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Marine Scotland

Exploration of Optimisation Modelling in the Scottish *Nephrops* Fleet

Policy Brief

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Introduction

The *Nephrops*[1] fishery was the second most valuable for Scottish vessels in 2018, after mackerel. The Scottish fleet landed over 18,000 tonnes of *Nephrops* in 2018 worth an estimated £63 million. This is almost 11% of the total value of landings by Scottish vessels. The Scottish fleet landed around 38% of the world's total supply of *Nephrops* in 2017.

Scotland's *Nephrops* fishery provides substantial employment through both direct employment on-board vessels and indirectly through various onshore jobs. Many of these jobs and much of the economic activity occurs in Scotland's more remote coastal communities. The Scottish *Nephrops* fishery contributes to the following Scottish Government National Performance Framework goals, including:

- We see our natural landscape and wilderness as essential to our identity and way of life.
- We take a bold approach to enhancing and protecting our natural assets and heritage.
- We are committed to environmental justice and preserving planetary resources for future generations.
- We successfully attract and retain new talent and fully support business and social enterprise.
- We take seriously the wellbeing and skills of our workforce and provide good quality, fair work, training and employment support for all.

Marine Scotland monitors Scotland's different fisheries and regularly undertakes research to develop an evidence base for policy development and fisheries management to increase the contribution to the above goals. This policy brief and accompanying research report (available under "supporting files") are part of this effort. This policy brief sets out a summary of the research approach and findings, as well as the context within which Marine Scotland commissioned this research. The research has provided valuable input into the evidence base on the *Nephrops* fishery, and this policy brief discusses a number of policy considerations and next steps.

[1] *Nephrops* are also known as Norway lobster, prawns, scampi, and langoustines.

Context

There are two main gear types that are used in the *Nephrops* industry:

- *Static gear* - typically creels that are baited and dropped to the seabed where they fish by trapping *Nephrops* that enter them. *Nephrops* that are caught tend to be landed whole and live; or,

- *Mobile gear* – typically nets that are trawled on the bottom of the sea to catch any *Nephrops* that are out of their burrows. *Nephrops* that are caught are landed whole or tailed.

Both creels and trawls can be used to fish for *Nephrops* in some parts of Scotland's inshore waters, and can compete for the same fishing grounds.

The mobile nature of trawling means trawl vessels can displace creels in their path. As a result, some in the creel fishing fleet believe the current fisheries management of *Nephrops* favour the trawl fleet, at their expense. They allege that they are forced to avoid some fishing grounds for fear of losing their gear. Some in the mobile sector report, however, that static gear is placed in "traditional trawl tows" effectively to block access to fishing grounds. Such practices can introduce inefficiency in vessel operations across both mobile and static gears as well as present a safety hazard.

Nephrops quotas are typically not fully utilised. Instead the constraining factor for fishers attempting to increase their landings appears to be access to fishing grounds. Part of the underlying cause for why there is competition to access some fishing grounds is that fishers are not necessarily assigned exclusive control over sea areas as part of their quotas. Both gears are left to contest for access to fishing grounds.

The issue of competition between vessels operating creel and trawl gear, including competition for access to fishing grounds, has been documented in two reports that were published by the Scottish Creel Fishermen's Federation (SCFF) in May 2017[2] and by the Scottish Fishermen's Federation (SFF) in October 2017[3]. Following these reports, Marine Scotland has invested in developing the evidence base further around the following areas:

(a) Looking at market opportunities if the supply of live *Nephrops* was to increase. This has been addressed to some extent by work carried out by Seafood Scotland which showed that there is scope for a modest increase in

[2] *Scottish Creel Fishermen's Federation* (2017) Correcting the Misallocation of *Nephrops* Stocks in Scottish Inshore Waters: Untapping a vast economic (and environmental) potential. http://www.scottishcreelfishermensfederation.co.uk/report/CORRECTING%20THE%20MISALLOCATION%20OF%20%20*NEPHROPS*%20STOCKS%20-%20SH2.pdf

[3] *Scottish Fishermen's Federation and Scottish Fishermen's Organisation* (2017) Analysis of *Nephrops* industry in Scotland. http://www.sff.co.uk/wp-content/uploads/2017/10/AS-*Nephrops*-FINAL-report-171017-ISSUED.pdf

the amount of creel caught *Nephrops* sold to the EU, although this was based on Scotland and the UK remaining in the EU.

(b) Understanding the relative environmental performance of the two fishing methods, for example in terms of impacts on the sea bed and on other fish stocks. This is the focus of an on-going evidence review by Marine Scotland Science.

(c) Assessing baseline activity and opportunities to improve economic and social outcomes via reallocating access to fishing grounds between and within vessels operating trawl and creel gear. This is the subject of this policy brief and the accompanying research report.

The objectives of the commissioned research were to:

(i) build a more detailed picture of the current *Nephrops* fishing activity in Scotland;

(ii) create an economic model that can help identify what an optimal allocation of access to *Nephrops* fishing grounds could look like under different policy objectives that could inform Future of Fisheries Management discussions, taking vessels' characteristics into account;

(iii) use this economic model to determine if the current allocation of access to fishing grounds deviates from the optimum for different objectives.

In addressing the above objectives, the accompanying research report provides a valuable input to help guide ongoing discussions on the Future of Fisheries Management in Scotland policy programme. A national Discussion Paper on the Future of Fisheries Management in Scotland was published in March 2019[4] to start an in-depth nationwide conversation with stakeholders to develop Scotland's Future of Fisheries Management policy. In terms of inshore fisheries, there are three broad themes:

1. improving the evidence base on which fisheries management decisions are made;

2. streamlining fisheries governance, and promoting stakeholder participation;

3. embedding inshore fisheries management into wider marine planning.

Several key discussion points are also raised in the Discussion Paper, including looking into introducing a low-impact trial that will separate mobile and static gear

[4] https://www.gov.scot/publications/national-discussion-paper-future-fisheries-management-scotland/pages/0/

and looking at alternative approaches to tackle instances of gear conflict. These are key themes and areas that the evidence presented in the accompanying research report can be considered.

Background to Scotland's *Nephrops* Fishing Fleet

From the two key gear types (trawl and creel) referred to previously, *Nephrops* tend to either be landed whole, sometimes live, or tailed. Some primary processing occurs on-board the vessel when only the tails of the *Nephrops* are landed. These two broad categories of landing tend to serve different markets in different countries. Whole fresh and live *Nephrops* are mostly exported to EU markets, while tailed *Nephrops* tend to go to the domestic scampi market.

Of the 18,000 tonnes (liveweight) of *Nephrops* landed by Scottish vessels in 2018, the breakdown by gear type and whole or tailed are:

- 1,300 tonnes (liveweight) was landed whole by creel, worth around £9 million, priced at around £6,900 per tonne.
- 6,800 tonnes (liveweight) was landed whole by trawl, worth around £34 million, priced at around £5,100 per tonne.
- 9,800 tonnes (liveweight) was landed tailed by trawl, worth around £17 million, priced at around £1,800 per tonne.

Understanding the Report

To deliver on the objectives of this research consultants Sandfish Associates developed and applied a novel way to assess whether the current allocation of access to *Nephrops* fishing grounds is optimal. This used more spatial data on fishing activity for over 12 metre vessels and new data on the spatial distribution of under 10 metre vessels, to provide a more detailed picture of the location of fishing activity of the *Nephrops* fishing fleet than has previously been available. For modelling purposes, the Scottish *Nephrops* fleet was split into 25 fleet segments, covering 85% of Scottish *Nephrops* landings, according to their characteristics (length, area fished, *etc*.).

The optimal allocation of access to fishing grounds was examined under two broad scenarios:

1. Scenario 1 - maximising gross value added for the 2017 *Nephrops* fleet. This is a measure of the contribution of an economic activity to the economy and broadly captures income to workers and company profits; or,

2. Scenario 2 - maximising full time equivalent employment for the 2017 *Nephrops* fleet. This is a standardised measure of employment that takes into account different working patterns.

The model optimises for the above scenarios following three broad steps:

i. estimating each *Nephrops* vessels' fishing and economic characteristics based on 2017 data;

ii. determining the best way to fish in each of the 355 spatial areas modelled across Scotland's inshore waters based on 2017 fishing patterns;

iii. determining the best area for each vessel to fish for *Nephrops* based on its characteristics from (i).

The fishing activity for each of the scenarios was compared with current activity based on 2017 to highlight where there is opportunity to either increase employment or gross value added primarily using an economic model that does not explicitly take account of biological stock dynamics between gears. The optimisation process incorporates a number of constraints that are designed to increase the realism and applicability of the model. It shows where fishers may be best off locating their fishing activity to maximise fleet's gross value added or employment. Further detail is presented in the accompanying main research report.

However, the research was not commissioned to nor does consider the costs and practicalities of achieving such an optimal setup. First and foremost, this economic research is not a policy appraisal, it provides valuable information of what an optimal setup of the *Nephrops* fishery could have looked like in 2017 from a spatial perspective under the two modelled scenarios. The impacts of such a setup in relation to wider economic considerations as well as social and environmental considerations was not within the scope of this work. Any policy or arrangement aimed to move the *Nephrops* fishery closer to such optimal positions would likely have compliance and operational costs and considerations. Crucially, the economic research does not explicitly explore what the drivers are of the current setup.

These and other points would need to be carefully considered as part of the Future of Fisheries Management discussion.

Key Findings

The research shows that in 2017 employment on *Nephrops* creel vessels in the West of Scotland was around 210 on a full time equivalent basis, generating gross value added of around £5 million and landing 1,300 tonnes of *Nephrops*. Employment was around 510, on a full time equivalent basis, on-board trawl vessels in the West of Scotland, generating gross value added of around £12 million and landing 8,500 tonnes of *Nephrops*. In the North Sea, there were insufficient creel vessels with a

great enough dependency on *Nephrops* to be modelled as individual fleet segments without breaching data disclosure thresholds. However, there was employment of around 540 on a full time equivalent basis working on North Sea trawl vessels, generating around £18 million in gross value added and landing around 9,000 tonnes of *Nephrops*. Note that the number of people working in the fishery will be higher than that shown by full time equivalence in the case where some people work part time.

The research found that for access to *Nephrops* fishing grounds from the perspective of maximising employment, the current allocation based on 2017 data was already near optimal given the various considerations. The distribution of fishing grounds between creel and trawl, and within these gear types could moderately increase total employment for the *Nephrops* fishing fleet, which in 2017 employed 1,264 on a full time equivalent basis. The research shows that redistributing access to fishing grounds to maximise employment could increase employment by around 10%. This comprises additional employment of 88 for *Nephrops* creel vessels (41% increase) and 75 for trawl vessels (7% increase), both on a full time equivalent basis.

The research shows that there is scope to increase gross value added by redistributing access to fishing grounds. In particular, an additional £14 million of gross value added may be achieved if fishing access was redistributed to maximise gross value added. This is equivalent to a 39% increase in total gross value added for the *Nephrops* fleet. Of the £14 million in additional gross value added, £10 million would accrue to the creel fleet and £3 million to the trawl fleet. It shows that overall both fleets can gain from reallocating access to *Nephrops* fishing to maximise gross value added.

While the modelled increase in gross value added is achieved by reallocating access to fishing grounds, there will be winners and losers within both the *Nephrops* creel and trawl fleets. For example, in some areas the optimisation model allocates very large amounts of fishing opportunities to certain fleets. Such increases may not feasibly be taken up by these fleets and these results must be carefully considered. Similarly, there are some fleets which the optimisation model moves fishing opportunities away from. While the model ensures that all fleets remain profitable, the reactions of vessel owners to different levels of profit are unknown.

The above impacts are reduced if vessels that are identified to benefit from the reallocation of access to *Nephrops* fishing grounds cannot increase their effort. In this case new vessels matching the characteristics of these vessels would need to be introduced, which results in a smaller increase in gross value added – an additional £9 million (down from £14 million). Despite the use of constraints which aim to increase the realism of the outputs, sensitivities around certain variables and data may still be present. An example of this is that if the potential gains from the fleet segment with the largest increase in gross value added were removed then the overall gain in gross value added falls to £5 million (down from the £9 million above).

The modelling also suggests that a trawling ban within 3 nautical miles of the coast (an option being promoted by some West Coast creel fishing interests) may result in an increase in gross value added of around £6 million. This is lower than the £14 million that could potentially be achieved through a more targeted reallocation of access to fishing grounds between and within the creel and trawl fleets. While a requirement to only land whole *Nephrops* leads to the largest potential increase in gross value added – £42 million, however this scenario would be highly sensitive to markets and price changes as it would lead to a large change in end-product composition (from tails to whole *Nephrops*). All of the above outcomes show that there may be opportunities to increase or change the product mix of *Nephrops* for a better outcome in terms of gross value added. However, the modelling assumes that there is a market to take any additional quantities at 2017 average prices.

Conclusions and Policy Considerations

The research has shown that there is potentially an opportunity for economic gains if access to fishing grounds is redistributed between and within the *Nephrops* creel and trawl fleets. The research provides valuable evidence to guide ongoing discussions on Future Fisheries Management in Scotland, the route through which Marine Scotland will consider evidence from this research to make policy decisions. In doing so, policy will need to take account of a number of factors, some of which are discussed below.

First, the results from the research do not take into account costs to businesses of amending fishing patterns, nor the management and compliance costs associated with any fisheries management designed to achieve what the research identifies as the optimal outcome. The reasons why vessels' activity in 2017 was not consistent with the optimum identified by the research are likely to be numerous and complex. They could include factors such as: weather, other fisheries management restrictions, perceived gear conflict itself, or other business or personal decisions. Understanding how these factors affect vessel fishing patterns and fishers' behaviour would be important in devising policies to try and maximise gross value added or employment.

Second, it is unclear whether the optimum outcome identified by this research could be achieved in practice. This research was an exploration of optimisation modelling, which while shown to be feasible includes a number of data and modelling challenges that need to be carefully considered when interpreting the results. While the model and assumptions used have been rigorously tested, consideration may be needed to sense-check these further, and whether modelled changes in some of the fleet segments are feasible let alone desirable. The Future of Fisheries Management discussions would also have to consider what the future policy objectives would be for the Scottish *Nephrops* fishery.

Third, economic considerations are only one basis on which Marine Scotland approaches fisheries management. Other factors to consider would be the environmental impacts of the fishery, impacts across supply chains, social impacts, continued access to markets including EU exit impacts, and the impact on prices to changes in the quantity of landings. Further research is required in these areas to build a more complete evidence base. For instance, to maximise gross value added would lead to substantial changes within the creel fleet as well, allocating fishing opportunities to the most efficient, typically larger, creel vessels. This could be to the detriment of smaller scale creel vessels operating on a less commercialised basis but making important contributions to social outcomes to our remote communities.

Fourth, while the research includes around 85% of the *Nephrops* landings value, there is a need to consider the impact on vessels in other fleet segments more fully. Crucially, the *Nephrops* fishery does not operate in isolation from other fisheries and interactions with other species needs to be explored further, both in environmental and business terms. *Nephrops* targeting vessels land other species, and *Nephrops* may be a by-catch of vessels targeting other species. Impacts on other marine users, including recreational fishers or offshore wind, are also not considered in this report, and would be important factors in any consideration of how best to use Scotland's marine space.

Despite the above points, the research indicates potential opportunities to improve economic outcomes within the Scottish *Nephrops* fishery. Marine Scotland will explore these opportunities as part of the Future of Fisheries Management programme while carefully considering the above points. Marine Scotland is already involved in a number of projects that look to build on several of the evidence gaps identified by the research and that have the scope to test some of the points it identifies. For example, the Scottish Inshore Fisheries Integrated Data System (SIFIDS) project has examined ways to improve data collection within the inshore fleet, which may lay the foundation for more targeted analysis and management in the future, while the Inshore Fisheries Pilots will expand the evidence base around the scope and practical challenges facing local fisheries management. In terms of environmental impacts, Marine Scotland Science are undertaking an evidence review in relation to both the biological stock impacts of different gears as well as their wider environmental impacts.

The research has highlighted that optimisation modelling in the context of a *Nephrops* fishery is possible with the available data. However, there are a number of significant challenges in relation to undertaking and using such modelling that should be borne in mind. The quantity and quality of data have improved substantially in recent years, especially through the provision of Fish1 form data for under 10 metre vessels. This has allowed spatially disaggregated work to be done, however there are still gaps in the evidence base such as spatial information for 10-12 metre

vessels and much of the socio-economic data are based on whole fleet segment averages and may not accurately reflect regional variations.

This research sets out to show whether optimisation modelling could be undertaken in this area, which it has shown is possible albeit there are still points, such as those above, to take into consideration. Marine Scotland will carefully consider these points and continue to develop the evidence base, exploring new data, testing new assumptions, filling the identified evidence gaps, and taking on-board feedback from stakeholders. As such Marine Scotland welcome any feedback on the model and its outputs to allow us to create as robust an evidence base as possible for future policy and fisheries management consideration.

This publication is available at **www.gov.scot**

Any enquiries regarding this publication should be sent to us at

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