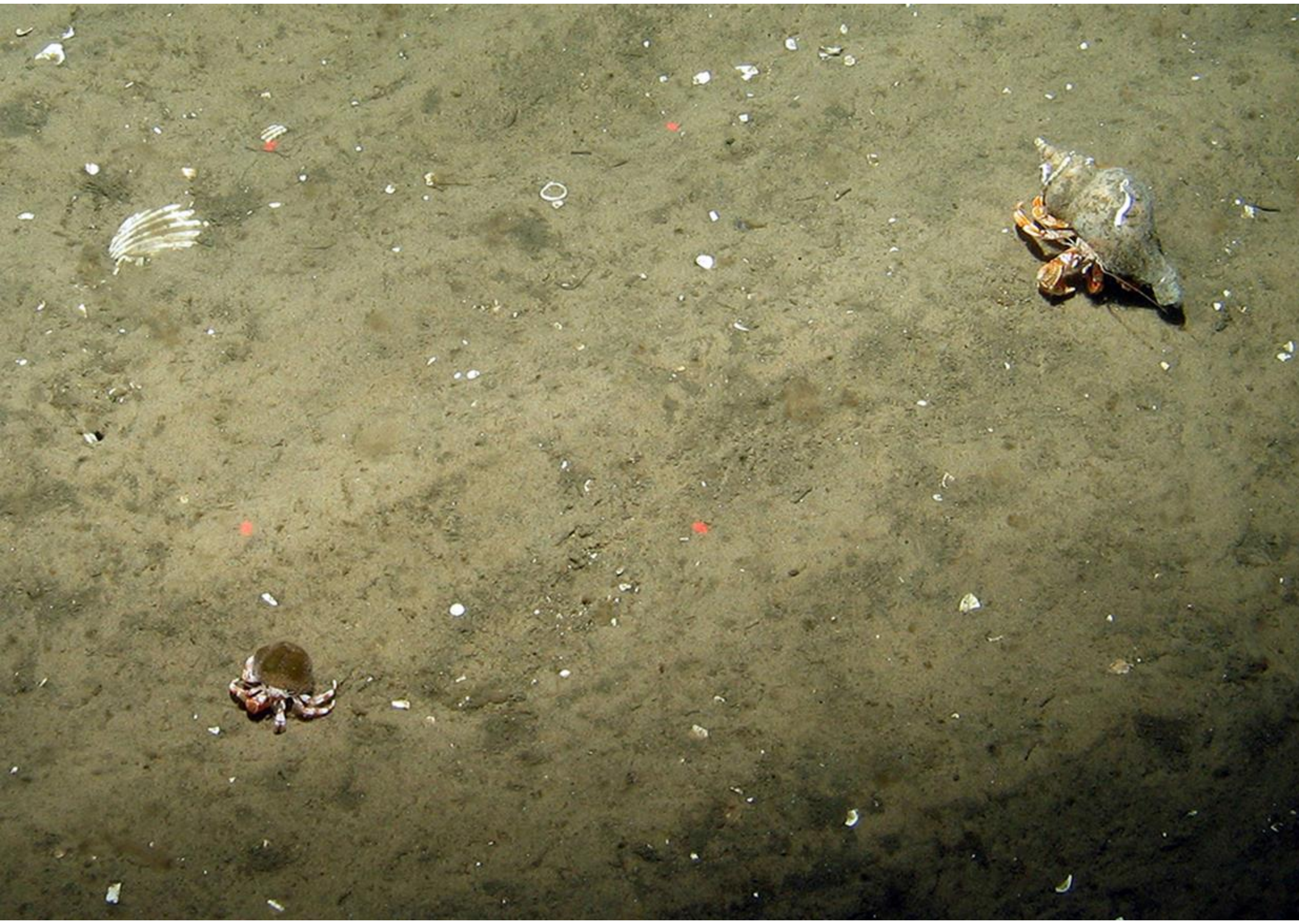

Round 4 Compensation

Potential site locations for Dogger Bank Compensation measures

The Crown Estate

Date: 19th April 2024

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Rev.no.	Date	Description	Prepared by	Verified by	Approved by
1.0	06/10/23	Technical Note	PCAU	IGP	SPAC
1.1	10/10/23	Revised due to comments	PCAU	IGP	SPAC
1.2	17/11/23	Updated with main report	PCAU	IGP	SPAC
2.0	28/02/24	Revision following EWG / SG review, Defra advice on site designation/extension & SGDM11 and SGDM12	PCAU / IGP	TNO	TNO
2.1	08/03/24	Revision following TCE / TL review	PCAU	IGP	SPAC
2.2	05/04/24	Revision following SG review	PCAU	MCLA	IGP
2.3	12/04/24	Revision following TCE / TL review & SGDM13	IGP	SPAC	TNO
2.4	19/04/24	Revision following SG review	SPAC	MCLA	IGP

Contents

1 Introduction

1.1.1 The Round 4 HRA concluded an AEOSI in relation to sandbank at Dogger Bank SAC due to the footprint of subsea infrastructure, and construction methods with potential to damage or disturb seabed habitats, associated with offshore wind leasing Round 4 projects Dogger Bank South East (DBSE) and Dogger Bank South West (DBSW) (the projects). The Crown Estate decided to progress with the Plan, putting forward a derogation case. In the absence of any alternative solutions to achieve the objectives of the Plan, it was argued that the Plan should progress for reasons of over-riding public interest (IROPI). It was agreed with the UK Government that The Crown Estate would proceed with the Plan on the basis of a derogation, subject to appropriate strategic environmental compensation plans being developed. There was no objection from Welsh ministers.

1.1.2 Special areas of conservation (SAC) with marine components are designated for the protection of Annex I habitats or Annex II species in the marine environment (JNCC, 2020). Conservation objectives for SACs are set to maintain or restore those features to favourable conservation status. Dogger Bank SAC has been designated in its entirety for the protection of the Annex I feature 'sandbanks which are slightly covered by sea water all the time' (sandbank). Strategic (Plan level) measures to compensate for loss and physical damage to the sandbank feature of the Dogger Bank SAC are currently being investigated by NIRAS on behalf of The Crown Estate, in conjunction with an appointed Steering Group.

1.1.3 A long list of potential compensation measures was developed based on expert opinion and precedent from other projects. Evidence for each measure was compiled and is being discussed with the Steering Group. This note looks at potential site locations for the following measures:

- New site designation or extension
- Seagrass restoration

1.1.4 Identification of candidate locations where these measures could be implemented is a key requirement and it is important that the optimum locations are selected where alternatives exist. It is therefore important that clear criteria are established to support objective selection of sites. Furthermore, it is essential that criteria for measuring success are also identified at an early stage.

1.1.5 This note presents proposed criteria used to identify a potential sites and evaluate deliverability and success for each of the measures. It is the first step in identifying compensation sites. It is expected that those sites identified as a result of this process will undergo further evaluation, which may include other desk studies and environmental surveys, before final site selection.

1.1.6 Whilst restriction of activities are included as potential measures, determination of the sites are to be undertaken by the licensing authorities and in consultation with the SG have not been included at this time.

2 New site designation or extension

2.1.1 Based on the Round 4 Plan Level assessment, it is expected that the Round 4 projects will result in damage to 32.209 km^2 of sandbank and the loss of 2.035 km^2 from Dogger Bank SAC, which represents a risk to the conservation objectives of the site. New site designation or extension aims to compensate for the lost and damaged habitat by providing at least the same level of protection to Annex I sandbank habitat outside of Dogger Bank SAC, thereby maintaining the integrity of the marine protected area (MPA) network.

2.1.2 Through the steering group several forms of site designation or extension have been explored:

- Extension of Dogger Bank SAC;
- Designation of a new SAC or extension to an existing SAC for the protection of sandbank feature;
- Designation of a new MCZ for the protection of a sandbank feature; and,
  Protecting or enhancing associated habitat (e.g. troughs between sandbanks).
- Amending SAC citation to protect or enhance associated habitat (e.g. troughs between sand-banks).

2.2 Method

2.2.1 Potential locations for either a new SAC designation, or extension of an existing SAC, were identified using following the categories:

- Annex I Sandbanks present outside any protected site (for Annex I sandbank) using the JNCC (2019) Annex I sandbank layer;
- Sandbanks that fully or partially overlap MCZ areas; and;
- The area identified and currently being surveyed by RWE.

2.2.2 A technical report on the spatial assessment of benthic compensatory habitats (Ward *et al*., 2022) was also reviewed, however this did not lead to the selection of additional sites. It is important to note there may be other potential options available.

Site consideration criteria

2.2.3 Site consideration criteria were developed to identify sandbanks most suitable as compensation habitat and inform preferred sites. The selection criteria for sandbank habitat was modified from criteria developed by the JNCC (2009), with input also from strategic marine compensation ecological assessment criteria developed by The Wildlife Trust (2023). The flow diagram (Figure 2.1) presents the criteria (orange boxes) in order of importance from top to bottom.

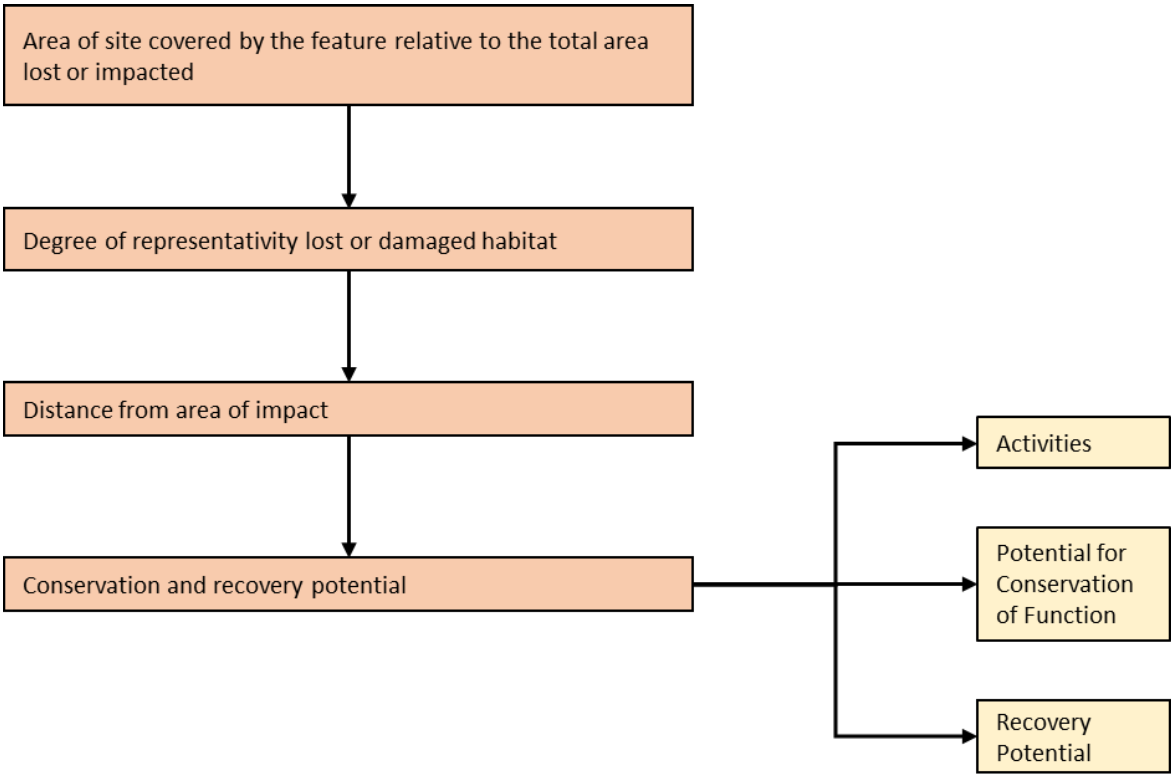

Figure 2.1 Site consideration criteria for new site designation or extension. Conservation and recovery potential is separated in to sub-criteria 'Activities', 'Potential for Conservation of Function' and 'Recovery potential'.

Area

2.2.4 The first criterion relates to the area of coverage of the feature within the proposed site relative to the area lost and damaged within Dogger Bank SAC. Areas with greater Annex I sandbank coverage, preferably greater than 100% of the area expected to be lost or damaged, are preferred.

Representativity

2.2.5 Representativity pertains to the degree to which the feature within the proposed compensation site represents that within Dogger Bank SAC. Sites that more closely reflect the habitat within Dogger Bank SAC are preferred.

Distance from the impacted area

2.2.6 Relevant to the connectivity with the impacted habitat, which in turn is relevant to the integrity of the MPA network. Sites that are in close proximity to the impacted area (e.g. adjacent to the area, or offshore and within the same regional sea) are preferred.

Conservation and recovery potential

2.2.7 This criterion is separated into three sub-criteria:

- Activities: relates to human activities taking place within the site, or having taken place within the site historically and are still affecting site condition.
- Potential for conservation of function: relates to ecological functioning within the ecosystem (e.g. productivity, carbon sequestration and nutrient cycling). As ecological functioning is challenging to quantify, particularly in the marine environment, function in this context is taken to mean the

prospects (capacity and probability) of the habitat to maintain its structure, the biotic and abiotic characteristics of the habitat (e.g. species composition and geomorphology) (JNCC, 2009).

- Recovery potential: is the extent to which recovery is possible and relates to the conservation of functions and activities taking place within the sites.

2.2.8 The subcriteria "Potential for conservation of function" and "Restoration potential" could not be given full consideration at this stage as the necessary data was not available, but they should be utilised for the final site selection.

2.3 Results

2.3.1 Using the site consideration criteria, potential sites for new SAC designation or extension were identified. Examples are outlined and discussed in this section, but all sites identified are shown in Figure 2.2 Category D sandbanks, which do not meet the criteria to be classified as Annex I sandbanks, have not been included in the map and are not listed here as this is covered under a different measure.

2.3.2 Many sites are expected to provide sufficient sandbank area to compensate for more than 100% of the estimated area of impact from the Round 4 projects. For Site 19, the shapefile was provided by the developer. The area within the boundary of Site 19 is 3197.6 km^2, based on the shapefile as provided by the developer. However, the extent of Annex I sandbank habitat within Site 19 was unknown. It is assumed here that most of this area is sandbank habitat, and would therefore provide compensation.

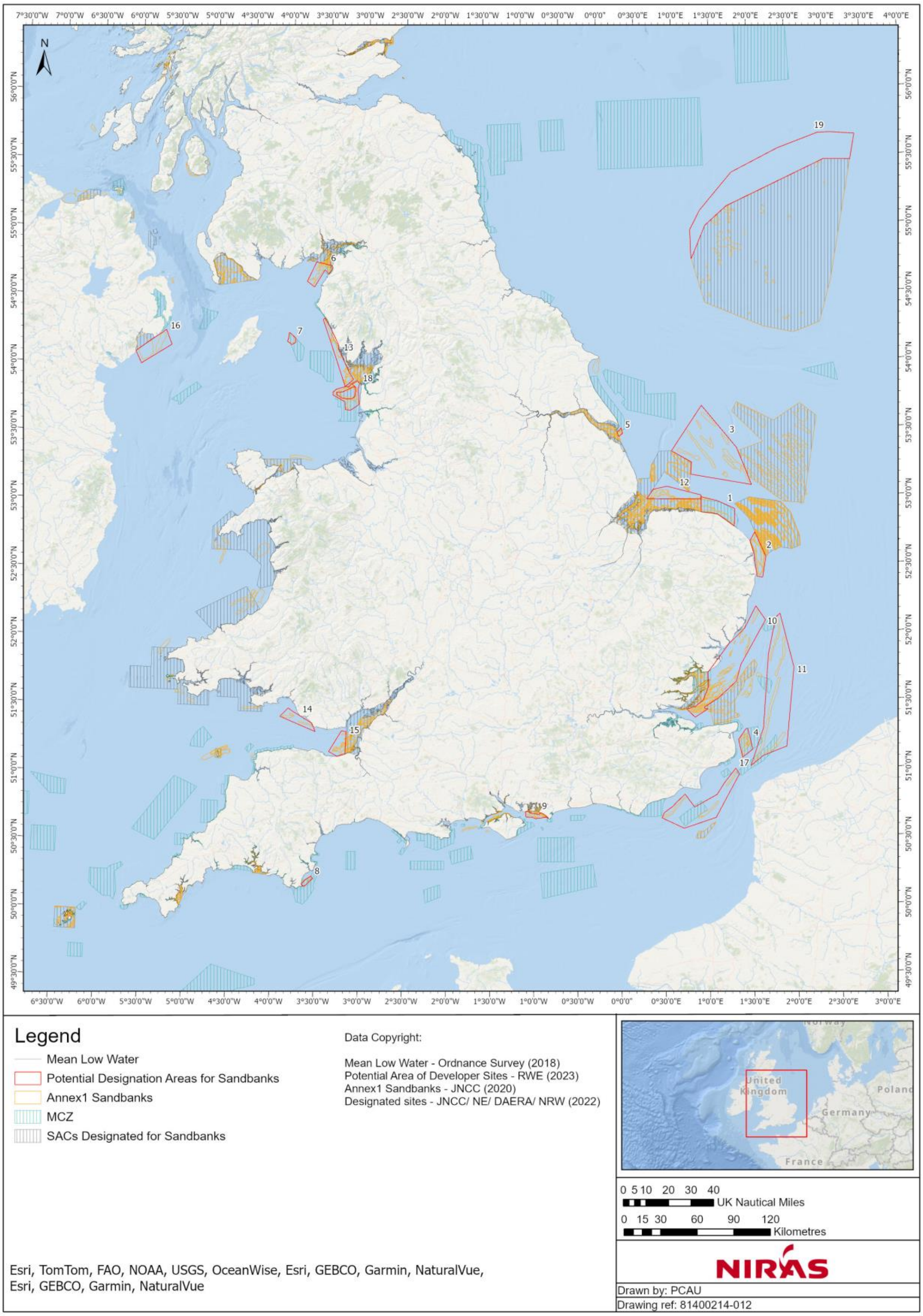

Figure 2.2 Annex I sandbanks with potential sites for New Site Designation/Extension.

2.3.3 Sites 19 and 3 are entirely offshore, beyond the 12 nm limit. Site 15 is predominantly offshore, but the southernmost sandbank within the site is located within 12 nm from the coast. Multiple activities are currently taking place in all of the potential sites.

2.3.4 Site 19 is located to the North of Dogger Bank SAC. This is an area of search that is being investigated as a possible site for the extension of Dogger Bank SAC. Although results are not yet published, surveys have taken place to characterise the habitat and communities within the area. Data on sandbank habitat within this area was not available for use in mapping. The shapefile for Site 19 was provided by RWE.

2.3.5 An extension to Dogger Bank SAC represents the most similar option of the compensation measures proposed. Should it be determined that the habitat within Site 19 meets the classification of Annex I sandbank it is likely to provide a good representation of the sandy mound habitat lost or damaged as a result of the projects.

2.3.6 Of the sites with sandbank area available, Site 3 contained the largest sandbank area. All sandbanks within this site are offshore (beyond 12 nautical miles from the coast), but not adjacent to Dogger Bank SAC. It is located between North Norfolk Sandbanks and Saturn Reef SAC (NNSSR SAC) and Inner Dowsing, Race Bank and North Ridge (IDRBNR) SAC, both of which have been designated for the protection of Annex I sandbanks. Therefore, Site 3 presents a potential area for extension of either of the existing SACs. Both NNSSR SAC and IDRBNR SAC contain current tidal sandbanks (JNCC, 2019b), which differ from the relic sandbank within Dogger Bank SAC.

2.3.7 Site 2 stretches north from Lowestoft, and the northern area of the site lies between the coast and Haisborough, Hammond and Winterton (HHW) SAC, which has been designated for the protection of sandbanks. The site presents a potential area for extension of HHW SAC. As HHW SAC contains current tidal sandbanks. The sandbank is coastal, and may lie within 100 m of the coast at its closest point.

2.3.8 Sites 1 and 12 are located to the south of site 3 and north and east, respectively, of The Wash and North Norfolk Coast (TWNNC) SAC, which is an MPA designated for the protection of sandbanks. To the North of site 12 is IDRBNR SAC, which has also been designated for the protection of sandbanks. To the East of site 1 is HHW SAC. The surrounding sites contain current tidal sandbanks (Foster-Smith and Sotheran, 1999; JNCC, 2019b. Both sites 1 and 12 are coastal, lying within a few hundred metres and 10 kms of the coast at their closest points respectively. Both sites present potential areas for extending TWNNC SAC. Site 1 also presents a potential area for extension of IDRBNR SAC.

2.3.9 Site 10 is located within the Outer Thames Estuary and Site 11 is located outside of the Outer Thames Estuary. Sandbanks within Site 10 extend from the coast of Southend on Sea, between Essex Estuaries SAC and Margate and Long Sands SAC, north east to Sizewell, north east of Alde, Ore and Butley Estuaries SAC. Sandbanks within Margate and Long Sands SAC are highly mobile (JNCC, 2023). All sandbanks within Site 10 are located within 12 nm of the coast. Both Essex Estuaries SAC and Margate and Long Sands SAC have been designated for the protection of sandbanks. Thus Site 10 presents a potential area for extension of either of the existing SACs.

2.3.10 Sandbanks within Site 11 stretch from the Strait of Dover north to a point approximately 17 km east of Alde Ore and Butley Estuaries SAC. Most of the sandbanks within site 11 are located beyond 12 nm from the coast, with the exception of the southernmost sandbank, which falls within the 12 nm boundary. Site 11 presents a potential area for a new SAC designation.

2.4 Discussion

Success

2.4.1 Through mapping sandbanks, it was found that there are multiple suitable areas where new sites may be designated or existing sites extended, provided the area meets the established criteria for designation and the impacts on other sea users is taken into account. Moreover, the area of undesignated sandbanks is sufficient to provide significant over-compensation. Within HHW SAC alone, an extension of 120 km^2 was proposed as a possible measure to compensate for habitat loss of up to 0.03 km^2 as a result of Norfolk Vanguard offshore wind project (Royal Haskoning DHV, 2020).

2.4.2 Evaluating the success of the measure would require analysis of the available evidence and where necessary, surveying the sandbank habitat prior to designation to determine the condition of the sandbank and whether there is sufficient sandbank habitat within the area to offset the area of impact. Any sandbank designated for the purpose of compensation should have the potential to be brought in to favourable condition. If the site is in unfavourable condition prior to designation, there may be a requirement that a larger area of sandbank be designated to account for the time it would take to achieve favourable condition.

2.4.3 There are no prior examples of site designation or extension for the purpose of compensation, and monitoring requirements have not yet been determined, however as the new or extended sites become part of the network, it is considered that monitoring requirements may fall under the responsibility of NE or the JNCC as part of statutory condition assessment obligations. Under such a scenario it is expected that funding to support monitoring of the newly designated area will be secured from the developers.

2.4.4 Although the measure has a high probability of success, Defra have advised that the process for designating or extending an SAC may take up to 7 years. If sandbanks within selected sites that are in unfavourable condition there may also be a need to reduce pressures from damaging activities, such as fishing, to allow recovery. As such, there is a potential for conflict with other sea users. Byelaws could take an additional 2 years to establish (Steering Group correspondence). Collaboration on Offshore Wind Strategic Compensation (COWSC) expert working group 6 are undertaking work on the feasibility of using MMO byelaws as a tool to deliver strategic compensation for benthic impacts, however the output of this work may not be available within the necessary timeframes for strategic compensation for the projects.

Deliverability

2.4.5 Designation of a new SAC or extension of an existing SAC for the protection of sandbanks or supporting habitat is a deliverable measure. However, the process for delivery is largely outside of the control of the developer. Ultimately, the measure must be delivered by Defra's Secretary of State with the support of Defra and Statutory Nature Conservation Bodies (SNCBs) and regulators, as per the current UK practice and guidance. Although, the developer can provide support with developing an area of search, surveying/ gathering evidence and submitting a draft SAC (dSAC) to the UK government and through the consultation (Royal Haskoning DHV, 2020). This measure is expected to be funded through the Marine Recovery Fund, which the developer would pay in to, and will follow the full legal process required for designation, including public consultation.

2.4.6 Of the areas identified, an extension to Dogger Bank SAC would be the preferred option from an ecological perspective. However, this assessment relies on several assumptions about the habitat. Survey data is yet to be made available which would allow for a complete and accurate assessment of the habitat. Ultimately, the site may prove to be unsuitable and an alternative would need to be selected.

2.4.7 There are other sites which could provide the level of compensation required, although these sites are likely to be less representative of the habitat within Dogger Bank SAC. North Norfolk Sandbanks and Saturn Reef SAC could be extended to incorporate sandbanks identified in site 3. Alternatively, Inner Dowsing, Race Bank and North Ridge SAC could be extended to incorporate sandbanks in sites 3 and 12.

2.4.8 Once designated, management of the site falls within the remit of the regulators with NE and JNCC advising on conservation advice on the management. For an extension to an existing site, management can be aligned with the existing management for that SAC (Royal Haskoning DHV, 2020). Management would need to be funded by the developer as part of the compensation package.

Conclusions

2.4.9 Based on our findings, it is concluded that designation of a new site or extension of an existing site as a measure of compensation can be delivered and that there is a high probability of success. There is evidence that the measure can provide compensation at a measure significantly greater than 1:1. However, due to the timescales involved, there is a risk that compensation will not be in place and contributing to the MPA network prior to any impact taking place within Dogger Bank SAC.

3 Seagrass restoration

3.1.1 Seagrass meadows have an important role in supporting biodiversity (Attrill *et al*, 2000; Lee *et al*, 2001; Barnes, 2017), nutrient cycling (Welsh 2010; Tarquinio *et al.* 2018) and sequestering atmospheric carbon (Röhr *et al.,* 2018; Johannessen, 2022). There are two species of seagrass in UK coastal waters; *Zostera marina* is the largest and predominant species. It typically occurs in shallow (up to 10 m), fully marine conditions on relatively coarse sediments (MMO, 2019). Although *Z. marina* can tolerate reduced salinity levels (e.g. 20ppt) their performance is reduced with extended exposure (Salo *et al.*, 2014). *Zostera nolii* better tolerate large fluctuations in salinity and extended periods of desiccation, and are typically found high up in the intertidal zone (MMO, 2019).

3.1.2 In Northern Europe, the population of *Z. Marina* was heavily impacted in the 1930s by a major outbreak of eel grass wasting disease (*Labyrinthula zosterae*) (Den Hartog 1987; Short *et al*, 1988; Muehlstein 1989). This led to a loss of up to 70% of the seagrass extent in north west Europe (Fonseca *et al*, 2009). Declines continued through the second half of the 20th century due to direct (e.g. anchoring boats, fishing, and other recreational and commercial activities) and indirect (e.g. sedimentation and eutrophication) pressures on seagrass habitats (Dunic *et al*. 2021; Potouroglou *et al*., 2021; Turschwell *et al*. 2021). It was estimated that, between the 1920's and 2005, 85% of the UK's seagrass had been lost (Hiscock *et al*, 2005). Recent estimates indicate that the UK contains 8,493 ha of mapped seagrass (Green *et al*. 2021), although there is considerable uncertainty. Methods used to quantify area, and the definitions of seagrass beds, vary considerably (Potouroglou *et al*., 2021). OSPAR (2009) define seagrass as having a minimum 5% density, although much higher densities may be needed for beds to be self-sustaining. Furthermore, many spatial mapping data sources lack metadata and many maps are out of date (Potouroglou *et al*., 2021).

3.1.3 Generally, there is an urgent need for seagrass to be restored. However, seagrass restoration for the purpose of compensation for Round 4 projects Dogger Bank South East and Dogger Bank South West is a non-feature specific measure; the habitat being restored is different to the habitat being damaged by the development. It is also in a different location. Therefore, as a compensation measure, seagrass restoration is low on the hierarchy of compensation measures (Defra, 2021).Restoration of seagrass meadow could, however, provide comparable ecological function to the habitat being impacted (Defra, 2021). As such, when identifying potential sites for restoration, consideration must be given to whether seagrass can provide benefit to a sandbank.

3.2 Method

3.2.1 Using the seagrass potential data layer from the Environment Agency (2023), potential areas of seagrass were mapped to identify possible sites suitable for restoration. All potential areas of seagrass were considered in mapping, but particular attention went in to identifying areas of seagrass within:

- SACs where seagrass is a designated subfeature of Annex I sandbanks
- SACs where seagrass is a designated subfeature of a feature other than sandbanks
- MCZs designated for the protection of seagrass
- SPAs that contain seagrass.

Site consideration criteria

3.2.2 Due to fundamental differences in the measures, site consideration criteria for seagrass was modified from that for new site designation and extension. For example, as a non-like-for-like measure of compensation, sites suitable for seagrass restoration would not be expected to provide a good representation of the habitat lost from the projects. As such ‘Degree of representativity of lost or damaged habitat’ was dropped from the criteria for seagrass sites. The flow diagram (Figure 3.1) presents the criteria (orange boxes) in order of importance from top to bottom.

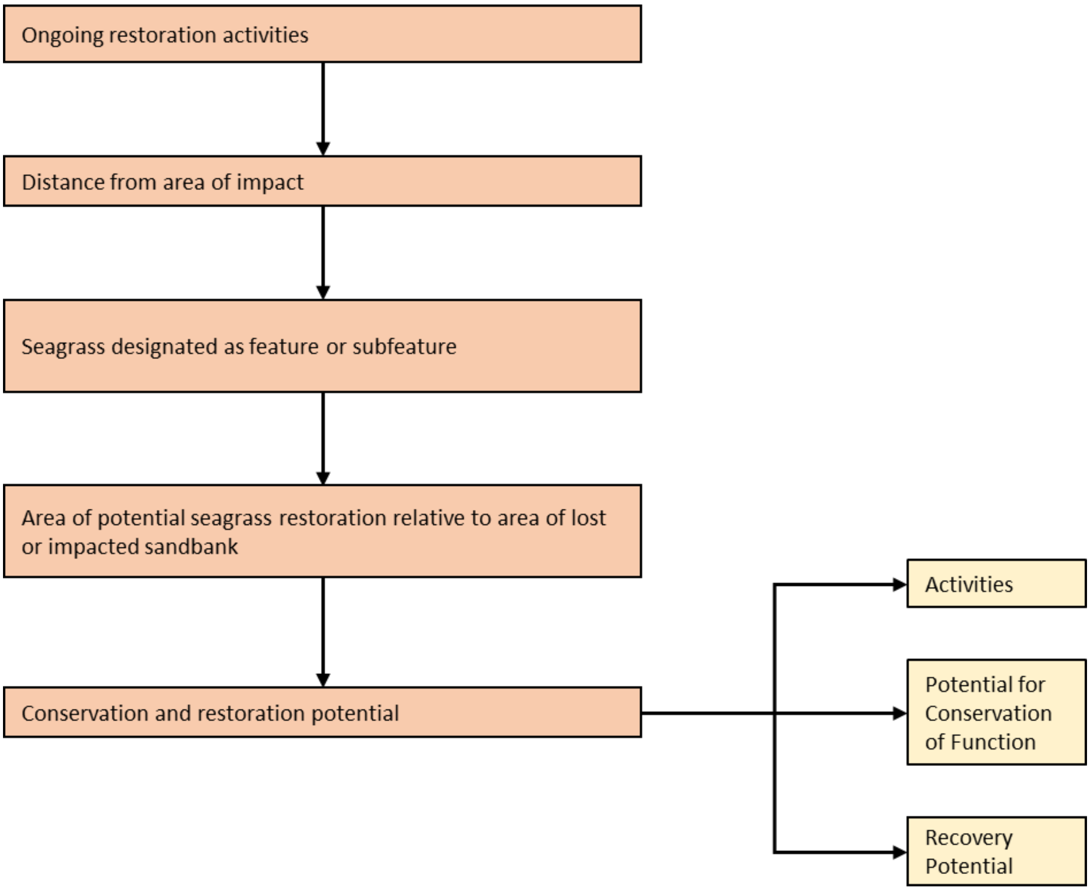

Figure 3.1 Seagrass restoration site consideration criteria. Conservation and recovery potential is separated in to sub-criteria 'Activities', 'Potential for Conservation of Function' and 'Recovery potential'.

Ongoing restoration activities

3.2.3 The principal criteria is whether seagrass restoration activity is taking place within the site. It has been determined by the steering group that supporting existing restoration projects is favoured. This could include funding a new area not currently being restored (due to funding restrictions for example) or funding work in an area of ongoing restoration to accelerate recovery or improve success rates. However, in areas where seagrass restoration is ongoing, demonstrating that additional seagrass has been provided as a result of the funding would be challenging. Therefore, sites where restoration activities are not already taking place were prioritised in identifying potential areas for restoration. Restoration was found to be taking place within 9 sites in England and 1 site in Scotland). Although not currently active, a seagrass restoration project was conducted in Pembrokeshire Marine SAC on the coast of Dale in Wales, and there are other projects planned (Project Seagrass, 2023).

Distance from the impacted area

3.2.4 As with for site extension or new designation, this criteria is relevant to the connectivity of the site with the impacted habitat. However, given that this is in relation to a non-feature specific measure, this does not in turn support the connectivity of the MPA network. Rather, seagrass restoration, particularly on sandbanks, may support functional benefits similar to those provided by the sandbank habitat within Dogger Bank SAC, such as carbon sequestration. For this criteria, an area within the same regional sea (e.g. Southern North Sea) is preferred.

Seagrass designated as a feature or subfeature

3.2.5 There are coastal SAC's, designated for the protection of sandbanks where seagrass has been designated as a subfeature of the sandbank. Such sites were preferred, followed by sites where seagrass habitat was not a subfeature of a sandbank but seagrass was a feature in itself (e.g. within an MCZ), or subfeature of another habitat, with priority given to subtidal seagrass.

Area

3.2.6 In the case of seagrass restoration, at this stage the area criteria is considered less important than for new site designation or extension. As a non-feature specific measure of compensation, direct comparison in terms of area may not be the most suitable metric. Seagrass habitat provides a similar level of some benefits over a different scale.

3.2.7 It should also be noted that the layer used in identifying potential seagrass areas was based on outputs from large scale models, through which potential seagrass habitats were derived from wave and current energy, elevation and salinity criteria (Environment Agency, 2023a). It provides an indication and the true coverage of seagrass would need to be surveyed prior to final site selection.

Conservation and restoration potential

3.2.8 As with new site designation and extension, this criteria is separated in to three sub-criteria:

- Activities: relates to the other human activities taking place within the site, or having taken place within the site historically and are still affecting site condition.
- Potential for conservation of function: relates to ecological functioning within the ecosystem. As ecological functioning is challenging to quantify, particularly in the marine environment, function in this context is taken to mean the prospects (capacity and probability) of the habitat to maintain its structure, the biotic and abiotic characteristics of the habitat (e.g. species composition and geomorphology) (JNCC, 2009).
- Restoration potential: is the extent to which restoration is possible and relates to the conservation of functions and management of activities taking place within the sites, and environmental conditions. For example, it may not be possible to replace all traditional moorings in shallow water depths and this may limit the area that could be restored.

3.2.9 The subcriteria "Potential for conservation of function" and "Restoration potential" could not be given full consideration at this stage as the necessary data was not available, but they should be utilised for the final site selection.

3.3 Results

3.3.1 Using the site consideration criteria, potential sites where seagrass restoration may be implemented as part of strategic compensation for the Round 4 projects were identified and discussed further in this report, a full list of sites can be seen in Figure 3.2. These include areas that overlap 5 SACs that have been designated for the protection of sandbanks.

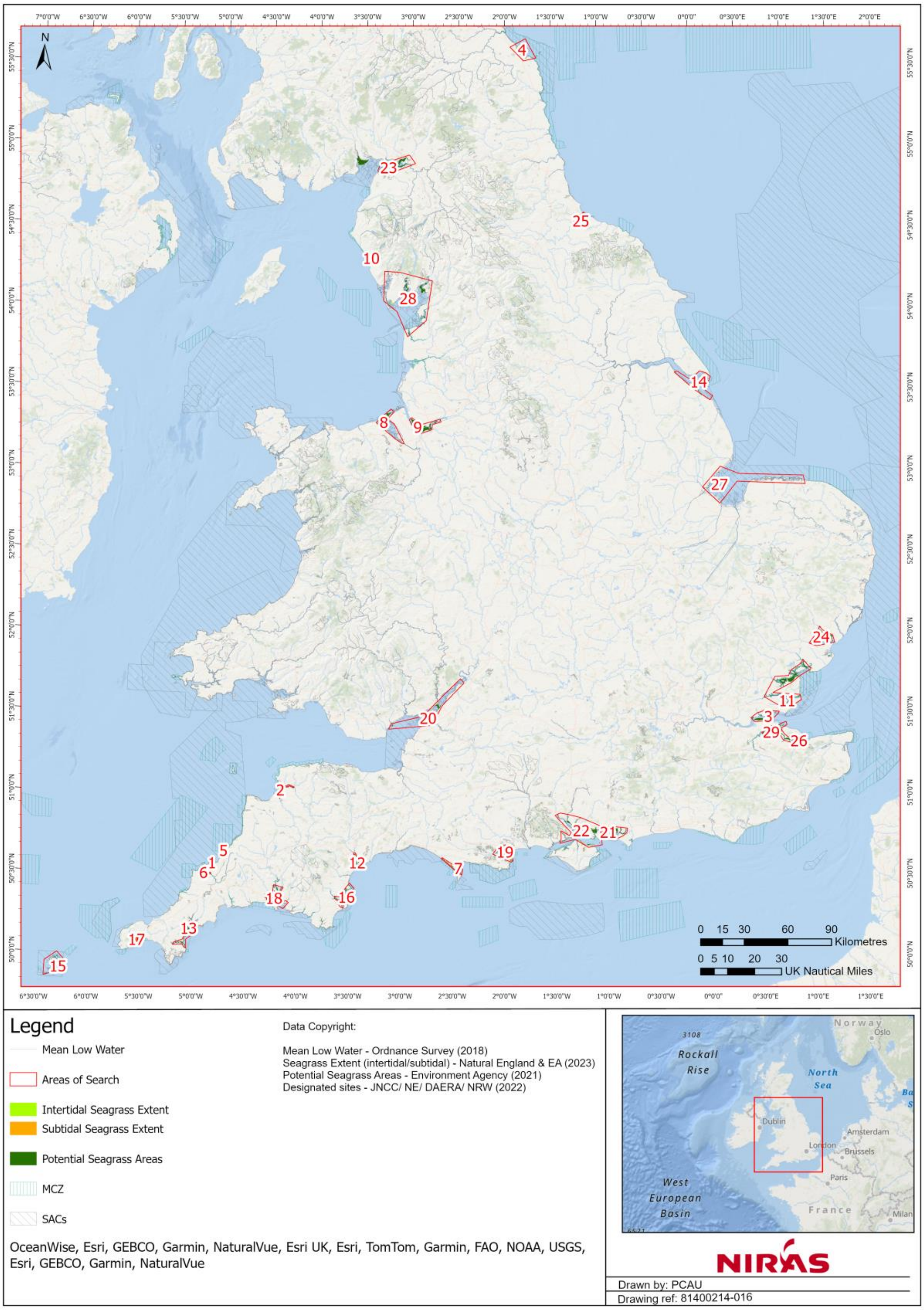

Figure 3.2 Potential sites for seagrass restoration based on the Environment Agency's seagrass potential layer (EA, 2021) and the Natural England's national seagrass layer (NE, 2023).

3.3.2 Sites on the east coast of England are shown in Figure 3.3. Site 27, which overlaps The Wash and North Norfolk SAC, is located on the East coast of England in the Southern North Sea. It is within the closest proximity to Dogger Bank SAC and it has been designated for protection of the Annex I sandbanks. Subtidal seagrass is not a subfeature of sandbanks, or other features within the site, intertidal seagrass is a subfeature of "Mudflats and sandflats not covered by seawater at low tide". The area of seagrass is low compared with the area of impact from the Round 4 projects, and multiple activities are taking place within this area.

3.3.3 Site 4 is located within Berwickshire and North Northumberland Coast SAC, which has been designated for the protection of other Annex I habitats including "Mudflats and sandflats not covered by seawater at low tide"; Intertidal seagrass are a subfeature of this feature within the SAC. The area of seagrass is low compared with the area of impact from the Round 4 projects. Of the activities considered, none are taking place within this area.

3.3.4 Sites 26 and 29 are adjacent to one another. They are The Swale Estuary and Medway Estuary, and they drain into the Southern Thames Estuary. Neither site overlaps SACs designated for the protection of sandbanks. They do overlap MCZs but they are not designated for the protection of seagrass. Of the activities considered, none are taking place within site 26 but multiple activities are taking place within site 29.

3.3.5 The Wash and North Norfolk SAC is the only SAC designated for the protection of sandbanks with the potential for seagrass restoration located on the east coast where restoration is not already taking place. Active restoration work is underway within Humber Estuary SAC and Essex Estuaries SAC, through Wilder Humber and Project Seagrass respectively.

3.3.6 Other sites that overlap SACs designated for the protection of Annex I sandbanks with the potential for seagrass restoration are located on the West Coast (Figure 3.4). Site 28 overlaps Morecambe Bay SAC on the west coast of England, site 20 overlaps Severn Estuary SAC on the border between England and Wales, and site 23 overlaps Solway Firth SAC on the border of England and Scotland. It should be noted that, whilst subtidal seagrass is not a subfeature of sandbanks within Morecambe Bay SAC, intertidal seagrass habitats are a subfeature of mudflats and sandflats not covered by seawater at low tide as well as large shallow inlets and bays.

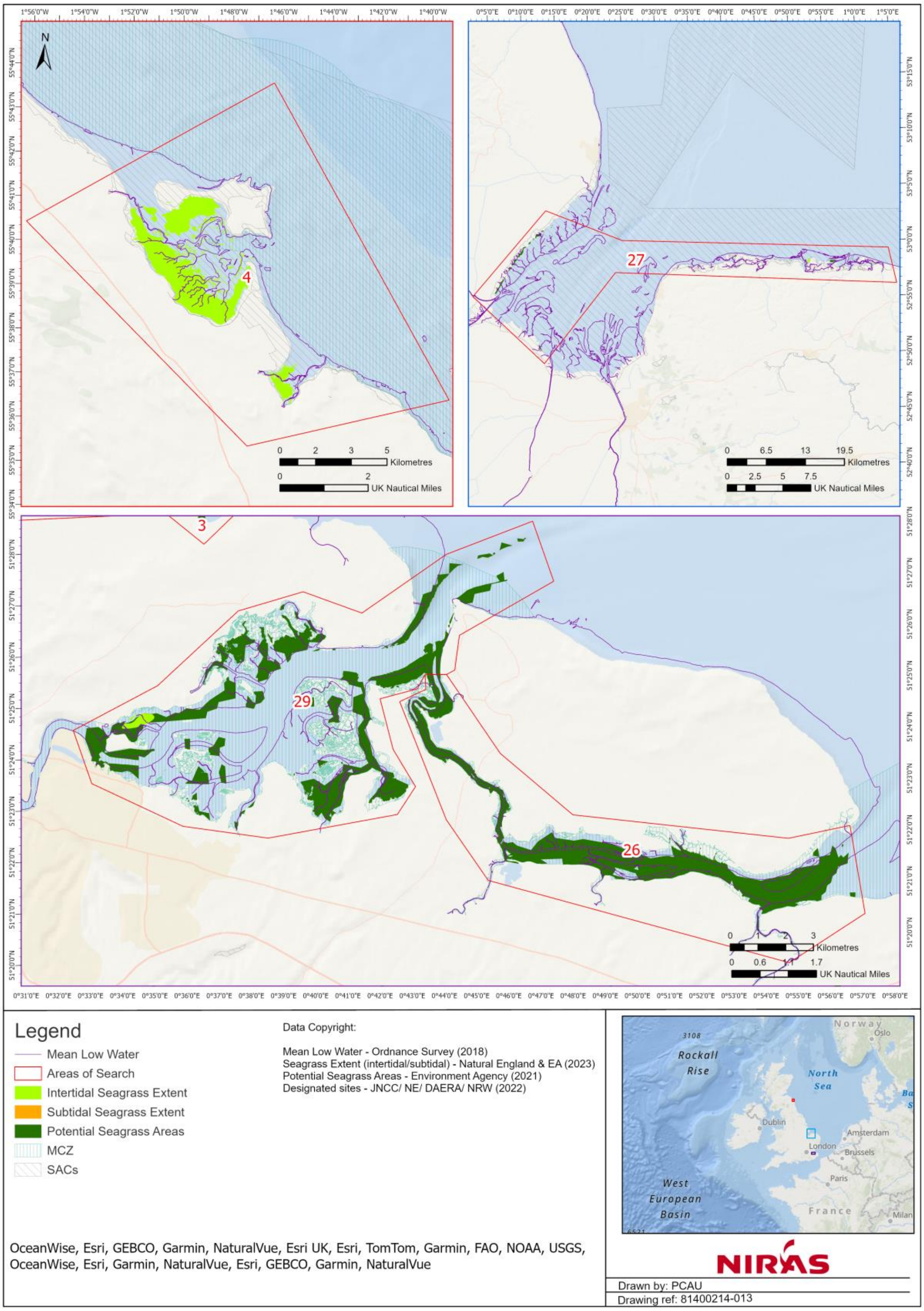

Figure 3.3 Potential sites for seagrass restoration on the east coast of England.

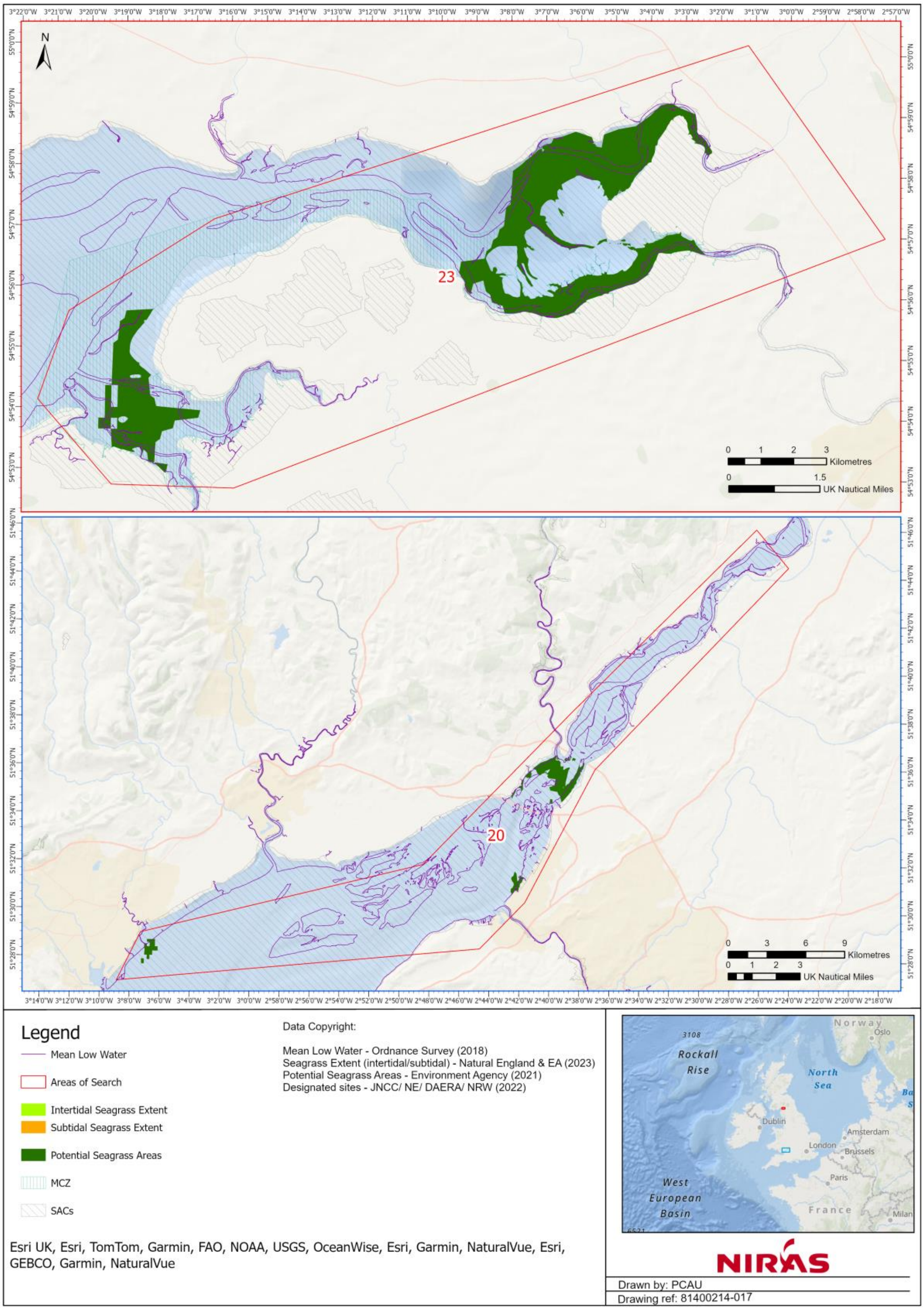

Figure 3.4 Potential sites for seagrass restoration on the west coast of England.

3.3.7 Although proximity to the area of impact is relevant to the connectivity, presently, there are no sites where subtidal seagrass occurs on the east coast of England. Based on NE and JNCC advice, restoration for the purpose of compensation should be restricted to subtidal seagrass. It is not yet understood if there are historical records of subtidal seagrass meadows along the east coast of England and whether there is a possibility of restoring such habitat. Should this not be the case, seagrass restoration may be limited to sites outside of the southern North Sea, such as along the south coast of England (Figure 3.5).

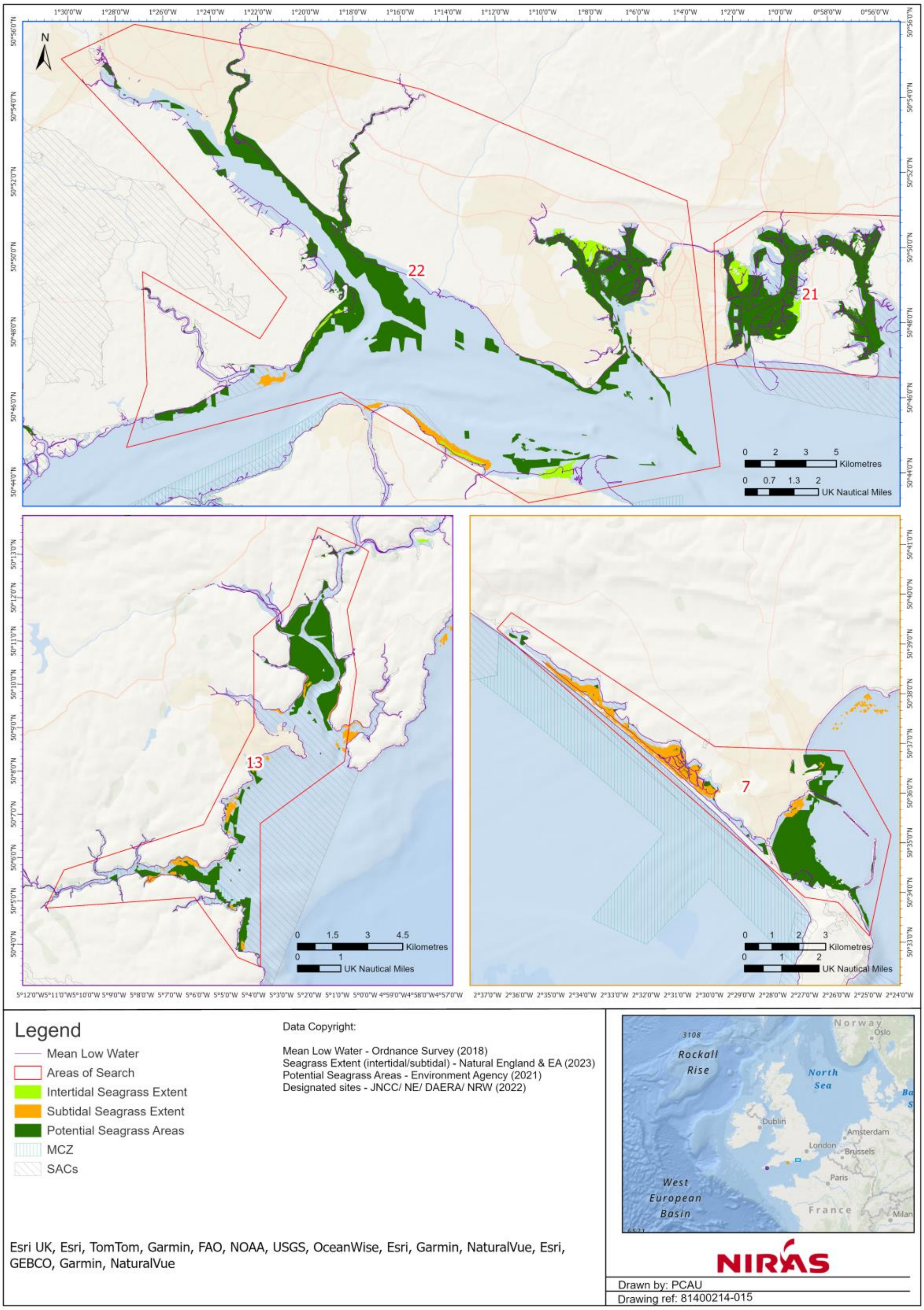

Figure 3.5 Sites located on the south coast where subtidal seagrass occurs. These sites may be used as reference areas for east coast subtidal restoration projects.

3.4 Discussion

3.4.1 The seagrass potential layer indicated where it may be possible to implement seagrass restoration. However, restoration projects are already in place at a number of the sites identified. The focus of the site selection was on sites where seagrass restoration was not in place.

Success

3.4.2 For seagrass restoration to be successful, restored seagrass meadows must sustain themselves long-term. To determine whether seagrass is self-sustaining, long-term monitoring would be required. If restoration were to take place within an MPA where seagrass was a designated feature or subfeature, monitoring would fall within the remit of a SNCBs, such as Natural England. Delivery of the measure, and subsequent monitoring, is expected to be funded through the Marine Recovery Fund, which the developer would pay in to.

3.4.3 Ideally the site undergoing restoration would be compared with a minimum of two healthy seagrass meadows at reference sites (other locations with similar physical and environmental characteristics) (Hendy *et al*., 2021). If in the long-term, the restored seagrass beds meet or exceed the structural, functional and genetic indicators at those reference sites a restoration project can be considered successful (Hendy *et al*., 2021). Indicators would also need to be compared with previous years and the baseline condition to determine trends over time. Table 3.1 lists suggested metrics for indicators and provides an indicative timeline for monitoring (Hendy *et al*, 2021). It should be noted that subtidal seagrass beds are currently absent on the east coast. Should seagrass restoration be implemented as compensation, comparisons would need to be made with the nearest subtidal seagrass beds, which are on the south coast. These sites may be subject to different pressures and environmental conditions.

*Table 3.1 : Suggested timeline and metrics for a seagrass restoration monitoring programme from Hendy et al., 2021 (£ = cheap, ££ = medium expense, and £££ =expensive; * = optional indicators to assess seagrass status). Before year five there will be minimal underground carbon storage. Thus, carbon would be assessed as a functional indicator post year 5. "Destructive" indicates an extractive or damaging activity.*

Structural Indicators				
Timeline	**Year 0**	**Years 1–5**	**Year 6+**	**Note**
Cover/extent	After 1, 3, 6 months	Yearly	Yearly	£
Shoot density and leaf morphology	After 1, 3, 6 months	Yearly	Yearly	£
Biomass*	Once	Yearly	Yearly	££ (destructive)
Epiphyte cover and disease assessment	After 1, 3, 6 months	Yearly	Yearly	£
Functional indicators				
Timeline	**Year 0**	**Years 1–5**	**Year 6+**	**Note**
Biodiversity	Before-Once	Year 5	Yearly	£££ (destructive)
Water quality	Once	Year 5	Yearly	£
Sediment structure*	Before-Once	Year 5	Yearly	££
Carbon stock assessment sequestration measurements	Before-Once	Year 5	Yearly	£££ (destructive)
Genetic monitoring*	-	Yearly	Year 10	£££

3.4.4 When measuring restoration success the resistance of the restored habitat to disturbance should also be assessed. An accepted approach is to measure the natural parameter value range of the restored seagrass meadows and compare that of the reference sites. If the natural parameter value ranges of restored seagrass meadows falls within the ranges of the reference seagrass meadows it can be assumed they can resist disturbance (Hendy *et al* 2021). Where annual variability has been recorded, this can be used to define the limits for the natural parameter value range, if not variability across space can be used (Hendy *et al* 2021).

Deliverability

3.4.5 There are ongoing efforts to restore seagrass meadows at coastal locations around the UK. Two main methods have been used in seagrass restoration, replanting and reseeding, which can be used in combination (MMO, 2019; Potouroglou *et al.*, 2021). Replanting involves harvesting adult shoots from an existing seagrass meadow and transplanting them at the restoration site. Replanting must be done by hand by divers, so it is labour-intensive and time consuming (MMO, 2019; Potouroglou *et al.*, 2021). Reseeding involves collecting wild seed and performing targeted redistribution of that seed. To generate a self-sustaining meadow, seagrass restoration must occur at sufficient scale to facilitate positive feedbacks (van Katwijk *et al.*, 2016).

3.4.6 Whilst restoration programmes are at an early stage, experience with restoration is growing rapidly. Nonetheless, to date success in restoring seagrass meadows has been limited. A major challenge relates to existing pressures, which have led to declines in health and coverage of seagrass meadows and continue to do so. Should seagrass restoration be implemented as part of a strategic compensation package, in the first instance further investigation of the site conditions and pressures would be required before final site selection. There is a high risk of failure if little consideration has been given to the habitat requirements for seagrass and continued exposure to pressures (MMO, 2019). It should be noted that sites with the most suitable conditions may still require further reduction of pressures (e.g. relocating moorings or improving water quality) to maximise the chances of successful restoration. This may be, costly and time consuming; it would involve public consultation and engagement with stakeholders. Identifying suitable mechanisms for reducing pressures (e.g. implementing bye-laws) requires further consideration.

3.4.7 Should habitat be restored within any MPA, consideration must also be given to the potential for loss of other designated features. Careful consideration around the location of the restored habitat within the MPA and management of that habitat is required to minimise the risk to other features.

3.4.8 The Steering Group had significant concerns about the deliverability of seagrass restoration, especially on a small scale as there have been no long term successes with seagrass restoration in the UK. Successful examples from abroad such as in Chesapeake Bay occurred at a large scale (3,600 ha).

3.4.9 There are existing seagrass restoration initiatives, for example Life Recreation ReMEDIES (Save Our Seabed, 2019). An alternative pathway to delivering seagrass restoration as a measure of compensation is for the developer to pay in to a fund to support existing seagrass restoration projects. There are several advantages to this route. Firstly, compensation would be delivered through a wider programme rather than by the developer. This puts resources for restoration in the hands of those with the most experience, who have already been through the site selection process and project planning stages. Furthermore additional funds or work could be provided to support with activities that can aid success, such as the development of less damaging anchor systems, or activities to improve water quality. Careful consideration would need to be given as to how success would be proven, but if this approach were included alongside supporting restoration at a new site, then it is considered that it could be considered as additional.

Conclusions

3.4.10 There are questions around the deliverability of seagrass restoration and, therefore, its potential value as a compensation measure. It is also a lower preference compensatory measure (Defra, 2021). Notwithstanding these comments, the measure has potential to benefit subtidal sandbank habitat.

3.4.11 It is recommended that seagrass restoration be retained as an option, but only as a potential part of a package of higher preference compensation measures and pending collation of further evidence to support implementation at an appropriate scale.

3.4.12 For seagrass restoration to provide compensation, it must provide ecological benefits, particularly to sandbank habitats. Therefore a significant coverage of seagrass meadow would need to have been restored and be self-sustaining before compensation could be said to be delivered. Seagrass restoration is, however, a long-term endeavour; success would need to be measured over a number of years using multiple indicators. To minimise the chances of failure, existing pressures would need to be identified and reduced, which would add to the timeline for delivery of the compensation.

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