



**A Draft Long Term Management Plan
for North Sea *Nephrops***

NB. This is a draft for further discussion.

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1. The Scope of the Long Term Management Plan

This Long Term Management Plan (LTMP) for the *Nephrops* fisheries of the North Sea is intended to set out clear objectives and a range of management options or scenarios for managing the fisheries. Initially, the plan covers *Nephrops* in the North Sea, Skagerrak and Kattegat. The overall goal is to ensure that development and improvement of the *Nephrops* fisheries can take place in a sustainable way without affecting natural resources adversely.

The plan has been prepared at a time when reforms to the CFP are being discussed. Those reforms are expected to lead to a greater degree of self-management of fisheries within the North Sea: to adoption of a “stewardship” approach; where authorities delegate management responsibilities to stakeholders within set limits, while retaining the right to intervene if the fishery moves in a damaging direction. There might also be much greater scope for a regional approach. This management plan has anticipated those changes and is intended to work within a new, reformed, regional CFP where participation of fishers and others in management is readily accepted.

Individuals and communities must be involved in any management decisions that will significantly affect them. In developing this plan for the *Nephrops* fisheries the NSRAC has aimed at a plan that has industry “buy in”. The plan is one which has not simply been passed down from above but has been developed as a result of discussions with fishers and other interested parties, including those responsible for accrediting the *Nephrops* fisheries.

This version of the management plan is specifically aimed at identifying objectives and management options for consideration by stakeholders. Following discussions with stakeholders those objectives and options will be consolidated, or modified, and summarised within the draft management plan.

Long Term Management Plans must meet biological and ecological objectives whilst ensuring that fishing businesses are prepared for the economic shocks that are inevitable when exploiting a variable natural resource in an uncertain global economy. There is a real challenge in developing plans for sustainable fisheries that are both biologically orientated and fleet orientated. A series of objectives must be developed which bring together biological and business related factors. The output of the plan must also sit comfortably with the aims of any accreditation schemes being entered into by the fishing industry.

This Long Term Management Plan for North Sea *Nephrops* aims to:

- analyse the current position of *Nephrops* fisheries in the North Sea and state clearly what we are now trying to achieve;
- set out the balance which must be struck between economic, social and environmental priorities and outline a series of objectives and future targets;
- describe the instruments needed to reach those targets and deliver sustainability for the *Nephrops* fishery;

- identify the roles and responsibilities of different parties, including stakeholders, in meeting those targets and achieving sustainability;
- outline the institutional changes that will be necessary to ensure that our vision of a sustainable *Nephrops* fishery can be achieved

Under this plan it is important that fishers should become more responsible for recording what they remove from the sea. It is their responsibility to:

- Ensure that landing are within quota
- Reduce discards and show that they have reduced discards

The Long Term Management Plan is multi-annual, is intended to last for fifteen years and its targets are intended to be reviewed regularly. It is intended to be adaptive and capable of being adjusted to match any major change in circumstances. It is also intended to be compatible and interdependent with other management plans. Once the plan is agreed and put into operation then progress with implementing it must be monitored.

2. The Long Term Management Plan

Where we are now

There has been a great increase in the landings of *Nephrops* from the North Sea since the 1950s. The landings have progressively increased in a series of steps. ICES scientists have noted that most stocks appear to be stable in terms of abundance and size composition.

However, despite this apparent stability the scientific advice from ICES and STECF is that there are benefits to be gained from the *Nephrops* fishery as a whole moving progressively towards lower fishing mortalities giving higher yields.

Currently, in the North Sea itself, *Nephrops* stocks are divided into eight separate Functional Units (FUs). For some of these functional units, like the Fladen ground, *Nephrops* has shown a marked increase in abundance over the years. In others, like the Farne Deeps, the population has recently fallen.

The scientific advice from ICES and STECF is that current management of *Nephrops* in the North Sea (both in terms of TACs and effort) does not provide adequate safeguards to ensure that local effort is sufficiently limited to avoid depletion of resources in the functional units. Catches can be taken anywhere in the North Sea and vessels are free to move between grounds, allowing effort to develop on some grounds free of any restriction. This freedom, although it permits flexibility for fishing vessels, may lead to unacceptably high harvest rates from some of the functional units.

A major management consideration for *Nephrops* stocks therefore is whether management should be at the functional unit level rather than a North Sea level. Management at the functional unit level would provide the controls to ensure that catch opportunities and effort are compatible and in line with the scale of the resources in each of the stocks defined by the functional units.

In assessing the North Sea *Nephrops* trawl fishery for accreditation it has already been recommended that there should be a formal stock rebuilding strategy with monitoring to demonstrate recovery. The stock must be above the point where recruitment would be impaired and should be at or fluctuating around a target reference point. In addition ICES should be supported in its recommendations and advice.

Transfer of effort into the North Sea *Nephrops* fishery has occurred recently as an unintended consequence of restrictions imposed on other sectors of the fleet and in other areas, some of them outside the North Sea. This issue must be addressed in the management plan. It is also evident that reduction of discards must form an important component of the plan, and that impacts upon the ecosystem must also be addressed.

Fishing fleets themselves should be economically resilient, with an ability to withstand changes in their circumstances. However, this is a management plan, not a business plan. The fleets themselves are very diverse and conditions in member states differ. Although this plan will set out some general economic guiding principles, it will not be prescriptive in defining economic measures to be taken by member states or fishing businesses.

Where we want to be - the objectives of the LTMP

Biological objectives

We consider that the most important objective of the plan for North Sea *Nephrops* must be to match overall fishing capacity to the long term sustainable yield. Fishing must be at a level which will allow *Nephrops* stocks to renew themselves.

Overall the *Nephrops* stocks in the North Sea do not appear to be over exploited. STECF has remarked that there does not seem to be an immediate biological risk to any of the stocks assessed by means of underwater television surveys. A conservative objective might be for the *Nephrops* fisheries on those stocks to continue at about the current level, maintaining the existing rate of fishing mortality. However, even under constant fishing mortality, the size of the stock will vary due to fluctuations in recruitment. The overall objective must be to match fishing capacity to a longer-term sustainable yield, whilst accommodating fluctuations in the state of the stocks. STECF (2009) has stressed that long term management plans should be developed with the objective of achieving high long-term yields and low risk to the stocks.

What might that appropriate level of fishing mortality be? A proxy for the Commission's general target of F_{MSY} would lie between $F_{0.1}$ and F_{MAX} . If a consistent F of between $F_{0.1}$ and F_{MAX} is maintained then there should be no need to change this value with variations in the stocks. Each year, a TAC will be set consistent with the size of the stocks and the target F .

Fishing at this rate for *Nephrops* is estimated to be equivalent to capturing in the region of 10-15% of the standing stock each year, the latter being determined from underwater TV surveys. However, a proportion of that stock will consist of undersized animals. The proportion of the harvestable stock which can be taken is more likely to be in the region of 30%.

STECF has suggested that there are wide benefits to be gained from the *Nephrops* fishery as a whole moving progressively towards lower fishing mortalities giving higher yields. It has recommended a precautionary target for fishing mortality of $F_{0.1}$ should be adopted for North Sea *Nephrops* until a better proxy for F_{MSY} can be derived.

Setting a target value between $F_{0.1}$ and F_{MAX} would result in lower fishing mortalities than those currently prevailing in the North Sea.

In the North Sea we are currently moving from a state where species which prey upon *Nephrops*, like cod, have been at a very low level, to a state where they may become more abundant. It is necessary to take account of these species interactions and other changes to the ecosystem which may have a significant future effect upon *Nephrops* stocks. Ecological systems are dynamic and unpredictable with major effects, for example from climate change, which we cannot influence. Management systems and management plans must be robust in the face of uncertainty. They must be adaptive and capable of changing with circumstances.

What management action should be taken in the event of a major fall in the abundance of *Nephrops*? For example if there is a fall in the abundance assessed from the TV surveys over several years? Such a fall might result from an increase in the abundance of cod and other predators. In these circumstances a biomass trigger point needs to be set which will prompt a revision of the target value for fishing mortality. A value for B_{TRIGGER} has yet to be set for *Nephrops* in the North Sea. However, if such a value is reached, then an appropriate management response would be to reduce the target value set for F in line with the decline in biomass. Such a measure would ensure that the plan is adaptive. The intention would be to monitor developments in the stocks and to look at the implications of any increase in natural mortality upon the F reference points.

Even with a more sustainable approach towards the total *Nephrops* stock in the North Sea, there may be a risk to *Nephrops* in some of the functional units. Some have shown evidence of over-exploitation. In addition there is a lack of information on some of the functional units (e.g. Botney Gut), where UWTV abundance estimates are lacking. It is also evident that there is a question over the designation and assessment of the functional units. There may be a case for designating the Devil's Hole fishery (and perhaps other separate and identified fisheries areas) as a discrete functional unit.

Thus, the objectives for the management plan for *Nephrops* must also set out how fishing mortality on the vulnerable functional units might be limited. One issue is whether certain functional units are always likely to be vulnerable and whether they should receive some permanent form of protection. This will be difficult to resolve. There is likely to be some resistance to such measures by some sectors of the industry which value their current flexibility to move from one functional unit to another. However, if the management plan is to be consistent with ICES and STECF advice, and with the recommendations of accreditation agencies, then management at a functional unit level must be introduced with the aim of safeguarding individual functional units against depletion.

Transfer of effort into the North Sea *Nephrops* fishery has occurred recently as an unintended consequence of restrictions imposed on other sectors of the fleet and in other areas, some of them outside the North Sea. This issue must be addressed in this management plan. Currently transfers are not a problem as effort caps are imposed within the North Sea as a result of the cod recovery plan. Those measures were not imposed to protect *Nephrops* but to curb illegal landings and reduce discards. Should the days at sea regime be removed, perhaps as a result of cod recovery, then other mechanisms may need to be sought to reduce the risk of effort transfers on to *Nephrops*. In practice, the North Sea TACs should limit any transfer of effort from other regions. Increase in effort should not be a problem if the fishing mortality is properly controlled and monitored.

Taking all the above considerations into account a draft set of objectives for the North Sea *Nephrops* fishery might be:

- To exploit *Nephrops* at rates that are sustainable by setting a target fishing mortality (F) consistent with F_{MSY}
- In the absence of an agreed value or proxy for F_{MSY} then an F between $F_{0.1}$ and F_{MAX} (and an equivalent harvest ratio) could be used as a precautionary target fishing mortality

- In the absence of immediate biological risk to any of the stocks assessed by UWTV, then the target F could be reached gradually, in an incremental way
- Should stock size fall below a level at which recruitment is likely to be significantly impaired then F should be reduced in line with the reduction in stock size indicated by the UWTV surveys
- Should stocks increase the F should be increased in line with the increase in stock size shown by the UWTV surveys up to the agreed F_{MSY} proxy.
- Management should be at the functional unit level so that catch and effort are compatible and in line with the scale of the resources available in each of the stocks defined by the functional units
- Fishing mortality upon *Nephrops* must be properly monitored and controlled.

Wider ecological objectives

Ecological sustainability is also important. Management practices must be set so as to maintain ecological processes and minimise impact on other species and on habitats for the benefit of future generations. A key goal of the *Nephrops* fishery LTMP is to minimise impacts on the ecosystem.

ICES has stressed that it is important that emerging year classes of other species of fish should not be subject to mortality as by-catch in the *Nephrops* fishery. The risk of catching whitefish is currently intended to be reduced by the imposition of catch composition rules and by the application of measures to improve the selection of *Nephrops* and reduce catches of whitefish. Vessels legitimately targeting *Nephrops* may catch quantities of haddock, whiting and cod but they may be forced to discard marketable fish to comply with catch composition rules. The catch composition rules are seen as unnecessarily restrictive and there is a wish that consideration should be given to alternative solutions, perhaps through a discard pilot project.

It is important that the plan should take account of the existence of other management plans for particular stocks or for other fisheries. There must be interdependence between plans

It has also been suggested that there is a need to reduce the impact of the *Nephrops* fishery on threatened endangered and protected species, as well as the effects of bottom disturbance from *Nephrops* trawls upon habitats and sensitive benthic communities.

We have identified three objectives to achieve these ecological goals:

1. Reduce discards in the fishery

2. Minimise damage to threatened, endangered and protected species
3. Minimise impacts on benthic habitats and associated communities.

Common to each of these objectives is a long term aim of reducing fishing pressure by whatever means are available. The development and implementation of environmentally friendly fishing gear and fishing practices must also be encouraged to minimise impacts on the ecosystem.

Economic objectives

The main economic aim for any fishery must be to achieve economic resilience based on a sustainable level of profit. Profitability is also a necessary precondition for higher compliance with fishery regulations. In economic terms the *Nephrops* plan should aim in the long term (say over the next 15 years) for a modern, safe fishing fleet, able to renew itself, capable of providing a stable supply of fish matched to the needs of the market at reasonable prices. Essentially the plan must provide conditions where all those involved in the industry can achieve the best possible outcome for their businesses – but without specifying in detail how those businesses should operate.

There is an emerging problem in that the biological objective of progressively reducing F in the interests of long term sustainability may result in a mismatch between fleet capacity and fishing opportunities. Failure to match fleet capacity to the future state of the resource will both reduce long term profitability and undermine compliance with the regulations. One objective must therefore be to provide incentives for fishers to move the fishery in the direction of lower fishing mortality while enabling them to meet their own business aims and objectives

It is also recognised that there is a problem with technology creep and that fishing capacity will tend to increase in a progressive way with time. Failure to match fleet capacity to the future state of the resource will both undermine compliance and mean that revenues are flowing into businesses with no chance of long-term profitability.

Under a more accountable system of quota and effort management any increase in capacity will be felt not by the stocks but by the fleets themselves. It is for member states and fishing business to decide how to reduce those economic pressures.

Effort restrictions have a profoundly negative effect and would drive the race for fish. There is also a need to rationalise and harmonise various management measures and regulations that make fleets less efficient.

The economic objectives of the plan must aim:

- To provide incentives for fishers to move the fishery in the direction of lower fishing mortality while enabling them to meet their own business aims and objectives

- To avoid regulation that makes fleets less efficient or provides perverse incentives which act to the detriment of the fishery and the *Nephrops* stock
- Any change imposed on the fishery to meet biological and ecological objectives must take place at a rate that can be absorbed by individual businesses and communities.

The main instruments of the management plan - How are we going to get there?

Biological instruments

The NSRAC proposes that in the absence of full analytical assessments for *Nephrops*, and in the absence of any definite reference points, there should be a pragmatic approach to managing the *Nephrops* fisheries. We accept that there are benefits to be gained from the *Nephrops* fishery as a whole moving progressively towards lower fishing mortalities and higher yields.

In the absence of immediate biological risk to any of the stocks assessed by UWTV, the NSRAC suggests that:

- An F of between $F_{0.1}$ and F_{MAX} should be used as a precautionary target fishing mortality and TACs set accordingly
- This target can be reached gradually, through incremental annual reductions in fishing mortality through reduced TACs

If stock abundance falls to a level at which recruitment is likely to be significantly impaired, as indicated by the UWTV surveys, the NSRAC suggests that:

- F should be reduced in line with the reduction in stock size indicated by the UWTV surveys
- If recruitment improves and stock size increases, F should be increased in line with that.

The management plan for *Nephrops* must also consider how fishing mortality might be reduced on the vulnerable functional units. ICES and others have laid great stress on the need to safeguard functional units against local depletion. It is appreciated that some sectors of the industry will be unhappy with measures which restrict their flexibility, and therefore a wide range of possible options have been listed:

- Setting separate TACs for the different functional units. This is a preferred arrangement from a scientific standpoint. It should be noted that those experts addressing accreditation of the North Sea *Nephrops* fishery have recommended that there should be separate TACs for each functional unit. However individual TACs for the functional units would give rise to problems of relative stability and

in the allocation of TACs, both domestically and internationally. Perhaps quota holders could elect which area their quota could be attached to?

- The inclusion 'of which no more than x tonnes' provisions for functional units which are under threat. However, this might affect adversely those dependent on particular functional units
- Profiling the TACs by quarter or time of year, to conform to the expected fishing pattern for particular functional units.
- Basing an overall North Sea TAC on the state of the weakest functional unit. However, this would be unduly precautionary and would also restrict fishing in areas where *Nephrops* were abundant.
- Application of days at sea (or 'of which' days at sea) restrictions within a functional unit
- A capacity cap in terms of setting out a list of permitted vessels (based on historic activity) allowed to fish within a functional unit. Restrictive licensing.
- A cap on the size of vessels permitted to fish within a functional unit.
- Gear restrictions – for example restricting gears to single rig within a functional unit.
- Limits to the number of pots for vessels fishing by this method.
- Seasonal closures of a functional unit (e.g. during 'green sac' periods).
- Real time closures of functional units which are depleted.
- It is possible that different measures might apply to different sectors of the fleet; e.g. inshore and offshore.

Wider ecological instruments

Reducing discards in the *Nephrops* fishery is an important objective. There are many instruments available for achieving this, and they are different for different fleets. Gears must be adjusted to particular circumstances depending on whether vessels have quota for whitefish, and the fleet category into which they fit. Options for avoiding the capture of fish for which a vessel has no quota include:

- Larger meshes in the main part of the net
- Square mesh panels and other escape panels
- Selection grids

- Low headline trawls
- Adaptations to the foot rope
- Real time closures to protect spawning grounds or aggregations of juvenile fish.

Under this plan it is important that fishers should become more responsible for recording what they remove from the sea. It is their responsibility to:

- Ensure that landing are within quota
- Reduce discards and show that they have reduced discards

The management plan does not favour catch composition rules, which lead to discarding and are difficult to comply with. The adoption of other measures to reduce discards would allow catch composition rules to be removed.

The plan recognises the need to respect the wider obligations to reduce the impact of the *Nephrops* fishery on threatened endangered and protected species, as well as the effects of bottom disturbance from *Nephrops* trawls upon habitats and sensitive benthic communities. These ecological objectives might be achieved through the following management options:

- Reducing fishing pressure
- Identifying and implementing Marine Protected Areas to reduce the spatial footprint - including 'real-time', seasonal and permanent closed areas. To be done in collaboration with fishers to protect a small part of the *Nephrops* area
- Restrict the range of gears that can be used in vulnerable areas (including creel only areas)
- Promote the development of environmentally friendly fishing practices, for example gears with less bottom contact, larger meshes and better selectivity profiles
- Monitor discarding and associated impacts, including those on discard-dependent seabird communities
- Improve data recording systems to capture fishing interactions with endangered, threatened and protected species
- Assess impacts on habitat and associated species communities, including benthic communities, ecologically related, associated or dependent species, water column communities

To effectively address some of these proposals the plan may need to set out a research & monitoring programme to address data gaps within the fishery and on its wider

environmental impact. This should include fishery dependent and independent data collection, including the material which is currently provided by the various research institutes.

Economic instruments

An important over-riding objective of this management plan is to prevent any increase in mortality rates on *Nephrops*. Technological developments must not threaten stocks. With a properly accountable system of quota or effort management the mortality rate will be controlled. If there is any expansion in fishing capacity, brought about for example by technology creep, then the pressure will not fall on the stocks but upon the fleets.

This plan does not propose that there should be effort restrictions imposed upon vessels in order to protect *Nephrops*. The imposition of effort restrictions would have a profoundly negative effect and would drive the race for fish.

Rather, it is for member states and fishing businesses to decide how to deal with changing economic pressures. There are no specific economic instruments that require to be imposed by this management plan. However, it is sensible to add the proviso that in meeting the biological and ecological objectives it is important to avoid regulation that makes fleets less efficient or provides perverse incentives which act to the detriment of the fishery and the *Nephrops* stock. It is also important to provide incentives for individual fishers to change to meet new business aims and objectives. Moreover, any change imposed on the fishery to meet biological and ecological objectives must take place at a rate that can be absorbed by individual businesses and communities.

Monitoring of the management plan

An important feature of the management plan should be to track its successes and failures. The extent to which the Management Plan is achieving the range of stated goals and objectives should be assessed using a combination of indicators designed to measure performance of the fishery. These performance indicators may be biological or non-biological. Possible performance indicators are:

- Level of fishing mortality (with respect to a target F)
- Abundance trends obtained through UWTV surveys (with respect to a trigger point for assessing deterioration in the stock)
- Level of discarding
- Uptake of environmentally friendly fishing practices
- Number of Marine Protected Areas

Future institutional structures

How is the management plan for North Sea *Nephrops* to be applied? The strength of stakeholder involvement should evolve over time in the management of the fishery, the aim being to develop full 'co-management'. New institutional structures for implementation of this and other LTMPs must now be discussed in the context of reforms to the CFP.

Future research & monitoring priorities

- Further development and extension of fishery independent surveys, including UWTV surveys, are an important feature of the plan, not only to aid the assessment of prawn stocks, and aid the overall fishery management process, but also to play a crucial role in monitoring the fishery's broader ecological performance.
- Refine the target fishing mortality
- Determine a biomass trigger point (B_{TRIGGER}) where decisions to change the target F may need to be made
- Further work is needed to ascertain whether the current division into functional units adequately reflects the distribution of *Nephrops*. Are there other areas containing *Nephrops* which should be incorporated into the assessments? Are there small pockets of *Nephrops* at different locations which should be brought into the assessments?
- For some of the FUs with lower levels of landings (e.g. Botney Gut), there are no UWTV abundance estimates. This problem must be addressed
- Also monitor the capture and discarding of undersized species including other crustaceans, fish and small *Nephrops*.
- Improve data recording systems to capture fishing interactions with endangered, threatened and protected species
- Determine which threatened endangered and protected species and habitats are most affected by trawling for *Nephrops*
- Analyse the numbers and types of vessels and their capacity, from all nations, operating within the different functional units. There is a general lack of effort data, especially for the under-10m fleet.
- A case can be made for mapping of fishing effort for *Nephrops* in the North Sea, using VMS and other sources, for protective purposes, to monitor the distribution of effort between functional units and to ensure that any displacement of effort as a result of MPA and wind-farm proposals can be evaluated

3. Background information

The Norway lobster

The Norway lobster, *Nephrops norvegicus* (L.), also called the Dublin Bay prawn, prawn, langoustine or scampi, is a pale orange crustacean which may grow up to 25 cm in length (9-10 in), but is often much smaller. It is found in the north-eastern Atlantic Ocean and North Sea as far north as Iceland and northern Norway, and south to Portugal and Morocco (Figueiredo & Thomas, 1967). It is also found in the Mediterranean Sea, particularly the northern Adriatic. *Nephrops* is common across the North Sea and into the Skagerrak and Kattegat.

Nephrops live in shallow, often branching burrows, in soft stable mud at depths ranging from 20m to 800m (Rice & Chapman, 1971; dos Santos & Peliz, 2005). The presence of suitable mud defines the habitat and distribution of the species. Burrows may be up to 10 cm in diameter, over a metre long and penetrate the sediment to a depth of 20-30 cm (Rice & Chapman, 1971; Hillis, 1974). Although *Nephrops* appear to be solitary animals, there may be several animals within the same burrow (Marrs et al. 1996). The burrows may also be shared by a variety of other species, including small fish. *Nephrops* typically remain within their burrows by day and emerge at sunset to forage during the night (Chapman and Rice, 1971; Hillis, 1971). In deeper water this activity changes and individuals may be more active by day (Höglund and Dybern, 1965; Hillis, 1971). At intermediate depths, greatest activity may occur at dawn and dusk (Chapman and Howard, 1979). There is also a seasonal pattern of burrow emergence associated with mating and moulting, and this is most pronounced in mature female *Nephrops*. After spawning, berried females largely remain in their burrows for the entire incubation period, which is generally from late summer until spring (Redant, 1987; Sardà, 1991; Briggs, 1995).

There is marked geographical variation in the density of burrows, and the size and growth rate of *Nephrops* which may depend on physical factors such as the nature of the sediments on the sea bed, temperature and food availability (Tuck et al., 1997; Thompson et al., 1998). There is currently no standard method for determining the age of *Nephrops*.

Nephrops are preyed upon by many species of demersal fish (Farmer, 1975), including cod, whiting and skates and rays. *Nephrops* may be more abundant when these fish species are scarce and this has implications for the management of the *Nephrops* and other fisheries.

Currently, in the North Sea (which is ICES Sub-area IV) *Nephrops* stocks are divided into eight separate Functional Units (Figure 1) plus the Skagerrak and Kattegat in Sub-area III. These functional units were defined by mapping the areas of muddy sediment in which *Nephrops* live. However, additional landings of *Nephrops* are taken from smaller, isolated patches of mud elsewhere in the North Sea in areas such as Devil's Hole. Although small planktonic *Nephrops* larvae are transported by the currents and may be carried from one part of the North Sea to another, it is believed that there is very little exchange of adults between functional units. Adult *Nephrops* are relatively sedentary, seldom moving more than a few hundred metres (Jensen, 1965; Chapman, 1982).

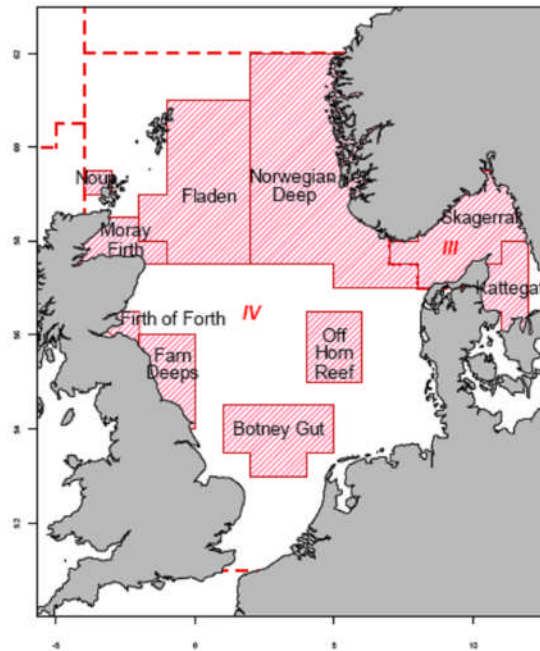


Figure 1: *Nephrops* functional units in the North Sea and Skagerrak/Kattegat region

Within a functional unit, the *Nephrops* distribution may vary in terms of density, size, sex and biological characteristics depending on sediment composition (Tully & Hillis, 1995; Tuck et al., 1997). Some of the functional units are regularly surveyed by means of underwater television (UWTV) mounted on towed sledges. Other units are not regularly surveyed, and information on the distribution and numbers of *Nephrops* in these un-surveyed areas is more limited.

The *Nephrops* fisheries

The *Nephrops* fisheries began to grow in the North Sea in the early 1950s when demand for shellfish increased. Before that *Nephrops* were hardly exploited – those caught incidentally during the capture of whitefish were often discarded. There has since been a great increase in the global catch of *Nephrops*. North Sea landings have increased in a series of jumps. The UK holds the bulk of the North Sea TAC for *Nephrops* (87% in 2009). Other countries with an interest are Belgium (5%), Denmark (5%) and Holland (3%). The Belgian quotas are often traded with other countries. *Nephrops* is especially valuable to Scotland, where 80% of the landings take place.

Although there are some dedicated *Nephrops* vessels within the North Sea, *Nephrops* is also an important component of the catch for vessels fishing for other species. In addition, *Nephrops* vessels may also rely on catching other species to maintain their profitability. Currently, in the North Sea, *Nephrops* are mainly caught in otter trawls. Originally the trawls were single-rig, but more recently twin-rig trawls and multi-rig trawls have been applied. Scotland has introduced a ban on all Scottish boats using multi-trawl gears; the ban also extends to all British vessels in Scottish waters, limiting the expansion of fishing capacity but also potentially limiting the business efficiency of vessels which are capable of multi-rig trawling.

The *Nephrops* fisheries in the Skagerrak and Kattegat show differences to those in the North Sea. Mesh sizes are larger and are not tailored especially for *Nephrops* as the fishery is a mixed one. Selection grids are used in the Swedish inshore fisheries in the Kattegat, but as they remove a large part of the fish catch they are not used in the mixed fisheries.

Fisheries in each of the functional units are quite different. On some grounds, like the Fladen, there is predominantly a mixed fishery and whitefish are an important part of the catch. On other grounds there is a small by-catch of white fish which nevertheless can make an important contribution to the earnings of the vessel. On some grounds, like the Firth of Forth, the whitefish by-catch is very small.

In the North Sea the *Nephrops* fisheries are managed through the setting of an overall TAC. Minimum Landing Sizes apply and is 25mm in the North Sea and 40mm in the Skagerrak and Kattegat. Minimum net mesh sizes are also set, but these also vary with area and with the type of vessel – for example whether it is targeting mainly whitefish or *Nephrops*. By-catch limits have been imposed. *Nephrops* fishers have recently adopted a series of technical measures including mesh size, square mesh panels and twine thickness to conserve fish stocks.

In addition to TACs, days-at-sea regulations introduced under the cod recovery plan have also reduced fishing opportunities for *Nephrops* trawlers. Division of the fleet into white fish vessels, with large mesh nets and fewer days at sea, and *Nephrops* vessels, with smaller mesh nets and more days at sea, has resulted in a transfer of effort into the *Nephrops* fleet. Moreover, pressures on stocks elsewhere have resulted in an influx of vessels fishing *Nephrops* into the North Sea.

Note: There is a need for an analysis of the numbers and types of vessels and their capacity, from all nations, operating within the different functional units. There is a general lack of effort data, especially for the under-10m fleet.

Markets for *Nephrops*

There are two distinct markets for *Nephrops* from the North Sea: further processing of the *Nephrops* “tails” into breaded scampi, sold into caterers and supermarkets in the UK and Ireland; and packing into trays for sale as “whole” *Nephrops*, mainly sold into Italy, France and Spain.

In the UK, *Nephrops* are not sold at auction; boats are contracted to agents or landing directly to processors. Boats typically align themselves to one agent or factory. With delays in communicating with boats a glut can develop, leading to large quantities having to be processed all at once, and working capital resources exhausted. This leads to processors capping volumes from the boats, who in turn seek other outlets for their catch, while the fishing is still good. This can lead to a general oversupply on the market, which forces suppliers to drop prices significantly. The reverse can happen during periods of poor weather and undersupply, with processors battling to maintain and win new supply, and prices being bid up.

In the Netherlands and Denmark *Nephrops* are sold through auctions in the normal way.

Difficulties in auctioning *Nephrops* in the UK are said to be due to quality variation, product deterioration and the high cost of *Nephrops*. Attempts have been made in the UK to introduce an auction, as in other countries, but due to a lack of interest by buyers and processors have failed to be sustained.

The whole langoustine, exported mainly to mainland Europe, needs to be carefully graded, usually by eye, or placed piece by piece on to conveying graders. This laborious task makes up a large part of the processing itself, as the *Nephrops* can snag into each other's claws which without careful handling, causes costly damage to takes place. An auction therefore relies both on grading at sea and trust between boat and processor with regards to the grade and the freshness of the *Nephrops* landed. It is easier to auction *Nephrops* tails. However, as this is only a small part of the catch by value, it cannot be handled separately without extra transport and administrative costs being generated.

In terms of supply, the different FUs have different peak landing seasons determined by weather and spawning pattern of the stock. For instance in the Southern North Sea, the Botney Gut fishery takes place from mid May – September. The fishery is in shallow water, as shallow as 11 fathoms, so that bad weather makes fishing there outside that period impossible. The Farne Deeps *Nephrops* are most abundant from Mid September to Mid April. Here weather and location of the FU plays a large role, as the prevailing south westerly's are offshore, thus causing less swell than deeper sea FUs (such as the Fladen Ground). The other FUs in the North Sea have similar characteristics, so that it is possible for an oversupply to develop should settled weather coincide with good fishing periods.

There is a seasonal problem with “green sac” in *Nephrops* females where the egg sac develops behind the head and discolours the shell.

Assessment of the *Nephrops* stocks

Determining the existing status of the North Sea *Nephrops* stocks, and advising on the potential yield from those stocks under different management strategies is the responsibility of ICES. The process of stock assessment is very technical and requires specialist knowledge. The assessments are rarely presented in a form which can readily be understood by non-specialists, including fishermen. As part of this LTMP we believe it is important to express the results of the scientific assessments and the management objectives in clear every-day language.

For the North Sea, ICES has defined eight *Nephrops* functional units for the purposes of stock assessment and the provision of advice. These are:

- Off Horns' Reef (FU 33)
- Botney Gut (FU 5)
- Fladen Ground (FU 7)
- Norwegian Deeps (FU 32)
- Farne Deeps (FU 6)
- Noup (FU 10)
- Moray Firth (FU 9)
- Firth of Forth (FU 8)

There is a lack of information on some of the functional units (e.g. Botney Gut). It is also evident that there is a question over the designation and assessment of the functional units.

Most fish stocks are assessed by monitoring catches and by obtaining for successive years information on the age structure and growth rate of the species. *Nephrops* are crustaceans, which periodically moult. It is not yet possible to determine their age. The very different growth rates of male and female *Nephrops*, and the lack of information on their age, make the use of standard stock assessment and forecasting methods very difficult to apply. Some progress may be possible in the future using length-based assessments.

Historical landings have been uncertain for *Nephrops* stocks, making assessments based on catch data unreliable. Recently, these data have greatly improved (since the introduction of buyers and sellers legislation), but a longer time series of data are required before they can be used fully in the assessments.

Sampling of *Nephrops* landings is carried out at markets & processors to obtain information on the size composition of landings. In addition, discards are monitored at sea. However, the main method for assessing the state of *Nephrops* stocks is by carrying out underwater television (UWTV) surveys.

A number of the FUs in the North Sea (FUs 6, 7, 8, 9 and occasionally 10) are also examined directly through these UWTV surveys (Bailey *et al.*, 1993; Marrs *et al.*, 1996). A sledge carrying a TV camera is towed across the seabed, and the number of burrows counted along a track. The surveys are carried out at stations in areas of different sediment type, with 10 minute tows at each station. A 1:1 occupancy rate is assumed for the burrows and the total density of *Nephrops* is raised to the total area of that sediment type and summed across sediment types for the FU. Further details of the UWTV survey protocols can be found in the reports from recent ICES workshops (ICES, 2007 & 2009b).

The UWTV surveys provide estimates of abundance which are independent of the fishery itself. STECF (2005) suggested that a combination of an absolute abundance estimate from an UWTV survey and a harvest rate based on an estimate of fishing mortality could be used to calculate appropriate landing limits. This approach has been further elaborated and evaluated by ICES (ICES, 2007 and 2009a).

A recent ICES Benchmark meeting on *Nephrops* (ICES 2009a) addressed concerns which had previously been raised in relation to factors which could potentially bias the UWTV survey results. The main sources of bias were estimated for each functional unit and an overall bias correction factor introduced which could be used to adjust the estimates of abundance and allow them to be treated as absolute abundance levels. In addition, the workshop calculated harvest ratios equivalent to fishing at different fishing mortality rates for each FU and agreed a protocol for providing a catch options table (ICES, 2009a).

Because full analytical assessments, based on traditional ICES methods, cannot be carried out for *Nephrops* precautionary reference points have not been determined for this species. ICES scientists have suggested that an estimated fishing mortality of $F_{0.1}$

could be used as a fishing mortality reference point (i.e. as a target for a sustainable fishery). However, currently there are no agreed management objectives for North Sea *Nephrops* stocks. STECF (2009) has recommended that management plans be developed with the objective of achieving high long-term yields and low risk to the stocks. They have said that such plans should be applicable to the separate FUs.

In 2009, ICES based their advice on the approach outlined above, offering a choice of harvest ratio depending on the current estimate of fishing mortality and the recent trend in UWTV abundance. For FUs without an UWTV survey, no new advice was provided in 2009. However, typically in such cases, ICES advises landings should be determined on the basis that there should be no increase above the recent average.

In its review of the ICES advice, STECF (2009) noted that in the long-term the aim for management should be to exploit *Nephrops* at rates that will give rise to maximum sustainable yield. In the absence of an agreed value or proxy for F_{MSY} STECF recommended that $F_{0.1}$ (and an equivalent harvest ratio) should be used as a precautionary target fishing mortality. They also concluded that given there does not seem to be an immediate biological risk to any of the stocks assessed by UWTV, then the $F_{0.1}$ target could be reached through incremental annual reductions in fishing mortality.

ICES (and STECF) have opined that current management of *Nephrops* in the North Sea (both in terms of TACs and effort) does not provide adequate safeguards to ensure that local effort is sufficiently limited to avoid depletion of resources in functional units. In the current situation catches can be taken anywhere in ICES subarea IV and this could imply inappropriate harvest rates from some regions. More importantly, vessels are free to move between grounds, allowing effort to develop on some grounds free of restriction. This appears to have been a particular problem in the Farne Deeps in 2006 where increased activity by vessels from other parts of the UK occurred.

An overriding management consideration for these stocks is therefore that management should be at the functional unit rather than the ICES subarea level. Management at the functional unit level could provide the controls to ensure that catch opportunities and effort are compatible and in line with the scale of the resources in each of the stocks defined by the functional units.

There are a number of gaps in information which we need to fill if the assessments for *Nephrops* are to be improved:

- If full analytical assessments are to be made (and this may or may not be necessary) then further research is required to enable the age of *Nephrops* to be determined
- Further work is needed to ascertain whether the current division into functional units adequately reflects the distribution of *Nephrops*. Are there other areas containing *Nephrops* which should be incorporated into the assessments? Are there small pockets of *Nephrops* at different locations which should be brought into the assessments?
- It has been pointed out by those considering accreditation of the fishery that current management advice is based on a fixed harvest ratio rather than

biological reference points. In a situation where stocks are stable or increasing this can be appropriate, however recent information indicates that some stocks may be declining. Therefore there is a risk of the harvest ratio approach failing to protect these stocks. Action is therefore required in consultation with the appropriate scientific and management bodies to develop appropriate biological reference points for the fishery.

In summary, the main weaknesses in the stock assessments for North Sea *Nephrops* are the lack of precautionary reference points and the lack of control of TAC uptake at the functional unit level.

4. Major trends

Nephrops landings have progressively increased over the years. There have been jumps in the upward trend, perhaps associated with transfers of effort from other fisheries but perhaps also because of rectification of misreporting. The introduction of buyers and sellers regulations in the UK in 2006 considerably tightened up levels of reporting for *Nephrops*, and landings figures since then are considered to be more reliable. Recent increases in reported landings may just be the result of the increase in reporting levels rather than an increase in actual landings. Effort in terms of hours fished is a non-mandatory record on the log sheets and therefore landings per unit effort do not necessarily reflect changes to the stock. ICES scientists have noted that most stocks appear to be fairly stable in terms of abundance and size composition. Notable exceptions are the Fladen Ground stock which showed a marked increase in abundance and the Farne Deeps stock where the population size dropped in 2007 and unusual changes in the seasonal sex-ratio pattern occurred.

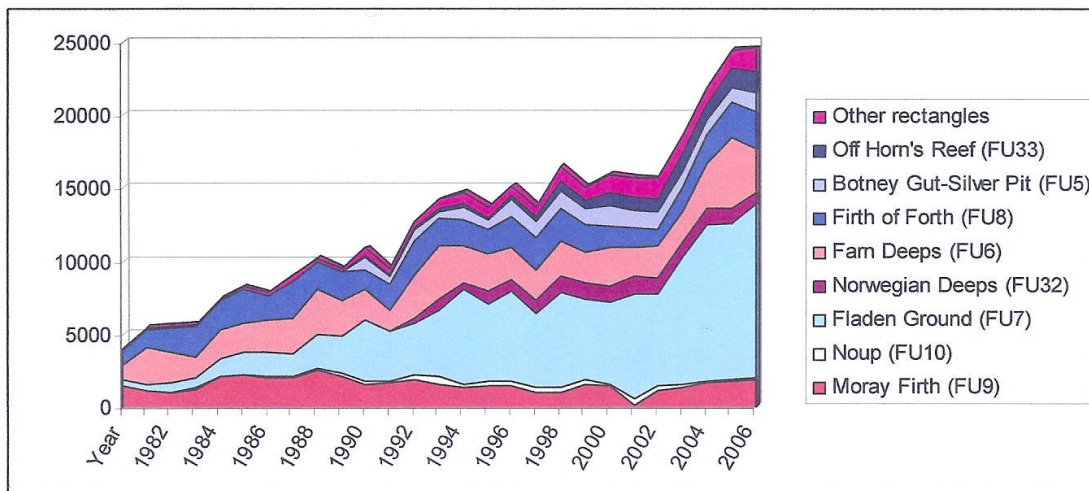


Figure 3: *Nephrops* in ICES Subarea IV. Total landings divided into functional units and other rectangles (tonnes)

In 2009, ICES provided updated assessments and information on stock status for those FUs for which UWTV surveys are available. The advice was presented separately for each functional unit. In addition, there were increasing and significant landings from some isolated patches outside the functional units, most notably the Devil's Hole. In 2008 overall landings in Subarea IV were around 22 100 tonnes, similar to landings in 2005.

Perceived abundance of *Nephrops* from the Fishers Survey conducted by the NSRAC is also increasing but levelling off and even declining at some locations in the most recent years.

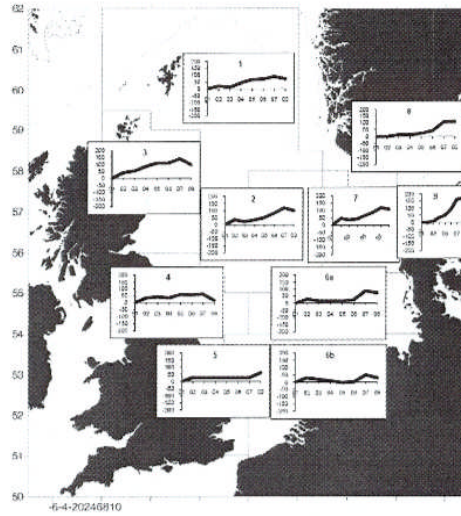


Figure 4: Results of the North Sea Fishers' Survey 2008

Table 1: Nephrops in Subarea IV. Officially reported landings by functional unit

Year	FU 5	FU 6	FU 7	FU 8	FU 9	FU 10	FU 32	FU 33	Other IV	Total
1981		1073	373	1006	1416	36			76	3980
1982		2524	422	1195	1120	19			157	5437
1983		2078	693	1724	940	15			101	5551
1984		1479	646	2134	1170	111			88	5628
1985		2027	1148	1969	2081	22			139	7386
1986		2015	1543	2263	2143	68			204	8236
1987		2191	1696	1674	1991	44			195	7791
1988		2495	1573	2528	1959	76			364	8995
1989		3098	2299	1886	2576	84			233	10176
1990		2498	2537	1930	2038	217			222	9442
1991	862	2063	4220	1404	1519	196			560	10824
1992	612	1473	3338	1757	1591	188			401	9360
1993	721	3030	3521	2369	1808	376	339	160	434	12759
1994	503	3683	4566	1850	1538	495	755	137	703	14230
1995	869	2569	6442	1763	1297	280	489	164	844	14717
1996	679	2482	5220	1688	1451	344	952	77	808	13701
1997	1149	2189	6171	2194	1446	316	760	276	662	15163
1998	1111	2177	5138	2145	1032	254	836	350	694	13736
1999	1244	2391	6505	2205	1008	279	1119	724	988	16463
2000	1121	2178	5580	1785	1541	275	1084	597	900	15060
2001	1443	2574	5545	1528	1403	177	1190	791	1268	15919
2002	1231	1953	7234	1340	1118	401	1170	861	1383	16691
2003	1144	2245	6305	1126	1079	337	1089	929	1390	15644
2004	1070	2152	8733	1658	1335	228	922	1268	1224	18590
2005	1058	3094	10685	1990	1605	165	1089	1050	1120	21855
2006	986	4858	10789	2458	1803	133	1028	1288	1249	24591
2007	1311	2966	11910	2652	1842	155	755	1467	1637	24695
2008*	695	1213	12240	2450	1514	173	675	1444	1673	22077

* Preliminary

5. Mixed Fishery Considerations

Much of the North Sea *Nephrops* trawl catch was originally taken in mixed fisheries, and that is still the case in many areas like the Fladen ground, the Skagerrak and Kattegat and in the Scottish, Dutch and Danish fisheries. A range of vessels catch *Nephrops* while at the same time targeting other species like plaice, cod, whiting or haddock. Even where *Nephrops* is the main target a significant income may be obtained from the whitefish species caught. As a result of the cod recovery plan vessels targeting whitefish are required to use 120 mm nets, which lose a large part of the *Nephrops* catch. Such vessels are subject to greater days at sea restrictions.

Nephrops vessels are permitted to use smaller meshes. By-catches of cod in the inshore *Nephrops* fisheries of the North Sea are currently fairly small (ICES 2009c). However, the *Nephrops* fishery at the Fladen has a by-catch of cod and ICES has stressed that it is important that emerging year classes should not be subject to mortality as by-catch. Two of the three retained by-catch species, cod and whiting, are currently considered outside biological limits although effective management strategies have been imposed to assist their recovery. These two species, as well as haddock, may be discarded. The risk of catching whitefish is reduced by the imposition of catch composition rules and by the application of measures to improve the selection of *Nephrops* and reduce catches of whitefish. Efforts are being made in Scotland through the Conservation Credits scheme, requiring vessels targeting *Nephrops* to use gear with larger square mesh panels (110 mm). Further selective measures are being considered.

Nephrops fishers are especially concerned about measures which regulate the catch composition to a minimum percentage of *Nephrops*. Vessels legitimately targeting *Nephrops* may catch quantities of haddock, whiting and cod but they may be forced to discard these marketable fish to comply with catch composition rules. The technical conservation regulations which specify catch compositions in relation to a number of mesh ranges require discarding to take place if the vessel is to fish legally.

Days-at-sea regulations and cod recovery measures have reduced opportunities for directed whitefish fishing. The STECF effort database suggests that effort transfer to the smaller mesh *Nephrops* fisheries of the North Sea took place shortly after the introduction of the regulations. In addition, restrictions on fishing in other areas, including western waters, has also resulted in effort being transferred to the North Sea. Any further reductions in whitefish effort can be expected to result in a transfer of further effort into the *Nephrops* fishery, perhaps with an impact upon the by-catch.

Transfer of effort into the North Sea *Nephrops* fishery has been the unintended consequence of restrictions imposed elsewhere and on other sectors of the fleet. This issue must be addressed in the LTMP. It is also evident that reduction of discards must form an important component of the LTMP.

6. Ecosystem Considerations

Any LTMP must consider ecological, as well as social, and economic objectives. In particular, the plan must address the complexity of natural ecological processes and adopt an adaptive management approach in the face of uncertainty. We have already commented on the relationship between *Nephrops* and predatory fish and have pointed out that increasing abundance of cod, in particular, may have an impact upon *Nephrops* populations.

We have mentioned concerns over by-catch and discards of non-target whitefish. There may also be a problem with the capture of undersized species including other crustaceans, fish and small *Nephrops*. The LTMP must address the issue of discarding by vessels fishing for *Nephrops*.

Impact upon sensitive seabed habitats has been raised as a problem by Environmental NGOs. There is concern over the impact of trawling upon areas of seabed by weighted ground lines and otter doors. Organisms which might be particularly affected by trawling include the sea pens (sea pens are colonial corals supported by internal skeletal structures which live partly imbedded in fine sediments on the sea floor, extending well above the sea surface) and echinoderms (including sea urchins, sea cucumbers, crinoids, starfish and brittle-stars). Towed fishing gears such as otter trawls and beam trawls can alter the physical structure of the seabed. The impact on benthic communities and ecosystems will vary with the sensitivity and natural disturbance of the seabed. The high mud content and soft nature of *Nephrops* grounds means that trawling readily marks the seabed, and trawl marks may remain visible for some time. Twin-rigged and multi-rigged trawls may have a more detrimental effect on *Nephrops* habitat and the sea bed as they employ heavy weights to couple the gears together.

Burrowing fauna can be seen re-emerging from freshly trawled *Nephrops* grounds, implying that there is some resilience to trawling. Nevertheless, technical measures to reduce seabed impacts should be encouraged.

The loss of locked up carbon from disturbed sediments may need investigation.

A number of ecosystem objectives have been discussed. The target of ecological sustainability for all North Sea fisheries acknowledges the need to minimise the impacts of fishing on the ecosystem.

Ecological sustainability of the North Sea's fisheries is essential not only for long-term species and ecosystem viability but also to underpin economic sustainability. A key goal of the *Nephrops* fishery LTMP is to minimise its impacts on the ecosystem. Such factors and impacts have to be accounted for and addressed by the plan if it is to meet its overall goals.

The extent to which the Management Plan is achieving the range of stated goals and objectives should be assessed using a combination of indicators designed to measure performance of the fishery. These performance indicators may be biological or non-biological. Possible performance indicators are:

- Level of fishing mortality (with respect to a target F)
- Abundance trends obtained through UWTV surveys (with respect to a trigger point for assessing deterioration in the stock)
- Level of discarding
- Uptake of environmentally friendly fishing practices
- Number of Marine Protected Areas

Research and Monitoring

There are a number of research and monitoring requirements for the *Nephrops* fishery to achieve the objectives of this Management Plan.

The development and extension of fishery independent surveys, including UWTV surveys, is an important feature of the plan, not only to aid the assessment of prawn stocks, and aid the overall fishery management process, but also to play a crucial role in monitoring the fishery's broader ecological performance.

By-catch - species that are discarded from the catch or retained for scientific purposes, and that part of the “catch” that is not landed but is killed as a result of interaction with fishing gear. This includes, but is not restricted to, discards of commercially valuable species.

7. Uncertainties

Although ICES consistently advises that the fisheries should be managed by functional units, in recognition of the relatively localised and isolated nature of *Nephrops* stocks, *Nephrops* continue to be managed as if they were a single North Sea stock. Moreover, some of the functional units are of uncertain status. In considering the North Sea *Nephrops* fishery for accreditation it has been recommended that catch from the Farne Deeps functional unit be excluded from the unit of certification.

Differences in the importance of *Nephrops* to different Member States means that there are differences in the level of commitment to scientific research into *Nephrops* and in the collection of data to support scientific assessments. In the main, scientific studies of *Nephrops* are confined to the UK and Denmark. There are few data available for some of the functional units. For example, for some of the FUs with lower levels of landings (e.g. Botney Gut), there is no UWTV abundance estimate and in addition, commercial sampling data (length frequency information) have often only been gathered in recent years. The management plan will need to consider whether additional information is required for management to be effective, and how that additional information might be obtained.

One uncertainty for the *Nephrops* fisheries is the extent to which fishing grounds may be affected by international and national initiatives to introduce marine protected areas (MPAs). The Netherlands portion of Botney Gut is about to be designated a Natura 2000 Special Area of Conservation (SAC) under the Habitats and Species Directive, which may affect the activities of fishers from all Member States. Further threats may develop from proposals to site wind-farms and other energy-based developments.

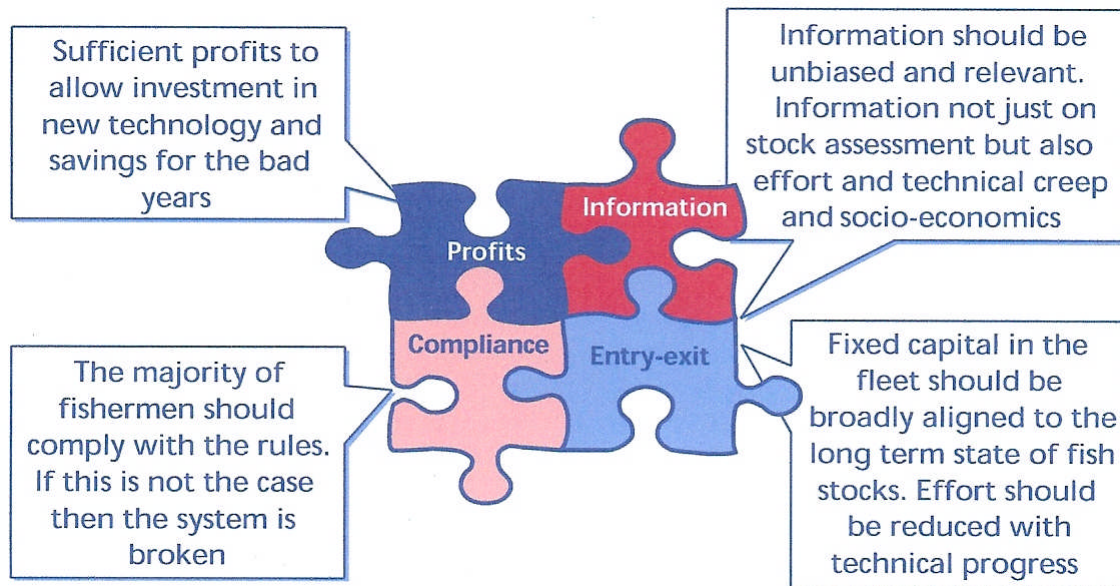
A case can be made for defensive mapping of fishing effort for *Nephrops* in the North Sea, using VMS and other sources, to ensure that any displacement of effort as a result of MPA and wind-farm proposals can be evaluated.

A particular problem for *Nephrops* from a management standpoint is the absence of a full analytical assessment. It is most unlikely that analytical assessments and forecasts will be available for the different *Nephrops* stocks in the foreseeable future. In these circumstances it may be more appropriate to move towards a more pragmatic management approach.

8. Defining Objectives

The Report on Long-term Management of North Sea Fisheries produced for the NSRAC pointed out that it is only by taking account of ecological, economic, and social factors within an appropriate institutional structure that development can continue without exhausting natural resources. It went on to point out that the overall goal of achieving sustainable fisheries could not be achieved by prioritising any one of the components of sustainability to the exclusion of others – for example targeting a high biomass or making profit maximisation the only goal. All aspects of sustainability had to be considered together.

This point has been echoed within the Net Benefits Report from the UK Cabinet Office. There is a management jigsaw, where all the separate issues must mesh together to create the overall picture:



Ecologically, the general reductions in mortality rate on some functional units being called for by scientists might be brought about by agreeing a time scale for reducing fishing mortality significantly and by agreeing a mechanism for applying it to the different functional units.

Economically, fishing businesses must be to achieve economic resilience based on sustainable level of profit. There is also a need to rationalise and harmonise various management measures and regulations that make fleets less efficient.

Socially, it is preferable for change to take place at a rate that can be absorbed by businesses ports and communities, especially if change is imposed through regulation. It is also important for stakeholders to be involved in any decisions that will have significant impact upon them.

Biological Objectives

The main biological objective is to avoid over-exploiting the resource. *Nephrops* in the North Sea must remain at or close to their full reproductive capacity and must be kept away from a state where they would be unable to replace themselves. There must be a low risk of the stocks showing a reduced production potential. They must be well above the lowest observed level of biomass.

Nephrops stocks in the North Sea for which assessments are available are considered to be stable in terms of abundance and size composition (except for the Farne Deepes). Indeed, *Nephrops* on the Fladen and other grounds have showed a marked increase in abundance in recent years. However, the Farne Deepes stock showed a population size drop in 2007 and unusual changes in the seasonal sex-ratio pattern have also occurred which may have been due to increased effort in the fishery on this functional unit. ICES has therefore made it clear that *Nephrops* should be managed by functional unit, rather than at an over-arching North Sea level.

We have already mentioned the need for management plans to take account of species interactions and other changes to the ecosystem which may have a significant effect upon *Nephrops* stocks. Within the North Sea there is a risk that a recovery of whitefish stocks, and especially cod, may result in increased predation upon *Nephrops*, leading to a decline in the available resource. The management objectives must deal with this uncertainty.

Assessments of the *Nephrops* functional units within the North Sea utilise a number of approaches, including TV surveys, length composition information, and basic fishery data such as landings and effort. Owing to uncertainties in the accuracy of historic landings and to inaccurate effort figures in some fisheries, increasing attention is paid to the TV survey information and size composition data as an indicator of stock abundance and trends.

STECF (2009) has recommended that management plans be developed with the objective of achieving high long-term yields and low risk to the stocks and that the plans should be applicable to the separate functional units. A decision rule is required for setting the TAC. The usual harvest control rule which appears in a management plan sets a particular target fishing mortality F when biomass is above B_{PA} , but if biomass falls below B_{PA} (but is above B_{LIM}) the F is reduced accordingly - following a sliding scale down to some fixed lower level which is applied if B falls below B_{LIM} . For other species these rules have depended on traditional methods of assessment and the reference points are derived from assessment results. The lack of an analytic assessment and forecast for *Nephrops* means that any decision rule for this fishery may have to be based on the UWTV survey abundance. The current approach of applying a harvest ratio (to the TV abundance) equivalent to fishing at an F_{MSY} proxy could be part of the harvest control rule.

It is expected that the quality of fishery data available for the *Nephrops* stocks will continue to improve. The UK registration of buyers and sellers legislation (since 2006) has led to more accurate landings information from these stocks and within a few years this should improve the basis for assessment and forecasts of catch. Stock monitoring continues, and enhanced work on observer trips on-board commercial vessels should furnish additional data on by-catches and discards. However, if future management is to

be based largely on the results from UWTV surveys then it is important to extend these surveys to cover all the functional units. This will require action by all Member States significantly engaged in the *Nephrops* fishery.

Economic Objectives

The overall economic objective might be to achieve a modern, stable and profitable fishing industry; with a fishing fleet able to renew itself; able to provide a supply of fish matched to the requirements of the market at appropriate prices for the processing industry and consumers; operating in a way which would enable the costs of all the participants to be met.

It is important to recognise that some of the markets for *Nephrops* are quite volatile and current prices are low. At the same time retailers are increasingly insisting on products which can be guaranteed to originate from a sustainable fishery. The costs of achieving certification of a particular fishery are substantial, and may not provide an adequate return on investment.

In developing this management plan we have concluded that member states and fishing businesses must be able to set their own priorities.

In addressing those economic issues member states and fishers may need to consider:

- Whether the fleet is the right size and type and has the right balance in terms of overall profitability and in terms of the fishing opportunities available

- Whether there is scope for further growth in the market, and the implications of that growth for management of the fisheries

- What degree of overall economic stability should be sought? If the fleet is currently acceptably profitable, and stocks stable, how can that position be maintained?

- How to deal with the problems of technology creep and the introduction of more efficient fishing methods (like multi-rig trawls) at a time when greater stability in fishing capacity is being sought

- Issues over the maintenance of open access to inshore fishing grounds (see section on Social Objectives below)

- Issues over the extent to which effort should remain mobile over the different functional units within the North Sea

Perhaps the major economic risk for the *Nephrops* fisheries is likely to come from excess fishing capacity. Fishing capacity is the maximum quantity of *Nephrops* over a period of time that can be caught by the fishing fleet if it is fully utilized. There are indications that Scottish North Sea *Nephrops* fleets are already over capacity.

Excess capacity in a fleet implies unnecessary excess investment in fixed assets which must then achieve higher amounts of profit to generate an acceptable return for that increased investment. Because fishing is a fairly risky business venture, the required return on investments should be quite high compared to alternative business investments. Capacity in the *Nephrops* fishery may already be too high (judging from the relative low profitability of individual vessels) and total capacity is likely to increase within the North Sea *Nephrops* fisheries as more vessels enter the fishery, attracted by the high value of the product, the stable state of the stocks, the pressure on other stocks, the lack of barriers to transfer into the fishery and into the area from another under the open access provisions of the CFP, and also as existing vessels become more capable due to the inevitable technology creep resulting from the ingenuity of fishers in developing increasingly efficient gears. Technology creep alone is estimated by the Commission to result in a 2-4% increase in fishing capacity every year. Such an expansion in capacity may threaten the economic stability of some, if not all, sectors of the fleet as well as threatening the stability of *Nephrops* stocks. Increase in capacity leads to poor economic performance and low resilience to external pressures, including pressures on the stocks.

However, managing fleet capacity is no part of this management plan. It is not the role of any LTMP to instruct fishing enterprises on how they should operate or take their own economic decisions, or to micro-manage the industry. This plan is a management plan not a business plan.

Social Objectives

It has become increasingly apparent that it is not only ports and coastal communities which benefit from fisheries. People in centres elsewhere and even away from the coast also derive income from it and are affected by any changes in the fishery. The important social objective is to ensure that changes do not harm the resilience of the fleet and all those people engaged in the industry. There must be fairness and equity in managing changes to the fishery and to ensure that any human impacts fall within reasonable bounds and do not take place at a speed which is difficult for dependents to deal with.

9. Instruments

Currently a TAC is applied to *Nephrops* across the North Sea. There is an issue over whether the TAC should be set for the North Sea, or for the various functional units. Some functional units may require additional measures to protect them if stocks fall outside given parameters. It will be necessary to consider a number of options for achieving this, for further discussion. Some of those measures might require clearer definition of the vessels attached to particular functional units, perhaps in terms of their commitment to a particular conservation code or agreement to restrictions on fishing method.

In terms of impacts upon other stocks, the *Nephrops* fishery, especially in Scotland, has already gone some way in reducing impacts upon whitefish stocks. Scientists have

stressed the importance of not subjecting emerging year classes to capture. This problem is already being addressed through the use of more selective gears and initiatives are in place to reduce the discard problem with respect to small fish. Efforts are being made in Scotland through the Conservation Credits scheme, requiring vessels targeting *Nephrops* to use gear with larger square mesh panels (110 mm). There is the possibility of linking mesh size changes to new Minimum Landing Sizes. There may still be some scope for improving gear selectivity. The introduction of Real Time Area Closures (RTCs) may be effective in some areas in reducing impact upon young fish. The imposition of permanent or seasonal restrictions on fishing in cod nursery areas offers an additional tool.

The NSRAC recognises the wish of the Commission to minimise discarding by 2012. By-catch and discards are amongst the most serious challenges in seeking sustainable fisheries and reducing them is part of 'the ecosystem approach' to fisheries management. It is also part of the process for achieving certification of a fishery, as discard reduction is often a requirement for receiving certification. However, the Commission has not yet defined what it means by "discards" and whether the term refers to all finfish and crustaceans in the by-catch or to commercial/quota species only. The *Nephrops* fleets will continue to trial measures to improve selectivity and is now confident that further improvements can be achieved. Any initiatives taken will need to be monitored and their efficacy assessed.

It is possible the *Nephrops* could provide a pilot project for dealing with discards. The Commission previously mentioned the possibility of a series of discard pilot projects, but has recently given less emphasis on this as a result of the Commissioner's own wish to introduce a discard ban for all fisheries.

There is legitimate concern by fishers over catch composition rules in the *Nephrops* fishery which force the discarding of species like cod. It is recognised that there is a need to discourage excessive targeting of white fish by vessels using smaller mesh gears without quota to land the fish. However the catch composition rules can result in discarding even where quota is available and whitefish are not being targeted. Some thought needs to be given to resolving this problem. Perhaps now that cod is recovering in the North Sea there is scope for easing the catch composition rules, as part of an adaptive approach.

It is acknowledged that bottom disturbance from *Nephrops* trawls may have an impact upon benthic communities and ecosystems. Emerging proposals to establish marine protected areas in the North Sea may facilitate study of these impacts and provide some basis for the protection of especially vulnerable organisms. Alternative towed gears with less bottom contact, larger meshes, and better selectivity profiles may offer a solution in some fisheries. Other measures might include the provision of dropout openings, and "wheeled" foot-gears replacing rock-hoppers.

It will be useful at the conclusion of the consultation stage to prepare a table of objectives, against which different instruments might be inserted. The following shows a simplified version, but merely for illustrative purposes. The actual objectives and instruments are set out in more detail in Section 2 of this document for further discussion with stakeholders.

Objectives <i>Where do we want to go?</i>	Instruments <i>How do we get there?</i>
Exploit <i>Nephrops</i> at rates that are sustainable	Set an appropriate/sustainable target fishing mortality (F) and fish according to this
Manage at the functional unit level	Apply a 'no more than' rule to the vulnerable units
Reduce discarding of emerging whitefish year-classes	Adopt additional robust and proven technical measures
Ease catch composition rules catch composition rules in the <i>Nephrops</i> fishery which force the discarding of species like cod.	Adopt additional robust and proven technical measures
Take account of cod recovery, which may result in a significant increase in natural mortality for <i>Nephrops</i> stocks	Prepare for the possible introduction of a reduction in the <i>Nephrops</i> TAC(s)
Minimise damage to threatened, endangered and protected species	Consider the introduction of MPAs to protect these species
Reduce impact of bottom disturbance from <i>Nephrops</i> trawls upon sensitive benthic communities	Implement environmentally friendly fishing gear and fishing practices
Any change imposed on the fishery to meet biological and ecological objectives must take place at a rate that can be absorbed by individual businesses and communities.	If TACs are to be reduced then this should be done in an incremental way

The above section needs extensive further discussion with the fishing fleets and other interests.

10. Timeframe

The NSRAC sees the LTMP for *Nephrops* fisheries as a gradual sequential response to risk operating over a period of about 15 years. The plan needs to be responsive and adaptive, changing as circumstances change.

11. Conclusions

To be considered

12. Review of Progress & Adaptive Management

To be considered

13. References

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