



Meeting of the *Nephrops* Long Term Management Plan Development Group

Tuesday 14th April 2009
Pentland House, Edinburgh

Rapporteur: Tony Hawkins

Draft for ExCom

1. Introduction, Apologies & Report of Last Meeting

1.1 The chairman, Michael Park welcomed participants to the meeting. The first meeting of the *Nephrops* LTMP Development Group had been held two years ago. The group had concluded:

- A stable TAC should be set for North Sea *Nephrops*, based on simple catch indicators and the results of TV surveys
- Both Maximum Sustainable Yield (MSY) and Maximum Economic Yield (MEY) were too simplistic as targets
- A simple effort control system, linked to monitoring of reference points seemed the best option
- Whether separate stock components needed separate management was an issue
- Catch composition rules were unhelpful
- Selectivity measures had reached their limit (but our position has moved somewhat since then)
- Achieving a long term sustainable fishery would deliver the necessary standards to achieve certification

1.2 Michael Park, in his introduction, pointed out that a number of management tools were listed in Article 4 of the basic regulation (EC 2037/2002) which could be applied to management plans under Article 6:

- limiting catches;
- fixing the number and type of fishing vessels authorised to fish;
- limiting fishing effort;
- adopting technical measures, including:
 - (i) measures regarding the structure of fishing gear, the number and size of fishing gear on board, their methods of use and the composition of catches that may be retained on board when fishing with such gear;
 - (ii) zones and/or periods in which fishing activities are prohibited or restricted including for the protection of spawning and nursery areas;
 - (iii) minimum size of individuals that may be retained on board and/or landed;
 - (iv) specific measures to reduce the impact of fishing activities on marine eco-systems and non target species;
 - (h) establishing incentives, including those of an economic nature, to promote more selective or low impact fishing;
 - (i) conducting pilot projects on alternative types of fishing management techniques.

1.3 The management plan we were embarking upon would be for the North Sea *Nephrops* fishery. *Nephrops* fisheries in the Skagerrak and Kattegat would be included, but there were differences in these fisheries which would need to be reflected within the plan.

2. NSRAC Perspective on LTMPs

2.1 Barrie Deas gave a short presentation on why we were here. What was the function of a long term management plan, and what should it look like? There were two main drivers for change to long term planning:

- The Council of Ministers wanted to get away from the annual debate on management measures. They wanted to see a multi-annual approach
- The Commission and Member States were committed to the Johannesburg Accord to maintain or restore stocks to levels that can produce the Maximum Sustainable Yield (MSY) by not later than 2015.

- 2.2 The commitment to LTMPs by the Commission was already being followed up and there were already plans for haddock, saithe and some pelagic stocks. However, these particular plans amounted to little more than the adoption of simple harvest control rules. Moreover, they had been developed and approved with almost no involvement from the industry.
- 2.3 The NSRAC had taken a long hard look at LTMPs. A focus group on long term fisheries objectives had met at Schiphol in 2005 and had concluded that LTMPs offered an opportunity to adopt a different, more inclusive, approach to fisheries management aimed at bringing all fish stocks within sustainable limits through the management of individual fisheries. That initiative had been followed by a workshop on long term management of North Sea fisheries, attended by scientists, managers, fishers and other interests. The workshop had come up with a series of clear recommendations:
- LTMPs had to be developed in an inclusive way, with industry buy-in. All interested parties should be involved in their development
 - The plans should embrace economic and social as well as biological objectives
 - The plans should be tailored to particular fisheries, not stocks
 - The plans should aim to move the fisheries in the right direction, rather than seek a particular, final destination.

The workshop had ended by concluding that:

- Better governance is a pre-condition for the development of long term management plans
- The process must be 'bottom-up' not 'top-down'
- The RACs should formulate their own plans, with help from the Commission & Member States
- First, the key fisheries would need to be defined
- Expert advice would then be required to set out the options
- It would be especially important for fishers & other stakeholders to choose the options and set the objectives
- Above all there would have to be extensive engagement with those who would be affected by the plans.

A template had been prepared for saithe in the North Sea and West of Scotland, setting out the points which would need to be included in a LTMP.

- 2.4 Recently, ICES had accepted the need for LTMPs and a meeting had been held involving ICES, STECF and the RACs to address the issue of how such plans should be prepared. The meeting had agreed that fishery management plans needed to have economic as well biological objectives. It had also suggested that the plans required something different to the traditional sequential evaluation of plans by scientists. Instead the preparation of the plans required an iterative approach. The plans would have to go back and forth between the different parties before agreement could be reached.
- 2.5 Today we would not be preparing a finished management plan for *Nephrops*. Rather, we would be aiming to set out the main elements of a plan, including various options. Those options would then need discussion amongst the different interested parties. The plan would move away from *ad hoc* measures devised late at night, and would remove politics from the process of management. The role of scientists would change. They would be there not to evaluate the plans but to provide expert information which would assist in the preparation and formulation of the plans.

- 2.6 Points made in the subsequent discussion included:

The Commission and Environmental NGOs should be participating in these discussions. It was unfortunate that they had decided not to attend this meeting

LTMPs should not be unduly deterministic. They should simply set out agreements to act in particular ways when faced with different future scenarios

The scale and variety of the fisheries is important. One size does not fit all.

The economics of the industry are changing. We now lived in a more volatile world where marketing issues are increasingly important.

3. Economic Contribution of the North Sea *Nephrops* Fishery

- 3.1 Louise Cunningham of the Stock Conservation and Negotiations Policy division of the Scottish Government gave a short presentation on the *Nephrops* fishery. In Scotland, the fishery had started in early 1950s. Before that the stocks were not exploited – any caught incidentally during the capture of whitefish were discarded. There had followed a great increase in the global catch of *Nephrops*. The North Sea landings had increased, often in a series of jumps. The North Sea TAC for *Nephrops* is currently 24,837 tonnes, with a UK North Sea TAC of 21,513 t (87%). 24% of the global catch is landed in Scotland and 94% of the North Sea catch. The North Sea catch is worth over £56 million at first sale and *Nephrops* is by far the most valuable stock to Scotland.
- 3.2 Total landings for the whole of Scotland for Scottish trawlers in 2007 were £89.210M, with landings by Scottish vessels from the North Sea trawl fishery worth £62.27 M, an average of £415,133 per vessel. The catch composition is 80% *Nephrops*. The creel fishery from the whole of Scotland (mainly taken on the west coast) is worth £12.386 M, an average of £73,290 per vessel. The catch composition is 95% *Nephrops*. The total value of *Nephrops* to Scotland is £104.3

M, including *Nephrops* landed by non-Scottish vessels, compared to only £14.5 M for cod. The main export markets for *Nephrops* are in Spain, Italy, & France, but there are emerging markets in Russia, the Far East and Middle East. Exports are 90% of all sales.

3.3 The Scottish Government is keen to see a LTMP in place for this important fishery.

3.4 Points raised in discussion were:

The 'jumps' in *Nephrops* landings in the past reflect a switching of vessels from one fishery to another but the figures have also been influenced by misreporting. Misreporting ceased with the introduction of buyers and sellers registration in 2006.

The price per kilo has dropped significantly in 2008 and 2009, perhaps through over supply, but also because of the current economic crisis especially in southern Europe.

Nephrops is now a much more valuable stock than cod, but management of the *Nephrops* fishery is greatly affected by the cod recovery plan.

4. An overview of North Sea *Nephrops*: biomass and harvest rates

4.1 Helen Dobby, of Marine Scotland – Science (formerly FRS) gave a presentation on the assessment of *Nephrops* stocks. In the North Sea the stocks have been divided into 8 functional units, viz:

- Off Horns' Reef
- Botney Gut
- Fladen Ground
- Norwegian Deep
- Farne Deep
- Noup
- Moray Firth
- Firth of Forth

Catches on some of these grounds are no longer increasing, but there are upward trends for some, and especially for the Fladen Ground. In addition there are significant landings from areas which are not within the defined functional units.

4.2 The typical assessment process for finfish stocks involves two stages. A retrospective analysis of fish population age structure is carried out using fishery and survey data to reconstruct the stock and estimate fishing mortality. Then forward predictions of catch and stock size are made using best estimates of future mortality and biology (including a stock recruitment relationship). There are, however, difficulties with the assessments of *Nephrops* which means that this process cannot be followed. Crustaceans like *Nephrops* cannot readily be aged. Their growth and behaviour differs with sex and other factors. They live in burrows and have a complex pattern of burrow emergence behaviour which means that trawl surveys are not thought to provide a reliable index of abundance. Finally, the

historic landings have been uncertain for a number of stocks, making assessments based on commercial catch data unreliable, although these data are now greatly improved (since the introduction of buyers and sellers legislation).

- 4.3 In Scotland, sampling of the landings is carried out at markets & processors. In addition, discards are monitored at sea. Stocks are also examined directly through underwater TV surveys. A sledge is dragged across the seabed, and the number of burrows counted along a track. The surveys are randomly stratified by sediment type, with 10 min tows at each station. A 1:1 occupancy rate is assumed for the burrows and the total number of *Nephrops* is raised to the total area of that sediment type and summed for the functional unit. Trends in the counts vary from one functional unit to another. In the Moray Firth and Farne Deeps they have recently declined. On the Fladen they show an upward trend.
- 4.4 Estimates of sustainable harvest rates – the proportion or percentage of the stock that can be removed in a given time - can be made and applied to the TV survey results to give an estimate of the total numbers removed. Knowing the size distribution of the catch this can be used to estimate the predicted landings (minus discards). There have been issues recently in agreeing an appropriate harvest rate to be applied. It is possible to use the ratio of landings and TV survey abundance averaged over some historical period. However, if historical landings have been underreported or the fishery in a functional unit is newly developing then this method may not provide an estimate of the harvest rate that a particular functional unit can potentially sustain. Alternatively, the harvest rate can be based on a sustainable F. Yield-per-recruit calculations carried out by ICES at recent Assessment Working Groups indicate $F_{0.1}$ to be around 0.2 for many of the functional units; equivalent to a harvest rate of just under 20%.
- 4.5 The approach of the ICES North Sea Assessment Working Group in 2008 was to apply $F_{0.1}$ based harvest ratios to the TV survey data for each functional unit to obtain catch options. The landings portion of these catches was then summed over all functional units to give the total TAC for the North Sea. The assessments are forwarded to the ICES Review Groups, Advice Drafting Groups and finally the ICES Advisory Committee (ACOM) which finalises the advice. The Advisory Committee concluded that that the TV surveys provides a good indication of stock status. Most stocks appear relatively stable. Noted exceptions were the Fladen Ground which showed a marked increase and the Farne Deeps where the population size dropped in 2007 and unusual changes in the seasonal sex-ratio pattern occurred. ICES added the caution that the TV surveys were likely to be biased and probably overestimate absolute stock size. However, no agreement could be reached on the level of likely bias (for each functional unit) with which to adjust the survey abundance estimates and the advice for 2009 was based on average landings (over 2006 and 2007) and no effort increase. The bias results from a number of factors including: 'edge effects' (accounting for burrows overlapping the edge of the TV screen twice), burrow detection rate and species identification.
- 4.6 The very limited use of the TV survey data by ICES in the provision of advice on *Nephrops* was disappointing for the Assessment Working Groups. A recent ICES Benchmark meeting on *Nephrops* has now, for each functional unit, estimated the bias; calculated harvest rates based on range of survey selection lengths and

assumptions of $F_{0.1}$ and F_{max} ; and agreed a protocol for providing a catch options table.

- 4.7 In terms of a LTMP for *Nephrops*, the biological objective is to keep stocks within sustainable limits. A decision rule is required for setting the TAC, and trigger points are required. These rules depend on traditional methods of assessment, however, and we do not have these for *Nephrops*. We only have empirical indicators i.e. based on data collected as part of the monitoring process. For *Nephrops* in the North Sea these empirical indicators include:

- Raw catch or catch-per-unit-effort
- Mean length/weight of sampled individuals
- Length structure
 - recruitment fraction
 - mature fraction
- Spatial distribution
- Fishery independent surveys

For *Nephrops* there is no forecast of population size and therefore any harvest control rules will probably have to be based on empirical indicators, for example, using the TV surveys as an adjusted (for likely bias) absolute abundance or a relative index and modifying the TAC according to the gradient of the index or % change in the index.

- 4.8 What are safe biological limits for *Nephrops*? Due to the absence of analytic stock assessments for *Nephrops*, no reference points are defined. However, reference points (not necessarily in the traditional ICES sense) for the empirical indicators discussed above could be defined from historical data, expert knowledge or simulation. These reference points must be able to trigger management action to protect stocks from depletion. Stock size reference points related to the TV survey could perhaps be based on a value equal to a particular fraction of the maximum TV abundance or the minimum TV abundance. Fishing mortality reference points could be determined from a yield-per-recruit relationship. Clearly different functional units could have different stock status with respect to any reference levels and therefore different management actions might be implied for the different functional units. This would be difficult to reconcile with the current management regime which is a total North Sea TAC. Additionally, for some of the functional units there are no TV survey results. How do we deal with this and merge the results into a TAC for the North Sea?
- 4.9 The general conclusion was that analytic assessments for *Nephrops* were still some way off. A LTMP might be based on abundance estimates from the TV surveys combined with a fishing mortality figure taken from the yield per recruit relationship. A question remained, however, about the appropriate spatial scale.
- 4.10 A number of points emerged from the ensuing discussion:

There was disappointment that ICES had not made more use of the TV survey data in the provision of their advice for 2009. For *Nephrops* there was essentially a lack of the kind of information which would lead to a conventional analytical

assessment. The life history of *Nephrops* simply did not allow these data to be collected.

The ICES Advisory Committee does not seem particularly willing to embrace new approaches to assessment and the provision of catch forecasts. There is no sound basis for deciding on a particular value for fishing mortality. $F_{0.1}$ is an arbitrary fishing mortality used as a proxy (more cautious than F_{max}) for F_{MSY} .

There was agreement that the TV surveys provided good, new, empirical knowledge, which offered a way forward. However, there was still a need to set a reference level; to know where the stock abundance was now in relation to where it ought to be. The coverage of the TV surveys is currently rather limited and only four out of the eight North Sea functional units have regular TV surveys.

There was concern that the functional units themselves might be inappropriate. The Farne Deeps extend from the Bass Rock to the Humber, and include St Abbs Head. These different areas should not be lumped together. The areas had simply been decided upon from the distribution of sediment types and they might not be true functional units in terms of *Nephrops* stocks/populations.

- 4.11 The general conclusion was that this Development Group should not allow itself to be inhibited unduly by the conclusions of the ICES Advisory Committee, or by past scientific assessments. The group should proceed with producing an outline for a *Nephrops* Long Term Management Plan, to be progressively built upon. It should include options for fishers, managers, scientists and other interest groups to reflect upon and consider.
- 4.12 The draft plan, prepared as a result of the discussions of the Development Group, is presented as Annex I. It follows the template originally laid down for saithe. At this stage it is presented for discussion and to stimulate the acquisition of additional relevant information. The Development Group envisages the plan being developed in stages.
- 4.13 An important issue is how we engage more closely with the industry at the options stage, and how we resolve difference between different sectors of the industry. It is likely that we will need to visit the fishing ports to ensure that all the options are thoroughly discussed. Industry buy-in will be necessary.
- 4.14 What do we do next? It is clear that the framework we have set out for the LTMP and the text inserted into it need to be reviewed by experts and commented upon further within the NSRAC before it can be taken forward. The primary requirement would seem to be to develop clear, unequivocal economic and social objectives for the plan. The biological objectives may well be easier to resolve. A focused discussion of the economic and social aspects should be high on our agenda.
- 4.15 There may be money available to fund a pilot project associated with the plan. Suggestions for appropriate topics should be forwarded to Ann Bell.

5. Attending

Michael Park	Chair, SFF/NSRAC
Tony Hawkins	Rapporteur
Michael Andersen	Danish Fishermen's Association/NSRAC
Svend-Erik Andersen	Danish Fishermen's Association
Barrie Deas	NFFO/NSRAC
Pim Visser	EAFPA/NSRAC
Ann Bell	NSRAC
Louise Cunningham	Marine Scotland
Ian Wakenshaw	NFFO
Sandy Ritchie	ASFA
Dennis Clarke	NFFO
Helen Dobby	Marine Scotland
Rory Campbell	SFF
Bill Wiseman	SWFPA
John Watt	SWFPA
Craig Burton	Seafood Scotland

Annex I

A Draft LTMP for North Sea *Nephrops*

1. 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 and especially the northern Adriatic.

Nephrops is common across the North Sea and into the Skagerrak and Kattegat. It lives in shallow often branching burrows in soft stable cohesive mud at depths ranging from 20m to 800m (Rice & Chapman, 1971; dos Santos & Peliz, 2005). The presence of suitable sediment 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, and a burrow may also have more than one entrance. The burrows may also be shared by a variety of other species, including small fish. *Nephrops* remain within their burrows by day and emerge at sunset to forage during the night but in deeper water this activity is reversed and individuals may be more active by day. At intermediate depths, greatest activity occurs at dawn and dusk (Chapman and Howard, 1979). *Nephrops* also exhibit seasonal burrow emergence patterns associated with mating and moulting, and these are most pronounced in mature female *Nephrops*. After spawning, berried females largely remain in their burrows for the entire incubation period, which for most functional units is 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. 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, and therefore *Nephrops* may be more abundant when these fish species are scarce.

The lack of age-structured data and the particular life-history features including the highly variable and sexually dimorphic growth rates make the use of standard stock assessment methods very difficult to apply. An approach which makes use of an underwater TV survey of *Nephrops* burrows to estimate population abundance has therefore been developed (ICES 2007).

Currently, in the North Sea the stocks are assessed as eight separate functional units (Figure 1) based on the distribution of sediments. It is unlikely that there is exchange of

individuals between functional units, except possibly at the planktonic stage, as adult *Nephrops* are relatively sedentary, seldom moving more than a few hundred metres (Jensen, 1965; Chapman, 1982). However, within a functional unit, the *Nephrops* distribution can be quite heterogeneous, in terms of density, size and sex composition and biological characteristics (possibly dependent on sediment composition) and therefore the existence of separate sub-stocks within some of the larger functional units cannot be ruled out (Tully & Hillis, 1995; Tuck *et al.*, 1997). There are therefore spatial problems in carrying out stock assessments and setting TACs.

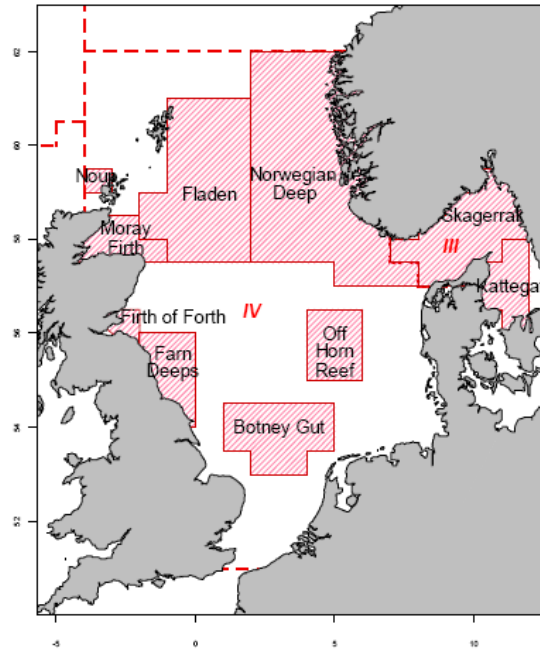


Figure 1: *Nephrops* functional units in the North Sea and Skagerrak/Kattegat region

NB. This section needs to be revised by a Nephrops expert, and references to appropriate scientific papers included.

The *Nephrops* fisheries

Nephrops are caught by two markedly different fishing methods. In some areas they are caught in baited creels or pots, fished by small vessels. In others they are caught in otter trawls. Originally the trawls were single, but more recently twin-rig trawls and multi-rig trawls have been applied in the *Nephrops* fisheries. 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. In some areas (but rarely in the North Sea) there may be conflict between creel fishers and trawl fishers.

In the North Sea the *Nephrops* fisheries are managed through the setting of a TAC. Minimum Landing Sizes apply and may vary from 7 – 13 cm total length depending on

the area. Minimum net mesh sizes are also set, but these also vary with area. By-catch limits have been imposed. *Nephrops* fishers have recently adopted technical measures including mesh size, square mesh panels and twine thickness to conserve fish stocks.

Days-at-sea regulations introduced under the cod recovery plan have 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, may have resulted in transfer of effort into the *Nephrops* fleet shortly after the introduction of the regulations.

The *Nephrops* fisheries started in the North Sea in the early 1950s. Before that the stocks were not exploited – any caught incidentally during the capture of whitefish were 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 (87%), the remainder being caught predominantly by Denmark and Belgium. *Nephrops* is an especially valuable stock to Scotland.

The *Nephrops* fisheries in the Skagerrak and Kattegat show differences to those in the North Sea. Mesh sizes are larger and are not tailored solely 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.

Nephrops is a luxury product and exports are the bulk of all sales, the main export markets being in Spain, Italy, & France, but with emerging markets in Russia, the Far East and Middle East. The bulk of *Nephrops* are sold as fresh or frozen tails or whole lobsters, but there is also an important market for live langoustines.

NB. This section needs to be revised and added to by an appropriate expert with more detail provided on the different fleets and their characteristics.

Assessment of the *Nephrops* stocks

In the North Sea *Nephrops* stocks have been divided into 8 functional units, viz:

- Off Horns' Reef
- Botney Gut
- Fladen Ground
- Norwegian Deeps
- Farne Deeps
- Noup
- Moray Firth
- Firth of Forth

The typical assessment process for finfish stocks involves two stages. A retrospective analysis of fish population age structure is carried out using fishery and survey data to reconstruct the stock and estimate fishing mortality. Then forward predictions of catch and stock size are made using best estimates of future mortality and biology (including a stock recruitment relationship). There are, however, difficulties with the assessments of *Nephrops* which means that this process cannot be followed. Crustaceans like

Nephrops cannot readily be aged. Moreover, their growth and behaviour differs with sex and other factors. They live in burrows and have a complex pattern of emergence behaviour. Finally, the historic landings have been uncertain for a number of stocks, making assessments based on commercial catch data unreliable, although these data are now greatly improved (since the introduction of buyers and sellers legislation).

Sampling of *Nephrops* landings is carried out at markets & processors. In addition, discards are monitored at sea. In Scotland, stocks are also examined directly through underwater TV (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 randomly stratified by sediment type, with 10 min 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 for the functional unit.

These surveys have enabled the development of fishery-independent indicators of abundance. STECF has suggested that a combination of an absolute abundance estimate from an UWTV survey and a harvest rate based on $F_{0.1}$ from a combined sex-length cohort analysis (LCA) and the mean weight and selection pattern from the commercial fishery could be used to calculate appropriate landings. This approach has been further elaborated and evaluated by ICES. The conclusion was that the use of UWTV surveys for absolute abundance estimates could lead to an overestimation bias due to misidentification of burrows, uncorrected 'edge effects' (Campbell *et al.*, 2009), and occupancy rate. The amount of overestimation bias could not be specified. ICES therefore did not base the advice for 2009 on the approach indicated above but used the UWTV survey only as a relative indicator of abundance.

A recent ICES Benchmark meeting on *Nephrops* has now provided estimates of the bias based on simulations (Campbell *et al.*, 2009) and expert opinion; calculated harvest rates based on range of survey selection lengths and assumptions of $F_{0.1}$ and F_{max} ; and agreed a protocol for providing a catch options table (ICES, 2009).

Currently, because of the assessment problems, no management objectives have been set for North Sea *Nephrops* stocks. Precautionary reference points have not been determined for *Nephrops*. ICES has suggested that $F_{0.1}$ estimates from a yield-per-recruit analysis based on a combined sex-length cohort analysis (LCA) could be used as a fishing mortality reference point (i.e. as a proxy for F_{msy}).

In 2008, ICES concluded that given the apparent stability of the stocks current levels of exploitation and effort appear to be sustainable. However, ICES recommends that effort and catches should not increase above recent average values (2006–2007).

ICES has 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 the subarea 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 in a largely uncontrolled way. 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.

NB. This account needs to be reviewed by a Nephrops assessment expert and modified as necessary.

2. 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 the buyers and sellers regulations in Scotland in 2006 considerably tightened up the levels of reporting for *Nephrops*, and the landings figures since then are considered to be more reliable. Recent increases in landings and landings per unit effort (lpue) may have resulted from the increase in reporting levels and do not necessarily reflect changes to the stock. ICES has 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.

The economics of the *Nephrops* fishery are changing and marketing issues are becoming increasingly important to all fisheries in the current economic climate. Prices for *Nephrops* dropped significantly in 2008 and 2009.

3. Mixed Fishery Considerations

Much of the *Nephrops* trawl catch was originally taken in mixed fisheries, and that is still the case in the Skagerrak and Kattegat and in the Dutch and Belgian fisheries where other species like plaice are also being targeted. In general, however, in the North Sea itself there has been a move towards separation between whitefish vessels and *Nephrops* vessels, brought about largely because 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, and the risk of catching whitefish is then 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.

In general, by-catches of cod in the *Nephrops* fisheries have been fairly small, particularly in recent years in inshore grounds in the North Sea. However, ICES has stressed that it is important that emerging year classes should not be subject to mortality as by-catch. Trawling for *Nephrops* does result in by-catch and discards of other species, including cod, haddock, and whiting. 80 mm is the predominant mesh size used in *Nephrops* fisheries and the resulting discarding of fish can be high. The capture of juvenile fish or other species such as haddock is considered to be a problem in some

of the functional units and discarding of these is a problem in some years. This problem can be addressed with 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 meshed panels (110 mm). Subject to evaluation of the effectiveness of these measures, ICES considers that further action may be required to reduce by-catch.

Days-at-sea regulations have reduced opportunities for directed whitefish fishing. The STECF effort database suggests some effort transfer occurred to the smaller mesh fisheries of the North Sea shortly after the introduction of the regulations; since then effort in these categories has been fairly stable.

It is worthy of note that currently far reaching recovery arrangements have been put in place for a very cheap fish (cod) which preys on a much more expensive species (*Nephrops*).

4. Ecosystem Considerations

Some concern has been expressed over the environmental consequences of fishing for *Nephrops* (whether with creels or otter trawls). This concern is focused on discards (of non-target species and undersized commercial species) made up of other crustaceans, fish and small *Nephrops*. There is also 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.

5. Uncertainties

As outlined above, ICES has 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.

This is because catches can be taken anywhere in the subarea and this could lead to over-exploitation of some functional units. ICES has suggested that management should be at the functional unit rather than the ICES subarea level. However, there is currently no certainty that these are the most appropriate functional units. The defined areas may not be completely separate and recruitment from one may affect another. On the other hand, some of the units are very large and there may be smaller sub-units within them that behave differently. The availability of information on the different functional units varies greatly. There is almost no information available on some functional units, eg Botney Gut.

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. This problem must be addressed.

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. 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.

Climate change and regime shift has the potential to affect *Nephrops* fisheries, but the extent of this problem cannot yet be assessed.

There is concern that the *Nephrops* fisheries have been greatly affected by measures taken under the cod recovery plan. The effort regime introduced to protect cod has certainly restricted the activities of *Nephrops* fishers and may have resulted in a transfer of effort into the *Nephrops* fishery. There is a perception that concern over cod, which is now a relatively unimportant stock for the North Sea, is driving the management of all the North Sea fisheries.

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 the catch composition rules. Indeed, 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.

A particular problem for *Nephrops* from a management standpoint is the absence of a full analytical assessment. It is most unlikely that analytical assessments will be available for the different *Nephrops* stocks in the foreseeable future. In these circumstances it may be more appropriate to move towards the more pragmatic management approach outlined in the Commission's non-paper on Managing Fish

Stocks without Catch Option Tables. This paper sets out a new approach for stocks subject to poor scientific advice. The NSRAC has welcomed the Commission's initiative on this issue, which is a very important one. It has particular relevance to North Sea *Nephrops* and provides a starting point for discussion on how to deal with *Nephrops* stocks, where analytical assessments may never be achievable. This theme is developed further below.

6. Defining Objectives

The NSRAC has proposed that LTMPs plans should embrace economic and social as well as biological objectives.

Economic Objectives

Currently, the only economic information available to the NSRAC is from the Scottish fleet. For Scottish North Sea *Nephrops* trawlers (>10m) the average value of the landings per vessel is £415,133 per annum. For all Scottish *Nephrops* creel vessels (<10m) the average value of the landings per vessel is £73,290 per annum. At first sight the income per crew member is not large, especially for creel vessels. Further examination of the economic information is necessary to determine the level of profitability within the *Nephrops* fleet. Until that is done it is difficult to set clear economic objectives or to develop options for the future. However, it is important to recognise that the markets are now 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 high.

One starting point is to consider what the market wants. The interests of buyers may differ from country to country, however, and in the case of *Nephrops* many of the ultimate consumers are in southern Europe and elsewhere.

Economic issues which might be addressed through the setting of objectives within the LTMP include:

Whether the fleet is the right size and has the right structure 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 profitable, and stocks stable, should we aim to maintain that position?

Dealing 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 (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, or should be allocated by post code

Perhaps the major economic risk for the *Nephrops* fisheries is likely to come from expansions in 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. Whereas fishing effort can be measured in terms of kilowatts or other physical parameters the capacity expresses the ability of the fleet to catch *Nephrops*. Capacity in the *Nephrops* fishery may already be too high (judging from the relative low profitability of individual vessels). Capacity is also likely to increase within the North Sea *Nephrops* fisheries as a result of the attractiveness and high value of the product, the stable state of the stocks, the pressure on other stocks, the ability of vessels to transfer into the fishery and into the area from another under the open access provisions of the CFP, and the inevitable technology creep resulting from the ingenuity of fishers in developing increasingly efficient gears. Technology creep alone is estimated 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.

Such expansion in capacity can only be dealt with by limiting fishing effort (number of vessels or days at sea) or by limiting fishing efficiency (for example by controlling improvements to the efficiency of fishing gears).

In developing objectives it may be necessary to explain to the different industry sectors how they might benefit from developing a management strategy for *Nephrops*. It is important to recognise, however, that 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.

One of the major problems in setting out the economic options is a lack of data on the economics of the *Nephrops* fishery. The collection of appropriate data from all Member States engaged in the fishery should be a priority.

Social Objectives

We have seen that current management of *Nephrops* in the North Sea 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 this might result in very heavy harvest rates from some regions. As vessels are free to move between grounds, effort may develop on some grounds in a largely uncontrolled way. This appears to have been a particular problem in the Farne Deeps but it may occur on other grounds.

There are particular social problems where such grounds are situated close inshore. In many cases the larger vessels are able to spread their fishing over several functional units. However, small local vessels may only be able to fish local grounds, and they may be severely disadvantaged by a large influx of larger nomadic vessels. This mobility of effort may be a disincentive to local fishermen to take conservation measures on

grounds in their proximity as any benefits will be wasted if larger additional vessels arrive. One option which may need to be considered is strengthening the fishing rights of local vessels, or vessels which commit themselves to particular conservation measures.

Below it is suggested that the stability of the various *Nephrops* functional units should be achieved through a 'no more than' clause. Thus, the TAC set for the North Sea would be accompanied by a statement 'of which no more than x tonnes shall be taken from functional unit X'. The 'no more than' figure might be set at a level which would enable local fishers to remain operating. However, on its own this measure would not protect local fishers from an influx of large nomadic vessels.

NB. The NSRAC needs to develop a view on this, including a series of options for dealing with the problems which have arisen and are likely to occur again.

Biological Objectives

Nephrops stocks in the North Sea are considered to be stable in terms of abundance and size composition. Indeed, *Nephrops* on the Fladen Ground have showed a marked increase in abundance. However, the Farne Deep stock showed a population size drop in 2007 and unusual changes in the seasonal sex-ratio pattern also occurred. ICES has therefore made it clear that *Nephrops* should be managed by functional unit, rather than at an over-arching North Sea level.

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 stability.

In terms of a LTMP for *Nephrops*, the main biological objective will be to keep stocks within sustainable limits. A decision rule is required for setting the TAC, and trigger points need to be defined. For other species these rules have depended on traditional methods of assessment and reference points derived from the assessment results. However, we do not have these analytical assessments for *Nephrops*. We only have empirical indicators. These empirical indicators include:

- Raw catch or catch-per-unit-effort
- Mean length/weight of samples
- Length structure
 - recruitment fraction
 - mature fraction
- Spatial distribution
- Fishery independent surveys

Thus, for *Nephrops* there is no forecast of population size. Any harvest control rules must be based on empirical indicators, using the TV surveys as the adjusted (for the biases mentioned previously) absolute abundance or as a relative index.

We have suggested above that it may be more appropriate in managing *Nephrops* to move towards the more pragmatic management approach outlined in the Commission's non-paper on Managing Fish Stocks without Catch Option Tables. Thus, any decrease in the index of stock status derived from UWTV surveys might be accompanied by a decrease in TAC. For precautionary reasons, the decrease might be disproportionate, so that if the index goes down by say 20% the TAC would go down by more than 20%. The reverse would apply as the index of stock abundance increases. An increase of 20% in the stock index might be accompanied by a rather smaller increase in the TAC. This aim of this type of approach is to move *Nephrops* stocks in the right direction.

The index of stock status might be based on the various empirical indicators discussed above.

There is of course an issue over the extent to which the TAC should be set for the North Sea, or for the various functional units. It may be necessary to restrict the quantities taken from a particular functional unit. Rather than set individual TACs the Development Group suggests that this should be achieved through a 'no more than' clause. Thus, the TAC set for the North Sea would be accompanied by a statement 'of which no more than x tonnes shall be taken from...'. The 'no more than' figure attention might be set to enable local fishers to remain operating.

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 (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.

NB. To be considered further and discussed

7. Instruments

NB. The measures to be taken to achieve management objectives need to be set out as a series of options. However, first the actual economic, social and biological objectives need to be agreed at grass roots level. The sections above need to be developed further and they need to end with a set of agreed objectives.

In some respects the biological objectives may be the easiest to deal with for the *Nephrops* fishery. It would seem that the TAC system applied to the *Nephrops* fishery is effective and appropriate for controlling the impact of the fishery upon *Nephrops* stocks, although there is a clear problem in deciding whether the TACs should relate to each functional unit or to the North Sea as a whole. The Development Group is proposing that the main control should be through the setting of North Sea TACs, with the functional units being dealt with through 'no more than' clauses.

Some functional units may require additional measures to protect them if stocks fall outside given parameters. In this situation consideration may need to be given to measures which provide some protection for those local fishers unable to fish elsewhere. Such measures would require clear definition of such vessels, 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. ICES has 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 eliminate 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.

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 may offer a solution in some fisheries. Other measures might include the provision of dropout openings, and "wheeled" foot-gears replacing rock-hoppers.

Measures will need to be put forward as part of a strategy for dealing with expected increases in fishing capacity within the *Nephrops* fishery. The main options are:

Setting a limit to fishing effort (number of vessels, days at sea, fuel restrictions, kW restrictions)

Limitations in fishing efficiency (for example by restricting the use of twin-rig and multiple-rig gears)

Acceptance of the decline in economic performance of vessels that would follow if no action at all was taken.

Measures to meet social objectives have still to be discussed. There is an issue over the extent to which local fishers should receive preferential treatment within a particular functional unit.

Taken together, these measures should ensure that the *Nephrops* fisheries are stable, sustainable, well managed and profitable.

NB. The above section needs extensive further discussion. We have only made a start in considering the measures to be adopted as part of the management plan.

8. Timeframe

The NSRAC sees the LTMP for *Nephrops* fisheries as a gradual sequential response to risk. The plan needs to be responsive and adaptive, changing as circumstances change.

9. Conclusions

To be considered

10. Review of Progress & Adaptive Management

To be considered

References

Briggs (1995)
Chapman (1982)
Chapman & Howard (1979)
Dos Santos & Peliz (2005)
Farmer (1975)
Figueiredo & Thomas (1967)
Hillis (1974)
Jensen (1965)
Redant (1987)
Rice & Chapman (1971)

Sardà (1991)
Tuck *et al.* (1997)
Tully & Hillis (1995)