Project UK: Scallop

Ecosystem Scale Intensity Consequence Analysis (SICA)

September 2021

POSEIDON
AQUATIC RESOURCE MANAGEMENT

Report Information

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Abbreviations used

ETP	Endangered, threatened or protected
EUNIS	European Nature Information System
FIP	Fishery Improvement Project
FU	Functional Unit
ICES	International Council for the Exploration of the Sea
MSC	Marine Stewardship Council
PI	Performance indicator
RBF	Risk-based framework
SAR	Swept Area Ratio
SG	Scoring guidepost
SICA	Scale intensity consequence analysis
UoA	Unit of Assessments
VMS	vessel monitoring system

1. Introduction

1.1 Context

1.1.1 This report presents an ecosystem scale, intensity and consequence analysis (SICA) undertaken to inform the Project UK Round 2 UK Scallop Fishery Improvement Project (FIP). The outcome status performance indicator (PI) of the Principle 2 ecosystem component (2.5.1) was assessed for the UK king scallop, *Pecten maximus*, dredging Unit of Assessments (UoA) to score 60-79 in the Marine Stewardship Council (MSC) pre-assessment completed in May 2019 (Poseidon, 2019). The following action was set within the Action Plan to work towards moving this score to a level of 80 or above:

> **Action 9.a:** Constitute expert group and conduct SICA analysis to determine main ecosystems and ecosystem services impacted by scallop dredging across the UoAs under assessment.

1.1.2 The UK scallop dredging UoA included in this FIP occur across the North Sea, West of Scotland and Irish Sea.

1.1.3 This report was prepared by Poseidon Aquatic Resource Management Ltd (Poseidon) as part of ongoing support provided to the Project UK Round 2 Scallop FIP.

2. Methodology

2.1 Approach

2.1.1 The Project UK secretariate (MSC) organised a SICA workshop, which was facilitated by Poseidon. Members of the Project UK Scallop Steering Group with expertise in the ecosystem and/or the scallop fishing industry were invited to join the SICA workshop, and to recommend additional ecosystem experts to be invited. The participants that attended the SICA workshop and formed this ecosystem expert group are provided in Appendix A.

2.1.2 Ahead of the workshop, the expert group was provided with guidance on the MSC ecosystem outcome status performance indicator and scoring guideposts (Appendix B); a SICA questionnaire (Appendix C); vessel monitoring system (VMS) data for dredging (Appendix D) and additional guidance on consequence analysis (Appendix E).

2.1.3 The workshop was held on 03 March 2021 and minutes are available online (Project UK, 2021). During the workshop, each SICA question was discussed by the group, followed by real-time interactive voting using Mentimeter to answer multiple choice questions.

2.1.4 This report combines the Mentimeter voting results, identifies whether consensus was reached by the expert group, documents key points /discussions and further considers the research literature raised during the workshop. The conclusion for each question provides justification and rationale for the final answer chosen.

2.2 Objective

2.2.1 Within the MSC framework a SICA can be used to assess the ecosystem outcome status component using the risk-based framework (RBF) where there is not sufficient quantitative evidence to determine a score for the fishery. It can also be used where quantitative data is available as a means of obtaining a range of viewpoints and constructing the probability interpretation of the scoring guideposts (i.e., whether SG60, SG80 or SG100 are achieved). Undertaking a formal RBF is not proposed for this component, therefore the SICA methodology was used as a means to facilitate discussion and draw together expert judgement.

2.2.2 The objective of the workshop was to bring together experts in scallop dredging and ecosystem interactions, and in doing so understand a range of viewpoints and expert judgement on the effects of scallop dredging on the ecosystem; collate research and evidence cited by participants; provide consensus around the scoring of ecosystem outcome status and therefore inform the direction of recommendations and future management.

2.3 Definitions

Definition of an ecosystem

2.3.1 The ecosystem component is defined as being the broad ecological community and ecosystem in which the fishery operates. Ecosystem is the fifth component of Principle 2 and care is required not to duplicate assessment of the four other Principle 2 components, including, primary and secondary species, habitats or endangered, threatened or protected (ETP) species, as well as the target species assessed under Principle 1.

2.3.2 Instead of focusing on one specific species or habitat (which would be assessed within these other Principle 1 and Principle 2 components), the ecosystem assessment considers wider structure, function and system-wide issues, primarily impacted indirectly by the fishery, including:

- Ecosystem structure;
- Trophic relationships;
- Biodiversity; and
- Community resilience.

Definition of serious or irreversible harm

2.3.3 Examples of instances where serious or irreversible harm may occur include:

- Trophic cascade caused by depletion of predators;
- Depletion of top predators caused by depletion of key prey species;
- Severely truncated size composition of the ecological community;
- Gross changes in the species diversity of the ecological community e.g., loss of species, major changes in species evenness and dominance; and
- Change in genetic diversity of species caused by selective fishing e.g., genetically determined change in parameters such as growth or reproductive output.

Definition of sub-components of the ecosystem

2.3.4 The SICA methodology requires delineation of ecosystem sub-components to determine where the greatest effect of the fishery on the ecosystem occurs. The specified ecosystem sub-components include:

- **Composition of species** in ecosystem – detectable changes in the identity of species within the ecosystem;
- **Functional group** - species that share similar suites of traits and provide a similar ecological function or service to the ecosystem;
- **Distribution of communities** – change in geographic range of communities which can impact community dynamics;
- **Trophic structure** – change in mean trophic level within the ecosystem. Species within the ecosystem, not specifically target species; and
- **Size structure** – change in biomass/number in each size class for each species. Species within the ecosystem, not specifically target species.

2.4 Steps for undertaking a SICA

2.4.1 The steps for undertaking a SICA are illustrated in Figure 2.1. This sequence has been followed in the order of questions developed within the SICA questionnaire (Appendix C).

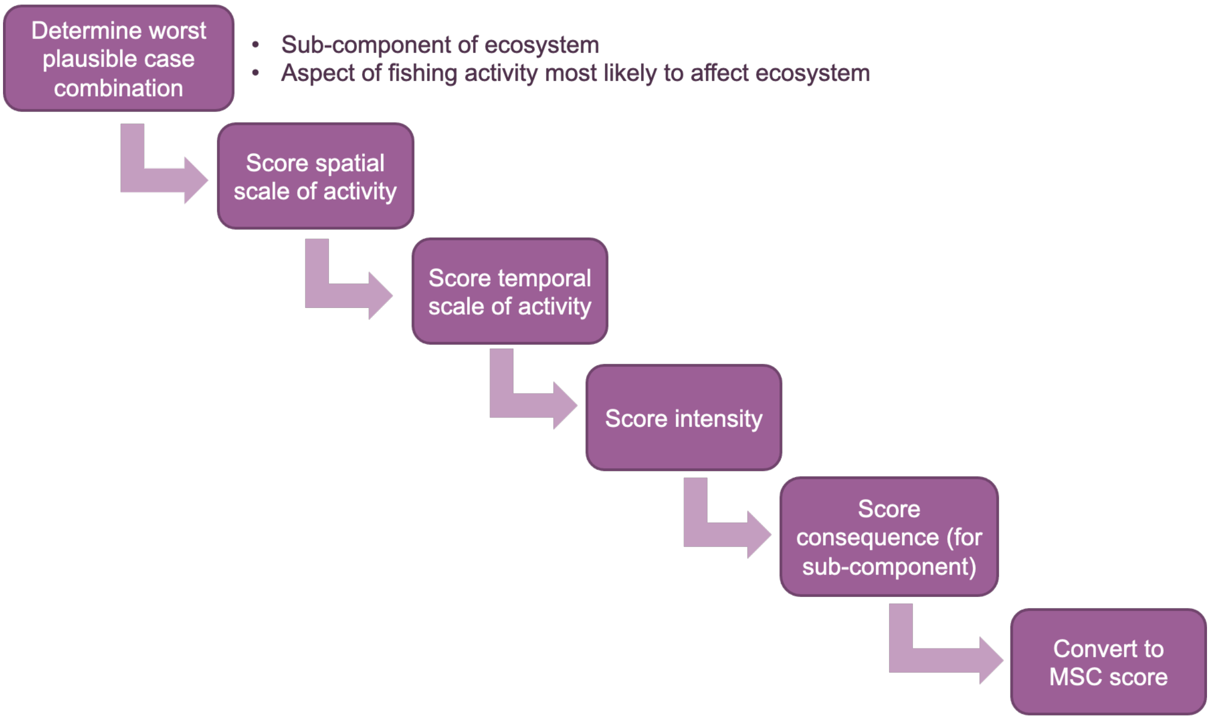

Figure 2.1: Steps for undertaking the Scale Intensity Consequence Analysis

2.5 Structure of the report

2.5.1 The remaining sections of this report are structured as follows:

- Discussion and conclusions: are presented for each question of the SICA questionnaire, detailing the discussion points and expert judgements provided during the workshop, as well as details of any further research cited. A conclusion for each question provides the overall justification for the answer chosen.
- SICA overview: presents the overall conclusions and justifications for the SICA in MSC table format.
- Recommendations: provides recommendations for updates to, and next steps within, the Action Plan.

3. Results and discussion

3.1 Geographic area of the ecosystem(s)

Question 1

3.1.1 Define the geographic area of the ecosystem(s) and specify reason for this choice. Options provided:

- One overall ecosystem for all waters targeted by the fishery
- Three ecosystems: North Sea, West of Scotland, Irish Sea
- More than three ecosystems (by stock assessment area or other split)

Results and discussion

3.1.2 Project UK scallops includes 9 stock assessment areas across the North Sea (including North Sea south, Dogger Bank, East Coast, North East, Shetland and part of Orkney), West of Scotland (part of Orkney, North West, West of Kintyre and Clyde) and the Irish Sea, as shown in Figure 3.1.

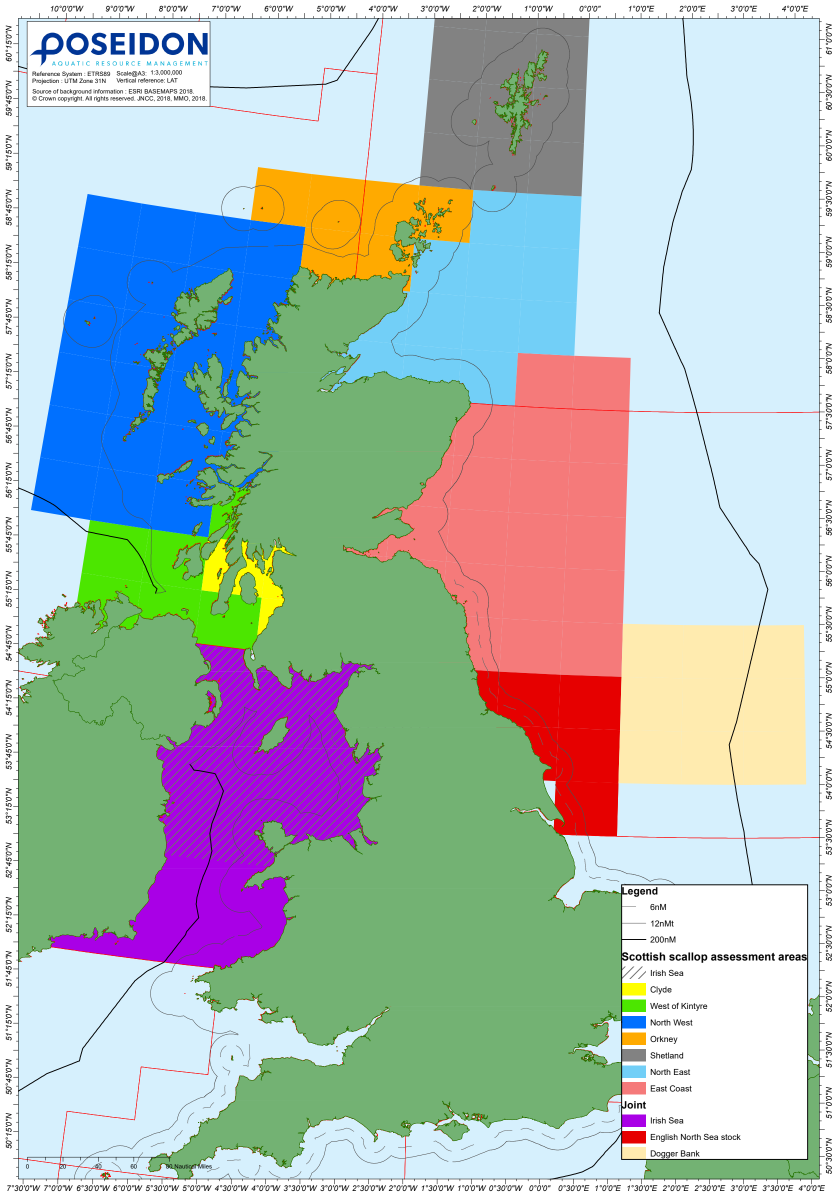

Figure 3.1: Scallop assessment areas included in Project UK

3.1.3 Defining the ecosystem geographic areas is important because it will impact the scores of later questions when considering the overlap of fisheries on a spatial and temporal scale.

3.1.4 As described in Section 2, the working definition of an ecosystem is a broad ecological community and ecosystem in which the fishery operates. Generally, existing full assessments consider the entire ecosystem that the fishery operates within, without splitting the ecosystem component into separate geographic areas. However, there is scope and justification to split the UoAs into a number of ecosystems, especially with multiple stocks under assessment across a wide area. In such a case, each ecosystem would be assessed and scored separately.

3.1.5 The results of the expert working group interactive voting for division of the ecosystem by geographic area is shown in Figure 3.2. It is agreed that the ecosystem component should not be considered as one overall ecosystem and should be split into different ecosystem areas.

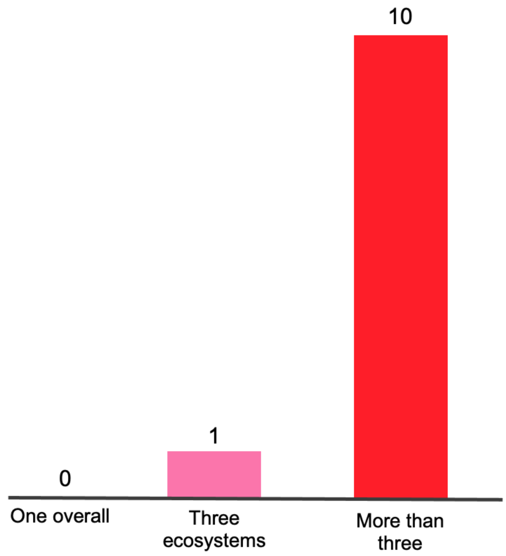

Figure 3.2: Expert working group interactive voting for division of the ecosystem by geographic area(s)

3.1.6 The majority of the expert group voted for assessing more than three ecosystems with responses linked to being precautionary, splitting based on stock areas and the different species compositions of each different ecosystems, e.g., comparing sheltered inshore regions with more dynamic offshore grounds.

3.1.7 Difference in ocean energetics and capacity to recover were also noted, with the Irish Sea cited as an example that has areas highly sensitive to disturbance and areas highly resilient. Variability in both resilience and intensity of use in the Irish Sea make it an important consideration when defining ecosystem areas. If large areas were grouped, than the case could arise where high resilient areas compensate for sensitive areas or species. As Sciberras *et al.* (2018) state "a large proportion of less sensitive species in any given grouping (community, taxon) may mask the response of more sensitive but less abundant species".

3.1.8 The group consider that both physical and biological indicators should be used in defining the ecosystems (including depth, intensity of fishing, VMS data, population structures, JNCC habitat classifications, genetic population data, scallop assessment areas). In general, participants considered that the ecosystem component should be assessed as more than three geographic areas, but could not form consensus on the most appropriate delineation.

Conclusion

3.1.9 Without agreement on defining the geographic areas of the ecosystem, it was agreed to move forward with three defined ecosystems (North Sea, West of Scotland, Irish Sea) and adjust this according to further findings through the SICA and wider Project UK research.

3.2 Ecosystem sub-components affected by the fishery

Question 2 & 3

3.2.1 What elements of the ecosystem do you think may be affected by the fishery?

Question 2: Please rank elements 1 to 5, where 1 is most affected and 5 is least affected.

Question 3: Please choose one option as the most likely to be affected.

- Composition of the species
- Functional group
- Distribution of communities
- Size structure
- Trophic structure
- Other (specify)

Results and discussion

3.2.2 The expert group agreed that ranking ecosystem sub-components and choosing which is more affected than the other is challenging due to the intrinsic interlinking of sub-components, where changes to one is likely to stimulate changes in the other sub-categories. The results of the ranking of sub-components are shown in Figure 3.3 and selection of most affected shown in Figure 3.4.

3.2.3 The broad range of responses, indicate that all sub-components are considered important for this fishery. Although, this may also reflect the specific scope of interest for attendees present. Composition of species and functional group were considered the most important sub-components, with composition of species voted highest in the ranking exercise.

3.2.4 It is noted that the SICA undertaken for the Project UK English Channel scallop FIP identified 'Functional group composition', as the most affected sub-component due to fishing grounds being occupied by short-lived, opportunistic mobile species that could be most affected by dredging.

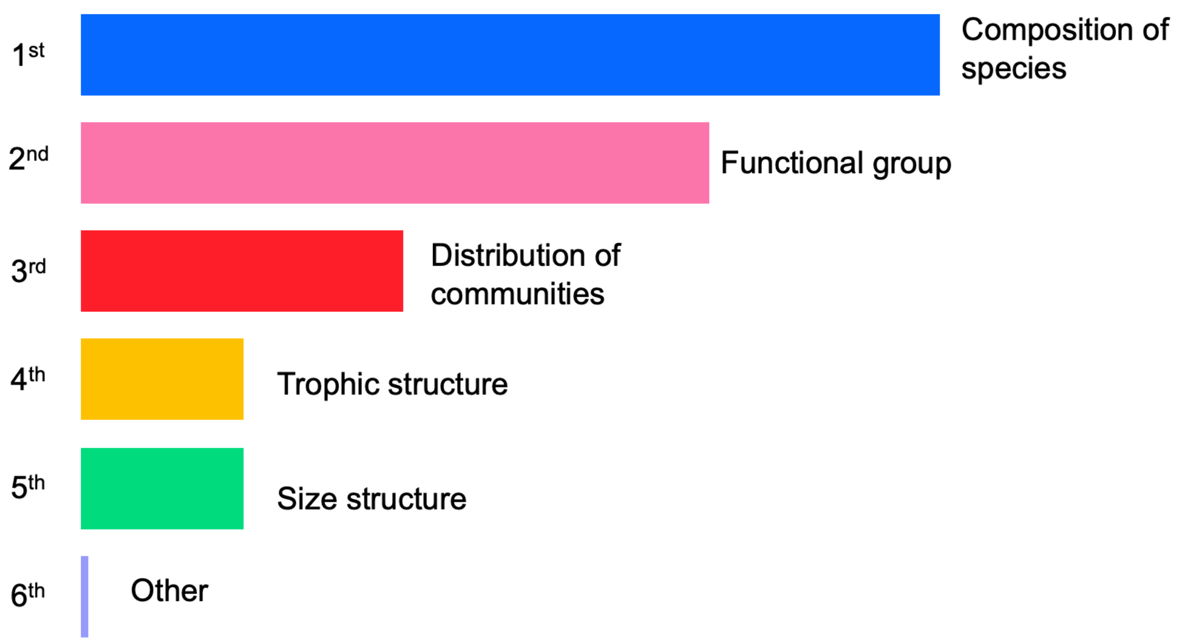

Figure 3.3: Expert working group interactive voting for ranking of ecosystem sub-components affected

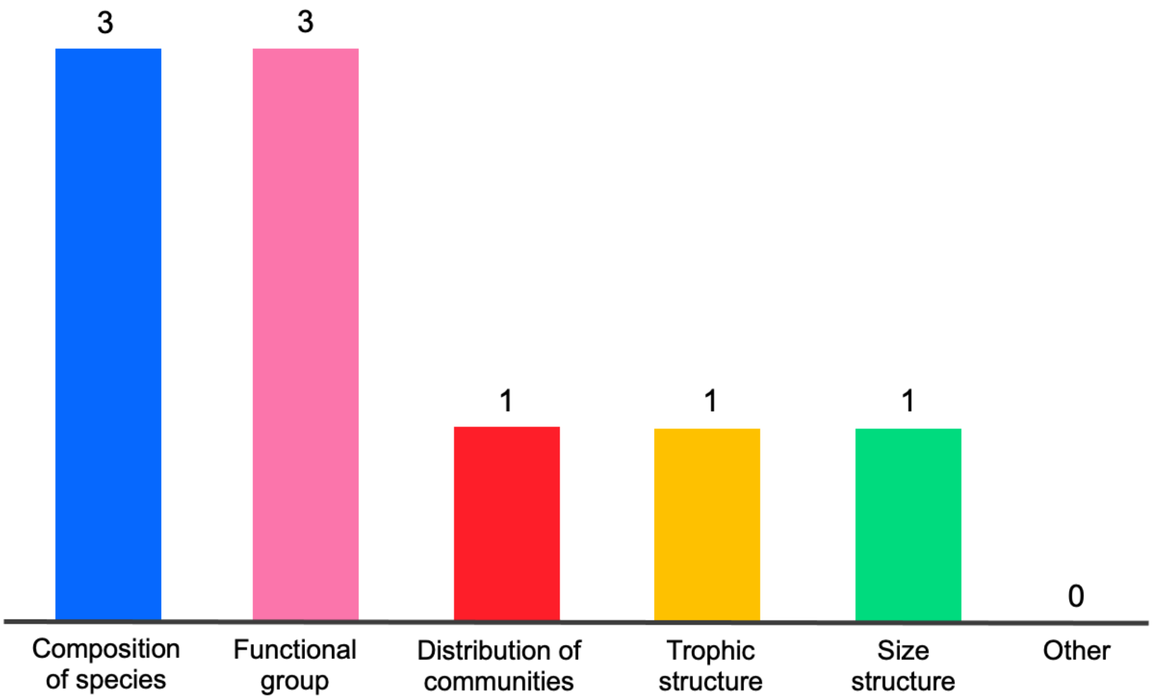

Figure 3.4: Expert working group interactive voting for most affected ecosystem sub-component

3.2.5 Hidink *et al.* (2017) comprehensively documents how bottom contact fishing gear that is trawled or dredged across the seabed causes a range of effects including;

- Resuspension of sediments;
- Reduction in topographic complexity and biogenic structures;
- Reduction in faunal biomass, numbers and diversity;
- Selection for communities dominated by fauna with faster life histories; and
- Production of carrion that attracts scavenging and predatory epifaunal species.

3.2.6 Overall, these effects lead to changes in the community production, trophic structure and function.

3.2.7 In relation to composition of species, the expert group highlighted that dredging can simplify the seabed and affect epi/benthic fauna, with particularly acute effects to biogenic reefs.

3.2.8 The impact on trophic structure was highlighted in relation to a specific example for flapper skate, with ongoing research focused on skate nurseries coinciding with rocky/gravely habitats that are targeted as scallop grounds. Potential for damage and disturbance to egg capsules due to dredge activity resulting in removal of this apex predator and impact to the trophic balance is being investigated.

3.2.9 Research cited during the discussion (including Hiddink *et al.,* 2017; and Sciberras *et al.,* 2018) focus on the quantitative assessment of reduction in benthic community numbers, biomass and abundance.

Conclusion

3.2.10 Overall, given the results from the workshop voting, coupled with the scientific evidence that quantifies the impact, it is considered that **composition of species** and **functional group** are the two most pertinent ecosystem sub-components affected by the fishery.

3.3 Aspect of fishing activity causing the affect

Question 4

3.3.1 What aspect of fishing activity is most likely to affect the ecosystem? *Please choose one option.*

- Fish removal (i.e. removal of the target species and/or other species caught)
- Interaction with the habitat
- Loss of fishing gear
- Bait collection (if relevant to the fishing industry)
- Anchoring gear (if relevant for fishing)
- Boat mooring (if relevant for fishing)

Results and discussion

3.3.2 The expert group consider the gear **interaction with the habitat** to be the key aspect of the fishing activity to affect the ecosystem (Figure 3.5).

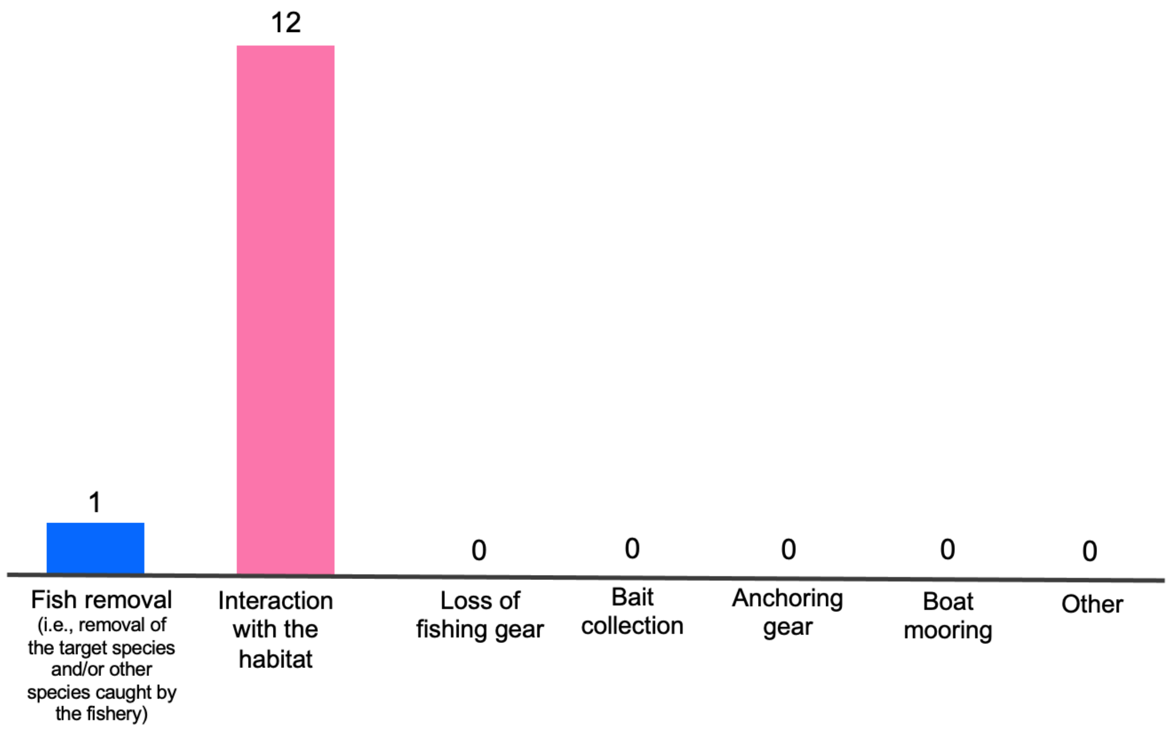

Figure 3.5: Expert working group interactive voting for aspect of fishing activity causing the affect

Conclusion

3.3.3 The aspect of fishing activity most likely to affect the ecosystem is the **interaction of the fishing gear with the habitat**.

3.4 Spatial scale of overlap

Question 5

3.4.1 Spatial scale: what is the scale of overlap between the fishery and the element of the ecosystem that is most likely to be affected by it? *Please select one option based on your* *expert judgement.*

- Less than 1% overlap
- 1-15% overlap
- 16-30% overlap
- 31-45% overlap
- 46-60% overlap
- Over 60% overlap

Results and discussion

3.4.2 The VMS data presented in Appendix D indicates the spatial distribution of UK and EU vessels 12m and over in length dredge KW fishing hours. This indicates a variable spatial overlap across relatively defined scallop grounds.

3.4.3 The interactive voting during the workshop ranged from 1-15% overlap to >60% overlap (Figure 3.6). The majority of votes was for 1-15% and 16-30% overlap. Those voting for >60% highlighted that this related to the 'fishable' elements of the ecosystem, rather than across the ecosystem as a whole, i.e., the scallop dredge fishery overlaps with >60% of the areas that are fishable, rather than >60% of the wider ecoregion.

3.4.4 The group agreed that habitat mapping would help inform responses, as would information on the relative benthic status and predicted distribution of habitat features – which is expected to be delivered as part of the ongoing scallop habitats PhD. It was noted that the sediment on the seabed could not be considered exclusively; the overlaying water column and oceanographic features must also be considered, as well as the scallop transport process. This is exemplified by the low VMS records south-east of the Isle of Man due to poor scallop fishing despite the relatively highly fished surrounding area. It was highlighted that current restrictions on days at sea in Western Waters causes fishing effort to concentrate towards the coast.

3.4.5 Fishing industry experience highlighted the link between spatial and temporal changes in dredge fishing intensity. Specifically the cyclical nature of the areas targeted, with scallop grounds often fished in 7 year cycles.

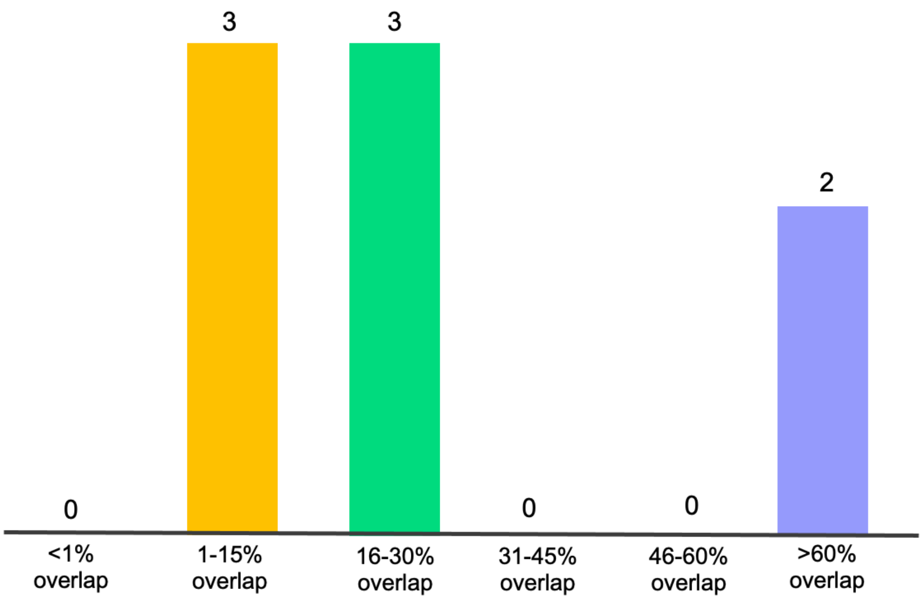

Figure 3.6: Expert working group interactive voting for spatial scale of overlap

Conclusion

3.4.6 Based on an average of the responses provided by the expert group, the spatial scale of overlap of the scallop dredge fishery with the ecosystem is within the 31-45% category.

3.5 Temporal scale of overlap

Question 6

3.5.1 Time scale: how often does the fishery interact with the element of the ecosystem that is most likely to be affected by it? *Please select one option based on your expert judgement.*

- 1 day every 10 years or so
- 1 day every few years
- 1-100 days per year
- 101-200 days per year
- 201-300 days per year
- 301-365 days per year

Results and discussion

3.5.2 The majority of the expert group voted for a temporal overlap of 1-100 days per year, with 3 respondents considering a temporal overlap of greater than 101 days, as depicted in Figure 3.7.

3.5.3 The discussions noted that quantitative data is available allowing the frequency of disturbance per area to be calculated [and frustration was voiced over qualitatively estimating this parameter].

3.5.4 It was agreed that this quantitative assessment be added as an additional milestone to provide an evidence-based evaluation of the temporal overlap.

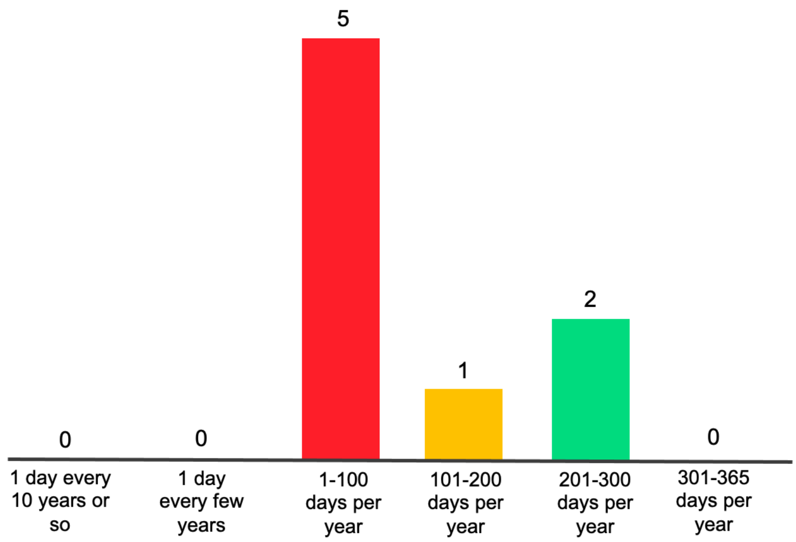

Figure 3.7: Expert working group interactive voting for temporal scale of overlap

Conclusion

3.5.5 While the majority consider that the temporal overlap of scallop dredge activity is within the 1-100 days per year category, 3 scored above this. To be precautionary, a temporal overlap of 101-200 days is concluded. However, further analytical assessment is recommended.

3.6 Intensity of the interaction

Question 7

3.6.1 Intensity: How intense is the interaction of the fishing industry with the element of ecosystem that is most likely to be affected by it? *This relates to the ecosystem sub-component identified in Q.3. Please select one option based on your expert judgement.*

- Negligible - Remote probability of the effect of the activity detected at any spatial scale or temporary;
- Minor – Minor activity occurs rarely or in some restricted places, and evidence of activity even at these scales it is rare;
- Moderate - Moderate activity detection on a wider spatial scale or obvious detection but local;
- Major – The detectable evidence of activity occurs reasonably often on a broad spatial scale;
- Severe - Easily detectable localized evidence of activity and widespread and frequent evidence of activity;
- Catastrophic Local or regional evidence of activity or continuous and widespread evidence.

Results and discussion

3.6.2 The majority of responses were for major or moderate intensity of interaction, as the effect of activity is detectable in highly dredged areas (Bradshaw et al 2002), VMS activity shows the extent of scallop fishing around the UK, and localised reports of grounds being fished extremely hard.

3.6.3 The level of severity does depend on the status of the ground and the previous levels of interaction, e.g., the impact to an area frequently swept will be very different to the impact to a previously unfished area.

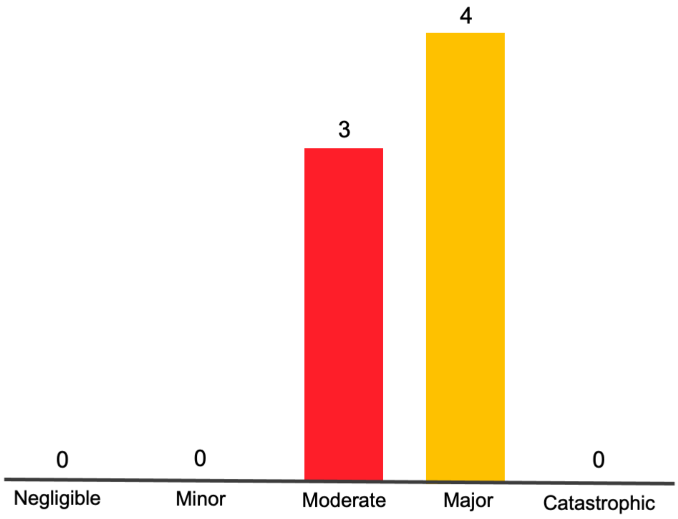

Figure 3.8: Expert working group interactive voting for intensity of the interaction

Conclusion

3.6.4 Overall, it was considered by the expert group that detectable evidence of scallop dredging occurs reasonably often and on a broad spatial scale; to be precautionary, the intensity of the interaction is therefore deemed to be major.

3.7 Consequence of the impact

Question 8

3.7.1 Consequence: what do you think are the consequences of the impact of the fishery on the aspect of the ecosystem most likely to be affected? *This relates to the element identified in Q.3. Please see Annex A for further guidance on justifications relevant for each option.*

- Interactions are unlikely to be detectable against natural variation (SG100);

- Interactions are likely to cause up to 5% change in characteristic; impact recovery is likely to take up to 5 years. (SG80);
- Interactions are likely to cause up to 10% change in characteristic; impact recovery is likely to take up to 20 years. (SG60);
- Interactions are likely to cause greater than 10% change in characteristic; impact recovery is likely to more than 20 years. (<SG60) [Note: this option was not included in the questionnaire, but discussed at the expert group workshop].

Results and discussion

3.7.2 The expert group discussed available research that quantifies the level of removal of biota post trawling events.

3.7.3 The challenges of assessing the proportion of interaction in combination with the recovery time is noted, as the effect is very species specific and variable across regularly fished areas compared to unfished areas. It is noted that the proportion of biota removal (e.g., 10%) varies in severity depending on the species composition within that 10%. This is considered within the Benthic Ecosystem Fisheries Impact Study (BENTHIS) undertaken by Rijnsdorp et al. (2017), which found that:

> *Fishers concentrate their activities in only a part of their total fishing area. These core fishing grounds are characterised by a relative low status (high impact). Additional fishing in these core grounds have only a small impact. In the peripheral areas where fishing intensity is low, additional fishing will have a much larger impact. Hence, shifting trawling activities from the core fishing grounds to the peripheral areas will increase the overall impact. Shifting activities from the peripheral grounds to the core will reduce the overall impact.*

3.7.4 Other points raised by the expert group included:

- There is potentially higher impact for the Irish Sea and West of Scotland based on intensity of the fishery;
- There is good recruitment in the Isle of Man despite the sustained level of dredging;
- There are relatively low impact scores in dredged areas of the North Sea (Rijnsdorp et al 2020).
- Concern for sensitive species, notably slow recovery of flame shells and documented declines in and concerns for biogenic habitats.

3.7.5 The results of the interactive voting are presented in Figure 3.9, for the consequence of the fishery impact on composition of species and functional group.

3.7.6 The voting for scale of consequence was relatively evenly split between up to 5% change in characteristic, recovery in 5 years and up to 10% change in the characteristic, recovery taking up to 20 years.

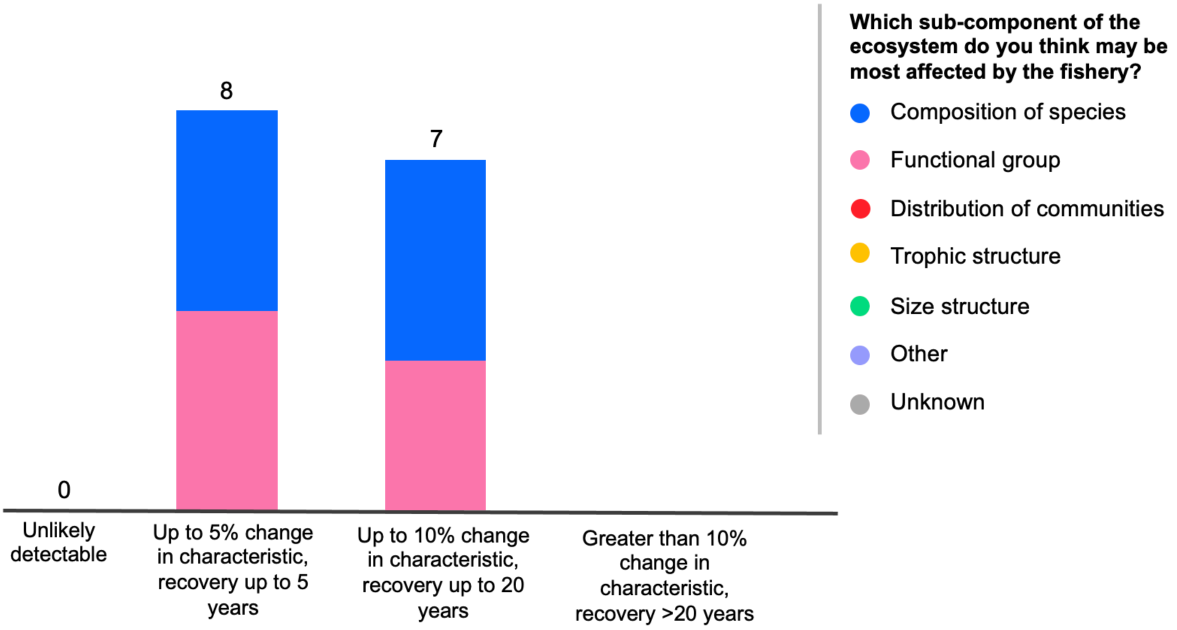

Figure 3.9: Expert working group interactive voting for consequence of the impact (figure is colour coded based on the answers provided for question 3)

3.7.7 Hiddink et al. (2017) found through meta-analysis that towed dredge gear removed 20% of community biomass and abundance per pass, penetrating the seabed on average 5.47 cm (Hiddink et al., 2017, SI Appendix, Table S4). The study found benthic community reduction to increase with higher gravel content. Communities on gravel may be more sensitive to bottom contact fishing gear because they have a higher proportion of larger, long-lived and sessile epifauna.

3.7.8 Sciberras et al., (2018) found (also through meta-analysis) that the mean initial response in community abundance to towed dredge per gear pass was -8% (ranging from -20% to +5%) and the time to recover was 3+ years. The initial impact of towed dredges reduced community species richness by 12% (-19% to -5%) and the time to recover was 27 days.

3.7.9 Recovery rates depend on the level of active movement of individuals from adjacent habitats (including scavenging species), recruitment of new individuals and growth of surviving biota.

3.7.10 Median recovery rates post-trawling (including demersal otter trawling, beam trawling, towed dredge and hydraulic dredge) ranged from 1.9 to 6.4 years (Hiddink et al., 2017).

3.7.11 Sessile and low mobility biota with longer life-spans such as sponges, soft corals and bivalves took much longer to recover after fishing (>3 year) than mobile biota with shorter life-spans such as polychaetes and malacostracans (<1 year) (Sciberras et al., 2018).

Conclusion

3.7.12 Based on the responses provided during the expert workshop, coupled with the research outlined above, it is concluded that the consequence of the fishery interactions with the ecosystem are considered likely to cause up to 10% change in the sub-component characteristic, with the impact likely to take up to 20 years to recover.

3.7.13 This meets the SG60 SICA requirement. The SG80 and SG100 are not met.

4. SICA overview

<table>
<tr><th>2.5.1 Ecosystem</th><th>Spatial scale of fishing activity</th><th>Temporal scale of fishing activity</th><th>Intensity of fishing activity</th><th>Relevant subcomponents</th><th>Consequence score</th></tr>
<tr><td rowspan="4">Scallop dredge gear targeting king scallops in North Sea, West of Scotland and Irish Sea</td><td rowspan="4">4
[31-45%]</td><td rowspan="4">4
[101-200 days]
[to be confirmed quantitatively]</td><td rowspan="4">4
[Major]</td><td>Species composition</td><td>60</td></tr>
<tr><td>Functional group composition</td><td>60</td></tr>
<tr><td>Distribution of the community</td><td></td></tr>
<tr><td>Trophic size/structure</td><td></td></tr>
<tr><td>Justification for spatial scale</td><td colspan="5">Habitat mapping, relative benthic status and predicted distribution of habitats will further inform this score. Based on VMS data reviewed, together with industry knowledge on the cyclical nature of targeted grounds for scallops, the spatial overlap is considered to be between 31-45%.</td></tr>
<tr><td>Justification for temporal scale</td><td colspan="5">Further quantitative data including surface Swept Area Ratio data is recommended to inform the temporal assessment.
Based on outputs from the expert workshop, and being precautionary, the temporal overlap is qualitatively assessed at 101-200 days overlap.</td></tr>
<tr><td>Justification for intensity of fishing</td><td colspan="5">Detectable evidence of scallop dredging occurs reasonably often and on a relatively broad spatial scale. The intensity of the interaction is therefore deemed to be major.</td></tr>
<tr><td>Justification for consequence score</td><td colspan="5">Scientific evidence indicates that post dredging events there is a 20% reduction in community biomass and abundance (Hiddink et al. 2017), and 12% reduction in species richness (Sciberras et al., 2018). Recovery times range from 27 days to 1.9-6.4 years post dredging (Sciberras et al., 2018, Hiddink et al. 2017).
Overall, the expert group consider the consequence of the fishery interactions with the ecosystem likely to cause up to 10% change in the sub-component characteristic, with the impact likely to take up to 20 years to recover. This is supported by scientific research. This meets the SG60 SICA requirement. The SG80 and SG100 are not met.
At this stage there is no difference in scores between the ecosystem regions of North Sea, West of Scotland and Irish Sea. Further quantitative data may result in different scores for these regions.</td></tr>
</table>

5. Recommendations

5.1.1 This SICA report brings together a range of views provided by an expert group, facilitated through an interactive workshop.

5.1.2 The ecosystem regions have been defined as the scallop stock assessment areas within the West of Scotland, Irish Sea and North Sea.

5.1.3 Overall, the SICA for ecosystem outcome status (2.5.1) meets SG60 requirements for scallop dredge and the findings align with the scoring assessment of the scallop pre-assessment (Poseidon, 2019).

5.1.4 This SICA highlighted the association with a number of ongoing tasks being undertaken within the scallop habitat PhD, including: habitat mapping, predicted habitat distribution, dredge footprint analysis, and assessment of relative benthic status.

5.1.5 This SICA has recommend further work to:

- Quantitatively assess the temporal overlap of the fishery through (for example) swept area ration analysis.

5.1.6 While it is recognised that assessments are based on the best available data at the time of analysis, it is recommended that this SICA is reviewed when fishing spatial data becomes available for vessels <12m in length.

5.1.7 Based on the fishing gear interaction with the habitat being most likely to cause effect on the ecosystem, it is recommended that ecosystem management is focused on managing the effort and / or footprint of the fishery. This may be aligned with habitat management measures, forming a partial strategy for ecosystem i.e., a cohesive arrangement of one or more measures that may not have been designed specifically to manage the impact on the ecosystem component, but is effective in achieving an outcome status of SG80.

References

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Appendix A: List of SICA workshop participants

Attendees	Organisation
AB: Abigayil Blandon	WWF-UK
AL: Andy Lawler	Centre for Environment, Fisheries and Aquaculture Science
BL: Bill Lart	Seafish
CD: Calum Duncan	Scottish Environment Link
CM: Chris McGonigle	Ulster University
CP: Claire Pescod	Macduff Shellfish
CJ: Clara Johnston	Scottish Environment Link
FN: Fiona Nimmo	Poseidon
HF: Hannah Fennel	Orkney Fisheries Association
JH: Jan Geert Hiddink	Bangor University
JP: Jo Pollett	Marine Stewardship Council
KK: Katie Keay	Marine Stewardship Council
MS: Matthew Spencer	Marine Stewardship Council
KC: Kenny Coull	Scottish White Fish Producers Association
LB: Lynda Blackadder	Marine Scotland Science
MF: Mairi Fenton	Herriot-Watt University
MK: Mike Kaiser	Herriot-Watt University
PC: Patrick Collins	Queens University Belfast

Appendix B: MSC Ecosystem Component

MSC default assessment tree for Ecosystem Outcome Status (2.5.1)

Component	PI	Scoring issues	SG60	SG80	SG100
Ecosystem	Outcome Status **2.5.1** The UoA does not cause serious or irreversible harm to the key elements of ecosystem structure and function.	(a) Ecosystem status	**The UoA is unlikely** to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.	**The UoA is highly unlikely** to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.	**There is evidence** that the UoA is highly unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.

Definitions

Ecosystem	Broader ecosystem elements such as trophic structure and function, community composition, and biological diversity.
Highly unlikely	Probability requirement for highly unlikely = less than the 30th percentile. i.e. there is less than a 30% probability that the UoA disrupts key elements of the ecosystem. {unlikely = <40th %ile. Highly unlikely = <30th %ile. Evidence = <20th %ile}
Key elements	Key ecosystem elements are the features of an ecosystem considered as being most crucial to giving the ecosystem its characteristic nature and dynamics, and are considered relative to the scale and intensity of the UoA. They are features most crucial to maintaining the integrity of its structure and functions and the key determinants of the ecosystem resilience and productivity.
Serious of irreversible harm	Serious or irreversible harm to "structure or function" means changes caused by the UoA that fundamentally alter the capacity of the ecosystem to maintain its structure and function. This could be the reduction of key features most crucial to maintaining the integrity of the ecosystem structure and functions and ensuring that ecosystem resilience and productivity is not adversely impacted. This includes, but is not limited to, permanent changes in the biological diversity of the ecological community and the ecosystem's capacity to deliver ecosystem services.

Scale intensity consequence analysis (SICA)

The 2.5.1 PI is scored via risk based framework (RBF) where information is not available to support an analysis of the impact of the fishery on the ecosystem.

However, the team may consider using the SICA to assess this PI in the default assessment tree as a means of obtaining the range of viewpoints and constructing the probability interpretation of the scoring guideposts.
The overall SICA scoring template is provided in the table below.
The stakeholder questionnaire tab is intended to provide information for this table to be completed.

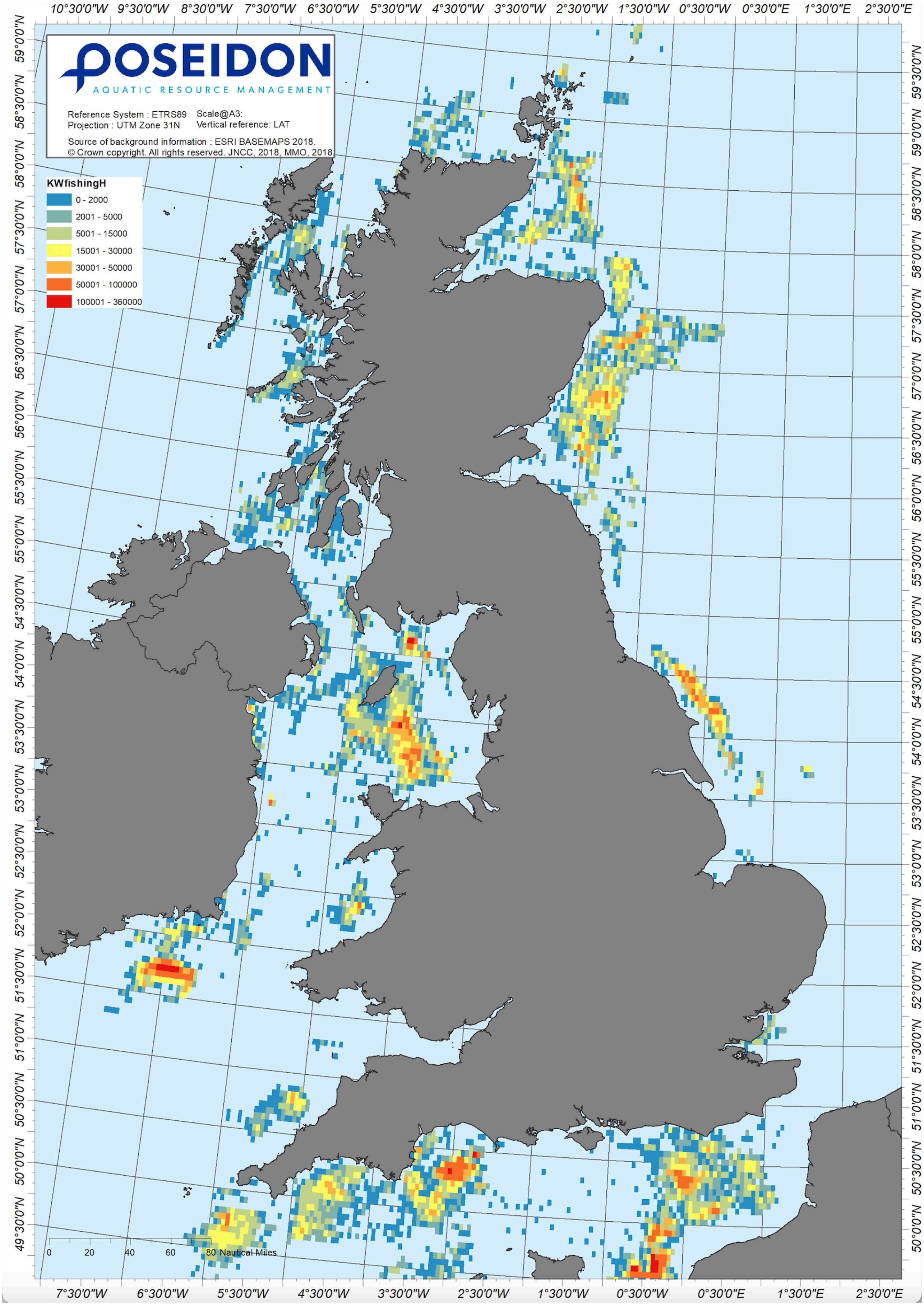
Performance indicator PI 2.5.1 Ecosystem	Spatial scale of fishing activity	Temporal scale of fishing activity	Intensity of fishing activity	Relevant subcomponents	Consequence score
Fishery name	scores 1, 2, 3, 4, 5 or 6	scores 1, 2, 3, 4, 5 or 6	scores 1, 2, 3, 4, 5 or 6	Species composition	scores 60, 80 or 100
				Functional group composition	scores 60, 80 or 100
				Distribution of the community	scores 60, 80 or 100
				Trophic size/structure	scores 60, 80 or 100
Justification for spatial scale of					
Justification for temporal scale of					
Justification for intensity of fishing					
Justification for consequence					

Appendix C: Stakeholder Questionnaire

Question			Answers			
Q.1	**Define the geographic area of the ecosystem(s) and specify reason**					
	a	One overall ecosystem for all waters targeted by the fishery				
	b	Three ecosystems: North Sea, West of Scotland and Irish Sea				
	c	More than three ecosystems: please specify				
Q.2	**What elements of the ecosystem do you think may be affected by the fishery?** Please rank elements 1 to 5, where 1 is most affected and 5 is least affected. Please enter answers in one column OR many columns where your answer varies across different ecosystems.		One overall ecosystem	North Sea	West of Scotland	Irish Sea
	a	Composition of the species in the ecosystem				
	b	Functional group (for example, plankton)				
	c	Distribution of communities				
	d	Trophic structure				
	e	Size structure				
	f	Other element of the ecosystem (specify)				
Q.3	**Which element of the ecosystem do you think is most likely to be affected by the fishery?** Please choose one option - this is likely to align with the element ranked as 1 in Q.2. Please enter answers in one column OR many columns where your answer varies across different ecosystems.		One overall ecosystem	North Sea	West of Scotland	Irish Sea
	a	Composition of the species in the ecosystem				
	b	Functional group (for example, plankton)				
	c	Distribution of communities				
	d	Trophic structure				
	e	Size structure				
	f	Other element of the ecosystem (specify)				
	Please explain the basis for your choice.					
Q.4	**What aspect of fishing activity is most likely to affect the ecosystem?** By please choose one option. Please enter answers in one column OR many columns where your answer varies across different ecosystems.		One overall ecosystem	North Sea	West of Scotland	Irish Sea
	a	Fish removal (i.e. removal of the target species and/or other species caught by the fishery)				
	b	Interaction with the habitat				
	c	Loss of fishing gear				
	d	Bait collection (if relevant to the fishing industry)				
	e	Anchoring gear (if relevant for fishing)				
	f	Boat mooring (if relevant for fishing)				
	g	Other fishing activity (please specify)				
	Please explain the basis for your choice.					
Q.5	**Spatial scale: what is the scale of overlap between the fishery and the element of the ecosystem that is most likely to be affected by it?** Please select one option based on your expert judgement. Please enter answers in one column OR many columns where your answer varies across different ecosystems.		One overall ecosystem	North Sea	West of Scotland	Irish Sea
	a	Less than 1% overlap				
	b	1-15% overlap				
	c	16-30% overlap				
	d	31-45% overlap				
	e	46-60% overlap				
	f	Over 60% overlap				
	Please explain the basis for your choice.					

Question			Answers			
Q.6	**Time scale: how often does the fishery interact with the element of the ecosystem that is most likely to be affected by it?** Please select one option based on your expert judgement. Please enter answers in one column OR many columns where your answer varies across different ecosystems.		One overall ecosystem	North Sea	West of Scotland	Irish Sea
	a	1 day every 10 years or so				
	b	1 day every few years				
	c	1-100 days per year				
	d	101-200 days per year				
	e	201-300 days per year				
	f	301-365 days per year				
	Please explain the basis for your choice.					
Q.7	**Intensity: How intense is the interaction of the fishing industry with the element of ecosystem that is most likely to be affected by it?** This relates to the element identified in Q.3. Please select one option based on your expert judgement. Please enter answers in one column OR many columns where your answer varies across different ecosystems.		One overall ecosystem	North Sea	West of Scotland	Irish Sea
	a	Remote probability of the effect of the activity detected at any spatial scale or temporary (negligible)				
	b	Activity occurs rarely or in some restricted places, and evidence of activity even at these scales it is rare (minor)				
	c	Moderate activity detection on a wider spatial scale or obvious detection but local (moderate)				
	d	The detectable evidence of activity occurs reasonably often on a broad spatial scale (major)				
	e	Easily detectable localized evidence of activity and widespread and frequent evidence of activity (severe)				
	f	Local or regional evidence of activity or continuous and widespread evidence (catastrophic)				
	Please explain the basis for your choice.					
Q.8	**Consequence: what do you think are the consequences of the impact of the fishery on the aspect of the ecosystem most likely to be affected?** This relates to the element identified in Q.3. Please select one option based on your expert judgement. Please enter answers in one column OR many columns where your answer varies across different ecosystems. Please see **Annex A** for further guidance on justifications relevant for each option.		One overall ecosystem	North Sea	West of Scotland	Irish Sea
	a	Interactions are unlikely to be detectable against natural variation.				
	b	Interactions are likely to cause up to 5% change in characteristic; impact recovery is likely to take up to 5 years.				
	c	Interactions are likely to cause up to 10% change in characteristic; impact recovery is likely to take up to 20 years.				
	Please explain the basis for your choice.					
Q.9	**Other comments: Do you have any other comments on this evaluation of the fishery?**					
Q.10	**Other references: Do you have any other sources of info / references relevant to this fishery?**					

Appendix D: VMS Data



Guidance for assessing consequence category for each ecosystem subcomponent

Subcomponent	Fail	60	80	100
Species composition	Consequence is higher risk than 60 level.	Detectable changes to the community species composition without a major change in function (no loss of function). Changes to species composition up to 10%. Time to recover from impact on the scale of several to 20 years.	Impacted species do not play a keystone role (including trophic cascade impact) – only minor changes in relative abundance of other constituents. Changes of species composition up to 5%. Time to recover from impact up to 5 years.	Interactions may be occurring that affect the internal dynamics of communities, leading to change in species composition not detectable against natural variation.
Functional group composition		Changes in relative abundance of community constituents up to 10% chance of flipping to an alternate state/ trophic cascade.	Minor changes in relative abundance of community constituents up to 5%.	Interactions that affect the internal dynamics of communities leading to change in functional group composition not detectable against natural variation.
Distribution of the community		Detectable change in geographic range of communities with some impact on community dynamics. Change in geographic range up to 10% of original. Time to recover from impact on the scale of several to twenty years.	Possible detectable change in geographic range of communities but minimal impact on community dynamics change in geographic range up to 5% of original.	Interactions that affect the distribution of communities unlikely to be detectable against natural variation.
Trophic/size structure		Changes in mean trophic level and biomass/number in each size class up to 10%. Time to recover from impact on the scale of several to 20 years.	Change in mean trophic level and biomass/number in each size class up to 5%.	Changes that affect the internal dynamics unlikely to be detectable against natural variation.

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