Nature Conservation Advice from NatureScot and JNCC: North Sea and West Coast of Scotland Nephrops FMPs

Executive Summary

This advice forms part of a commission from the Marine Directorate (MD) to NatureScot and JNCC to provide nature conservation advice to support the development of UK Fisheries Management Plans (FMPs). The advice provides information on the risks arising from the Scottish fisheries contained within the North Sea Nephrops and West Coast of Scotland Nephrops FMPs, hereafter referred to as **the Nephrops FMPs**, to:

- The designated features of Marine Protected Areas (MPAs) in Scottish waters
- Priority Marine Features (PMFs)
- UK Marine Strategy (UK MS) descriptors

This advice sets out our approach and a brief assessment of risks to MPA features, PMFs and UK MS descriptors in Scottish waters from the Nephrops fisheries. Although the underlying impact pathways are similar (e.g. bycatch is a risk in all three assessments) and some species which function as UK MS indicators are also MPA features and/or PMFs, there are also important differences. The UK MS and PMFs list cover a much broader range of species than those protected by MPA designations, especially for cetaceans and fish. Also, the underlying objectives are different and therefore there may be subtle but important differences to the assessment of risk and precaution. Therefore, our advice is presented separately for MPA features, PMFs and UK MS descriptors.

This advice has scoped in demersal otter trawls and creels as being the most relevant gear types for consideration. Although the risk profiles of the fishery in the North Sea and the West of Scotland differ due to variations in species distribution and fishing activities, the outcomes of our assessment based on the presented framework are the same and applicable to both FMPs, unless otherwise stated. More specific information on gear types, location and fishing effort will improve the ability to assess environmental risks associated with each FMP and may alter some of the risk-ratings presented. However, the primary aim of this advice is to provide a pragmatic steer on where the greatest concerns lie for interactions between Nephrops fisheries gear types and the designated features of MPAs, PMFs, and UK MS descriptors.

Risks relating to the designated features of MPAs in Scottish Waters

Fisheries contained in the Nephrops FMPs have the potential to impact the designated features of MPAs in 3 primary ways;

(i) through the **bycatch and entanglement** of species that are designated features of MPAs

(ii) the direct (targeted) and indirect (bycatch) **removal of prey species** on which designated species depend, and
(iii) **physical impacts to seafloor** resulting in alterations to habitat feature or supporting habitat condition.

These impacts can potentially occur both inside and outside MPA site boundaries.

Assessments of the impact of fishing activity occurring within MPAs in Scottish waters has been carried out by the Marine Directorate of the Scottish Government. Management measures for relevant fishing activities within MPAs have been implemented or are in development, to ensure any fishing within MPAs is compatible with the MPA's conservation objectives. Therefore, the existing assessment and management pathways mitigate risks arising from fishing activity within Scottish MPAs, and no additional action is suggested for the Nephrops FMPs *within* Scottish MPA site boundaries at this time. **Pressures occurring within MPA sites have therefore been screened out of this advice.** However, potential risks to designated mobile species from bycatch/entanglement and removal of prey species may remain when they move outside of the MPA.

The results of an initial consideration of the available evidence and expert opinion of the main risks arising from the Nephrops FMPs to the designated features of Scottish MPAs are summarised below.

Risk Summary:

While the risk to the conservation status of MPA designated mobile species through bycatch from Nephrops *trawls* is generally considered low, certain fish species, such as the flapper skate, may be at greater risk owing to their life histories.

Several protected marine mammal and fish species have been identified as a bycatch risk in *creel* fisheries, including basking shark, minke whale, and to a lesser extent, Risso's dolphin. Humpback whales, though not an MPA feature, are also at risk of entanglement. In the case of minke whale, there is considerable evidence of entanglement risk in creel ropes. However, it is unclear if the scale of this impact is likely to impede the achievement of MPA conservation objectives for these species and to what extent Nephrops creeling contributes to this risk.

Owing to significant gaps in the available evidence, **the risk rating for bycatch in Nephrops fisheries is considered moderate.** Additional evidence collected to fill these gaps could enable us to revisit this risk assessment.

Although they contribute to the diet of several MPA designated species, Nephrops are not considered a key prey species, and bycatch of key prey species is not thought to be at a level of concern. Bycatch, consisting primarily of gadoids such as juvenile cod and whiting, has historically been high, but mitigation measures adopted by the fishery have reduced this (Ungfors et al., 2013). Although several relevant marine mammal species utilise these fish as part of their diet, these species are considered generalist feeders. This feeding strategy has weak association with the availability of particular prey species; generalist feeders tend to feed on whichever species happen to be abundant (Dickey-Collas et al., 2014).

Therefore, we consider there to be a low risk of removal of important prey species that designated species depend on. If routine monitoring (or improved evidence via REM) indicates that bycatch levels of gadoids or other key forage fish species increase significantly then this risk will need to be reassessed.

Risks relating to Priority Marine Features

Priority Marine Features (PMFs) in Scotland represent a selection of habitats and species identified for their conservation importance. These eighty-one features are acknowledged for their national significance and the role they play in supporting marine biodiversity. The list includes highly mobile marine mammals and fish, as well as habitats and benthic species of conservation interest. The purpose behind identifying PMFs is to focus conservation efforts, guide management actions, and ensure the protection and enhancement of marine biodiversity within Scottish waters.

The primary impact pathways for PMFs are the same as those listed above for MPA features: (i) bycatch and entanglement, (ii) prey reduction, and (iii) physical impacts to the seafloor.

The results of an initial consideration of the main risks to PMFs also echo the assessment for MPA features, albeit covering an additional suite of features. In addition, we consider physical impacts to the PMF 'burrowed mud' which is identified as the primary habitat over which Nephrops fishing occurs. The results of our assessment are summarised here.

Risk Summary:

In addition to the bycatch risks outlined for MPA designated species above, creeling may present a risk of entanglement for other large cetaceans such as fin whales, sperm whales, and humpback whales (although this latter species is not listed as a PMF). While the risks of bycatch of most PMF fish species in Nephrops trawl fisheries may be mitigated through their own stock management processes, significant gaps in the available evidence remain, and there may be instances where localised depletion can have a wider impact on PMF fish stocks. **The risk rating for bycatch of PMFs in Nephrops fisheries is therefore considered to be moderate.** Additional evidence collected to fill these gaps could enable us to revisit this risk assessment.

Although they contribute to the diet of several PMF listed species, Nephrops are not considered a key prey species, and bycatch of key prey species is not thought to be at a level of concern for PMFs. Historically high bycatch rates have been reduced through mitigation efforts in recent years (Ungfors et al., 2013) and PMF species that utilise these fish as part of their diet are considered generalist feeders and not significantly affected by the availability of particular prey species (Dickey-Collas et al., 2014). **Therefore, we consider there to be a low risk of removal of important prey species that PMFs depend on.** If routine monitoring (or improved evidence via REM) indicates that bycatch levels of gadoids or other key forage fish species increase significantly then this risk will need to be reassessed.

Nephrops fishing, in particular trawling, has the capacity to impact the benthic habitats over which they occur, primarily through physical penetration, abrasion, and disturbance of the seabed. Nephrops fishing activities are highly habitat specific as the target species only occurs within burrowed mud. As such, physical impacts from Nephrops fishing are only considered for mud habitats.

As the burrowed mud PMF is also represented across the Scottish MPA network, this habitat will be offered some protection through the MPA management process. As some of these impacts will be mitigated, **the risk rating for physical impacts to benthic and habitat PMFs is considered moderate**. This rating is primarily driven by the trawl fishery, but creeling also contributes to this risk, with the relative impact linked to the intensity of creel fishing in an area. Recommendations for further work with respect to physical impacts of the Nephrops fisheries are highlighted below under the assessment of risk for GES descriptor D6 “seafloor integrity”.

Risks relating to UK Marine Strategy Descriptors

The UK Marine Strategy Regulations 2010 (SI 2010/1627) provide the policy framework for delivering marine environmental policy at the UK level and set out how the vision of clean, healthy, safe, productive, and biologically diverse oceans and seas will be achieved. The Regulations require authorities to define the characteristics of Good Environmental Status (GES) and in turn develop an associated Programme of Measures to deliver GES. Good Environmental Status (GES) establishes a ‘benchmark’ for our seas which seeks to ‘*protect the marine environment, preventing its deterioration and restoring it where practical, while allowing sustainable use of marine resources*.’ For each descriptor there are a number of practical targets and indicators that facilitate assessment of our delivery against each descriptor.

The UK Marine Strategy Regulations require management action to be taken to achieve or maintain GES. The Fisheries Act (2020) enables regulators to deliver on this ambition through the Ecosystem Objective, which states that fish and aquaculture activities should be managed using an ecosystem-based approach, which is, in-part, defined in the Act by the achievement of GES. Equally, the recently published Joint Fisheries Statement (2022) lays out the ambition across UK administrations to take action to achieve or maintain Good Environmental Status (GES) in all UK waters (Joint Fisheries Statement, 2022).

This advice focuses only on the most relevant descriptors in terms of risks posed by commercial and recreational fisheries: D1 biodiversity, D3 commercial fish and shellfish, D4 food webs, D6 seafloor integrity and D10 marine litter. In the UK MS, these descriptors are assessed using indicators for each of their constituent ‘ecosystem components.’ This is carried through to this advice resulting in advice on risks to eight descriptor-ecosystem component combinations: D1, D4 cetaceans; D1, D4 seals; D1, D4 seabirds; D1, D4 fish; D4 food webs; D1, D6 seafloor integrity and D10 Marine Litter.

The results of an initial consideration of the available evidence and expert opinion of the main risks arising from the Nephrops FMPs to UK MS Descriptors are summarised below.

Risk Summary:

There is a moderate risk to achieving GES for the biological diversity of cetaceans, seals and birds, due to impacts from Nephrops fishing activities. Although the risks caused by Nephrops fishing in terms of bycatch and reduced prey are likely to be low for these species, there are still significant gaps in the available evidence. As a result, the FMP risk rating has been upgraded to moderate.

There is a high risk to seafloor integrity due to benthic disturbance caused by mobile demersal fishing activities. However, this indicator looks at impacts across the >12m UK mobile demersal fishing fleet. It does not include impacts from the Nephrops creel fishery – while these are likely to be lower risk, these gears may impact seafloor integrity if operating at a high intensity. Further work is needed to disentangle and quantify impacts from individual fisheries. Strategic work at a broad geographic scale is required to understand the relative impact from this fishery and identify opportunities to reduce/remove risk and understand trade-offs across the UK fishing fleet.

There is a moderate risk to marine litter. More robust estimates of abandoned, lost, or discarded fishing gear in the fishery are required.

Further Recommendations

The detailed advice, upon which this summary advice is based, also makes recommendations for the Nephrops FMPs to reduce associated risks to the designated features of MPAs in Scottish waters (arising from fishing activity outside site boundaries), PMFs, and achievement of GES (UK MS); these include:

- A recommendation to undertake additional targeted evidence collection to improve estimates of bycatch of marine mammals, seabirds, and designated fish for Nephrops gear types, utilising remote electronic monitoring where appropriate.
- A recommendation to support the ongoing development of actions to mitigate bycatch risk in creel fisheries.
- A recommendation to prioritise the establishment of a strategic Benthic Impacts Working Group to focus on achieving GES for seabed integrity, including through developing and testing targeted mitigation strategies to manage the impacts of fishing and other activities on benthic habitats.

Contents

1 Scope and purpose of SNCB advice

This document provides Statutory Nature Conservation Bodies (SNCB) advice to inform the development of the North Sea and the West Coast of Scotland Nephrops Fisheries Management Plans (FMPs), focusing on the fisheries contained within these FMP and their potential risks to:

- The designated features of Marine Protected Areas (MPAs) in Scottish waters
- Priority Marine Features (PMFs)
- UK Marine Strategy (UK MS) descriptors

This advice sets out our approach and a brief assessment of risks to MPA features, PMFs and UK MS descriptors in Scottish waters from Nephrops fisheries. Although the underlying impact pathways are similar (e.g. bycatch is a risk in all three assessments) and some species which function as UK MS indicators are also MPA features and/or PMFs, there are also important differences. The UK MS and PMFs list cover a much broader range of species than those protected by MPA designations, especially for cetaceans and fish. Also, the underlying objectives differ for each and therefore there may be subtle but important differences to the assessment of risk and precaution. Therefore, our advice is presented separately for MPA features, PMFs and UK MS descriptors.

The advice has scoped in demersal otter trawls and creels as the most relevant gear types for consideration. More specific information on gear types, location and fishing effort will improve the ability to assess environmental risks associated with each FMP and may alter some of the risk-ratings presented. However, the primary aim of this advice is to provide a pragmatic steer on where the greatest concerns lie for interactions between Nephrops fisheries gear types and the designated features of MPAs, PMFs, and UK MS descriptors. It intends to guide the FMP's development process, focusing on where to best allocate resources to mitigate wider environmental impacts of the fisheries. Further SNCB advice will be required to support the Habitats Regulations Appraisal of any management measures stemming from the FMP.

2 Approach to assessing risk

2.1 Indicative risk ratings

In contrast to the SNCBs routine advice around environmental sensitivity, the ‘indicative risk ratings’ developed for this advice consider the scale of risk associated with the different components of the Nephrops fishery to help identify where the greatest impacts are likely to occur. For example, the risk rating associated with a gear-feature/descriptor interaction may be lowered if the higher-risk activity only makes up a small proportion of the fishing activity covered by the FMP and thus there is low exposure of the feature/descriptor to the higher-risk activity.

Low Risk: An impact pathway exists, but evidence or expert opinion suggests that impacts are minimal or unlikely. This applies in the MPA context where a theoretical impact is either absent or the scale of impact is minimal. For PMFs, the fishery may have defined impact pathways, but it would be considered low risk where there is either no empirical evidence of

significant adverse effects on the national status of PMFs or the impacts are negligible across relevant spatial and temporal scales. This rating is appropriate when interaction with PMFs is minimal or when existing mitigation measures effectively negate potential harm. For UK MS, impacts were rated low risk where fisheries were considered unlikely to adversely impact the achievement of GES.

Moderate Risk: Interactions rated as moderate risk typically have an evidenced impact or expert judgment indicates a genuine risk. For MPAs, this risk rating would be appropriate where the overall impact level might be ambiguous, possibly due to, limited spatial overlap between relevant gears and protected features, significant variation in impact over space and time, or differences between fisheries covered in the FMP and those from which the evidence base was derived. For PMFs, moderate risk was deemed appropriate where there is a clear linkage between the fishery's activities and potential adverse effects on the national status of PMFs, albeit mitigated by factors like limited spatial overlap, existing management measures, or the resilience of PMFs. It also covers scenarios where potential risk is identified although more evidence is required to enhance assessment confidence. For UK MS, moderate risk refers to instances where a clear impact pathway exists between the relevant fishing gears and the achievement of GES. However, further evidence might be needed, or other activities also significantly influence the current indicator status.

Such a precautionary approach to risk assessment is aimed at managing identified risks proactively while acknowledging gaps in current understanding. It is recommended that FMPs consider enhancing data collection or mitigation efforts if a moderate risk is identified, taking a proactive approach towards minimising impacts.

High Risk: Interactions identified as high risk are those where available evidence or expert opinion suggests there is an impact at such a scale as is likely to require mitigation. In the MPA context, this rating would be assigned where the scale of impact is likely to have an adverse effect or hinder the achievement of an MPAs' conservation objectives, and the fishing activities managed by the FMP are believed to significantly contribute to these risks. For PMFs, the rating applies where activities or conditions within the fishery have well-documented, significant negative impacts on PMFs, threatening their national conservation status through direct harm or habitat degradation. High-risk scenarios are those where the intensity, scale, or nature of the impact could lead to a decline in PMF populations/extent or degradation of critical habitat, which would affect the national conservation status of that PMF in the absence of substantial mitigation measures. This rating would be given for UK MS where a well-evidenced link exists between the fishery and the failure to attain GES based on current indicators, with fishing activities covered by the FMP being assessed as contributing significantly to that failure.

3 Risks relating to the designated features of Marine Protected Areas in Scottish waters

Marine Protected Areas (MPAs) in Scottish waters include Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) which are protected under the Conservation of Habitats and Species Regulations 2017 and the Conservation of Offshore Marine Habitats and Species Regulations 2017, collectively referred to as the Habitats Regulations.

Additionally, Nature Conservation Marine protected Areas (NCMPAs) are designated and protected by the Marine (Scotland) Act 2010 and Marine and Coastal Access Act 2009. Impacts of activities are assessed against the conservation objectives of MPAs and activities should not have an adverse effect on the integrity of SACs or SPAs and should not hinder the conservation objectives of NCMPAs.

Fisheries within the Nephrops FMPs can potentially impact MPA designated features in 3 main ways:

i) through the **bycatch and entanglement** of designated features of MPAs
ii) the direct (targeted) and indirect (bycatch) **removal of prey species** on which designated species depend, and
iii) **physical impacts** to seafloor resulting in alterations to habitat feature or supporting habitat condition.

These impacts can affect the designated features of MPAs both inside and outside the boundaries of MPAs.

Assessments of the impact of fishing activity occurring within MPAs in Scottish waters has been carried out by the Marine Directorate of the Scottish Government. Management measures for relevant fishing activities within MPAs have been implemented or are in development, to ensure any fishing within MPAs is compatible with the MPA's conservation objectives. Therefore, the existing assessment and management pathways mitigate risks arising from fishing activity within Scottish MPAs, and no additional action is suggested for the Nephrops FMPs *within* Scottish MPA site boundaries at this time. **Pressures occurring within MPAs have therefore been screened out of this advice.** However, potential risks to designated mobile species from bycatch/entanglement and removal of prey species may remain when they move outside of the MPA.

3.1 Impacts to designated features outside MPA boundaries

The potential for fishing activities outside of MPAs to impact designated features, particularly mobile species that move beyond the protections of MPA boundaries, necessitates broader management consideration.

3.1.1 Risk of bycatch to mobile MPA features from Nephrops fishing

3.1.1.1 Risk to marine mammals

Bottom trawling

Marine mammals, including harbour porpoise, minke whales, Risso's dolphins, grey and common seals, featured in Scottish MPAs, face a limited risk of bycatch in demersal trawls. Historically, these gear types have not been included in the UK Bycatch Monitoring Programme's sampling regime due to the perceived lower risk compared to static nets or longlines. Incidents of harbour porpoise bycatch, though not common, have been recorded (CEFAS 2015). The infrequency of such events suggests a limited impact on the overall population status within MPAs. However, in the interest of vigilance, there is a value in continued or expanded monitoring, whether via enhanced observer coverage or remote

electronic monitoring, to further refine risk assessments and strengthen mitigation for marine mammals.

Creeling

Minke whales are considered sensitive to bycatch in creel fisheries (MacLennan et al., 2021). In Scottish waters, the most frequently documented cause of mortality for minke whales is entanglement, typically in creel ropes (based on Scottish Marine Animal Stranding Scheme data 2012-2017), though entanglement in other passive gears has been noted. Evidence of entanglement for Risso's dolphins indicates that this species may also be sensitive to bycatch in the Nephrops creel fishery (Bearzi et al., 2011).

The entrapment of otters (*Lutra lutra*) in crab and lobster pots has been recognized as an issue since the 1980s, with early research done in Scotland (Twelves, 1983). National otter survey reports in England and Wales suggest that pots set at shallow depths of 2-5m at low tides result in most bycatch incidents, while those set deeper than 10-15m are unlikely to catch otters (Strachan, 2015). Factors like the bait being used, pots with internal compartments (parlour pots), and a relationship with rocky substrates have also been linked to increased bycatch risk. However, the Nephrops creel fishery likely has very low exposure to otters given that the creels are typically set at greater depths over sediment rather than rocky areas. We have little direct evidence of Nephrops creeling contributing to otter entrapment, as most studies have focused on shallow crab and lobster fisheries. While otters are not explicitly mentioned in UK Marine Wildlife Bycatch Mitigation Initiative, the principles and actions outlined could be applicable.

3.1.1.2 Risk to seabirds

Bottom trawling

Demersal trawls represent a bycatch hazard for seabirds, particularly for diving species susceptible to entanglement. Current bycatch levels have not been shown to significantly undermine seabird populations or the integrity of Special Protection Areas (SPAs). However, the limited data calls for an enhancement of the bycatch monitoring regime to capture a clearer picture of the risks these gears pose to seabirds.

39 of the 109 UK SPA species and subspecies are seabirds that could potentially be affected by benthic trawling. Historical data and studies point to species such as deep diving shags, scaups, eiders, and cormorants being most vulnerable to this fishing method (CEFAS, 2015; Bradbury et al., 2017). Although the focus of recent research, such as Northridge et al. (2020), reflects the perception that benthic trawling is less risky than set nets or longlines, the existing data gaps on the bycatch exposure of sensitive seabirds warrant caution (Anderson et al., 2022).

Given the current evidence, the risk of significant seabird bycatch affecting population levels or SPA conditions is assessed as low. Nevertheless, improving monitoring through adaptations to existing observer programmes or implementing remote electronic monitoring is advisable to reduce uncertainty.

Creeling

The relative risk of bycatch for marine birds in Nephrops creels is low (Ellis et al., 2013; Jarrett et al., 2017; Krieger & Eich, 2021). There is some potential for bycatch of diving birds in shallow waters; these species may enter pots while foraging (Krieger & Eich, 2021), but there is little evidence suggesting that bycatch in traps occurs frequently.

3.1.1.3 Risk to fish

Bottom trawling

Demersal trawls present a potential bycatch risk to certain fish species that are integral to the biodiversity of SACs and NCMPAs. Among these, Atlantic salmon, river lamprey, and sea lamprey spend critical parts of their lifecycle within coastal and marine waters protected by SACs in Scottish waters. Similarly, NCMPAs are designed to safeguard species like basking shark and flapper skate which utilise coastal habitats and likely overlap with Nephrops fishing areas.

Flapper skate are considered vulnerable to bycatch impacts, owing to their slow growth, late age at maturity and site fidelity. Landings of flapper skate are prohibited. However, towed demersal gears (otter trawls and dredges) are known to take flapper as bycatch (adults, juveniles, and eggs) (STECF, 2017; Fox, 2010). Mitigation of bycatch risk is possible (e.g. the removal of tickler chains on trawls to reduce by catch, Kynoch et al., 2015). For example, this measure in combination with temporal/spatial restrictions forms part of the management measures used in the Loch Sunart to the Sound of Jura MPA (Loch Sunart to the Sound of Jura Marine Conservation Order 2016).

Creeling

There are a number of accounts of basking shark entanglement in creel rope (Bloomfield & Solandt, 2008; MacLennan et al., 2021) although the extent and frequency of this is unknown. Basking sharks are considered sensitive due to their surface feeding habits, slow growth rate, lengthy maturation time (Sims & Quayle, 1998) and site-faithfulness.

3.1.1.4 Conclusions and recommendations relating to bycatch risk

While the risk to the conservation status of designated mobile species through bycatch from Nephrops trawls is generally considered low, evidence gaps remain. Flapper skate may be at greater risk owing to their habitat preferences.

Several protected marine mammal and fish species have been identified as a bycatch risk in creel fisheries, including basking shark, minke whale, and to a lesser extent, Risso's dolphin In the case of minke whale, there is considerable evidence of entanglement risk in creel ropes, however it is unclear if the scale of this impact is likely to impede the achievement of MPA conservation objectives for these species and to what extent Nephrops creeling contributes to this risk.

This risk is most relevant to the West Coast of Scotland Nephrops FMP which encompasses the majority of creeling activity. However, the potential for this impact exists wherever creeling and species which are sensitive to bycatch in this fishery interact. Therefore, this

risk should be considered across the Nephrops FMPs, wherever creeling is occurring or likely to occur in future.

Owing to significant gaps in the available evidence, **the risk rating for bycatch in Nephrops fisheries is considered moderate.** Additional evidence collected to fill these gaps could enable us to revisit this risk assessment.

3.1.2 Risk of prey depletion of important prey species to mobile MPA features from Nephrops fishing

Nephrops are not themselves generally considered a key prey species. However, there is the potential for some species of fish which are important prey for marine predators to be part of the fish bycatch in the Nephrops trawl fishery. Key potential prey fish species at risk of bycatch include small gadoids like juvenile cod, haddock, and whiting. Given the Nephrops fishery's operational characteristics, and mitigation measures adopted by the fishery, the potential for catching significant quantities of any single gadoid species, which could subsequently impact the abundance of juveniles important as prey, is relatively low compared with demersal/whitefish fisheries. Given that primary marine mammal and seabird predators feeding on these species tend to have generalist diets, the direct impacts of reducing one gadoid species' numbers might be relatively low. Thus, the direct risk to mobile features of MPAs from reduced food availability due to bycatch in this fishery seems minimal. Nevertheless, evaluations may be necessary if significant quantities of other key forage fish groups were caught as bycatch. Overall, based on the fishery's characteristics and available evidence, the risk of impacting mobile MPA features through diminished prey availability appears low.

3.1.2.1 Conclusions and recommendations relating to prey depletion risk

Although they contribute to the diet of several designated species, Nephrops are not considered a key prey species, and bycatch of key prey species is not thought to be at a level of concern. **There is a low risk of removal of important prey species that designated species depend on.** If routine monitoring (or improved evidence via REM) indicates that bycatch levels of gadoids or other key forage fish species increase significantly then this risk will need to be reassessed.

4 Risks relating to PMFs in Scottish waters

Priority Marine Features (PMFs) in Scotland represent a selection of habitats and species identified for their conservation importance. These 81 features are acknowledged for their national significance and the role they play in supporting marine biodiversity. The list includes highly mobile marine mammals and fish, as well as habitats and benthic species of conservation interest. The purpose behind identifying PMFs is to focus conservation efforts, guide management actions, and ensure the protection and enhancement of marine biodiversity within Scottish waters. Fisheries within the Nephrops FMPs can potentially impact PMFs in 3 main ways:

(i) through the catch or **bycatch** of PMFs

(ii) the direct (targeted) and indirect (bycatch) **removal of prey species** on which PMF species depend, and
(iii) **physical impacts** to seafloor resulting in alterations to PMF habitat feature or supporting habitat condition.

4.1.1 Risks of bycatch to mobile PMFs from Nephrops fishing

4.1.1.1 Risk to marine mammals

Bottom trawling

The Scottish PMF list includes most of the UKs resident marine mammals. As mentioned in Section 3.1.1.1, marine mammal species face a limited risk of bycatch in demersal trawls. However, demersal trawls are not routinely monitored for marine mammal bycatch due to their perceived low risk. Continued or expanded monitoring, whether via observer coverage or remote electronic monitoring, would help to further refine risk assessments and lessen the need for a precautionary risk rating for marine mammals.

Creeling

Entanglement risks for Minke whale, Risso's dolphin and otters have been outlined in Section 3.1.1.1 above. In addition, creeling may present a risk of entanglement for other large whale species such as fin, sperm whales, and, humpback whales (although this latter species is not currently listed as a PMF). Recent research (MacLennan et al., 2021) has provided a broad assessment of the extent of entanglement in Scottish waters and potential mitigation options (predominantly on the west coast). However, this research does not provide a full understanding of the risk, and assessment can be improved through a better understanding of creel fishing (extent and intensity) and improved reporting of incidents.

4.1.1.2 Risk to fish and crustaceans

Bottom trawling

The PMF list includes 31 fish species, all of which are vulnerable to bycatch in bottom trawls. The distribution of deep-sea species (such as the orange roughy and blue ling) are unlikely to overlap with Nephrops fisheries, effectively mitigating risk to these species. Though there may be instances where localised depletion can impact wider PMF fish stocks, the majority of shelf-associated fish species are also commercial species, and their bycatch within the Nephrops fisheries is addressed through existing stock management measures and the development of Scotland's Future Catching Policy. Protected species previously outlined in Section 3.1.1.3 above, along with eel, sand goby, sea trout and sparling, risk potential capture as bycatch in the Nephrops trawl fishery, although there is no evidence that this risk is significant.

Creeling

In addition to the species listed in Section 3.1.1.3 as sensitive to creel impacts, the spiny lobster features on the PMF list and is sensitive to bycatch in creels. However, interaction

with the Nephrops creel fishery is likely to be very low due to the very different habitat preferences of the two species.

4.1.1.3 Conclusions and recommendations relating to bycatch risk

In addition to the bycatch risks outlined for MPA designated species above, creeling may present a risk of entanglement for other large whale species such as fin, sperm whales, and, humpback whales (although this latter species is not listed as a PMF). Work to monitor and mitigate this risk is ongoing through the Scottish Entanglement Alliance. While the risks of bycatch of most PMF fish species in Nephrops fisheries may be mitigated through their own stock management processes, gaps in the available evidence remain. **The risk rating for bycatch of PMFs in Nephrops fisheries is therefore considered to be moderate.** Additional evidence collected to fill these gaps could enable us to revisit this risk assessment.

4.1.2 Risks of prey depletion to mobile PMFs from Nephrops fishing

While the principles of predation pressure and ecosystem dynamics, discussed in Section 3.1.2, apply broadly across marine species, including birds, cetaceans, and seals, this section expands on the specific risks to fish PMFs that prey on Nephrops.

Fish listed as PMFs include benthic feeding species such as cod, whiting, and haddock. While not exclusively dependent on Nephrops, many of these species do utilise them as a component of their diet. The Nephrops FMPs ensure that fishing practices are designed to maintain Nephrops stocks above the Maximum Sustainable Yield (MSY). This management strategy inherently supports the sustainability of PMF fish species by maintaining a stable prey base, thereby mitigating the risk of significant prey depletion.

Effective implementation of the FMP, with adaptive management responsive to ongoing scientific assessments, ensures that the Nephrops fisheries do not disproportionately impact the food availability for PMF-designated fish species. Thus, the current fisheries management framework is considered adequate to prevent any substantial prey depletion risk to these PMFs, supporting their conservation and the broader ecosystem health within Scottish waters.

4.1.2.1 Conclusions and recommendations relating to prey depletion risk

Although they contribute to the diet of several designated species, Nephrops are not considered a key prey species, and the associated bycatch of key prey species is not thought to be at a level of concern for PMFs. **There is a low risk of removal of important prey species that PMFs depend on.** However, there is value in continuing to develop/improve measures for minimising bycatch of fish in the Nephrops fishery to support stock sustainability and wider biodiversity outcomes.

4.1.3 Risks of physical impact on habitat PMFs from Nephrops fishing

The Nephrops fishery is one of the most habitat specific fishery types prosecuted in Scottish waters – the target species only occurs within the burrowed mud feature. The burrowed mud habitats, characterized their unique assemblages of fauna and sediment composition,

play a critical role in Scotland's marine ecosystems. These habitats, predominately composed of finer particle sizes such as fine mud, sandy mud, and muddy sand, occur mainly in sheltered, deep waters which are less prone to natural disturbance and are therefore considered to be particularly susceptible to disturbance caused by fishing activities (Greathead et al., 2007).

Bottom trawling

Demersal otter trawls are known to have potentially significant impacts on the "burrowed mud" habitat PMF.

The direct physical impacts of abrasion and penetration introduced by Nephrops trawling can affect local topography (Tuck et al., 1998; Fonteyne, 2000; Clements et al., 2018) and by removing and/or damaging infauna assemblages and sessile organisms, can reduce the habitat complexity and alter the community composition (Kefalas et al., 2003), which has the potential to significantly impact habitat functioning.

Abrasion impacts are documented to have lasting negative effects on the population density and diversity of benthic communities; The level of impact in a given area will depend on the intensity and frequency of the trawling activity and the sensitivity of the species which make up the characterising community of the site (Ball et al., 2000; Hiddink et al., 2018; Whitton & Hiddink, 2023). Small, short-lived species show greater resilience and recovery capacity compared with the longer-lived and larger species (Bolam et al., 2017; Bastari et al., 2018; Gonzalez-Irusta et al., 2018; Hiddink et al., 2018), which can have significant implications for burrowed mud communities as many of the characteristic fauna are relatively large and long-lived (Greathead et al., 2007; OSPAR, 2010).

The targeted removal of *Nephrops norvegicus*, a key species within the burrowed mud habitat, by trawling, also presents ecological risks. While the juveniles and egg-carrying females may remain largely unaffected due to their burrowing habits, the overall population structure and habitat function could be compromised. However, evidence suggests that Nephrops may be reasonably tolerant to fishing pressures (Johnson et al., 2013; Gonzalez-Irusta et al., 2018), but this may vary with location; some areas have maintained high landings for over 30 years despite being trawled 7 times or more a year, whilst other areas have seen stock declines at similar scales. Fishing can reduce the average size of Nephrops which may result in an increased density of smaller burrows, potentially affecting the associated faunal communities and overall habitat integrity (Atkinson, 1989; Hiddink et al., 2006).

Creeling

The use of creels in the Nephrops fishery represents a less invasive fishing method compared to trawling, yet it still poses conservation risks to burrowed mud habitats. Creel operations can still cause physical impacts to the seabed and characteristic communities, though the magnitude of these impacts is likely to be smaller than that of trawling (Eno et al., 2001; Lewis et al., 2009; Stephenson et al., 2017; Gall et al., 2020; Rees et al., 2021).

Abrasion from creels is thought to primarily affects mobile and sessile epifaunal species and shallow burrowers, as the gears are not expected to penetrate the seabed consistently or extensively (though penetration can occur and should not be discounted). The placement and retrieval of creels can disturb surface sediments and physically damage component species including sea pens, such as *Funiculina quadrangularis*, which are sensitive to physical disturbances. Experimental studies have demonstrated some resilience among sea pens; they can bend to the pressure wave created by creels before they hit the seabed and can re-anchor themselves if dislodged (Eno et al., 2001) and can persist in heavily fished areas (Eno et al., 2001). However, the long-term effects of creel fishing remain unclear (Johnson et al., 2013; Rijnsdorp et al., 2017).

While creel fishing is generally more selective and causes less direct habitat disruption than trawling, the removal of a significant number of Nephrops can still have profound ecological effects. However, the impacts of creel fishing on Nephrops populations are not well understood; Ziegler (2006) found that higher numbers of berried females were recorded in creel catches compared to trawl catches. However, this was contradicted in a modelling study by Eichert et al. (2018) based in Portuguese waters which suggested that creels would protect female Nephrops as they are rarely caught in pots. Further work is needed to elucidate the impacts of creeling on Nephrops populations.

4.1.3.1 Conclusions and recommendations

Nephrops fishing, in particular trawling, has the capacity to impact the benthic habitats over which they occur, primarily through physical penetration, abrasion, and disturbance of the seabed. Nephrops fishing activities are highly habitat specific as the target species only occurs within burrowed mud. As such, physical impacts from Nephrops fishing are only considered for mud habitats.

As the burrowed mud PMF is also represented across the Scottish MPA network, this habitat will be offered some protection through the MPA management process. As some of these impacts will be mitigated, **the risk rating for physical impacts to benthic and habitat PMFs is considered moderate**. This rating is primarily driven by the trawl fishery, but creeling also contributes to this risk, with the relative impact linked to the intensity of creel fishing in an area. Recommendations for further work with respect to physical impacts of the Nephrops fisheries are highlighted below under the assessment of risk for GES descriptor D6 “seafloor integrity”.

5 Risks relating to UK Marine Strategy Descriptors

5.1 The UK Marine Strategy and FMPs

The UK Marine Strategy Regulations 2010 (SI 2010/1627) provide the policy framework for delivering marine environmental policy at the UK level and set out how the vision of clean, healthy, safe, productive, and biologically diverse oceans and seas will be achieved. The Regulations require authorities to define the characteristics of Good Environmental Status (GES) and in turn develop an associated Programme of Measures to deliver GES. Good Environmental Status (GES) establishes a ‘benchmark’ for our seas which seeks to ‘protect the marine environment, preventing its deterioration and restoring it where practical, while

allowing sustainable use of marine resources.' For each descriptor there are a number of practical targets and indicators that facilitate assessment of our delivery against each descriptor.

The UK Marine Strategy Regulations require management action to be taken to achieve or maintain GES. The Strategy applies an ecosystem-based approach to the management of all relevant human activities. In doing so, it seeks to keep the collective pressure of human activities within levels compatible with the achievement of GES and does not compromise the capacity of marine ecosystems to respond to human-induced changes. The Fisheries Act (2020) enables regulators to deliver on this ambition through the Ecosystem Objective, which states that fish and aquaculture activities should be managed using an ecosystem-based approach, which is, in-part, defined in the Act by the achievement of GES. Equally, the recently published Joint Fisheries Statement (2022) lays out the ambition across UK administrations to take action to achieve or maintain Good Environmental Status (GES) in all UK waters (Joint Fisheries Statement, 2022).

The full list of UK MS descriptors can be seen in Annex 1. This advice focuses only on the most relevant descriptors in terms of risks posed by the fisheries within the scope of the FMP: D1 biodiversity, D4 foodwebs, D6 seafloor integrity and D10 marine litter. Additional consideration of screened-out descriptors may be required in the future if evidence emerges of those descriptors being vulnerable to pressures generated by Nephrops fisheries. Furthermore, the status of many of the current indicators is currently 'uncertain' or 'unassessed' (see Annex 2). As the evidence base develops, or the suite of indicators associated with a specific descriptor evolves (e.g., after UK MS Assessment of our Seas review, next scheduled for 2024), the advice pertinent to those descriptors will need to be updated.

UK Marine Strategy Descriptor D3 (commercial fish and shellfish) focuses on achieving maximum sustainable yield (MSY) for commercially exploited stocks. The indicators prioritise maintaining reproductive capacity and fishing mortality rates that support MSY. As the primary objective of this Fisheries Management Plan is establishing sustainable exploitation of the target stocks, following the precautionary and sustainability principles outlined in the UK Fisheries Act, significant progress should be made toward meeting Good Environmental Status for D3. While risks exist due to current exploitation levels and data limitations, the plan's emphasis on long-term stock viability provides a pathway for reducing these risks. We therefore do not present detailed advice for D3 here, as the plan's development process directly addresses the descriptor through its foundational objectives. However, it is noted that achieving D3 targets alone may not fully support GES for associated descriptors, like D1 (biodiversity) and D4 (food webs), that require wider ecosystem considerations beyond single-stock MSY.

In the UK MS, these descriptors are assessed using indicators for each of their constituent 'ecosystem components.' This is carried through to this advice resulting in advice on risks to seven descriptor-ecosystem component combinations: D1, D4 cetaceans; D1, D4 seals; D1, D4 seabirds; D1, D4 fish; D4 foodwebs; D1, D6 seafloor integrity and D10 Marine Litter.

5.2 Assessing risk to UK MS Descriptors

This section provides an overview of the main risks posed to UK MS Descriptors by gear types likely to be covered by the Nephrops Fisheries Management Plans.

The advice draws upon an existing risk analysis by French et al. (2022), conducted for Natural England as part of a REM prioritisation exercise, which evaluated the impact of various fishing gears on GES descriptors. This study has provided a good foundation for the risk assessment conducted here; although the work focused on fishing interactions relevant to English inshore waters, a broad approach was undertaken in screening-in metiers and the analysis is considered relevant in the Scottish context.

This advice considers the 'overall risk scores' from French et al. (2022), using or adapting these based on additional relevant evidence (e.g., specific to the FMP) and/or expert opinion. The risk rating assigned isn't merely an assessment of gear-feature interaction but also gauges the overall risk in the FMP's context. For example, the risk rating associated with a gear-feature/descriptor interaction may be lowered if the higher-risk activity only makes up a small proportion of the fishing activity covered by the FMP and thus there is low exposure of the feature/descriptor to the higher-risk activity.

The risk ratings aim to provide a pragmatic direction on the significant concerns regarding interactions between fishing gear types and UK MS descriptors for this FMP. A description of how these risk ratings were derived is given in section 2.1 above. It should be noted that the work undertaken by French et al. (2022) used a slightly different grouping of UK MS descriptors to those used in this advice - see Objective 1 in their paper for the full methodology and associated literature reviews.

5.3 Risks to UK MS Descriptors

The risks to UK MS descriptors are detailed in Tables 1 and 2 below. Sections 5.3.1- 5.3.7 elaborate on the justifications for these risk ratings.

Table 1 Risks to UK MS descriptors from demersal trawls

UK MS Descriptor	Risk rating	Additional comments on risk	Recommendation
D1, D4 Cetaceans	Moderate	The bycatch risk in this fishery is thought to be low/moderate but this assessment has a degree of precaution as substantial data gaps exist. Further evidence collection and analysis will strengthen robustness and confidence in assessment.	Continue to improve the evidence base to understanding the scale of the pressure and improve this risk assessment. This could focus on improved bycatch data collection for sensitive species, including through enhanced reporting and remote electronic monitoring
D1, D4 Seals	Moderate	The bycatch risk in this fishery is thought to be low/moderate but this assessment has a degree of precaution as substantial data gaps exist. Further evidence collection will strengthen robustness and confidence in assessment.	Continue to improve the evidence base to understanding the scale of the pressure and improve this risk assessment. This could focus on improved bycatch data collection for sensitive species, including through enhanced reporting and remote electronic monitoring
D1, D4 Seabirds	Moderate	The risk in this fishery is thought to be low/moderate but this assessment has a degree of precaution as substantial data gaps exist. Further evidence collection will strengthen robustness and confidence in assessment.	Continue to improve the evidence base to understanding the scale of the pressure and improve this risk assessment. This could focus on improved bycatch data collection for sensitive species, including through enhanced reporting and remote electronic monitoring
D1, D4 Fish		While most fishing activities pose inherent high risks to the biological diversity of fish stocks due to non-target bycatch, we are not presenting detailed advice on this descriptor for the Nephrops FMPs. See section 5.3.4. for further details and rationale.	**No action thought to be required at an FMP scale at present, but further work is required by appropriate Authorities and ALBs to understand the indicator and identify appropriate management actions.** Focus of FMPs on sustainability & precautionary objectives of the Fisheries Act and policies developed to support delivery of the bycatch objective of the Fisheries Act should contribute to the achievement of GES for this descriptor. Actions at an FMP scale may be required to support achievement of GES for this descriptor in future.

UK MS Descriptor	Risk rating	Additional comments on risk	Recommendation
D4 Foodwebs		Comprehensive fishery-level advice is not included here, as substantial further work by appropriate authorities and ALBs is needed to determine appropriate actions. Achieving Good Environmental Status will require strategic collaboration to improve ecosystem models and understand fishing mortality impacts on complex food web dynamics.	**No action currently thought to be required for FMP**. FMP progress towards sustainability and precautionary objectives under the Fisheries Act, this may result in incremental steps towards GES
D1, D6 Seafloor integrity	High	Mobile gear benthic fisheries are the key pressure driving failure of GES. Further work is required to understand contribution of different gear types and fisheries to failure to reach GES.	Requires strategic response from appropriate authorities and ALBs, potentially through the Benthic Impacts Working Group to consider the opportunities to reduce/remove risk. FMP should seek to support the development of such a group and integrate with its work.
D10 Marine Litter	Moderate	The risk of losing mobile fishing gear is significantly lower than the risk of losing static fishing gear. However, polyethylene, polypropylene and nylon nets and ropes contribute to non-biodegradable marine litter when lost or discarded at sea. MCS beach litter data suggests fishing contributes <10% of total. Thus, actions targeting fishing litter alone are unlikely to achieve GES.	More robust estimates of ALDFG rates are needed for all gear types. Gear-specific estimates have low certainty due to small numbers of studies and sample sizes. FMPs should seek to develop evidence base. FMPs are also well placed to identify regional fishery specific mitigation measures.

Table 2 Risks to UK MS descriptors from creels

UK MS Descriptor	Risk rating	Additional comments on risk	Recommendation
D1, D4 Cetaceans	Moderate	Entanglement in pot ropes is known to occur for a number of sensitive species, but it is unclear if this is likely to impact UK populations at a level which will affect reaching GES for this descriptor. Further evidence collection and analysis will strengthen robustness and confidence in assessment.	Continue to improve the evidence base to understanding the scale of the pressure and improve this risk assessment. This could focus on improved bycatch data collection for sensitive species, including through enhanced reporting and remote electronic monitoring
D1, D4 Seals	Low	N/A	**No action currently thought to be necessary for the FMPs under consideration**, although requirement to report bycatch incidents would improve ability to assess risk
D1, D4 Seabirds	Low	N/A	**No action currently thought to be necessary for the FMPs under consideration**, although requirement to report bycatch incidents would improve ability to assess risk
D1, D4 Fish		While most fishing activities pose inherent high risks to the biological diversity of fish stocks due to non-target bycatch, we are not presenting detailed advice on this descriptor for the Demersal FMPs. See section 5.3.4. for further details and rationale.	**No action thought to be required at an FMP scale at present, but further work is required by appropriate Authorities and ALBs to understand the indicator and identify appropriate management actions.** Focus of FMPs on sustainability & precautionary objectives of the Fisheries Act and policies developed to support delivery of the bycatch objective of the Fisheries Act should contribute to the achievement of GES for this descriptor. Actions at an FMP scale may be required to support achievement of GES for this descriptor in future.

UK MS Descriptor	Risk rating	Additional comments on risk	Recommendation
D4 Foodwebs		Comprehensive fishery-level advice is not included here, as substantial further work by appropriate authorities and ALBs is needed to determine appropriate actions. Achieving Good Environmental Status will require strategic collaboration to improve ecosystem models and understand fishing mortality impacts on complex food web dynamics.	**No action currently thought to be required for FMPs under consideration**. FMP progress towards sustainability and precautionary objectives under the Fisheries Act, this may result in incremental steps towards GES
D1, D6 Seafloor integrity		Whilst pots and traps do have the ability to cause localised impacts, it is not currently thought to be at a scale likely to affect achievement of GES for this descriptor.	**No action currently thought to be required for FMPs under consideration** for this gear-descriptor combination
D10 Marine Litter	Moderate	Evidence that abandoned, lost, or discarded pots and associated rigging may pose entanglement risk to several large coastal mobile species (minke whale; basking sharks). Extent of risk is not clear.	Fishing litter is likely to be a relatively small component of overall marine litter, thus fishing measures on their own are unlikely to contribute significantly to achievement of GES. Greatest harm is likely to be associated with entanglement and ghost fishing from abandoned, lost or discarded gear. Greatest risk associated with static gears. Action required to better record and map ALDFG. Adopt appropriate technical measures to minimise ghost fishing from pots (e.g. weak links) and rope entanglement (minimised pot lines).

5.3.1 UK MS Descriptor D1, D4 biological diversity of cetaceans

The current targets and indicators for the Descriptor 'D1, D4 Biological diversity of cetaceans' re set out in Table A2 (Annex 2) and a summary of the risks and actions for this descriptor can be found in Tables 1 and 2 above.

Potential risks to this UK MS descriptor arising from the fisheries covered by this FMP arise primarily from bycatch of descriptor species and from reductions in their available prey.

5.3.1.1 Risks to cetaceans from bycatch

To be compatible with UK MS GES targets, fisheries must not result in a situation where the long-term viability of a cetacean population is threatened by incidental bycatch. In addition, there should be no significant decrease in abundance caused by human activities and the population range should not be significantly lower than the favourable reference value for the species.

Benthic trawling isn't perceived as high-risk for cetacean bycatch. However, occasional harbour porpoise bycatch in otter trawlers has been reported (CEFAS, 2015). The 2019 report on bycatch levels (Kingston et al., 2021) emphasised that the sampling wasn't specifically tailored for protected species, making the data less conclusive, but current understanding is that this is not at a level that would have impacts on population. Although certain cetaceans are sensitive to entanglement in creels, it is unclear whether the population level impacts are sufficient to threaten their long-term viability. Further evidence is required to increase confidence in this assessment.

5.3.1.2 Risks to cetaceans from reductions in prey

While Nephrops aren't a key prey species themselves, bycatch in these fisheries might serve as prey for cetaceans. As discussed in Section 3.1.2, it is not thought that any prey species are caught as bycatch in sufficient quantity to impact the availability of prey for predators. However, if large numbers of prey species are bycaught, risks might need to be reassessed.

5.3.1.3 Conclusions and recommended actions for cetaceans

While the risk to achieving GES for the biological diversity of cetaceans is generally considered low, there are still significant gaps in the available evidence. As a result, **the FMP risk rating has been assessed as moderate**. Additional evidence collected to fill these gaps could enable us to revisit this risk assessment.

5.3.2 UK MS Descriptor D1, D4 biological diversity of seals

The current targets and indicator for the Descriptor '*D1, D4 Biological diversity of seals in maintained*' are shown in Table A3 (Annex 2). A summary of the risks and actions for this descriptor are found in Tables 1 and 2.

5.3.2.1 Risks to seals from bycatch

For grey seals, whilst bycatch represents the principal fisheries-related pressure, the species is meeting its Good Environmental Status (GES) targets as outlined in Table A3 (Annex 2). In contrast, the common seal population is below target levels in the Greater North Sea, although this decline is not attributed to bycatch.

Demersal trawls and creels are not considered high-risk gear types for seal bycatch. The Data Collection Framework programme for England and Wales in 2019 did not record any marine mammal bycatch associated with beam, otter, and twin otter trawls. Nevertheless, more comprehensive evidence gathering is necessary to increase confidence in the assessment of bycatch risk to seals.

5.3.2.2 Risks to seals from reductions in prey

Whilst Nephrops are not considered a key prey species, some of the associated bycatch may constitute part of a seal's diet (e.g., flatfish, cephalopods, and gadoids). However, the direct risk to seals from bycatch of their prey in the Nephrops fishery alone is likely to be low, as bycatch levels are unlikely to reach levels that would directly impact the overall abundance of these prey species. Nevertheless, the cumulative effect of bycatch from multiple fisheries could potentially impact prey populations over time. However, seals, being generalist feeders, are thought to exhibit weak ecological interactions with specific prey populations, as they consume a variety of species (Dickey-Collas et al., 2014) and are able to exploit alternative prey choices in response to the reduced abundance of any single prey species. However, further work is needed to better understand the impact of prey reduction on seal populations and the ecosystem interactions between fish and higher predators. A collaborative approach between appropriate authorities and ALBs to develop ecosystem modelling approaches will support a better understanding of the potential impacts of prey reduction on seal populations.

5.3.2.3 Conclusions and recommended actions for seals

While the risk to achieving GES for the biological diversity of seals is generally considered low, there are still significant gaps in the available evidence. As a result, **the FMP risk rating has been assessed as moderate**. This risk is predominantly related to the Nephrops trawl fishery rather than creel activity. Additional evidence collected to fill these gaps could enable us to revisit this risk assessment.

5.3.3 UK MS Descriptor D1, D4 biological diversity of birds

The objectives and indicators for the descriptor 'D1, D4: Biological Diversity of Seabirds is Maintained' are detailed in Table A4 (Annex 2). Summaries of risks and actions for this descriptor are provided in Tables 1 and 2.

5.3.3.1 Risks to birds from bycatch

To align with UK MS GES targets, fisheries shouldn't compromise the long-term viability of marine bird populations due to incidental bycatch. There shouldn't be significant population decline or distribution changes since 1992 caused by human interventions. Widespread breeding failures in marine birds induced by human activities shouldn't persist for more than three out of six years.

Demersal trawling is thought to pose a potential risk to certain species of seabirds. This is highlighted by both anecdotal reporting during fish bycatch monitoring (CEFAS observer programme report 2015; unpublished), and by previous work looking at the relative risk of bird bycatch that incorporated the behavioural traits of different species (Bradbury et al., 2017). This latter work highlights deep diving shags, scaups, eiders, scooters, guillemots, great northern divers, and cormorants as the most sensitive to demersal trawls. The abundance of European Shags within the North Sea does not meet GES.

Demersal trawling is not included in more recent work looking at seabird bycatch (e.g., Northridge et al., 2020) as it is not generally considered to present a high bycatch risk to birds at scale that is likely to threaten GES descriptors. Creels are also considered low risk in relation to marine bird bycatch. An improved monitoring regime would help fill the current data gaps and therefore reduce the uncertainties. This could potentially be done by adapting or expanding existing observer programmes, or through the appropriate use of REM.

5.3.3.2 Risks to birds from reductions in prey

Whilst Nephrops are not considered a key prey species, some of the associated bycatch may serve as prey for seabirds. Potential prey fish species at risk of bycatch include small gadoids like juvenile cod, haddock, and whiting. Given the Nephrops fishery's operational characteristics, and mitigation measures adopted by the fishery, the potential for catching significant quantities of any single gadoid species, which could subsequently impact the abundance of juveniles important as prey, is relatively low. Thus, the direct risk to seabirds from reduced food availability due to bycatch in this fishery seems minimal. Nevertheless, the cumulative effect of bycatch from multiple fisheries could potentially impact prey populations over time, and risks may require reassessment if large quantities of any prey species are caught.

5.3.3.3 Conclusions and recommended actions for seabirds

While the risk to achieving GES for the biological diversity of seabirds is generally considered low, there are still significant gaps in the available evidence. As a result, **the FMP risk rating has been assessed as moderate**. Again, this risk is predominantly related to the Nephrops trawl fishery rather than creel activity. Additional evidence collected to fill these gaps could enable us to revisit this risk assessment.

5.3.4 UK MS Descriptor D1, D4 biological diversity of fish

The current targets and indicators for 'D1, D4: Biological Diversity of Fish' are outlined in Table A5 (Annex 2). Risks and actions for this descriptor are summarised in Tables 1 and 2.

While most fishing activities pose inherent high risks to the biological diversity of fish stocks due to non-target bycatch, we are not presenting detailed advice on this descriptor for the Nephrops Fisheries Management Plan. This is because the indicator comprises over 100 sensitive species, and further collaborative work is first needed between relevant government bodies to determine how best to evaluate risks and provide actionable advice at the fishery management level. Given the complexity of interactions between multiple species, fleets, and fishing methods, strategic solutions may be most effective for achieving Good Environmental Status. We will continue engaging with the FMP working group as part of developing a coherent strategy for restoring and protecting biological diversity across fishing activities in the region. In the interim, progress towards the Fisheries Act's sustainability and precautionary objectives will facilitate steps in the right direction.

5.3.5 UK MS Descriptor D4 foodwebs.

The current targets and indicators for 'D4, Foodwebs' are presented in Table A7 (Annex 2). Risks and actions associated with this descriptor are summarised in Tables 1 and 2.

We are not presenting comprehensive advice for UK MS Descriptor D4 foodwebs in this advice, as substantial further work is required to determine appropriate actions at the fishery level. The current indicators focus on size and trophic structure of ecological communities, involving complex interactions between multiple stocks and fisheries. Strategic collaboration will be imperative to improve ecosystem models and our understanding of how fishing mortality impacts food web dynamics. Isolated changes within individual fisheries are unlikely to meaningfully contribute to achieving Good Environmental Status for this descriptor. As the FMP progresses towards sustainability and precautionary objectives under the Fisheries Act, this may result in incremental steps towards GES for D4. However, we will continue engaging with government and other research bodies as part of developing a coherent overarching strategy for food web protections in the region. The close involvement of the FMP working group in this strategic development will help align operational and policy objectives regarding D4 moving forward.

5.3.6 UK MS Descriptor D1, D6 seafloor integrity

The current targets and indicator for the Descriptor '*D1 & D6 seafloor integrity*' are shown in Table A8 (Annex 2). A summary of the risks and actions for this descriptor are found in Tables 1 and 2.

5.3.6.1 Risks to seafloor integrity from Nephrops fishing

All mobile demersal gears pose a risk to this descriptor. For the purposes of this advice SNCBs have focussed on the 'Extent of Physical damage' indicator as it most closely tied to fisheries pressure (see Table A8, Annex 2). This indicator is shared with OSPAR and is commonly known as 'BH3' and will be referred to as such in the current advice.

BH3 is the primary indicator used to assess the level of disturbance from fishing on benthic habitats. The target determines that the level of exposure to pressure (measured on the spatial scale of OSPAR sub-regions) should not result in more than moderate impact/vulnerability of the habitat (dependent on the sensitivity of the habitat to this pressure). The calculations for the BH3 indicator are complex, but essentially fishing effort data is aggregated so that the relative impact of different mobile benthic gears cannot be readily assessed within it. To be able to provide advice, which is meaningful at the scale of an FMP, the way BH3 is currently aggregated and presented needs to be addressed. Natural England is currently working on dis-aggregating the BH3 indicator as a first step in developing specific FMP-relevant advice.

Collaborative working between government, ALBs and regulators to provide more detailed advice on contributions of different mobile demersal gears within the geographic context of FMPs is required. Detailed consideration of mitigation options should extend across different fisheries and draw on a wide range of stakeholder expertise. The UK Marine Strategy Part 3 (Programme of Measures) suggests the drawing together of a **Benthic Impact Working Group** and this could be a pragmatic option for delivering future advice, including identifying, developing, and trialling possible mitigation or management options, in partnership.

It is not currently thought that fisheries are contributing significantly to the failure of other indicators for this descriptor (e.g., the 'physical loss of predicted habitats'), however if evidence were to emerge in the future, then further advice may be required.

5.3.6.2 Conclusions and recommended actions for D1, D6 seafloor integrity

There is a high risk to seafloor integrity. However, this indicator looks at impacts across the >12m UK mobile demersal fishing fleet. It does not include impacts from the Nephrops creel fishery – while these are likely to be lower risk, these gears may impact seafloor integrity if operating at a high intensity. Further work is needed to disentangle and quantify impacts from individual fisheries. Strategic work at a broad geographic scale is required to

understand the relative impact from this fishery and identify opportunities to reduce/remove risk and understand trade-offs across the UK fishing fleet.

5.3.7 UK MS D10 marine litter

The current targets and indicator for Descriptor 'D10 Marine litter' are shown in Table A9 (Annex 2). A summary of the risks and actions for this descriptor are found in Tables 1 and 2.

5.3.7.1 Risks from marine litter from Nephrops fishing

Gear specific estimates of rates of abandoned, lost, or discarded gear (ALDFG) have low certainty due to a small number of studies and low sample sizes. Risks are highest in static gear fisheries (French et al., 2022) where significant quantities of gear are deployed into the marine environment and left unattended. Mobile gears are a lower risk but may be a source of plastic ropes and netting which contribute to non-biodegradable marine litter when lost, abandoned, or discarded at sea. ALDFG is associated with entanglements and ghost fishing. However, fishing litter is likely to be a relatively small component of overall marine litter, therefore fishing measures alone are unlikely to contribute significantly to the achievement of GES. Some gear loss is driven by the spatial conflict between mobile and static fleet sectors, where competition for space leads to interaction between mobile and static fishing gears. FMPs may consider ways in which to mitigate this conflict, if identified, and any associated gear losses.

5.3.7.2 Conclusions and recommended actions for D10 marine litter

There is a moderate risk to marine litter. More robust estimates of ALDFG in the fishery are required.

FMPs could consider initiatives to gather relevant data to record and map gear losses in relevant fisheries in order to better understand the levels of risk and establish baselines.

Individual FMPs may be able to identify and develop mitigating measures/technologies to reduce losses and minimise impacts of ghost fishing and entanglements on marine life.

6 Conclusion and recommendations

This advice has highlighted several risks to the designated features of Scottish MPAs outside site boundaries, PMFs, and UK MS descriptors, namely bycatch of protected species, reductions in prey of marine mammals and birds, physical impacts to the seafloor, and the introduction of marine litter. The role of industry will be crucial in both gathering evidence in the form of fisheries-dependent data, and in identifying practical, workable, and locally relevant solutions that can reduce pressures and mitigate risks accordingly. Government will likely need to coordinate different policy areas and delivery tools, going beyond FMPs, and to provide resourcing to develop synergies and maximise the impact of

those actions instigated through FMPs. ALBs will need to ensure timely analysis of evidence supplied and the subsequent provision of robust and appropriate advice. Such an approach is essential to ensure the conservation objectives of MPAs are met or furthered, fisheries make a significant contribution to the achievement of Good Environmental Status, and important steps towards an ecosystem-based approach to fisheries management are taken.

In some cases, existing initiatives will complement the work of the FMPs, such as the UK Bycatch Mitigation Initiative, Clean Catch UK and the Scottish Entanglement Alliance; these will be important for coordinating and achieving progress beyond the regional scale of FMPs and individual fisheries stock units. In other challenging areas, such as benthic integrity to meet GES, further work to develop the appropriate vehicles to deliver strategic work at a suitable scale will be required. Government may need to develop a strategy guiding where reductions in pressures need to occur across the fleet and to make decisions accounting for the trade-offs between industry sectors. It might be difficult to do this at the individual FMP level, and thus actions may be necessary at a programme level.

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Annex 1.

Table A1 Full list of UK MS descriptors. Those in bold are scoped into this advice.

UK MS Descriptor	**Ecosystem component**	**Screened into this fisheries advice**
D1 – Biological diversity	Cetaceans	Yes
	Seals	Yes
	Birds	Yes
	Fish	Yes
	Pelagic habitats	No
	Benthic habitats	Yes
D2 -Non-indigenous species	N/A	No
D3 -Commercially-exploited fish and shellfish	N/A	Yes
D4 -Food webs	Cetaceans	Yes
	Seals	Yes
	Birds	Yes
	Fish	Yes
	Pelagic habitats	No
D5 -Eutrophication	N/A	No
D6 -Sea-floor integrity	Pelagic habitats	No
	Benthic habitats	Yes
D7 -Hydrographical conditions	N/A	No
D8 -Contaminants	N/A	No

D9 -Contaminants in fish and other seafood for human consumption	N/A	No
D10 -Litter	N/A	Yes
D11 -Introduction of energy, including underwater noise	N/A	No

Annex 2

Table A2 UK MS indicators and targets for D1, D4 Cetaceans

Descriptor	Target 2019	Indicator	North Sea	Trend	Celtic Seas	Trend
D1; D4: CETACEANS	The long-term viability of cetacean populations is not threatened by incidental bycatch.	Harbour porpoise bycatch - Marine online assessment tool (cefas.co.uk) Cetaceans - Marine online assessment tool (cefas.co.uk)	GES Achieved	Insufficient data to assess	GES status unknown/uncertain	Insufficient data to assess
	There should be no significant decrease in abundance caused by human activities.	Abundance and distribution of coastal bottlenose dolphins (OSPAR)	Achieved	stable/mixed	GES status unknown/uncertain	stable/mixed
		Abundance and distribution of cetaceans other than coastal bottlenose dolphins (OSPAR)	Partial	stable/mixed	GES status unknown/ uncertain	stable/mixed
	Population range is not significantly lower than the favourable	Abundance and distribution of coastal bottlenose dolphins (OSPAR)	Achieved	stable/mixed	GES status unknown/ uncertain	stable/mixed

	reference value for the species.	Abundance and distribution of cetaceans other than coastal bottlenose dolphins (OSPAR)	Partial	stable/mixed	GES status unknown/ uncertain	stable/mixed

Table A3 UK MS indicators and targets for D1, D4 Seals

Descriptor	Target 2019	Indicator	North Sea	Trend	Celtic Seas	Trend
D1; D4: SEALS	The long-term viability of seal populations is not threatened by incidental bycatch.	Marine mammal bycatch (OSPAR)	GES status unknown/ Uncertain	Unknown	GES status unknown/ uncertain	Unknown
	Population abundance and distribution are consistent with favourable conservation status.	Grey seal abundance and distribution	Achieved	improving	achieved	improving
		Harbour seal abundance and distribution	Not achieved	stable/mixed	GES status unknown/ uncertain	Unknown
	Grey seal pup production does not decline substantially in the short or long-term.	Grey seal pup production (OSPAR)	Achieved	improving	achieved	improving

Table A4 UK MS indicators and targets for D1, D4 Birds

Descriptor	Target 2019	Indicator	North Sea	Trend	Celtic Seas	Trend
D1; D4: BIRDS	The long-term viability of marine bird populations is not threatened by deaths caused by incidental bycatch catch in mobile and static fishing gear.	Seabird bycatch				
	The population size of species has not declined substantially since 1992 as a result of human activities.	Marine bird abundance (OSPAR)	Not achieved	**declining**	Not achieved	**declining**
	Widespread lack of breeding success in marine birds caused by human activities should occur in no more than three years in six.	Marine bird breeding success/failure (OSPAR)	Not achieved	**declining**	Partial	**declining**
		Kittiwake breeding success	Not Achieved	**declining**	Not assessed	Unknown
	There is no significant change or reduction in population distribution caused by human activities.	Distribution of breeding and non-breeding marine birds	Not assessed	Unknown	Not assessed	Unknown
		Invasive mammal presence on island seabird colonies	Not assessed	Unknown	Not assessed	Unknown

Table A5 UK MS indicators and targets for D1, D4 Fish

Descriptor	Target 2019	Indicator	North Sea	Trend	Celtic Seas	Trend
D1; D4; FISH	Incidental bycatch is below levels which threaten long-term viability and recovery of fish populations.	To include bycatch numbers of vulnerable species and catch rates per fishing fleet	GES status unknown/ Uncertain	Unknown	GES status unknown/ Uncertain	Unknown
	The population abundance of sensitive species is not decreasing due to anthropogenic activities and long-term viability is ensured.	Recovery in the population abundance of sensitive fish species (OSPAR)	Not achieved	stable/mixed	Achieved	stable/mixed
	For fish species in the Habitats and Birds Directive population abundance and geographic distribution meets established favourable reference values.	UK assessments of listed fish species	Not achieved	stable/mixed	Achieved	improving
	For listed fish species, the area and the quality of the habitat is sufficient.		GES status unknown/ Uncertain	Unknown	GES status unknown/ Uncertain	Unknown

Table A6 UK MS indicators and targets for D3 Commercial Fish

Descriptor	Target 2019	Indicator	North Sea	Trend	Celtic Seas	Trend
D3: COMMERCIAL FISH AND SHELLFISH	The Fishing mortality rate of populations of commercially exploited species is at or below levels which can produce the maximum sustainable yield.	Commercial fishing pressure for stocks of UK interest.	Partial	**Improving**	Partial	**Improving**
	The Spawning Stock Biomass of populations of commercially exploited species are above biomass levels capable of producing the maximum sustainable yield.	Reproductive capacity of commercially exploited stocks of UK interest.	Partial	**Improving**	Partial	**Improving**

Table A7 UK MS indicators and targets for D4 Foodwebs

Descriptor	Target 2019	Indicator	North Sea	Trend	Celtic Seas	Trend
D4: FOODWEBS	The species composition and relative abundance of representative feeding guilds are indicative of a healthy marine food web.	Mean maximum length of fish (OSPAR).	Not achieved	Stable/mixed	Not achieved	Stable/mixed
		Selected plankton lifeforms pairs (e.g., large vs small zooplankton) (OSPAR)	GES status unknown/ Uncertain	Unknown	GES status unknown/ Uncertain	Unknown
	The balance of abundance between representative feeding guilds is indicative of a healthy marine food web.	An indicator of biomass of predatory feeding guilds for fish is currently under development using current data. This could be expanded to seabirds and marine mammals.	Not assessed	Unknown	Not assessed	Unknown
	The size structure of fish communities is indicative of a healthy marine food web.	Fish community size structure: Typical Length (Tyl - OSPAR) and/or Large Fish Index (LFI - OSPAR)	Not achieved	Stable/mixed	Partial	Improving
	Productivity of the representative feeding guilds, characterised by key species, is indicative of a healthy marine food web.	D4C4s required information on multiple components (seabirds, marine mammals, fish, and pelagic habitat).				

Table A8 UK MS indicators and targets for D1, D6 Seafloor integrity

Descriptor	Target 2019	Indicator	North Sea	Trend	Celtic Seas	Trend
D1; D6: BENTHIC	The physical loss of each seabed habitat type caused by human activities is minimised and where possible reversed.	Physical loss of predicted habitats	Not achieved	unknown	Not achieved	Unknown
	The extent of habitat types adversely affected by physical disturbance caused by human activity should be minimised.	Extent of Physical damage indicator to predominant and special habitats (OSPAR)	Not achieved	Unknown	Not achieved	Unknown
		Benthic communities' indicator (OSPAR)	GES status unknown/ Uncertain	Unknown	GES status unknown/ Uncertain	Unknown
	Habitat loss of sensitive, fragile, or important habitats caused by human activities is prevented, and where feasible reversed.	Physical loss of predicted habitats indicator (Extent of benthic habitat)	Not achieved	Unknown	Not achieved	Unknown
	The extent of adverse effects caused by human activities on the condition, function and ecosystem processes of	Benthic communities' indicator (OSPAR)	Not assessed	Unknown	Not assessed	Unknown
		Aggregated Infaunal Quality Index	Not achieved	Unknown	Partial	Unknown
		Aggregated Saltmarsh Tool	Not achieved	Unknown	Achieved	Unknown

	habitats is minimised.	Aggregated Rocky Shore Macroalgal Index	Achieved	Unknown	Achieved	Unknown
		Aggregated Intertidal Seagrass Tool	Achieved	Stable/mixed	Achieved	Stable/mixed
		Intertidal rock community change indicator (MarClim)	GES status unknown/ Uncertain	Unknown	GES status unknown/ Uncertain	Unknown

Table A9 UK MS indicators and targets for D10 Marine Litter

Descriptor	Target 2019	Indicator	North Sea	Trend	Celtic Seas	Trend
D10: MARINE LITTER	A decrease in the total amount of the most common categories of litter found on surveyed beaches	Litter types on beaches	Not achieved	Declining	Not achieved	Declining