

Economic Aspects of Discarding

UK Case Study:
Discarding by North Sea Whitefish Trawlers

FINAL REPORT

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Executive Summary

1. This report is the final phase in a study looking at the Economic Aspects of Discarding, jointly funded by MAFF, UK and DG FISH of the European Commission. The team lead by LEI in the Netherlands and partnered by Nautilus Consultants, UK and Cofrepeche, France, considered recent fish discarding levels and fishermen's behaviour in three European case studies from a predominantly economic viewpoint.
2. The case studies were UK North Sea whitefish trawlers, the Dutch beam trawl Fishery and the French *Nephrops* fishery.
3. The economic cost of discarding in these fisheries was calculated along with the economic incentive for discarding and high-grading¹ of particular species in each fishery. The equation used to calculate the incentive to discard is:

$$Id_i = Cl_i(q_i) - Cd_i(q_i)$$

Where:

$$Cd_i(q_i) = p_i * q_i + \underline{Cd}_i(q_i)$$

- Id_i = Incentive for discarding quantity (q) of species (I)
 $Cl_i(q_i)$ = Costs of landing species i
 $Cd_i(q_i)$ = Costs of discarding species i
 p_i = Price of species
 i = the opportunity costs of discarding species i
 $\underline{Cd}_i(q_i)$ = Labour costs onboard of discarding

4. The case studies also included a survey of skippers involved in prosecuting the particular fisheries to determine their perceptions of discarding. Over 70 UK skippers were interviewed by telephone to determine their estimation of discarding levels in the fishery, the main reasons for discarding and their thoughts on current regulations and potential policy changes.
5. These case studies were then compared with experiences in Norway and other countries outside the European Union. All the information compiled was analysed in order to explore the range of regulatory possibilities available to reduce discarding.

Costs of discarding

6. The main discard problem in the cases of the EU fisheries studied is the discarding of undersized fish. Survey results indicate that in the UK whitefish trawl fishery over two thirds of the discarded catch consists of commercial species, of which undersized fish account for the vast majority (cod 98%, haddock 87% and whiting 97%). The cost to the fisheries and individual vessels that has been calculated is therefore mainly the loss of future income.
7. The estimated annual cost of discarding in the three case studies varies from approximately 70% of total annual landed value in the Dutch case to 42% in the UK whitefish case² and 43% in the French *Nephrops* case.

¹ High-grading is defined here as the discarding of lower grade fish in favour of higher grade fish of the same species. The incentive to high-grade is calculated as the difference in revenue between landing a higher grade of fish and a lower grade fish minus additional costs (potentially additional fuel/labour/etc.)

² Cost of discarding of cod, haddock and whiting as percentage of landed value of these three species

8. In the UK North Sea trawl fisheries for cod, haddock and whiting, an estimated £47 million (€75 million) worth of these species was discarded in 1999 (£11m cod, £31m haddock and £5m whiting).

9. These high discard levels for the UK, based on onboard sampling data, are far higher than the £25 million (€40 million) calculated from skipper survey responses. This underestimation by skippers is thought to be due to a number of reasons, including the normal situation where skippers are in the wheelhouse and unable to see the scale of discarding from each haul.

Incentives to discard

10. Table 1 presents the results from calculations using the formula shown above, along with similar calculations to estimate the relative incentives to high-grade.

Table 1 Incentives to discard in the North Sea whitefish fishery

Species	Incentive to discard	Relative incentive to discard (incentive / revenues per kg)	Incentive to Highgrade	Relative incentive to Highgrade (incentive / revenues per kg)
cod	-0.77	-0.65	0.384	0.33
haddock	-0.53	-0.68	0.129	0.17
whiting	-0.45	-0.79	0.039	0.07
saithe	-0.41	-0.74	0.028	0.05
<i>Nephrops</i>	-1.22	-0.58	0.724	0.34

Source: Nautilus Consultants survey

11. For all commercial species considered in the UK case study (cod, haddock, whiting, saithe, *Nephrops*) there is a negative economic incentive to discard and a positive incentive to high-grade.

12. With additional costs associated with high-grading such as fuel being factored into the calculation, certain lower-value species such as whiting and saithe would show a negative economic incentive to high-grade.

13. Although the cod fishery shows a strong incentive to high-grade, in the current situation of low stock levels, high-grading of cod does not occur as the likelihood of capturing replacement cod of a higher grade is low.

14. The effects on discarding behaviour of individual transferable quota systems (in the Netherlands and informally in the UK) are ambiguous. Generally the effect is that fishermen tend to concentrate on the high-value grades of the quota species in order to maximise the value of their quota. In a mono-species fishery ITQ's may therefore induce fishermen to use more selective gear and thus avoid bycatch and discards of juveniles.

15. In a multi-species fishery, however, ITQ systems may give fishermen incentives to high-grade and to discard over-quota fish, particularly where species have different minimum landing sizes (MLS) as in the North Sea whitefish fishery.

16. The introduction of multi-species, size-specific or value based quota, could lower or even remove positive incentives to high grade. These measures do, however, have other consequences for fisheries management. Multi-species and value-based quota lead to a less fine-tuned fisheries management system, but it can be argued that the present detailed policies are not relative to the degree of accuracy achieved in current stock assessments and biological predictions.

17. The methodology developed within this study for determining economic incentives to discard and high-grade provides a simple tool for estimating the potential consequences of proposed policy changes and quantifying their impacts once in place.

Fishermen’s Perceptions of discarding

18. In the skipper survey conducted by the consultants during November and December 1999 respondents were asked a number of questions where ranked responses and the proportions of positive responses were assessed. These are presented in the table below divided by the four main vessel types operating in the North Sea whitefish fishery.

Table 2 North Sea whitefish vessels - skipper responses

Question	inshore	offshore single	offshore twin	pair seine	average for all
Think square mesh panels a good idea	85%	72%	61%	80%	75%
Discarding over the last 10 years: increased	15%	36%	42%	63%	39%
same	30%	50%	13%	25%	30%
decreased	40%	14%	42%	12%	27%
Think current levels of discarding too high	7%	43%	35%	38%	31%
Proportion by weight of haul is discarded	37%	17%	22%	25%	25%
Commercial species making up discards	53%	79%	60%	71%	66%
Main reasons for discarding:					
1=most important, 5=not at all important					
Below Minimum Landing Size	1	2	1	1	1
Damaged fish	3	3	3	4	3
Above MLS but below marketable size	4	4	4	5	4
Enforcement of quota restrictions	5	4	3	3	4
Market price for fish	4	4	4	4	4
Price of quota	5	4	4	4	4
Storage space availability	5	4	4	5	5
Length of trip time remaining	5	4	4	5	5
Handling effort by crew	5	4	4	5	5
Occasionally highgrade	0%	43%	52%	75%	43%

Source: Nautilus Consultants survey

Table 3. Proportions of positive skipper responses to proposed management options (%)

Management options	inshore	offshore single	offshore twin	pair seine	average for all
Increase gear selectivity	70	93	74	75	78
Discards ban –all deducted from quota	0	0	0	0	0
Discards ban – with penalties equal to value	0	0	3	0	1
Fixed Closed Areas	40	79	68	63	63
Flexible Closed Areas	40	79	65	38	56
Increased enforcement	30	29	16	25	25
Roll-over quota (year to year)	60	43	65	50	55
Multi-species quota	30	7	35	38	28
Multi-annual quota	10	0	32	50	23
Reduced effort	70	36	61	88	64

Source: Nautilus Consultants survey

Management options

Table 4 below highlights which management options are expected to reduce certain types of discarding.

Table 4 Five discard problems and possible solutions

Discard problem	Undersized fish	Over-quota fish	Low value species	High-grading	Non-commercial species
Increase gear selectivity:	•			•	•
Discard ban	•	•	•	•	
Seasonal quota	•				
Fixed closed areas	•				
Flexible closed areas	•				
Roll-over quota		•			
Multi-annual quota		•			
Multi-species quota		•			
Market development			•		
Value-based quota				•	
Size-specific quota				•	
Adjustment / change of fishing gear or method					•

Gear Selectivity

19. The main anti-discard policies applied in the EU are technical regulations regarding fishing methods and fishing gear, e.g. minimum mesh size and minimum landing size regulations.

20. 78 per cent of UK skippers surveyed, along with the majority of Dutch skippers interviewed, are in favour of increasing gear selectivity for targeting North Sea fisheries.

21. Further blanket increases to mesh size are not the favoured option for increasing selectivity as too much marketable catch would be lost in multi-species fisheries. The

use of selectivity devices specific to fisheries and the target species within those fisheries are encouraged.

22. 75 per cent of UK skippers interviewed see square mesh panels as a good idea. It is evident, however, that positioning of the panel is critical to its effectiveness in reducing discards of juveniles. Current regulations on positioning in relation to the cod-end are a compromise between effective operation and fishermen's concerns over loss of earnings.

23. Selectivity devices such as grids, separator trawls and electric beam trawling are being used and developed to reduce discarding in a number of specific European fisheries. Up to now there has been very limited investigations into the possible use of these alternatives in a UK context.

Discard Ban

24. The discards ban was introduced in Norway mainly to permit the more accurate estimation of fishing mortality for improved stock assessment by fisheries scientists, rather than to prevent discarding. Several policies (gear selectivity, flexible closed areas, by-catch allowances) were already in place to minimise the capture of unmarketable fish.

25. A discard ban is difficult to enforce and therefore should only be considered after the application of other measures to minimise discard levels. It cannot be introduced in EU fisheries in the present situation.

26. 99 per cent of UK skippers interviewed are against the introduction of a discard ban, seeing it as unworkable and ineffective in stock conservation.

Closed Areas

27. The flexible closed area policy is a high cost option for EU fisheries management. This type of policy requires intensive monitoring of discard levels in the sensitive areas and the costs of enforcement and monitoring may be too high in relation to the revenue generated by those fisheries in many EU countries.

28. In addition, in the UK and wider EU context, monitoring, control and surveillance (MCS) resources and communication between authorities and the industry are inadequate for a workable flexible closed area system.

29. 63 per cent of UK North Sea trawler skippers surveyed see the introduction of fixed closed areas as beneficial; fewer (56%) are in favour of flexible closed areas, as many suggest such a system would be more difficult to operate.

The Quota System

30. In most instances of discarding in the UK North Sea whitefish trawl fisheries quota restrictions and their enforcement are not a factor. There are, however, circumstances where, on occasion, large hauls of fish are discarded due to a lack of quota (particularly saithe). The increased flexibility of the quota system (purchase/lease of quota) should help skippers to gain additional quota to deal with such situations should they arise.

31. While flexibility in the quota system does allow skippers more freedom to choose whether or not to discard marketable fish, most are against multi-species and multi-

annual quota as these are thought to further complicate an already complicated system.

32. Over half the skippers interviewed are, however, in favour of rollover quota, which could better balance fishing effort around the year-end, removing the incentive to fill quota at the expense of discards of other species.

Overall

33. The broad range of reasons to discard suggest that it is not possible to adequately tackle discard problems in all EU fisheries using a single approach.

34. Tailored workable solutions should be found that address the particular circumstances and motivating factors in each fishery.

Recommendations for the UK North Sea Whitefish Trawl Fishery

Increase gear selectivity,

Initially this should be through

- 1) more widespread use and more effective positioning of square mesh panels for trawlers; and
- 2) tighter controls on twine thickness.

Simultaneously, further research should be undertaken to assess how appropriate a range of selectivity devices might be in North Sea context. This should be in addition to the continuing work on the efficiency of square mesh panels.

Introduce fixed closed areas on a seasonal basis

This measure should initially be adopted in order to protect defined areas in the North Sea known to be spawning and nursery areas for cod and haddock.

Establishing these areas will need to be a delicate balance (in terms of location, extent and permitted activity) between effectiveness and ensuring vessels (particularly coastal vessels with limited range) can remain viable.

The areas to be closed should therefore be defined by a working group consisting of industry, scientists, fishery managers and government.

Greater industry consultation

The fishing industry should be fully integrated into the decision-making process for fisheries policy to ensure better practical knowledge and compliance.

This involvement should be in the form of an advisory group consisting of industry, scientists and government that is able to react quickly and be pro-active in proposing regulatory changes.

Such a group could be a continuation and broadening of the working group proposed above for defining closed areas.

1. Introduction

1.1 Background

This report is the final phase in a study looking at the Economic Aspects of Discarding, jointly funded by MAFF, UK and DG FISH of the European Commission. The team lead by LEI in the Netherlands and partnered by Nautilus Consultants, UK and Cofrepeche, France, considered recent discarding levels and behaviour in three European case studies from a predominantly economic viewpoint. These were then compared with experiences in Norway and other countries outside the European Union. All the information compiled was analysed and discussed in order to explore the range of regulatory possibilities available to reduce discarding.

It is recognised that an overall decrease of effort should lead to a decrease in the level of discarding overall and is perhaps the most effective solution to the problem. Effort and capacity reduction, however, are usually pursued for reasons other than reducing the level of discarding. They form a powerful existing policy tool and as such have not been analysed explicitly in this study as possible solutions to the discard problems.

This study attempts to address the discarding levels of individual vessels by focuses on the incentives and disincentives to discard and how these incentives are influenced by different regulations. On the basis of the analysis of incentives for discarding at the individual level, the feasibility of different approaches to the discards problem is examined. One possible solution could be the introduction of a ban on discards of certain species, similar to the Norwegian discard ban. This and other policy tools are considered in the report.

1.2 Study Objectives

The main objectives of this study are:

1.2.1. Identification of the economic causes of discarding

- Analysis of the techno-economic background of discarding in three case studies within the EU: Dutch North Sea beam trawl flatfish fishery, UK whitefish fishery and French Nephrops fishery.
- Assessment of the composition of discards and seasonality differences in discards in the three case studies: shares of juveniles, commercial species and non-commercial species.
- Examinations of incentives and disincentives for discarding: quota regulations, bulk fishing mentality, time saving, price return on quality, etc.
- Examination of prices for landed fish by size to determine an economic value for discards of commercial species

1.2.2. Role of regulations with respect to discarding

- Analysis of the role of quota systems, input regulations and technical measures in the discard problem.
- Specification of techno-economic conditions for an effective solution of the discard problem under EU conditions.

1.2.3. Evaluation of possible solutions

A. Assessment of the feasibility of a discard ban under EU conditions

- Analysis of the Norwegian experience with the discard ban: effectiveness, costs and benefits to fishermen and government, ecological effects, effects on the size and composition of by-catch, especially the effect on the share of juveniles in by-catch.
- Assessment of relevant similarities and differences between the Norwegian situation and EU conditions (represented by the three cases) in order to evaluate the feasibility and desirability of a discard ban in EU conditions.

B. Assessment of other approaches

- Identification of international experiences with other possible solutions to the discard problem.
- Assessment of the expected degree of effectiveness of these alternative solutions under EU conditions.

1.3 The UK Case Study

The UK case study addresses the first objective of the study by presenting the techno-economic situation in the North Sea whitefish trawl fishery. Based on its findings, this report goes on to discuss the second objective, the role of regulations in discarding. A more thorough analysis of regulatory impacts is then presented as all three case studies are compared with each other in conjunction with Norwegian and international experiences.

The North Sea is one of most heavily fished sea areas in the world. It is also the most economically important to the UK fishing industry. As a result it has the most extensive amount of scientific and operational information available compared to other areas in the UK. An analysis of the fishery is presented in chapter 2 in terms of the resource, and the physical and economic dimensions of the North Sea whitefish trawl fleet.

The whitefish fishery in the North Sea is a mixed fishery, which is one of several factors contributing to a complex discard problem for the fishery. This and other biological and non-biological characteristics of the fishery are discussed in chapter 3. The overall economic value of discards in the fishery is calculated in chapter 4, while the incentives to discard specific fish species for an individual operating in the fishery are estimated in chapter 5.

As a result of the heavy fishing pressure, the North Sea is an area with high levels of enforcement and tight regulations stipulating how fishing can be conducted in the area. A summary of the role of regulations in the discards debate is addressed in chapter 6. This includes both EC and UK-only regulations as the UK has adopted a number of unilateral regulations in attempts to safeguard the North Sea roundfish fishery for the UK fishing industry.

Several sources of data on the North Sea whitefish fishery have been used in this report in association with the results of an original survey conducted during November and December 1999. The survey (a sample questionnaire for which is shown in Annex IV.) involved questioning 70 skippers of North Sea Trawlers on the level of discarding that occurs with their vessel, the broader situation in their fishery and their perceptions of the discard problem. The analysis of responses are presented in chapter 7.

Globally, fisheries managers are attempting to find regulatory solutions to excessive discarding. In Chapter 8 the situation in the Dutch Beamtrawl and French *Nephrops* fisheries are presented, along with experiences in Norway and other non-EU countries.

By understanding the situation in other fisheries and how these relate to the UK whitefish fishery, practicable and proven solutions to discarding can be discussed. Chapter 9 combines the findings from the study with existing data to discuss possible solutions to the discard problem and the options open to policy makers and fishery managers.

Conclusions drawn from the previous chapters along with recommendations specific to the UK whitefish fishery are presented in Chapter 10.



2. The Fishery

2.1 Overview

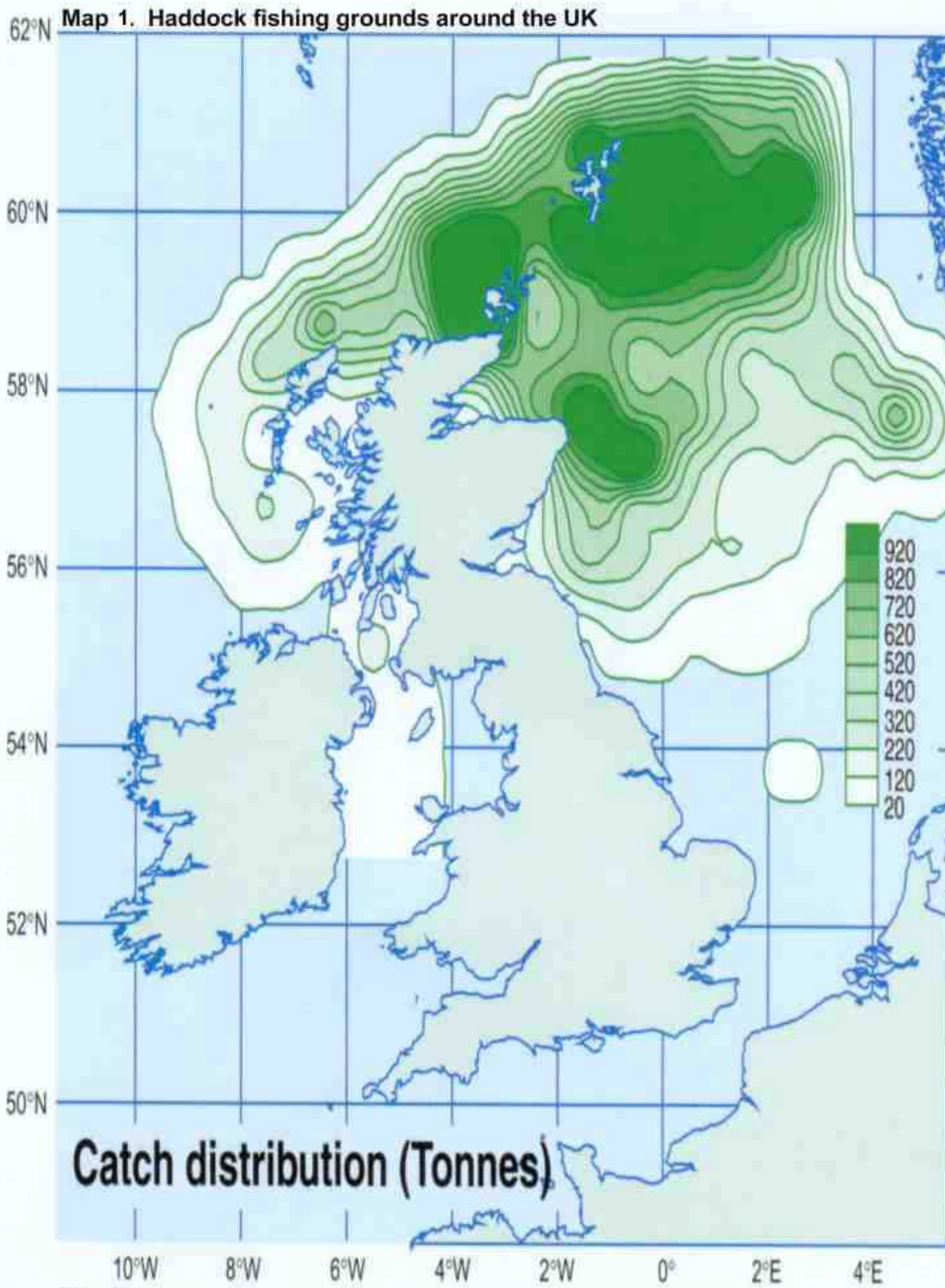
It is estimated that between 800 and 1,000 UK registered vessels target the North Sea whitefish fishery ranging in size from under 10m boats targeting inshore populations, usually on one day trips, up to large Scottish trawlers over 30m on trips averaging two weeks long. Distinguishing which vessels are operating within the fishery at any one time has become complicated through a number switching to targeting Nephrops rather than whitefish either part or full-time.

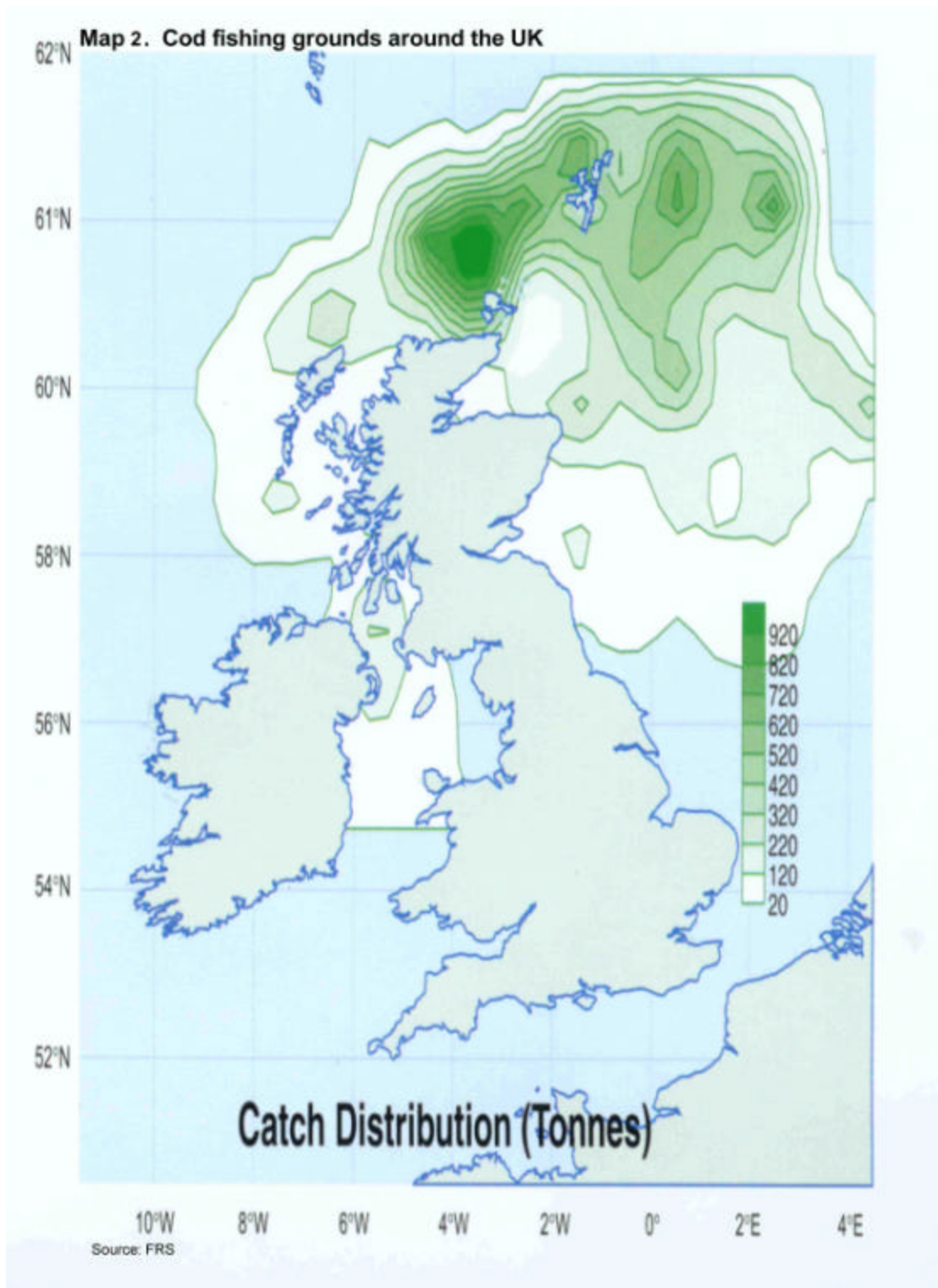
While discards of whitefish bycatch in the Nephrops fishery are significant, the focus of this case study remains on those vessels targeting whitefish. The survey of skippers has, however, included qualitative information on discarding from vessels targeting Nephrops with smaller mesh nets.

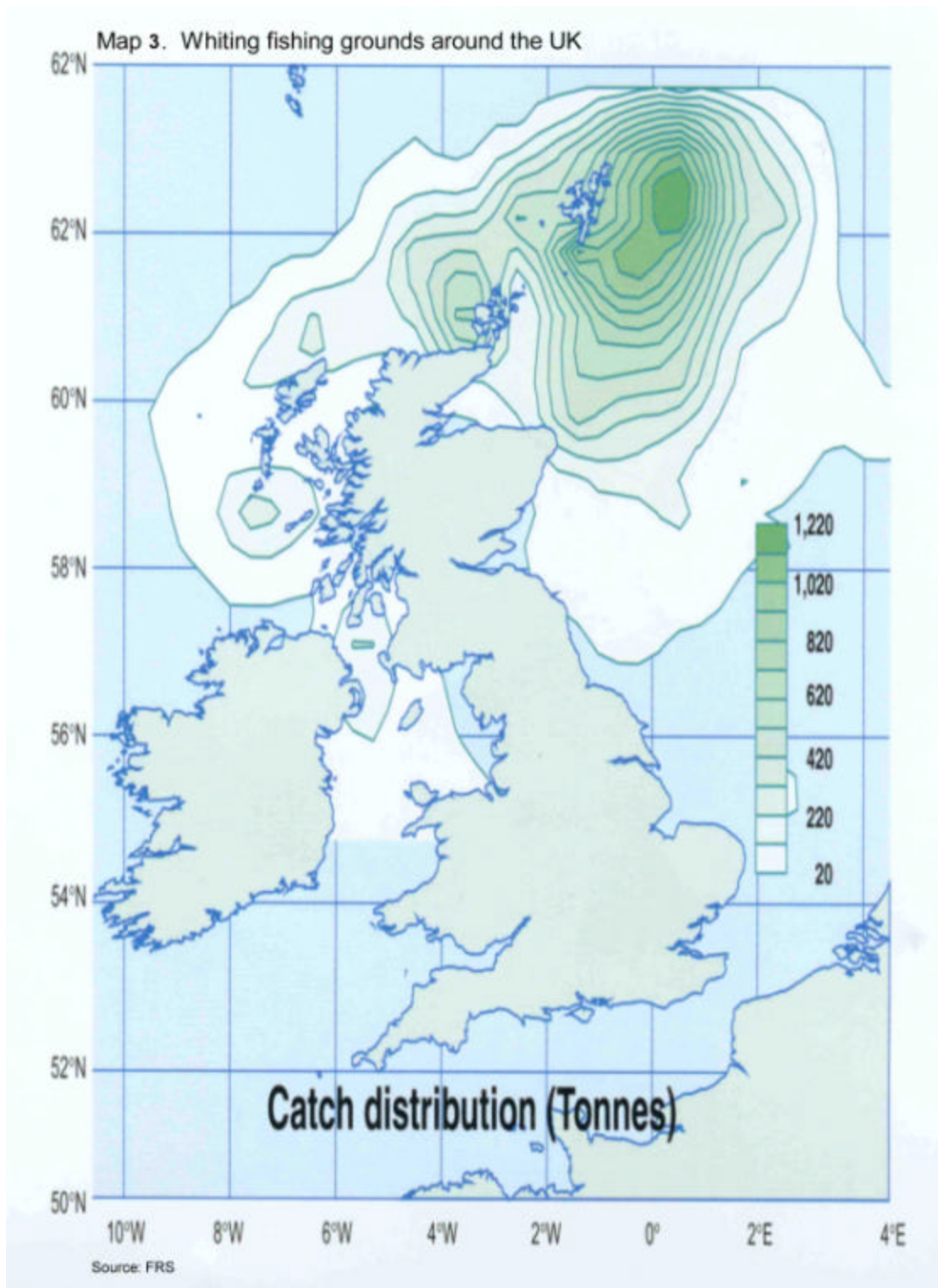
The main target species in the North Sea whitefish fishery are cod, haddock and whiting. These tend to be targeted in the more northerly and central areas of the North Sea (between 58 and 62 degrees north). Vessels operating in the southern North Sea tend to target flatfish.

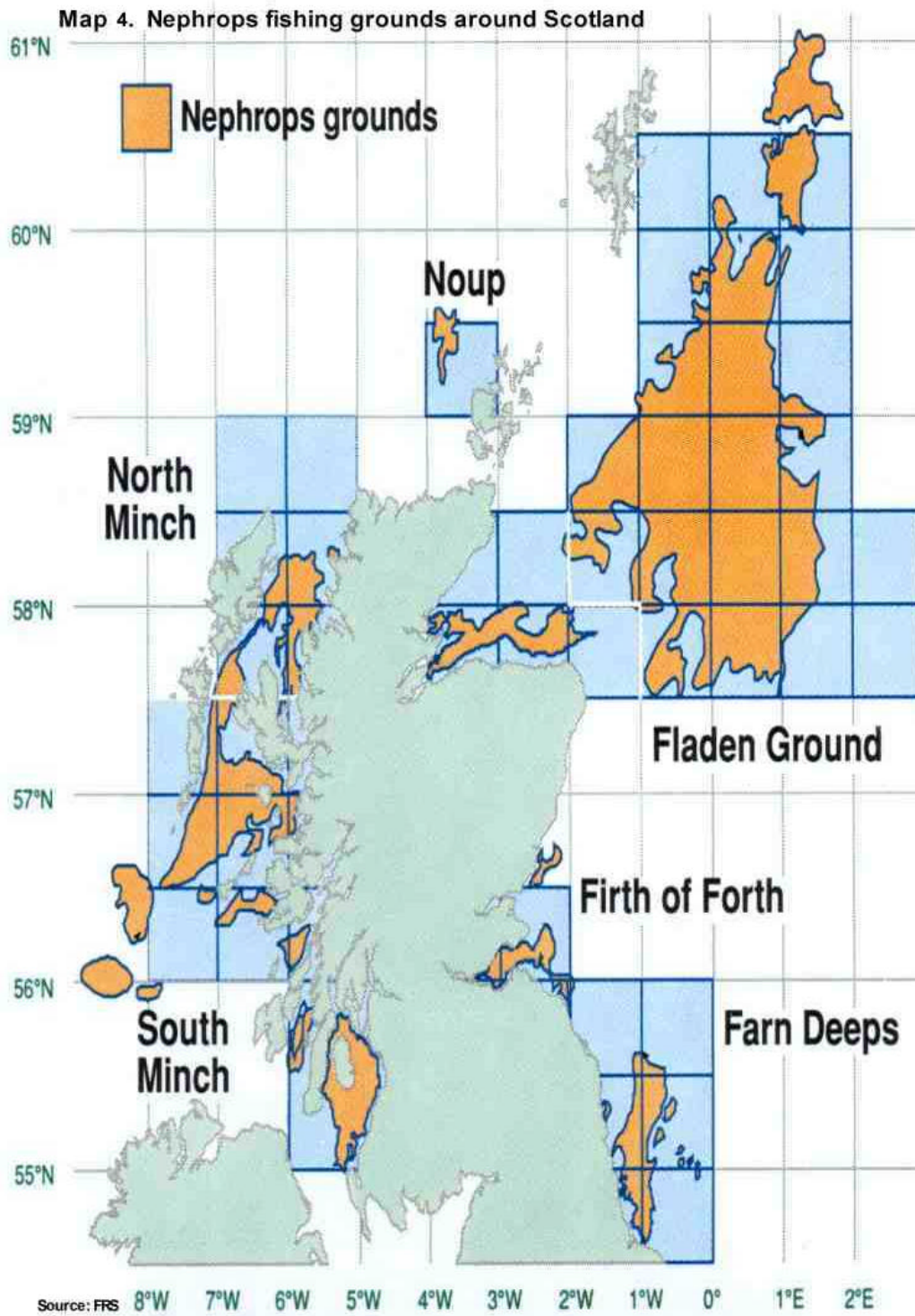
The North Sea is considered a mixed fishery with species maturing at varying ages and lengths. With vessels operating quota allocated for each individual species, they will continue to fish these mixed grounds, but are legally only able to retain that portion of the catch they have quota for. This can result in high discards, particularly of saithe and cod where quota may be exhausted early in the year. Only a small number of cod reach maturity after two years, yet they grow quickly, often reaching the Minimum Landing Size (MLS) within their second year and are therefore vulnerable to recruitment overfishing.

Maps 1 to 4 show the fishing grounds for haddock, cod, whiting and Nephrops around the UK with catch levels.









2.2 The Resource

2.2.1 Landings

The tables below show the landings of cod, haddock, whiting, saithe and Nephrops by UK vessels into the UK between 1994 and 1998. Data are presented for the weight and value of each species.

Table 2.1. Landings by UK vessels into UK ports ('000 tonnes)

	1994	1995	1996	1997	1998
Cod	65.7	74.4	75.7	71	72.7
Haddock	92.9	85.3	89.1	82.6	82.8
Whiting	41.8	39.8	37.3	34.5	26.7
Saithe	12.5	12.8	13.3	12.3	10.1
Nephrops	29.8	31.1	29	31.1	28.6

Source: Scottish Sea Fisheries Statistics

The quantity of Nephrops and saithe landed has remained relatively constant in recent years at approximately 30,000 tonnes and 12,000 tonnes respectively. Whiting landings have declined steadily from over 40,000 tonnes in 1994 to 27,000 tonnes in 1998 (a drop of 36 per cent). Cod and haddock landings have shown more year on year variation fluctuating around averages of 72,000 tonnes and 87,000 tonnes respectively. Both species landings have a range of 10,000 tonnes between the maximum and minimum amounts landed over the time period presented.

Table 2.2 Landings by UK vessels into UK ports (£ million)

	1994	1995	1996	1997	1998
Cod	65.1	65.8	69.8	67.6	79.5
Haddock	61	54.7	54.3	44.8	57.1
Whiting	20.1	18.9	19	15.9	13.4
Saithe	4.9	5.6	5.7	4.9	5
Nephrops	56.4	60.7	57.2	63.5	56.8

Source: Scottish Sea Fisheries Statistics

The value of saithe landed has also remained relatively constant at about £5 million per year. The value of Nephrops has varied slightly more ranging between £56 million and £63 million. Whiting landings have declined in value as well as quantity, falling from over £20 million in 1994 to £13 million in 1998 - a drop of over 33 per cent.

Haddock landings have varied quite considerably in value from a high of £61 million in 1993 to a low of £45 million in 1997 – a range of over £16 million. Cod landings appear to have risen in value from £65 million in 1993 to over £79 million in 1998 – an increase of over 22 per cent.

Table 2.3 combines the information from tables 2.1 and 2.2 to present the average price of each species landed.

Table 2.3 Average price of landings by UK vessels into UK ports (£ per tonne)

	1994	1995	1996	1997	1998
Cod	991	884	922	952	1,094
Haddock	657	641	609	542	690
Whiting	481	475	509	461	502
Saithe	392	438	429	398	495
Nephrops	1,893	1,952	1,972	2,042	1,986

Source: Scottish Sea Fisheries Statistics

Whiting prices, despite a decrease in the quantity and value of fish landed have remained fairly constant, averaging £486 / tonne. Nephrops prices have increased slightly between 1994 and 1998. Cod prices have also increased recently, despite showing a fairly large decrease between 1994 and 1995. In 1998, the average price for cod was 10 per cent higher than in 1994. Haddock on the other hand, appear to have recently regained some of their value after decreasing average prices between 1994 and 1997. The 1998 average price of haddock is only marginally higher than that in 1994.

Figures for the first nine months landings in 1999 suggest that the quantity of fish landed, especially cod has decreased markedly compared to the same period in 1998. This has been partially offset by some significant increases in price.

2.2.2 State of stocks

The International Council for the Exploration of the Seas (ICES) advises the EU on the health of fish stocks. ICES gives advice mainly in terms of the spawning stock biomass (SSB) and fishing mortality of the different stocks. SSB is defined as the amount of fish in the population able to reproduce (expressed as weight). Fishing mortality is a measure of the proportion of a stock killed in a year by fishing. ICES proposes precautionary levels for SSB and fishing mortality at which the probability of the stock collapsing is low. They also propose limits for SSB and fishing mortality. If these limits are exceeded, the probability of the stock collapsing is high and recruitment to the fishery is impaired. ICES advises that these limits should not be breached. From 1999, the EU is adopting the "Precautionary Approach" to setting TACs and the 2000 TACs set reflect this, with many being dramatically cut from the 1999 levels.

- **Cod** has a long history as a commercially exploited fish in the North Sea and remains one of the most economically important species prosecuted by UK vessels. It is considered by ICES to be at risk of depletion and outside safe biological limits in Area IV. In response to this and on advice from ICES, the North Sea cod TAC for 2000 was cut by 39 per cent compared with the 1999 TAC.
- **Haddock** stocks in ICES Areas IV are considered to be overfished and close to their safe biological limit. North Sea haddock TACs were cut by 7 per cent between 1999 and 2000.
- **Whiting** are caught in a mixed fishery along with cod and haddock. The spawning stock biomass is below the precautionary limit advised by ICES and stocks are considered to be outside safe biological limits. Stocks in Area IV are considered to be fully exploited. The 2000 TAC was cut by 22 per cent.
- **Saithe** stocks in Area IV are considered to be overfished and outside safe biological limits. The spawning stock biomass was at its lowest recorded level in

1990 and is still below the precautionary level set by ICES. The saithe TAC for North Sea stocks was reduced by 23 per cent between 1999 and 2000.

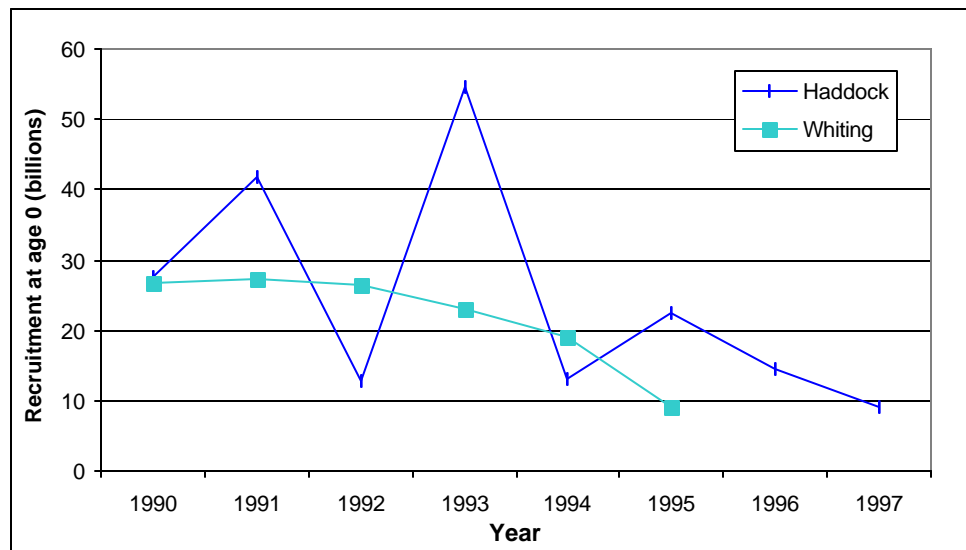
- **Nephrops** are more likely to survive the process of discarding or escape from fishing nets than other species, because of their hard protective shell. Nephrops burrows also act as a refuge for Nephrops and berried females tend to spend longer in their burrows than non-berried females and males, consequently protecting them and their eggs. Fishing effort on Nephrops has, however, increased dramatically in recent years and may continue to do so if other vessels see the fishery as an attractive alternative to whitefish in the face of declining quotas. Most North Sea stocks do, however, appear to be able to sustain the current level of exploitation. The Fladen Ground is considered to be underexploited while the Moray Firth fishery is considered to be fully exploited and the Firth of Forth overexploited. Advice concerning the status of Nephrops stocks is given biennially instead of annually.

The SSB for cod, haddock and saithe are above the limit levels (B_{lim}) advised by ICES below which a population is in danger of being unable to maintain stock levels year on year. All three stocks have shown a rise in SSB in recent years, although the rise in the haddock and saithe SSB appears to have levelled off. The cod SSB is nearing the precautionary level (B_{pa}) while the haddock SSB is greater than the precautionary level advised. The saithe SSB is still well below B_{pa} and the recent levelling off suggests that it will not rise above B_{pa} at current levels of exploitation.

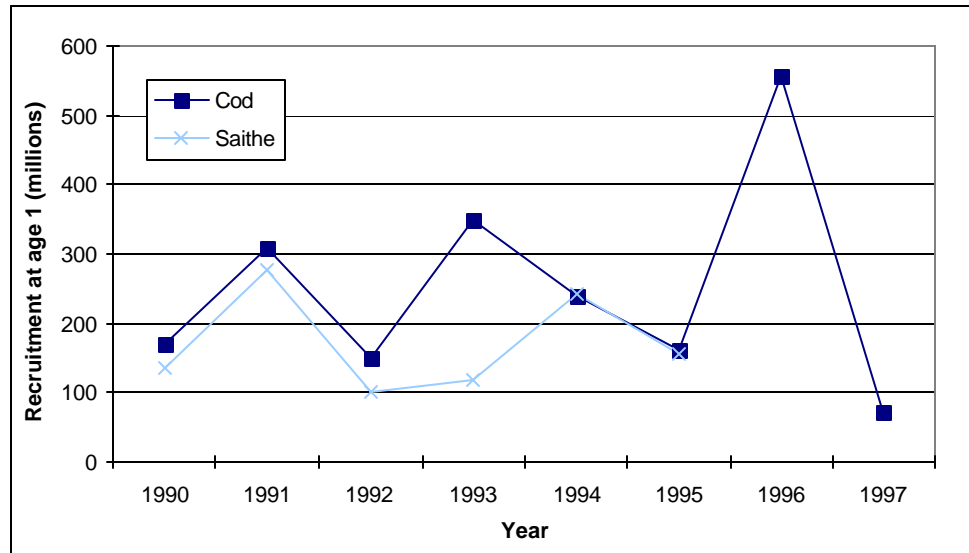
The upward trend indicates that cod, haddock and saithe stocks seem to be rebuilding with the number of adult fish capable of reproducing increasing in recent years. The whiting SSB, however, shows a downward trend throughout the whole time period presented.

The other important indication of the status of fish stocks is recruitment – the number of young fish that survive from spawning to enter the adult stock and become large enough to be caught in the fishery. Different species are recruited to the fishery at different ages depending on the rate at which they grow. Cod and saithe are both recruited to the fishery at age 1, while haddock and whiting are recruited at age nought. The graphs below show the trend in recruitment for cod, haddock, whiting and saithe.

Figure 2.1 Haddock and whiting recruitment 1990 - 1997



Source: UK Sea Fisheries Statistics

Figure 2.2 Cod and saithe recruitment 1990 – 1997

Source: UK Sea Fisheries Statistics

The graphs show that recruitment for all species is highly variable from one year to the next making it difficult to pinpoint clear trends over time. 1997 was a poor recruitment year for both cod and haddock.

The only obvious trend is the decline in the number of whiting recruited to the fishery in recent years. Added to the fact that the SSB for North Sea whiting has also been declining steadily over that same period, the future of the North Sea whiting does not look good and it is easy to see why ICES claims that this stock is outside safe biological limits.

The health of fish stocks has implications not only for fishermen that prosecute that stock but also for those that target other species. For example, the recent low numbers of cod in the waters around the UK has been implicated in the continued health and apparent robustness of the Nephrops stocks. Recent research suggests that Nephrops survival rates have increased because of a reduction in predation pressure due to low numbers of cod that usually feed on young Nephrops. Ecosystem effects such as this are extremely difficult to detect and prove conclusively.

2.3 The Quota

2.3.1 Quota allocation

The table below illustrates the relative allocation of North Sea quotas between the EU Member States for cod, haddock, whiting, saithe and Nephrops.

Table 2.4 Relative quota allocations for EU Member States

	Cod	Haddock	Whiting	Saithe	Nephrops
Belgium	4%	1%	3%	-	3%
Denmark	20%	7%	13%	9%	5%
Finland	-	-	-	-	-
France	4%	8%	19%	51%	-
Germany	13%	5%	3%	22%	1%
Ireland	-	-	-	-	-
Netherlands	12%	1%	7%	-	5%
Portugal	-	-	-	-	-
Spain	-	-	-	-	-
Sweden	-	1%	-	1%	-
UK	47%	78%	54%	17%	86%

Source: UK Sea Fisheries Statistics 1998

The northern EU countries bordering the North Sea are allocated the majority of the TAC for the five species presented. This is because the allocation key by which TACs are distributed among Member States is based on historical access to fishing grounds.

The UK receives the greatest share of the EU TAC for all species except saithe. The majority of this latter quota is allocated to France whose fishermen have historically targeted saithe. UK fishermen have only relatively recently begun to prosecute saithe.

2.3.2 Quota changes

Table 2.5 below presents the changes in total EU quotas from 1996 to 2000. The figures indicate the percentage change in the quota tonnage for five species – cod, haddock, whiting, saithe and Nephrops.

Table 2.5 Year on year percentage changes in EU quotas

	1996	1997	1998	1999	2000
Cod	7.8	-7.3	7.8	2.4	-39
Haddock	-0.3	0.3	-0.3	-15.9	-7
Whiting	-3.4	3.6	-3.4	-15.4	-22
Saithe	3.7	-3.6	3.7	-0.9	-23
Nephrops	0.3	-0.3	0.3	0.5	13

Source: UK Sea Fisheries Statistics 1998

Figure 2.3 presents these changes in terms of tonnage rather than percentage changes.

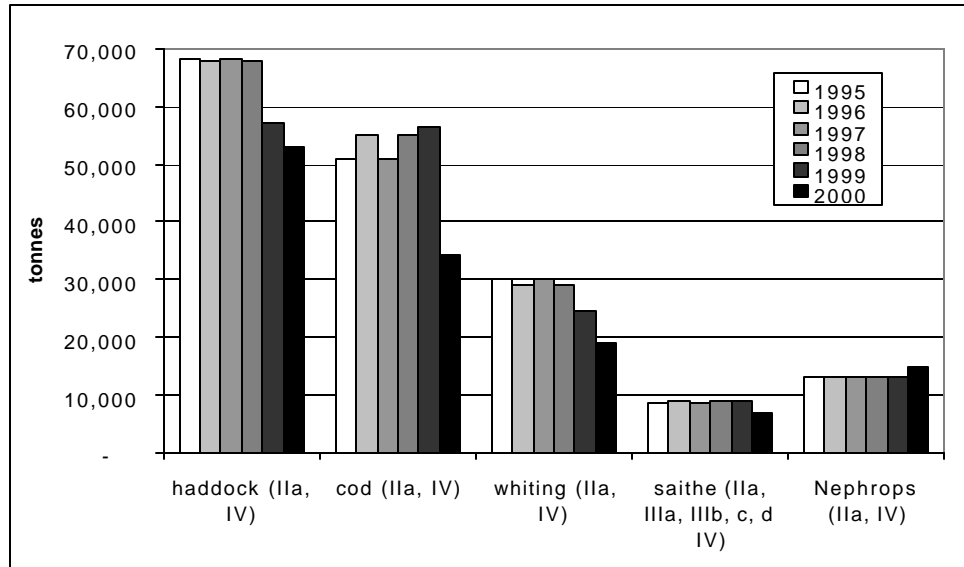
Figure 2.3 Changes in EU quotas 1995 – 2000 (tonnes)

Table 2.5 and Figure 2.3 show that saithe and *Nephrops* quotas have remained fairly constant over the past six years. Quotas for the other three species have been cut recently with the biggest cuts occurring between 1998 and 1999 and between 1999 and 2000. These large cuts in TACs coincide with the adoption of the Precautionary Approach by ICES and indicate EU Member States' commitment to rebuilding stocks.

2.3.3 Quota uptake

The table below presents the relative uptake of quota when compared to quota allocation. Quota uptake figures are given for the seven Member States that receive an allocation.

Table 2.7 Quota uptake as a percentage of quota allocation (1998)

	Cod	Haddock	Whiting	Saithe	Nephrops
Belgium	97	82	17	97	52
Denmark	92	42	1	99	84
France	90	10	20	97	-
Germany	53	33	6	99	72
Netherlands	92	41	52	37	99
Sweden	450	93	30	327	-
UK	91	95	70	99	81
EU total	87	81	47	100	81

Source: UK Sea Fisheries Statistics

Quota uptake is relatively high for most of the species presented (over 80 per cent) but uptake for whiting is less than 50 per cent of the quota allocation for the EU as a whole. Only Germany and the UK utilised more than 50 per cent of their individual quota allocations for whiting. This is probably due to the fact that whiting is seldom directly targeted but caught in a mixed fishery with the other species and that quota for the primary species is exhausted before the whiting quota. An alternative explanation is that whiting are so scarce that it has not been possible to catch the whole tonnage allocated.

Most Member States remained below their quota allocations for all five species except for Sweden which considerably exceeded its allocations for cod and saithe. There is, however, concern that 'over quota' fish continues to be landed resulting in an under-reporting of catches to Member States authorities.

2.4 The Fleet

The focus of this study is the North Sea whitefish trawl fleet. In the UK, this comprises vessels using a range of methods. The survey undertaken focussed on the main groupings of inshore, offshore single rig, offshore twin rig and pair seine.

In general terms, the fleet can be subdivided into inshore and offshore vessels. Inshore vessels are relatively small (generally less than 12m and for the purpose of the study considered to have engines less than 300kW) and fish waters close to shore, within the 6 to 12 mile limit. Inshore whitefish trawlers use single rig demersal otter trawls while offshore whitefish vessels use a wider range of fishing methods. This study focuses on those offshore vessels that use single and twin rig demersal otter trawls and pair seines. Offshore whitefish vessels (vessels with engines of greater than 300kW) range in size from 12m to over 60m and spend between five and eleven days at sea.

An alternate fishing method also used to target North Sea stocks is the bottom set gill net. Gill netting is chiefly carried out by under 10m craft, and by a few Grimsby based vessels of 15m to 20m, which set the gear around wrecks in the North Sea. Gill nets are highly selective gear, and they are used mostly to catch larger, more valuable fish like cod, hake, turbot and occasionally sole. Gill nets are not included in the case study, due to this high selectivity and the small number of vessels using this method of fishing.

Whitefish trawling takes place mainly in the Central and Northern North Sea and vessels are located in ports near to fishing grounds along the North East Coast of England and Scotland. Some large vessels registered in West of Scotland ports steam around to fish in the North Sea and, likewise, some East Coast registered vessels fish in waters off the West Coast of Scotland. Table 2.8 presents the size of the fleet in the main East Coast ports in 1998. The table includes all vessels over 10m in length, not just those targeting whitefish.

Table 2.8 UK over 10m fleet operating from East Coast ports (1998)

Licensing district	Number of vessels	Total tonnage GT	Total power (kW)	VCUs	Average VCUs per vessel
Shetland	65	17,911	40,917	31,904	491
Orkney	55	5,763	15,056	12,538	228
Buckie	84	6,112	33,056	27,504	327
Fraserburgh	184	29,660	94,667	77,943	424
Peterhead / Aberdeen	116	21,351	73,202	56,678	489
Eyemouth	52	1,756	11,300	9,794	188
Scotland other	187	9,075	48,257	39,559	212
North Shields	98	2,044	13,521	12,333	126
Scarborough	69	2,522	16,262	13,503	196
Grimsby	70	23,819	53,455	41,407	592
Total	980	120,013	399,693	323,163	330
% of UK fleet	46%	63%	57%	56%	

Source: Scottish Sea Fisheries Statistics, UK Sea Fisheries Statistics

The majority of fish caught in the Central and Northern North Sea (Area IVa and IVb) is landed to these East Coast ports. The table in Annex I shows that over 90 per cent of the five species (cod, haddock, whiting, saithe and Nephrops) caught in the Central and Southern North Sea is landed to these East Coast ports.

Table 2.9 gives approximate numbers of vessels fishing in the North Sea using the different fishing methods focused upon in this study. Values are approximate based on SERAD data, as detailed data for MAFF controlled ports do not exist in published form.

Table 2.9 Number of North Sea vessels by fishing method (1998)

Method	Number of vessels (approx.)	% of fleet (approx.)
Offshore		
Demersal single rig	283	29
Demersal twin rig	28	3
Demersal pair seine	40	4
Nephrops	234	24
Inshore		
Whitefish trawl	21	
Nephrops	154	

Source: Scottish Sea Fisheries Statistics, UK Sea Fisheries Statistics

2.5 Economic Performance

The costs and earnings of UK North Sea fishing vessels are presented in Table 2.10. Figures for inshore whitefish trawlers are those for earnings and expenditures of over 10m vessels only as the Seafish Fishermen's Handbook survey did not cover the under 10m fleet. Under 10m inshore whitefish trawlers are likely to have lower earnings than are presented in Table 2.10 but they are also likely to have lower expenses. Figures given for seine netters refer to individual seine net vessels, not pair seiners. It is likely that pair seiners will have a larger annual turnover than the individual seiners due to the fact that they are capable of catching more fish. They are also likely to have greater outgoings than the individual vessels.

The most profitable vessels presented are the Nephrops vessels with a net profit of over 31 per cent – more than twice the net profit of inshore and small offshore whitefish trawlers. The values presented in table 2.10 relate to earnings and expenditures for the tax year 1997 / 98. The first hand sale price of Nephrops in the UK has fallen quite dramatically since then. It is likely that fishing for Nephrops in the North Sea is no longer as profitable as the figures in the table suggest. The fall in Nephrops prices has been blamed on oversupply caused by vessels switching from other methods to targeting Nephrops. Whitefish vessels and scallop dredgers may have changed fishing method in response to a reduction in fishing opportunities caused by respectively cuts in quotas and scallop fishery closures. The previously high prices and profits earned from targeting Nephrops may have also been an incentive to switch to prosecuting Nephrops.

Table 2.10 Costs and Earnings of UK North Sea fishing vessels

	Inshore (< 300Kw)*		Offshore (>300Kw)			
	Single rig trawler	Single rig trawler (<24m)	Single rig trawler (>24m)	Twin rig trawler	Seine^	Nephrops
Earnings	326,472	526,232	772,399	965,878	622,818	186,197
Commission	21,877	24,743	34,363	39,808	26,550	7,692
Harbour dues	16,751	20,453	26,354	42,276	16,960	6,416
Subs & levies	3,230	4,136	6,486	7,310	5,316	1,088
Shore labour	4,218	11,728	22,024	24,763	9,625	1,028
Stores	-	-	3,615	-	4,992	-
Fuel & oil	22,343	42,665	50,006	71,415	42,802	18,238
Boxes	5,588	7,709	9,940	12,203	10,252	690
Ice	5,776	6,026	8,740	13,782	7,342	1,555
Crew travel	373	2,112	6,654	5,331	4,076	62
Food	6,911	10,745	16,655	16,221	15,638	3,311
Other	4,055	7,850	15,462	9,622	31,893	3,483
Crew share	114,616	174,104	276,488	352,800	221,047	46,528
Fishing Expenses	205,738	312,272	476,786	595,531	396,493	90,089
Insurance	15,654	23,486	33,480	39,349	21,735	7,857
Repairs	28,139	65,286	49,687	69,272	42,655	10,332
Gear	17,282	27,418	32,319	74,063	19,573	6,449
Hire & maint.	5,345	7,479	10,716	9,596	7,559	6,209
Other	4,762	10,267	10,680	13,162	16,187	6,151
Owner Expenses	71,182	133,936	136,882	205,442	107,710	36,998
Total Expenses	276,920	446,208	613,668	800,973	504,202	127,088
Net Profit	49,552	80,024	158,731	164,905	118,616	59,078
Net Profit (%)	15.2	15.2	20.6	17.1	19	31.7

* >10m vessels only

^ individual seine netter vessels only

Source: Seafish Fishermen's Handbook 1997 / 98

3. The Discard Problem

3.1 Biological Factors

The North Sea whitefish fishery is a mixed fishery with the three main demersal species, cod, haddock and whiting, occupying similar positions in the water column (just above the seabed) and favouring similar grounds. A fishery has therefore developed where all three may be captured in a haul in addition to by-catches of many other species including saithe, monkfish, Nephrops, plaice, lemon sole, megrim, as marketable by-catch.

The fishery cannot therefore be describe as a 'clean' fishery although many by-catch species have become highly marketable in recent years which therefore reduces the level of discards of these by-catch species. The minimum landing size for cod is 35cm, for haddock 30cm, and for whiting 27cm (UK only) suggesting that undersized cod are likely to be taken, particularly when whiting is targeted.

With regard to cod, haddock and whiting discards in the North Sea, the level of fishing pressure in recent decades has resulted in the fishery consisting of newly recruited fish. As growth is not uniform, a single year class will have a range of lengths at any given time. Only a proportion of these individuals will therefore reach the minimum landing size (MLS) when they become subject to fishing pressure.

According to the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)³, recruitment of cod has been well below average in most years since 1985. The strong 1996 year class resulted in high discards of this small cod in 1998 as they entered the fishery, with some reaching MLS and others being below MLS on capture. The 1997 and 1998 year classes have been poor resulting in low recruitment to the fishery in recent years (see figures 2.1 and 2.2).

The cyclical nature of recruitment is also obvious in the haddock fishery where the indications are that the 1999 year class is comparatively large. This opportunity to build up the spawning stock biomass, which is below average compared to the last 20 years, could easily be lost with a proportion of this small haddock entering the fishery in 2000 and so targeted. Reports from some fishermen (see skipper survey responses in Chapter 7) suggest these small haddock are already being captured and discarded as they are below MLS or are subject to high-grading.

Landings of whiting were at a record low level for 1998, with the 1996 year class estimated to be the weakest on record. Again recruitment of whiting appears to be highly variable year on year. However, the level of fishing pressure does not alter proportionally to this natural variation year on year. As a result the level of discarding in the North Sea whitefish fishery appears to vary considerably from one year to the next.

Although a mixed fishery, the behavioural differences of target species in the North Sea do provide the potential for developing gear with improved selectivity. Slower towing speeds improve the selection between the faster swimming species such as saithe and the slower swimmers (cod, haddock, whiting). As fish tire, they turn back into the cod end, but do so in different ways. Cod stay low, near the seabed, whiting are in the middle and haddock rise up as they turn. This behaviour allows for improved selectivity through the use of separator trawls, but the operation of such

³ Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak, ICES, October 1999

trawls is more complex and they are more costly than the single cod end nets used currently.

3.2 Fishing Gear

Vessels targeting whitefish in the North Sea are obliged to use nets with a minimum 100mm diamond mesh. However, those targeting whiting are permitted to use 90mm, and those targeting Nephrops 70mm with an 80mm square mesh panel. These exceptions allow for a 10% by-catch of protected species.

The discarded by-catch of haddock and cod in the whiting and Nephrops fisheries are of concern, particularly as a large amount of whitefish fishing effort has been redirected towards Nephrops. There is also a significant by-catch of whitefish by industrial fisheries targeting Norway pout and sandeel. These by-catches, and so discards, can be reduced with improved gear selectivity.

There is some disagreement amongst fishermen over the effectiveness of square mesh panels. Some suggest they do not work, particularly in certain positions, or are not necessary when prawn fishing as there are so few fish left on the grounds. Others claim 80mm square mesh panels are more selective than 100mm diamond mesh, particularly when thick or double twine is used in the 100mm nets.

Work carried out by the Marine Laboratory Aberdeen found that the use of square mesh compared to diamond mesh is equivalent to a linear mesh size increase of 15%. Many fishermen saw a complete switch to square mesh rather than diamond mesh cod ends too much of a jump, but have accepted the use of square mesh panels to improve selectivity.

Separator trawls and grids have been developed to further enhance selectivity, however the greater complexity and cost of operating such gear has for the most part dissuaded UK fishermen adopting this gear technology. Fishermen generally avoid taking such altruistic unilateral action to increase selectivity as this inevitably impacts upon their own income while benefiting all. They are therefore increasingly calling for technical regulations to improve selectivity.

3.3 Regulatory Factors

Regulations directly affecting discard levels can be divided into gear regulations, MLS regulations and quota regulations. Fishermen may cite other regulatory pressures resulting in a situation where they are forced to maximise profits and discard (high-grade) or land 'over-quota fish' as a result.

Regulations relating to technical measures have recently been amended, coming into force from 1st January 2000. The revised Council Regulation (EC) 850/98 of March 1998 aims to harmonise with Council Regulation (EC) 894/97 in order to minimise the catch of juvenile fish and thus reduce discards, through improved gear selection, prohibiting adverse manipulations and prohibiting the trade of undersized fish.

The main changes affecting those targeting the North Sea whitefish fishery are limits on twine thickness (8mm single, 12mm double) in cod ends and no more than 100 meshes around the cod end. The majority of nets used in the fishery already matches or exceeds these requirements and so little change has occurred. The mandatory inclusion of 80mm square mesh panels in Nephrops nets is coming into line with the UK's existing regulations.

The use of 80mm square mesh panels in 100mm roundfish nets is only voluntary at this stage and it is uncertain whether fishermen will choose to adopt this. Taking all

measures into account, few anticipate great changes in the selectivity of the fleet targeting roundfish.

Changes in MLS have been restricted to flatfish species. This move has been universally condemned by the industry, and the industry has chosen to retain the current MLS for plaice, as they fear the creation of a market for small plaice leading to the possible targeting of smaller fish. The industry views this as a backward step for stock conservation.

For roundfish it appears the present MLSs are acceptable to the industry and to the regulators, although a substantial proportion of roundfish entering the fishery is immature. Markets exist for all grades of fish landed, although the lower grades often fetch a much lower price than sizes 1 & 2 and are therefore subject to high-grading on occasion.

Fishermen often refer to quota regulations when discussing the discard problem. With stock assessment being an inexact science combined with seasonal and temporary concentrations of stocks, it is inevitable that an individual vessel will on occasion catch more fish than it has quota for. In such a situation the quota is often blamed for the discarding of marketable fish above the minimum landing size.

The trading and leasing of quota, as well as the group management of quota by Producer Organisations, does mitigate the effects of a quota system on the requirement to discard over-quota fish, as additional quota can be purchased. However, ITQ management programmes (which the industry appears to be informally moving towards in the UK) can provide incentives to discard low value fish and this is an unfortunate consequence of ITQs⁴.

3.4 Other factors

The factors outlined above have been recognised as the main factors affecting discarding in the North Sea whitefish fishery. At any given time a number of other factors impact upon the level of discarding in a fishery. While currently these other factors are seen as secondary, the high variability of North Sea whitefish stocks means that the following can become significant factors:

- **Storage Space** – mainly affecting vessels on longer trips and targeting high value species such as Nephrops where low value whitefish such as saithe and whiting may be discarded. This is not thought to be a deciding factor currently.
- **On-board handling** – Towards the end of a trip, in rough weather or if fishing has been good, marketable fish may be discarded rather than processed in order to reduce the crews' workload. This is particularly true for Nephrops where smaller sizes may be discarded rather than tailed.
- **Market factors** – Where there is over-supply through landings of large amounts of a strong year class, other vessels may be instructed or inclined to high-grade as prices for lower grades would be poor, but all retained catch would still count against quota.

⁴ 'An Economic Analysis of Highgrading in ITQ Fisheries Regulation Programmes', Anderson, Marine Resource Economics vol.9, number 3, Fall 1994

4. Economic Value of Discarding

4.1 Volume of discards

Information relating to North Sea whitefish discards suggests the level and amount of discards is highly variable year to year. Data on recent discard rates is presented below; however, the calculation of these rates is not uniform between data sources.

The North Sea trawl fishery has been the subject of a long-standing discards monitoring programme conducted by Fisheries Research Services (FRS), Aberdeen on behalf of the Scottish Office Agriculture Environment and Fisheries Department (SOAEFD)⁵, since the early 1970's. Table 4.1, below, shows the variable nature of discard rates by Scottish vessels in recent years, particularly for cod.

Table 4.1. Average Annual Discard Rates (proportion of catch by weight discarded) for species landed by Scottish Demersal vessels in the North Sea 1988 – 1993.⁶

Species	1988	1989	1990	1991	1992	1993
Haddock	0.34	0.36	0.42	0.48	0.52	0.48
Whiting	0.46	0.51	0.48	0.51	0.44	0.51
Cod	0.05	0.27	0.21	0.11	0.08	0.18
Saithe	0.01	0.09	0.04	0.17	0.18	0.62

Source: SERAD

Recent CEFAS estimates suggest that in 1997 between 31,000 and 35,000 tonnes of cod, 52,000 tonnes of haddock and 17,000 tonnes of whiting were discarded. When comparing these to the UK TACs in the North Sea, this suggests that the equivalent of 25% by weight of the total North Sea cod TAC, 45% haddock and 28% of the whiting TAC was discarded. No suitable data on the English fleet is available from CEFAS for 1999, but a new international discards programme involving CEFAS should provide data with a higher degree of confidence in future.

The majority of discards in the North Sea are undersized fish. The proportion of cod discarded in 1997 that was undersized was 82%, haddock 57% and whiting 67% by number. By weight the percentages were cod 73%, haddock 46% and whiting 53%.⁷

Table 4.2 presents the results of the FRS demersal sampling data, part of the continuing discards monitoring programme. Annex II provides a more detailed breakdown of discard levels recorded for cod, haddock and whiting by type of vessel (heavy trawler over 90ft or light trawler under 90ft), season and fishing area.

An inshore/offshore distinction is made in the FRS programme by sea area i.e. 'light trawlers' fishing in either inshore or offshore areas. The split between inshore and offshore in the skipper survey is, however, by vessel type i.e. inshore vessels <300kW engine power, offshore >300kW. Other definitive information differs between the FRS data and the groupings used in the skipper survey, but the FRS data is the best

⁵ Now known as the Scottish Executive for Rural Affairs Division (SERAD)

⁶ 'Discarding Levels in the North Sea & West of Scotland', Stratoudakis, Y. PhD Thesis, 1997

⁷ CEFAS estimates

available source with which to compare the level of discarding occurring in the North Sea during 1999 with that stated anecdotally by skippers.

Table 4.2 Proportion of catch of cod, haddock and whiting discarded by weight for trawlers operating in the North Sea.

vessel type & season*	Cod % discarded	Haddock % discarded	Whiting % discarded
heavy trawl, offshore, winter 1	13%	34%	25%
heavy trawl, offshore, summer	2%	21%	45%
heavy trawl, offshore, winter 2	1%	13%	35%
average for heavy trawl	6%	24%	35%
light trawl, offshore, winter 1	15%	42%	30%
light trawl, offshore, summer	5%	35%	45%
light trawl, offshore, winter 2	4%	28%	38%
average for light trawl offshore	9%	36%	36%
light trawl, inshore, winter 1	37%	39%	17%
light trawl, inshore, summer	60%	70%	66%
light trawl, inshore, winter 2	16%	41%	28%
average for light trawl inshore	43%	53%	42%
average for all trawlers	13%	40%	38%

*Heavy trawler defined as stern trawler >90ft., light trawler defined as stern trawler <90ft.

Winter 1 = Oct 98-Mar 99, summer = Apr – Sep 99, winter 2 = Oct – Dec 99

Source: FRS Aberdeen

The data in table 4.2 illustrates the high degree of variation in discarding levels both by vessel type, season and fishing area. Of particular interest is the difference in discarding levels in offshore areas between winter one and winter two. For cod and haddock, a lower percentage of the catch was discarded in winter two compared to winter 1, while the opposite is observed with whiting. For all three species, the amount discarded in inshore areas is generally higher than offshore areas, particularly in the summer.

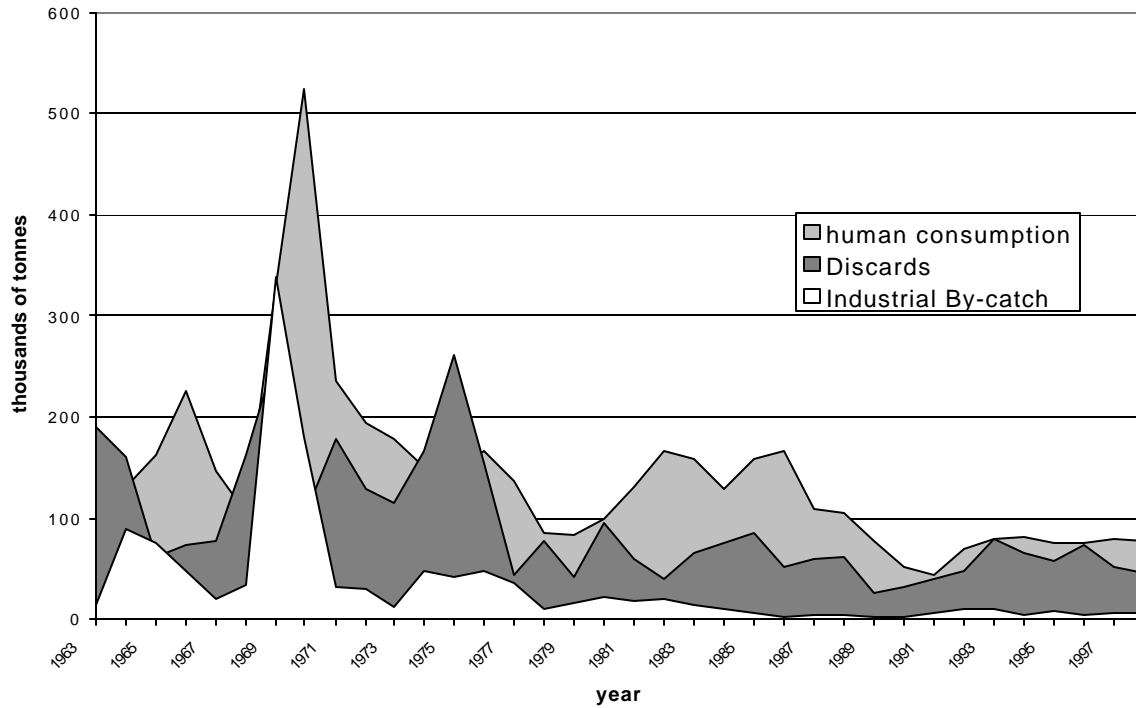
To establish the type of discarding occurring, the proportion of fish discarded under the legal landing size is recorded (see Annex II). Again this varies significantly both between species, vessel type, fishing area and season. In general the majority of cod discarded are below the MLS, which this is true for all three species in inshore areas. For whiting (and haddock on occasion) the majority of fish discarded in offshore areas are above the MLS, suggesting that fish is discarded due to either high-grading decisions or quota limitations.

The level of discarding recorded by the FRS sampling programme for 1999 is greater than the levels recorded anecdotally in the skipper survey. Possible reasons for these differences are discussed in Section 4.2 Value of Discards.

Graphs in Annex II show the levels of discarding per vessel type in 1999 as reported by fishermen in the consultant's skipper survey. These show the larger amounts and proportions of whitefish discarded by the larger offshore vessels, pair seiners in particular. To an extent this could be as a result of inshore vessels now targeting Nephrops predominantly (where an average of 12 per cent is discarded) rather than whitefish. Indications are that 1999 saw a greater proportion of small haddock compared to other whitefish and this is reflected in the higher discarding levels (19 per cent for twin rig trawlers and 24 per cent for pair seiners).

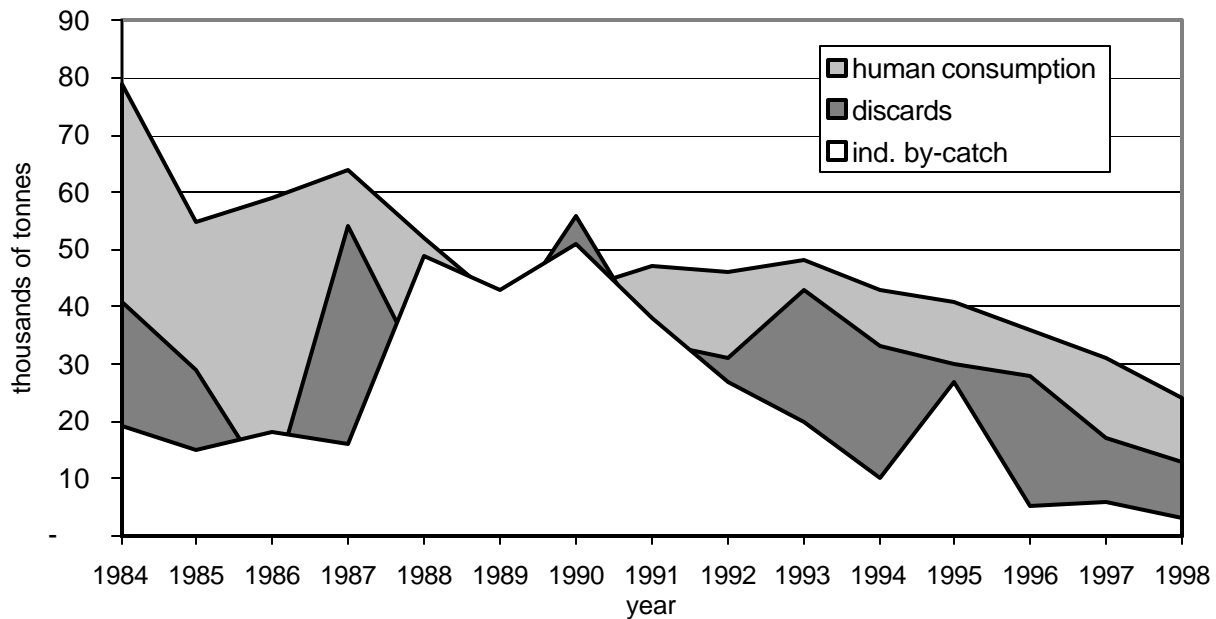
Figures 4.1 and 4.2 show the variability of estimates by ICES for discarding in the North Sea. For comparison, calculations later in this section use both the data from FRS sampling and the skipper survey conducted by the consultants.

Figure 4.1. Working Group Estimates of Catches ('000t) of Haddock from the North Sea



Source: ICES

Figure 4.2. Working Group Estimates of Catches ('000t) Whiting from the North Sea



Source: ICES

4.2 Value of discards

The three main whitefish target species of cod, haddock and whiting have been considered when calculating the value of discards. These, along with saithe, constitute the vast majority of commercial discards for North Sea whitefish trawlers. Saithe has not been considered here due to the lack of published data and the low volume and value of saithe landed in the UK. Discarding of Nephrops is not being considered here as currently the levels of discarding are thought to be relatively low with small specimens retained as tails rather than being discarded.

In the calculations presented, the following steps and assumptions were made:

- Average discard rates from the survey were calculated as cod 0.077, haddock 0.195 and whiting 0.159.
- Average discard rates from FRS data are cod 0.13, haddock, 0.40 and whiting 0.38.
- Discard mortality for the three species is estimated as being 100%. Recent trials suggest even those individuals appearing to survive initial discarding subsequently die through the stresses experienced.
- Catch rate or fishing mortality is estimated from ICES calculations of F_{pa} as: cod 0.65, haddock 0.63 and whiting 0.65.
- From natural mortality estimates by ICES Working Groups in 1997 the following natural mortality values used are averaged between years 1 and 2; cod 0.655, haddock 0.955, whiting 0.835.
- Growth rate is highly variable year to year and is dependent on temperature plus food availability. The trend has been a decline in mean weight/age over recent years. For the purposes of the calculations from 1998, mean weight changes from ages 1 to 2 are used. These are cod 1.87, haddock 1.65, and whiting 1.96.

Table 4.3. Estimate of Economic Value of discards from Nautilus skipper survey 1999

Estimates 1 - Nautilus Survey 1999				
	Total	Cod	Haddock	Whiting
Landings from North Sea (IV a & IV b) in 1998	133,325	50,217	63,602	19,506
Discards % of total		7.7%	19.5%	15.9%
Fish Discards (tonnes)	19,371	3,867	12,402	3,101
Discard mortality rate		100%	100%	100%
Dead discards (tonnes)		3,867	12,402	3,101
Above minimum landing size		2%	13%	3%
Above minimum landing size (tonnes)		77	1612	93
Undersized (cod<35, haddock <30, whiting <27)	17,588	3,789	10,790	3,008
% reaching minimum landing size after 1 year		0.66	0.96	0.84
% weight gain		187%	165%	196%
Quantity reaching minimum size (tonnes)	41,866	7,123	27,307	7,436
Catch rate of sized fish		0.65	0.63	0.65
Foregone future catches		4,630	17,203	4,833
Average price/kg 1998		1.39	0.82	0.57
Value undersized (present value) (£ million)	22.7	6.2	13.8	2.7
Average price/kg 1998 smallest class		1.00	0.69	0.54
Value sized (£ million)	1.25	0.078	1.12	0.051
Total Value (£ million)	23.9	6.3	14.9	2.7
Total Value (€ million)	36.8	9.7	22.9	4.2

Table 4.4. Estimate of Economic Value of Discards from FRS data 1999

Estimates 2 - FRS sampling - 1999				
	Total	Cod	Haddock	Whiting
Landings from North Sea (IV a & IV b) in 1998*	133,325	50,217	63,602	19,506
Discards % of total landings**		13%	40%	38%
Fish Discards (tonnes)	39,381	6,528	25,441	7,412
Discard mortality rate		100%	100%	100%
Dead discards (tonnes)	39,381	6,528	25,441	7,412
Above minimum landing size		14%	24%	58%
Above minimum landing size (tonnes)		914	6,106	4,299
Undersized (cod<35, haddock <30, whiting <27)		5,614	19,335	3,113
% reaching minimum landing size after 1 year weight gain		0.66	0.96	0.84
Quantity reaching minimum size (tonnes)		187%	165%	196%
Catch rate of sized fish		10,634	49,188	7740.16
Foregone future catches		0.65	0.63	0.65
Average price/kg 1998		6,912	30,988	5,031
Value undersized (present value)	37.89	1.39	0.82	0.57
Average price/kg 1998 smallest class		9.61	25.41	2.87
Value sized	7.448	1.00	0.69	0.54
		0.914	4.213	2.321
Total Value (£ million)	45.338	10.524	29.623	5.191
Total Value (€ million)	69.809	16.204	45.611	7.993

While UK landings figures for 1999 have not been published as yet, indications are that they were significantly down compared to 1998 figures. Reports⁸ for the first nine months of 1999 suggest the landed value of cod fell by 22% compared to 1998 (due to a large drop in volume of 37%, but tempered by a 22% increase in quayside prices), whiting also followed this downward trend, but the value of haddock rose by 8 per cent. If these trends continued throughout 1999, the value of discards from the survey would represent approximately 10 per cent of cod, 24 per cent of haddock and 22 per cent of whiting landed.

The results from the two data sources differ significantly, with the skipper survey indicating far lower discard rates (almost half) than the FRS sampling data. This is not surprising given the very different data sources, one from anecdotal evidence, and the other from on-board sampling. There are limitations with each methodology (particularly a reliance on purely anecdotal evidence) that makes it difficult to compare results with any degree of confidence. If some basis for comparability is assumed, however, the differences in results are thought to be a combination of a number of factors:

- Skippers provide conservative estimates as they do not wish to admit to the extent of discarding as it is seen as a wasteful practice
- As discarding varies so much per haul, estimating an average is difficult
- Skippers who remain in the wheelhouse do not know exactly what is being discarded from a haul, particularly with the prevalence of shelter-decks that enclose the deck area to a great extent.

⁸ 'Big Fall in Cod Landings', Fishing News, 10th March 2000

5. Costs & Benefits of Discarding

In the methodology report⁹ the incentive for discarding was defined as the difference between the costs of landing and the costs of discarding, the latter including the opportunity costs of landing.

$$Id_i = Cl_i(q_i) - Cd_i(q_i) \quad (1)$$

Where:

$$Cd_i(q_i) = p_i * q_i + \underline{Cd}_i(q_i) \quad (2)$$

Id_i = Incentive for discarding quantity q of species

$Cl_i(q_i)$ = Costs of landing species

$Cd_i(q_i)$ = Costs of discarding species

p_i = Price of species i = the opportunity costs of discarding species

$\underline{Cd}_i(q_i)$ = Labour costs onboard of discarding

In section 5.1 the items determining the costs of landing will be discussed and in section 5.2 the factors determining the costs of discarding. Section 5.3 deals with the incentives for discarding for different species and section 5.4 concerns costs and benefits of using alternative fishing methods.

5.1 Costs of landing

The factors determining the costs of landing in the UK whitefish fisheries include:

Costs depending on catch weight

- *Ice costs*
- *Shore labour*
- *Transport before first sale if required*

Costs depending on value of landings

- *Auction commission*
- *Seafish, PO, Association Levies*
- *Costs of sorting by auction staff*
- *Price differential between low value grades and high value grades*

In the case of quota species for which the quota is restrictive, the price differential between low value grades and high value grades should be regarded as one of the factors in the costs of landing these low value grades. Tables presented in Annex III show the average price differentials for target species at North Sea ports between July and December 1998.

5.2 Costs of discarding

The costs of discarding include the opportunity costs of landing the species considered:

- *Market price of potentially discarded species.*
- *Extra effort.*

In some cases the extra effort needed to catch better quality should be regarded as one of the factors in the costs of discarding. This is dependent on the size of the individual quota in relation to catchability of the fish.

⁹ See LEI/Nautilus/Cofrepeche Methodology and Progress Reports

5.3 Incentives to discard

The tables below take into account the costs of landing and discarding mentioned above for haddock, cod, whiting, saithe and Nephrops. The figures presented give both the incentive to discard compared to the incentive to land the fish and the incentive to high-grade (i.e. the cost of landing one grade of fish compared to the cost of landing a better grade of fish).

In all cases it is assumed that no extra effort is required to catch better quality fish as effort is not considered to be a salient factor in decision-making in the UK whitefish fishery. Should an effort factor be included, the incentive to discard will be positive if the price at landing after considering the differential between fish grades, is greater than the cost of additional effort.

The calculations for the incentive to discard each species are presented in Annex III. Table 5.1, below, summarises those incentives:

Table 5.1. Incentives to Discard in the North Sea Whitefish Fishery

Species	Incentive to discard	Relative incentive to discard (incentive / revenues per kg)	Incentive to Highgrade	Relative incentive to Highgrade (incentive / revenues per kg)
Cod	-0.77	-0.65	0.384	0.33
Haddock	-0.53	-0.68	0.129	0.17
Whiting	-0.45	-0.79	0.039	0.07
Saithe	-0.41	-0.74	0.028	0.05
Nephrops	-1.215	-0.58	0.724	0.34

Table 5.1 shows, unsurprisingly for commercial species, that there is a negative incentive to discard compared to the costs of landing: the landing of these species will produce a profit when the costs of landing are taken into account. In addition, the table illustrates that there is a positive incentive to high-grade. This positive incentive is, however, very low for whiting and saithe, suggesting that only a small cost for extra effort factored into the equation would create a negative incentive. There appears to be a strong incentive to high-grade cod, but the poor condition of stocks suggests that this does not occur to any great extent in the fishery at present.

5.4 Costs and benefits (incentives) of alternative fishing methods

It is anticipated that the most practical and acceptable developments in fishing methods for targeting demersal species will revolve around the increased selectivity of towed gear. A switch to static gear would not produce the volume required to supply the UK whitefish and Nephrops markets, nor would it be practical in the North Sea with its busy marine traffic and grounds targeted by several nations. There are, however, a number of adaptations to trawled gear being researched that increase gear selectivity. A number of these are discussed below.

- **Increase in mesh size**

The North Sea cod fishery has seen an increase in mesh size in recent years to 100mm and this has had some impact on the reduced levels of discarding of small cod as well as small haddock and whiting. However, other variables such as the poor cod recruitment and resulting switch in effort by some vessels to Nephrops prevents any assessment of the level of impact caused by increasing mesh sizes.

The mesh size increase to 100mm has been further mitigated by the move towards double 6mm twine in cod-ends which reduces selectivity, estimated to be the equivalent of under 90mm with double 4mm twine. The recent EC gear regulations do include twine thickness, but they currently only qualify the thickness being widely used by the UK trawl fleet in the North Sea. Any regulations on mesh size must take twine thickness into account in future to avoid anticipated impacts being minimised.

- **Square Mesh**

It has been widely known in the fishing industry that square mesh panels increase the selectivity of nets as the shape is not distorted through towing speed or weight to the extent that diamond mesh is. Research suggests a simple replacement of diamond mesh with square mesh of the same size and thickness has the same effect as increasing diamond mesh size by 15%. This would have very large short term impacts on the income of fishermen, particularly as the North Sea fishery is so dependent on recruits entering the fishery anew each year.

Those fishermen operating in the Norwegian sector already experience the differences in catch composition from towing 100mm nets compared to 115mm nets. These vessels, however, mainly target cod in the Norwegian sector and do not take the significant amounts of haddock and whiting found in Areas IVa and IVb of the North Sea. Such a sudden increase for the North Sea would result in a very significant reduction in catch and therefore an unacceptable reduction in income.

The regulatory and industry move has therefore been towards square mesh panels rather than a whole cod end constructed with square mesh.

- **Square Mesh or Escape Panels**

80mm square mesh panels are mandatory for UK vessels targeting Nephrops in the North Sea with 70mm mesh nets. The intention is to select out small haddock and whiting. However, the high headline (3-4m) of mixed Nephrops/whitefish trawls in the North Sea means that fish are often not near enough the panel to escape before they have tired and entered the cod-end. The correct positioning of the panel is therefore vital for it to have the desired effect¹⁰.

Fewer fish escape when the panel is moved forward, but fishermen complain that with panels close to the cod end some of the catch may be lost when hauling if the net twists. The 80mm panel must be fitted in the extension panel of the net and an improvement to selectivity of around 5% is about average. 90mm panels, now being advocated by the Scottish Whitefish Producers Association and the National Federation of Fishermen's Organisations, increase selectivity by around 10 per cent.

An increase in selectivity does not directly equate to a proportional reduction in income. For the North Sea, with the current dependence on recent year classes

¹⁰ From 3rd August 2000 90mm square mesh panels became mandatory for Scottish vessels. See Annex V for SERAD's new Technical Regulations.

entering the fishery and high proportions of small fish in catch compositions, reductions in income may be greater for the first couple of years.

Trials in Shetland¹¹ suggested that with 80mm square mesh panels in diamond mesh seine nets of 80mm (80/80mm) a reduction in earnings of 20 per cent was found compared to standard 100mm diamond mesh nets. For trawl nets the reduction in earnings was 21 per cent with the same 80/80mm mesh combinations.

With 90/90mm mesh combinations compared to 100mm, the reductions were 81 per cent for seine netters and 71 per cent for trawlers. With 100mm square mesh panels in 100mm nets the reductions in earnings were 90% for seine net and 94% for trawl nets. These results suggest the loss in earnings from anything other than an 80/80mm set up would be unacceptable for the Shetland inshore fishermen. A 20% loss of earnings remains a substantial cut particularly when operational costs continue to rise (such as fuel rising by approx. 30% in recent months).

Interest in 90mm square mesh panels is now very high with a year-long monitoring programme being conducted on a trawler fitted with a 90mm square mesh panel.¹²

- **Selection Grids**

Selection grids are now commonly used in shrimp fisheries utilising fine mesh nets where discards of fish were worryingly high. A rigid grid is used to direct fish up and out of the net. It has been found that these grids can also select between fish species and between sizes of the same species.

Internal grids vary in design from a single grid filling the net to a cod-end divided into a top and bottom section with a grid at the top and a guide panel at the bottom that large fish will push past. The weakness of internal grids is that their effectiveness is dependent on positioning to a matter of a few degrees and they are prone to clogging with debris such as seaweed.

Wall mounted grids avoid some of the problems encountered with internal grids, but do add complications when hauling and are currently used in large stern trawlers which do not haul the net aboard using a power winch or a net drum.

Tests indicate that using a grid with a bar spacing of 50mm is equivalent in selectivity to a 100mm diamond mesh net.

- **Separator Trawls**

These utilise the different capture behaviours of gadoids to increase selectivity using two cod ends top and bottom. In a mixed haddock, whiting, *Nephrops* fishery a larger mesh size in the top cod-end captures mostly haddock and whiting, with the bottom one capturing *Nephrops*. In a mixed cod, haddock and whiting fishery the top cod end mesh would be smaller capturing the haddock and whiting, while cod would be caught in a larger meshed bottom cod end. The negative aspects of separator trawls are price (around 30% more than conventional trawls), complexity of operation and time required in clearing two cod-ends. This latter issue is however countered by the improved selectivity of the net reducing sorting time.

¹¹ 'The potential Short Term Economic Impacts of Square Mesh Panels on the Shetland Inshore Fishing Fleet', Laurenson & Beveridge, North Atlantic Fisheries College, Fisheries Development Note, 1997.

¹² "Skippers Happy with Square Mesh Panels", Fishing News, 17th March, 2000

6. The Role of Regulations

The regulatory environment is a key element in determining the extent and type of discarding taking place in any fishery. It is the design and implementation of fishing regulations that will determine, to a large degree, just how a skipper deploys the resources at his disposal, and modifies his otherwise unfettered commercial behaviour.

The main aspects of regulatory impact relate to input and output controls. Input controls relate to mesh size and effort limitations, fishing area restrictions and closed seasons, and the basic issue of limited entry through licensing. Output controls relate to quota restrictions, minimum landing sizes and by-catch limits.

In addition to these, other formal and informal regulations apply to various aspects of reporting (log-book entries, use of designated ports) and of administrative and scientific inspection (compliance with monitoring and control activities, collaboration in observer programmes, and assistance in the collection of size, weight and age data).

In terms of discarding, the two most influential factors are regulations governing minimum landing sizes and the gear conformations that can be used in particular fisheries. These two aspects – one an output control and the other an input control – are inextricably connected. As a general premise, an owner / skipper will seek to deploy that combination of fishing vessel, fishing gear and fishing skills that will yield catches capable of delivering the highest profit to the vessel. As a general principal, this will be achieved in compliance with ruling regulations governing fishing activities.

6.1 Minimum landing sizes and mesh size restrictions

It is illegal to hold on board a vessel any fish that falls below the minimum size limits presented below. If caught, such fish must be discarded by law (unless as an industrial by-catch and channelled for conversion to fishmeal or to some use other than for human consumption), and must be discarded immediately after a catch is sorted. In terms of minimum size regulations, the following figures are indicative of the regime in place in the North Sea fisheries.

species	minimum size
cod	35 cms
haddock	30 cms
saithe	35 cms
whiting	27 cms
Norway lobster	8.5 cms

These minimum size restrictions are to some extent co-limited by gear restrictions, which seek to optimise the balance between target fishery specificity, marketable by-catch, and under-sized fish and fish of no commercial value. Gear restrictions have great impact on the type and size of fish that can be caught. At the same time, however, restrictions diminish the responsibility of the fisherman for the range of species and sizes of fish that are caught with that gear (he can argue that it is largely outside his control), whilst leaving scope for modification of the gear to subvert the

intended purpose of the regulation for commercial advantage. Nevertheless, this combination of controls is considered to be particularly effective, and remains under constant review; a process which has led to the steady evolution of this form of control.

Relevant gear controls, with accompanying target species and by-catch constraints, affecting the North Sea fisheries may be listed as:

- 100mm - For vessels targeting cod, haddock and saithe, existing legislation dictates a minimum mesh size of 100mm.
- 90mm - The minimum mesh size applicable for directed whiting fisheries is 90mm. Whiting has to form at least 70% of all whiting, cod, haddock, saithe and cod caught. Cod, saithe and haddock must make up no more than 10% of the catch, and plaice must make up no more than 10% of the catch. In addition it is forbidden to carry on board any trawl or netting with a mesh size smaller than 90mm.
- 80mm – The minimum mesh size applicable for directed sole fisheries will be 80mm south of latitude 55°N. The target species must form a minimum 5% of the catch, of which not more than 10% may be cod, haddock or saithe.
- 70mm - The minimum mesh size applicable for Norway Lobster is 70mm. Catches must contain a minimum of 30% Norway Lobster, and a maximum of 60% of protected species (those demersal species for which a minimum landing size has been set – 23 species in all – plus ling, eel, monkfish, salmon, sea trout and cuttlefish).
- 32mm – The minimum mesh size for pelagic trawls is 32mm. At least 50 per cent of the catch must be made up of target species (mackerel, horse mackerel, herring, squid / cuttlefish, pilchards, blue whiting), and by-catch of protected species must be no more than 10%.
- 16mm – The minimum mesh size for use in pelagic trawling for industrial species (Norway pout, sprat, blue whiting and sandeels) is 16mm, where at least 50% of the catch must be made up of target species, and by-catch of protected species must be no more than 10%.
- Quantities of protected species falling outside the maximum allowable by-catch must be discarded immediately into the sea following sorting of the catch.
- The percentages referred to above shall be calculated as the proportion by weight of all fish, crustaceans and molluscs on board after sorting or on landing, taking into account quantities which have been transhipped. The percentages may be calculated on the basis of one or more representative samples.
- All catches shall be deemed to have been taken with the net on board having the smallest mesh size unless the log-book, kept in accordance with Article 6 of Council Regulation (EEC) No. 2847/93 of 12 October 1993 establishing a control system applicable to the common fisheries policy, and with the rules laid down in implementation of that Article, shows otherwise.
- These basic mesh size restrictions are also further modified by a number of narrower conditions that apply in respect of the deployment of such gear – some in general, some limited to particular fisheries or fisheries areas. Thus:

- The cod end of a demersal trawl must have no more than 100 meshes around the cod end.
- The number of meshes at any point on the circumference of any extension piece must not be less than the number of meshes on the circumference of the cod end ie. the circumference of the cod end must not exceed the circumference of any extension piece..
- The cod end must be either cylindrical shape, being the same circumference throughout, or be of a shape tapering towards the rear end only.
- For the purposes of calculating the number of meshes, selvages shall be excluded and each square mesh shall be counted as two meshes.
- Allowance is also made for the incorporation of a square mesh panel or a “Baltic Panel” into a cod end or trawl extension. Thus, any trawl, Danish seine or similar towed net of which the mesh size is equal to or greater than 100mm may be equipped, in the upper part of the cod end, with a section (panel or window) of square meshed netting attached to the joinings or selvages, having a mesh size equal to or greater than 90mm.
- Restrictions on the use of twin and multi-rig trawls for Nephrops are applicable to all areas except the Fladen Ground. When using this gear, a mesh size of less than 100mm is prohibited in the North Sea (except the Fladen Ground) and in waters to the West of Scotland north of 56° N.
- Any net used to fish for Nephrops in ICES IV (North Sea) with meshes between 70mm and 89mm inclusive must include an 80mm square mesh panel. The square mesh panel must be at least 2 metres in length in the case of a boat with a registered engine power not exceeding 112kW and must be at least 3 metres in length in the case of any other boat.
- Undersized fish shall not be retained on board or be transhipped, landed, transported, stored, sold, displayed or offered for sale, but shall be returned immediately to the sea.

All in all, these constraints are highly influential in determining what can and cannot be held on-board a vessel, and what can and cannot be offered for sale. This provides very good guidance as to what conforms to acceptable harvesting practice within these fisheries. Nevertheless, the application of these minimum standards to the fisheries of the North Sea requires that discarding is an inevitable component of normal fishing practice.

By-catch limits provide very specific linking conditions between operation of gear and that part of the catch which may be retained on board. These conditions allow continued fishing on the target species, even where this entails limited catches of species (or sizes of fish) that are subject to conservation measures of one degree or another. This can lead to the specific conservation of stocks whilst maintaining a workable balance between conservation and economic interests, but can also lead to high-grading where bi-catch limits are incidentally or wilfully exceeded.

Minimum landing size conditions encourage skippers and crew to identify and use gear and fishing techniques that achieve an economic and ethical balance to suit the individual. But, the existence of these rules specifically requires, and therefore encourages, discarding, and distorts the economic decision-making processes of the skipper. This is particularly problematic in mixed species fisheries (such as cod, haddock, whiting and saithe), where the different biological and value characteristics of each species constantly create economic (and, at least in theory, ethical) dilemmas.

Mesh size limits also encourage skippers and crew to identify and use gear and fishing techniques in ways that achieve an economic and ethical balance suited to the individual characteristics of the vessel and its skipper / owners, but generally at the minimum standard set in the legislation. Using a larger mesh size than is nominated in the legislation may involve lower levels of discarding, but unless there were crystal clear evidence that such action leads to immediate economic advantage, such behaviour would impose a commercial penalty on the vessel relative to the ruling economics within the fleet.

Voluntary movement to larger mesh size will only be achieved on the basis of clear commercial logic, or through regulation. This aspect is particularly problematic in mixed species fisheries (such as cod, haddock, whiting and saithe), where the ever changing biological and value characteristics of each species means that every circumstance results in a different optimisation equation.

In the absence of a situation where the use of a larger mesh size results in more profitable operation (and incidentally lower discard levels), the fleet will only moderate its discarding practices on the basis of legislation. To do otherwise would be to volunteer to operate at a comparative disadvantage to competitors, even though the medium to long term outlook might be highly desirable – on both conservation and commercial grounds.

6.2 Area restrictions

Another form of input constraint is the permanent or temporary closure of fishing areas, or time constraints on the use of some forms of gear. Whilst these are primarily established as a means of reducing / stopping the exploitation of particular target species at specific stages in its lifecycle (as juveniles or during spawning), they can also be established to protect particular eco-systems and non-target species. In addition, however, they have the effect of limiting the opportunity to discard. Accordingly they offer an indirect, and more specific mechanism for controlling some forms of discarding.

A number of such restrictions impact on the fisheries of the North Sea, and others are in active debate (notably in dialogues between environmental interests and the fishing industry). These include the following:

- limits as to who may fish within territorial limits – this has positive indirect impacts on discarding, since there is some evidence of beneficial linkage between the technology employed and the nature of the resource being exploited;
- fishing within recognised ICES demarcated areas – at the boundaries this has an impact on discarding, since it provides some constraint to a vessel's freedom to follow the fish, though it may result in more cavalier behaviour – catch it now, and sort out what to keep later;
- closed areas – these have a potentially major impact on the distribution of discarding by stock component;
- seabed conditions and obstructions – seabed type, including such things as offshore oil installations, constrains the gear that can be safely (or legally) used in the area, and thus alters the catch characteristics of fish taken from that area – sometimes this leads to less discarding (wreck fishing, long-lining), sometimes to more (requirement to use higher or wider opening nets, or larger gear sizes, or longer tow lengths);

- closed seasons – potentially major impact on the distribution of discarding – in time and by stock component – for example, the North Sea sandeel fishery is closed from 1 March to 31 October;
- effort constraints, such as no weekend fishing – most commonly applied on a voluntary basis within the Nephrops and small boat fisheries.

There is however the concern that closed areas result in greater fishing pressure in 'open' areas. Full comprehension of both natural systems and fishing pressure is necessary to ensure an overall effect for the fishery that is positive.

6.3 Resource access entitlements

The UK applies a limited entry regime in all its fisheries, and requires that commercial fishing vessels are registered, are sea-worthy, and hold a valid fishing license for the gear and resources being deployed and exploited. Of these, it is the fishing licence that has relevance to discarding. The vessel owner must also hold resource access entitlements sufficient to cover expected catches of pressure stock species (those species where an EU TAC has been established) for those areas in which he expects to fish.

Such entitlement needs to at least cover the tonnage of quota species caught by the vessel. Where tonnage entitlement is out of alignment with the catching capacity of the vessel, the skipper is particularly likely to high-grade, as a means of maximising the benefit of his resource access entitlement. In addition, a skipper in this situation may also be tempted to land over-quota fish, running the risk of being detected and fined, but, if undetected, being able to benefit from the sales revenues. The risk can also be run as a strategic gamble, delaying logbook entry of catches so that a proportion of the catch may be landed unrecorded.

Under circumstances where there remains significant imbalance between the fishing capacity of that fleet exploiting North Sea resources and its resource access entitlements, combined with reducing TACs for North Sea fisheries, the economic incentives to both high-grade and land over-quota fish are considerable. The complexities of the North Sea mixed fisheries, particularly relating to gadoid species, are such that hi-grading within the mixed gadoid fisheries may be high. Under current circumstances, however, this needs to be balanced against the increasing scarcity of target fish populations in the North Sea, such that fewer opportunities for hi-grading are reported to now exist.

7. Perceptions of Stakeholders

7.1 Fishermen's Perceptions of the Discard Problem

A certain proportion of fishermen still maintain that discarding is an inevitable consequence of fishing and therefore do not perceive the levels of discarding to be a problem. As quotas continue to be reduced and competition for what in many cases is a declining resource intensifies, only a minority of North Sea fishermen now holds this view.

Most trawlermen targeting whitefish in the North Sea have seen discarding increase in frequency, with the amount of discarding only decreasing in the last couple of years due to an overall shortage of fish. Of the five types of discarding outlined in the 1997 FAO overview of discarding¹³, the following perceptions are commonly held by North Sea whitefish fishermen:

7.1.1 Discards of damaged fish

A certain proportion of damaged fish is seen as an inevitable consequence of the catching process. Many are now adopting better on-board handling, sorting and icing procedures in order to minimise damage to the catch once aboard and to maximise the value. Improved gear technology is also assisting in making the catching process cleaner and less destructive, though this is not seen as a major weakness of the demersal trawl and seine-net fisheries.

7.1.2 Discards of low value quota fish while quota is still open (high grading)

Many fishermen would argue that high-grading is a thing of the past as the volume of fish is not available these days to allow skippers to make a choice over different grades of fish; they will land everything they can. The recent high whitefish prices for all grades and sharp increases in fuel prices have also meant that a skipper is less likely to delay landing in order to catch better grades of fish.

In the survey high-grading was admitted to by most pair seiners (75% of respondents) and by 52% of twin-riggers, 43% of single-riggers. No inshore skippers said they high-graded. The larger vessels appear more inclined to high-grade. A possible reason is that larger vessels are more likely to calculate what returns on quota are required for a profitable trip and so develop a fishing strategy accordingly, including minimum size of fish retained. Smaller vessels appear to operate in a more 'hand to mouth' fashion and with less opportunity to catch replacement fish due to less catching capacity and shorter trips, are less inclined to discard marketable fish.

It appears that the volume of fish caught also determines the decision to high-grade. Fish will not be discarded if the probability of catching sufficient quantities of fish on the trip is not high.

In 1999 skippers who decided to high-grade did so with haddock, as it was reasonably plentiful, but small. Fish was therefore discarded despite being above the MLS. This year (2000), with less fish on the grounds (particularly cod) less high-grading is occurring.

¹³ Pascoe, S. 1997, Bycatch management and the economics of discarding, FAO Fisheries Technical paper 370

Storage space is not seen as a limiting factor in the fishery; a vessel will rarely run out of space in the hold to retain any marketable fish.

7.1.3 Discards of non-commercial species

Discards of non-commercial species in the North Sea trawl fishery is not perceived to be a major problem by fishermen. This is both because, compared to beam trawling for example, they haul a smaller amount of non-target benthic organisms and because they are not losing money as a direct result of these 'ecosystem discards'.

In the mixed whitefish fishery of the North Sea, most of the fish species captured have some commercial value. The main organisms falling into the non-commercial category are therefore benthic invertebrates such as urchins and starfish. Survival rate is thought to be high for these invertebrates compared to fish species. Any loss of future income as a result of catching and then discarding this category of by-catch is too diffuse for an individual in this fishery to recognise his impact in this regard.

7.1.4 Discards of fish illegal to land: over-quota landings, too small (juveniles)

The vast majority of discards in the North Sea whitefish fishery fall into this category. Most discards are of commercial species either below the minimum landing size or by vessels without quota to retain the species.

The capture of juvenile fish is widely and increasingly condemned within the fishing industry. Many fishermen are, however, often reluctant to take unilateral action by increasing the mesh size used. They anticipate a loss of income with the greater chance of escape for fish over the MLS and see their own conservation efforts as futile with the majority of the fleet continuing to use a smaller mesh size than them.

Those fishermen operating in the Norwegian sector are required to use at least 110 mm diamond mesh net and some retain this when fishing in the North Sea rather than reverting back to smaller meshed nets as they get a 'cleaner' catch with less sorting required.

Most fishermen operate to the framework of regulations stipulating minimum mesh sizes permissible when targeting certain species and therefore suggest that it is the regulators' responsibility to prevent excessive catches of juvenile fish. A recent development has seen the membership of the Scottish Whitefish Producers Association (SWPA) agree an increase both in net and square mesh panel mesh sizes in order to increase selectivity in their fishery. This is perhaps both an acknowledgement of shared responsibility and recognition that legislative channels are slow to react to the complex dynamics of a mixed fishery.

The greatest complaint from fishermen is the discarding of 'over-quota' fish. Marketable fish cannot be retained on board without sufficient quota for that fish and so must be discarded. In recent years this has been spectacularly illustrated on occasion with large hauls of saithe being discarded as very little quota has been available for this species. By-catch allowances and more flexible quota management by Producer Organisations has meant that there is more opportunity for this type of discard to be avoided. Fishermen catching fish they have no quota for have the choice to:

- discard
- request additional quota for that month from the PO (who take it off next month's allocation)

- purchase or lease additional quota as an individual if available
- land the fish without quota (illegal)

The final choice will be down to quota availability, enforcement levels, the skipper's financial position and his disposition towards breaking the rules. The amount of over-quota fish taken in a haul in volume and value terms will determine the level of risk or financial investment a skipper is willing to commit to.

Discards of low value quota fish while quota is still open (See High grading above)

7.2 Survey responses

In the skipper survey conducted by the consultants during November and December 1999 respondents were asked a number of questions where ranked responses (1 most important, 5 least important) or the proportions of positive responses were assessed. These are presented in the table below divided by the four main vessel types. Figures showing discard levels, a sample questionnaire and the vessels' operational characteristics are presented in Annex IV.

Table 7.1 North Sea Whitefish Vessel - Skipper Responses

Question	inshore	offshore single	offshore twin	pair seine	average for all
Think square mesh panels a good idea	85%	72%	61%	80%	75%
Discarding over the last 10 years: increased	15%	36%	42%	63%	39%
same	30%	50%	13%	25%	30%
decreased	40%	14%	42%	12%	27%
Think current levels of discarding too high	7%	43%	35%	38%	31%
Proportion by weight of haul is discarded	37%	17%	22%	25%	25%
Commercial species making up discards	53%	79%	60%	71%	66%
Main reasons for discarding:					
Below Minimum Landing Size	1	2	1	1	1
Damaged fish	3	3	3	4	3
Above MLS but below marketable size	4	4	4	5	4
Enforcement of quota restrictions	5	4	3	3	4
Market price for fish	4	4	4	4	4
Price of quota	5	4	4	4	4
Storage space availability	5	4	4	5	5
Length of trip time remaining	5	4	4	5	5
Handling effort by crew	5	4	4	5	5
Occasionally highgrade	0%	43%	52%	75%	43%
Reasons for problem of discarding:					
gear selectivity	40%	49%	42%	50%	45%
Too much effort (mainly due to twin-rigging)	30%	36%	10%	0	19%
quota system	20%	0	10%	10%	10%

Source: Nautilus Consultants survey

A high degree of consistency within the fleet subgroups was found in the responses given. One area where no consensus is evident was in answering whether the amount of discarding had increased in the last 10 years.

Interviewees were prompted for their overall assessment of discard levels for the fishery they operate in, but many could only refer to their own operation and still struggled to estimate discard levels for their own vessel. Such responses are indicative of the fact that average discard levels are difficult to assess, as catch composition per haul is highly variable. There is also the suggestion that in the last 10 years high-grading has become more prevalent with maximising returns on quota increasingly prevalent. In recent years, however, low stock levels have resulted in less high-grading

The skippers were asked if they know of any fishing grounds where discarding is higher than average (a greater proportion of juvenile fish). The following grounds were mentioned by several skippers as areas where there are comparatively higher discard levels either all year or at certain times of the year:

- The Jungle (50-60 miles NNE of Peterhead)
- The Skate Hole (50-60 miles NE of Fraserburgh)
- Aberdeen Bank (30 miles SE of Aberdeen)
- Grave Yard (Prawn grounds north of Whitby)
- And also: Just east of Fair Isle, Cupton Field, Turbot Bank, Sandy Riggles

The proportion of commercial species contributing to discards is 66 per cent averaged over the fleet. Closer examination of the information supplied suggests the vast majority of these commercial species are undersized fish. As the tables in annex I show, 98 per cent of discarded cod, 87 per cent of haddock and 97 per cent of whiting discarded are undersized.

Table 7.2 shows that the skippers surveyed are in broad agreement on how best to tackle the problem of discarding. Respondents are overwhelmingly in favour of increased gear selectivity to reduce the capture of undersized fish.

Closed areas are also seen as beneficial by the skippers, though to a lesser degree, with many including the proviso that closed areas should be based on consultation and sound scientific judgement. Fixed closed areas are seen as a more enforceable solution than flexible closed areas.

The support for reduced effort was often in the form of days at sea, rather than fleet cuts along with numerous calls for a ban on twin-rigging from the other segments.

Table 7.2 Proportions of positive skipper responses to management options

Management options	inshore	offshore single	offshore twin	pair seine	average for all
Increase gear selectivity	70	93	74	75	78
Discards ban –all deducted from quota	0	0	0	0	0
Discards ban – with penalties equal to value	0	0	3	0	1
Fixed Closed Areas	40	79	68	63	63
Flexible Closed Areas	40	79	65	38	56
Increased enforcement	30	29	16	25	25
Roll-over quota (year to year)	60	43	65	50	55
Multi-species quota	30	7	35	38	28
Multi-annual quota	10	0	32	50	23
Reduced effort	70	36	61	88	64

Source: Nautilus Consultants survey

7.3 Policy-makers perceptions of the discards problem

Although the incomes of policy makers are not impacted upon directly by discarding, their decision-making is affected by it. Fishery managers gather information from a number of sources in order to propose adequate and enforceable regulations for the fishermen prosecuting the fishery. At present the lack of accurate data on discarding often prevents this important additional variable being considered when the health of stocks is being assessed.

ICES recognises that discarding is a wasteful practice to be avoided, but to a greater extent sees it as a hindrance to developing accurate stock models, and therefore a hindrance to achieving a sustainable fishery.

The perceptions of the discards problem by both fishermen and other stakeholders such as fisheries scientists, managers and policy makers are important factors that will influence the policies developed and the effectiveness of such policies. The recent support for increasing gear selectivity through the introduction of 90mm square mesh panels from the fishing industry organisations themselves points towards better decision-making through improved dialogue by those developing policies intended to reduce discards.

Discard experiences in other fisheries

The following section presents brief overviews of the other case studies conducted as part of this study. The case studies include the Dutch Beam Trawl Fishery and the French *Nephrops* Fishery using the same methodology as this investigation into the UK whitefish trawl fishery.

A case study on experiences of tackling discarding in Norwegian fisheries is also presented based on a fact-finding visit to Norway and interviews with stakeholders. A discard ban has been operating in certain Norwegian fisheries in recent years and it is this ban and the associated regulatory framework in particular that is addressed by the consultants.

The case studies are summarised in Table 8.1 along with experiences in other countries relating to discarding and discard bans in fisheries including Canada, USA, Namibia, Iceland, New Zealand and Australia. Full accounts can be found in the European Commission report 97/SE/018 carried out by the consultants.

8.1 The Dutch Beam Trawl Fishery

8.1.1 The fishery

The Dutch beam trawl fishery for flatfish is mainly directed at sole and plaice. In 1998 the flatfish beam trawler fleet consisted of 204 boats with a total tonnage of 71,400 GT and a total engine power of 273,600 kW. In addition, part of the shrimper fleet is seasonally fishing for flatfish.

Total landings in 1998 amounted to 70,100 t with a total value of € 230 million. The target species plaice and sole contributed nearly two thirds to the volume and more than three quarters to the value. Commercial by-catches consist mainly of other flatfish species (turbot, brill, dab, flounder) and cod and whiting.

The North Sea plaice stock has been below minimum biologically acceptable level (MBAL) since the early nineties; the fishing mortality should be reduced from 0.35 (in '98) to 0.30 to become consistent with the precautionary approach. The sole stock is above MBAL, but for a precautionary approach the fishing mortality should be reduced from 0.54 to 0.40.

8.1.2 The discard problem

The main discard problem of the beam-trawl fishery is the large scale discarding of undersized plaice, partly due to the different physical characteristics of the target species, plaice and sole. Even with the general minimum mesh size of 100 mm for trawling in the North Sea, significant discarding of undersized plaice can occur, as this mesh size is not related to the minimum landing size of plaice (retained by the industry as 27 cm). When fishing for sole south of 55°N with 80 mm mesh the problem is even more widespread, but to catch the minimum size of sole (24 cm), the mesh size would preferably be even smaller than 80 mm. High-grading of marketable fish is not a very big issue in the flatfish fishery.

From an ecological point of view the beam trawl fishery is criticised due to the extensive discarding of benthic species like crabs, starfish, worms and the direct damage to the benthic environment caused by the gear. A reduction of the discards of benthic species would require rigorous changes in the fishing method.

8.1.3 The economics of discarding

The value of discards of marketable species in the Dutch beam trawl fisheries is estimated at about € 160 million, 70% of the annual landings value of the fishery). This is based on the estimate of the volume of discards by the Dutch Institute for Fisheries Research (Van Beek, 98), derived from data collected on 51 commercial fishing trips during the period 1976-1990. The estimate should be seen as an upper limit, as several changes have occurred since the measurement period. The increase of minimum mesh size from 75 mm to 80 mm for sole and 100 mm for plaice, the development of markets for low-value species and the introduction of the plaice box are factors that may have caused a decrease of discarding.

Interviews with fishermen also indicate a decrease of discards during the last decade. This concerns particularly discards of low value non-quota species like dab, flounder, pout and grey gurnard. On average, Eurocutter fishermen estimate total discards at 57% of the total catch weight and those operating larger beamers at 45%. Discards of commercial species are estimated at about 25% of total catch weight by both groups of fishermen.

Incentives for discarding of small plaice above minimum size are dependent on how restrictive quota is and market prices. In some periods the incentive for discarding the smallest size-class of plaice is positive, particularly when the price differential between low grades and high grades is high and when the plaice quota is more restrictive than the sole quota. The incentives for discarding low value species like pout and grey gurnard tend to be negative. This is in accordance with the results of the interviews, indicating that discards of low value non-quota species have significantly diminished during the last decades. The incentives for high-grading of cod and whiting tend to be positive in case of restrictive (by-catch) quota. The interviewed fishermen pointed out that large amounts of whiting were discarded during the time of the interviews (early 2000).

8.1.4 The role of regulations

When fishing for sole with the minimum allowed mesh size of 80 mm, discarding of large numbers of undersized plaice is unavoidable. The mesh size allows a higher fraction of sole above minimum landing size (24 cm) than usual to escape. This induces fishermen to use liners, resulting in even more plaice discards and in additional discards of undersized sole.

The mesh size for fishing for sole (80 mm) is allowed with limitations to the amount of by-catch. With the old regulations, the narrow restrictions occasionally led to discarding of good, marketable fish (cod in particular), but the new by-catch regulation has relaxed the amount of permissible by-catch, thus reducing the necessity to discard such by-catch.

The closure of the plaice box for the larger beamtrawlers has not resulted in better catches of plaice or a recovery of the plaice stock to above MBAL. This could (partly) be due to the high discard rates of the small beam trawlers and the shrimpers, which are still active in this area. In the interviews, fishermen said that the German Bight is notorious for high discard rates of undersized plaice, not only from Eurocutters fishing within the plaice box, but also from the larger beamers frequenting the grounds along the borders.

High-grading of plaice and whiting is directly connected with the individual quota system. This gives fishermen an incentive to maximise the value from their quota and consequently may under some conditions induce discarding of low-value grades.

Until recently, the days-at-sea allocations for Dutch beam trawlers have not been restrictive, but now effort is being further restricted by the MAGP IV targets. These further restrictions of fishing time will reduce the possibilities for high-grading.

8.1.5 Options for improvement and opinions of fishermen

Beam trawl fishermen accept a certain level of discarding as being part of their trade, but they are concerned about exceptionally high levels of discarding of juvenile fish. Fishing with larger mesh size is not a solution for the discard problems in the sole fishery. Too much marketable sole would be lost, probably leading to an increase in illegal fishing with liners.

Closed area policies are not very popular with Dutch fishermen. Fixed closed areas are rejected, with fishermen referring to the disappointing effects of the plaice box. Some fishers are in favour of a flexible closed area policy in order to protect juveniles, but most fear that closed areas will not be reopened.

None of the interviewed Dutch fishermen is in favour of a discard ban. They feel that it would not solve anything to land non-marketable fish. Besides, as they feel that a large proportion of the discards survive, the option of a discard ban is seen as a waste because the survival rate will be reduced to zero.

Some fishermen think that multi-annual quota would possibly reduce discarding as this option would increase their flexibility with respect to the distribution of landings over time. Reduction of effort is recognised by all fishermen as an effective solution to reduce discarding, but most of them feel that this would also lower their revenues. They state that they need the present number of fishing days to catch their quota.

Extensive research into adaptations of beam trawls and alternative fishing methods has not led to good (ready for use) alternatives for conventional beam trawling so far. Electrical beam trawling is one of the more promising alternatives, but it requires more research and testing.

A reduction of the quota for sole would reduce the incentives for fishing with liners and might even give incentives to fish with larger meshes, reducing catches and discards of undersized plaice. A small increase of the sole MLS is probably impractical for market reasons, as it would exclude a very marketable category and thus give rise to illegal landings.

Fishermen and their organisations have stressed that the planned reduction of the MLS for plaice to 22 cm is not a solution for the extensive discarding of undersized plaice. They want to maintain the 27 cm minimum size and do not intend to land plaice below at minimum 25 cm, because they fear a decrease of prices for all size-classes.

8.2 French *Nephrops* Fishery

8.2.1 The Fishery

The French *Nephrops* fishery is composed of two activities: a coastal fleet of 132 boats which operates in the bay of Biscay Villa and an offshore fleet of 98 fishing boats which mainly operates in the Celtic Sea. These boats are nearly all located in South Brittany in an area called the Pays Bigouden.

The coastal boat activity is done on a daily fishing trip basis whereas the offshore fleet operates on a two week fishing trip basis. The fishing strategies and adaptability of these fleets are quite different. Since 1998, the twin rig trawl is widely used by the

offshore trawlers. Due to the characteristics of the fishing gear, the differences between a single rig and a twin rig trawler have changed the type of fishing strategy within the offshore fleet. Twin riggers are more dedicated to target *Nephrops* all the year long whereas the single riggers tend to target demersal species during the lowest *Nephrops* season (September- February).

The landings by the *Nephrops* fleet are around 20,000 tons per year of which 4,000 tones is *Nephrops*, but it is difficult to precisely attribute landings to specific segments of the fleet. The total value of the landings in the fishing harbour of the Pays Bigouden is around € 200 Min 1999, of which nearly half is from the *Nephrops* fleets.

The fishery is a multi-species fishery pattern. In the Celtic Sea, the state of the stock is worrying for *Nephrops*, whiting and cod but not for megrim. In the Bay of Biscay, the situation is considered fairly bad for hake and some doubts remain on the *Nephrops* stock.

8.2.2 Discard Issues

It is difficult to develop a clear picture of the current discards situation. There are differences between scientific assessments and there have also been recent evolutions in regulatory & fishing operations: implementation of new conservatory measures since the 1st January 2000 and the slight modifications of the type of fishing in the Celtic sea since 1998 with the spreading of the twin rig trawls.

The fishermen's perceptions of average levels of discarding are quite different to the results of the most recent scientific surveys of 1997. The range of the discards rates varies between 20 to 45% according to the species and to the season.

On the basis of IFREMER evaluation, it appears that the average amount of discards in 1997 was around 14,000 tons for the coastal fishery and 13,600 tons for the offshore fleets. The main species discarded in weight in the coastal area is horse mackerel, and blue whiting with around 2,500 to 3,000 tons per year. The main species in weight for the offshore area is whiting with 8,800 tons per year and secondly *Nephrops* with 1,380 tons per year. The level of discarding for the target species, *Nephrops*, is rather high, as it represents around 50% of the landings and 30% of the catches.

8.2.3 The Economics of Discarding

It is estimated by Cofrépêche that the economic value of discards in this fishery is around €11.7 M for the coastal fleet and €31.5 M for the offshore fleet. Put together, these values represent around €43 M - nearly the same amount as the value of the *Nephrops* sold under the Pays Bigouden auctions.

The fish (horse mackerel, blue whiting, squat lobster, pout) discarded in the bay of Biscay do not have any value at the markets landed to and the reason for discarding is approaching the situation of non commercial species. The *Nephrops* discarded in this area are mainly under the Minimum Landing Size (MLS) which could be explained by a problem on the selectivity of the gear. The discards have diminished during the last years, due to the increase of the minimum mesh sizes.

The Celtic Sea discards can be classified between discards for high-grading reasons (*Nephrops*, whiting, megrim, hake), discards for undersized fishes (cod) and discards of species with no local market value (haddock). The high grading is linked to a situation of low value species and for whiting due to quota restriction.

8.2.4 Regulatory impacts and future options

The main regulatory impact is linked to the MLS of *Nephrops* in the Celtic Sea given by the French PO which is stricter than the European MLS. This regulation induces some discards through high-grading.

Square mesh panels are found to be ineffective in the Bay of Biscay due to the behaviour of hake. But they are effective in the Celtic Sea, especially on whiting. It has to be noted that none of the fishermen interviewed were using square mesh panel, either in the Bay of Biscay or in the Celtic Sea. As whiting is one of the more discarded species in the Celtic Sea by the French *Nephrops* fleet, some information could be provided to the fishermen to encourage them to use this selective device. This information should be quite pragmatic and should contain some information on short-term effects on the profitability of the fishing boat.

Other than the square mesh panel in the Celtic Sea, there is no gear available that is more selective. A Norwegian company has developed a new grid (NETRASEL) especially for *Nephrops*. This device has not been tested yet in France.

Market aspects seem to play an important role in the incentive to discard in the majority of the cases. The evolution of the markets and an increase of the prices may play more in favour of lowest grades. But this evolution will also play on higher grades except if their abundance decreases. The question of discards for high - grading reasons is directly linked to the abundance of the highest value species or grades.

The storage capacity onboard is also an important parameter, but is difficult to take into account in an economic analysis. For Celtic Sea discards because of low value species or grade, the solution is not easy to implement. The question of onboard cold storage capacity is directly linked with the size of the boat and MAGP structural questions.

Discards other than *Nephrops* in the Bay of Biscay are mainly due to them being non commercial species. Here, the solution appears to be in the creation of local (at the landing point) markets for the commercial species currently discarded. Some recent improvements have to be noted in the commercialisation of squat lobster.

The quota system does not seem to be a major contributor to the discarding occurring in this fishery. For *Nephrops* in the Celtic Sea, the recommendation of the PO is not so much linked to a question of fulfilling the quota with the more valuable fishes, rather it is more a question of price sensibility. Whiting is perhaps the only species, which induces high-grading for quota reasons. High-grading between all the species, which could be linked to the onboard storage capacity, is a question of the various market prices for each grade/species.

8.2.5 Opinions on possible changes

The fishermen perceive the problem of discards to be less important now than in previous years, due mainly to decreasing bycatches. This decrease might have two reasons: the improvement of the fishing gear selectivity due to an increase in mesh size, and perhaps a decrease in stock abundance.

Fishermen try to diminish the level of bycatch at sea as it induces some extra work in sorting the fish. They explain their motivation to discard as a respectful approach to the European and PO measures. The approach to high-grading is more to do with fishermen keeping up to date with market prices.

Fishermen are quite reluctant to use selective devices, and there is a lack of information on the direct and short-term effects on the yields. The restriction of the use of selective device is not so much the costs of investment but more the costs of using it (short-term economical loss). The maintenance and operational difficulties of the device and the relative fragility it induces in the fishing gear also contribute to a negative perception.

The introduction of regulations aiming to include the discards in the TAC or to ban discards of quota species altogether is not supported by the industry. The introduction of fixed or flexible closed areas is also not very popular, especially for the coastal fleet which does not have the ability to shift easily from one area to another. Quota management over multiple years could be interesting but is seen as quite difficult to implement. All fishermen are in favour of a more regional approach and the enhancement of economic value of species and grades now discarded, some of an enhancement of fishing gear selectivity.

8.3 Norwegian management policy and practice

8.3.1 The Fishery

Much of Norway's 2.2 million km² EEZ is highly productive, resulting in annual catch levels of 2.5 to 3 million tonnes. Consequently fisheries is Norway's third biggest export (after oil and gas extraction) making up 7 per cent of Norway's total export of goods. In the county of Finnmark, in the far north, fishing accounts for as much as 75 per cent of all income for small communities.

Around 90 per cent of Norwegian caught and farmed fish is exported. The total first-hand sale of fish in 1997 was valued at 9.1 billion NOK (€ 1.13 billion). Most of the fish is processed to an extent before being exported, resulting in fisheries exports being valued at 24.6 billion NOK (€ 3.05 billion) in 1997. Almost half of all processors are involved in the production of salted or dried cod.

The most important species in Norwegian fisheries is cod (*Gadus morhua*), accounting for 32 per cent of total landings by value in 1998. The Norwegians differentiate between migrating pelagic cod and resident coastal cod. Around 70 per cent of the total Norwegian cod quota is allotted to the coastal fleet. The larger Norwegian vessels hold licences specific to the fishery they prosecute and the method of fishing. In 1997 731 licences were issued for fishing sealing and whaling to 471 offshore vessels.

Herring (*Clupea harengus*) is the most important species by volume; in 1998 it made up 29 per cent of landings. Other important species in Norwegian waters include saithe, mackerel, haddock and deep water prawn (*Pandalus borealis*). Commercial fisheries in Norway exploit many other species with national statistics listing the landings of 24 species.

The 62 degrees North line is seen as a suitable delineation between Norwegian fisheries to the North in the Arctic Ocean (Barents Sea and Norwegian Sea) and those to the South in the Northern North Sea. Both the regulations and the enforcement agency, the Coastguard, differentiate between these Northern and Southern areas using the 62°N line.

8.3.2 Regulatory Measures

Norwegian regulations distinguish between coastal fisheries where the coastline is divided into zones allocated to specific fishing methods, and offshore fisheries. Coastal

vessels often use highly selective methods such as longline and gillnet compared to the offshore trawlers. The offshore vessels are therefore subject to a greater proportion of regulation and enforcement.

Control at sea by the Coastguard is the main thrust of MCS activity. The Directorate of Fisheries (DoF) also has vessels with which to place inspectors aboard fishing vessels as part of the surveillance programme in the Barents Sea. The DoF also carries out a lesser amount of shore-based control with assistance from the Sales Organisations (equivalent to EU Producer Organisations).

The principal objectives of Norwegian fisheries policy are:

- obtain a balance between catches and stock renewal, i.e. a sustainable harvesting of the ocean resources in their entirety;
- maintain the pattern of settlement along the coast;
- increase the profitability of the fishing industry;
- secure safe and good jobs for the fisheries population.

To achieve the above, Norway has developed a 'toolbox' of regulations that authorities can implement rapidly to deal with issues in specific fisheries. The two pillars of Norwegian regulations are gear selectivity (to prevent capture of juveniles) and closed areas (to avoid areas with high proportions of juveniles).

Norwegian regulations make it an offence to catch undersized fish rather than land undersized fish. There has therefore been a great deal of effort over many years to increase gear selectivity. This has resulted in the use of 135mm mesh nets for cod trawls and the use of separator grids in both the demersal and prawn fisheries.

The minimum catching size of 47cm for cod in the Barents Sea is larger than the Russian minimum catching size of 42cm in the same area and the North Sea minimum landing size of 35cm.

8.3.3 Discards issues

Discarding of commercially important fish species is prohibited. The ban on discards should, however, be seen in connection with the policies regarding the compelled use of sorting grids, the closed area policies and the obligation to change fishing grounds in case of too many discards in the catch. The main reason for introducing the discards ban was an attempt to make landing statistics resemble catch more closely, providing more accuracy for stock assessment by fisheries scientists.

Fisheries managers discourage fishermen from capturing fish under the minimum catching size in the first place, but capture of juveniles does still occur to a lesser extent. A by-catch of juveniles, as well as of other species, is therefore permitted up to around 15 per cent, but this varies with the fishery. The Coastguard accepts that a discards ban is not completely enforceable and so is never 100 per cent effective. As an incentive not to discard, the authorities have therefore introduced 20 per cent compensation towards the cost of landing fish that would otherwise have been discarded.

There are very few discarding infringements brought to trial. The authorities talk to the captain asking why discarding has occurred. If there is no reasonable excuse then it is reported to the court. The sanctions are then determined by the regional court, which often feels a degree of empathy towards the fishermen. In 1999 only a handful of

cases were heard relating to the discards ban. A normal sanction for illegal discarding is €50,000, but fines are proportional to the quantity discarded.

8.3.4 Regulatory impacts and future options

Recruitment to cod and other demersal stocks, which is considered to be highly temperature dependent, has been poor for several years, slowing the stock's recovery despite tighter controls on fishing activity. The Norwegians have not reached sustainable harvesting levels as yet. Sustainable harvesting year on year requires management to be prompt and based on sound scientific advice. It could therefore be argued that the Norwegians are closer than most as they are able to impose control measures, i.e. closed areas, very quickly in order to ensure as few juveniles are caught as possible. Technical regulations (selective grids) have also been introduced to avoid the capture of juveniles in the first place. The discards ban therefore only contributes to sustainable harvesting indirectly through the improved accuracy of data being used by fisheries scientists in determining sustainable yields the following year.

It is difficult to establish with the data available if Norway is moving closer to more sustainable exploitation levels. An allowable by-catch of juveniles and the inclusion of these fish in an accepted size grade of 'under 1 kg' (with the catch being presented headed) masks the evidence of impacts of control measures. There is, therefore, more flexibility with such allowances than first appears to those not operating within the Norwegian management system.

Although there has been significant contraction in the Norwegian fleet, particularly the numbers of smaller coastal vessels, tonnage has remained stable, overall power has increased and the value of landings has increased steadily in the last 10 years, as has profitability. It is acknowledged that despite progress towards efficient and sustainable harvesting patterns the Norwegian fleet remains over capacity. Additional contraction is expected, but the remaining fleet should be more profitable and sustainable as a result. A number of factors contribute to the maintenance of a viable industry:

- ***A flexible suite of management measures***

A combination of both long and short-term input and output controls is in place. Many were introduced to address specific problems in particular fisheries. The different situations required different combinations of measures, which are regularly amended to adapt to changing situations in the fisheries. The regulatory system has remained flexible to allow for a rapid response to situations in any of Norway's fisheries.

- ***MCS resources to enforce regulations***

The coastguard's visible and highly mobile sea-based MCS operation ensures high levels of compliance with many of the regulations put in place. Frequent boardings and inspections at a moment's notice have resulted in fishermen interviewed stating that '[Fishermen] would not get away with breaking the rules'. The discards ban is, however, more difficult than most to enforce and the coastguard admits 100 per cent compliance cannot be guaranteed even if a full observer programme were put in place.

- ***Co-operation and support from the industry itself***

Industry co-operation has been an essential component in the execution of Norway's fisheries policy. The government has enjoyed continued support from the industry in the measures imposed, despite further quota cuts, due to general agreement on long-term goals. In return the industry has enjoyed increasing influence in the development of fisheries policy, which has proved to be mutually beneficial.

- ***Political will and support***

The importance of fishing to Norway as a whole has ensured continued political and public support. Fisheries issues have a higher priority in Norway than in most other states in the European Economic Area. As a result, government inaction on fisheries matters is not an option and financial support to the industry in times of poor catch is not merely seen by Norwegians as acceptable, but necessary. In recent years the government has gradually been redirecting public monies from direct subsidy to support for marine research and enforcement. Subsidy mechanisms are still in place and with some quotas still being cut it is possible that direct subsidies to the industry could be reintroduced if the fishing industry's financial situation were to deteriorate below acceptable levels. The industry is, however, on the whole becoming more profitable.

8.3.5 Applying similar policies to the European Union

Norwegian fisheries authorities would encourage their counterparts in Europe to bring the CFP into line with Norwegian policy. While the intended long-term goals of Norwegian policy are seen as desirable by all, the short-term consequences are more difficult to deal with.

Norway's regulatory measures required the industry to be given significant financial support throughout the 80's and 90's at a time of poor catches. Although subsidies to the industry have now been reduced in Norway, it would be difficult to start such a programme in Europe in the current anti-subsidy climate.

Most EC Member States do not enjoy as much co-operation from the industry as the Norwegian authorities appear to. This could, however, be a consequence of the current regulatory regime. Changes to that regime, particularly through increased industry consultation could improve the situation.

Norway's cod fisheries and fishermen still enjoy a reputation of comparatively large fish. This tradition has helped the smooth introduction of larger mesh sizes and greater gear selectivity in the fishery. The 'cleaner' (less mixed) fisheries found in the NEZ compared to the North Sea also lend themselves to regulations targeting specific fisheries as they do not impact as much on the exploitation of other fisheries. The argument against greater gear selectivity due to loss of marketable catch is therefore stronger in some European fisheries.

Table 8.1 Comparison of Discarding in a number of case studies

Country	Fishery	Main type of discarding	Ban on discarding	Effective and why?	Future/recent developments
UK	North Sea Whitefish	Undersized fish	No	/	Greater gear selectivity & closed areas
The Netherlands	North Sea Beam Trawl	Undersized and ecosystem	No	/	Electric beam trawl
France	<i>Nephrops</i>	High grading and low value by-catch	No	/	Market development for low value sp.
Norway	Arctic cod	Undersized fish	Yes	Mostly effective. Policies in place to avoid capture of juveniles in first place, some by-catch allowances	20% costs - incentive for landing by-catch
New Zealand	Multi-species coastal	Over quota fish	Yes	Mostly effective. Flexibility permits excessive by-catch with roll-over, quota trade, quota exchange, landing to a processor without payment or penalty	Industry self-regulation through voluntary Code of Conduct
Australia	Prawn trawl	Undersized fish	Yes	Not effective. No technical measures to reduce commercial by-catch. Lack of control and no incentives to land by-catch.	Multi-species approach to TAC calculation for some species
Canada	Atlantic shrimp	Undersized fish	No	/	Considering individual quota rather than TAC in limited time period
Namibia	Single-species offshore	Over-quota fish	Yes	Yes. Heavy control at sea (observer system) and few landing points facilitating port control.	Continued monitoring of effectiveness
USA		Undersized fish and non-commercial by-catch	No	/	Environmentalists lobbying for further restrictions on gear and fishing periods
Iceland	North Atlantic Cod	High-grading	Yes	Partly effective. No control at sea, but by-catch does not use up ind. quota	Considering introduction of days at sea scheme as well as ITQs

Source: Nautilus Consultants

9. Discussion - Solutions to Discard Problems

This section discusses proposed solutions to reducing discards. From the case studies it is apparent that the prevailing types of discarding differ in different fisheries. There is not one single discard problem, but several related to the different reasons for discarding. Different problems require different solutions, although some measures might be suited to solve several problems. In Table 9.1 five types of discard problems are presented and for each of these types some measures are listed that theoretically might contribute to a solution of these problems.

It is recognised that a reduction in effort through a reduced catching capacity will also lead to a reduction in discarding overall.

Table 9.1 Five discard problems and possible solutions

Discard problem	Undersized fish	Over-quota fish	Low value species	High-grading	Non-commercial species
Increase gear selectivity:	•			•	•
Discard ban	•	•	•	•	
Seasonal quota	•				
Fixed closed areas	•				
Flexible closed areas	•				
Roll-over quota		•			
Multi-annual quota		•			
Multi-species quota		•			
Market development			•		
Value-based quota				•	
Size-specific quota				•	
Adjustment / change of fishing gear or method					•

Source: Nautilus Consultants

9.1 Discarding of undersized fish

This is an important problem in each of the cases studied and the predominant factor for discarding in the UK case study. The most obvious category of solutions is increasing selectivity by changing mesh size, type of gear or the fishing method. Much effort has already been made to increase selectivity, but the large amounts of fish still being discarded indicate that more can be done to improve gear selectivity.

In the UK whitefish fishery both authorities and the industry have accepted that stocks, cod in particular, are at a critically low level. The Scottish industry called for tighter technical regulations and in August 2000, 90mm square mesh panels were made mandatory for Scottish vessels.

There are some suggestions that the permitted positioning of the panel up to 12m from the cod end is preventing sufficient juvenile haddock escapees (the reason for the rapid introduction of the regulations). Some fleet segments (in particular coastal seiners) are also complaining that the panels cause excessive loss of marketable catch. Currently, however, with fishermen facing the closure of North Sea fishing grounds for cod in 2001, even greater gear selectivity that would allow the continuation of fishing may well be accepted.

In the Dutch sole fishery a further increase of mesh size does not seem to be acceptable because the losses of marketable sole would become too great. In the

plaice fishery north of 55°N increasing of mesh size is possible and more or less supported by the fishermen.

For different fisheries the minimum mesh size has been increased in recent years. Square mesh size panels and Bycatch Exclusive Devices (BED) such as Nordmore grids have been tested and in some cases introduced, either voluntarily or by regulations. Problems with determining the most appropriate mesh size occur in multi-species fisheries where different species have different MLS. Square mesh panels are not an option for beam trawlers as they don't increase selectivity for flatfish.

Dutch fishermen argue for better enforcement at sea to stop the common practice of fishing with liners (a net within the net) which has the effect of decreasing selectivity. Many fishermen feel that they would like to stop this practice but only if they are sure that others will stop it too. Much effort is now being made with testing the electric beam trawl, which might not only increase selectivity regarding size but also with respect to non-commercial species. This is however still at an experimental stage.

In the French *Nephrops* fishery an increase of mesh size is not a very popular option; fishermen still remember the economic loss from the last increase in mesh size. The problem remains the balance between short-term impact and long term profit.

Theoretically, a discard ban may also contribute to a solution to this type of discard problem as fishermen would improve selectivity themselves to avoid filling quota with small or undersized fish. EU fishermen however are strongly against this measure. Moreover, it seems very difficult to enforce and it will probably not be effective without a range of accompanying measures. The Norwegian discard ban appears to be well accepted by the fishermen but only because other measures prevent them from catching high proportions of undersized fish. The main function of the discard ban is to bring catches more in line with landing statistics.

Seasonal quota might contribute to a solution because the catches of undersized fish fluctuate during the year. Lower quota during the spawning time could reduce the problem. Further research into the seasonal fluctuation of catches of undersized fish in different EU fisheries will be needed to implement such a measure.

A policy of closed areas is also one of the more obvious solutions for this type of discard problem. A fixed closed area policy would concern closing the most sensitive nursery areas. This type of policy is supported by a majority of fishermen in the UK whitefish case but the Dutch beam trawl fishermen and the French *Nephrops* fishermen have a very negative attitude to this type of measure. For the Dutch case this can be explained by the negative experiences with the plaice box. A more sophisticated approach would be the introduction of flexible closed areas following the Norwegian strategy. This would imply close monitoring of the proportion of juveniles caught in each area and closing areas where this proportion exceeds a certain level. When the proportion of discards decreases the area can be reopened for the fishery again. This type of policy, however, requires intensive monitoring by inspection vessels and has in Norway lead to rather high enforcement costs.

9.2 Discarding of over-quota fish

The discarding of over-quota fish is inherent to quota managed multi-species fisheries. The quota for different species will not usually be exhausted at the same time; filling one quota will imply catching over-quota fish of other species which either has to be discarded or is sold on the black market. For most fishermen interviewed in the three EU cases did not consider this type of discarding one of the main problems, although some of them admitted that sometimes over-quota fish is being discarded. A well-publicised example is the occasional capture of large shoals of mature saithe and

subsequent discarding by UK fishermen, which is used by the industry to exemplify the weaknesses of existing regulations.

An adjustment to the quota system may help to alleviate this type of discard: introduction of multi-species quota or multi-annual quota. Both measures have the effect of increasing flexibility and thereby reducing the chances that fishermen will be forced to discard over-quota fish. Multi-annual quota appears to be one of the most preferred policy options for the interviewed Dutch beam trawl fishermen and for the French *Nephrops* fishermen. Multi-species quota were not welcomed by most of the interviewed fishermen as they feel that this would complicate the system too much. A related measure is quota-substitution as applied in Iceland, where quota for different species can be substituted in proportions based on the market prices relations.

Incentives to land over-quota by-catches can be increased by allowing fishermen to sell by-catches on the market and confiscating part of the revenues in such a way that fishermen are just compensated for landing costs (as in New Zealand). This has to be applied very carefully in order to prevent an incentive to target these by-catch species.

9.3 Discarding of low value (non-quota) species

In this situation the costs of landing exceed the costs of discarding. This problem is an important reason for discarding in both the French and Dutch case studies. The most obvious solution for this problem is to try to develop a market for these species. As supplies of high value species diminishes, demand for species of a lower value increases. In time the market and price for these species will improve. This has occurred in The Netherlands for species like dab and flounder. According to the interviewed fishermen, discards of these species have decreased significantly during the last decade.

In the French case, some species could have a market (for example Blue Whiting, Horse Mackerel and Pout), but the value is too low to overcome the costs to reach the market. For these species, questions of both economical value and availability of a commercial outlet at the landing point have to be taken into account. A market for squat lobster is developing and discards may be expected to decrease in the near future.

9.4 High-grading

This is usually, although not necessarily, connected with situations where quota is allocated to individual vessels of fishermen, as these provide fishermen with an incentive to maximise the value of their quota. This incentive may be decreased by creating possibilities for pooling, renting and trading of quota, which leads to a less rigid quota system.

The tradability of quota may also have the opposite effect, however, as fishermen will try to cover quota prices by concentrating on high value catches. High-grading appears to occur in all three EU case studies, although only in the French case study is it currently classified as very important.

Storage capacity is the main high-grading problem in the French case. It plays no role in the Dutch and UK case study. For the targeted species, *Nephrops*, the price differential between the cheapest grade and the more expensive grades is so important that the PO has strengthened the regulation on MLS and thus created a situation of 'compulsory high-grading'. This measure is motivated by the high price-sensitivity for this species.

One type of solution for this problem is adjusting the quota system: size-specific quota or value-based quota. If size specific quota can be enforced effectively, this will take away an important reason for discarding low value grades of quota species. A system of value-based quota by definition takes away the incentive of maximizing the value of the quota catches and replaces it with an incentive to fill the quota at minimal costs (Turner, 1996). The potential problem with this solution is that it may induce fishermen to fill their quota with minimal effort, which might have an adverse effect on catches of juveniles because it may stimulate them to use less selective fishing gear or methods.

Another solution could be the same as for discards of low commercial value: improving economic value of lower grades.

Other measures that might contribute to a solution are reduction of effort and introduction of a ban on discarding. An increase in gear selectivity can also potentially reduce the opportunity to high-grade, as the catch composition should consist of a lower proportion of the lower grades.

9.5 Discards of non-commercial (non-marketable) species

These are a major problem in Dutch beam trawl fishery and to a lesser extent in the French *Nephrops* fishery for which the situation is closer to a 'very low value' species. In The Netherlands this is considered an important problem from the perspective of ecosystem management. Solutions for this problem will have to be found in changes of fishing gear or fishing method. One of the most promising alternatives for the beam trawl fishery is the electric beam trawl, which is still in an experimental stage.

9.6 Norwegian policies

Norwegian fisheries authorities would encourage their counterparts in Europe to bring the CFP into line with Norwegian policy. They stress the importance of introducing a discards ban in EU fisheries. However, from the Norwegian case study it appears that the discard ban is not the central feature of the Norwegian anti-discard policies. The discard ban is to be seen as a capstone for Norwegian policies that are directed to preventing the catch of illegal (undersized and over-quota) fish.

The most important of these policies are the regulations aiming at increasing the selectivity of fishing gear and the flexible closed area policy. The combination of these policies and the mono-species or few-species character of most Norwegian fisheries has led to rather low captures of illegal fish (although there are no clear statistics regarding the landings or discards of illegal fish) and has made it possible to apply a discard ban. Moreover this discard ban allows fishermen to land considerable percentages of illegal fish without sanction.

The main purpose of the Norwegian discard ban is not reducing the level of discards but bringing the landing statistics in line with the actual catches which, of course, is very important for an effective fisheries management.

9.7 Other international experiences

Through the international case studies, summarised in Table 8.1, some relevant facts on the management of discards have to be pointed out. Policy on discards cannot be separated from general fisheries management. It must take into account the existing balance between the different levels of stock exploitation which induce by-catches.

This explains why discards in mono-specific industrial fisheries are more easily managed. These fisheries have one species per area and thus can be adaptable to

limit their by-catch rate. Individual Vessel Quotas (IVQ) or Individual transferable Quotas (ITQ) have shown their efficiency in some of these fisheries.

In the cases where such a management system has been applied to multi-species fisheries it has shown its shortcomings regarding discards. Low value fishes were subjected to high-grading.

Two main solutions can be applied to multi-species fisheries. The first is to have seasonal quotas of a few months so that there is less catching time in which to choose what is captured and retained. Although the opportunity for high-grading is reduced, the economic incentive to do so is not. The intensified fishing pressure within those months rather than spread over the year could also be more damaging in terms of ecosystem discards of non-commercial by-catch.

The second is to have a more global and flexible approach of quota management. More flexible quota management can be accomplished through multi-species quota or quota substitution. Individual quota calculation should then be made on the whole aggregation of fishes caught by one fishery, pondering various species according to their market value. Such a global approach can also be found through flexibility in quota allocation, with allowance of quota exchange or extra hiring.

In cases where by-catches consist of low value species, possibilities for valorisation of these by-catches should be explored. This would lead fishermen to land them. Such a valorisation could also be done through supplying to processing industry.

A ban on discards has been implemented in several countries (New Zealand, Australia, Namibia). These cases show that a discard ban can be implemented if fishermen's profitability is not affected too much. Moreover, its implementation requires a complete control. Thus, a ban is more likely to be effective in the case of single species fisheries, if such a measure has little impact on profitability, or if control is such to enforce the measure whatever the effect on profitability..

In most cases a ban becomes less feasible as control costs are too high. Flexibility in implementation is therefore required, with measures to minimise by-catches introduced simultaneously or prior to the ban. These measures could be an increase in gear selectivity, closed areas or seasons or valorisation of by-catches.

To conclude, discards management as conducted in the international cases, appears to be less easily applicable to most European fisheries, due to the multi-species character of fisheries where discard problems are most severe.

9.8 Considerations for the UK whitefish fishery

A reduction in the level of discards in a fishery is a likely consequence of a reduction in fishing capacity. It is already an objective of European policy to reduce the fishing capacity in the European fleet and this will include reductions in the North Sea whitefish trawler fleet. Below we discuss conditions where discarding can be reduced independent of capacity reductions. The effectiveness of measures to reduce discards will depend on:

- Effect on incentives to reduce unwanted (by)catch (catches for which costs of landing are higher than costs of discarding).
- Effect on costs of landing and costs of discarding.
- Effect on catch per unit of effort and the profitability of fishing.
- Enforcement of measures including industry support

Incentives to reduce unwanted by-catch

For the North Sea whitefish or Nephrops fisheries by-catch is generally of commercial species where the costs of landing are less than the cost of discarding. However, this is not the case for commercial species below the minimum landing size as they cannot be landed legally and there is currently no (albeit illegal) market for these fish.

The economic incentives to discard in the fishery are at the present time outweighed by the regulatory obligation to discard. With the hoped-for improvement in the health of North Sea demersal stocks, the incentive to discard may once again swing towards economic reasons (i.e. highgrading) and new regulations should be assessed as to their impact on economic incentive prior to their introduction.

Recent regulatory changes have attempted to reduce the discarding of undersized flatfish by reducing or removing minimum landing sizes, therefore making it legal to land and sell fish that was previously discarded. This move has, however, been widely condemned by the fishing industry; they see this as a backward step for stock conservation and are retaining the previous MLS regulations for the present.

Costs of landing and costs of discarding

For all the species generally captured in the fishery there is a negative incentive to discard; this should be maintained and not jeopardised by future regulatory changes. This should not be difficult in a fishery where most of the catch is of commercial species and storage space is not a major issue. Greater flexibility in the quota system (roll-over, multi-species, multi-annual) could create an opportunity for less discarding due to a lack of quota. Any such changes need to be looked at carefully as they could cause more problems in enforcement and administratively than they solve in discard reduction.

The strong positive incentive to high-grade should be reduced. At present it is economically advantageous for a vessel to replace fish already caught with larger or better fish that the vessel has just caught or expects to catch. The extra effort (additional costs) required for this high grading, combined with regulatory requirements to enter catches into a vessel's log book at the time of capture, should be such that there is a negative incentive for this practice.

Anecdotal evidence points towards high grading not occurring to the same extent as a few years ago, due mainly to the poor state of the stocks. The increases in quota trading in the fishery suggest that, if stocks recover, high grading could increase in the future as the UK moves closer towards an ITQ system.

Regulations to combat the incentive to high grade are difficult, as the market will pay a better price for bigger or better fish. The market will, however, also pay a better price for fresher fish. Fishermen have reacted to this in recent years through better handling and icing of their catch. It is possible they will also begin to reduce trip length, particularly as a consequence of date-marked boxes from on-board weighing. A reduction in trip length will reduce the opportunity to high grade as vessels catch what they can on the fishing grounds and leave.

Moves to improve the specification of product offered at first hand sale are likely to result in a widening of the price spread achieved for fish of poor, mediocre and good quality. This will provide further price incentives to land fresher fish and thus reduce the propensity to high grade.

The recent increases in fuel prices may also have an impact, but the positive or negative implications of this factor will be dependent on the steaming time to and from

the grounds. A long steaming time will encourage a vessel to stay once there rather than expend more fuel on more trips to port.

A move towards more regionally managed fisheries, and introduction of further constraint on the mobility of vessels between different regional management regimes would, in combination with higher fuel prices, encourage more localised operations. Such regionally managed fisheries would have the security of limited entry, better guaranteeing future income streams and allowing more strategic planning by vessel owners, encouraging a move away from the 'race for fish' mentality.

Catches per unit effort and profitability

In the example above, fishermen are encouraged to increase efficiency to the extent that it is no longer efficient to fish for longer than necessary. An increase in gear selectivity has the opposite effect in the short term, reducing the catch per unit effort of the individual. Fishermen are willing to accept this as a consequence of improved stock conservation, but this is only tolerated to an extent; the profitability of a fishing operation is a greater priority than conservation. Demonstrating that more selective gear leads to improved profitability in the long-term makes new regulations more palatable for the industry, but they must be supported by legislative requirements for such gear in order to ensure adoption by all vessels at the same time.

Enforcement of Measures and Industry Support

The enforcement costs for a particular regulatory measure should be exceeded by the benefit gained by the industry and the wider economy through enforcing that measure. A certain degree of enforcement appears inevitable for a shared resource to prevent individuals gaining short-term benefit from breaking the rules.

The level of enforcement required can be minimised with industry support for regulatory changes. This can only be forthcoming with adequate dialogue between industry and policy-makers prior to formulating any regulations.

The North Sea is at present managed under a heavy regime of regulations, administration and enforcement. It is therefore not surprising that the fishermen favour tangible measures such as gear modifications, closed areas or days at sea as input controls rather than a system of document-related output controls.

In the case study survey it is overwhelmingly apparent that fishermen give the most support to increasing gear selectivity. This is illustrated by recent agreements by industry organisations to increase gear selectivity beyond current mandatory requirements. Such cross-industry agreement is rare and should be supported by policy makers wishing to reduce discard levels while maintaining a viable catching sector.

10. Conclusions and Recommendations

Discard problems

The main discard problem in the cases of the EU fisheries studied is the discarding of undersized fish.

High-grading and discarding of low-value species are, however, also important factors in the French *Nephrops* fishery and the discarding of non-commercial species is an issue in the Dutch beam trawl and French *Nephrops* fishery.

The main anti-discard policies applied in the EU are technical regulations regarding fishing methods and fishing gear, e.g. minimum mesh size and minimum landing size regulations. The possibilities for further increases in mesh size are, however, limited by the multi-species character of most EU fisheries including the North Sea whitefish fishery.

Moreover, enforcement of mesh size and other regulations regarding fishing gear requires effective enforcement at sea. In the Dutch situation, where enforcement is more concentrated on landings, this has, according to the fishermen, resulted in widespread illegal practices to reduce gear selectivity, like fishing with liners. Dutch fishermen therefore ask for more intensive monitoring and enforcement at sea.

Costs of Discarding

In the UK whitefish trawl fishery, the discarding of undersized fish (cod, haddock and whiting) is the predominant reason for discarding. Survey results indicate that over two thirds of the discarded catch consists of commercial species, of which undersized fish account for the vast majority (cod 98%, haddock 87% and whiting 97%). The cost to the fishery and individual vessels is therefore mainly the loss of future income.

The estimated annual cost of discarding in the three case studies varies from approximately 70% of total annual landings value in the Dutch case to 42% in the UK whitefish case¹⁴ and 43% in the French *Nephrops* case.

In the UK North Sea trawl fisheries for cod, haddock and whiting, an estimated £47 million (€75 million) worth of these species was discarded in 1999 (£11m cod, £31m haddock and £5m whiting).

These high discard levels, based on onboard sampling data, are far higher than the £25 million (€40 million) calculated from skipper survey responses. This underestimation by skippers is thought to be due to a number of reasons, including the fact that skippers are in the wheelhouse and unable to see the extent of discarding from each haul.

The high levels of discarding observed in European fisheries contribute to over-exploitation of stocks and to unreliable stock assessments. In the beam trawl fishery discards of non-commercial species are considered by some to be a threat to the ecosystem as a whole.

¹⁴ Value of Discards of cod, haddock and whiting as percentage of the value of landings of these three species

Incentives to discard

For all commercial species considered in the UK case study (cod, haddock, whiting, saithe, *Nephrops*) there is a negative economic incentive to discard and a positive incentive to high-grade.

With additional costs associated with high-grading such as fuel being factored into the calculation, certain lower-value species such as whiting and saithe would show a negative economic incentive to high-grade.

Although the cod fishery shows a strong incentive to high-grade, in the current situation of low stock levels high-grading of cod does not occur as the likelihood of capturing replacement cod of a higher grade is low.

The effects on discarding behaviour of individual transferable quota systems (in the Netherlands and informally in the UK) are ambiguous. Generally the effect is that fishermen tend to concentrate on the high-value grades of the quota species in order to maximize the value of their quota. In a mono-species fishery ITQ's may therefore induce fishermen to use more selective gear and thus avoiding bycatch and discards of juveniles.

In a multi-species fishery, however, ITQ systems may give fishermen incentives to high-grade and to discard over-quota fish, particularly where species have different minimum landing sizes (MLS), as in the North Sea whitefish fishery.

Adjustment of the quota system in the form of introduction of multi-species, size-specific or value based quota, could lower or even take away these incentives. These measures will, however, have other consequences for fisheries management. Multi-species and value-based quota lead to a less fine-tuned fisheries management system, but it can be argued that the present detailed policies are not relative to the degree of accuracy achieved in stock assessments and biological predictions at present.

The ongoing reduction of fishing capacity in EU fisheries will reduce the incentives for high-grading and discarding over-quota fish. It will probably also reduce the discard levels of low-value and non-commercial species as a side-effect of reducing total catches. The effect on discards of juveniles is, however, unclear. On one hand effort reduction will reduce total catches and therefore the total volume of discards. On the other hand, if effort is reduced too much, this may induce fishermen to use less selective gear in order to make sure that they can fill their quota, thus increasing the proportion of juvenile discards.

The methodology developed within this study for determining economic incentives to discard and high-grade provides a simple tool for estimating the potential consequences of proposed policy changes and quantify their impacts once in place.

Management options

Gear Selectivity

78 per cent of UK skippers surveyed, along with the majority of Dutch skippers interviewed, are in favour of increasing gear selectivity for targeting North Sea fisheries.

Further blanket increases to mesh size are not, however, the favoured option for increasing selectivity as too much marketable catch would be lost in multi-species

fisheries. The use of selectivity devices specific to fisheries and the target species within those fisheries is encouraged.

75 per cent of UK skippers interviewed see square mesh panels as a good idea. It is evident, however, that positioning of the panel is critical to its effectiveness in reducing discards of juveniles. Current regulations on positioning in relation to the cod-end are a compromise between effective operation and fishermen's concerns over loss of earnings.

Selectivity devices such as grids, separator trawls and electric beam trawling are being used and developed to reduce discarding in a number of specific European fisheries. up to now there have been very limited investigations into the possible use of these alternatives in a UK context.

Discard Ban

The discards ban was introduced in Norway for greater accuracy in the estimation of fishing mortality for improved stock assessment by fisheries scientists.

A discard ban is difficult to enforce and therefore should only be considered after the application of other measures to minimise discard levels. It therefore cannot be introduced in EU fisheries in the present situation of high discard levels.

99 per cent of UK skippers interviewed are against the introduction of a discard ban, seeing it as unworkable and ineffective in stock conservation.

Closed Areas

The flexible closed area policy appears to have successfully reduced the level of discarding in Norwegian fisheries and could be an option for the EU fisheries management. However, this type of policy requires intensive monitoring of discard levels in the sensitive areas and the costs of enforcement and monitoring may be too high in relation to the revenues of the fisheries in many EU countries.

Norwegian fisheries management including the flexible closed area policies and the discard ban is well supported by the Norwegian fishermen and their organisations. In the UK and wider EU context, monitoring, control and surveillance (MCS) resources and communication between authorities and the industry are inadequate for a workable flexible closed area system.

63 per cent of UK North Sea trawler skippers surveyed see the introduction of fixed closed areas as beneficial; fewer (56%) are in favour of flexible closed areas, as many suggest such a system would be more difficult to operate.

Increased Enforcement

Only 25 per cent of those interviewed saw the benefit of increased enforcement. Some management options such as flexible closed areas would require tighter policing of fishing vessel activities. The costs of any additional enforcement must be carefully reviewed in value for money terms and in the broader European context.

Changes to the Quota System

In most instances of discarding in the UK North Sea whitefish trawl fisheries quota restrictions and their enforcement are not a factor. There are, however, circumstances where, on occasion, large hauls of fish are discarded due to a lack of quota

(particularly saithe). The increased flexibility of the quota system (purchase/lease of quota) should help skippers to gain additional quota to deal with such situations when they arise.

While flexibility in the quota system does allow skippers more freedom to choose whether or not to discard marketable fish, most are against multi-species and multi-annual quota as these are thought to further complicate an already complicated system.

Over half the skippers interviewed are, however, in favour of rollover quota, which could better balance fishing effort around the year-end, losing the need to fill quota at the expense of discards of other species.

Overall

It is evident that discarding remains a problem in many European fisheries including the UK case study examined. Any recovery of North Sea stocks will be slowed, or even prevented, by the continued high levels of discarding of juvenile target species.

The broad range of incentives to discard suggest that it is not possible to adequately tackle discard problems in all fisheries using a single approach.

Tailored workable solutions should be found that address the particular circumstances and motivating factors in each fishery.

Recommendations for the UK North Sea Whitefish Trawl Fishery

Considering possible solutions to excessive discarding of juveniles in the UK North Sea Whitefish fishery in terms of effectiveness, practical application, cost of enforcement and industry acceptance, the following management options are proposed:

Increase gear selectivity,

Initially this should be through

- 1) more widespread use and more effective positioning of square mesh panels for trawlers and
- 2) tighter controls on twine thickness.

Simultaneously, further research should be undertaken to assess how appropriate a range of selectivity devices might be in North Sea context. This should be in addition to the continuing work on the efficiency of square mesh panels.

Introduce fixed closed areas on a seasonal basis

This measure should be adopted in order to protect defined areas in the North Sea known to be spawning and nursery areas for cod and haddock.

Establishing these areas will need to be a delicate balance (in terms of location, extent and permitted activity) between effectiveness and ensuring vessels (particularly coastal vessels with limited range) can remain viable.

The areas to be closed should therefore be defined by a working group consisting of industry, scientists, fishery managers and government.

Greater industry consultation

The fishing industry should be fully integrated into the decision-making process for fisheries policy to ensure better practical knowledge and compliance.

This involvement should be in the form of an advisory group consisting of industry, scientists and government that is able to react quickly and be pro-active in proposing regulatory changes.

Such a group could be a continuation and broadening of the working group proposed above for defining closed areas.

Annex

I. (Relating to Chapter 2 – The Fishery)

Table showing landings from North Sea (Area IV) in 1998 to East Coast UK Ports

II. (Relating to Chapter 4 – Economic Value of Discards)

Graphs showing discard levels from 1999 Skipper survey

Tables of Discard Levels (% of total haul) and proportion below MLS from 1999 Skipper survey

FRS discard data – proportion by weight discarded above MLS

FRS discard data – weight of fish discarded by vessel type, season and fishing area (inshore/offshore)

III. (Relating to Chapter 5- Costs and Benefits of Discarding)

Price Differentials for Grades of Target Species

Calculations of Incentive to Discard

IV. (Relating to Chapter 7 – Perceptions of Stakeholders)

Operational Characteristics of Sample Vessels in Survey

Sample of Survey Questionnaire

V. SERAD Guidance on New Technical Conservation Regulations

Annex I. (Relating to Chapter 2)

Table showing landings from North Sea (Area IV) in 1998 to East Coast UK Ports

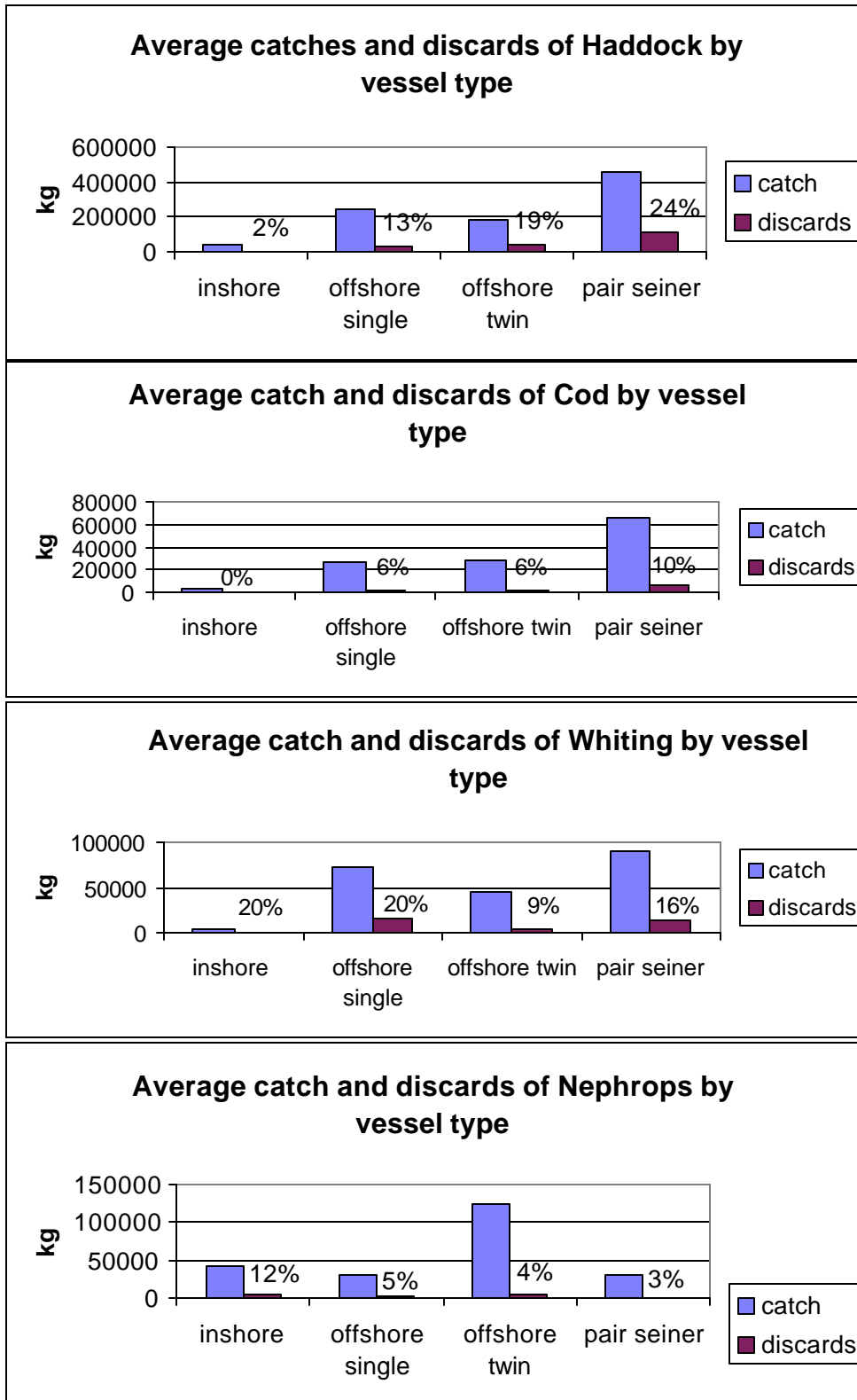
Port / Landing District	Haddock			Cod			Whiting			Saithe			Nephrops		
	quantity tonnes	value £'000	average price per Kg	quantity tonnes	value £'000	average price per Kg	quantity tonnes	value £'000	average price per Kg	quantity tonnes	value £'000	average price per Kg	quantity tonnes	value £'000	average price per Kg
Shetland	3,297	2,648	0.80	2,027	2,685	1.32	1,020	633	0.62	459	238	0.52	67	208	3.10
Orkney	140	136	0.97	76	58	0.76	47	37	0.79	52	38	0.74	6	15	2.57
Wick	3,177	2,687	0.85	2,344	3,428	1.46	942	604	0.64	540	321	0.59	270	509	1.88
Buckie	608	422	0.69	297	391	1.32	185	93	0.50	38	23	0.59	501	924	1.84
Fraserburgh	5,538	3,489	0.63	1,945	2,296	1.18	1,945	784	0.40	299	171	0.57	3,758	8,473	2.25
Peterhead	29,981	23,019	0.77	16,739	21,997	1.31	7,986	4,851	0.61	3,753	2,205	0.59	1,794	4,938	2.75
Aberdeen	12,691	10,810	0.85	6,221	7,938	1.28	2,345	1,543	0.66	1,201	713	0.59	186	589	3.17
Arbroath	147	146	1.00	212	259	1.22	23	11	0.47	57	34	0.60	35	71	2.02
Pittenweem	695	683	0.98	119	110	0.92	52	37	0.72	2	1	0.50	1,343	2,127	1.58
Eyemouth	1,497	1,177	0.79	860	906	1.05	516	300	0.58	24	12	0.50	975	1,837	1.88
North Shields	462	278	0.60	1,173	1,189	1.01	470	173	0.37	8	4	0.50	1,044	1,614	1.55
Amble	314	197	0.63	668	530	0.79	462	179	0.39	1			330	612	1.85
Blythe	257	140	0.54	499	440	0.88	340	128	0.38	6	3	0.50	401	687	1.71
Hartlepool	82	43	0.52	436	406	0.93	119	34	0.29				157	289	1.84
Hull**	1,190	1,229	1.03	12,119	11,928	0.98	8	3	0.38	1,005	506	0.50			
Whitby	620	404	0.65	2,713	2,876	1.06	652	279	0.43	22	9	0.41	1	4	4.00
Scarborough	590	438	0.74	2,783	2,857	1.03	387	155	0.40	23	11	0.48			
Bridlington	247	179	0.72	1,887	1,921	1.02	60	18	0.30	59	31	0.53			
Grimsby	283	294	1.04	2,744	3,350	1.22	112	40	0.36	62	33	0.53	1	2	2.00
Total	61,816	48,418	0.78	55,862	65,564	1.17	17,671	9,903	0.56	7,611	4,353	0.57	10,869	22,898	2.11
North Sea (IV a & IV b)	63,602			50,217			19,506			7,640			11,073		
% of UK North Sea landings	97%			over 100%**			91%			100%			98%		

*operating in ICES areas IV(a) and IV(b)

**landings from freezer trawlers operating further North included (significant impact on cod figures)

Annex II. (Relating to Chapter 4)

Graphs showing discard levels from 1999 Skipper survey



Tables Showing Discard Levels (% of total haul) and proportion below MLS

Inshore

Summer	average % discarded	amount below MLS	Winter	average % discarded	amount below MLS
cod	12	100	cod	12	100
haddock	15	100	haddock	15	100
Nephrops	2		Nephrops	2	
whiting	13	100	whiting	13	100

Offshore single

Summer	average % discarded	amount below MLS	Winter	average % discarded	amount below MLS
cod	5.43	95.6	cod	5.67	96.7
haddock	16.1	75.7	haddock	16.9	82.9
Nephrops	8.1		Nephrops	7.5	
whiting	17	95.5	whiting	17.3	95.5

Offshore twin

Summer	average % discarded	amount below MLS	Winter	average % discarded	amount below MLS
cod	2.5	95.8	cod	3.7	96.0
haddock	13.6	83.6	haddock	13.9	82.0
Nephrops	5.7		Nephrops	5.0	
whiting	9.3	96.1	whiting	10.5	95.7

Pair Seine

Summer	average % discarded	amount below MLS	Winter	average % discarded	amount below MLS
cod	12	99.2	cod	14.4	99
haddock	22.57	86.4	haddock	21.4	82.14
Nephrops	10.0		Nephrops	5.0	
whiting	15.0	100.0	whiting	18.4	92.0

FRS discard data – proportion by weight discarded above MLS

vessel type & season	Cod			haddock			whiting		
	under mls	over mls	% over mls	under mls	over mls	% over mls	under mls	over mls	% over mls
heavy trawl, offshore, winter 1	653	209	24%	2308	465	17%	92	277	75%
heavy trawl, offshore, winter 1b	15	19	56%	1018	439	30%	47	132	74%
heavy trawl, offshore, summer	91	59	39%	880	1447	62%	184	914	83%
heavy trawl, offshore, winter 2	34	25	42%	234	698	75%	184	616	77%
average for heavy trawl	793	312	28%	4440	3049	41%	507	1939	79%
light trawl, offshore, winter 1	2178	874	29%	18790	3727	17%	903	3855	81%
light trawl, offshore, winter 1b	2413	545	18%	11113	7663	41%	4686	4580	49%
light trawl, offshore, summer	1681	235	12%	22604	8084	26%	6807	9562	58%
light trawl, offshore, winter 2	440	211	32%	5770	5061	47%	712	9254	93%
average for light trawl offshore	6712	1865	22%	58277	24535	30%	13108	27251	68%
light trawl, inshore, winter 1	1970	0	0%	5959	2884	33%	340	158	32%
light trawl, inshore, winter 1b	488	45	8%	5372	572	10%	538	381	41%
light trawl, inshore, summer	3306	0	0%	26087	2312	8%	6653	1272	16%
light trawl, inshore, winter 2	325	0	0%	4847	238	5%	1362	8	1%
average for light trawl inshore	6089	45	1%	42265	6006	12%	8893	1819	17%
average for all trawlers	13594	2222	14%	104982	33590	24%	22508	31009	58%

Source: FRS Aberdeen

Cod - level of discards from North Sea Trawlers winter 98 - winter 99

vessel type & season	Numbers of fish			% discarded	Estimated weight			% discarded
	landings	discards	catch		landings	discards	catch	
heavy trawl, offshore, winter 1a	359	250	609	41%	3958	861	4820	18%
heavy trawl, offshore, winter 1b	116	10	126	8%	2021	34	2055	2%
heavy trawl, offshore, winter 1 total	475	260	735	35%	5979	895	6875	13%
heavy trawl, offshore, summer	477	43	519	8%	6592	149	6741	2%
heavy trawl, offshore, winter 2	330	16	346	5%	4470	59	4529	1%
average for heavy trawl	1282	319	1600	20%	17041	1103	18145	6%
light trawl, offshore, winter 1a	1756	848	2604	33%	17217	3052	20269	15%
light trawl, offshore, winter 1b	1057	885	1944	46%	16296	2958	19255	15%
light trawl, offshore, winter 1 total	2813	1733	4548	38%	33513	6010	39524	15%
light trawl, offshore, summer	2380	631	3009	21%	34888	1917	36804	5%
light trawl, offshore, winter 2	1235	185	1420	13%	14997	651	15647	4%
average for light trawl offshore	6428	2549	8977	28%	83398	8578	91975	9%
light trawl, inshore, winter 1a	385	618	1003	62%	2933	1970	4903	40%
light trawl, inshore, winter 1b	162	161	323	50%	1384	533	1918	28%
light trawl, inshore, winter 1 total	547	779	1326	59%	4317	2503	6821	37%
light trawl, inshore, summer	252	1882	2133	88%	2239	3306	5545	60%
light trawl, inshore, winter 2	234	147	381	39%	1656	325	1982	16%
average for light trawl inshore	1033	2808	3840	73%	8212	6134	14348	43%
average discard rates for cod	8743	5676	14417	39%	108651	15815	124468	13%

Source: FRS Aberdeen

Haddock - level of discards from North Sea Trawlers winter 98 - winter 99

vessel type & season	Numbers of fish			% discarded	Estimated weight			% discarded
	landings	discards	catch		landings	discards	catch	
heavy trawl, offshore, winter 1a	1121	1580	2701	58%	4640	2773	7412	37%
heavy trawl, offshore, winter 1b	789	887	1676	53%	3657	1458	5115	29%
heavy trawl, offshore, winter 1 total	1910	2467	4377	56%	8297	4231	12527	34%
heavy trawl, offshore, summer	1973	1095	3068	36%	8730	2327	11055	21%
heavy trawl, offshore, winter 2	1349	372	1723	22%	6124	932	7055	13%
average for heavy trawl	5232	3934	9168	43%	23151	7490	30637	24%
light trawl, offshore, winter 1a	7429	12873	20303	63%	30444	22517	52961	43%
light trawl, offshore, winter 1b	6764	9019	15782	57%	27115	18776	45889	41%
light trawl, offshore, winter 1 total	14193	21892	36085	61%	57559	41293	98850	42%
light trawl, offshore, summer	15023	15564	30588	51%	57986	30688	88675	35%
light trawl, offshore, winter 2	7146	2202	11791	19%	28549	10831	39379	28%
average for light trawl offshore	36362	39658	78464	51%	144094	82812	226904	36%
light trawl, inshore, winter 1a	3856	4315	8171	53%	14407	8843	23250	38%
light trawl, inshore, winter 1b	2692	3233	5925	55%	8874	5934	14818	40%
light trawl, inshore, winter 1 total	6548	7548	14096	54%	23281	14777	38068	39%
light trawl, inshore, summer	3632	20759	24392	85%	11902	28398	40301	70%
light trawl, inshore, winter 2	2042	3854	5896	65%	7398	5086	12484	41%
average for light trawl inshore	12222	32161	44384	72%	42581	48261	90853	53%
Average discard rates for haddock	53816	75753	132016	57%	209826	138563	348394	40%

Source: FRS Aberdeen

Whiting - level of discards from North Sea Trawlers winter 98 - winter 99

vessel type & season	Numbers of fish			% discarded	Estimated weight			% discarded
	landings	discards	catch		landings	discards	catch	
heavy trawl, offshore, winter 1a	417	213	629	34%	927	368	1294	28%
heavy trawl, offshore, winter 1b	248	107	356	30%	733	178	912	20%
heavy trawl, offshore, winter 1 total	665	320	985	32%	1660	546	2206	25%
heavy trawl, offshore, summer	566	593	1161	51%	1332	1098	2432	45%
heavy trawl, offshore, winter 2	645	453	1097	41%	1467	801	2267	35%
average heavy trawl	1876	1366	3243	42%	4459	2445	6905	35%
light trawl, offshore, winter 1a	4307	2521	6830	37%	10937	4758	15695	30%
light trawl, offshore, winter 1b	248	107	356	30%	733	178	912	20%
light trawl, offshore, winter 1 total	4555	2628	7186	37%	11670	4936	16607	30%
light trawl, offshore, summer	566	593	1161	51%	1332	1098	2432	45%
light trawl, offshore, winter 2	6576	4935	11511	43%	15966	9967	25933	38%
average light trawl offshore	11697	8156	19853	41%	28968	16001	44972	36%
light trawl, inshore, winter 1a	1919	417	2337	18%	4469	499	4966	10%
light trawl, inshore, winter 1b	1008	748	1756	43%	2519	920	3438	27%
light trawl, inshore, winter 1 total	2927	1165	4093	28%	6988	1419	8404	17%
light trawl, inshore, summer	2269	10490	12758	82%	4172	7925	12097	66%
light trawl, inshore, winter 2	1326	2195	3520	62%	3465	1371	4836	28%
average light trawl inshore	6522	13850	20371	68%	14625	10715	25337	42%
average discard rates for whiting	20095	23372	43472	54%	48052	29161	77214	38%

Source: FRS Aberdeen

Annex III. (Relating to Chapter 5)

Price Differentials for Grades of Target Species

species	size	volume (st wght)	proportion	price/tonne
Anglerfish (Monks)	1	392	11%	3,405
Anglerfish (Monks)	2	751	21%	3,332
Anglerfish (Monks)	3	1,389	40%	3,249
Anglerfish (Monks)	4	685	20%	2,961
Anglerfish (Monks)	5	294	8%	2,324
Total		3,511		11,061,255

av. Price/kg = 3.151

species	size	volume (st wght)	proportion	price/tonn ^e
Nephrops (Norway Lobster)	1	57	1%	4,351
Nephrops (Norway Lobster)	2	937	23%	2,946
Nephrops (Norway Lobster)	3	2,561	62%	2,209
Nephrops (Norway Lobster)	4	557	14%	1,595
Total		4,112		9,554,313

av. Price/kg = 2.323

species	size	volume (st wght)	proportion	price/tonne
Cod	1	1,105	8%	1,957
Cod	2	2,553	18%	1,863
Cod	3	2,872	20%	1,527
Cod	4	2,712	19%	1,274
Cod	5	5,008	35%	1,004
Total		14,250		19,789,716

av. Price/kg = 1.389

species	size	volume (st wght)	proportion	price/tonn ^e
Saithe (Coalfish)	1	97	5%	729
Saithe (Coalfish)	2	155	9%	692
Saithe (Coalfish)	3	503	28%	673
Saithe (Coalfish)	4	1,044	58%	591
Total		1,800		1,134,601

av. Price/kg = 0.630

species	size	volume (st wght)	proportion	price/tonne
Haddock	1	461	2%	1,508
Haddock	2	1,994	7%	1,281
Haddock	3	7,574	27%	978
Haddock	4	18,499	65%	694
Total		28,527		23,492,250

av. Price/kg = 0.824

species	size	volume (st wght)	proportion	price/tonn ^e
Whiting	1	14	0%	931
Whiting	2	219	3%	919
Whiting	3	521	7%	750
Whiting	4	6,274	89%	543
Total		7,028		4,012,954

av. Price/kg = 0.571

species	size	volume (st wght)	proportion	price/kg
Megrims	1	163	19%	1,847
Megrims	2	246	29%	1,264
Megrims	3	338	40%	1,114
Megrims	4	93	11%	984
Total		840		1,079,659

av. Price/kg = 1.286

Calculations of Incentive to Discard

Table 5.1. Haddock						
Incentive to discard	Discarding			High grading*		
	haddock			haddock		
Gross revenues (£'000)**	48,418			48,418		
Average gross revenues per trip	1,424 av. 34 trips - 7 days			1,424 av. 34 trips - 7 days		
Catches per year (tonnes)	61,816			61,816		
Costs depending on quantity or value of landings						
	% of total income			% of total income		
commission	2,276	4.7		2,276	4.7	
harbour dues	1,888	3.9		1,888	3.9	
subscriptions and levies	387.34	0.8		387.34	0.8	
shore labour	1,065	2.2		1,065	2.2	
boxes	726	1.5		726	1.5	
fuel	3,922	8.1		3,922	8.1	
Ice costs	532.60	1.1		532.60	1.1	
other	726.27	1.5		726.27	1.5	
subtotal	10,797	23.8		10,797	23.8	
	haddock	% of price £/kg		haddock	% of price £/kg	
market price=costs of discarding	0.69		0.694	0.69		0.694
Price alternative fish				0.824		
Cost of Extra effort				0		
Costs of landing alternative fish	-			0.17		
Costs of discarding	0.69			0.04		
commission	0.033	4.7		0.033	4.7	
harbour dues	0.027	3.9		0.027	3.9	
subscriptions and levies	0.006	0.8		0.006	0.8	
shore labour	0.015	2.2		0.015	2.2	
boxes	0.010	1.5	0.010	0.010	1.5	0.010
fuel	0.056	8.1	0.056	0.056	8.1	0.056
Ice costs	0.008	1.1	0.008	0.008	1.1	0.008
other	0.010	1.5		0.010	1.5	
Costs of landing	0.165	23.8	0.074	0.165	23.8	0.074
net price (costs of discarding - costs of landing)	0.529			- 0.129		
Inc to discard	- 0.529			0.129		
Gross profit / kg						
Gross Revenues / kg	0.78326			0.78326		
Rel inc to discard	- 0.68			0.17		

Average prices for North Sea ports from July to December 1998 used

* Assumes no additional costs for extra effort required

** Quantity and value of species landed by UK in 1998 (UK sea fisheries statistics)

Table 5.2. Cod						
Incentive to discard	Discarding			High grading*		
	cod			cod		
Gross revenues (£'000)**	65,564			65,564		
Average gross revenues per trip	1,928 av. 34 trips - 7 days			1,928 av. 34 trips - 7 days		
Catches per year (tonnes)	55,862			55,862		
Costs depending on quantity or value of landings						
	% of total income			% of total income		
commission	3,082	4.7		3,082	4.7	
harbour dues	2,557	3.9		2,557	3.9	
subscriptions and levies	524.51	0.8		524.51	0.8	
shore labour	1,442	2.2		1,442	2.2	
boxes	983	1.5		983	1.5	
fuel	5,311	8.1		5,311	8.1	
Ice costs	721.20	1.1		721.20	1.1	
other	983.46	1.5		983.46	1.5	
subtotal	14,621	23.8		14,621	23.8	
	cod		% of price £/kg		cod	
market price=costs of discarding	1.004		1.004		1.004	1.004
Price alternative fish	0				1.389	
Cost of Extra effort					0.24	
Costs of landing alternative fish					-	0.14
Costs of discarding	1.00					
commission	0.047	4.7		0.047	4.7	
harbour dues	0.039	3.9		0.039	3.9	
subscriptions and levies	0.008	0.8		0.008	0.8	
shore labour	0.022	2.2		0.022	2.2	
boxes	0.015	1.5	0.015	0.015	1.5	0.015
fuel	0.081	8.1	0.081	0.081	8.1	0.081
Ice costs	0.011	1.1	0.011	0.011	1.1	0.011
other	0.015	1.5		0.015	1.5	
Costs of landing	0.239	23.8	0.107	0.239		0.107
net price (costs of discarding - costs of landing)	0.765			-	0.384	
Inc to discard	- 0.765			0.384		
Gross profit / kg						
Gross Revenues / kg	1.17368			1.17368		
Rel inc to discard	- 0.65			0.33		

Average prices for North Sea ports from July to December 1998 used

* Assumes no additional costs for extra effort required

** Quantity and value of species landed by UK in 1998 (UK sea fisheries statistics)

Table 5.3 Whiting					
Incentive to discard	Discarding			High grading*	
	whiting			whiting	
Gross revenues (£'000)**	9,903			9,903	
Average gross revenues per trip	291 av. 34 trips - 7 days			291 av. 34 trips - 7 days	
Catches per year (tonnes)	17,671			17,671	
Costs depending on quantity or value of landings					
	% of total income			% of total income	
commission	465	4.7		465	4.7
harbour dues	386	3.9		386	3.9
subscriptions and levies	79.22	0.8		79.22	0.8
shore labour	218	2.2		218	2.2
boxes	149	1.5		149	1.5
fuel	802	8.1		802	8.1
Ice costs	108.93	1.1		108.93	1.1
other	148.55	1.5		148.55	1.5
subtotal	2,208	23.8		2,208	23.8
	whiting	% of price	£/kg	whiting	% of price
market price=costs of discarding	0.543		0.543	0.543	0.543
Price alternative fish				0.571	
Cost of Extra effort					
Costs of landing alternative fish				0.13	
Costs of discarding	0.54			0.10	
commission	0.026	4.7		0.026	4.7
harbour dues	0.021	3.9		0.021	3.9
subscriptions and levies	0.004	0.8		0.004	0.8
shore labour	0.012	2.2		0.012	2.2
boxes	0.008	1.5	0.008	0.008	1.5
fuel	0.044	8.1	0.044	0.044	8.1
Ice costs	0.006	1.1	0.006	0.006	1.1
other	0.008	1.5		0.008	1.5
Costs of landing	0.129		0.058	0.129	0.058
net price (costs of discarding - costs of landing)	0.414			- 0.028	
Inc to discard	- 0.414			0.028	
Gross profit / kg					
Gross Revenues / kg	0.56041			0.56041	
Rel inc to discard	- 0.74			0.05	

Average prices for North Sea ports from July to December 1998 used

* Assumes no additional costs for extra effort required

** Quantity and value of species landed by UK in 1998 (UK sea fisheries statistics)

Table 5.4 Saithe						
Incentive to discard	Discarding			High grading*		
	saithe			saithe		
Gross revenues (£'000)**	4,353			4,353		
Average gross revenues per trip	128 av. 34 trips - 7 days			128 av. 34 trips - 7 days		
Catches per year (tonnes)	7,611			7,611		
Costs depending on quantity or value of landings						
	% of total income			% of total income		
commission	205	4.7		205	4.7	
harbour dues	170	3.9		170	3.9	
subscriptions and levies	34.82	0.8		34.82	0.8	
shore labour	96	2.2		96	2.2	
boxes	65	1.5		65	1.5	
fuel	353	8.1		353	8.1	
Ice costs	47.88	1.1		47.88	1.1	
other	65.30	1.5		65.30	1.5	
subtotal	971	23.8		971	23.8	
	saithe	% of price	£/kg	saithe	% of price	£/kg
market price=costs of discarding	0.591		0.591	0.591		0.591
Price alternative fish				0.63		
Cost of Extra effort						
Costs of landing alternative fish				0.14		
Costs of discarding	0.59			0.10		
commission	0.028	4.7		0.028	4.7	
harbour dues	0.023	3.9		0.023	3.9	
subscriptions and levies	0.005	0.8		0.005	0.8	
shore labour	0.013	2.2		0.013	2.2	
boxes	0.009	1.5	0.009	0.009	1.5	0.009
fuel	0.048	8.1	0.048	0.048	8.1	0.048
Ice costs	0.007	1.1	0.007	0.007	1.1	0.007
other	0.009	1.5		0.009	1.5	
Costs of landing	0.141	23.800	0.063	0.141	23.800	0.063
net price (costs of discarding - costs of landing)	0.450			- 0.039		
Inc to discard	- 0.450			0.039		
Gross profit / kg						
Gross Revenues / kg	0.57194			0.57194		
Rel inc to discard	- 0.79			0.07		

Average prices for North Sea ports from July to December 1998 used

* Assumes no additional costs for extra effort required

** Quantity and value of species landed by UK in 1998 (UK sea fisheries statistics)

Table 5.5 Nephrops						
Incentive to discard	Discarding			High grading*		
	Nephrops			Nephrops		
Gross revenues (£'000)**	22,898			22,898		
Average gross revenues per trip	673 av. 34 trips - 7 days			673 av. 34 trips - 7 days		
Catches per year (tonnes)	10,869			10,869		
Costs depending on quantity or value of landings						
	% of total income			% of total income		
commission	1,076	4.7		1,076	4.7	
harbour dues	893	3.9		893	3.9	
subscriptions and levies	183.18	0.8		183.18	0.8	
shore labour	504	2.2		504	2.2	
boxes	343	1.5		343	1.5	
fuel	1,855	8.1		1,855	8.1	
Ice costs	251.88	1.1		251.88	1.1	
other	343.47	1.5		343.47	1.5	
subtotal	5,106	23.8		5,106	23.8	
	Nephrops	% of price	£/kg	Nephrops	% of price	£/kg
market price=costs of discarding	1.595		1.595	1.595		1.595
Price alternative fish				2.323		
Cost of Extra effort						
Costs of landing alternative fish				0.38		
Costs of discarding	1.60			-	0.34	
commission	0.075	4.7		0.075	4.7	
harbour dues	0.062	3.9		0.062	3.9	
subscriptions and levies	0.013	0.8		0.013	0.8	
shore labour	0.035	2.2		0.035	2.2	
boxes	0.024	1.5	0.024	0.024	1.5	0.024
fuel	0.129	8.1	0.129	0.129	8.1	0.129
Ice costs	0.018	1.1	0.018	0.018	1.1	0.018
other	0.024	1.5		0.024	1.5	
Costs of landing	0.380	23.800	0.171	0.380	23.800	0.171
net price (costs of discarding - costs of landing)	1.215			-	0.724	
Inc to discard	- 1.215			0.724		
Gross profit / kg						
Gross Revenues / kg	2.1067255			2.1067255		
Rel inc to discard	- 0.58			0.34		

Average prices for North Sea ports from July to December 1998 used

* Assumes no additional costs for extra effort required

** Quantity and value of species landed by UK in 1998 (UK sea fisheries statistics)

Annex IV. (Relating to Chapter 7)

Operational Characteristics of Sample Vessels in Survey

Physical and operational characteristics of respondents' vessels

vessel type	Number in fleet	% of fleet interviewed	mesh size (mm)	use of net (% effort)	av. length (m)	Eng.power (kW)	No.of crew	Storage (8st. Boxes)
inshore	175	9	70	90	10.9	200.4	2.9	89
			100	10				
offshore single rig	283	6	70	30	20.0	372.6	4.6	301.0
			100	70				
offshore twin rig	262	12	70	60	21	442	5.4	460
			100	40				
pair seine	40	20	100	80	22.9	448	5.7	519
			110	20				

*The breakdown of the fleet by vessel type is based on SERAD data and is an approximation due to the flexibility of the fleet in switching between targeting whitefish and Nephrops as well as recent changes from single to twin rigging.

vessel type	Trawl speed (knots/hr)	Trawl time (hours)	trawls per day	trip length (days)	steaming time (summer)	steaming time (winter)	No. crew sorting	Handling time
inshore	2.3	3.6	3.0	1.6	2.7	1.3	2.6	2.1
offshore single rig	2.6	5.1	4.1	5.4	7.4	6.3	3.8	1.8
offshore twin rig	2.4	5.6	3.5	6.7	11.4	8.3	4.6	3.0
pair seine	2.5	4.3	4.1	7.9	17.3	12.0	4.9	2.1

Discards Questionnaire

Vessel Information

1. Method of fishing:

UK	Inshore trawl (<300kw)	Offshore single rig (>300kw)	Offshore twin-rig
			Pair Seine
France	Nephrops single rig	Nephrops twin rig	
Netherlands	Beam Trawl	Eurocutter	

2. Length

3. Engine power

4. Number of crew

5. Gear characteristics:

- mesh size,
- storage capacity of hold
- length of beam (NL)
- Trawling speed

6. Do you use 80mm square mesh panels? Yes/no

7. Are compulsory square mesh panels a good idea and why?

--

Description of gear and set-up used (focusing on any attempts to increase selectivity)

--

Fishing Operation

1. Species targeted

Main species	Proportion of catch	
	Summer (approx. apr-sept)	Winter (approx. oct-mar)

2. Areas Fished? (prompt for both ICES areas and more specific grounds)

Season	ICES Areas	Grounds	Proportion of time spent on these grounds
Summer			
Winter			
Comments			

Average catch size per day (no boxes & size of box)

Breakdown of species/grade in summer	Av. No. boxes	Breakdown of species/grade in winter	Av. No. boxes

3. Average trawl time
4. Average hauls per day.
5. Length of fishing trip (days)
6. Length of Steaming time Summer/Winter split?
7. Number of crew involved in handling/grading catch
8. How long does it take to sort & process (gut, etc) an average catch?

Level of discarding

1. Has the level of discarding increased over the last 10 years and what is the reason for this?
(Prompt for timescale and type of discard)
2. Are there any areas traditionally associated with high discards?
3. Do you see the current level of discarding in the fishery as being too high
 - a. For the commercial species?
 - b. For all species including non-commercial species such as urchins, starfish etc.?
4. What percentage of your total haul is discarded?
5. How much of that are commercial species?
6. What are the main reasons for discarding commercial species
(1 most important, 5 least important)

	Rank 1 to 5
Below Minimum Landing Size	
Damaged fish	
Above MLS but below marketable size	
Enforcement of quota restrictions	
Market price for fish	
Price of quota	
Storage space availability	
Length of trip time remaining	
Handling effort by crew	

7. Breakdown of discards by species and type

Look at main target species and/or significant marketable by-catch

Species	Summer % of total discards	Main reasons for discarding above MLS (interviewer tick box(es))
	___% of total catch of this species ___% below MLS	Damaged fish Below marketable size Enforcement of quota restrictions Market price for fish Price of quota Storage space availability Length of trip time remaining Handling effort by crew
	___% of total catch of this species ___% below MLS	Damaged fish Below marketable size Enforcement of quota restrictions Market price for fish Price of quota Storage space availability Length of trip time remaining Handling effort by crew
	___% of total catch of this species ___% below MLS	Damaged fish Below marketable size Enforcement of quota restrictions Market price for fish Price of quota Storage space availability Length of trip time remaining Handling effort by crew
	___% of total catch of this species ___% below MLS	Damaged fish Below marketable size Enforcement of quota restrictions Market price for fish Price of quota Storage space availability Length of trip time remaining Handling effort by crew

Species	Winter % of total catch	Main reasons for discarding above MLS (interviewer tick box(es))
	___% of total catch of this species ___% below MLS	Damaged fish Below marketable size Enforcement of quota restrictions Market price for fish Price of quota Storage space availability Length of trip time remaining Handling effort by crew
	___% of total catch of this species ___% below MLS	Damaged fish Below marketable size Enforcement of quota restrictions Market price for fish Price of quota Storage space availability Length of trip time remaining Handling effort by crew
	___% of total catch of this species ___% below MLS	Damaged fish Below marketable size Enforcement of quota restrictions Market price for fish Price of quota Storage space availability Length of trip time remaining Handling effort by crew
	___% of total catch of this species ___% below MLS	Damaged fish Below marketable size Enforcement of quota restrictions Market price for fish Price of quota Storage space availability Length of trip time remaining Handling effort by crew

Comments (prompt for specific examples, recent changes due to regulations & differences between MLS and marketable size)

Decision-making

1. Who make the decisions about discarding? Skipper / Mate / Deckhands/ Varies
2. If it varies, who makes the decision about:

Non commercial species	Skipper / Mate / Deckhands
Undersized fish	Skipper / Mate / Deckhands
Over quota fish	Skipper / Mate / Deckhands
Non-marketable fish	Skipper / Mate / Deckhands
Highgrading	Skipper / Mate / Deckhands
3. If illegal landing occurs, what percentage of fish is landed illegally in your fishery?
4. When do you check the most recent market prices?
 - Based on previous landings
 - When leaving port
 - Daily
 - In regular contact with buyers
5. Do you compare costs of landing the fish with lost income from discarding it? Yes/No
If so, what are the main cost factors?
Please quantify whether significant or not

Factor	Significance (1 most, 5 least)	Cost
Labour (effort)		
Ice		
Box charges		
Fuel to remain at sea		
Landing levies		
Auction costs (if separate)		
Transport to market		
Market price		
Other		

6. Do you high-grade [*give definition of high-grading*]? Describe the process of high grading – when and who makes decisions? (looking for their strategy and any differences between dealing with low-value quota and low-value non-quota fish)

does this vary by species and grade

7. How do you assess that discarding is unacceptably high?

8. What do you do when discarding in a haul is high?

- nothing
- move to a new ground
- tell others
- change how you trawl

(explain - time, positioning, etc.?)

Management issues

1. What are the major problems with the current regulations relating to discarding?

2. What would you do to reduce the level of discards?

3. What are your views on the following policy changes and what effect would they have on your operation? See below for definitions used

(Prompt for actual costs if possible)

Option	Additional costs (y/n)	Additional benefits (y/n)	Comments
Increase gear selectivity			
Discards ban *–all deducted from quota			
Discards ban** – with penalties equal to value			
Fixed Closed Areas [^]			
Flexible Closed Areas ^{^^}			
Increased enforcement			
Roll-over quota (year to year)			
Multi-species quota			
Multi-annual quota			
reduced effort			
Alternative			

*"Discard ban – all deducted from quota" means you must land everything you catch and any quota species will go against the quota you have for that species

**"Discard ban – with penalties equal to value" means you must land everything, but it will not necessarily go against quota yet the value of what is landed in addition to quota is deducted so the vessel does not benefit.

[^]"Fixed Closed Area" means a defined sea area (often a recognised spawning area) where fishing is not permitted either at spawning times or all year

^{^^}"Flexible Closed Area" means the closure of a defined sea area based on the composition of catches and level of discarding occurring at any given time. Re-opening this type of sea area would be at the discretion of the responsible control authority.

Annex V

**GUIDANCE ON NEW
TECHNICAL CONSERVATION
REGULATIONS FOR
WHITEFISH AND NEPHROPS
NETS**

**Scottish Executive Rural Affairs Department
July 2000**

WHITEFISH AND NEPHROPS TECHNICAL CONSERVATION RULES

This guidance sets out advice on new technical conservation rules associated with the requirements to place 90mm square mesh panels in whitefish and Nephrops nets. The guidance is provided in good faith but the only authoritative source is the legal texts of the 2 relevant Statutory Instruments:

The Prohibition of Fishing with Multiple Trawls (Scotland) Order 2000 – S.S.I N° 2000/226; and

The Sea Fish (Specified Sea Areas) (Regulation of Nets and Other Fishing Gear) (Scotland) Order 2000 – S.S.I. N° 2000/227.

These are published by HMSO and are available on their website at:

<http://www.legislation.hmso.gov.uk/>. For further advice please contact your local fishery office.

BACKGROUND

1. Scientific advice produced by ICES last year in the run up to the December Council noted that although haddock stocks were under pressure, there was a large year class of juvenile haddock due to enter the fishery during the second half of 2000. Based on this information, UK officials successfully negotiated a higher North Sea haddock TAC (73,000 tonnes, rather than the initially proposed 65,000 tonnes) on the understanding that the UK, as the major stakeholder in this stock, would introduce appropriate unilateral measures to conserve the juvenile haddock.

2. The basis for those technical conservation measures was initially developed at a meeting of the Fisheries Conservation Group on 13 January 2000. This meeting also gained acceptance from the industry that the measures proposed for the North Sea should also be applied to the west of Scotland. The measures are not applicable in the Irish Sea, where the Cod recovery programme takes precedence, or to the English Channel and Western approaches where fisheries are very different from those in the area covered. SERAD carried out a consultation exercise on the proposals during April and May, and received broad approval for the proposals.

NEW MEASURES

3. The new measures are set out in two sections: those that will enter into force on 3 August 2000; and those that will enter into force on 1 March 2001.

NORWEGIAN AGREEMENT

4. On 30 June, the Scottish Executive received written confirmation that the Norwegian Authorities had agreed to allow during 2000 nets with 100mm diamond mesh with 90mm square mesh panels no more than 12 metres from the codline, into their waters. This allows UK fishermen to use the same gear in both UK and Norwegian waters. The Norwegian coastguard are rigorous in their application of the rules, and fishermen are reminded of the need to ensure that their gear clearly conforms to the legislation. Under the new regulations, it remains legal for boats to use nets of 120mm or greater without square mesh panels. In Norwegian waters it is legal to use nets of 100mm diamond mesh without square mesh panels, but these nets will no longer be legal for use in UK waters by British boats.

BY 3 AUGUST 2000**SQUARE MESH PANELS**

throughout ICES areas IIa south of 64°N latitude and east of 4° west longitude (Norwegian Sea), IV (North Sea) and VI (west of Scotland), 90mm square mesh panels shall be mandatory in all Nephrops nets and whitefish nets with a diamond mesh size **in the range of 70 to 119mm;**

the size of the panel, its construction and its distance from the selvages must comply with Article 7 of the new EC Regulation on technical conservation (Regulation EC No.850/98). This Article was circulated as an annex to the earlier guidance to the conservation Regulation;

the panel must be positioned in accordance with the diagram at **Annex A;**

the whole of the panel must be no more than 12 metres from the codline (the rearmost part of the cod end), except where the net is targeting Nephrops (and the catch meets the catch composition rules contained in EC Regulation No. 850/98). In such Nephrops nets, the panel must be no more than 18 metres from the codline.

5. Nets will be deemed to be used for targeting Nephrops if the catch retained on board a boat includes– (a) in the case of a 70 to 79 millimetre net, 35% by weight Norway lobsters and other target species applying to this mesh size; and (b) in

the case of an 80 to 99 millimetre net, 30% by weight Norway lobsters and other target species applying to this mesh size.

6. Where detached Norway lobster tails are retained on board a boat, the equivalent weight of the whole Norway lobsters shall be taken into account for the purpose of paragraph (4), and that equivalent weight shall be obtained by multiplying the weight of the tails by 3.

7. Since the Orders were laid, it has become apparent that there may be an issue of safety in relation to square mesh panels for stern ramp trawlers, which have very long codends, in the region of 20 metres long. Only a very small number of UK vessels which fish in the Scottish zone fall into this category. The Scottish Executive has undertaken to consider ways to address these concerns in advance of the entry into force date for panels of 3 August 2000.

NEPHROPS TWIN AND MULTI-RIGS

8. The legislation on twin rigs will prohibit fishing for Nephrops by any British fishingboat with any trawl other than a single trawl anywhere except on the extended Fladen Area. This prohibition does not apply to any beam trawler; to any trawler with 100mm nets in the North Sea and west of Scotland north of 56°N; and to any trawler with 80mm nets west of Scotland south of 56°N and in the Irish sea. The new Fladen Area has been extended to the area of the North Sea bounded by 57°30'N in the south and 4°W in the north, following the UK/Norway median line as before. In the new Fladen Area, twin rig fishing for Nephrops is permitted with 80mm nets. The new Fladen area is illustrated in

Annex B.**DEFINITION OF A TWIN RIG**

9. The circulation of the consultation document provoked a lot of comment on what was the precise definition of a twin rig. The Order prohibits fishing, in certain circumstances, for Nephrops by any British fishing boat with any trawl other than a single trawl. Certain fishermen taking advantage of the differential between the 80mm minimum mesh required for a single trawl and the 100mm minimum required for a twin rig (which are more efficient at catching fish) by lashing 2 nets together and calling the set up a single rig. It was therefore decided to define a single rig clearly, thus rigs that do not match this definition are by default, twin or multi-rig, and would fall foul of the prohibitions.

10. The Order defines a single trawl as: “**a single net towed by a two warp rig in which the net has a single groundrope bosom**”. This is illustrated in the diagram in **Annex C**. It is important to note that this definition prohibits any net with two groundropes (as found in two nets lashed together), or a single groundrope with two or more bosoms (as found in some ‘hybrid’ nets). Any net failing to meet the criterion of having a single groundrope bosom will be considered to be a twin or multi-rig.

BY 1 MARCH 2001**TWINE THICKNESS**

The sum of thickness of multiple twines in the square mesh panel, codend or extension piece should be a maximum of 10mm.

The EU rules governing single twines (8mm maximum) are continued (no need for a lead in time) except for nets targeting Nephrops with mesh sizes in the range 70-79mm and 80-99 mm where there should be a maximum thickness of 4mm single twine (and a ban on multiple twines).

These twine thickness requirements will apply to UK vessels in the whole of ICES Areas IIa south of 64°N latitude and east of 4° west longitude (Norwegian Sea), Area IV (North Sea) and Area VI (West of Scotland).

Pelagic trawls are specifically exempted from twine thickness requirements.

11. These twine thickness rules will apply only to the codend and extension piece, as presently in the EU Regulation 850/98. Codend covers and other net attachments will continue to be regulated by the EU net attachment regulations: Regulation (EEC) No 3440/84 as amended.

12. Detailed rules covering the measurement of twine thickness will be introduced before 1 March 2001. Ideally, this will be done at European level, as a further amendment to the current detailed rules regulation, Regulation No (EC) 2108/84 as amended. If not, then we shall bring in domestic rules governing the measurement of twine thickness

FUTURE ISSUES

13. It has been necessary to establish these new measures as quickly as possible in order to help preserve the juvenile haddock stock and the industry’s assistance in moving this forward is appreciated by SERAD. While drafting these Orders, it became apparent that there were other issues of detail (see below) that needed further consideration. The Scottish Executive intends to deal with these, and any other issues which arise from implementation of these measures, as soon as possible, and certainly before 1 March 2001. We therefore strongly recommend that fishermen and net manufacturers do not configure gear that would not comply with the following requirements.

Joining Ratio

The current EU Regulation does not specify a minimum width for a square mesh panel. In theory, fishermen could use a narrow panel, bunching the codend tight around this. It is not clear what effect this would have, but the Scottish Executive intend to rectify this situation by specifying a joining ratio between the diamond meshes and square meshes, to ensure that the square mesh panel is not too narrow.

Triple twine

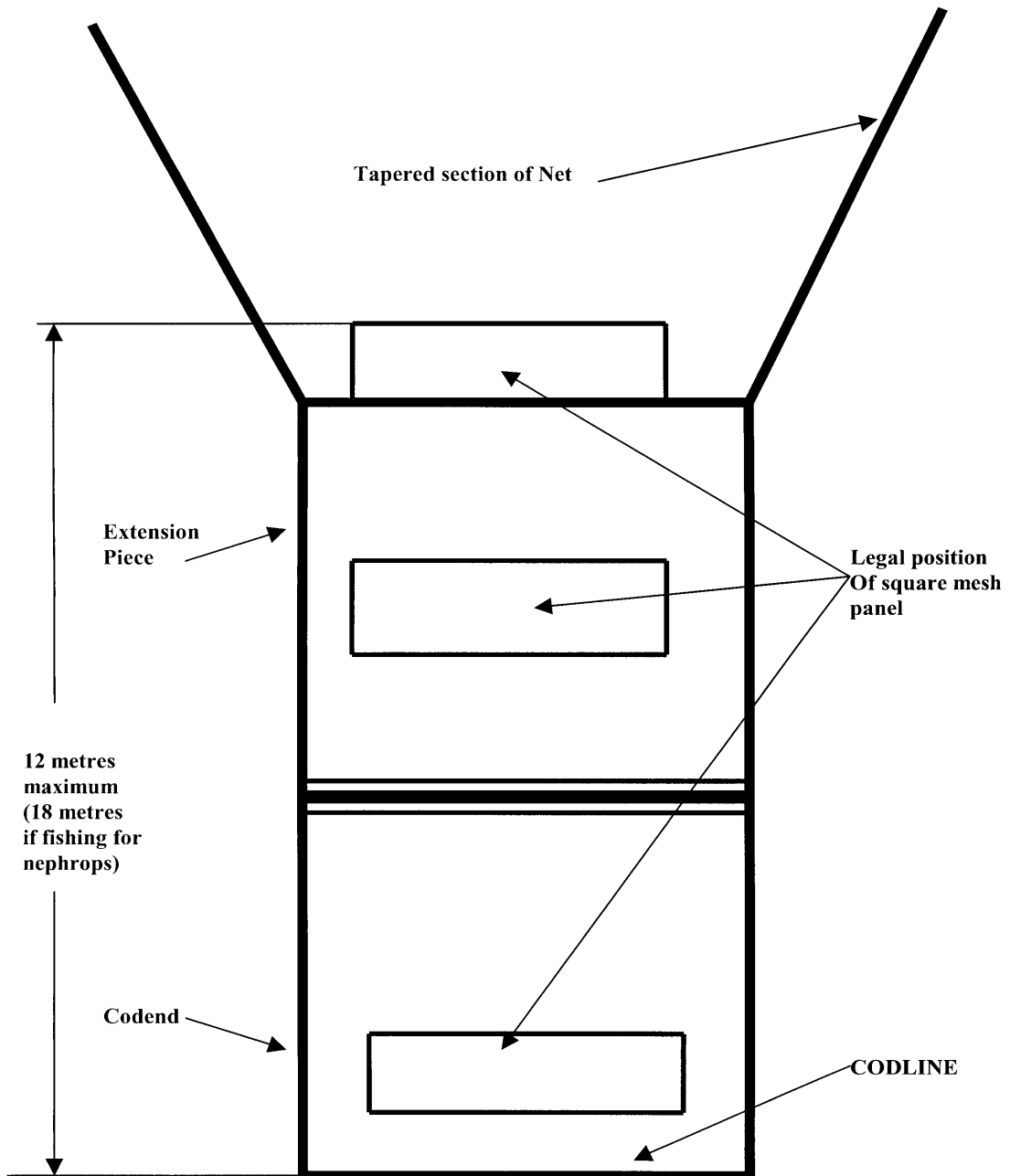
It is our intention to ban triple twine in demersal nets.

Mesh size in the tapered part of the net

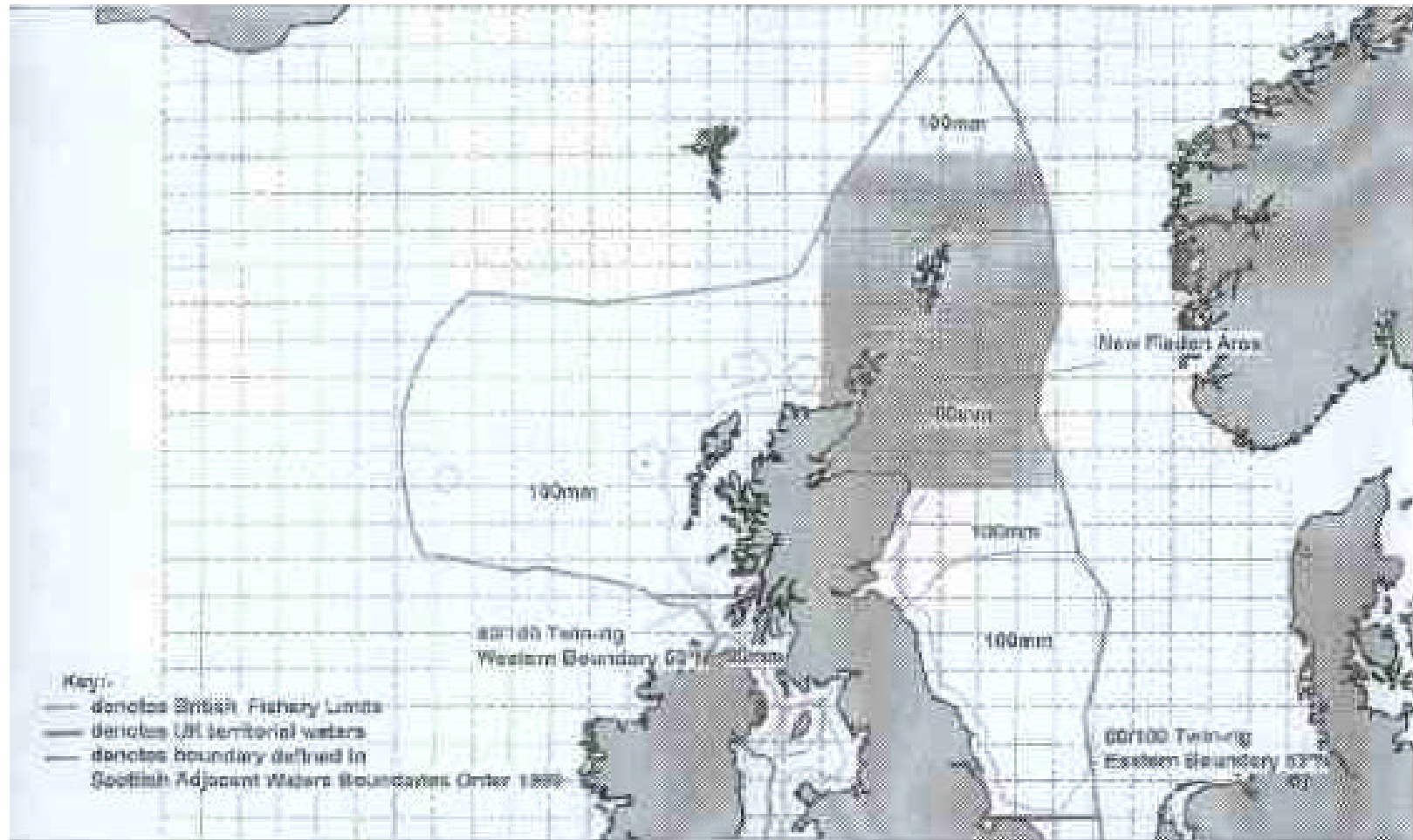
Unlike its predecessor, the EU Regulation 850/98 does not specify a mesh size for the tapered part of the net. This means that the tapered part of the net could have a smaller mesh size than the codend. While this is not important in whitefish nets, this could be important in Nephrops fisheries, where small Nephrops can be ‘riddled out’ through the bottom of the tapered part of the net. The Scottish Executive therefore intend to seek an amendment to the EU Regulation, to ensure that the tapered part of the net must have a mesh size no smaller than the codend and extension piece. In practice, this change may be foreshadowed by future Scottish legislation.

SERAD JULY 2000.

**ANNEX A
DIAGRAMMATIC REPRESENTATION OF TRAWL NET SHOWING
LEGAL POSITION OF SQUARE MESH PANELS
(DIAGRAM NOT TO SCALE - FOR GUIDANCE ONLY)**



ANNEX B



ANNEX C

