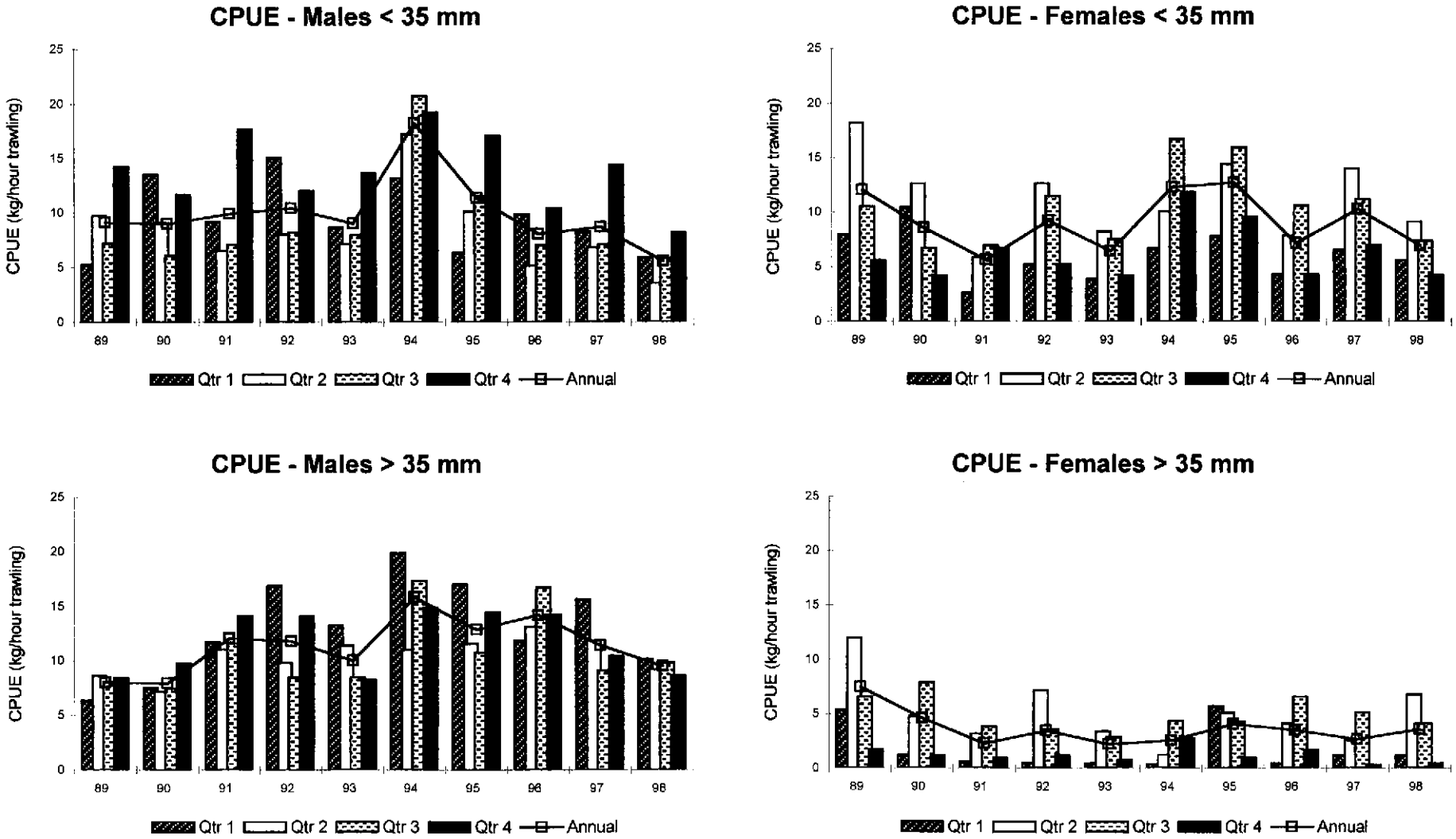
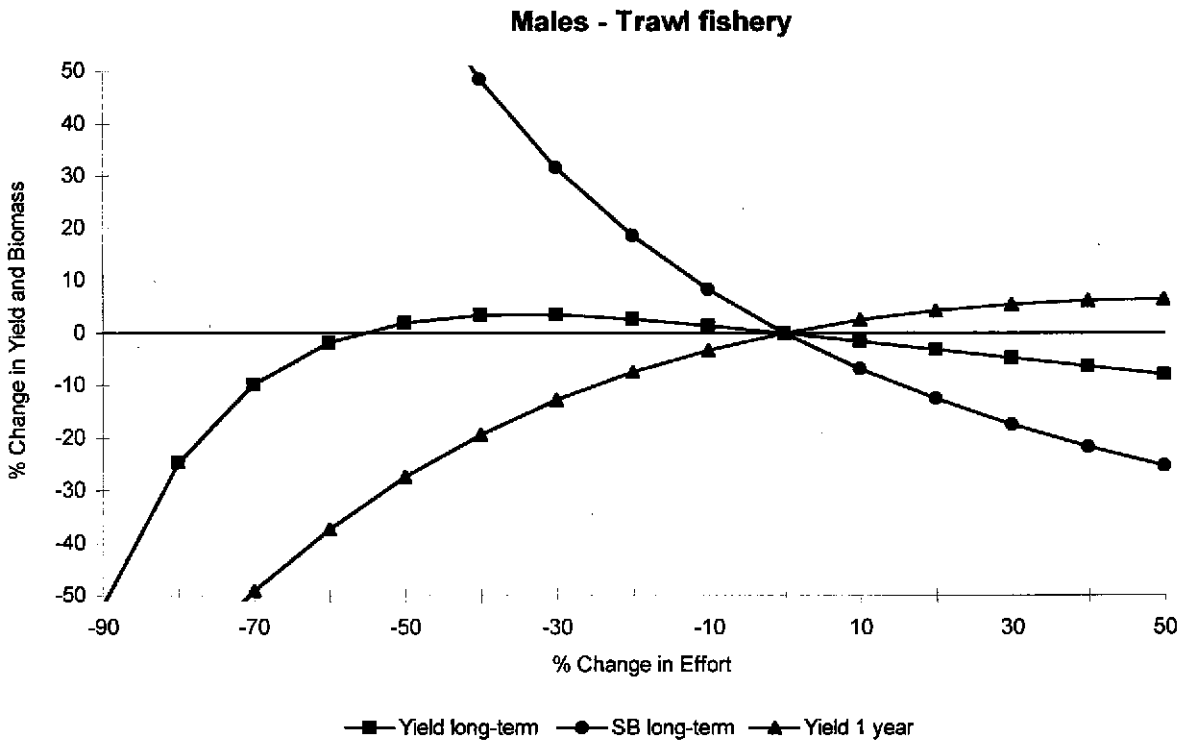


Figure 5.11.3. - North Minch (FU 11): CPUEs by sex and quarter, for selected size groups.



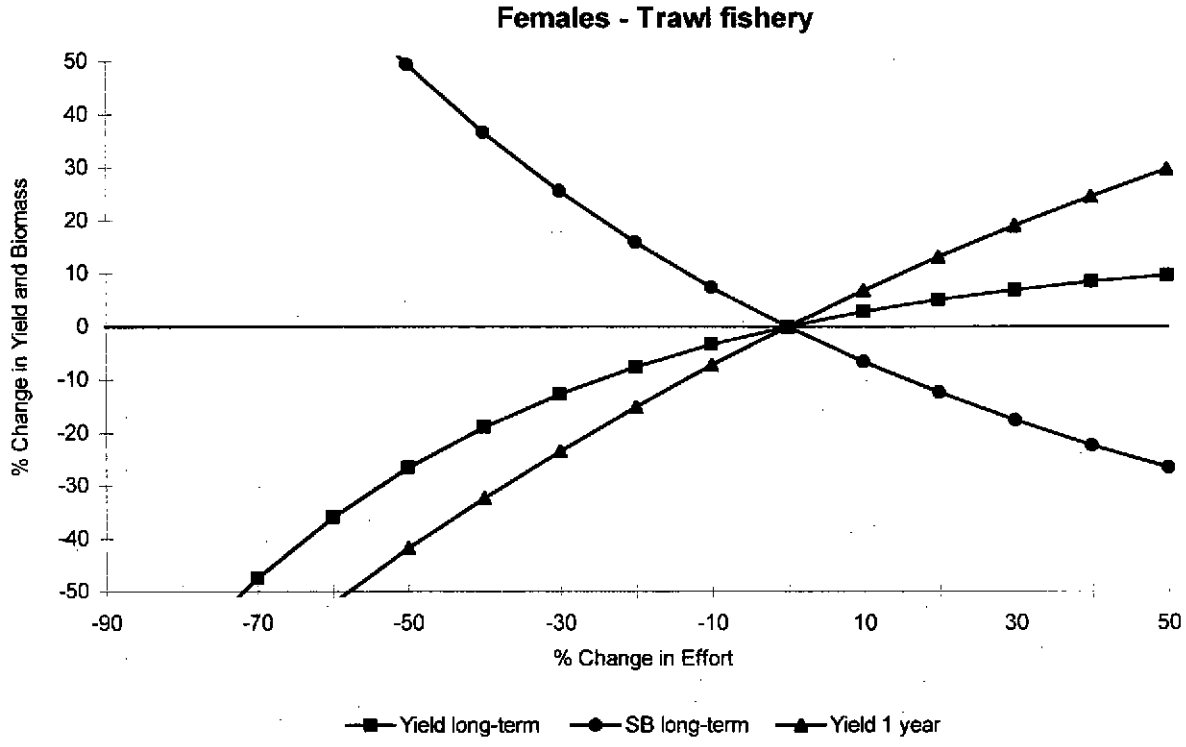
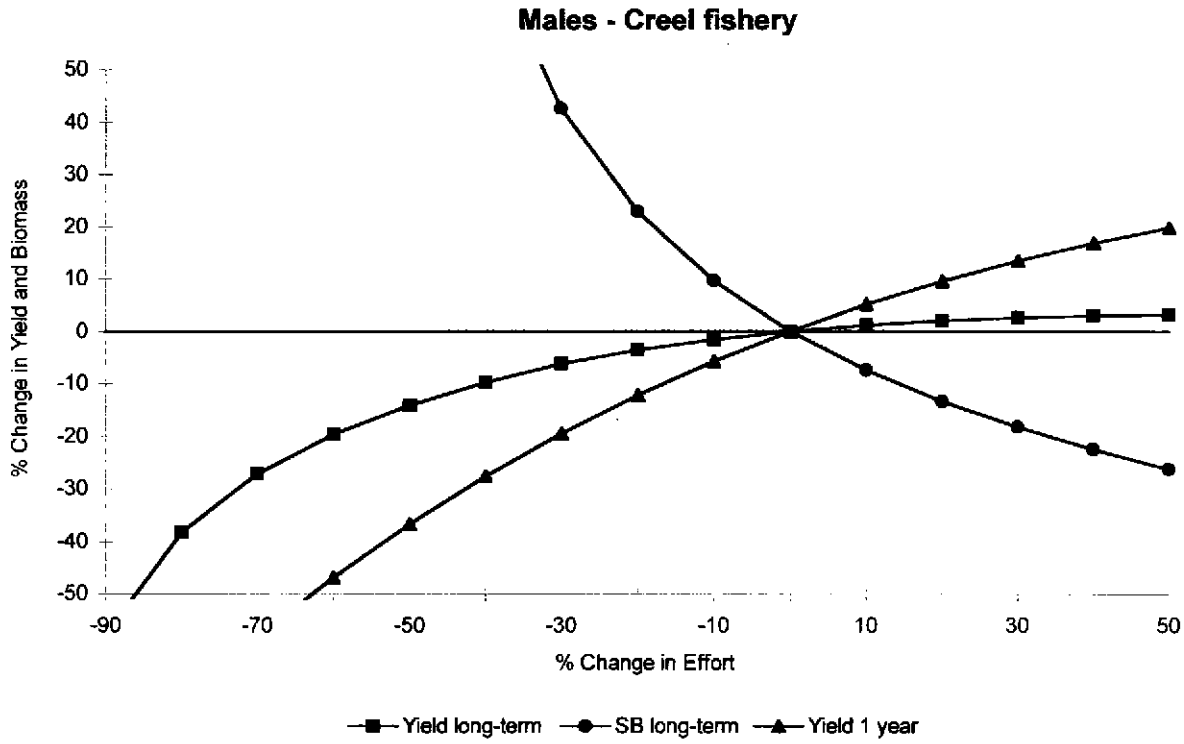


Figure 5.11.4. - North Minch (FU 11): Output LCA: Relative changes in short-term yield (ie after 1 year), long-term yield and long-term biomass upon relative changes in effort. Results for ***trawl fishery***. Males and females shown separately.



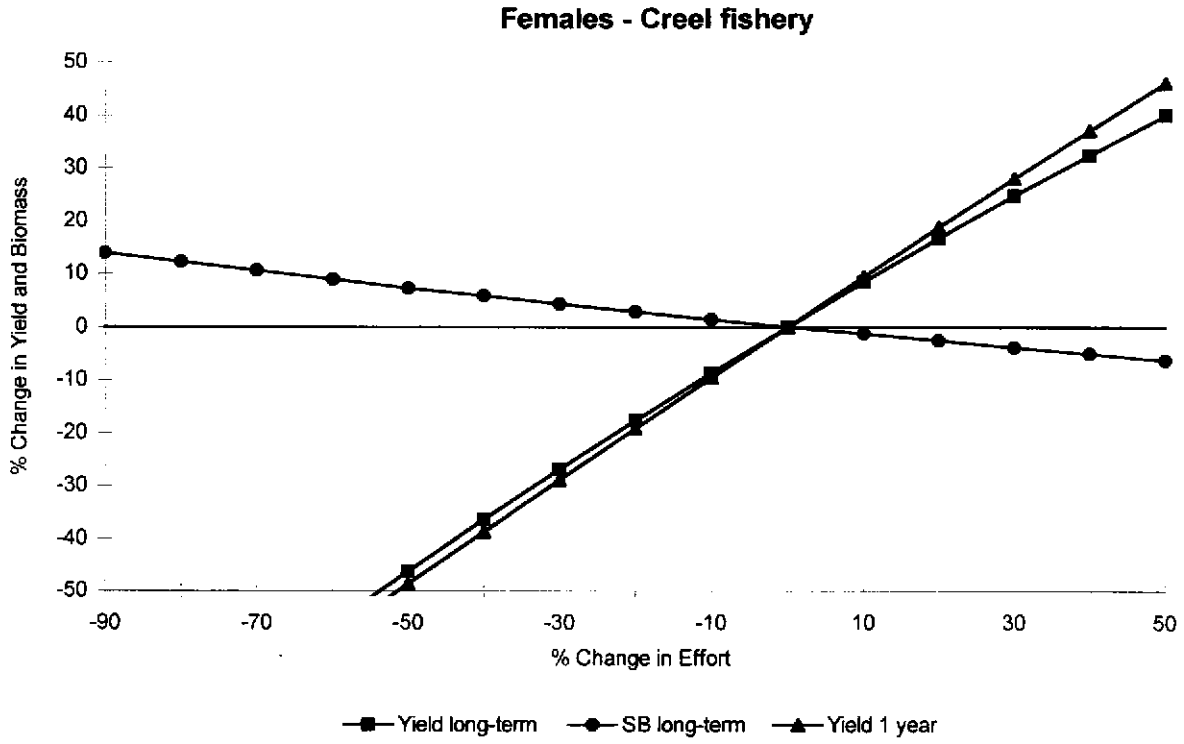


Figure 5.11.5. - North Minch (FU 11): Output LCA: Relative changes in short-term yield (ie after 1 year), long-term yield and long-term biomass upon relative changes in effort. Results for ***creel fishery***. Males and females shown separately.

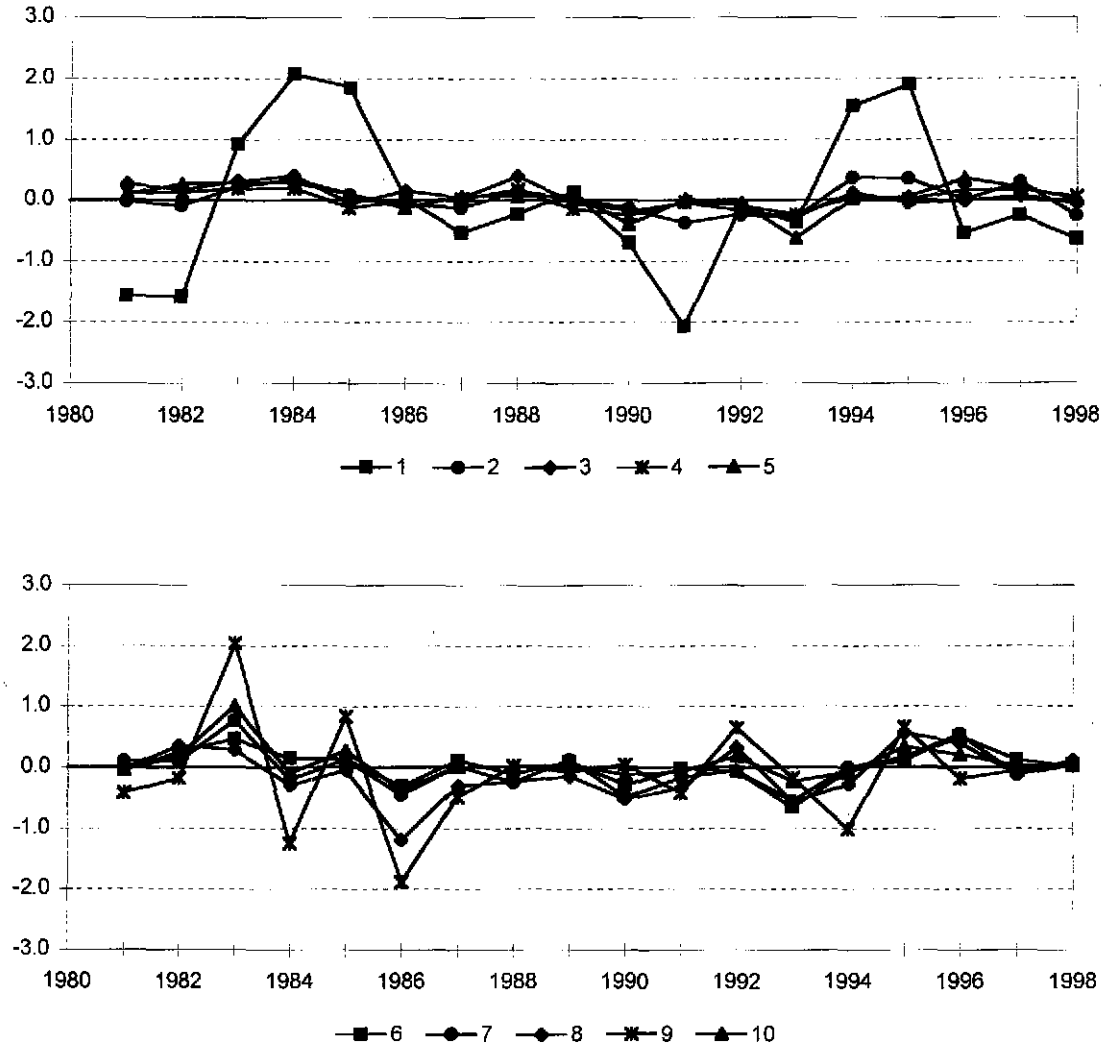
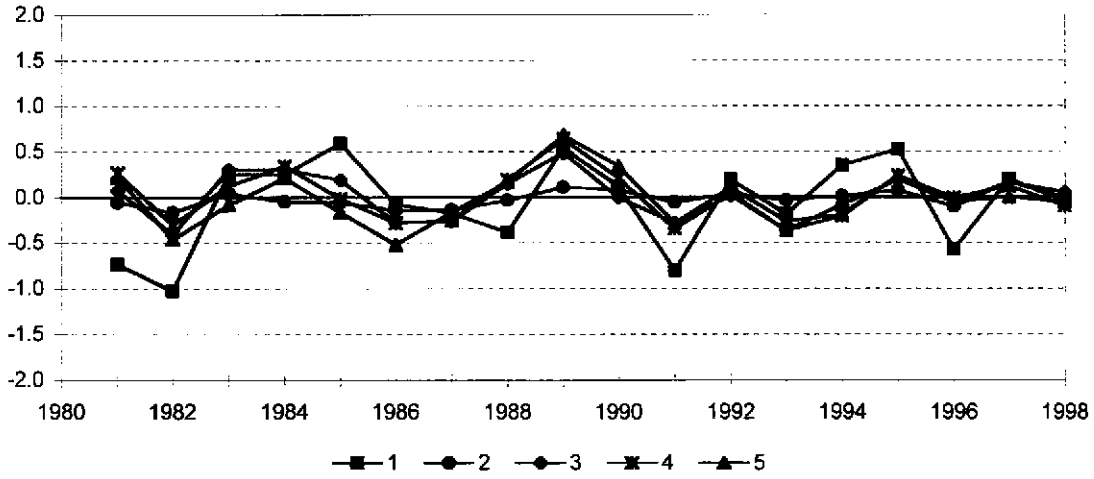
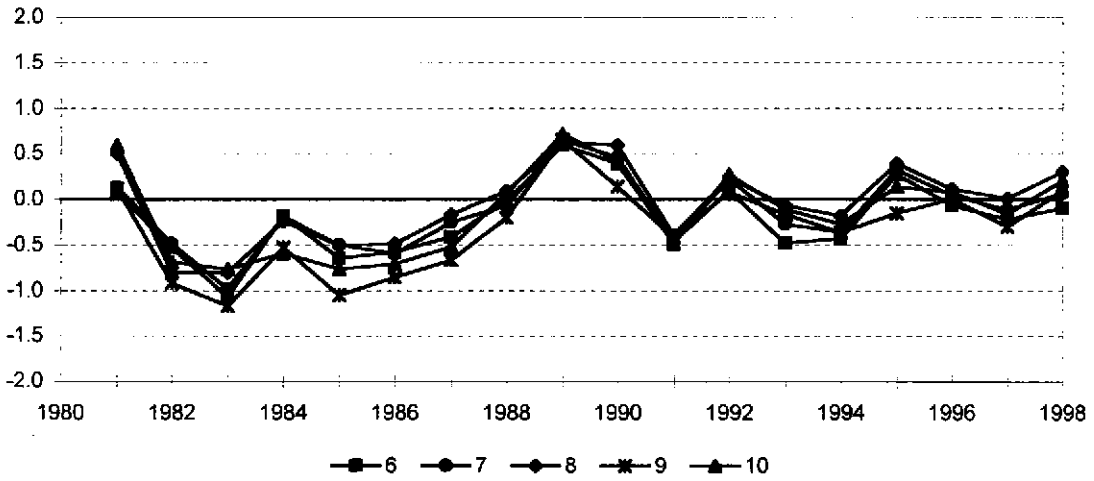


Figure 5.11.6. - North Minch (FU 11): Output VPA males: Log catchability residuals.





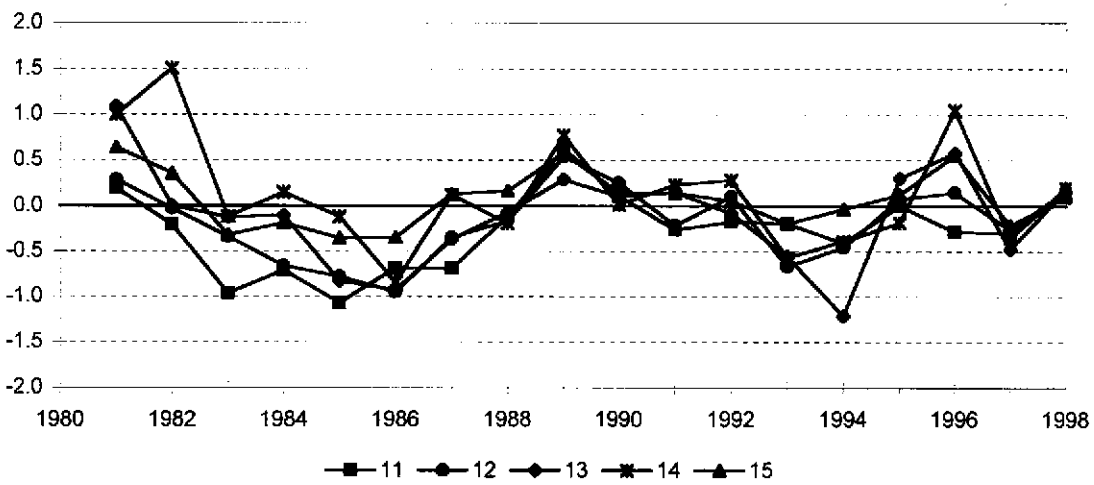


Figure 5.11.7. - North Minch (FU 11): Output VPA females: Log catchability residuals.

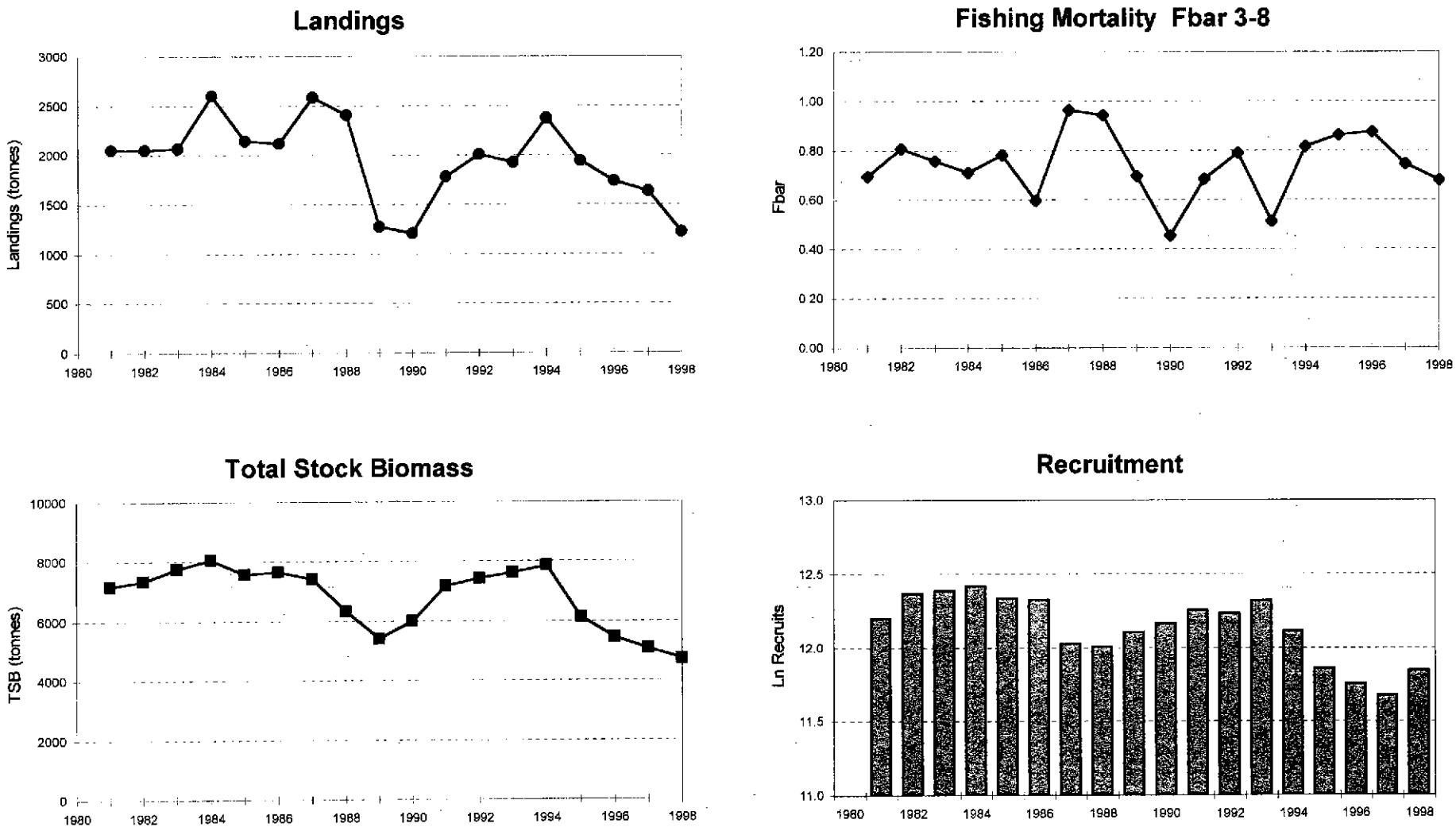


Figure 5.11.8. - North Minch (FU 11): Output VPA males: Trends in Landings, Fbar, TSB and Recruitment.

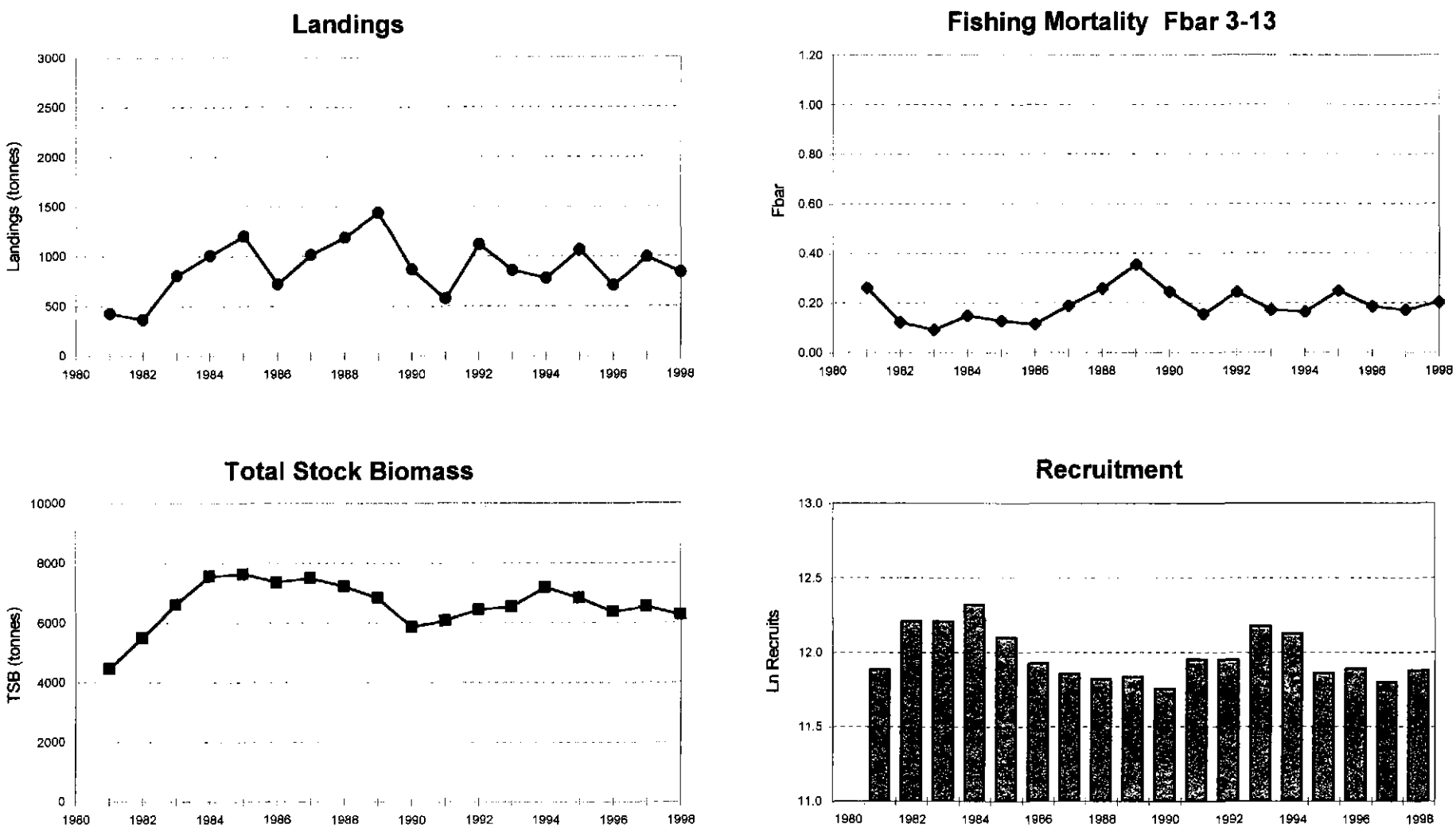


Figure 5.11.9. - North Minch (FU 11): Output VPA females: Trends in Landings, Fbar, TSB and Recruitment.

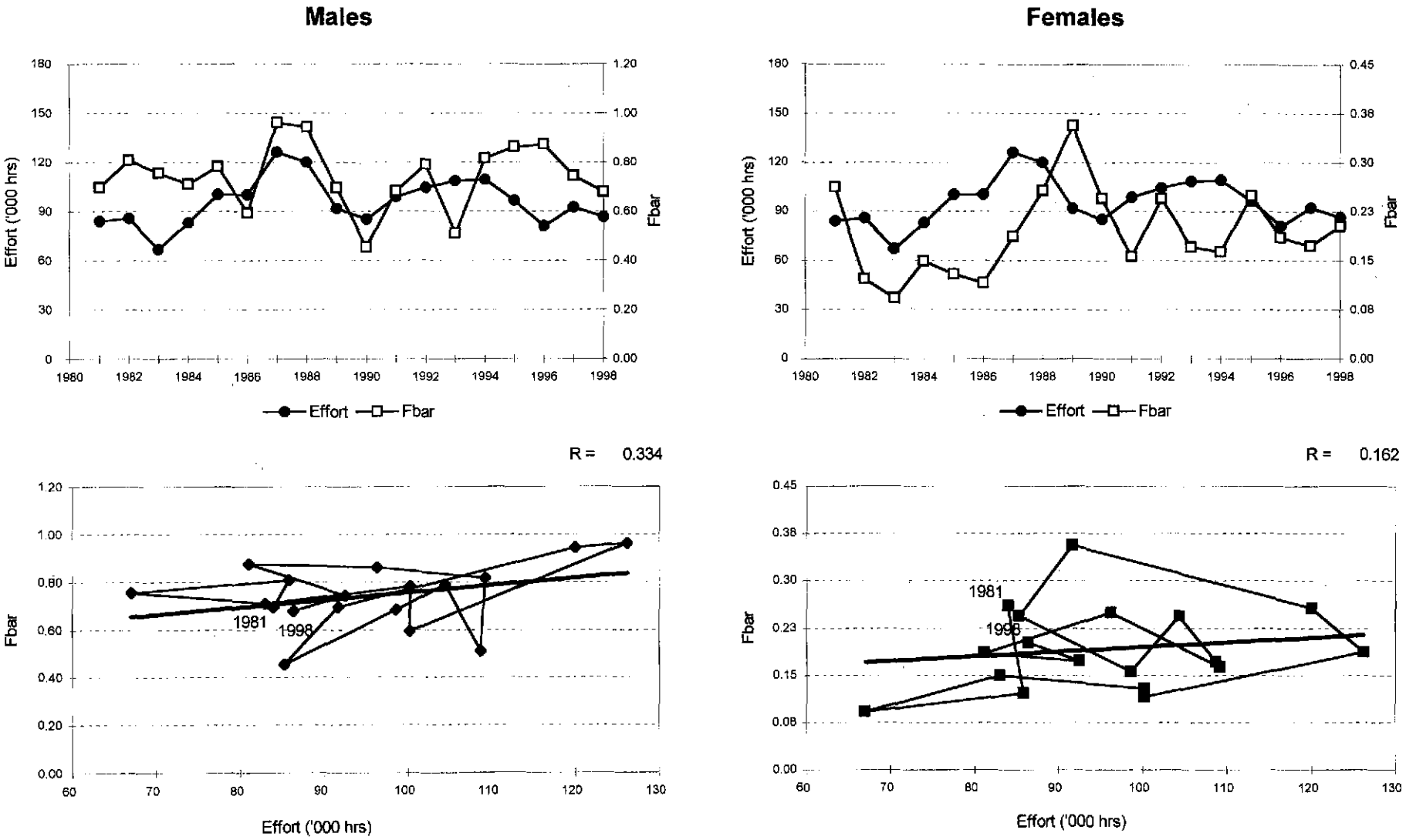


Figure 5.11.10. - North Minch (FU 11): Effort and Fbar, and relationship between them, for males and females.

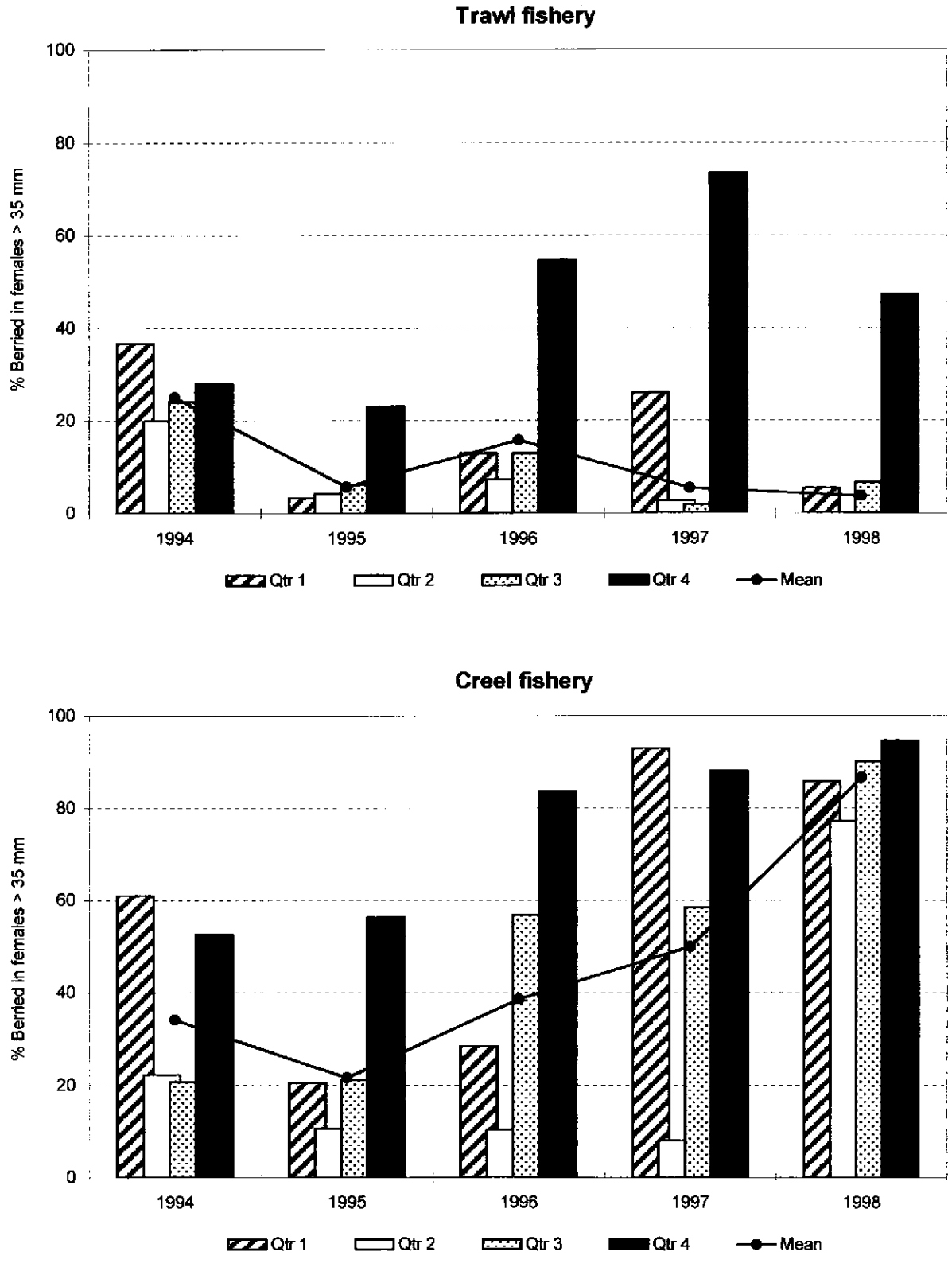


Figure 5.11.11. - North Minch (FU 11): % berried in females > 35 mm CL in the trawl and the creel fishery, by quarter, 1994-98.

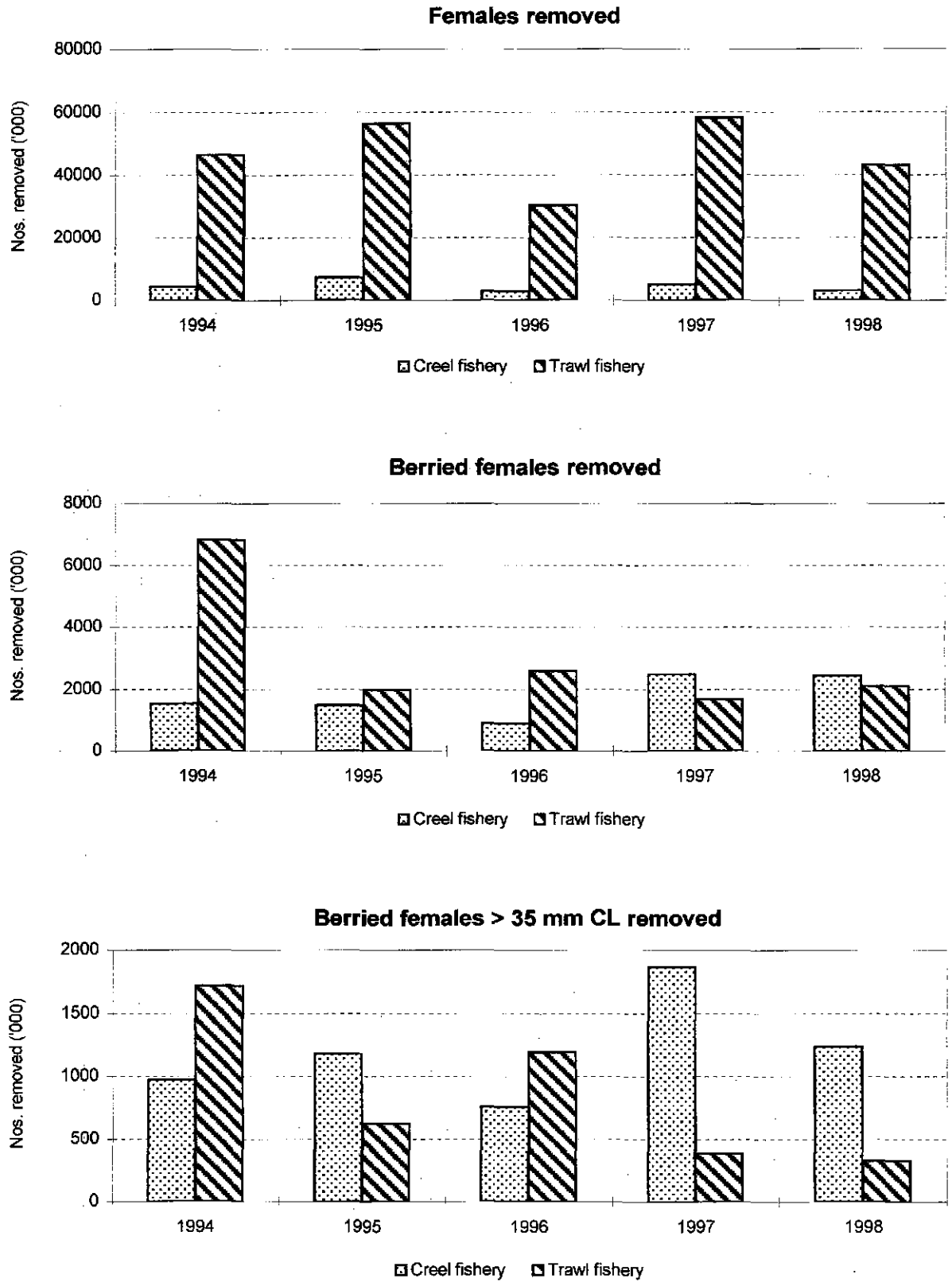


Figure 5.11.12. - North Minch (FU 11): Nos. of females removed from the population by the trawl and the creel fishery, 1994-98.

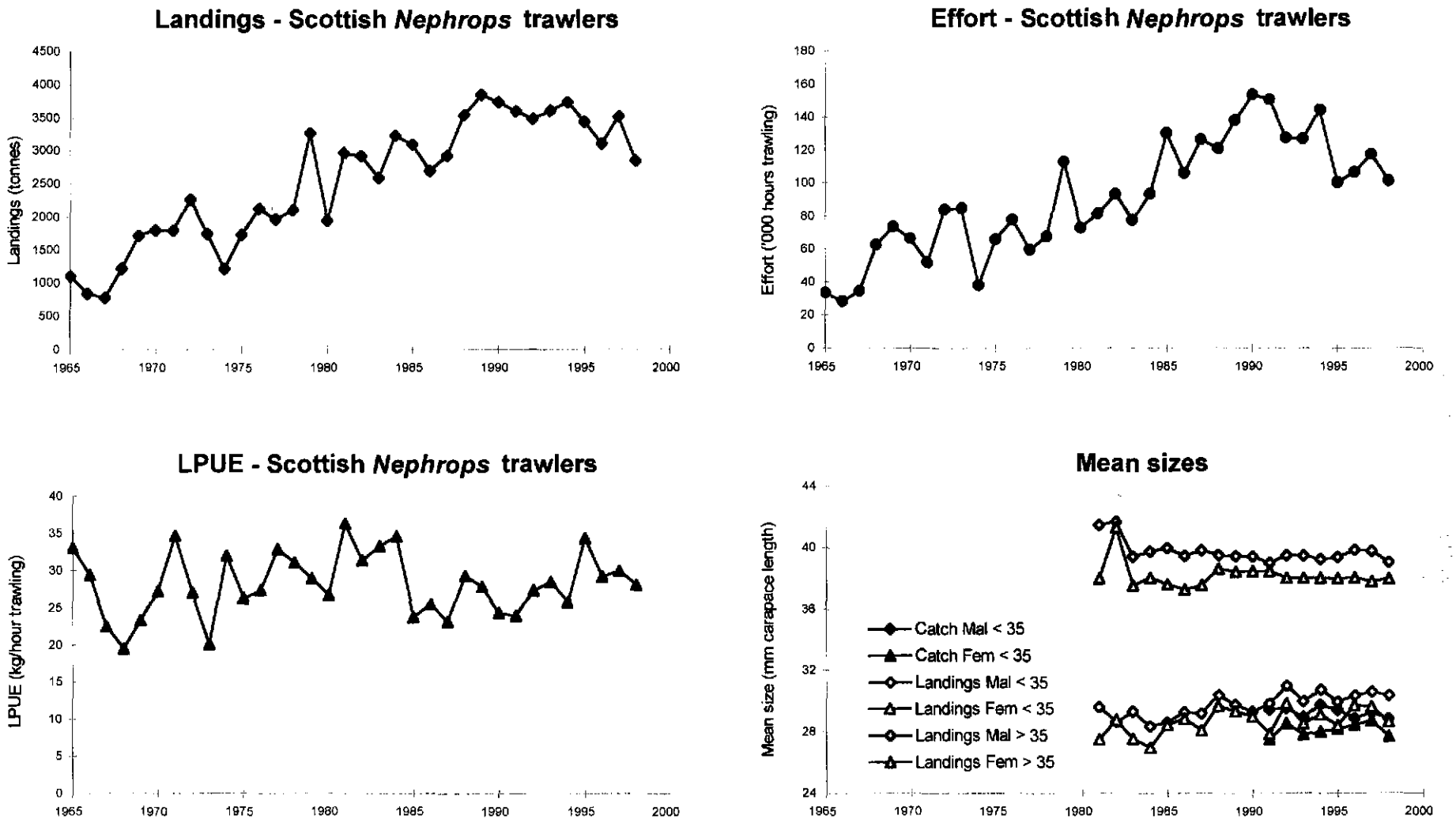


Figure 5.11.13. - South Minch (FU 12): Long-term trends in landings, effort, LPUEs and mean sizes of *Nephrops* in catches and landings.

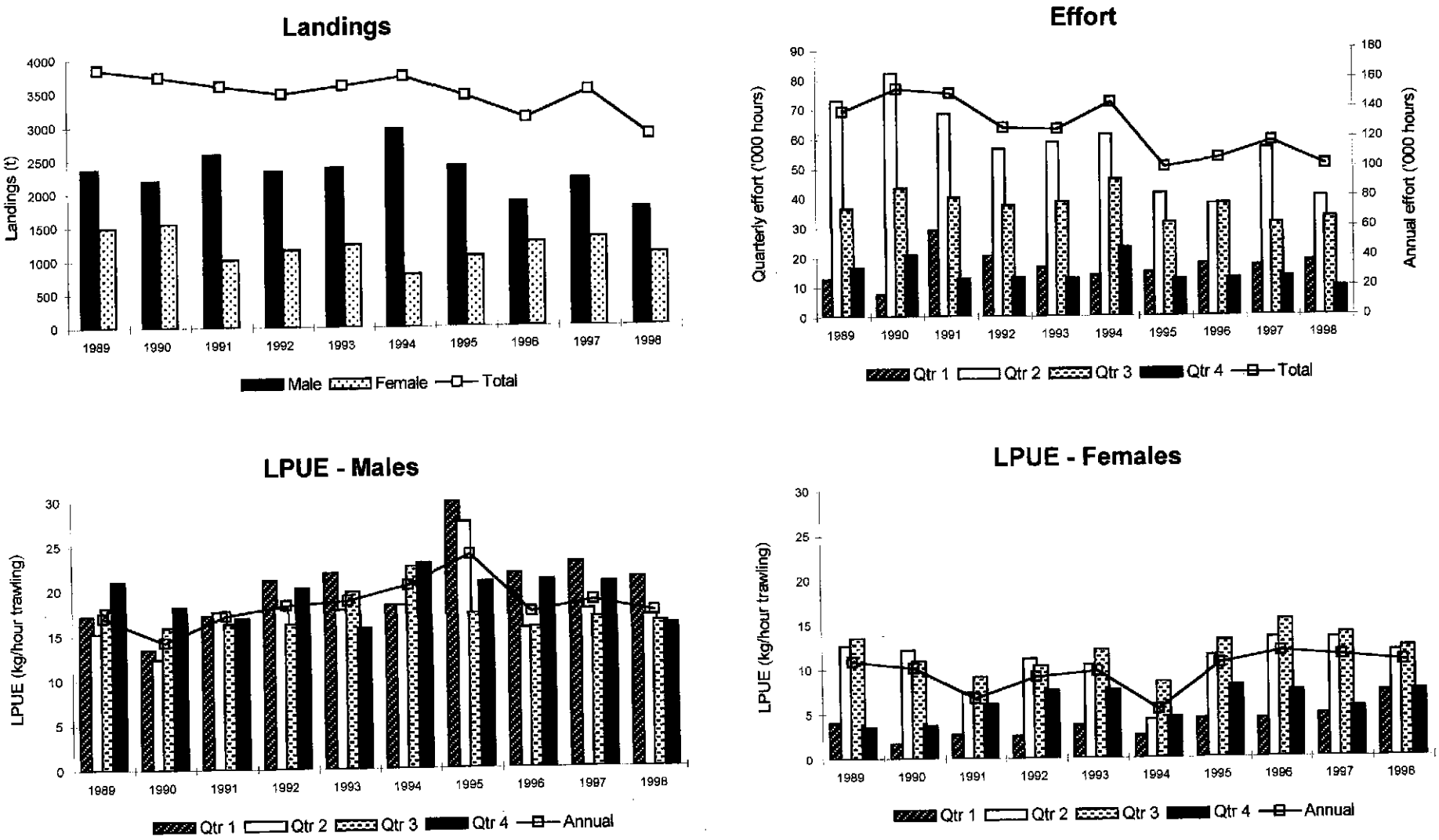


Figure 5.11.14. - South Minch (FU 12): Landings, effort and LPUEs by quarter and sex from Scottish *Nephrops* trawlers.

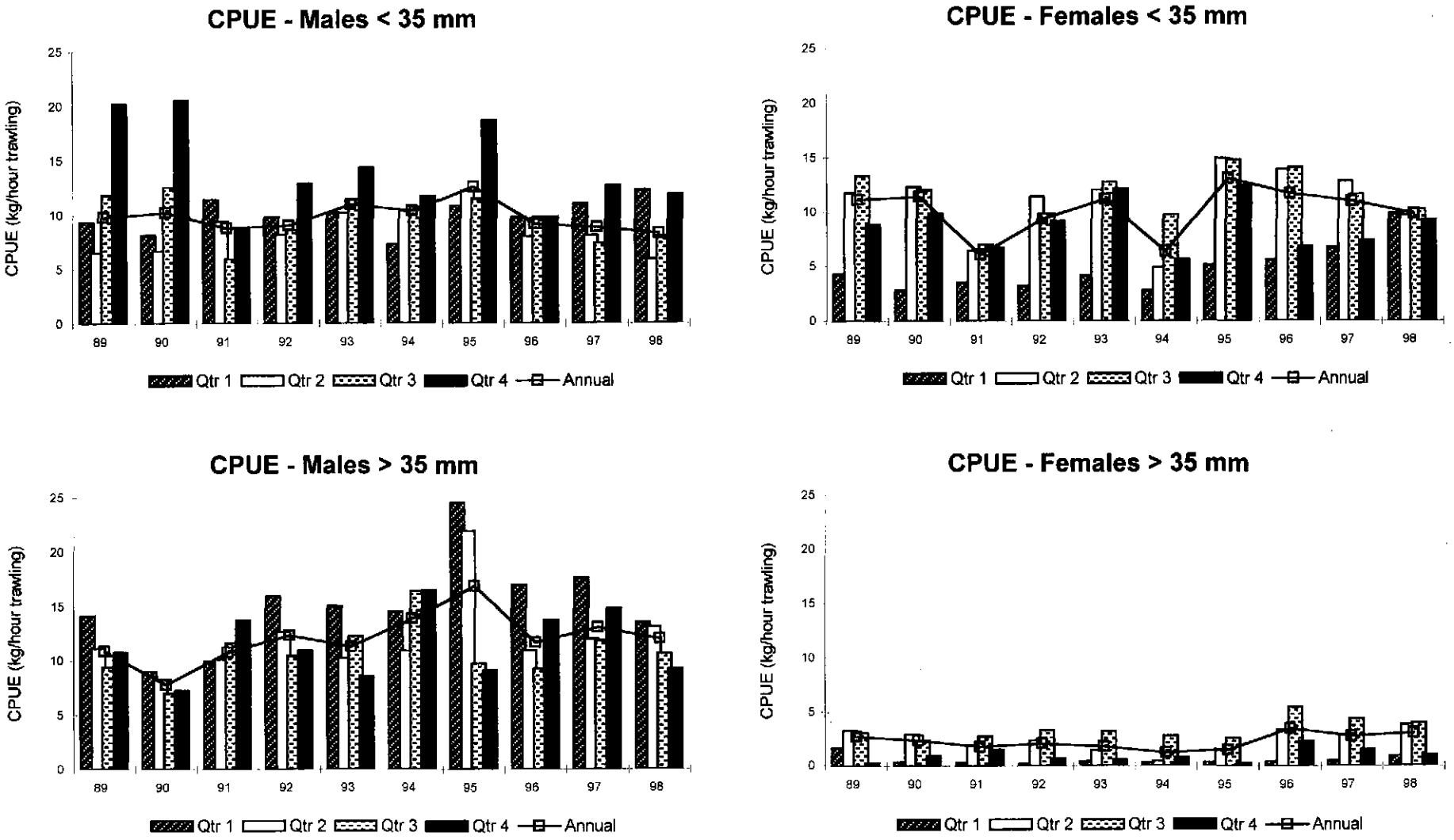
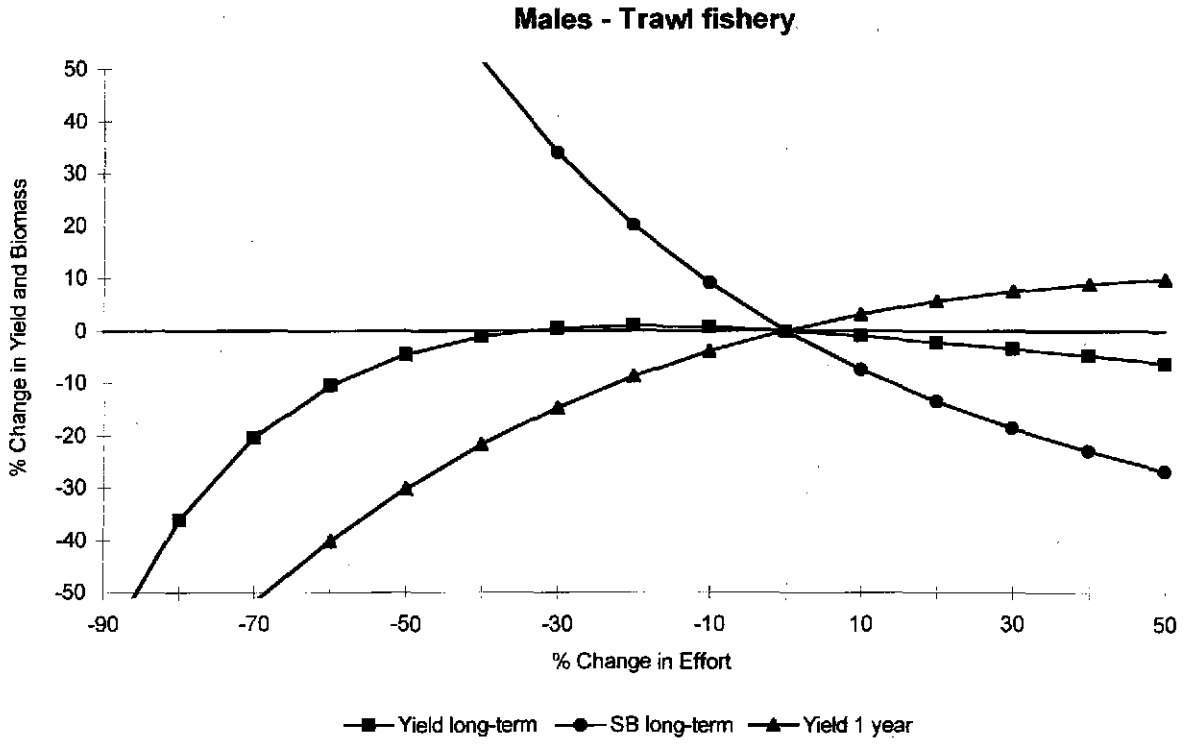


Figure 5.11.15. - South Minch (FU 12): CPUEs by sex and quarter, for selected size groups.



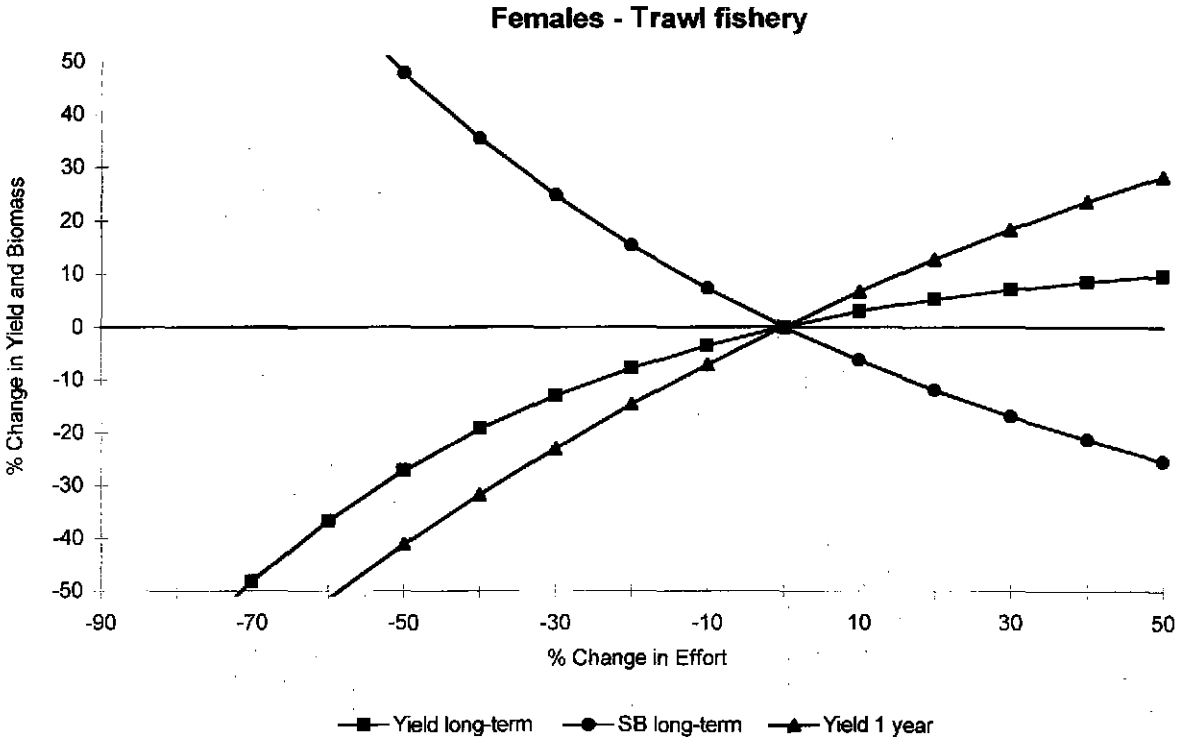
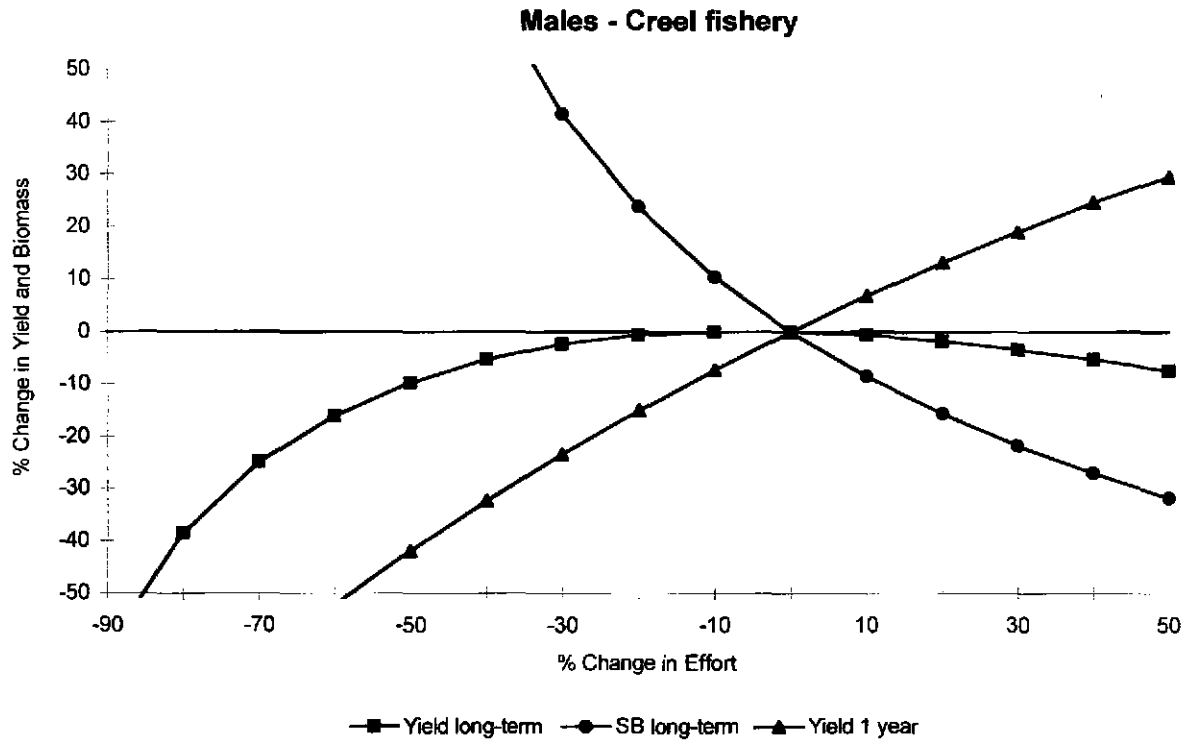


Figure 5.11.16. - South Minch (FU 12): Output LCA: Relative changes in short-term yield (ie after 1 year), long-term yield and long-term biomass upon relative changes in effort. Results for ***trawl fishery***. Males and females shown separately.



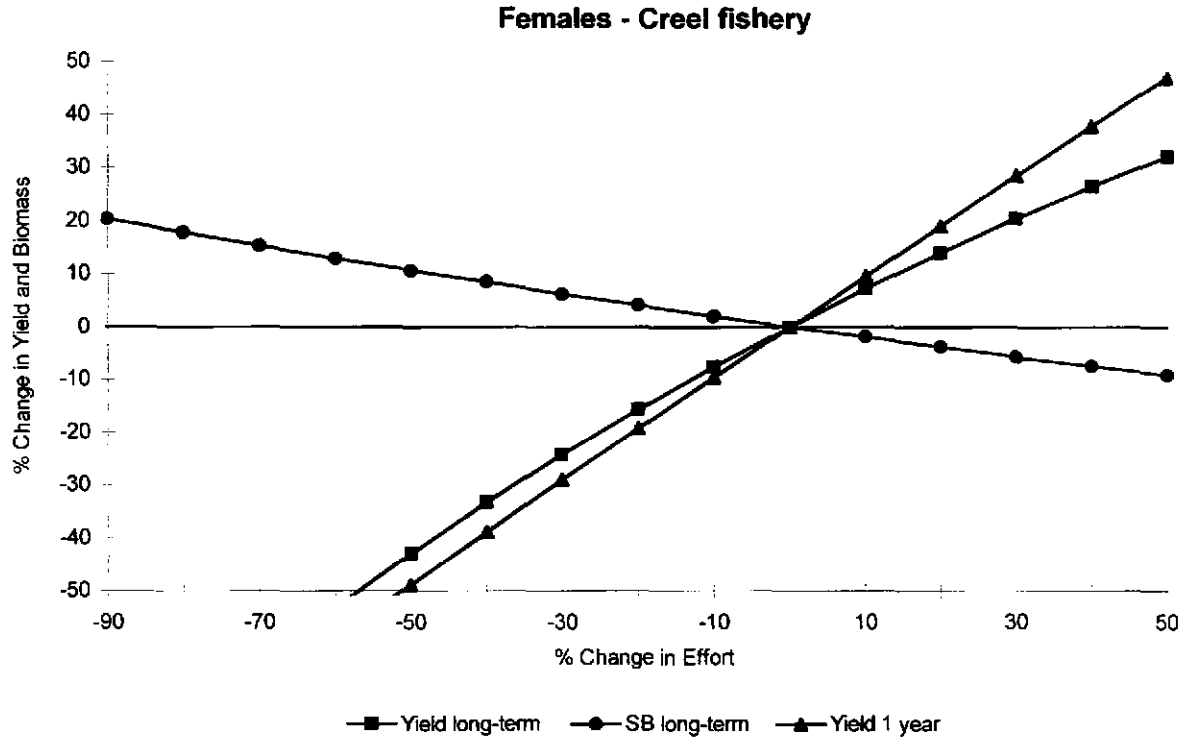


Figure 5.11.17. - South Minch (FU 12): Output LCA: Relative changes in short-term yield (ie after 1 year), long-term yield and long-term biomass upon relative changes in effort. Results for ***creel fishery***. Males and females shown separately.

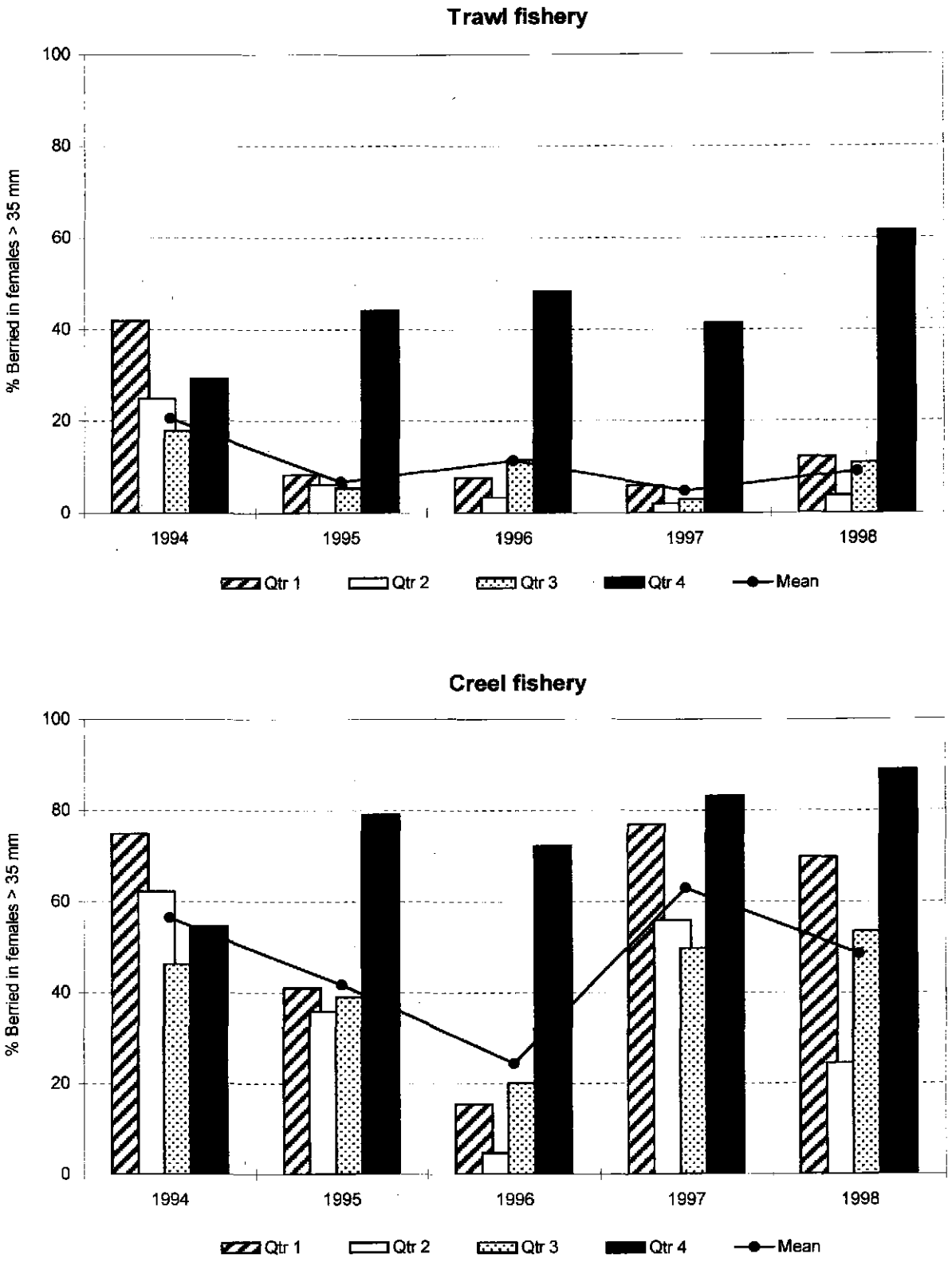


Figure 5.11.18. - South Minch (FU 12): % berried in females > 35 mm CL in the trawl and the creel fishery, by quarter, 1994-98.

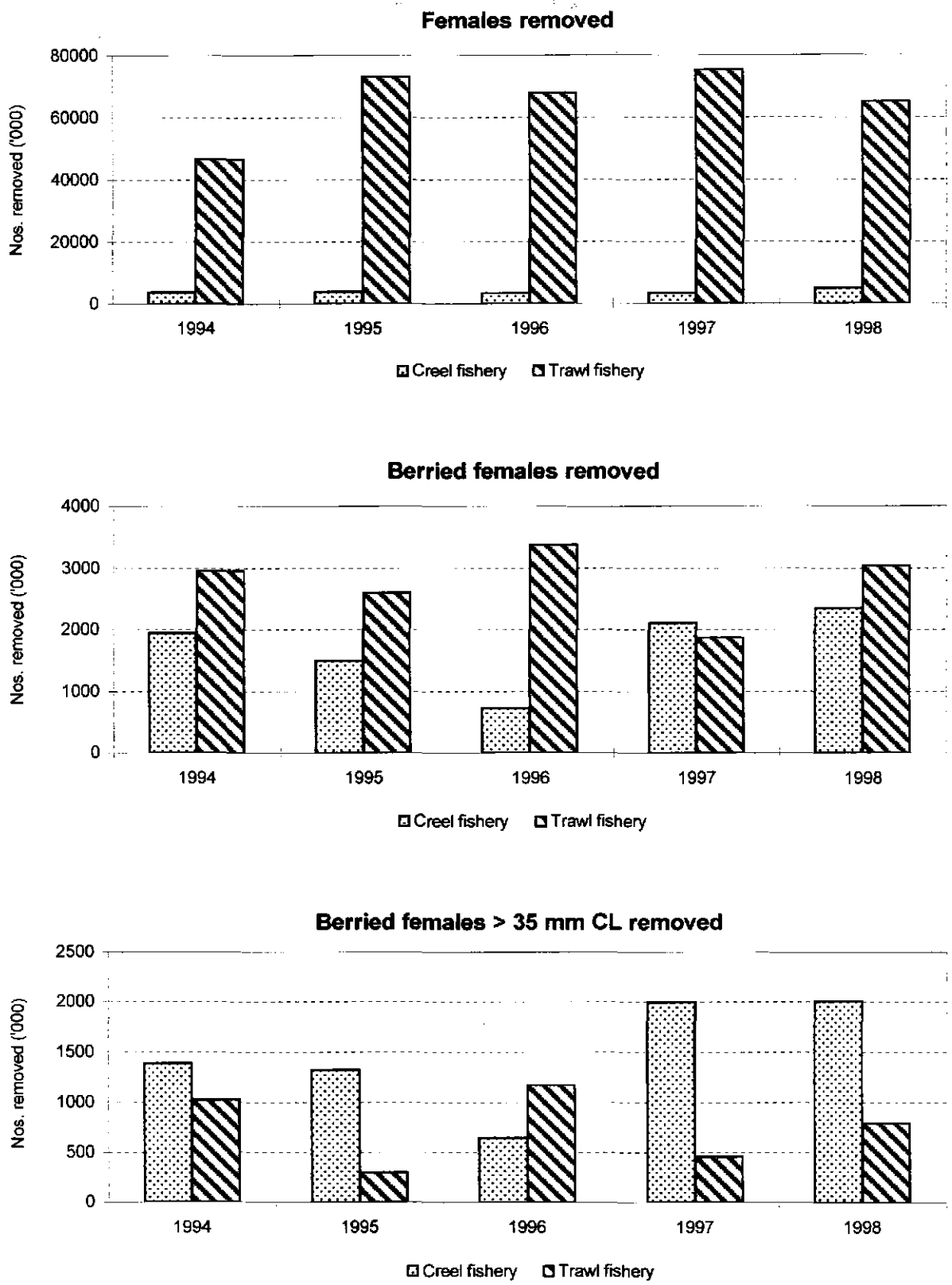


Figure 5.11.19. - South Minch (FU 12): Nos. of females removed from the population by the trawl and the creel fishery, 1994-98.

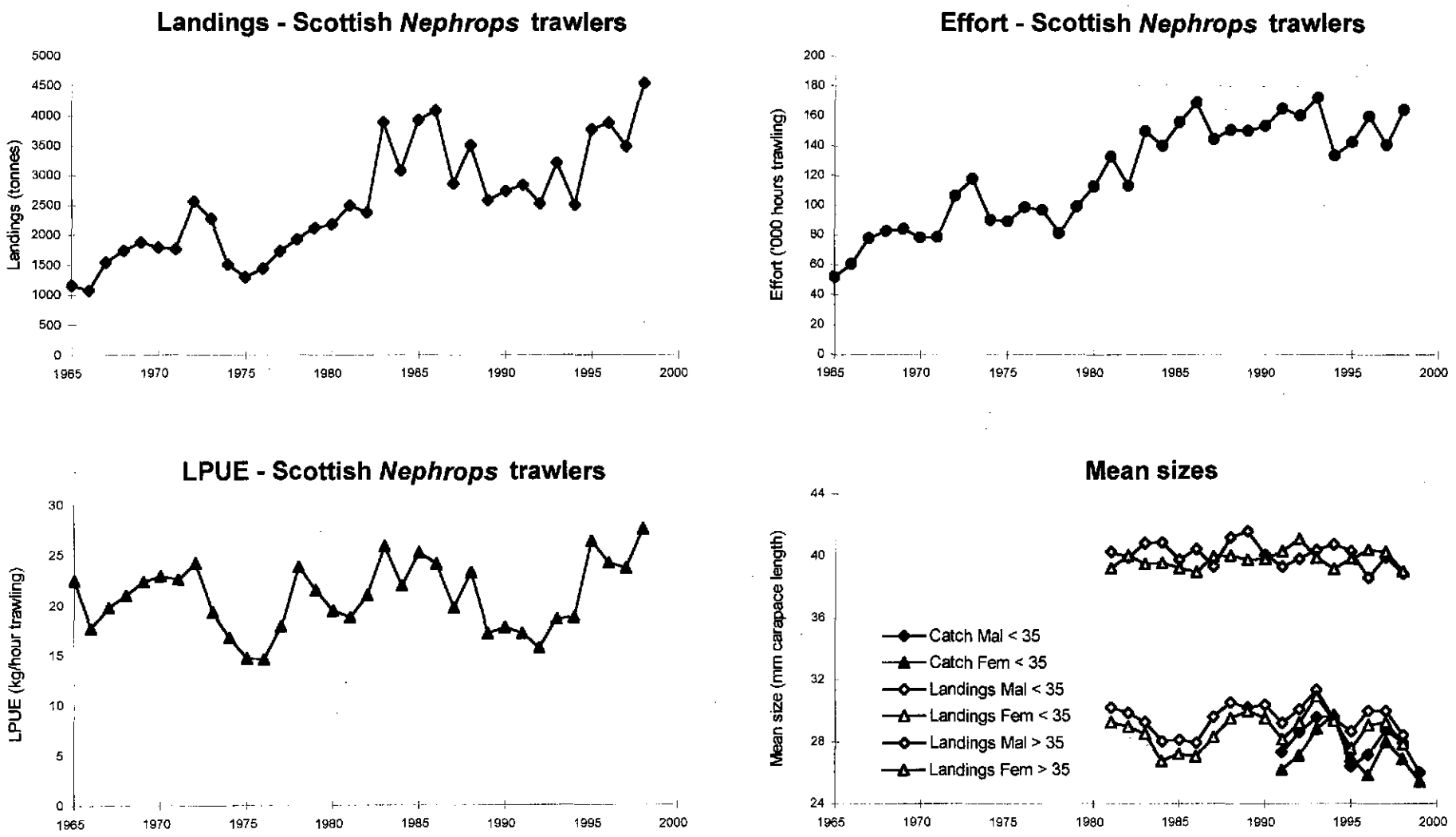


Figure 5.11.20. - Firth of Clyde (FU 13): Long-term trends in landings, effort, LPUEs and mean sizes of *Nephrops* in catches and landings.

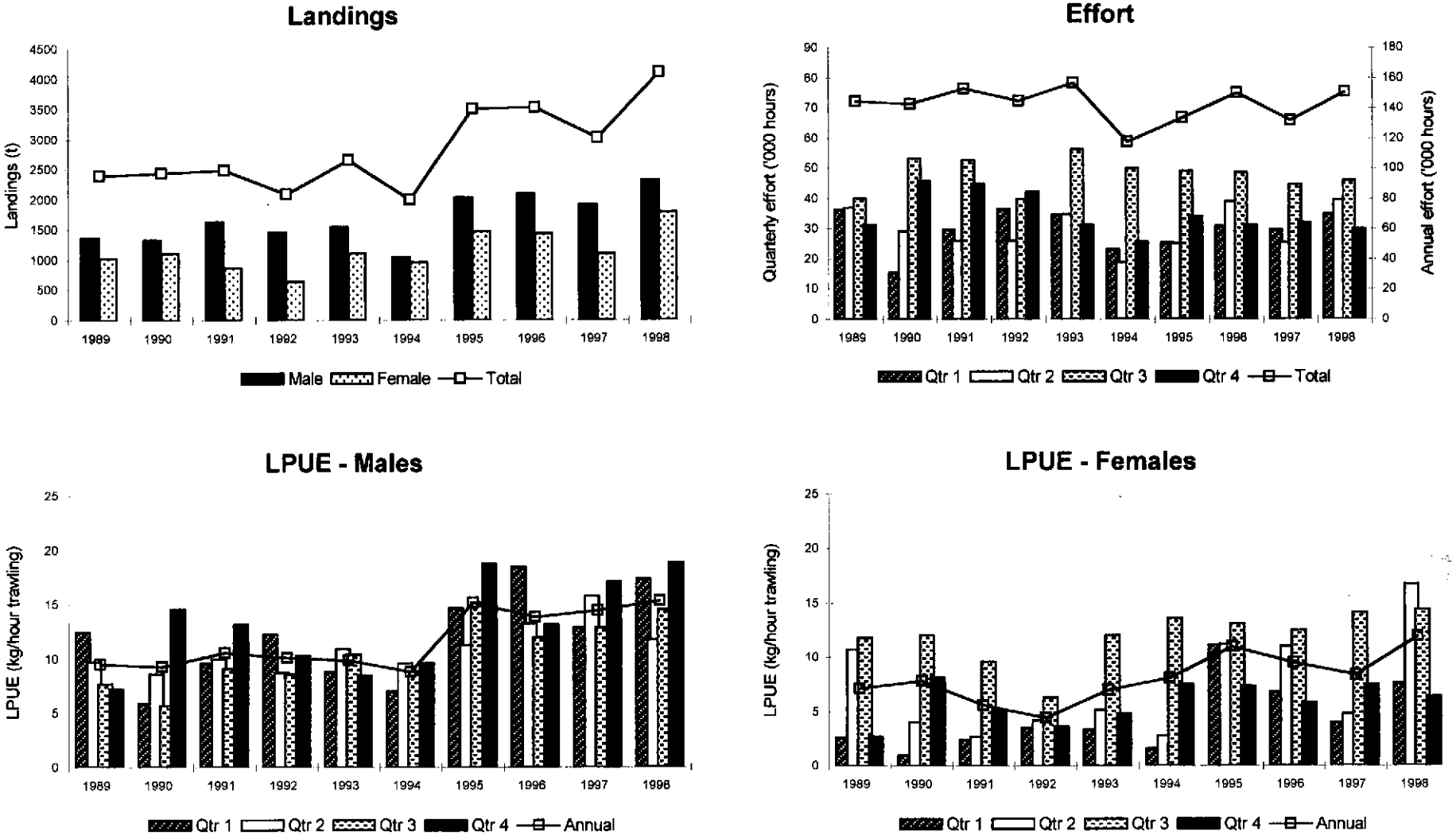


Figure 5.11.21. - Firth of Clyde (FU 13): Landings, effort and LPUEs by quarter and sex from Scottish *Nephrops* trawlers.

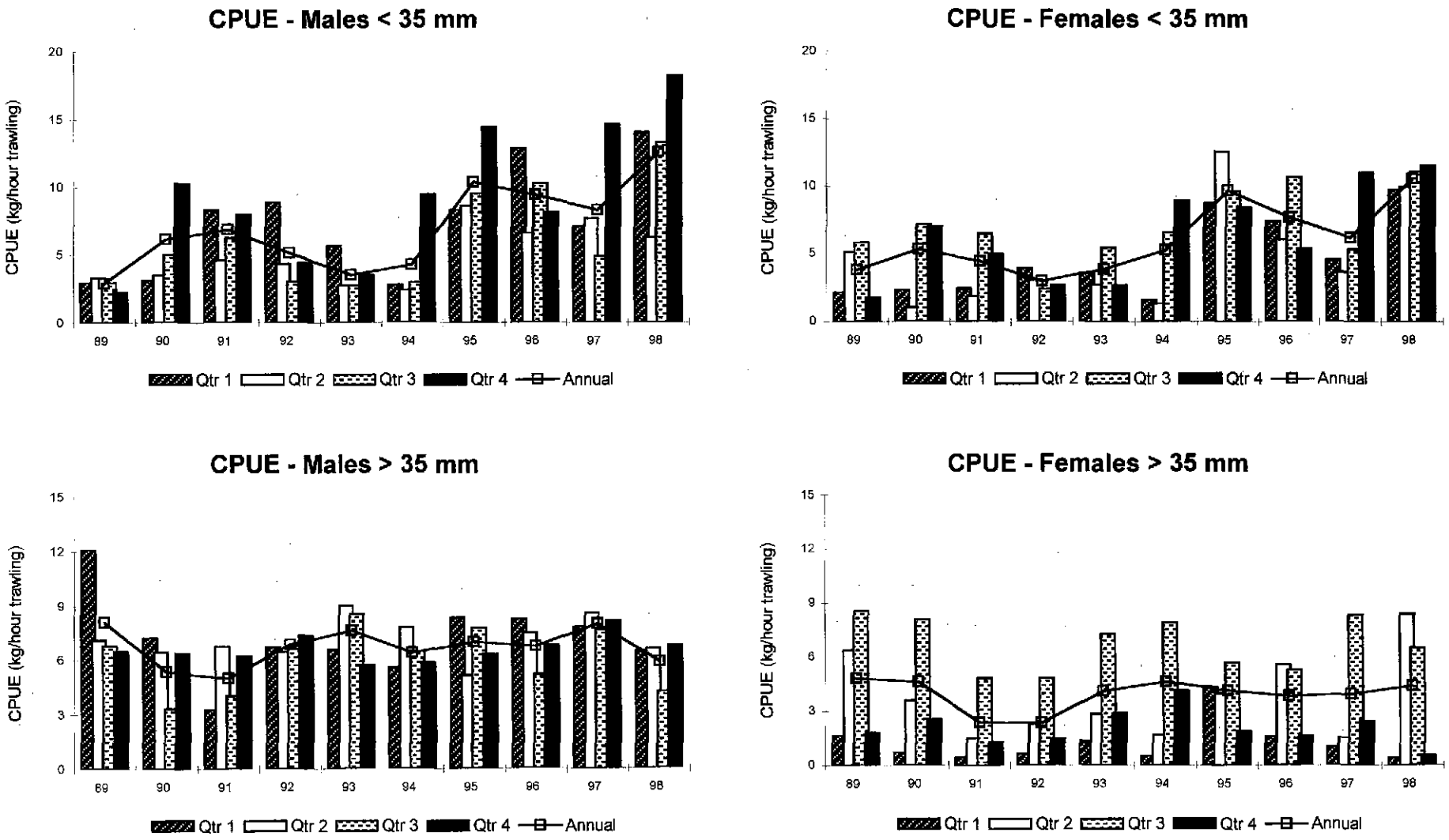
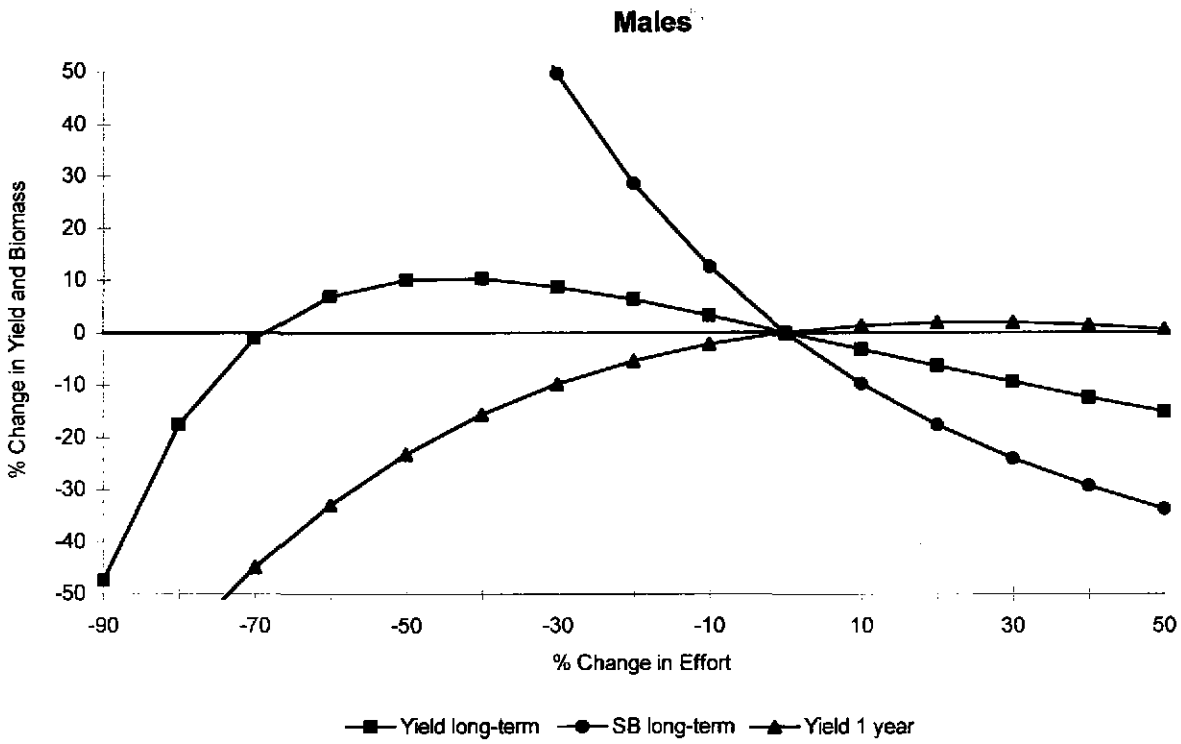


Figure 5.11.22. - Firth of Clyde (FU 13): CPUEs by sex and quarter, for selected size groups.



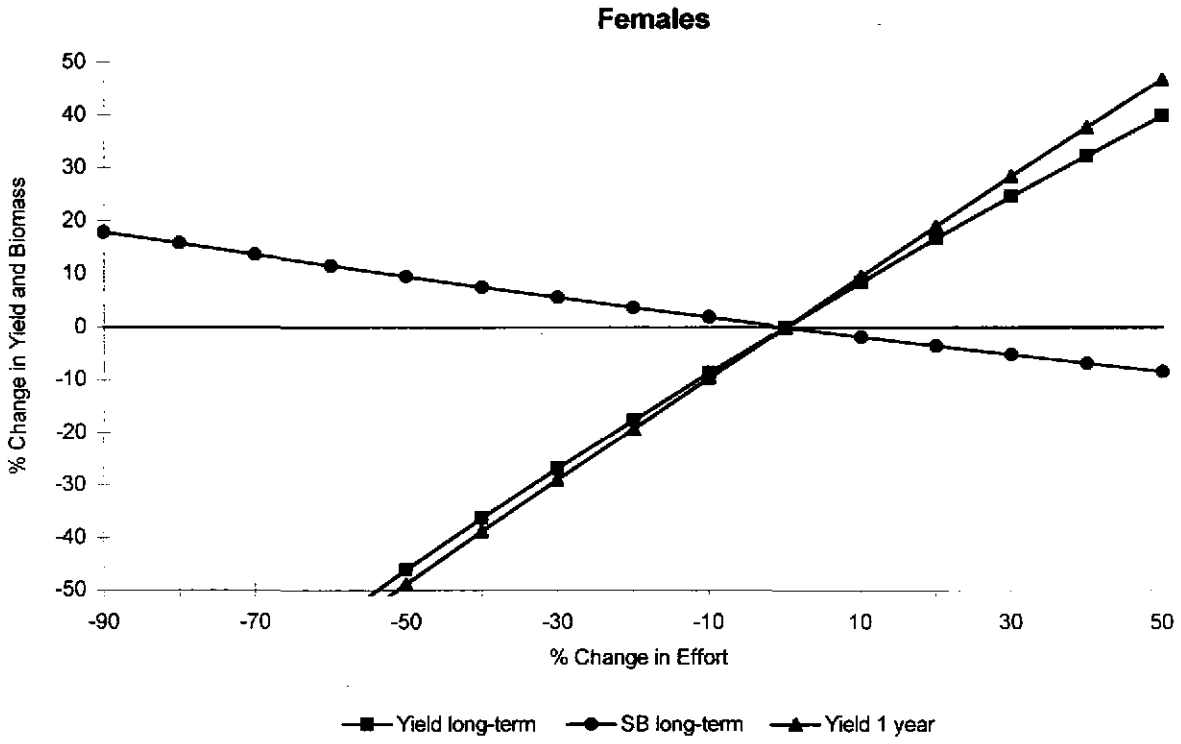


Figure 5.11.23. - Firth of Clyde (FU 13): Output LCA: Relative changes in short-term yield (ie after 1 year), long-term yield and long-term biomass upon relative changes in effort. Males and females shown separately.

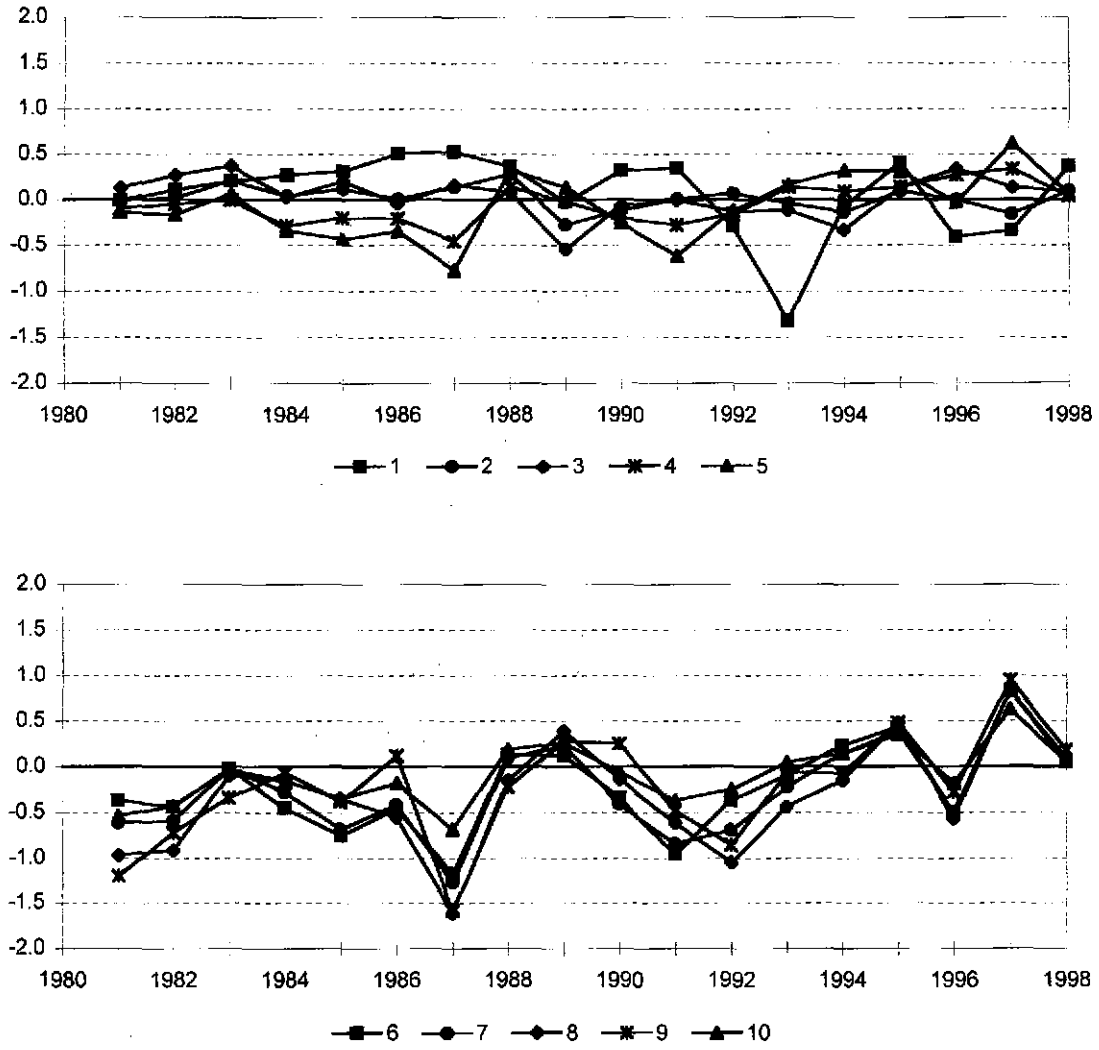
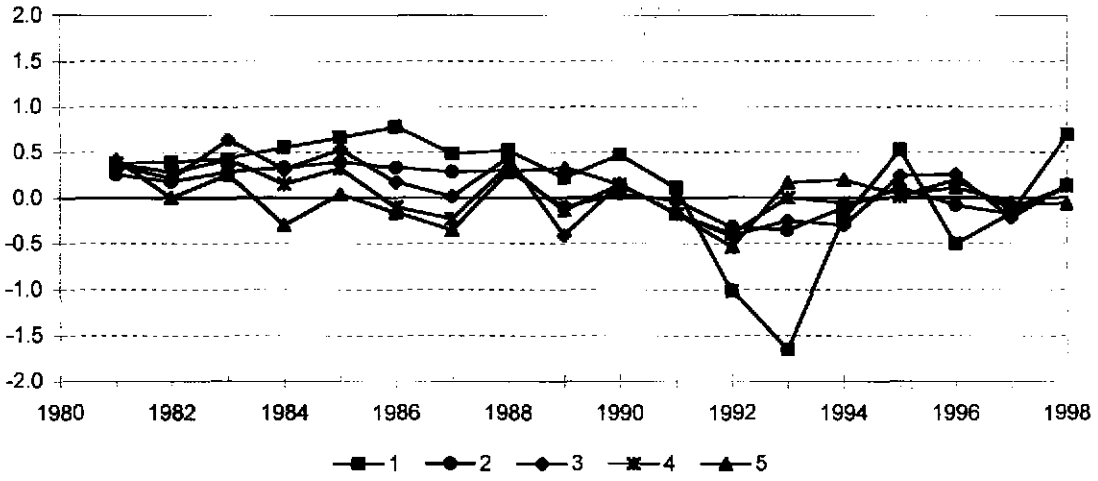
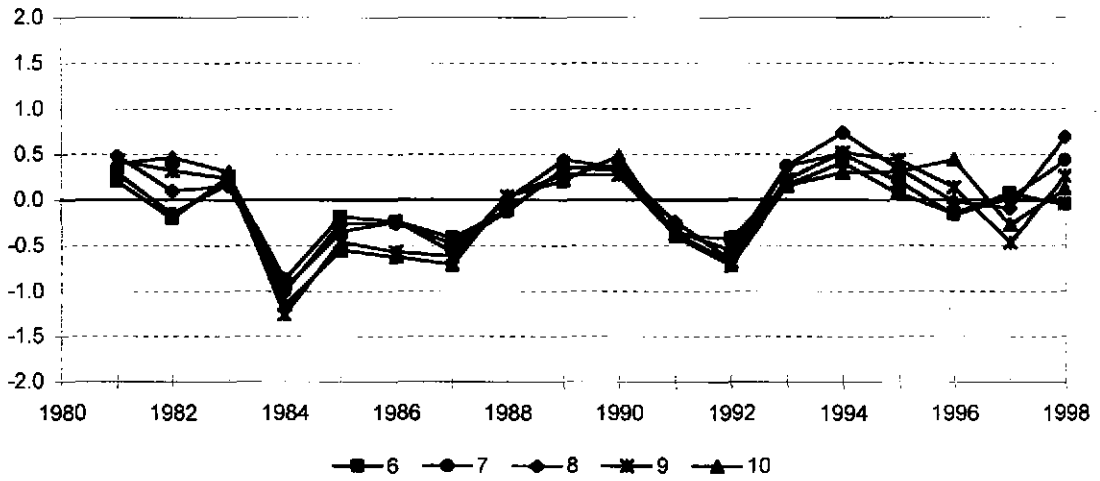


Figure 5.11.24. - Firth of Clyde (FU 13): Output VPA males: Log catchability residuals.





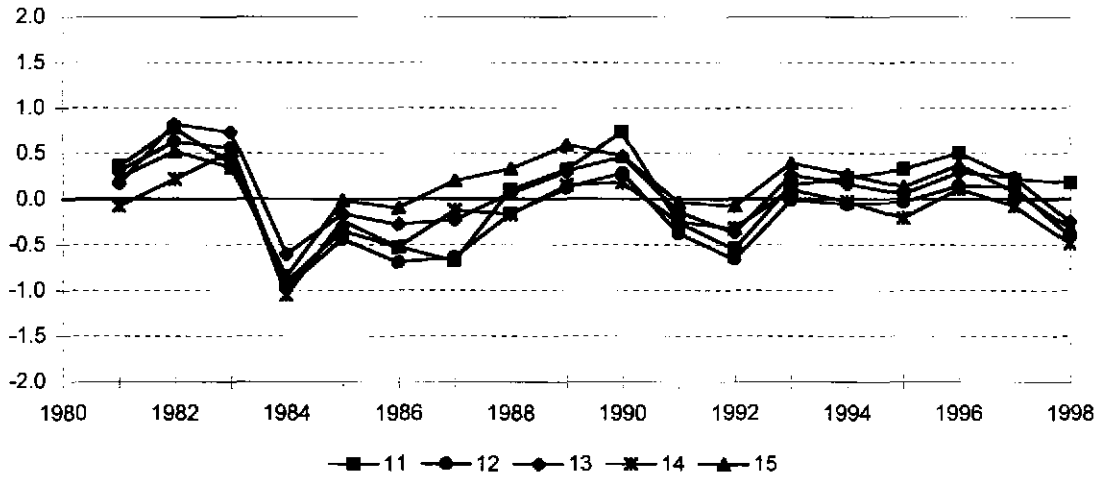


Figure 5.11.25. - Firth of Clyde (FU 13): Output VPA females: Log catchability residuals.

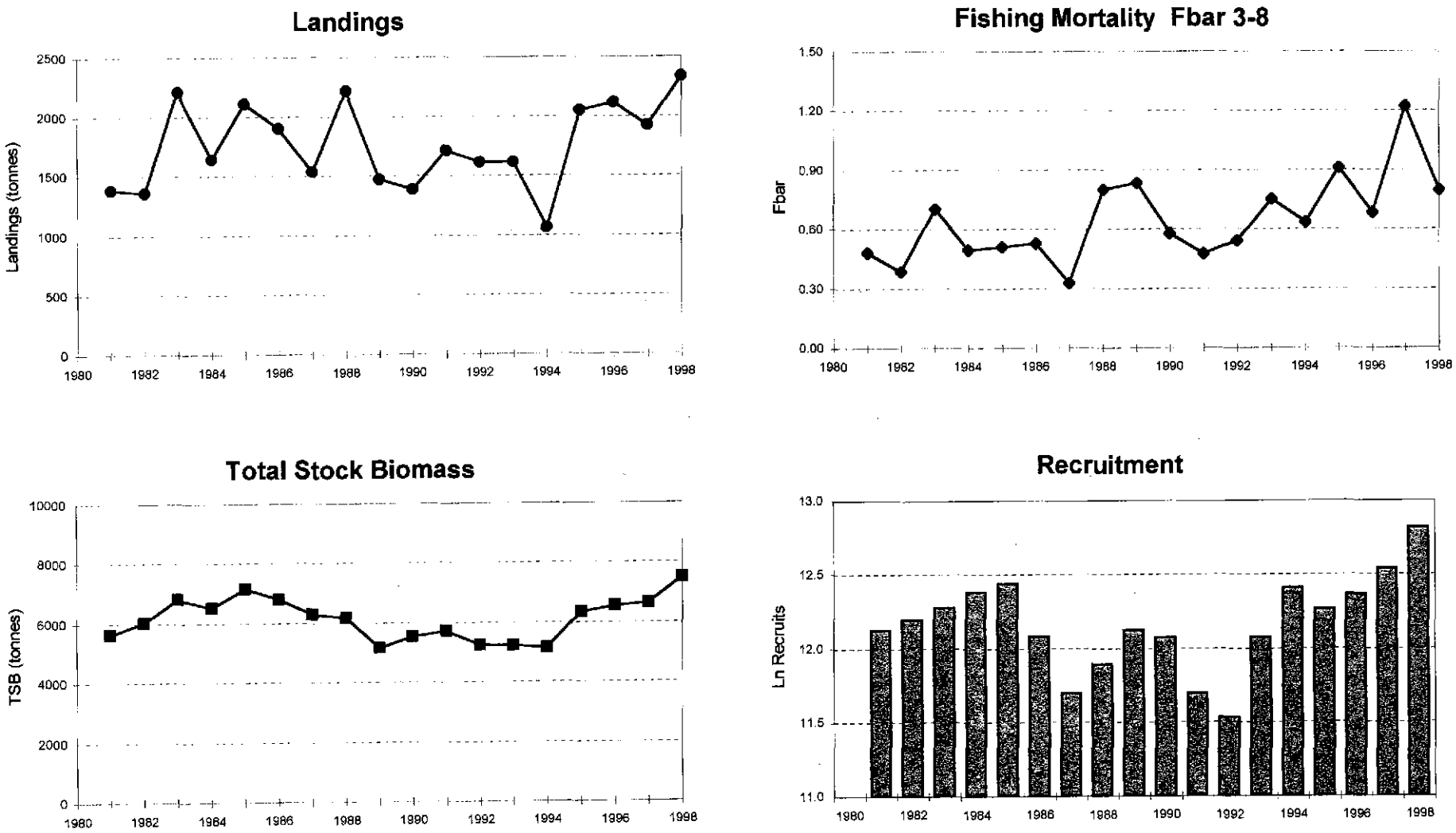


Figure 5.11.26. - Firth of Clyde (FU 13): Output VPA males: Trends in Landings, Fbar, TSB and Recruitment.

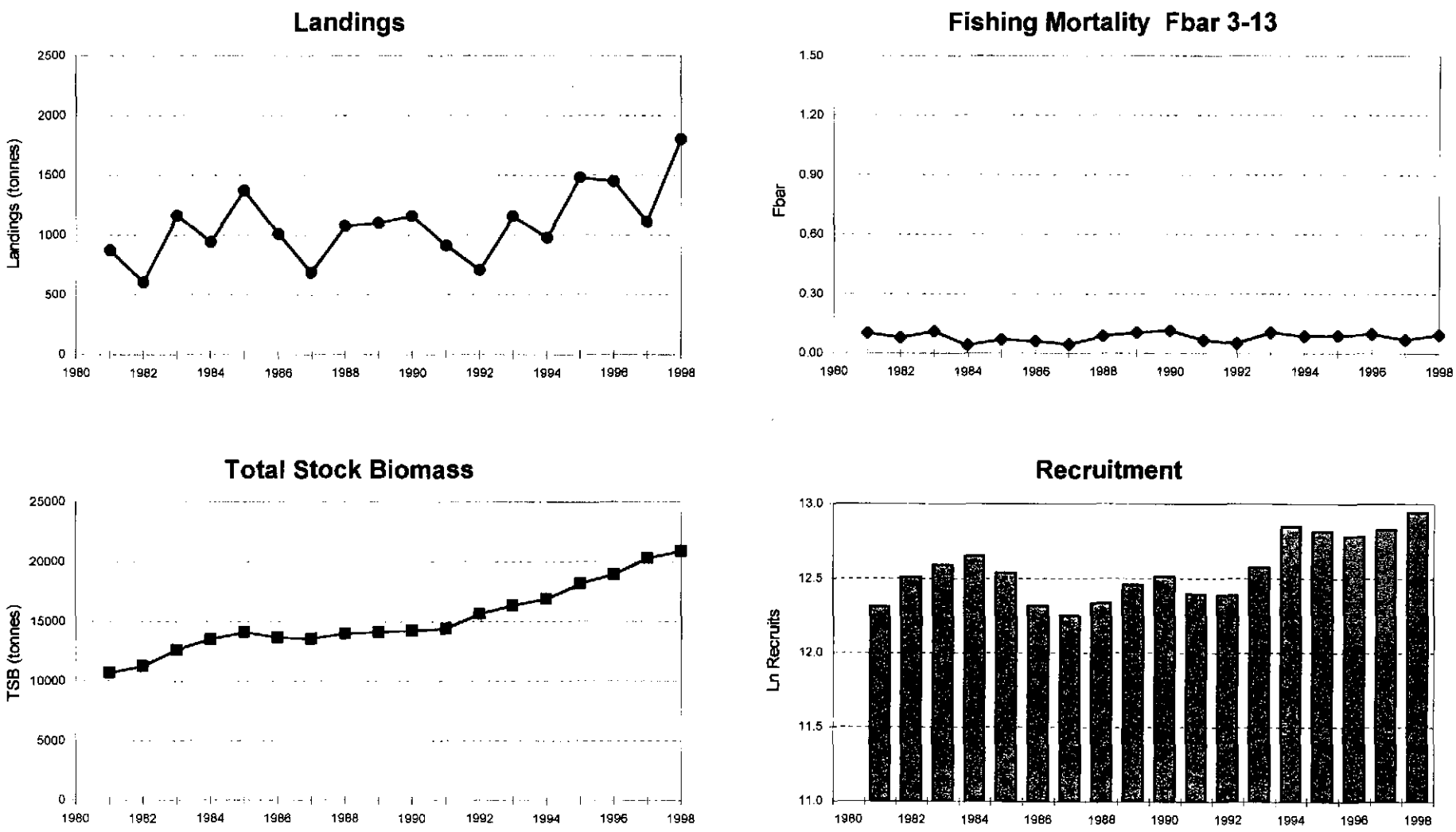


Figure 5.11.27. - Firth of Clyde (FU 13): Output VPA females: Trends in Landings, Fbar, TSB and Recruitment.

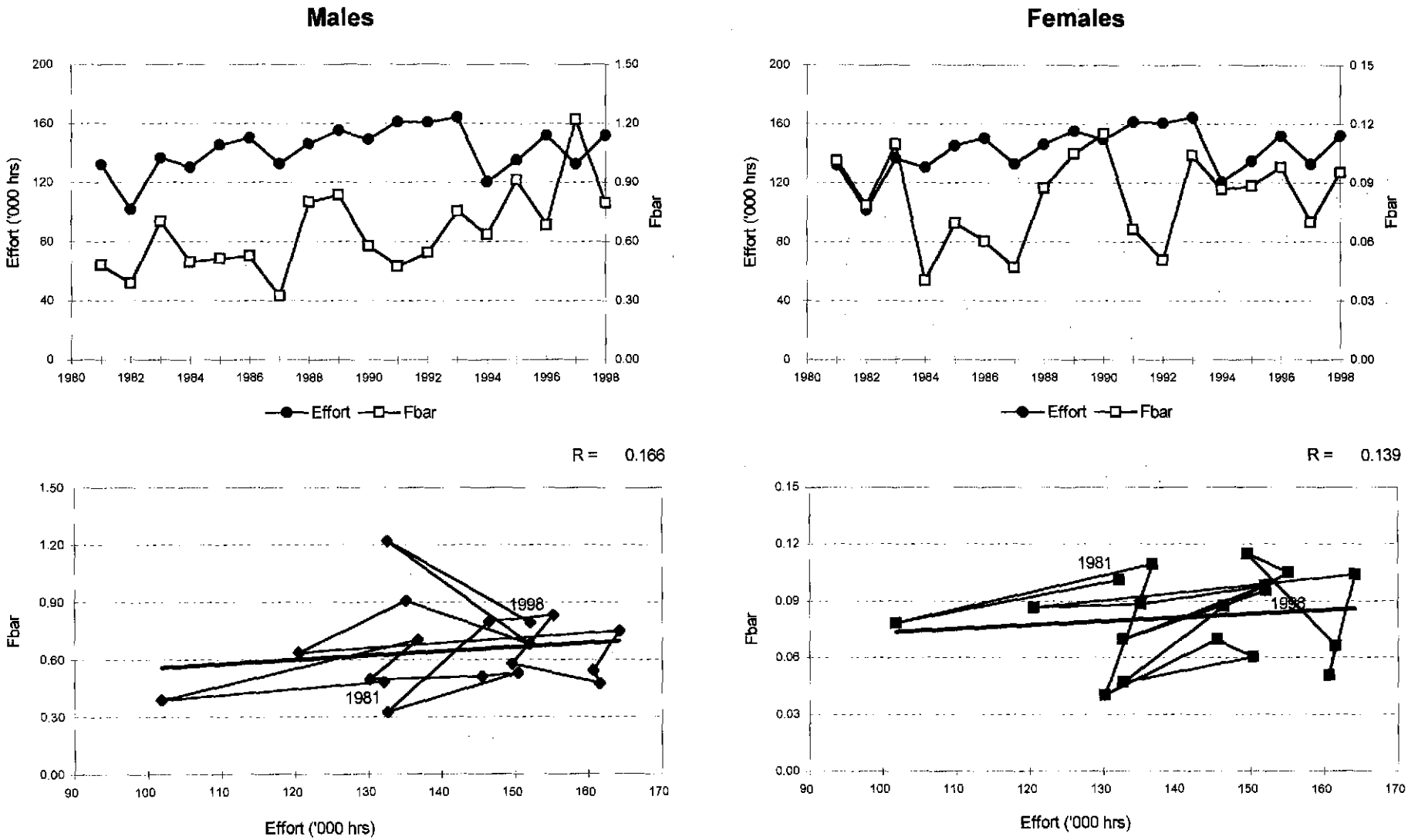


Figure 5.11.28. - Firth of Clyde (FU 13): Effort and Fbar, and relationship between them, for males and females.

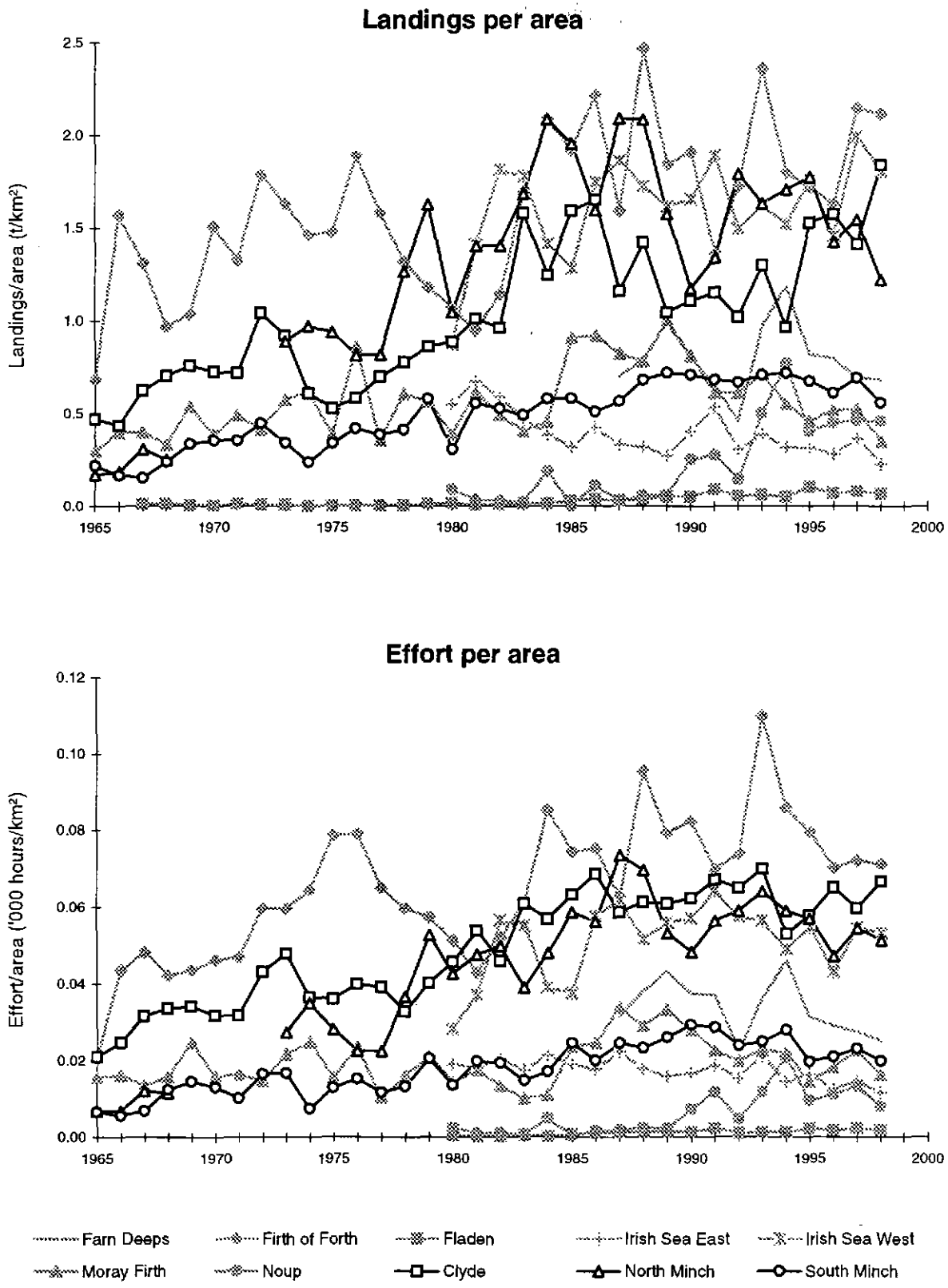


Figure 5.11.29. - *Nephrops* trawl landings per unit area (t/km²) and trawl effort per unit area ('000 hours trawling/km²) on various grounds.
Data relevant to this section of the report are shown in black.