Ardal Cadwraeth Arbennig Sir Benfro Forol / Pembrokeshire Marine Special Area of Conservation

Advice provided by Natural Resources Wales in fulfilment of Regulation 37(3) of the Conservation of Habitats and Species Regulations 2017.

June 2025

Freshwater West, Pembrokeshire © NRW.

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Mae Adran 1 yn cyflwyno'r safle, pwrpas y cyngor a strwythur yr amcanion cadwraeth. Mae Adran 2 yn cynnwys esboniad o'r rolau a'r cyfrifoldebau, ac mae Adran 3 yn amlinellu amcanion cadwraeth pob nodwedd a gwybodaeth ategol. Mae cyngor ar weithrediadau mewn perthynas â'r safle hwn i'w gael yn Adran 4. Mae rhagor o wybodaeth am yr ACA wedi'i chynnwys yn Atodiad 1.

Isod mae rhestr o nodweddion dynodedig yr ACA hon a dolen uniongyrchol i'r amcanion cadwraeth, ond mae'n bwysig darllen pob adran yn llawn.

Tabl 1. Crynodeb o nodweddion yr ACA a'r ddolen i'r amcanion cadwraeth.

Enw'r ACA	Nodweddion Dynodedig	Cysylltiad â'r Amcanion Cadwraeth
Sir Benfro Forol	• Cilfachau a baeau mawr bas • Aberoedd • Riffiau • Morlo llwyd *Halichoerus grypus* • Dolydd ar forfeydd arfordir y gorllewin • Gwastadeddau llaid neu dywod nas gorchuddir gan y môr ar lanw isel • Morlynnoedd neu Lagynau • Ogofâu môr sy'n danforol neu'n lleddanforo • Ponciau tywod sydd fymryn dan ddŵr y môr drwy'r amser • Herlyn *Alosa alosa* • Gwangen *Alosa fallax* • Lamprai neu lysywen bendoll yr afon *Lampetra fluviatilis* • Lamprai neu lysywen bendoll y môr *Petromyzon marinus* • Dyfrgi *Lutra lutra* • Tafolen y traeth *Rumex rupestris*	Amcanion cadwraeth

Executive Summary

This document contains NRW's advice for Pembrokeshire Marine special area of conservation (SAC) issued under Regulation 37(3) of the Conservation Regulations 2017.

Section 1 introduces the site, the purpose of the advice and the structure of the conservation objectives. Section 2 includes an explanation of the roles and responsibilities before Section 3 outlines each feature's conservation objectives and supporting information. Advice on operations in relation to this site is found in Section 4 and information on climate change and restoration in section 5. Further information on the site is captured in Appendix 1.

Table 1 lists the designated features of this site and provides a direct link to the conservation objectives, but it is important that all sections are read in full.

Table 1. Summary of site features and link to Conservation Objectives.

SAC Name	Designated Features	Link to Conservation Objectives
Pembrokeshire Marine	• Large shallow inlets and bays • Estuaries • Reefs • Grey seal *Halichoerus grypus* • Atlantic salt meadows *Glauco-Puccinellietalia maritimae* • Mudflats and sandflats not covered by seawater at low tide • Coastal lagoons • Submerged or partially submerged sea caves • Sandbanks which are slightly covered by seawater all the time • Allis shad *Alosa alosa* • twaite shad *Alosa fallax* • river lamprey *Lampetra fluviatilis* • sea lamprey *Petromyzon marinus* • *Otter Lutra lutra* • *Shore dock Rumex rupestris*	Conservation objectives

1. Introduction

The ardal cadwraeth arbennig (ACA) Sir Benfro Forol / Pembrokeshire marine special area of conservation (SAC) is situated on the southwestern tip of Wales. It is a large designated site covering 138,038 ha and forms part of the UK's National Site Network.

The SAC extends from just north of Abereiddy on the north Pembrokeshire coast to just east of Manorbier in the south. It includes the coast of the islands of Dewi/Ramsey, Sgomer / Skomer, Grassholm, Sgogwm / Skokholm, the Bishops and Clerks and The Smalls. The SAC encompasses a range of marine habitats and species, some of which are unique in Wales. Habitat and biological diversity are of great importance throughout the site, particularly the well documented reef habitats and the Aberdaugleddau/Milford Haven ria-estuary (drowned river valley). The site's location at a boundary between northern and southern species distributions contributes to the biological diversity.

The site was designated in 2004 under Article 4.2 of the Conservation of Natural Habitats and of Wild Fauna and Flora Directive (92/42/EEC) for eight habitat features under Annex I and seven species features under Annex II. It is one of the best areas in the UK for the following features,

- Large shallow inlets and bays (abbreviated to LSIB)
- Estuaries
- Reefs
- Grey seal *Halichoerus grypus*

And supports a significant presence of,

- Atlantic salt meadows *Glauco-Puccinellietalia maritimae* (abbreviated to ASM)
- Mudflats and sandflats not covered by seawater at low tide (abbreviated to mudflats and sandflats)
- Coastal lagoons
- Submerged or partially submerged sea caves (abbreviated to sea caves)
- Sandbanks which are slightly covered by seawater all the time (abbreviated to sandbanks)
- Allis shad *Alosa alosa*
- Twaite shad *Alosa fallax*
- River lamprey *Lampetra fluviatilis*
- Sea lamprey *Petromyzon marinus*
- Otter *Lutra lutra*
- Shore dock *Rumex rupestris*

Pembrokeshire Marine SAC overlaps the Skomer marine conservation zone (MCZ). The SAC also wholly or partly overlaps with 3 other SACs, 4 special protection areas (SPAs), and 23 sites of special scientific interest (SSSIs). A list of overlapping protected sites can be seen in Appendix 2 and their conservation objectives, or site management statements, can be found on the NRW website. The boundaries and geographical extents of these sites can be seen on the Joint Nature Conservation Committee (JNCC) MPA mapper. Several habitats and species within the SAC are also listed in Section 7 of the Environment Act (Wales) which lists habitats and species of principal importance in Wales. There are also OSPAR threatened and declining species and habitats within the SAC. For these additional conservation interests see Appendix 2.

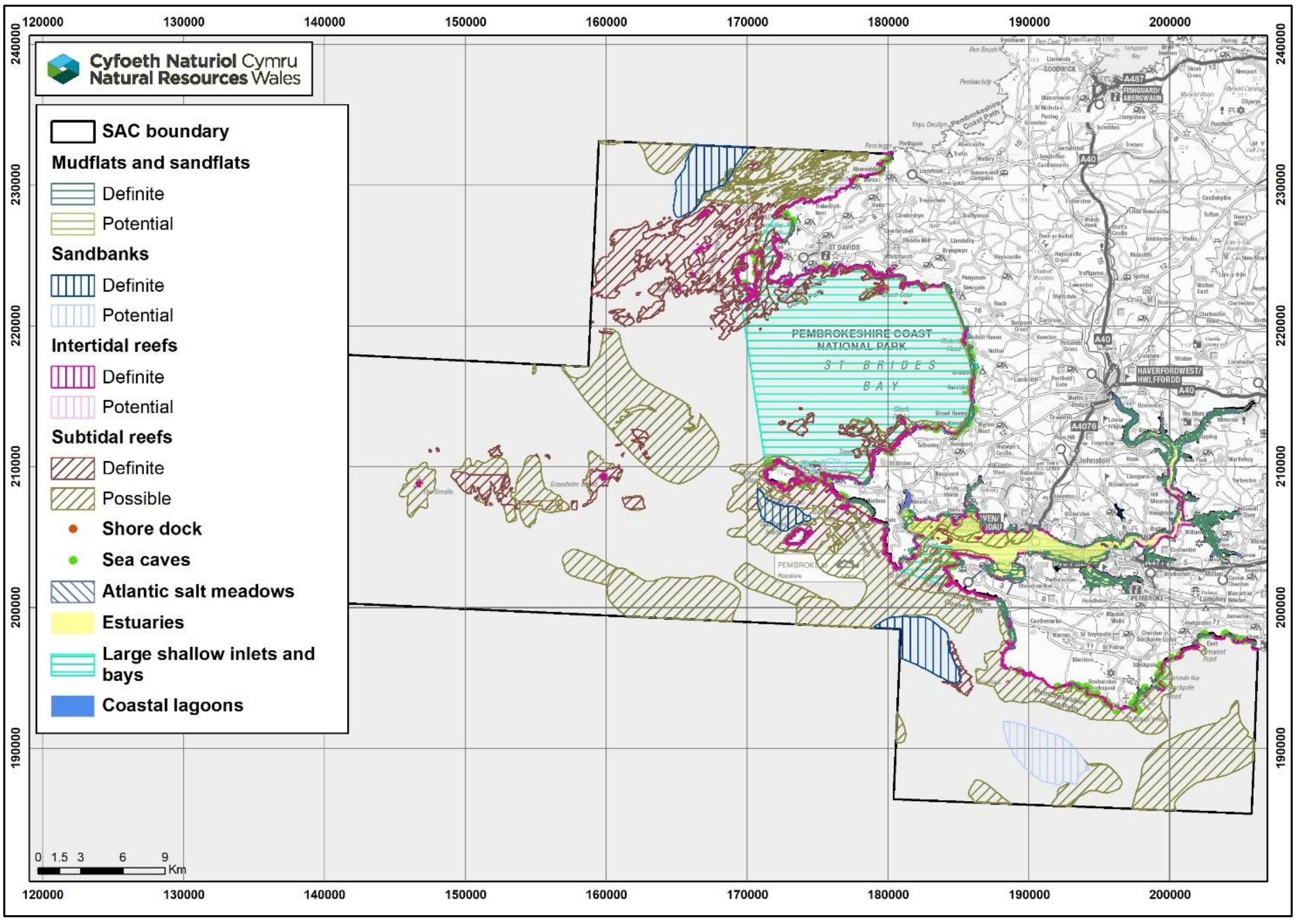
1.1. SAC Feature Map

The feature locations in maps are indicative and represent the best available evidence at the time of publication. No single habitat feature occupies the entire SAC and features overlap in some locations (See Figure 1). The extent of most habitat features is not known precisely because accurate mapping is very difficult, expensive and resource intensive. This is further complicated due to the dynamic and mobile nature of some habitats. Work is ongoing to improve our knowledge of where designated habitat features occur in our SACs and maps are updated periodically. When new areas of Annex I habitat are discovered within the boundary of a SAC they automatically become part of the SAC feature where it is already a designated feature of the site.

A map of each habitat feature within the SAC is shown before its conservation objectives. All maps in this document are for illustrative purposes only. Detailed maps for the features in Wales can be found on Data Map Wales.

All maps in this document are copyrighted as follows:

Figure 1. Map showing the site boundary and designated habitat features of Pembrokeshire Marine SAC.



1.2. The purpose of conservation advice

Conservation advice provides a framework for assessing developments and activities with the potential to affect the features for which a European marine site (EMS) is designated. An EMS is a SAC or SPA which consists of marine areas. Conservation advice presents site specific information, in addition to highlighting activities that are potentially capable of having an impact on the site and its designated species (known as a feature).

This SAC is an EMS subject to protection under the Conservation of Habitats and Species Regulations 2017, as amended (referred to in this document as the 'Habitats Regulations'). Under the Habitats Regulations, relevant and competent authorities with functions in relation to an EMS must exercise those functions to comply with the requirements of the 1992 European Commission (EC) Habitats and Species Directive and the 2009 EC Wild Birds Directive. The key requirements of these Directives include the conservation of the features (habitat types or species) for which SACs or SPAs are designated. This requires taking appropriate steps to avoid deterioration or disturbance of SAC or SPA features and carrying out appropriate assessment of any plan or project likely to have a significant effect on a SAC or SPA.

This document contains the conservation advice for the SAC. It is prepared by Natural Resources Wales (NRW) and given under our duty in Regulation 37(3) of the Habitats Regulations (see Section 2.1).

This advice is based on the best available evidence and information at the time of writing. In some cases, evidence can be limited. It will be kept under review by NRW and updated as and when appropriate.

1.3. Conservation objective structure

The conservation objectives for the designated features in this site are underpinned by conservation objective attributes. These attributes describe the ecological characteristics (e.g. population), and the ecological requirements that allow the conservation objectives for each feature to be met.

Conservation objective attributes have a target which is either quantified or qualified depending on the available evidence. The target identifies, as far as possible, the desired state to be achieved for the attribute. In many cases, the attribute targets show if the current objective is to either 'maintain' or 'restore' the attribute and are based on the latest condition assessment for the feature. Some aspects of feature condition may be assessed as unknown. In these cases, a 'maintain' target will be set as necessary. For attributes that have been assigned 'unknown' in the condition assessment, further information on feature condition and/or activities impacting the feature will be required to inform further advice. Each attribute target will need to be assessed on a case-by-case basis using the most current information available.

The conservation objective attributes that underpin the conservation objectives are used to measure if the objective is being met. This in turn can be used to see if site integrity is being maintained. Failure to meet any attribute means that the conservation objective is not being met and thus site integrity is not being maintained. Below is an example of a conservation objective and associated conservation objective attributes and targets.

Example Objective 1: The overall distribution and extent of the mudflats and sandflats feature within the SAC and each of its main component habitats are stable or increasing, subject to natural change.

Example Objective attribute	**Example Site specific target**
Feature extent and distribution	Maintain/restore the extent and distribution of mudflats and sandflats
Component habitat extent and distribution	Maintain/restore the extent and distribution of mudflat and sandflat component habitats.

The conservation objectives for the features of Pembrokeshire Marine SAC are set out in Section 3. As noted in Section 1.2, NRW may refine these in the future as further information becomes available and increases our understanding of the feature.

The feature's conservation objective section provides:

1. A clear statement of each conservation objective for the feature.

2. A table summarising the attributes, and the targets for those attributes.

3. Supporting information that underpins the selection of the attributes and targets.

2. Roles and responsibilities

2.1. NRWs role

Under Regulation 5 of the Habitats Regulations, NRW is a Nature Conservation Body and, in relation to Wales, is the Appropriate Nature Conservation Body (ANCB).

In its role as the ANCB, NRW has a duty under Regulation 37(3) of the Habitats Regulations to advise relevant authorities in respect of a EMS as to:

(a) the conservation objectives for that site

(b) any operations which may cause deterioration of natural habitats or the habitats of species, or disturbance of species, for which that site has been designated (see Section 1.2).

Advice on operations which may cause deterioration, together with the conservation objectives, is designed to assist relevant authorities and other decision-makers in complying with their statutory duties under the Habitats Regulations. The advice on operations which may cause deterioration given in this document is without prejudice to other advice given. This includes the conservation objectives themselves, and other advice which may be given by NRW from time to time in relation to any specific operations.

“Operations” is taken to cover all types of human activity, irrespective of whether they are under any form of regulation or management. Thus, the advice contains reference to operations which may not be the responsibility of any of the relevant authorities.

NRW will provide additional advice for the site to relevant authorities and competent authorities to allow them to fulfil their duties under the Habitats Regulations. For example, by providing advice to a competent authority assessing the implications of plans or projects on the features of the EMS. Each plan or project will be judged on its own merits, and this will determine the nature of any additional advice required.

2.2. The role of competent and relevant authorities

The expressions used in this advice of “relevant authority” and “competent authority” are as defined in Regulation 3 of the Habitats Regulations. Relevant authorities are specified in Regulation 6 of the Habitats Regulations. Competent authorities are specified in Regulation 7 of the Habitats Regulations.

Under Part 6 of the Habitats Regulations, all competent authorities must undertake a formal assessment of the implications that any new plans or projects may have on the designated features of a protected site. The implications must be assessed in the context of other plans and projects affecting the same site. Activities outside of the site may also affect the features of the site, therefore, plans and projects located outside of a designated site may still need to be assessed.

In respect of the assessment provisions in Part 6 (assessment of plans or projects) of the Habitats Regulations, NRW is also the ANCB in relation to Wales.

The assessment provisions comprise several distinct stages which are collectively described as a Habitats Regulations Assessment (HRA), for which guidance is available. Before deciding to undertake, or give any consent, permission or other authorisation for, a plan or project which is likely to have a significant effect on a European site or a European offshore marine site (either alone or in combination with other plans or projects), and is not directly connected with or necessary to the management of that site, the competent authority must make an appropriate assessment of the implications of the plan or project for that site in view of that site's conservation objectives.

In light of the conclusions of the HRA and subject to derogation under Regulation 64, the competent authority may agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the EMS. In considering whether a plan or project will adversely affect the integrity of the site, the competent authority must have regard to the manner in which it is proposed to be carried out or to any conditions or restrictions subject to which it proposes that the consent, permission or other authorisation should be given.

Carrying out the HRA process is the responsibility of the decision maker as the competent authority. However, it is the responsibility of the applicant to provide the competent authority with the information that they require for this purpose.

The competent authority has a duty to consult the ANCB for the purposes of the assessment. Under Regulation 63(3) of the Habitats Regulations the competent authority must have regard to any representations made by the ANCB when reaching its decision.

Under Regulation 38(1) of the Habitats Regulations it states that, "*the relevant authorities, or any of them, may establish for a European marine site a management scheme under which their functions (including any power to make byelaws) are to be exercised so as to secure compliance with the requirements of the Directives in relation to that site".*

In other words, a group of relevant authorities, or any individual relevant authority, may create a management plan for an EMS. Management plans should be used to help relevant authorities carry out their duties to secure compliance with the Habitats Regulations. Only one management scheme may be made for each EMS. A management scheme may be amended. An authority which has established a management scheme must as soon as practicable thereafter send a copy of it to the ANCB. Any management plans created on this site should be guided by the advice in this package.

Within their areas of jurisdiction relevant authorities must have regard to both direct and indirect effects of an activity on the designated features of the site. This may include consideration of issues outside the boundary of the site. Nothing within a Regulation 37(3) package will require relevant authorities to undertake any actions to maintain or improve the condition of designated features if it is shown that the changes result wholly from natural causes.

NRW will continue to review any new evidence or information about this site and will provide further advice as appropriate. This does not stop relevant authorities from taking any appropriate conservation measures to prevent deterioration to the designated features. Such actions should be undertaken when required.

2.3. The purpose of conservation objectives

The purpose of the conservation objectives for an EMS is to help meet the obligations of the Habitats Regulations in relation to that site. They do this by supporting:

- **Communication**. The conservation objectives help convey to stakeholders what is needed to maintain or restore a feature in/to favourable condition.

- **Site planning and management**. The conservation objectives guide the development of management measures for sites. Achievement of conservation objectives may require management action to be taken inside or outside the site boundary.

- **Assessment of plans and projects**. The Habitats Regulations require the assessment of plans and projects in view of a site's conservation objectives. Subject to certain exceptions, plans or projects may not proceed unless it is established that they will not adversely affect the integrity of a site. Conservation objectives can help develop suitable compensatory measures.

- **Monitoring and reporting**. Conservation objectives provide the basis for defining the evidence that will be used for assessing the condition of a feature.

This document includes both a statement of the conservation objectives and explanatory text on their intent and interpretation specific to the site (supporting information).

2.4. The purpose of advice on operations

NRW must provide advice to relevant authorities about operations that may cause,

- deterioration of designated natural habitats
- deterioration of the habitats of designated species
- the disturbance of designated species

This is statutory advice required by Regulation 37(3)(b) of the Habitats Regulations when considering operations which may cause impacts to designated features. These are operations which could take place within or outside the boundary of the [insert SAC/SPA].

NRW can provide specific advice on existing activities and management, advising on the extent to which activities are consistent with the conservation objectives. This advice, together with the list of activities in Section 4 and the latest condition assessments should direct required management measures within a site.

2.5. When to use this advice

This advice should be used together with case-specific advice issued by NRW when developing, proposing or assessing an activity, plan or project that may affect the features of the site. Any proposal or operation that has the potential to affect a site must not prevent the achievement of the feature’s conservation objectives. Any such prevention would amount to an adverse effect on the integrity of the site.

The advice given here is without prejudice to any advice which may be provided by NRW in relation to the consideration of individual plans or projects in the carrying out of the assessment provisions as defined in Part 6 of the Habitat Regulations.

2.6. Feature condition

NRW has a dedicated condition assessment process to assess feature condition. Each feature designated in Welsh EMS have their own set of performance indicators. These indicators have targets which are assessed with the most up to date evidence available. When all required indicator targets are met a feature is in favourable condition.

The condition assessment of a feature helps to determine if its conservation objectives are being achieved. Results determine if maintain or restore conservation objectives are needed. Appropriate management must be in place to enable conservation objectives to continue being met and for feature condition to be maintained or restored as required. The conservation objectives cannot be achieved if a feature is in unfavourable condition.

Feature condition is recorded in condition assessment documents. These are available on the NRW website. NRW will update this advice package when new condition assessment information is available.

2.6.1. Favourable conservation status and National Site Network

If features are in favourable condition, it is likely they are making an appropriate contribution to Favourable Conservation Status (FCS) of the feature at the UK level. A feature cannot make an appropriate contribution to FCS without meeting its conservation objectives. More information on FCS can be found in the joint statement from the UK Statutory Nature Conservation Bodies.

Regulation 16A of the Habitats Regulations creates the National Site Network on land and at sea, including both the inshore and offshore marine areas in the UK, and sets out the powers and duties of the appropriate authority (Welsh Government).

Information on how features in a site are meeting their conservation objectives will feed into the assessment of the National Site Network management objectives. The management objectives for the National Site Network are to maintain or restore designated SAC and SPA features to favourable conservation status across their natural range. More information on the UK National Site Network and its management objectives can be found on the gov.uk website.

2.7. Climate change and coastal squeeze

2.7.1 Vulnerability of Annex I habitats to climate change pressures

The oceans play a vital role in the global carbon cycle, and the importance of the oceans in mitigating against climate change is now widely recognised. Understanding the impacts of climate change on the features of our MPAs is Wales is important as we consider future potential management action.

Oaten et al. (2021) determined the vulnerability of Welsh Annex I marine features to a range of climate change pressures. The method involved developing a Geographical Information System (GIS) model using the best available climate projections and spatial data on marine habitats in Wales at that time. This was undertaken for a number of emissions scenarios and management timeframes.

A literature review on the sensitivities of Annex I habitats to physical and chemical pressures as a result of climate change was carried out which also informed the assessment. The biological resolution of Annex I habitats was considered too broad to undertake a meaningful vulnerability assessment, as individual biotopes that comprise the Annex I habitats have differing sensitivities to climate change pressures. Thus, the initial assessment was based on the vulnerabilities of component biotopes of Annex I marine habitats in Wales.

The biotopes were then re-assigned to the respective features within each MPA. While it was not possible to achieve full spatial coverage of biotopes that comprise the Annex I features (due to spatial gaps in data in some of the features), the resulting data was considered to sufficiently represent the types of communities that would be found (Gihwala et al., 2024).

The climate change pressure that were assessed included:

- Air temperature
- Deoxygenation
- Ocean acidification
- Salinity
- Sea level rise
- Sea temperature
- Wave exposure

There are other pressures that have not been assessed such as those arising from the terrestrial environment for example increased river and sediment run off due to predicted higher rainfall levels.

The vulnerability categories used in the analysis were ‘Not relevant’, ‘Not sensitive’, ‘Low’, ‘Medium’ and ‘High’. The overall vulnerability score for each climate change pressure was based on the vulnerability category with the greatest spatial coverage for the respective feature (based on the underpinning biotopes). It should be noted that climate change vulnerabilities assigned to each respective feature at the site level were only based on biotope sensitivities and did not consider any local circumstances (e.g. specific management policies or existing coastal structures) and were based on one specific emission scenario (RCP 8.5) and to one time period (up to 2049) (for more information see Gihwala et al., 2024). RCP 8.5 was developed as a baseline scenario for climate modelling and was intended to represent the 90th percentile of no-policy baseline scenarios at the time. It is now considered a high-emissions future for global warming.

In Section 5.1 a summary of the climate change vulnerabilities for each assessed feature on this site can be found. The full report includes the impact on Blue Carbon and maps of the different climate change pressures.

Climate change is likely to cause changes across a site and across the network of sites in Wales. There are likely to be differences in impacts across features with some features being more impacted by certain climate change pressures than others. There may also be perceived conflicts between features where potential management measures may impact one feature to the detriment of another e.g. the protection of a coastal lagoon may affect adjacent mudflats and sandflats. These challenges are difficult to address through conservation advice and a lot more thinking needs to be done on this issue. In the meantime they will need to be considered on a site-by-site basis, as and when they arise.

2.7.2. Vulnerability of coastal features to coastal squeeze

Besides the general work on climate change vulnerabilities above more specific detailed work has been carried out on the impacts of sea-level rise on our MPA network (Oaten et al., 2024).

This work regards the extent to which sea-level rise may cause coastal squeeze and natural squeeze, an issue which affects intertidal habitats.

Coastal Squeeze is “The loss of natural habitats or deterioration of their quality arising from anthropogenic structures, or actions, preventing the landward transgression of those habitats that would otherwise naturally occur in response to sea level rise in conjunction with other coastal processes. Coastal Squeeze affects habitat on the seaward side of existing structures.”

Natural squeeze is defined as the loss of habitat against any natural frontage that restricts the rollback of intertidal habitats. Two types of natural frontage are considered within the assessment of natural squeeze:

- Natural Ridge – e.g., a shingle / dune ridge or a natural bank that has an area of low-lying land behind that could be inundated by the tide if the ridge is breached; and
- High ground – naturally high ground that limits any inundation of the tide into the hinterland.

Further information on the specific feature impacts is provided in section 5.2.

Seven broad intertidal habitat groups were identified as being subjected to coastal squeeze. The following are of relevance for our marine Annex I habitats in our Welsh MPA network,

- Saltmarsh,
- Mudflats and sandflats,
- Intertidal reef, and
- Vegetated shingle.

The affected habitats for this SAC are saltmarsh and mudflats and sandflats. Coastal lagoons were considered using a different methodology. Further information on the specific feature impacts is provided in Section 5.2. The different timeframes, climate change scenarios and management scenarios can be found in the full assessment of coastal squeeze report.

3. Conservation objectives for Pembrokeshire Marine SAC

The conservation objectives for each designated feature are outlined in the sections below. Each objective is accompanied by objective attributes and targets (see Section 1.3) and supporting information specific to each objective. General site information can be found in Appendix 1. General feature descriptions and ecological characteristics can be found in the JNCC habitats list and species list.

The following terms are used in the conservation objectives.

Anthropogenic: In this document anthropogenic specifically relates to environmental changes caused or influenced by people, either directly or indirectly. NRW consider anthropogenic influences to include climate change.

Component habitat: Habitats that constitute the named features. E.g. Muddy gravels in mudflats and sandflats not covered by seawater at low tide.

Maintain: Where existing evidence from the most recent condition assessment suggests the feature to be in favourable condition, the conservation objective is for the feature to remain in favourable condition.

Natural change: This is defined as species or habitat changes which are not a result of anthropogenic influences. NRW consider anthropogenic influences to include climate change.

Natural variability: This is defined as species or habitat variability, which are not a result of anthropogenic influences. NRW consider anthropogenic influences to include climate change.

Restore: Where existing evidence from the most recent condition assessment suggests the feature, or part of the feature, to be in unfavourable condition the conservation objective is to return the feature to favourable condition. As the feature is being returned to favourable condition, further decline in the aspects of condition that are causing it to be unfavourable should be prevented. The ability to achieve favourable condition should not be inhibited.

Structure and function: Structure encompasses both the physical structure of a habitat feature (e.g. geology and morphology), together with the biological structure, including habitat forming species (both plant and animal) and species composition. Function encompasses the ecological processes influencing the habitat feature at different temporal and spatial scales.

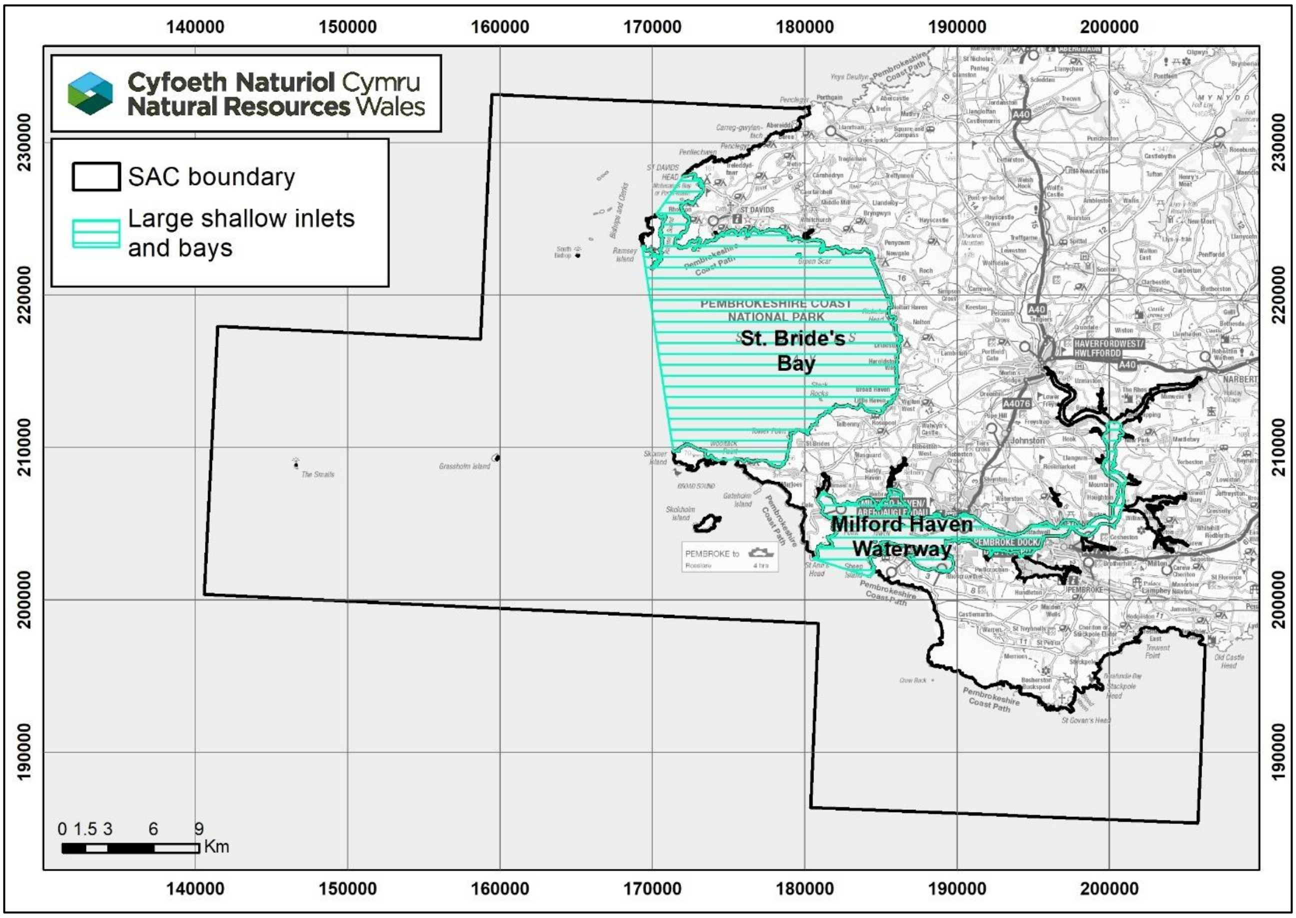
Unknown: Where there is not enough suitable evidence to conduct a condition assessment the feature is assigned an unknown condition.

3.1. Feature 1: Large shallow inlets and bays

The large shallow inlets and bays (LSIB) feature within Pembrokeshire Marine SAC is currently in **unfavourable** condition (medium confidence). NRW published the [latest condition assessment] in June 2025. NRW will review these conservation objectives when new condition assessment information is available.

Figure 2 is a map of the location of the LSIB feature within Pembrokeshire Marine SAC. The map is for illustrative purposes only. Detailed maps for this feature in Wales can be found on [Data Map Wales.]

Figure 2. Map of the large shallow inlets and bays feature within Pembrokeshire Marine SAC.



Below are the attributes and targets for each conservation objective alongside supporting information.

Objective 1: The overall distribution and extent of the large shallow inlets and bays feature within the SAC and each of its main component habitats are stable or increasing, subject to natural change.

Objective attribute	**Site specific target(s)**
1a. Feature extent and distribution	Maintain the extent and distribution of large shallow inlets and bays.
1b. Component habitat extent and distribution	Maintain the extent and distribution of component habitats and communities necessary for the structure and function of the large shallow inlets and bays feature. Restore the extent and distribution of the mearl bed necessary for the structure and function of the large shallow inlets and bays feature.

Supporting information

1a. Feature extent and distribution

The extent describes the presence and area of the feature across the whole site. The distribution describes the more detailed locations and patterns of different habitats that comprise the feature across the site. Two LSIBs make up the feature in the SAC. The embayment of St Brides Bay and the ria of Milford Haven.

St Brides Bay is a large, deeply indented, embayment located within a predominantly rocky coastline and is geographically isolated from very large bays to the north and the east (Carmarthen Bay and Cardigan Bay) by large headlands.

The lower Milford Haven waterway is also a LSIB and comprises part of the feature. This LSIB overlaps with the majority of the estuaries feature in the Milford Haven. The LSIB includes the main waterway channel from the confluence of the eastern and western Cleddau rivers to the entrance of the Haven between St Anne’s Head and Sheep Island. The majority of the tributary estuaries that feed into the main waterway are only included in the estuaries feature, with the exception of the bays at Angle Bay, Dale Bay and Sandy Haven which are also included in the LSIB feature.

The extent of the LSIB feature is judged to be favourable allowing a maintain target for objective 1a. See the latest condition assessment for more information (Jackson-Bué et al., 2025d).

1b. Component habitat extent and distribution

There are a variety of component habitats within the LSIBs of St Brides Bay and Milford Haven. For example, a large proportion of the seabed in both LSIBs have significant presence of the Annex 1 habitats, reefs, intertidal mudflats and sandflats and sea caves. The extent and distribution of the component habitats and communities needs to be maintained by sustaining suitable environmental conditions and limiting activities to which they may be sensitive to. The recovery of habitats will be influenced by the habitat type as well as the type and duration of impact.

There is an extremely wide range and complex mosaic of sediment habitats in St Brides Bay. Ranging from moderately and well sorted sands and muds to poorly sorted muddy gravels. Intertidal and subtidal reefs are also present throughout the bay, with a large horizontal reef in the southern part of bay (The Handmarks) that extends off West Dale Bay (outside of the LSIB feature).

As the Milford Haven LSIB feature partially overlaps with the estuaries feature, all habitats that are found with the LSIB and estuaries feature are included here, and only those that are found outside of the LSIB are included in the estuaries feature.

Milford Haven is the only example of a large ria in Wales and is the largest ria-estuary complex in the UK. Within Milford Haven, there is also a range of habitats, from rocky intertidal reef, intertidal mudflats and sandflats and subtidal sediment habitats. Of particular note is Wales' only maerl bed near South Hook and subtidal seagrass beds at Longoar Bay and between Littlewick and Milford Haven and along the Angle Peninsula. There are native oyster beds in certain areas of the Haven.

Further detail of the component habitats for the two LSIBs can be found in Appendix 1. All nested Annex I features are described in more detail under their individual feature Conservation Objectives.

The extent of the Milford Haven maerl bed within the feature has reduced dramatically between 2005 and 2023. This has resulted in the component habitat extent and distribution attribute failing to be met and a restore objective being set for objective 1b. The restore is specifically for the maerl bed. See the latest condition assessment for more information (Jackson-Bué et al., 2025d).

Objective 2: The hydro-morphological and chemical elements necessary for the structure and function of the large shallow inlets and bays feature are stable or improving, subject to natural change

Objective attribute	Site specific target(s)
2a. Water and sediment quality	Contaminants are at levels not detrimental to the structure and function of the large shallow inlets and bays feature. Nutrients are at levels not detrimental to the structure and function of the large shallow inlets and bays feature. Physicochemical characteristics are at levels not detrimental to the structure and function of the large shallow inlets and bays feature.
2b. Hydro-morphology	The characteristic hydrodynamics, sediment transport and morphology necessary for the structure and function of the large shallow inlets and bays feature are sustained.
2c. Sediment supply	The sediment type, size distribution and budget necessary for the structure and function of the large shallow inlets and bays feature are sustained

Supporting information

2a. Water and sediment quality

Various contaminants are known to affect species living within the water column and in or on the surface of sediments. The biological effect of a contaminant will vary depending on its nature. Contaminants include, but are not limited to, heavy metals (e.g. mercury and zinc), Polybrominated diphenol ethers (PBDEs), poly-aromatic hydrocarbons (PAHs), poly-chlorinated biphenyls (PCBs) and organotin and pesticides such as hexachlorobenzene. These chemicals (e.g. heavy metals) can degrade community structure and bioaccumulate within organisms, entering the marine food chain (e.g. PCBs) (OSPAR Commission, 2012)

High concentrations of nutrients (nitrogen and phosphorus) in the water column can cause phytoplankton and opportunistic macroalgae blooms. These blooms can lead to reduced dissolved oxygen availability especially in warmer months. This can have lethal and sub-lethal impacts on sensitive fish, epifauna and infauna communities (Best et al., 2007).

Physicochemical characteristics include salinity, pH, temperature, dissolved oxygen and turbidity. They affect habitats in terms of the abundance, distribution and composition of communities present. Changes in any of these properties, because of anthropogenic activities, may impact habitats and the communities they support.

Significant water and sediment quality issues have been identified for this feature. Information on water and sediment quality can be found in the latest condition assessment (Jackson-Bué et al., 2025d).

2b. Hydro-morphology

Hydro-morphology refers to patterns of water movement (caused by waves, wind, tides and fluvial input), coastal processes (e.g. erosion and deposition), and the physical characteristics of the environment. Waves and currents move sediment, which can change the shape of the seabed, which in turn can change the waves and the currents; meaning there is two-way feedback between the hydrodynamics and the morphology. As water movement transports nutrients, sediment and other particles, it also strongly influences the species and communities present.

Tidal streams within St Brides Bay are generally weak, however the SAC feature incorporates Ramsey Sound, where tidal flows are strong. Wave exposure varies within St Brides Bay, with the northern portion generally more exposed than the southern flank of the bay. The SAC feature includes Whitesands Bay to the north, which is moderately wave exposed, and where waves are strongly tidally modulated by flows through Ramsey Sound.

The Milford Haven ria has variable wave exposure: while the entrance is fully exposed, the narrow shape means that Dale Roads at the western end has a mean wave height of 0.57m (Neill et al., 2023) and further east into the ria wave heights reduce further. Detail of local sediment processes in open coast bays is not well known, though the Handmarks reef in the southern part of St Brides Bay has a strong influence on water movement and sediment distribution. A change in these environmental conditions could detrimentally affect the quality and variety and therefore functions of the various habitats in the LSIB.

Some hydro-morphology issues have been identified for this feature. See the latest condition assessment for information (Jackson-Bué et al., 2025d). Information on the hydro-morphology of the SAC can be found in Appendix 1.

2c. Sediment supply

Sedimentary habitats are subject to a range of deposition and erosion processes, which anthropogenic activity can influence. The size, shape, quantity and characteristics of sediments are important to the structure and function of the feature. Sediment type strongly influences the species present within a community, for example muddy areas are highly productive, containing high levels of organic material.

The sedimentology of the LSIB is variable throughout the site, depending on aspect, coastal topography, shore morphology, wave exposure and sediment budget present. Maintaining the natural sediment transport pathways (both quantity and sediment grain size) is important to ensure maintenance of the morphology and sediment type. Sediment budgets and transport are often on a regional scale, and therefore projects outside the SAC can still alter the sediment supply to features within the site.

Sediment type will also determine whether contaminants can accumulate. Mobile, loosely aggregated sands will not accumulate contaminants unlike muddy sediments. Activities that disturb sediments can release contaminates back into the water column.

No sediment supply issues have been identified for this feature. See the latest condition assessment for information (Jackson-Bué et al., 2025d). Information on the sediment transport in the SAC can be found in Appendix 1.

Objective 3: The abundance, distribution and diversity of species within component habitats and communities necessary for the structure and function of the feature are stable or improving, subject to natural variability.

Objective attribute	**Site specific target**
3a. Habitats and communities	Restore the abundance, distribution and diversity of species within component habitats and communities necessary for the structure and function of the large shallow inlets and bays feature.
3b. Invasive and non-native species	Introduction or spread of new non-native species to the SAC by anthropogenic activities should not have a detrimental impact on the structure and function of the large shallow inlets and bays feature.

Supporting information

3a. Habitats and communities

There are a variety of component habitats within the LSIBs of St Brides Bay and Milford Haven. With a large proportion of the seabed in both bays comprised of Annex 1 habitats (reefs, intertidal mudflats and sandflats and sea caves). The wide variety of habitats and hydro-morphological conditions across both LSIBs in the SAC create high species diversity that varies greatly between and within habitats. St Brides Bay and the Milford Haven LSIB both support an important, diverse and productive fish community across the range of habitat types present (ICES, 2024; Ellis et al., 2012). General information on the habitats and communities can be found in Appendix 1.

All the communities within the LSIB feature contribute to the overall representation, range and condition of the feature within the SAC. However, there are some notable habitats and their associated assemblages of marine plants and animals are of particular conservation importance. Due to overlap of features, the habitats and communities listed below occur in both the LSIB and estuaries feature.

- Seagrass beds (Zostera marina and *Z noltei*)
- Maerl bed in Milford Haven
- Tide-swept channels
- Sheltered muddy gravel communities
- Blue mussel beds (*Mytilus edulis*)

- Native oyster beds (*Ostrea edulis*)
- Communities of anthozoans, notably pink sea fans, sponges and bryozoans.

For more information on communities of the LSIB feature see Appendix 1. Information on habitats and communities of Annex I features found within the LSIB can be found in the corresponding conservation objectives.

The latest condition assessment found declines in species abundance, distribution and diversity in multiple component habitats and communities. This resulted in the habitats and communities attribute failing to be met and a restore target being set for objective 3a. For further information on the habitats and communities affected and the locations see the latest condition assessment (Jackson-Bué et al., 2025d).

3c. Invasive and non-native species

Non-native species (NNS) may become invasive non-native species (INNS) and displace native species by predating them or out-competing them for food, space or both. This can lead to the loss of indigenous species from certain areas or changes to community structure (JNCC, 2004b; Levin et al., 2002), as well as changes to biotope and habitat type. The introduction or spread of NNS within the SAC can occur through various regulated and unregulated pathways. As Milford Haven Waterway contains a busy international port, it is likely to account for the high concentrations of INNS in this area. Further information on introduction pathways can be found on the GB non-native species secretariat website.

The slipper limpet *Crepidula fornicata*, is widespread and often in high numbers especially in Milford Haven Waterway, with occasional records in St Brides Bay. Other species within Milford Haven include the Red ripple bryozoan *Watersipora subatra*, Devil’s tongue weed *Grateloupia turuturu*, Compass sea squirt *Asterocarpa humilis*, American jack knife clam *Ensis leei* and Pacific oyster *Magallana gigas*.

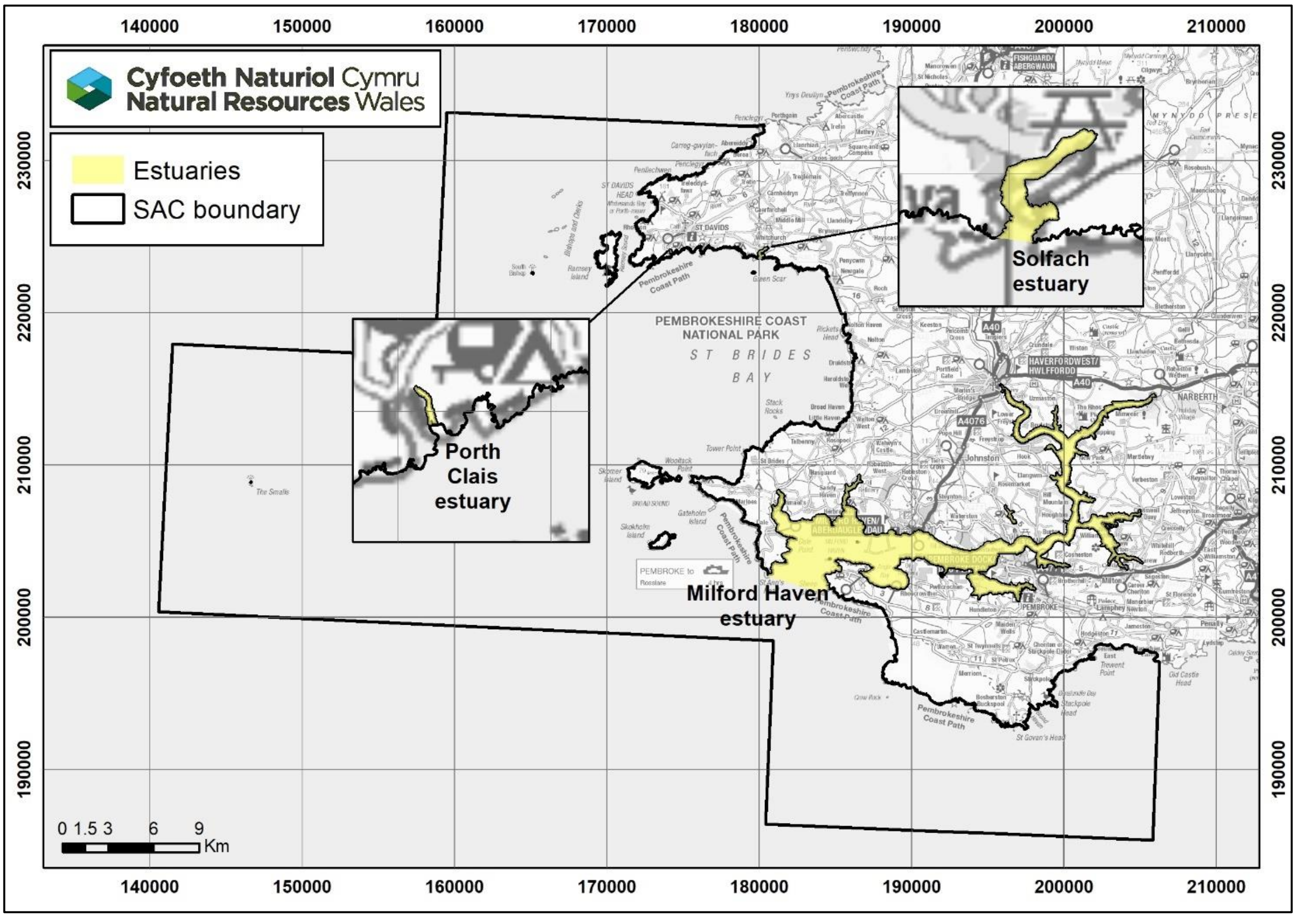
The carpet sea squirt *Didemnum vexillum* was found in Milford Haven in 2023 (NRW 2023). This INNS is of significant concern as it can spread rapidly, growing over and smothering benthic habitats. It may threaten extensive areas of reef habitat within the feature. More information on impacts of INNS species can be found in the latest condition assessment (Jackson-bué et al., 2025d).

3.2. Feature 2: Estuaries

The estuaries feature within Pembrokeshire Marine SAC is currently in **unfavourable** condition (medium confidence). NRW published the latest condition assessment in June 2025. NRW will review these conservation objectives when new condition assessment information is available.

Figure 3 is a map of the location of the estuaries feature within Pembrokeshire Marine SAC. The map is for illustrative purposes only. Detailed maps for this feature in Wales can be found on Data Map Wales.

Figure 3. Map of the estuaries feature within Pembrokeshire Marine SAC.



Below are the attributes and targets for each conservation objective alongside supporting information.

Objective 1: The overall distribution and extent of the estuaries feature within the SAC and each of its main component habitats are stable or increasing, subject to natural change.

Objective attribute	Site specific target
1a. Feature extent and distribution	Maintain the extent and distribution of estuaries, subject to natural change.
1b. Component habitat extent and distribution	Restore the extent and distribution of component habitats and communities necessary for the structure and function of the estuaries feature.

Supporting information

1a. Feature extent and distribution

The extent describes the presence and area of the habitat across the whole site, even where it is patchy. The distribution describes the more detailed locations and patterns of different habitats that comprise the feature across the site.

The estuaries feature within Pembrokeshire Marine SAC comprises of the large ria estuary in the Milford Haven Waterway estuaries complex and two small estuaries; the Afon Alun estuary at Porth Clais and the Solfach estuary in the north of St Brides Bay.

Milford Haven is the only large ria estuary in Wales and the largest in the UK. As noted in the LSIB Objective 1a, there is large overlap with the LSIB feature. The estuaries feature includes the eastern and western Cleddau, the tributary estuaries of Garron Pill; Carew / Cresswell Rivers; Cosheston Pill; Pembroke River; The Gann and Sandy Haven Pill. It includes the main channel of the waterway from Dale Point in the north and Thorn Island in the south. It is approximately 170 km long with an area of around 55 km2 of which approximately 30% is intertidal.

The extent and distribution attribute has been met, allowing a maintain target for objective 1a. See the latest condition assessment for more information (Jackson-Bué et al., 2025c).

1b. Component habitat extent and distribution

The Milford Haven Waterway estuaries complex is a system comprised of different component habitats, some of which are designated Annex I features. Extensive areas of intertidal mudflats and sandflats, Atlantic salt meadows, and reefs form a mosaic throughout the feature. Annex II species of allis and twaite shad, sea and river lamprey, and otter may use the feature for passage and / or feeding. Grey seal occasionally can be seen in the estuary as well.

There are an exceptionally wide range of sediment habitats, including large quantities of coarse, stony and (molluscan) shell debris material in both the intertidal and subtidal. In addition to the habitats and biological communities described in the LSIB feature, the Estuaries feature includes,

- Extensive intertidal mudflats that are found within the tributaries that feed into the main Milford Haven Waterway. These are often fringed by saltmarsh, but can also include areas of bedrock and mixed substrata. A more comprehensive description of the mudflats and saltmarsh can be found in the Atlantic salt meadows and intertidal mudflat and sandflat features.
- Blue mussel beds. These are found in various locations, including Lawrenny Quay and within Pembroke River and Carew River.

Component habitats of the feature need to be maintained by sustaining suitable environmental conditions and limiting activities to which they may be sensitive to. The recovery of habitats will be influenced by the habitat type as well as the type and duration of impact.

Further detail of the component habitats for the Milford Haven Waterway estuaries complex can be found in Appendix 1. There is currently no information on the habitats and communities of the other estuaries in the SAC. All nested Annex I features are described in more detail under their individual feature Conservation Objectives.

The extent of the Milford Haven maerl bed within the feature has reduced dramatically between 2005 and 2023. This has resulted in the component habitat extent and distribution attribute failing to be met and a restore objective being set for objective 1b. The restore is specifically for the maerl bed. See the latest condition assessment for more information (Jackson-Bué et al., 2025c).

Objective 2: The hydro-morphological and chemical elements necessary for the structure and function of the estuaries feature are stable or improving, subject to natural change.

Objective attribute	**Site specific target(s)**
2a. Water and sediment quality	Contaminants are at levels not detrimental to the structure and function of the estuaries feature. Nutrients are at levels not detrimental to the structure and function of the estuaries feature. Physicochemical characteristics are at levels not detrimental to the structure and function of the estuaries feature.
2b. Hydro-morphology	The characteristic hydrodynamics, sediment transport and morphology necessary for the structure and function of the estuaries feature are sustained.
2c. Sediment supply	The sediment type, size distribution and budget necessary for the structure and function of the estuaries feature are sustained.
2d. Freshwater flow	The freshwater flow and volume into the estuary necessary for the structure and function of the estuaries feature is sustained.

Supporting information

2a. Water and sediment quality

Various contaminants are known to affect species living within the water column and in or on the surface of sediments. The biological effect of a contaminant will vary depending on its nature. Contaminants include, but are not limited to, heavy metals (e.g. mercury and zinc), Polybrominated diphenol ethers (PBDEs), poly-aromatic hydrocarbons (PAHs), poly-chlorinated biphenyls (PCBs) and organotin and pesticides such as hexachlorobenzene. These chemicals (e.g. heavy metals) can degrade community structure and bioaccumulate within organisms, entering the marine food chain (e.g. PCBs) (OSPAR Commission, 2012).

High concentrations of nutrients (nitrogen and phosphorus) in the water column can cause phytoplankton and opportunistic macroalgae blooms. These blooms can lead to reduced dissolved oxygen availability especially in warmer months. This can have lethal and sub-lethal impacts on sensitive fish, epifauna and infauna communities (Best et al., 2007).

Physicochemical characteristics include salinity, pH, temperature, dissolved oxygen and turbidity. They affect habitats in terms of the abundance, distribution and composition of communities present. Changes in any of these properties, because of anthropogenic activities, may impact habitats and the communities they support.

Significant water and sediment quality issues have been identified for this feature. Information on water and sediment quality can be found in the latest condition assessment (Jackson-Bué et al., 2025c).

2b. Hydro-morphology

Hydro-morphology refers to patterns of water movement (caused by waves, wind, tides and fluvial input), coastal processes (e.g. erosion and deposition), and the physical characteristics of the environment. Waves and currents move sediment, which can change the shape of the seabed, which in turn changes waves and currents; in other words there is two-way feedback between the hydrodynamics and the morphology. As water movement transports nutrients, sediment and other particles, it also strongly influences the species and communities present.

Estuaries are complex dynamic systems that have a natural tendency to accumulate sediment. The width and depth of the estuary may change over time towards a state of dynamic equilibrium or “most probable state”. This equilibrium is a balance of tidal prism (volume of water leaving an estuary between high and low tide), current velocities and erosion/ depositional thresholds of the local sediment. A change in these environmental conditions could detrimentally affect the quality and variety and therefore functions of the various habitats in the estuaries.

Further detail on hydrodynamics, sediment transport and morphology of the Milford Haven Waterway estuaries complex can be found in Appendix 1. No hydro-morphology issues have been identified for this feature. See the latest condition assessment for information (Jackson-Bué et al., 2025c).

2c. Sediment supply

Sedimentary habitats are subject to a range of deposition and erosion processes, which anthropogenic activity can influence. The size, shape, quantity and characteristics of sediments are important to the structure and function of the feature. Sediment type strongly influences the species present within a community, for example muddy areas are highly productive, containing high levels of organic material.

The sedimentology of the estuaries is variable throughout and between site, depending on the available marine sediment, terrestrial sediment input from rivers and wave and tidal conditions. Maintaining the natural sediment transport pathways (both quantity and sediment grain size) is important to ensure maintenance of the morphology and sediment type. Sediment budgets and transport often operate on a regional scale, and therefore projects outside the SAC can still alter the sediment supply to features within the site.

Sediment type will also determine whether contaminants can accumulate. Mobile, loosely aggregated sands will not accumulate contaminants unlike muddy sediments. Activities that disturb sediments can release contaminants back into the water column.

No sediment supply issues have been identified for this feature. See the latest condition assessment for information (Jackson-Bué et al., 2025c). Information on the sediment transport in the SAC can be found in Appendix 1.

2d. Freshwater flow

The rate, quantity and variability of freshwater flow influences the salinity of an estuary, levels of stratification, location of the turbidity maximum and associated variation in suspended sediment concentrations, and flux of contaminants out to sea. Levels of salinity and turbidity can influence the species and communities present.

For the Milford Haven Waterway estuaries complex, the freshwater input is low compared to the total estuary volume; however, the long and narrow nature of the estuary means freshwater input and associated variation in salinity is important in the upper reaches. The Afon Alun and Solfach estuaries are both much smaller sized estuaries and fed by small streams; these estuaries dry significantly at low tide and so the significance of freshwater will be tidally variable.

No freshwater flow issues have been identified for this feature. See the latest condition assessment for information (Jackson-Bué et al., 2025c).

Objective 3: The abundance, distribution and diversity of species within component habitats and communities necessary for the structure and function of the estuaries feature are stable or improving, subject to natural variability.

Objective attribute	Site specific target
3a. Habitats and communities	Restore the abundance, distribution and diversity of species within component habitats and communities necessary for the structure and function of the estuaries feature.
3c. Invasive and non-native species	Introduction or spread of new non-native species to the SAC by anthropogenic activities should not have a detrimental impact on the structure and function of the estuaries feature.

Supporting information

3a. Habitats and communities

The species richness of the Milford Haven Waterway estuaries complex is extremely high. This is in part due to the range and variety of habitats and the waterway's biogeographical position in a region of overlap between northern and southern species distribution. Habitat maps exist for the Solfach and Afon Alun estuaries but they are not monitored for this objective.

Extensive areas of designated Annex I features, intertidal mudflats and sandflats, Atlantic salt meadows, and reefs form a mosaic throughout the feature. While all the communities within the estuaries contribute to the overall representation, range and condition of the feature within the SAC there are some notable habitats and their associated assemblages of marine plants and animals are of particular conservation importance. As the majority of the estuaries feature the Milford Haven Waterway estuaries complex overlaps with the LSIB feature, only those habitats and communities that do not occur in the LSIB are listed below. For other notable communities see objective 3a in LSIBs.

- Wide, horizontal intertidal mudflats. Fringing the estuaries draining into the main waterway support abundant and productive invertebrate (mainly annelid and mollusc) communities (see mudflats and sandflats feature).
- Muds typically supporting a greater biomass than other intertidal sediments, the abundance of bivalve and polychaete species being particularly high.

More information on the estuaries communities can be found in Appendix 1. Information on habitats and communities of Annex I features found within the estuaries feature can be found in the corresponding conservation objectives.

The latest condition assessment found declines in species abundance, distribution and diversity in multiple component habitats and communities. This resulted in the habitats and communities attribute failing to be met and a restore target being set for objective 3a. For further information on the habitats and communities affected and the locations see the latest condition assessment (Jackson-Bué et al., 2025c).

3c. Invasive and non-native species

Non-native species (NNS) may become invasive non-native species (INNS) and displace native species by predating them or out-competing them for food, space or both. This can lead to the loss of indigenous species from certain areas or changes to community structure (JNCC, 2004b; Levin et al., 2002), as well as changes to biotope and habitat type. The introduction or spread of NNS within the SAC can occur through various regulated and unregulated pathways. As Milford Haven Waterway contains a busy international port, it is likely to account for the high concentrations of INNS in this area. Further information on introduction pathways can be found on the GB non-native species secretariat website.

The slipper limpet *Crepidula fornicata*, is widespread and often in high numbers especially in Milford Haven Waterway, with occasional records in St Brides Bay. Other species within Milford Haven include the Red ripple bryozoan *Watersipora subatra,* Devil's tongue weed *Grateloupia turuturu*, Compass sea squirt *Asterocarpa humilis*, American jack knife clam *Ensis leei* and Pacific oyster *Magallana gigas*.

The carpet sea squirt *Didemnum vexillum* was found in Milford Haven in 2023 (NRW, 2023). This INNS is of significant concern as it can spread rapidly, growing over and smothering benthic habitats. It may threaten extensive areas of reef habitat within the feature. More information on impacts of INNS species can be found in the latest condition assessment (Jackson-bué et al., 2025c).

3.3. Feature 3: Reefs

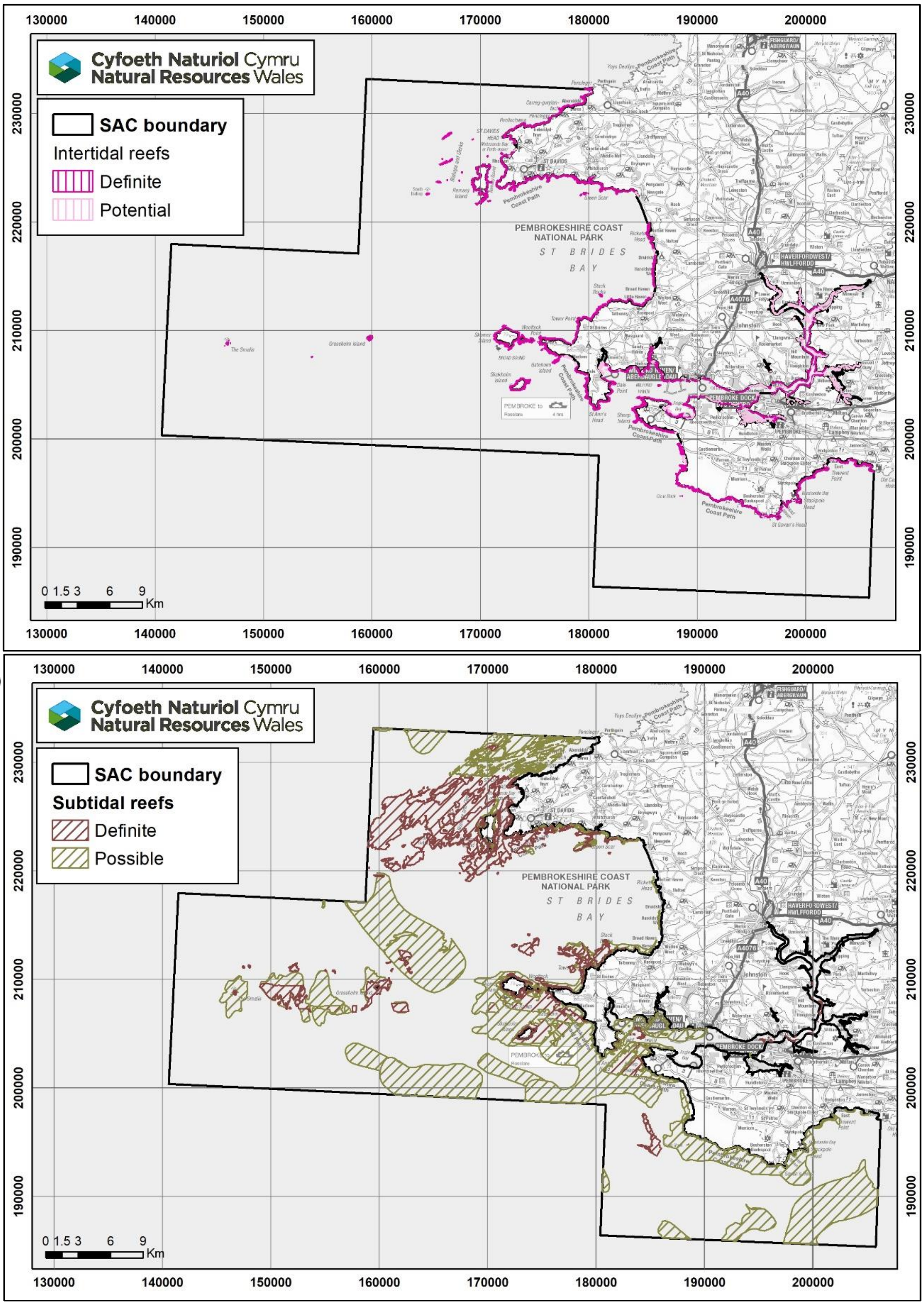
Reefs in the Pembrokeshire Marine SAC is currently in **unfavourable** condition (medium confidence). NRW published the latest condition assessment in June 2025. NRW will review these conservation objectives when new condition assessment information is available.

Figure 4 is a map of the location of the reefs feature within Pembrokeshire Marine SAC. The map is for illustrative purposes only. Detailed maps for this feature in Wales can be found on Data Map Wales.

Figure 4. Map of the reefs feature within Pembrokeshire Marine SAC. a) intertidal reefs and b) Subtidal reefs.

a)

b)



Below are the attributes and targets for each conservation objective alongside supporting information.

Objective 1: The overall distribution and extent of the reefs feature within the SAC and each of its main component habitats are stable or increasing, subject to natural change.

Objective attribute	Site specific target
1a. Feature extent and distribution	Maintain the extent and distribution of the reefs feature and reef types, subject to natural change.
1b. Component habitat extent and distribution	Maintain the extent and distribution of the component habitats and communities necessary for the structure and function of the reefs feature.

Supporting information

1a. Feature extent and distribution

The extent describes the presence and area of the habitat across the whole site, even where it is patchy. The distribution describes the more detailed locations and patterns of different habitats that comprise the feature across the site. The reefs feature occurs throughout the entire SAC in intertidal and subtidal areas.

Much of the intertidal zone is reef habitat, particularly along the open coast. Extensive areas of sublittoral rocky reefs stretch offshore from the west Pembrokeshire coast and around the islands and many small rocky islets. There are large, isolated reefs and islets immediately offshore of both the north and south coasts of St. Brides Bay. West Dale Bay and the south-eastern coast of Freshwater West predominantly comprise reef habitat and the Handmarks is a major extensive horizontal reef in the southern part of St. Brides Bay.

The Milford Haven Waterway has a variety of sizes and shapes of reefs at different depths including large, extensive and smaller discrete reefs such as the Mid-channel and Chapel Rocks complex and Stack Rocks. As reefs are predominately a feature of exposed coasts, the range of reefs in the sheltered conditions of the Milford Haven waterway is exceptional. For geographically defined areas of reefs that may be considered recognisable within the SAC, see Appendix 1.

Rock types forming reefs within the SAC include extensive areas of igneous rock, relatively friable old red sandstone and limestone. Habitat variety is increased by the presence of rock types that favour rock-boring and crevice-dwelling species. Rock folding, faulting, fracturing and the variability of erosion underlie the complex and ecologically important reef geomorphology within the SAC. Reef types need to be maintained by sustaining suitable environmental conditions and limiting activities to which they may be sensitive.

The extent and distribution attribute has been met, allowing a maintain target to be set for objective 1a. See the latest condition assessment for more information (Jackson-Bué et al., 2025b).

1b. Component habitat extent and distribution

Several reef types can be distinguished within the SAC but only their broad distribution is known. There are few comparable areas in UK with such a range and extent of reef habitats exposed to such extreme wave exposure and tidal streams as Pembrokeshire Marine SAC. Specific broadly defined combinations include:

- reefs exposed to both strong to very strong tidal streams and exposed to strong wave action (Grassholm, The Smalls, Bishops and Clerks, Hats and Barrels reef).
- reefs exposed to strong to very strong tidal streams and sheltered from wave action (Milford Haven).
- reefs sheltered from tidal streams and exposed to strong to very strong wave action and surge (particularly inlets and caves on Ramsey and Skomer islands and Castlemartin coast).
- reefs sheltered from strong water movement. Deep sheltered reef off north and east coasts of islands and within bays; Milford Haven waterway.

Surveys for development consenting have highlighted that there are areas of Stony reef to the entrance of Milford Haven and the potential for Ross worm (*Sabellaria spinulosa*) reefs. The extent and quality of these is relatively unknown. Blue mussel beds are found in within the LSIB and estuaries feature covered under these objectives.

The component habitat extent and distribution attribute is being met, allowing a maintain target to be set for objective 1b. See the latest condition assessment for more information (Jackson-Bué et al., 2025b).

Objective 2: The hydro-morphological and chemical elements necessary for the structure and function of the reefs feature are stable or improving, subject to natural change.

Objective attribute	**Site specific target(s)**
2a. Water and sediment quality	Contaminants are at levels not detrimental to the structure and function of the reefs feature. Nutrients are at levels not detrimental to the structure and function of the reefs feature. Physicochemical characteristics are at levels not detrimental to the structure and function of the reefs feature.
2b. Hydro-morphology	The characteristic hydrodynamics, sediment transport and morphology necessary for the structure and function of the reefs feature are sustained.
2c. Sediment supply	The sediment type, size distribution and budget necessary for the structure and function of the reefs feature are sustained.

Supporting information

2a. Water and sediment quality

Various contaminants are known to affect species living within the water column and in or on the surface of sediments. The biological effect of a contaminant will vary depending on its nature. Contaminants include, but are not limited to, heavy metals (e.g. mercury and zinc), Polybrominated diphenol ethers (PBDEs), poly-aromatic hydrocarbons (PAHs), poly-chlorinated biphenyls (PCBs) and organotin and pesticides such as hexachlorobenzene. These chemicals (e.g. heavy metals) can degrade community structure and bioaccumulate within organisms, entering the marine food chain (e.g. PCBs) (OSPAR Commission, 2012).

High concentrations of nutrients (nitrogen and phosphorus) in the water column can cause phytoplankton and opportunistic macroalgae blooms. These blooms can lead to reduced dissolved oxygen availability especially in warmer months. This can have lethal and sub-lethal impacts on sensitive fish, epifauna and infauna communities (Best et al., 2007). Overgrowth of opportunistic macroalgae species because of increased nutrient input on intertidal reef can reduce biodiversity, though the effect of grazers and wave action can help limit the impacts (Bokn et al., 2003; Worm and Lotze, 2006). High nutrient loads may be more of an issue on sheltered intertidal reef with low grazing pressure (Bokn et al., 2003).

Physicochemical characteristics include salinity, pH, temperature, dissolved oxygen and turbidity. They affect habitats in terms of the abundance, distribution and composition of communities present. Changes in any of these properties, because of anthropogenic activities, may impact habitats and the communities they support.

Significant water and sediment quality issues have been identified for this feature. Information on water and sediment quality can be found in the latest condition assessment (Jackson-Bué et al., 2025b).

2b. Hydro-morphology

Hydro-morphology refers to patterns of water movement (caused by waves wind and tides), coastal processes (e.g. erosion and deposition), and the physical characteristics of the environment. Waves and currents move sediment, which can change the shape of the seabed, which in turn can change the waves and the currents; meaning there is two-way feedback between the hydrodynamics and the morphology. As water movement transports nutrients, sediment and other particles, it also strongly influences the species and communities present.

Many anthropogenic activities can change the hydrodynamic and sediment transport process. For example, changes to depth or the introduction of barriers (including energy extraction) can change the speed of currents and the degree of wave exposure. While dredging and construction can have large, though short lived, increases in the volume of sediment deposited on a habitat.

Morphology of hard substrata reefs is unlikely to change without direct anthropogenic action (e.g. construction or demolition). Cobble and boulder reef morphology can also be altered by large wave events. Biogenic reef morphology can be affected by changes to the nutrient, food or sediment supply required for their maintenance, as well as storm events or anthropogenic activity. A change in these environmental conditions could detrimentally affect the quality and variety and therefore functions of the various habitats in the reefs feature.

No hydro-morphology issues have been identified for this feature. See the latest condition assessment for information (Jackson-Bué et al., 2025b). Information on the hydro-morphology of the SAC can be found in Appendix 1.

2c. Sediment supply

Sediment type, distribution and supply are important in determining the species and communities present in a habitat. The rate at which sediment is deposited is known to influence reef habitats and their associated communities. Sedimentation influences community composition, alters species growth rates, inhibits feeding or photosynthesis and potentially reduces larval recruitment. High levels of sediment deposition could lead to smothering or burying of sessile benthic species.

Sediment supply is important for reef forming Sabellaria species, as tube growth is dependent on the presence of suspended particles. A reduction in sediment transport may reduce the amount of sediment available for tube construction. Conversely an increase in sediment may facilitate tube building but clog up feeding apparatus. Subtidal Sabellaria reef has been found in the areas offshore of the mouth of Milford haven, though it is unclear what the extent and quality of this habitat are.

Sediment budgets and transport are often on a regional scale, and therefore projects outside the SAC can still alter the sediment supply to features within the site. No sediment supply issues have been identified for this feature. See the latest condition assessment for information (Jackson-Bué et al., 2025b). Information on the sediment transport in the SAC can be found in Appendix 1.

Objective 3: The abundance, distribution and diversity of species within component habitats and communities necessary for the structure and function of the reefs feature are stable or improving, subject to natural variability.

Objective attribute	**Site specific target**
3a. Habitats and communities	Restore the abundance, distribution and diversity of species within component habitats and communities necessary for the structure and function of the reefs feature.
3c. Invasive and non-native species	Introduction or spread of new non-native species to the SAC by anthropogenic activities should not have a detrimental impact on the structure and function of the reefs feature.

Supporting information

3a. Habitats and communities

The wide range of substrate type, topography, depth, wave and tidal current exposures, and light are major contributors to high species diversity on the reefs of Pembrokeshire Marine SAC. Changes to the spatial distribution of species and communities across the feature could highlight changes to the overall feature.

An enormous variety of different marine animals and plants together make up communities associated with the reefs feature. Intertidally, communities show patterns of vertical zonation from the top to the bottom of the shore, reflecting differing tolerances to uncovering by the tide and desiccation. Subtidally, reef communities show zonation from shallow subtidal areas into deeper water. In shallow areas, rocky reefs generally support different types of seaweed community dominated by kelps and other brown or red seaweeds. In deeper water they are dominated by animal species such as sponges, sea anemones, sea squirts, hydroids, bryozoans and molluscs. Varied assemblages of mobile species such as fish, crabs and other species are also part of the reef communities.

All the communities within the reef feature contribute to the overall representation, range and condition of the feature within the SAC. There are, however, some notable habitats and their associated assemblages of marine plants and animals that are of particular conservation importance, namely,

- reefs exposed to both strong to very strong tidal streams and exposed to strong wave action.
- reefs exposed to strong to very strong tidal streams and sheltered from wave action.
- reefs sheltered from tidal streams and exposed to strong to very strong wave action and surge.
- reefs sheltered from strong water movement.

The following are also important habitat communities within the SAC:

- Kelp beds (forests and parks)
- Underboulder communities
- Fragile sponge and anthozoan communities
- Tide swept channel communities
- *Sabellaria spinulosa* reefs and stony reef
- Blue Mussels beds

See Appendix 1 for more information on each of these and reef communities in general.

The latest condition assessment found declines in species abundance and diversity in habitats and communities in multiple subtidal reef sites. The habitats and communities attribute is failing to be met, resulting in a restore target being set for objective 3a. The restore is specifically for the declines seen in the subtidal reef of the feature. For information on these declines see the latest condition assessment (Jackson-bué et al., 2025b).

3c. Invasive and non-native species

Non-native species (NNS) may become invasive non-native species (INNS) and displace native species by predating them or out-competing them for food, space or both. This can lead to the loss of indigenous species from certain areas or changes to community structure (JNCC, 2004b; Levin et al., 2002), as well as changes to biotope and habitat type. The introduction or spread of NNS within the SAC can occur through various regulated and unregulated pathways. As Milford Haven Waterway contains a busy international port, it is likely to account for the high concentrations of INNS in this area Further information on introduction pathways can be found on the [GB non-native species secretariat website.]

Within Milford Haven the Red ripple bryozoan *Watersipora subatra* has been recorded Dale at Jetty Beach, South Hook and Pembroke Power station in 2023. Wakame *Undaria pinnatifida* is recorded on Skomer and Skokholm and the Leathery sea squirt *Styela clava* on Skomer / Marloes. The carpet sea squirt *Didemnum vexillum* was found in Milford Haven on intertidal boulder and cobble reefs at Neyland and Carr Rocks in 2023 and 2024 (NRW 2024). At the time of the latest condition assessment it has not been recorded on subtidal reef. This INNS is of significant concern as it can spread rapidly, growing over and smothering benthic habitats. It may threaten extensive areas of reef habitat in the site. More information on impacts of INNS species can be found in the latest condition assessment (Jackson-bué et al., 2025b).

3.4. Feature 4: Grey sea *Halichoerus grypus*

The grey seal *Halichoerus grypus* feature within Pembrokeshire Marine SAC is currently in **favourable** condition (medium confidence). NRW published the latest condition assessment in June 2025. NRW will review these conservation objectives when new condition assessment information is available. Below are the attributes and targets for each conservation objective alongside supporting information.

Objective 1: The grey seal population using the SAC is maintained in favourable condition and stable or increasing over the medium and long term.

Objective attribute	**Site specific target**
1a. Population using the SAC	Maintain the grey seal population that use the SAC in favourable condition, and stable or increasing in the medium and long term.
1b. SAC pup production	Maintain a stable or increasing grey seal pup production within the SAC in the medium and long term, including at important pupping sites.

Supporting information

1a. Population using the SAC

For the purposes of this objective, medium and long term have been defined as 10 and 20 years respectively.

Based on pup production estimates, Wales hosts around 3-4% of the UK's grey seals (SCOS, 2022). The Pembrokeshire coast contains the main grey seal colonies in Wales and the Irish and Celtic Seas region (SW British Isles) it's the most southerly in Europe of any significant size (Baines et al., 1995).

Grey seals within Pembrokeshire Marine SAC are considered part of the wider regional population, which is not isolated, but extends from the west coast of Scotland to France (SCOS, 2013; Carter et al., 2022; Langley et al., 2020; Pomeroy et al., 2014; Russel et al., 2017; Sayer et al., 2019).

An estimated 2,250 pups are born per year in Wales (Russell and Morris, 2020), though there is some uncertainty around this value (Thompson, in prep). Pup production at regularly monitored sites in Wales has increased markedly since monitoring began (Bull et al., 2017; Morgan et al., 2018; Robinson et al., 2023). This reflects similar regional and UK wide increases (SCOS, 2022).

Summer haul out census data obtained via aerial survey in 2023 estimated the grey seal population in Wales to be 5,284 individuals, + or -: 4,571- 6,195 (Thompson, in prep). This is thought to be an increase in the population (Thompson, in prep).

The population relevant to, and using, the SAC is judged to be doing well and assumed stable. The population using the site attribute is being met, allowing a maintain target to be set for objective 1a. Further detail on the wider population can be found in the latest condition assessment (Cuthbertson et al., 2025c).

1b. SAC pup production

There are three monitored colonies (pupping areas) in the SAC: Skomer MCZ (which includes the Marloes peninsula), Ramsey Island and Castlemartin Range SSSI. These colonies are used as proxies to give SAC pup production figures for the whole SAC. It is important that production at each colony remains stable or increases even if distribution of pupping across the SAC and/or total SAC pup production remains stable. Declines in production at individual colonies could indicate issues of concern, such as breeding seals being subject to disturbance at these pupping sites.

Pup production in Pembrokeshire Marine SAC has seen an upward trend since 2008 to 2024, though there are signs this trend is starting to level off (Büche and Bond, 2024; Bull et al., 2021). It is accepted that pup production across the whole SAC is likely to have followed that of monitored colonies and increased or at the least remained stable. The SAC pup production indicator is being met, allowing a maintain target to be set for objective 1b. For more information see the latest condition assessment (Cuthbertson et al., 2025c).

Objective 2: The grey seal population that use the SAC continue to have access to, and be able to utilise habitats necessary to maintain the population in favourable condition.

Objective attribute	**Site specific target**
2a. Distribution of grey seal pupping sites within the SAC	Maintain a stable or increasing distribution of grey seal pupping across the SAC. Allowing for natural change and variation.
2b. Accessibility to habitat used by seals	Grey seal that use the SAC should not be significantly constrained from accessing necessary habitats within or outside of the site.
2c. Anthropogenic disturbance	Grey seal that use the SAC should not be subject to significant anthropogenic disturbance within or outside of the site.

Supporting information

2a. Distribution of grey seal pupping sites within the SAC

Pupping takes place throughout the site on the coast where there is suitable habitat i.e. physically inaccessible, remote and/or undisturbed rocky coast beaches, coves and caves. Unusually for the species, about 42% of pupping sites in West Wales contain caves which host pups (Baines et al., 1995).

The distribution of pupping sites across the SAC is likely to reflect influencing factors impacting on seals, both positive and negative. Monitoring seal pupping distribution can help identify areas that are important to breeding seals, and enable sites to be managed for impacts where needed (JNCC, 2005). Impacts are most likely to be managed when they are anthropogenic rather than natural. Physical processes may alter the availability of some sites (e.g. rock falls caused by storms), but are considered to be part of the natural variation.

Any changes in the distribution of breeding seals across the SAC could be indicative of a reduction in habitat quality caused, for example, by disturbance. Reduction in use of available pupping sites may put pressure on the remaining sites and potentially limit seal pupping productivity due to lack of available space to pups.

Evidence suggests the number of pupping sites has increased across the SAC. This reflects a successful, increasing population. However, in some existing pupping sites pup production is stabilising, suggesting they are potentially reaching carrying capacity. The distribution of pupping site attribute is being met, allowing a maintain target to be set for objective 2a. For more information see the latest condition assessment (Cuthbertson et al., 2025c).

2b. Accessibility to habitat used by seals

Grey seal coastal habitat serves to support the species during all of its life phases and needs. From breeding, pupping, moulting and resting whilst on land, to foraging on the seabed and in the water column and travelling whilst at sea. Grey seals are a highly mobile species, and individuals that breed within the SAC may spend other times of the year in areas far from the site, dispersing widely within the Irish and Celtic Seas (Carter et al., 2022; Sayer et al., 2019). Similarly, seals that haul out in Pembrokeshire Marine SAC outside of the breeding period may also pup elsewhere in the wider region (Langley et al., 2020). It is vital that grey seal continue to have unimpeded access to habitats within and outside of the SAC that are necessary to maintain the population that use the SAC in favourable condition. It is not only physical barriers or constraints that could reduce access to their habitat, noise and visual stimuli could also prevent grey seals from accessing an area.

For example, West Hoyle sandbank in Liverpool Bay is a major, if not the biggest, grey seal haul out in the Irish and Celtic seas, and has demonstrated connectivity to the SAC (e.g. Carter et al., 2022; Langley et al., 2020). It is considered to have functional linkage (i.e. necessary). If access to this sandbank was constrained or impeded, for example, it may impact the seals that use Pembrokeshire Marine SAC. Whether an activity is causing significant constraint will be judged on a case by case basis.

There is currently no evidence grey seals that use the SAC are significantly constrained from accessing necessary habitats. For more information see the latest condition assessment (Cuthbertson et al., 2025c).

2c. Anthropogenic disturbance

Seal disturbance on land mainly comes in the form of recreational disturbance (e.g. dog walkers, wildlife watching boats etc), and from airborne noise such as from construction, military exercises and recreation (e.g. fireworks). Disturbance to seals while at sea is largely through underwater noise associated with construction of industrial developments. Changes in the distribution of breeding seals could be indicative of disturbance (see objective attribute 2a).

Disturbance can lead to seals abandoning haul outs as they flush into the water to avoid the perceived threat. This can stress seals and can also be a danger to new pups due to physical harm, as adults rush to the water, or through starvation due to temporary or permanent abandonment (SCOS, 2013).

Airborne noise occurs in the SAC from ongoing military activity within Castlemartin Range SSSI. The day to day activity does not appear to be inhibiting increases in pup production or pupping site use. However, there is potential for less routine exercises to have a detrimental impact on the seals.

We know grey seals forage and breed outside of the SAC boundaries. Therefore, we need to ensure that grey seals that use the SAC are not disturbed in such a way that the population that is adversely affected. Whether an activity is causing significant disturbance will be judged on a case by case basis.

The latest condition assessment found current disturbance is not significant enough to adversely affect the seal population. For more information see the latest condition assessment (Cuthbertson et al., 2025c).

Objective 3: The grey seal population that use the SAC have high quality habitat and sufficient food supply to support and maintain the population in favourable condition.

Objective attribute	**Site specific target**
3a. Habitat quality and function	Maintain the quality and functionality of habitat to support the grey seal population that use the SAC in favourable condition.
3b. Prey availability	Maintain the quality, abundance and diversity of prey needed for the grey seal population that use the SAC to remain in favourable condition.
3c. Water, sediment and prey contaminants	Contaminants are at levels not detrimental to the grey seal population using the SAC.

Supporting information

3a. Habitat quality and function

The exact habitat requirements of grey seals are not known (seemingly suitable habitat is often not occupied), but must include suitable pupping, moulting and resting haul-out areas on land as well as access to suitable foraging and passage areas at sea. Adults and weaned pups are assumed to feed at sea throughout the site, and some are known to make long foraging trips offshore to deeper waters off the Pembrokeshire coast (Thompson, 2011).

Many grey seals in Wales tend to use secluded coves and caves for pupping instead of forming large congregations of pupping females on open beach sites, differing from seals elsewhere in Britain (Baines et al., 1995; Stringell et al., 2013). Other preferred breeding sites tend to be secluded and sheltered from heavy wave action. Moulting and resting haul-out sites are distributed throughout the site, though only a small number of sites are regularly used as haul-outs by large numbers of seals (Baines et al., 1995; Thompson, in prep). Known winter moulting haul-outs and non-moulting / resting haul-outs are limited to offshore islands and remote, undisturbed and inaccessible rocky shores and beaches.

Pupping occurs at a limited number of favourable sites (towards the south-western end of the SAC which includes the North Pembrokeshire coast and Pembrokeshire Islands) with some use of less optimal sites to the south and south-east of the SAC (Baines et al., 1995). Suitable habitat for moulting and resting haul-out requirements is extensive throughout the SAC and is assumed to be adequate. Therefore, the habitat quality and function attribute is being met, allowing a maintain target to be set for objective 3a. For more information see the latest condition assessment (Cuthbertson et al., 2025c).

3b. Prey availability

Grey seals are generalist feeders, taking whatever food source is locally abundant (Brown et al., 2012; Thompson et al., 1991). They forage primarily on the seabed, taking a wide variety of prey including sandeels, gadoids (cod, whiting, haddock, ling), and flatfish (plaice, sole, flounder, dab (SCOS, 2013). A study of grey seal diets from scats collected in Pembrokeshire, found that gadoids (mainly whiting) and flatfish (mainly sole) dominated the diet (70% by weight) (Strong et al., 1996). Similar results were seen from a more recent comprehensive study of grey seal diet in Wexford Harbour, Southeast Ireland (Gosch et al., 2019) and in small seal diet study on Skomer Island (Lofthouse, 2017).

While stocks of some key prey species are depleted in the Irish/Celtic sea region, there is no reason to believe that prey is limited or has reduced diversity in the areas that grey seal are using to forage. The grey seal population in Wales has been expanding and pupping has an increasing trend in the SAC, suggesting prey is abundant enough to support a growing population.

Therefore, the prey availability attribute is being met, allowing a maintain target to be set for objective 3b. For more information see the latest condition assessment (Cuthbertson et al., 2025c).

3c. Water, sediment and prey contaminants

Grey seals, like many marine mammals, are exposed to a variety of anthropogenic contaminants. The main route of exposure is through ingestion of prey. As grey seals are top predators, they are at risk from contaminant biomagnification through the food chain (Hammond et al., 2005). This is particularly the case for persistent organic pollutants (POPs) like polychlorinated biphenyls (PCBs), which are lipid soluble, and heavy metals, like mercury. The toxic effects of these contaminants are well studied with impacts such as reduced reproduction and high susceptibility to disease (Hammond et al., 2005).

Degradation of habitat quality is possible from litter, waste and hazardous material. Entanglement in persistent synthetic debris (particularly fishing gear debris) is the most prevalent and visually obvious pollution impacting seals in the Skomer MCZ (Büche and Bond, 2024). Plastic litter and debris, while present, is not thought to be adversely affecting the wider seal population or the population using the SAC.

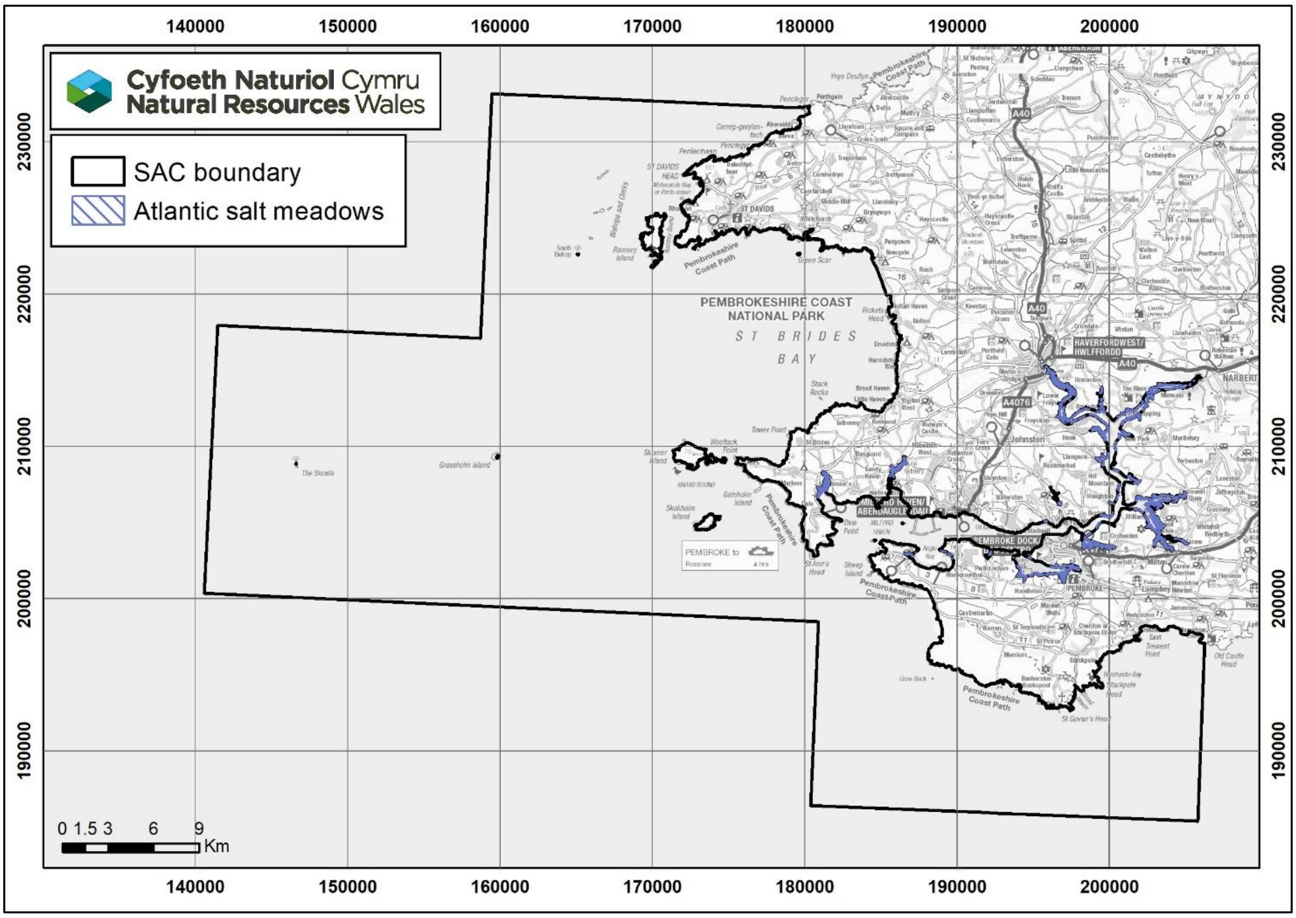
Some water quality issues have been identified for this feature. For information on water quality see the latest condition assessment (Cuthbertson et al., 2025c).

3.5. Feature 5: Atlantic salt meadow *Glauco-Puccinellietalia maritimae*

The Atlantic salt meadow *Glauco-Puccinellietalia maritimae* (ASM) feature within Pembrokeshire Marine SAC is currently in **unfavourable** condition (low confidence). NRW published the [latest condition assessment]() in June 2025. NRW will review these conservation objectives when new condition assessment information is available.

Figure 5 is a map of the location of the ASM feature within Pembrokeshire Marine SAC. The map is for illustrative purposes only. Detailed maps for this feature in Wales can be found on [Data Map Wales.]()

Figure 5. Map of the Atlantic salt meadows feature within Pembrokeshire Marine SAC.



Below are the attributes and targets for each conservation objective alongside supporting information.

Objective 1: The overall distribution and extent of the Atlantic salt meadow feature within the SAC and each of its main plant communities are stable or increasing, subject to natural change.

Objective attribute	Site specific target(s)
1a. Feature extent and distribution	Maintain the extent of Atlantic salt meadow habitats and its natural transitions within the sectors of the SAC, subject to natural change Maintain the broadscale distribution patterns of Atlantic salt meadow and natural transitions within the sectors of the SAC, subject to natural change.
1b. Zonation extent and distribution	Maintain the expected zonation extent and distribution of Atlantic salt meadow zones within the sectors of the SAC, subject to natural change.

Supporting information

1a. Feature extent and distribution

Atlantic salt meadow (ASM) is present together with lower saltmarsh and adjacent natural transitions including freshwater marsh and broadleaved woodland throughout the Milford Haven Waterway. Tributary estuaries and lagoons within the waterway are characterised by extensive pioneer saltmarsh and ASM habitat is distributed discontinuously on upper shores throughout and flanking both sides of the central-lower waterway, and extending into the large shallow bays of Dale, Angle Bay and Sandy Haven.

Saltmarshes are dynamic systems, therefore ASM distribution and extent can be stable or fluctuate naturally in the site, accreting and eroding depending on the main processes of hydrodynamics and sediment transport influence extent and distribution. The Annex I feature *Salicornia* and other annuals colonising on mud and sand, a pioneer saltmarsh vegetation community, forms an important characterising transition in the ASM of this SAC, but is not a designated feature of the site.

Transitions from pioneer communities in the low marsh and to natural and semi natural terrestrial communities in the upper marsh reflect the maintenance of natural process. However, the overall extent of ASM across the SAC should be maintained. ASM in Pembrokeshire Marine SAC is divided into sectors to aid monitoring. There should be no significant loss of extent within each sector, as this will help maintain the broadscale distribution of saltmarsh within the SAC. A change in distribution that leads to fragmentation of the ASM would be a negative impact.

The sectors of the site are, Angle Bay, Carew/ Cresswell, Cosheston, Crabhall saltings, Daugleddau, Eastern Cleddau, Martins Haven, Neyland Beach, Pembroke River, Sandy haven, Western Cleddau and Westfield Pill. The total extent of saltmarsh was measured as 296.17 ha in 2020 and there has been no loss of more than 20% of saltmarsh extent in any of the defined sectors (Jackson-Bué et al., 2025f). Therefore the extent and distribution attribute is being met, allowing maintain targets to be set for objective 1a.

One of the biggest threats to the extent and distribution of saltmarsh in the SAC is climate change and coastal squeeze as a result of rising sea levels. See Section 5 and the latest condition assessment for more detail (Jackson-Bué et al., 2025f).

1b. Zonation extent and distribution

A feature of saltmarsh vegetation is the zonation of different communities with increasing elevation from the sea. Zonation is generally displayed as bands of characteristic species assemblages that generally run parallel to the shoreline, although in many sites this is more complex. If expected zonation is not maintained, it can be a sign anthropogenic activities are impacting the feature and natural processes are being inhibited.

The Annex I feature *Salicornia* and other annuals colonising on mud and sand, a pioneer saltmarsh vegetation community, forms a characteristic zone in ASM, though it is not a designated feature within Pembrokeshire Marine SAC. Sustaining suitable environmental conditions and limiting activities to which ASM may be sensitive to will allow ASM zones to maintain themselves within their natural variation.

A lack of information means zonation in the SAC is unknown. This has resulted in a default maintain target for objective 1b. See the latest condition assessment for more information (Jackson-Bué et al., 2025f).

Objective 2: The hydro-morphological and chemical elements necessary for the structure and function of the Atlantic salt meadow feature are stable or improving, subject to natural change.

Objective attribute	**Site specific target(s)**
2a. Water and sediment quality	Contaminants are at levels not detrimental to the structure and function of the Atlantic salt meadow feature. Nutrients are at levels not detrimental to the structure and function of the Atlantic salt meadow feature. Physicochemical characteristics are at levels not detrimental to the structure and function of the Atlantic salt meadow feature.
2b. Air quality	Maintain nitrogen (N) deposition on the Atlantic salt meadow feature below the critical load of 10-20kg N per ha-1 per year.
2c. Hydro-morphology	The characteristic hydrodynamics, sediment transport and morphology necessary for the structure and function of the Atlantic salt meadows feature are sustained.
2d. Sediment supply	The sediment type, size distribution and budget necessary for the structure and function of the Atlantic salt meadows feature are sustained.

Supporting information

2a. Water and sediment quality

Studies have demonstrated that saltmarsh habitats can be a sink for pollutants including herbicides, pesticides, organochlorines, polychlorinated biphenyls and heavy metals. A significant proportion of contaminants in these pollutants are adsorbed onto fine sediment particles which are then deposited on the saltmarsh, locking them in. This can reduce the toxic impact in some cases. For example, Tributyl tin (TBT) has a half-life period of tens of years and burial of sediment contaminated with TBT over this time period can reduce loadings within a system. However, shifts in the dynamics of processes can lead to the remobilisation of sediments. Cyclical patterns of erosion and accretion may, therefore, lead to the release and re-deposition of pollutants within the system (Adnitt et al., 2007). There is little evidence available on the negative impact contaminants can have on saltmarsh plants themselves (Pontee et al., 2021).

Nutrient cycling within saltmarshes can have a significant effect on coastal and estuarine water quality. Healthy, functional saltmarsh habitat may have an important role to play in the control of nutrients. While saltmarsh habitats can remove land derived nutrients from a system, excessive nutrient loading (at levels that would induce eutrophication) has been shown to decrease root growth in some circumstances in saltmarsh plants, reducing sediment stability and increasing erosion over a 9-year period (Deegan et al., 2012). The threshold at which nutrients start to have a detrimental impact on saltmarsh is poorly understood.

High concentrations of nutrients (nitrogen and phosphorus) in the water column can cause phytoplankton and opportunistic macroalgae blooms. The impact of opportunistic macroalgae blooms is not well understood. It is possible short term or low-level exposure to macroalgae provides beneficial nutrient input (Wasson et al 2017). However, more intense exposure could be harmful as macroalgae mats have been shown to have negative impacts on saltmarsh, including reduced growth and biomass as a result of smothering (Wasson et al., 2017 and references therein).

Water and sediment quality issues have been identified for this feature. Information on water and sediment quality can be found in the latest condition assessment (Jackson-Bué et al., 2025f).

2b. Air quality

There are few studies of the effects of nitrogen (N) deposition on saltmarsh habitats. Work from the Netherlands suggest saltmarsh vegetation is N limited (Mitsch and Gosselink, 2000), which would make it vulnerable to eutrophication effects. However, as N addition experiments have neither used very realistic N doses nor input methods, results should be approached with caution.

Input of atmospheric N deposition is likely to be less than the large nutrient N loadings from river and tidal inputs. A review by Boorman and Hazelden (2012) suggested pioneer low to mid saltmarsh areas are more resilient and have a lower sensitivity to N deposition than the mature upper areas. These more mature areas may also be subject to direct run-off from the surrounding catchment. Sensitivity of saltmarsh is likely be a function of existing N supplies together with the maximum salinity of the habitat (Boorman and Hazelden 2012). Sensitivity will vary with site conditions.

The recommended deposition critical range for saltmarsh habitat is 10-20 kg N per ha per year (Bobbink et al., 2022). This is based on recent evidence suggesting this habitat is more sensitive to N deposition than previously thought (Bobbink et al., 2010). Evidence of exceedance of the deposition critical load would be indicated by increases in late successional species, decline in positive indicator species and increased dominance of graminoids in the upper-mid marsh (Bobbink et al., 2010; 2022).

At the time of the last condition assessment the N deposition within ASM in the SAC is not exceeding the target, allowing a maintain target for objective 2b. See the latest condition assessment for more information (Jackson-Bué et al., 2025f).

2c. Hydro-morphology

Hydro-morphology refers to patterns of water movement (caused by waves wind and tides), coastal processes (e.g. erosion and deposition), and the physical characteristics of the environment. Waves and currents move sediment, which can change the shape of the seabed, which in turn changes waves and currents; in other words there is two-way feedback between the hydrodynamics and the morphology. As water movement transports nutrients, sediment and other particles, it also strongly influences the species and communities present.

Geomorphology and tidal regime primarily determine ASM extent and distribution, while the topography is determined by foreshore breadth, morphology of waterway, and hydrodynamic and sediment processes. a saltmarsh: (1) relatively stable sediment that is covered by the tide for a shorter period than the time it is exposed; (2) a suitable supply of sediment within the period of tidal cover; (3) water velocities low enough for some sediment to settle out; and (4) a supply of seeds or other propagules for the establishment of vegetation cover.

Creeks and pans of varying size and density are frequent features of the ASM habitat influenced by vegetation cover, suspended sediment load and tidal influence. Creeks absorb tidal energy and assist with the delivery of sediment into saltmarshes. Creeks allow pioneer vegetation to be established along their banks higher into the saltmarsh system. Natural salt pans can occur at any level in a saltmarsh. Perched marsh is a morphological element of the saltmarsh within the lower reaches of the Cleddau river and occurs where marsh develops on raised rocky areas.

Significant erosion of saltmarsh can ultimately lead to the creation of mud basins or fragmented sections of saltmarsh. Erosion of the outer saltmarsh edge can be caused by changes to main channel position, increases in wave exposure, e.g. through dredging, or reduction in sediment availability.

No hydro-morphology issues have been identified for this feature. For more information see the latest condition assessment (Jackson- Bué et al., 2025f). Information on the hydro-morphology of the SAC can be found in Appendix 1.

2d. Sediment supply

The sediment structure of ASM habitat is predominantly muds or muddy sands, though many fringes and ribbons have developed in areas of mixed muddy gravels and stones and, in places, are associated with rocky substrate.

The sediment supply into and through the ASM is influenced by the saltmarsh morphology, which dictates water flow, energy dissipation and hence sediment deposition. Sediment budgets and transport are often on a regional scale, and therefore projects outside the SAC can still alter the sediment supply to features within the site.

No sediment supply issues have been identified for this feature. For more information see the latest condition assessment (Jackson- Bué et al., 2025f). Information on the sediment transport in the SAC can be found in Appendix 1.

Objective 3: The abundance, distribution and diversity of plant communities necessary for the structure and function of the feature are stable or improving, subject to natural variability.

Objective attribute	**Site specific target(s)**
3a. Plant communities	Maintain the abundance, distribution, structure and diversity of Atlantic salt meadows plant communities within the sectors of the SAC. Maintain the abundance and distribution of locally distinctive plants in the sectors of the SAC.
3b. Invasive native and invasive non-native species	Introduction or spread of new non-native species to the SAC by anthropogenic activities should not have a detrimental impact on the structure and function of the Atlantic salt meadow feature.

Supporting information

3a. Plant communities

All the ASM communities within the SAC contribute to the overall representation, range and condition of the feature within the SAC. Changes to the spatial distribution of communities across the feature could highlight changes to the overall feature.

Species composition of ASM plant communities are influenced by numerous factors such as morphology, sediment type, physical processes operating at a site and grazing management. Changes to the species that make up communities and structure are a good indication of changes to influencing processes and management practices.

Species and plant community richness is proportionately high relative to the extent of saltmarsh and comparable areas of ASM in south Wales (Prosser and Wallace, 2002), but also highly variable between and within areas of ASM. The range of substrates and topography are particularly important in contributing to this diversity. Communities, species and species assemblages of particular nature conservation importance, including nationally rare and scarce ASM / salt-marsh transition species have been recorded. Populations of notable saltmarsh species include: *Limonium humile, Limonium procerum, Salicornia pusilla, Althaea officinalis, Apium graveolens, Carex punctata, Hordeum secalinum and Lathyrus palustris*.

Species composition, variation and complexity of communities within and between areas of ASM, community structure, temporal patchiness in community distribution and extent, and variation in sward height together indicate species populations are dynamic, reproducing and recruiting successfully and in many areas self-maintaining.

Livestock grazing is carried out within Pembrokeshire Marine SAC, however a significant proportion of the site is un-grazed. Grazing can influence the plant community type, composition, structure and overall condition. Within Pembrokeshire Marine SAC un-grazed saltmarsh provides good conditions for invertebrate species, particularly where the saltmarsh has not been grazed historically. However, saltmarsh plant diversity and structure can also benefit from grazing under appropriate management regimes.

There is currently no monitoring of the habitats, communities and locally distinctive plants in the SAC. Therefore default maintain targets has been set for objective 3a. For more information see the latest condition assessment (Jackson-Bué et al., 2025f).

3b. Invasive native and invasive non-native species

Non-native species (NNS) may become invasive non-native species (INNS) and displace native species by predating them or out-competing them for food, space or both. This can lead to the loss of indigenous species from certain areas or changes to community structure (JNCC, 2004b; Levin et al., 2002), as well as changes to biotope and habitat type. The introduction or spread of NNS within the SAC can occur through various regulated and unregulated pathways. Further information on introduction pathways can be found on the GB non-native species secretariat website.

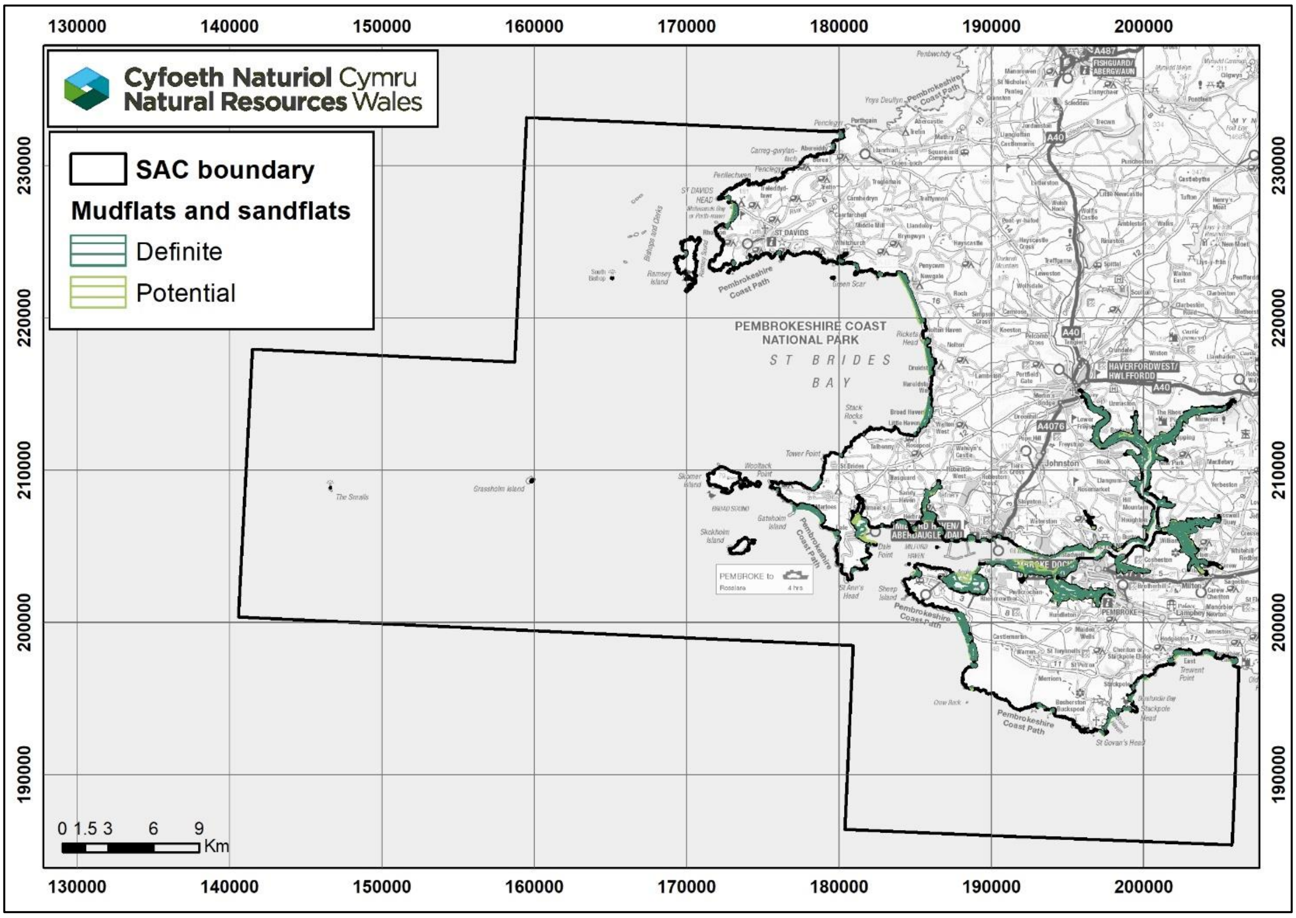
Saline conditions in ASM habitats prevent the more common terrestrial INNS in Wales becoming established. The American Skunk cabbage *Lysichiton americanus* has been recorded in the Milford Haven estuary, but this is not yet on the saltmarsh and likely to only reach the margins. There have been no other notable records of INNS within the feature within Pembrokeshire Marine SAC.

3.6. Feature 6: Mudflats and sandflats not covered by seawater at low tide

The mudflats and sandflats not covered by seawater at low tide (mudflats and sandflats) feature within Pembrokeshire Marine SAC is currently in **unfavourable** condition (medium confidence). NRW published the [latest condition assessment] in June 2025. NRW will review these conservation objectives when new condition assessment information is available.

Figure 6 is a map of the location of the mudflats and sandflats feature within Pembrokeshire Marine SAC. The map is for illustrative purposes only. Detailed maps for this feature in Wales can be found on [Data Map Wales.]

Figure 6. Map of the mudflats and sandflats feature within Pembrokeshire Marine SAC.



Below are the attributes and targets for each conservation objective alongside supporting information.

Objective 1: The overall distribution and extent of the mudflats and sandflats feature within the SAC and each of its main component habitats are stable or increasing, subject to natural change.

Objective attribute	**Site specific target**
1a. Feature extent and distribution	Maintain the extent and distribution of mudflats and sandflats
1b. Component habitat extent and distribution	Maintain the extent and distribution of component habitats and communities necessary for the structure and function of the mudflats and sandflats feature.

Supporting information

1a. Feature extent and distribution

The extent describes the presence and area of the habitat across the whole site, even where it is patchy. The distribution describes the more detailed locations and patterns of different habitats that comprise the feature across the site.

Intertidal mudflats and sandflats are widespread in the site, occurring from lowest to highest astronomical tide (highest influence of tidal waters). They are distributed throughout embayments, inlets, estuaries and on the open coast within the SAC. Sediment flats in open coast bays are often extensive, separated by rocky headlands, and often restricted in the upper shore by rock features at the base of cliffs. Flats in more sheltered bays, inlets and estuaries range from ‘pockets’ of sediment restricted by coastal geomorphology to extensive mudflats fringing inlets and estuaries.

Tributary estuaries and other wave-sheltered areas in the Milford Haven Waterway are characterised by extensive upper, mid and low shore mudflats, supporting extensive pioneer saltmarsh and Atlantic salt meadows.

The extent and distribution attribute of the mudflats and sandflats feature is being met, allowing a maintain target for objective 1a to be set. See the latest condition assessment for more information (Jackson-Bué et al., 2025a).

1b. Component habitat extent and distribution

There are a variety of component habitats within the mudflats and sandflats feature, ranging from exposed sandy shores in open coast areas, more sheltered muddy sands within embayments in Milford Haven waterway, soft muds in the main channel and tributary estuaries and rich muddy gravel habitats within Gann flats and at Pwllcrochan. Component habitats of the feature need to be maintained by sustaining suitable environmental conditions and limiting activities to which they may be sensitive to. The recovery of soft sediment habitats will be influenced by the type of sediment as well as the type and duration of impact.

Intertidal mudflats and sandflats form a major component of two other Annex I habitats (estuaries and large shallow inlets and bays) but also occur independently, sometimes covering extensive areas along the open coast. A variety of sediment types are present including wide gently sloping exposed sandy shores on the open coast, particularly St Brides Bay and Freshwater West; steeply sloping exposed sandy shores on the open coast and in the entrance to inlets and muddy sediment flats within small estuaries and inlets and the Milford Haven estuary complex.

Intertidal seagrass beds (*Zostera noltei*) are found in a number of locations within Milford Haven Waterway. Older observations have shown small beds in tributary estuaries including Sandy Haven and at Pwllcrochan Flats that were present up to the 1970s were no longer present in the late 1990s. When the intertidal was surveyed by CCW in 1998/99, intertidal seagrass was limited to Angle Bay and Pembroke River. Since then, seagrass has expanded at both of these locations. It has also been mapped through WFD monitoring in various locations, including Pwllcrochan Flats, Hobbs Point, Cosheston Pill, Carew and Creswell Rivers, Garron Pill, Sprinkle Pill and Fowborough Point. Seagrass extent is increasing in the SAC at the time of writing (Jackson-Bué et al., 2025a).

The component habitat extent and distribution attribute is being met, allowing a maintain target to be set for objective 1b. For more information see the latest condition assessment (Jackson-Bué et l., 2025a).

Objective 2: The hydro-morphological and chemical elements necessary for the structure and function of the mudflats and sandflats feature are stable or improving, subject to natural change.

Objective attribute	**Site specific target(s)**
2a. Water and sediment quality	Contaminants are at levels not detrimental to the structure and function of the mudflats and sandflats feature. Nutrients are at levels not detrimental to the structure and function of the mudflats and sandflats feature. Physicochemical characteristics are at levels not detrimental to the structure and function of the mudflats and sandflats feature.
2b. Hydro-morphology	The characteristic hydrodynamics, sediment transport and morphology necessary for the structure and function of the mudflats and sandflats feature are sustained.
2c. Sediment supply	The sediment type, size distribution and budget within the SAC necessary for the structure and function of the mudflats and sandflats feature are sustained.

Supporting information

2a. Water and sediment quality

Various contaminants are known to affect species living within the water column and in or on the surface of sediments. The biological effect of a contaminant will vary depending on its nature. Contaminants include, but are not limited to, heavy metals (e.g. mercury and zinc), Polybrominated diphenol ethers (PBDEs), poly-aromatic hydrocarbons (PAHs), poly-chlorinated biphenyls (PCBs) and organotin and pesticides such as hexachlorobenzene. These chemicals (e.g. heavy metals) can degrade community structure and bioaccumulate within organisms, entering the marine food chain (e.g. PCBs) (OSPAR Commission, 2012).

High concentrations of nutrients in the water column can cause phytoplankton and opportunistic macroalgae blooms. These blooms can lead to reduced dissolved oxygen availability especially in warmer months. This can have lethal and sub-lethal impacts on sensitive fish, epifauna and infauna communities (Best et al., 2007).

Physicochemical characteristics include salinity, pH, temperature, dissolved oxygen and turbidity. They affect habitats in terms of the abundance, distribution and composition of communities present. Changes in any of these properties, because of anthropogenic activities, may impact habitats and the communities they support.

Significant water and sediment quality issues have been identified for this feature. Information on water and sediment quality can be found in the latest condition assessment (Jackson-Bué et al., 2025a).

2b. Hydro-morphology

Hydro-morphology refers to patterns of water movement (caused by waves, wind, tides and fluvial input)coastal processes (e.g. erosion and deposition), and the physical characteristics of the environment. Waves and currents move sediment, which can change the shape of the seabed, which in turn changes waves and currents; in other words there is two-way feedback between the hydrodynamics and the morphology. As water movement transports nutrients, sediment and other particles, it also strongly influences the species and communities present.

Intertidal mudflats and sandflats are dynamic. Their distribution, extent, shape, topography, aspect and orientation are the product of complex interaction between hydrodynamic and sediment transport processes, sediment supply and coastal morphology. In shallower areas, wave driven processes largely dictate current and sediment movement, whereas lower down the profile a delicate balance of wave and tidal forcing can be important. The hydrographic functions that structure intertidal mudflats and sandflats vary on a range of timescales from short (e.g. storm events to spring – neap tidal cycles) to longer-term (e.g. summer – winter wave seasonality), to climatic influences. Importantly, the two-way feedback means as well as maintaining the wave and tidal forcing, maintaining the broad shape (e.g. beach type classification) of features is important.

The status of these parameters provides suitable conditions for sustaining the mudflats and sandflats feature. A change in these environmental conditions could detrimentally affect the quality and variety and therefore functions of the various habitats in the mudflats and sandflats feature.

No hydro-morphology issues have been identified for this feature. For more information see the latest condition assessment (Jackson- Bué et al., 2025a). Information on the hydro-morphology of the SAC can be found in Appendix 1.

2c. Sediment supply

Sedimentary habitats are subject to a range of deposition and erosion processes, which anthropogenic activity can influence. Most intertidal sediments stabilise over time so maintaining the sediment composition supports natural succession of the habitats and communities (Gray and Elliott, 2009). Sediment type strongly influences the species present within a community, for example muddy areas are highly productive, containing high levels of organic material. The size, shape, quantity and characteristics of sediments are important to the structure and function of the feature. For example, grain size can influence morphology with coarser grained areas often having steeper beach profiles.

The sedimentology of the mudflats and sandflats feature is variable throughout the SAC, depending on aspect, coastal topography, shore morphology, wave exposure and sediment budget present. Maintaining the natural sediment transport pathways (both quantity and sediment grain size) is important to ensure maintenance of the morphology and sediment type of intertidal sand and mudflats. Sediment budgets and transport are often on a regional scale, and therefore projects outside the SAC can still alter the sediment supply to features within the site.

Sediment transport processes within the Milford Haven Waterway are complex and dominated by tidal streams. Sediment flats in the waterway are accreting slowly but expansion is constrained by the geomorphology of the channel structure. Fluvial sediment inputs from the eastern and western Cleddau are estimated to contribute around 20,000 tonnes of suspended sediment per year (Fulford et al., 2021).

Although sediment transport processes and budgets in open coast bays are generally poorly known, there is no evidence to suggest wide scale processes have been modified although there may be local, chronic and acute, modification in the vicinity of vessel moorings.

No sediment supply issues have been identified for this feature. For more information see the latest condition assessment (Jackson- Bué et al., 2025a). Information on the sediment transport in the SAC can be found in Appendix 1.

Objective 3: The abundance, distribution and diversity of species within component habitats and communities necessary for the structure and function of the mudflats and sandflats feature are stable or improving, subject to natural variability.

Objective attribute	**Site specific target**
3a. Habitats and communities	Restore the abundance, distribution and diversity of species within component habitats and communities necessary for the structure and function of the estuaries feature.
3b. Invasive and non-native species	Introduction or spread of new non-native species to the SAC by anthropogenic activities should not have a detrimental impact on the structure and function of the estuaries feature.

Supporting information

3a. Habitats and communities

All the mudflat and sandflat communities within the SAC contribute to the overall representation, range and condition of the feature within the SAC. Changes to the spatial distribution of communities across the feature could highlight changes to the overall feature.

Species abundance varies throughout the site, contributing to community structure, diversity and biomass. The overall species diversity is high but varies considerably between and within communities, sediment types and individual sediment flats. The exposed, coarser sandflats typically have low diversity of species highly adapted to dynamic mobile substratum. Homogeneous mudflats also characteristically support a relatively low variety of species. Other sediment flats, depending on habitat complexity and stability are typically very rich in species, including worms, burrowing crustaceans and bivalve molluscs.

The fish community of the intertidal mudflats and sandflats feature of the Pembrokeshire Marine SAC contain many species important for grazing and bioturbating. The Gann Flats are thought to be the most biologically diverse intertidal sediment site in the Haven, despite being used heavily for bait digging. The muddy gravel *Venerupis corrugata* community at the Gann is considered to the richest in south-west Wales. Other areas of muddy gravels can be found at Pwllcrochan.

Seagrass beds (*Zostera marina* and *Z. noltei*) are found in various locations in the SAC. Most *Z. marina* beds are subtidal, but a small bed can be found intertidally at Gelliswick. Fully intertidal *Z. noltei* beds are found in numerous locations within the Milford Haven waterway. See Appendix 1 for more information.

Infaunal analysis at several locations within the Milford Haven Waterway indicated decreases in community composition and species richness and diversity across the monitoring period 2007-2021, indicative of anthropogenic disturbance. Therefore the habitats and communities attribute is not being met and a restore target has been set for objective 3a. This restore is specifically for the declines seen at the Gann Flats. For more information see the latest condition assessment (Jackson-Bué et al., 2025a).

3b. Invasive and non-native species

Non-native species (NNS) may become invasive non-native species (INNS) and displace native species by predating them or out-competing them for food, space or both. This can lead to the loss of indigenous species from certain areas or changes to community structure (JNCC, 2004b; Levin et al., 2002), as well as changes to biotope and habitat type. The introduction or spread of NNS within the SAC can occur through various regulated and unregulated pathways. As Milford Haven Waterway contains a busy international port, it is likely to account for the high concentrations of INNS in this area Further information on introduction pathways can be found on the GB non-native species secretariat website.

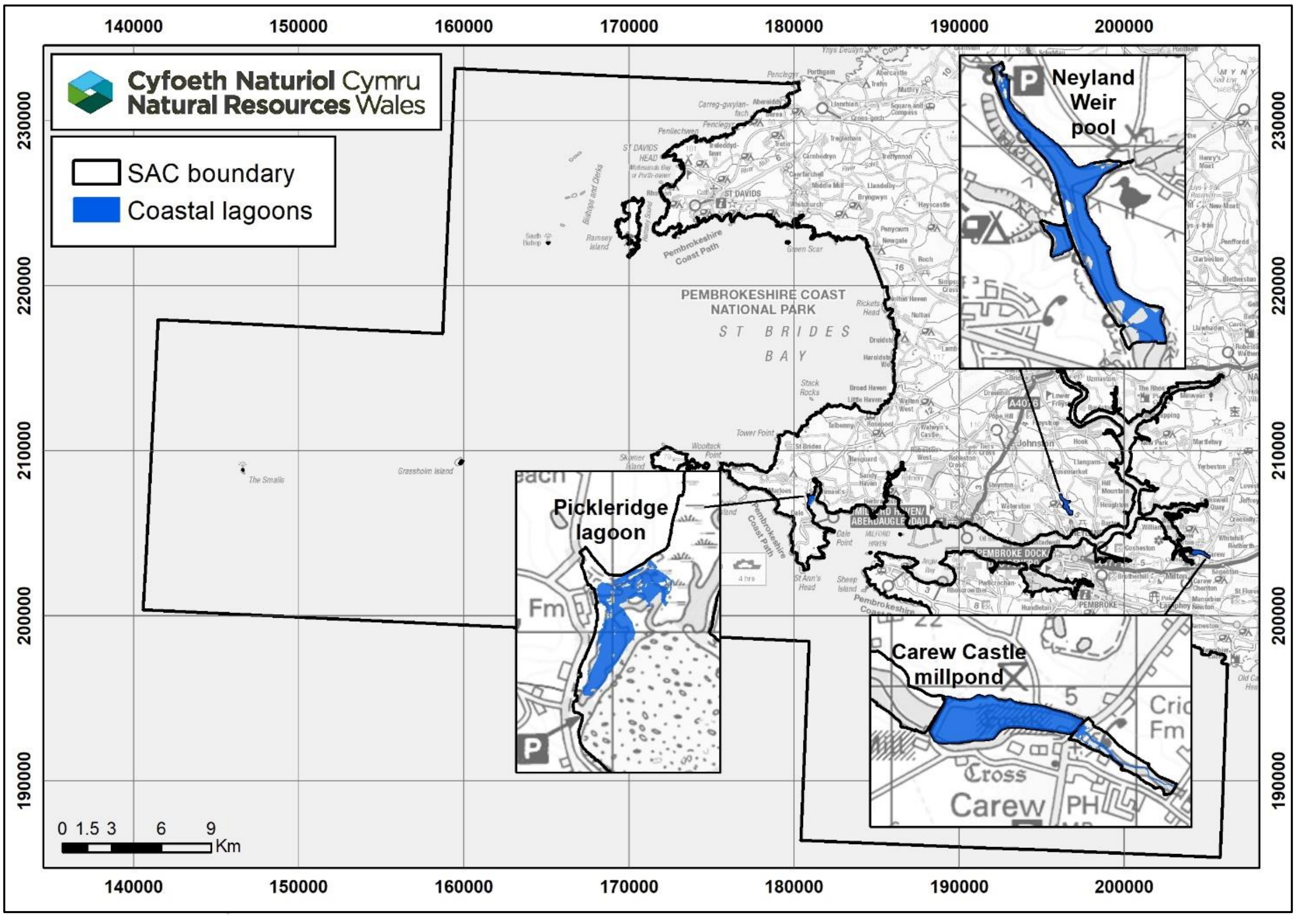
The slipper limpet *Crepidula fornicata*, has been found in a number of locations within the feature, often in high numbers, especially in Milford Haven Waterway. However, there is limited evidence to suggest that INNS are currently impacting the mudflats and sandflats feature in the SAC. More information on impacts of INNS species can be found in the latest condition assessment (Jackson-Bué et al., 2025a). Information on INNS in the SAC as a whole can be seen in Appendix 1.

3.7. Feature 7: Coastal lagoons

The coastal lagoons feature within Pembrokeshire Marine SAC is currently in **unfavourable** condition (high confidence). NRW published the [latest condition assessment]() in June 2025. NRW will review these conservation objectives when new condition assessment information is available.

Figure 7 is a map of the location of the coastal lagoons feature within Pembrokeshire Marine SAC. The map is for illustrative purposes only. Detailed maps for this feature in Wales can be found on [Data Map Wales.]()

Figure 7. Map of the coastal lagoons feature within Pembrokeshire Marine SAC.



Below are the attributes and targets for each conservation objective alongside supporting information.

Objective 1: The overall extent of the coastal lagoon feature within the SAC is stable or increasing, subject to natural change.

Objective attribute	Site specific target
1a. Feature extent	Maintain the extent of the coastal lagoon, subject to natural change.

Supporting information

1a. Feature extent

Three small coastal lagoons are in the upper extremities of tributary estuaries in the upper, middle and lower Milford Haven Waterway. All are naturalised impoundments formed by artificial structures.

- Pickleridge Lagoon
- Neyland Weir Pool
- Carew Castle Millpond

The extent of a coastal lagoon is primarily determined by the morphology of the surrounding area and the artificial impoundment structures. Seasonality and weather play a part in extent and should be considered. The extent of a lagoon's water in winter is likely the extent of the lagoon basin. The lagoon's extent influences the sensitivity of the habitat, and combined with its shape, the biological communities present e.g. smaller lagoons may have more extreme conditions and may be more sensitive to inputs. An increased variation in shape can result in sites with more diverse communities (JNCC, 2004a).

For some physical aspects of lagoons (hard bedrock and boulders/cobbles) we would not expect significant change in its extent via natural processes. However, where there are softer sediments there may be physical changes in extent and distribution over time through natural processes.

The coastal lagoon extent attribute is being met, allowing a maintain target to be set for objective 1a. See the latest condition assessment for more information (Cuthbertson et al., 2025a).

Objective 2: The hydro-morphological and chemical structure necessary for the function of the coastal lagoon feature is stable or improving, subject to natural change.

Objective attribute	Site specific target(s)
2a. Water depth	Maintain the water depth within Pickleridge and Neyland lagoons needed to support the structure and function of the coastal lagoon feature. Restore the water depth within Carew lagoon needed to support the structure and function of the coastal lagoon feature.
2b. Isolating barrier	Restore the presence and integrity of the lagoon isolating barrier.
2c. Water and sediment quality	Contaminants are at levels not detrimental to the structure and function of the coastal lagoon feature. Nutrients are at levels not detrimental to the structure and function of the coastal lagoon feature. Physicochemical characteristics are at levels not detrimental to the structure and function of the coastal lagoon feature.
2d. Sediment type	The sediment size and distribution necessary for the structure and function of the coastal lagoon feature is sustained.

Supporting information

2a. Water depth

Water depth in a lagoon needs to be shallow enough to allow photosynthesis to take place but also deep enough to submerge plants and provide optimal habitat for lagoon animals (JNCC, 2004a). Depth strongly influences environmental parameters such as temperature and salinity which in turn contribute to determining the species and communities that reside within the lagoon.

Lagoons are prone to becoming shallower over time due to the natural process of sedimentation. However, Anthropogenic activities such as infilling, land claim, increased runoff or adjacent developments may impact sediment transport processes with the potential to increase the sedimentation rate of a lagoon and subsequently reduce the depth.

At Carew lagoon the leaks in the dam wall and open sluice gates have resulted in the lowering of the water depth. At times when the sluice gate is open, and the tide is out, the area of water remaining is very small. To compound the lack of water depth issue further, Carew lagoon has been accreting sediment, as silt laden water enters the lagoon during periods of heavy rain, potentially further reducing the water depth. The severely reduced water depth is thought to be a primary contributing factor to the decline in the lagoonal specialist, the tentacled lagoon worm *Alkmaria romijni* (see objective 3b).

The water depth attribute is not being met and restore objective has been set for objective 2a. The restore is specifically set to try and improve the extremely low water depth at Carew. The water depth in Pickleridge and Neyland was judged to be stable. For more information see the latest condition assessment (Cuthbertson et al., 2025a).

2b. Isolating barrier

The presence, nature and integrity of the isolating barrier is fundamental to the structure and function of a lagoon.

Pickleridge lagoon is isolated from the sea by a shingle ridge. The ridge has been assessed as having good integrity and not in danger of breaching in the next 10 years. However, the lack of active management means the barrier is slowly deteriorating (Pye and Blott, 2023). If repairs to the barrier stop, its integrity will eventually fail. Climate changes poses a risk to the integrity of the isolating barrier through sea level rise and increased storminess increasing the frequency and intensity with which waves overtop the barrier.

At Carew a brick wall with sluice gates separates the lagoon from the estuary. While the dam wall was never constructed to be a watertight barrier, the wall is leaking significantly, despite repair (Bunker, 2023). This is causing large volumes of water to drain out, resulting in lack of integrity in the isolating barrier. The sluice gates, which are opened during heavy rainfall and high tides to reduce flood risk to the road on the north of the lagoon, can cause the lagoon to drain rapidly as river levels drop. This further impacts the integrity of the isolating barrier (Cuthbertson et al., 2025a).

The isolating barrier attribute is not being met and a restore objective has been set. The restore objective is specifically to improve the integrity of the isolating barrier at Carew.

Neyland is a weir lagoon with a lower bund embankment separating it from the Cleddau Estuary. An upper bund splits the lagoon into two pools. The isolating barrier and lagoon banks at Nayland have both been judged to have good integrity (Cuthbertson et al., 2025a).

2c. Water and sediment quality

Lagoons tend to have low flushing rates which may mean they are slow to clear any contaminants or slow to recover from any impacts (JNCC, 2004x). This makes lagoonal sediments vulnerable to accumulating contaminants. Various contaminants are known to affect the species that live in or on the surface of sediments. These can impact species sensitive to particular contaminants (e.g. heavy metals), degrading the community structure and bioaccumulating within organisms, entering the marine food chain (e.g. poly-chlorinated biphenyls) (OSPAR Commission, 2012). The degree of sensitivity will be influenced by the type of communities and species present and by the type of lagoon.

High concentrations of nutrients in the water column can cause phytoplankton and opportunistic macroalgae blooms. These blooms can lead to reduced dissolved oxygen availability especially in warmer months and can smother benthic habitats. This can have lethal and sub-lethal impacts on sensitive fish, epifauna and infauna communities (Best et al., 2007). Coastal lagoons act as sinks for nutrients, which are introduced through seawater, freshwater and run-off from surrounding areas, and can be increased through a variety of land uses (JNCC, 2004a).

Sediment organic enrichment may be of less concern given that lagoonal sediments are naturally high in organic material (Johnston and Gilliland, 2000). Lagoonal sediments commonly have an organic content of 10-15 % by weight, compared with 3-8 % in coastal muddy sands (Bamber et al., 2010). This organic loading encourages the seasonal growth of annual algae and phytoplankton. Some lagoons may be adapted to low oxygen conditions (Bamber et al., 2010). However, elevated organic inputs might be of concern in some cases because of low flushing rates in particular lagoons or parts of lagoons.

Salinity and temperature in lagoons are primarily linked to season, water depth, tidal exchange and the degree of freshwater input into the lagoon. Any changes to these, e.g. through artificial diversion or blocking of drainage ditches and streams, could alter the balance of seawater and freshwater inputs and result in either a lower or high salinity system. Salinity plays a primary role in controlling the biological communities present (Joyce et al., 2005).

Water quality issues have been identified for this feature. For more Information on water quality see the latest condition assessment (Cuthbertson et al., 2025a).

2d. Sediment type

Sediment type is important in determining the biological communities present within a lagoon. The sedimentary bed of the lagoon is usually a combination of original sediment present prior to the isolating barrier formation and input of fine silts and clays subsequently deposited (Bamber et al., 2010). Commonly the substrate will become progressively, but slowly, finer with time. The most common sedimentary substratum within UK lagoons is muddy sand (Bamber et al., 2010).

Carew lagoon has been shown to be accumulating silt. This led to a slight decrease in the area and volume of the lagoon (Pye and Blott, 2023). Continued siltation will lead to further reduction in water depth and potentially impact some biological communities. See the latest condition assessment for further detail (Cuthbertson et al., 2025a).

Objective 3: The abundance, distribution and diversity of species within communities and habitats necessary for the structure and function of the coastal lagoon feature are stable or improving, subject to natural variability.

Objective attribute	Site specific target(s)
3a. Habitats and communities	Maintain the abundance, distribution and diversity of species within communities and habitats in Pickleridge and Carew lagoon necessary for the structure and function of the coastal lagoons feature. Restore the abundance, distribution and diversity of species within communities and habitats in Neyland lagoon necessary for the structure and function of the coastal lagoons feature.
3b. lagoonal specialist species	Maintain the abundance, distribution and extent of listed lagoonal specialist species and habitats within Pickleridge and Neyland lagoons. Restore the abundance, distribution and extent of listed lagoonal specialist species and habitats within Carew lagoon.
3c. Invasive and non-native species	Introduction or spread of new non-native species to the SAC by anthropogenic activities should not have a detrimental impact on the structure and function of the coastal lagoons feature.

Supporting information

3a. Habitats and communities

Lagoon communities are generally considered to be made up of opportunistic and specialist species from freshwater, marine and brackish sources (Barnes, 1988; 1994). Saline lagoons often support filamentous green and brown algae and several aquatic vascular plants. They have an abundance of molluscs and crustaceans (Barnes, 1994), despite an often-limited invertebrate diversity (Bamber et al., 2001).

In the latest condition assessment, the communities in both Carew and Pickleridge showed expected variations in species composition. However, Neyland lagoon has seen a negative shift in the composition of its infaunal communities since 2017, with opportunistic short-lived species beginning to dominate. This is indicative of anthropogenic disturbance, though no cause could be attributed (Cuthbertson et al., 2025a).

The habitats and communities attribute has not been met and a restore target has been set for objective 3a. The restore target is specifically for the negative shift in species composition of communities in Neyland lagoon. See the latest condition assessment for more information (Cuthbertson et al., 2025a).

3b. lagoonal specialist species

Many species characterising lagoons are rare and of conservation importance. Some species seem to be mostly restricted to saline lagoons and hence known as lagoonal specialists (see Bamber et al., 2001). It has been argued that specialist lagoonal species are better able to tolerate the large environmental variations (e.g. in salinity, hydrology) than freshwater, estuarine and marine species (Bamber et al., 1992).

The lagoonal specialist species in Carew, Neyland and Pickleridge lagoon are.

- *Cerastoderma glaucum* (Pickleridge)
- *Alkmaria romijni* (Neyland and Carew)
- *Gammarus chevreuxi* (Neyland)
- *Monocorophium insidiosum* (Pickleridge and Carew)
- *Ecrobia ventrosa* (Pickleridge and Neyland)
- *Ficopomatus enigmaticus* (Pickleridge and Neyland)
- *Palaemon varians* (Carew, Pickleridge and Neyland)
- *Lekanesphaera hookeri* (Neyland)
- *Conopeum seurati* (Pickleridge)

In Carew the lagoonal specialist *Alkmaria romijni* has shown declines at two of the three sampling stations. These two stations currently dry out when the sluice gates stay open. *Monocorophium insidiosum* was recorded in 2011 and has not been recorded since. However, this is of limited concern as the sampling method is unlikely to adequately represent *M. insidiosum* density (Cuthbertson et al., 2025a).

The lagoonal specialist species attribute has not been met and a restore objective has been set for objective 3b. The restore target is specific for the abundance of lagoonal specialists at Carew lagoon. More detail can be seen in in the latest condition assessment (Cuthbertson et al., 2025a).

3c. Invasive and non-native species

Non-native species (NNS) may become invasive non-native species (INNS) and displace native species by predating them or out-competing them for food, space or both. This can lead to the loss of indigenous species from certain areas or changes to community structure (JNCC, 2004b; Levin et al., 2002), as well as changes to biotope and habitat type. The introduction or spread of NNS within the SAC can occur through various regulated and unregulated pathways. As Milford Haven Waterway contains a busy international port, it is likely to account for the high concentrations of INNS in this area Further information on introduction pathways can be found on the GB non-native species secretariat website.

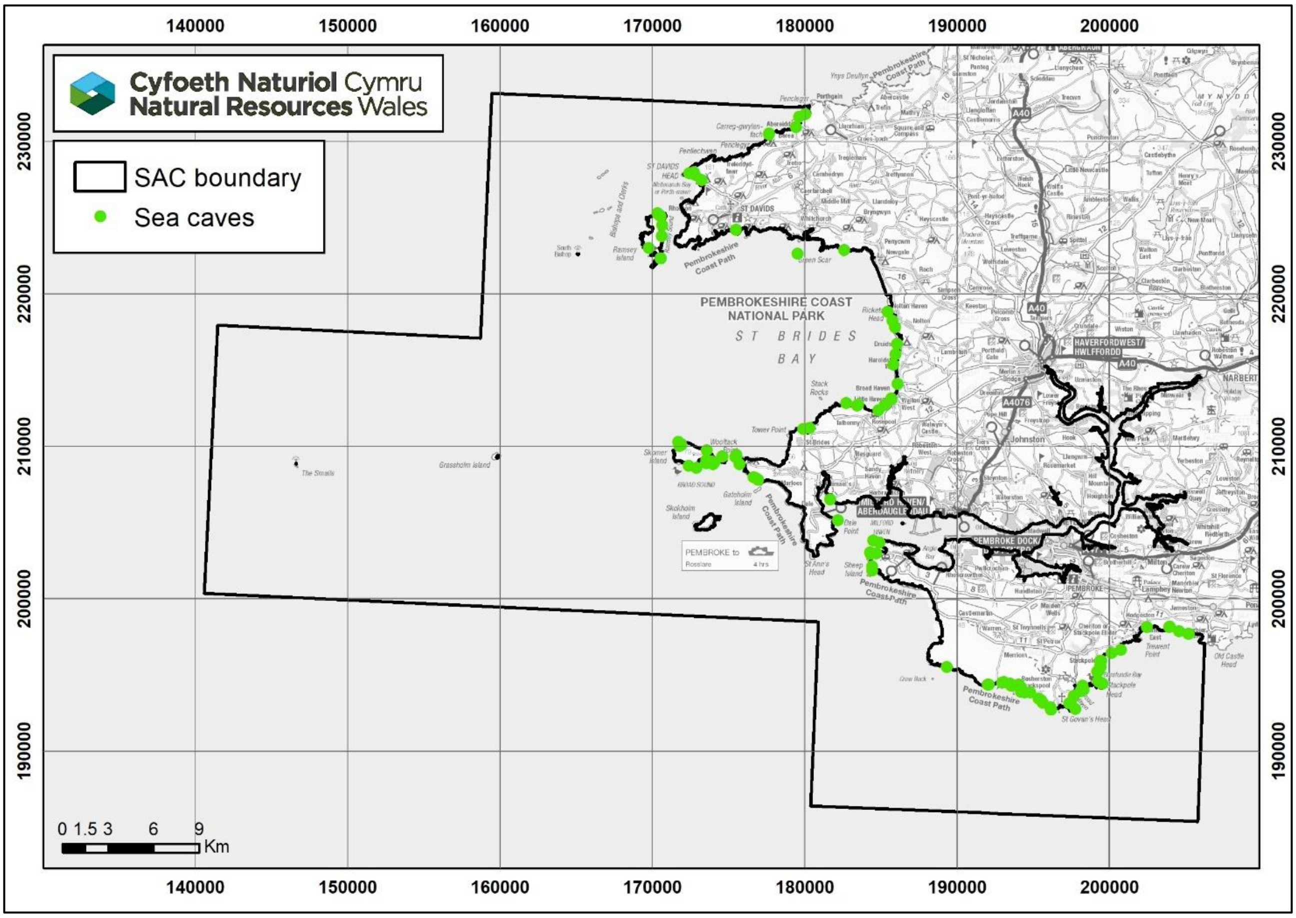
Some non-native species have been recorded in the lagoons of Pembrokeshire Marine since 2006. The freshwater hydroid, *Cordylophora caspia* has occasionally been recorded in Pickleridge and Neyland, but occurrence is very low. The Japanese polychaete, *Pseudopolydora paucibranchiata* was recorded in every Pickleridge sample station in 2020, but it was found in low number in 2021. The New Zealand spire snail, *Potamopyrgus antipodarum* has been observed both in Carew and Neyland lagoons, but sporadically in low numbers. The latest condition assessment found that non-natives were not impacting the lagoons of Pembrokeshire Marine SAC (Cuthbertson et al., 2025a).

3.8. Feature 8: Submerged or partially submerged sea caves

The submerged or partially submerged sea caves (sea caves) feature within Pembrokeshire Marine SAC is currently in **unknown** condition. NRW published the latest condition assessment in June 2025. NRW will review these conservation objectives when new condition assessment information is available.

Figure 8 is a map of the location of the sea caves feature within Pembrokeshire Marine SAC. The map is for illustrative purposes only. Detailed maps for this feature in Wales can be found on Data Map Wales.

Figure 8. Map of the sea caves feature within Pembrokeshire Marine SAC.



Below are the attributes and targets for each conservation objective alongside supporting information.

Objective 1: The overall distribution and extent of the sea caves feature within the SAC and each of its main component habitats are stable or increasing, subject to natural change.

Objective attribute	**Site specific target**
1a. Feature extent and distribution	Maintain the extent and distribution of sea caves habitat, subject to natural change.

Supporting information

1a. Feature extent and distribution

The extent describes the presence and area of the habitat across the whole site. The distribution describes the more detailed locations and patterns of different habitats that comprise the feature across the SAC. The sea caves feature is distributed widely throughout much of the SAC in intertidal and subtidal areas. The largest known concentrations of intertidal sea caves are on St. David's peninsula, Ramsey Island, Skomer Island and the Castlemartin coast. There are also probably many small, inconspicuous or inaccessible intertidal caves that have not been surveyed.

The distribution and extent of subtidal sea caves is less well known as most have been discovered opportunistically. These tend to be from just below the surface down to around 20m. As sea levels were up to 40m below present levels during previous glacial periods many more are likely to have been formed, including in deeper water. The total area of both intertidal and subtidal sea caves is small relative to the size of the SAC.

Sea caves in the SAC can be broadly grouped on the basis of their underlying geology being found in volcanic rock e.g. Skomer and Ramsey, in limestone rock in along the south Pembrokeshire coast and in areas of faulted sedimentary rock and complex geology e.g. Ramsey, St Brides Bay, St. David's and Marloes Peninsula. Habitat variety is increased by the presence of limestone, slates and shales that support rock boring and crevice dwelling species.

The extent and distribution attribute is being met, allowing a maintain target to be set for objective 1a. For more information see the latest condition assessment (Hatton-Ellis et al., 2025).

Objective 2: The hydro-morphological and chemical elements necessary for the structure and function of the feature are stable or improving, subject to natural change.

Objective attribute	Site specific target(s)
2a. Water and sediment quality	Contaminants are at levels not detrimental to the structure and function of the sea caves feature. Nutrients are at levels not detrimental to the structure and function of the sea caves feature. Physicochemical characteristics are at levels not detrimental to the structure and function of the sea caves feature.
2b. Hydro-morphology	The characteristic hydrodynamics, sediment transport and morphology necessary for the structure and function of the sea caves feature are sustained.
2c. Sediment supply	The sediment type, size distribution and budget necessary for the structure and function of the sea caves feature are sustained

Supporting information

2a. Water and sediment quality

Various contaminants are known to affect species living within the water column and in or on the surface of sediments. The biological effect of a contaminant will vary depending on its nature. Contaminants include, but are not limited to, heavy metals (e.g. mercury and zinc), Polybrominated diphenol ethers (PBDEs), poly-aromatic hydrocarbons (PAHs), poly-chlorinated biphenyls (PCBs) and organotin and pesticides such as hexachlorobenzene. These chemicals (e.g. heavy metals) can degrade community structure and bioaccumulate within organisms, entering the marine food chain (e.g. PCBs) (OSPAR Commission, 2012).

High concentrations of nutrients in the water column can cause phytoplankton and opportunistic macroalgae blooms, leading to reduced dissolved oxygen availability. This can impact sensitive fish, epifauna and infauna communities. Overgrowth of opportunistic macroalgae species because of increased nutrient input on intertidal reef can reduce biodiversity, though the effect of grazers and wave action can help limit the impacts (Bokn et al., 2003; Worm and Lotze, 2006). High nutrient loads may be more of an issue on sheltered intertidal reef with low grazing pressure (Bokn et al., 2003). This is likely to be true for intertidal and shallow sub-tidal sea caves.

Physicochemical characteristics include salinity, pH, temperature, dissolved oxygen and turbidity. They affect habitats in terms of the abundance, distribution and composition of communities present. Changes in any of these properties, because of anthropogenic activities, may impact habitats and the communities they support.

Water quality issues have been identified for this feature. For more information see the latest condition assessment (Hatton-Ellis et al., 2025).

2b. Hydro-morphology

Hydro-morphology refers to patterns of water movement (caused by waves, wind, tides and fluvial input), coastal processes (e.g. erosion and deposition), and the physical characteristics of the environment. Waves and currents can move sediment, which can change the shape of the seabed, which in turn changes waves and currents; in other words there is two-way feedback between the hydrodynamics and the morphology. As water movement transports nutrients, sediment and other particles, it also strongly influences the species and communities present.

The most important structure and function characteristics for the sea caves feature are the geology and geomorphology, including topography (surface features), together with hydrodynamic processes (wave action and tidal currents) and water quality and clarity (turbidity). Sea cave morphology and topography is varied and determined by the underlying geology. Microtopography is a further important dimension to habitat variation. Cave surfaces range from smooth, unbroken rock walls to fractured, fissured and perforated surfaces.

Caves on the shore and in the shallow sublittoral zone are frequently subject to conditions of strong wave surge and tend to have floors of coarse sediment, cobbles and boulders, which often scour the cave walls. Caves that occur in deeper water are subject to less water movement from the surrounding sea, and silt may accumulate on the cave floor.

Tidal streams in the vicinity of sea caves vary from nil to extremely strong (>5 m sec-1; e.g. Jack Sound, Ramsey Sound). The inside of the majority of sea caves themselves are inherently current sheltered, though many tunnel-caves, particularly those in headlands and islands, are exposed to, and accelerate moderate to strong tidal streams. A change in these environmental conditions could detrimentally affect the quality and variety and therefore functions of the various habitats in the sea caves feature. Information on the hydro-morphology of the SAC can be found in Appendix 1.

2c. Sediment supply

Sediment type, distribution and supply are important in determining the species and communities present in a habitat. The rate at which sediment is deposited is known to influence sea cave habitats and their associated communities. Sedimentation influences community composition, alters species growth rates, inhibits feeding or photosynthesis and potentially affects reproductive success by reducing larval recruitment. High levels of sediment deposition could lead to smothering or burying of sessile benthic species.

The mobilisation and deposition of sediment as a result of water movement is regular and widespread and can lead to rapid fluctuations in sediment height. The floors of many sea caves are areas of sediment or mixtures of sediment and pebbles, cobbles and boulders, with sheltered locations in caves tending to accumulate silt. The sediments contribute to the habitat and species diversity and composition and have a strong influence on the amount of scouring of cave walls. Suspended particulate concentrations are generally significantly higher in sea caves subject to water movement with sediment floors or with a nearby sediment source, than levels in the adjacent external water column.

The combined effects of scour from suspended particulates and sediment and food particle supply are particularly important to the development, survival and diversity of cave species populations, especially in caves adjacent to sediment or with sediment floors. The species populations in different sea caves reflect the differing balance between these effects. Information on sedimentology in the SAC can be found in Appendix 1.

Objective 3: The abundance, distribution and diversity of species within component habitats and communities necessary for the structure and function of the sea caves feature are stable or improving, subject to natural variability.

Objective attribute	Site specific target
3a. Habitats and communities	Maintain the abundance, distribution and diversity of species within component habitats and communities necessary for the structure and function of the sea caves feature.
3c. Invasive and non-native species	Introduction or spread of new non-native species to the SAC by anthropogenic activities should not have a detrimental impact on the structure and function of the estuaries feature.

Supporting information

3a. Habitats and communities

All the sea cave communities within the SAC contribute to the overall representation, range and condition of the feature within the SAC. Changes to the spatial distribution of communities across the feature could highlight changes to the overall feature.

The wide range of rock type, cave morphology, topography, depth and exposures to water movement, scour and light contribute to the high species diversity in sea caves within the SAC. Sea caves also typically support species that seem out of place, because caves provide environmental conditions which differ from those immediately outside, for example sponges typical of deep-water in intertidal caves and mud dwelling anemones in sediments on the floor of caves in exposed rocky areas. The number of marine algal and invertebrate species associated with sea-caves can be high, but highly variable between and within sea-caves.

Many sea cave habitats provide highly favourable environmental conditions for key ecological structuring species (e.g. grazing molluscs, scavenging crustaceans) and predatory fish species. More information in the communities found in the sea caves of Pembrokeshire Marine SAC can be found in Appendix 1.

There is no information on the habitats and communities of this feature. Therefore a default maintain target has been set for objective 3a.

3c. Invasive and non-native species

Non-native species (NNS) may become invasive non-native species (INNS) and displace native species by predating them or out-competing them for food, space or both. This can lead to the loss of indigenous species from certain areas or changes to community structure (JNCC, 2004b; Levin et al., 2002), as well as changes to biotope and habitat type. The introduction or spread of NNS within the SAC can occur through various regulated and unregulated pathways. Further information on introduction pathways can be found on the GB non-native species secretariat website.

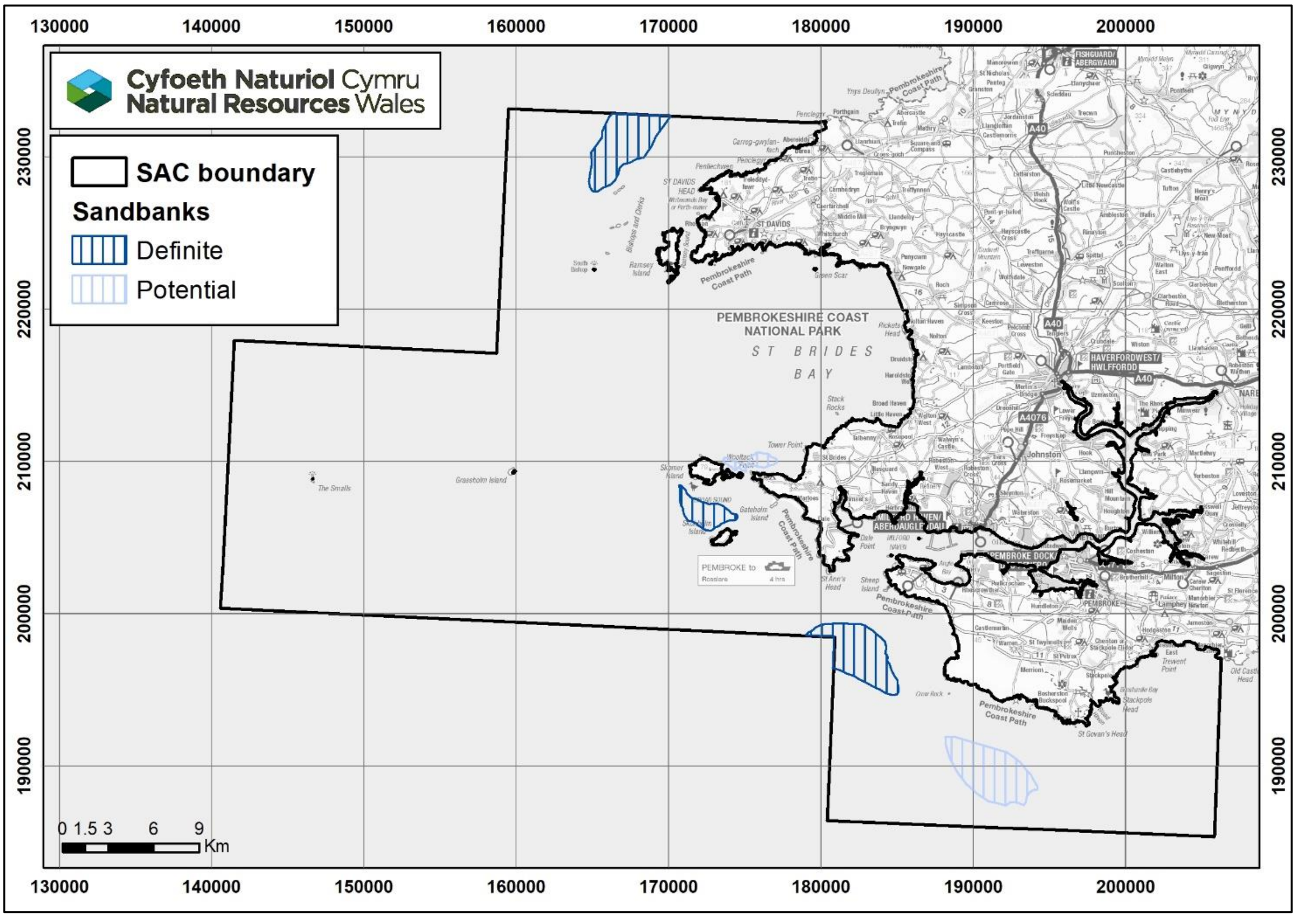
There is no information on INNS in the sea caves in Pembrokeshire Marine SAC. Information on INNS in the SAC as a whole can be seen in Appendix 1.

3.9. Feature 9: Sandbanks which are slightly covered by sea water all the time

The sandbanks which are slightly covered by sea water all the time (sandbanks) feature within Pembrokeshire Marine SAC is currently in **favourable** condition (medium confidence). NRW published the [latest condition assessment] in June 2025. NRW will review these conservation objectives when new condition assessment information is available.

Figure 9 is a map of the location of the sandbanks feature within Pembrokeshire Marine SAC. The map is for illustrative purposes only. Detailed maps for this feature in Wales can be found on [Data Map Wales.]

Figure 9. Map of the sandbanks feature within Pembrokeshire Marine SAC.



Below are the attributes and targets for each conservation objective alongside supporting information.

Objective 1: The overall distribution and extent of the sandbanks feature within the SAC is stable or increasing, subject to natural change.

Objective attribute	Site specific target
1a. Feature extent and distribution	Maintain the extent and distribution of each of the sandbanks that form the sandbanks feature, subject to natural change.

Supporting information

1a. Feature extent and distribution

The extent describes the presence and area of the habitat across the whole site, even where it is patchy. The distribution describes the more detailed locations and patterns of different habitats that comprise the feature across the site.

The major known subtidal sandbanks in the SAC include Bais Bank, Turbot Bank and sandbanks in the vicinity of Skokholm (The Knoll). There are also sandbanks associated with St Govan's Shoals reefs and in south-west St Brides Bay. The gross distribution of the main subtidal sandbanks themselves appears quite stable and stability is likely to increase with depth.

The extent and distribution attribute is being met, allowing a maintain target to be set for objective 1a. See the latest condition assessment for more information (Jackson-Bué et al., 2025e).

Objective 2: The hydro-morphological and chemical elements necessary for the structure and function of the sandbanks feature are stable or improving, subject to natural change.

Objective attribute	Site specific target(s)
2a. Water and sediment quality	Contaminants are at levels not detrimental to the structure and function of the sandbanks feature. Nutrients are at levels not detrimental to the structure and function of the sandbanks feature. Physicochemical characteristics are at levels not detrimental to the structure and function of the sandbanks feature.
2b. Hydro-morphology	The characteristic hydrodynamics, sediment transport and morphology necessary for the structure and function of the sandbanks feature are sustained.
2c. Sediment supply	The sediment type, size distribution and budget necessary for the structure and function of the sandbanks feature are sustained.

Supporting information

2a. Water and sediment quality

Various contaminants are known to affect species living within the water column and in or on the surface of sediments. The biological effect of a contaminant will vary depending on its nature. Contaminants include, but are not limited to, heavy metals (e.g. mercury and zinc), polybrominated diphenol ethers (PBDEs), poly-aromatic hydrocarbons (PAHs), poly-chlorinated biphenyls (PCBs) and organotin and pesticides such as hexachlorobenzene. These chemicals (e.g. heavy metals) can degrade community structure and bioaccumulate within organisms, entering the marine food chain (e.g. PCBs) (OSPAR Commission, 2012).

The water quality contaminant indicator met its targets for the sandbanks feature in the latest condition assessment (Jackson-Bué et al., 2025). Much of the sandbank feature lies outside of WFD waterbodies and outside of the 1 nautical mile from mean high water routine sampling area. Accumulation of sediments in sandbanks is likely to be minimal due to the coarse and mobile nature of the sand. Dilution effects of chemicals are also likely.

High concentrations of nutrients in the water column can cause phytoplankton and opportunistic macroalgae blooms. These blooms can lead to reduced dissolved oxygen availability especially in warmer months. This can have lethal and sub-lethal impacts on sensitive fish, epifauna and infauna communities (Best et al., 2007). Sandbanks are at lower risk from issues caused by excess nutrients due to their subtidal nature and being further away from the shore where inputs are diluted.

Physicochemical characteristics include salinity, pH, temperature, dissolved oxygen and turbidity. They affect habitats in terms of the abundance, distribution and composition of communities present. Changes in any of these properties, because of anthropogenic activities, may impact habitats and the communities they support.

No water or sediment quality issues have been identified for this feature. More information on water and sediment quality can be found in the latest condition assessment (Jackson-Bué et al., 2025e).

2b. Hydro-morphology

Hydro-morphology refers to patterns of water movement (caused by waves, wind, tides and fluvial input) coastal processes (e.g. erosion and deposition), and the physical characteristics of the environment. Waves and currents move sediment, which can change the shape of the seabed, which in turn changes waves and currents; in other words there is two-way feedback between the hydrodynamics and the morphology. As water movement transports nutrients, sediment and other particles, it also strongly influences the species and communities present.

Many of the sandbanks in the Pembrokeshire Marine SAC are headland-associated sand banks (e.g. Bais Bank). These types of sandbanks are stable and principally maintained by current (and associated sediment transport) residuals which circulate the banks. Therefore, changes to residuals have the potential to affect the bank stability and morphology and should be avoided.

Sandbanks often have smaller rhythmic morphological features (described as ripples, mega-ripples or sand waves depending on length scales) superimposed on the bank morphology. These smaller features are important to water flow and sediment transport around or over the sandbanks. A change in these environmental conditions could detrimentally affect the quality and variety and therefore functions of the various habitats in the sandbanks feature.

No hydro-morphology issues have been identified for this feature (Jackson-Bué et al., 2025e). Information on hydro-morphology within the SAC can be found in Appendix 1.

2c. Sediment supply

The size, shape, aspect and orientation, as well as the macro- and micro-topography and sediment characteristics of sandbanks are largely determined by the sediment supply and the influence of the hydrodynamic processes affecting each bank. They change shape over time and while some are ephemeral, most large banks are relatively stable and long-established. Mobile sediments that form temporary sandbanks are associated sediments that should be retained in the system, although their location may change.

Typically, well-sorted medium sand occurs on uppermost parts of a sandbank, becoming coarser down the flanks and poorly sorted with increased silt and coarse sediments around the base. Bais Bank is mostly uniform medium sand and Turbot Bank fine to medium sand. South St Brides Bay is medium-coarse sand to gravely sand. Sediment budgets and transport are often on a regional scale, and therefore projects outside the SAC can still alter the sediment supply to features within the site.

No sediment supply issues have been identified for this feature. More information on water and sediment quality can be found in the latest condition assessment (Jackson-Bué et al., 2025e). Information on the sediment transport in the SAC can be found in Appendix 1.

Objective 3: The abundance, distribution and diversity of species within component habitats and communities necessary for the structure and function of the sandbanks feature are stable or improving, subject to natural variability.

Objective attribute	**Site specific target**
3a. Habitats and communities	Maintain the abundance, distribution and diversity of species within communities and habitats necessary for the structure and function of the sandbanks feature
3b. Non-native species	Introduction or spread of new non-native species to the SAC by anthropogenic activities should not have a detrimental impact on the structure and function of the sandbanks feature.

Supporting information

3a. Habitats and communities

Biological processes and interactions such as competition and predation also play an important structural and functional role in influencing the assemblages of marine species associated with the subtidal sandbanks feature throughout the SAC.

Species richness is higher in deeper, more heterogeneous sediments toward the lowest extremities of the banks and where there is less exposure to waves and currents. It is lowest in the dynamic well-sorted sands on the upper parts of the banks. Species colonising sandbanks provide a rich food source for birds and fish. Infauna of surveyed banks is dominated by polychaete worms, crustaceans and molluscs. Benthic fish species such as gobies, some flatfish, skates and rays and weevers inhabit sandbanks and form an important part of the epifauna and food web of the sandbanks feature of the site.

There has been a decline the in species diversity of Bais Bank sandbank. However this was not considered to be large enough to fail the attribute. Therefore, the habitat and communities attribute is being met, allowing a maintain target to be set for objective 3a. For more information see the latest condition assessment (Jackson-Bué et al., 2025e).

3b. Non-native species

Non-native species (NNS) may become invasive non-native species (INNS) and displace native species by predating them or out-competing them for food, space or both. This can lead to the loss of indigenous species from certain areas or changes to community structure (JNCC, 2004b; Levin et al., 2002), as well as changes to biotope and habitat type. The introduction or spread of NNS within the SAC can occur through various regulated and unregulated pathways. Further information on introduction pathways can be found on the GB non-native species secretariat website.

No INNS have been recorded in any of the three monitored sandbanks of the feature (Jackson-bué et al., 2025e). Information on INNS in the SAC as a whole can be seen in Appendix 1.

3.10. Features 10 and 11: Allis Shad *Alosa alosa* and Twaite shad *Alosa fallax*

The allis Shad *Alosa alosa* and twaite shad *Alosa fallax* features in the Pembrokeshire Marine SAC are currently in **unfavourable** condition (low confidence). NRW published the latest condition assessment in June 2025. NRW will review these conservation objectives when new condition assessment information is available.

Below are the attributes and targets for each conservation objective alongside supporting information.

Objective 1: The wider allis and twaite shad populations that use the SAC are restored to favourable condition and are stable or increasing in the long-term.

Objective attribute	Site specific target
1a. Population	Restore the wider allis and twaite shad populations relevant to the SAC to favourable condition.
1b. Anthropogenic mortality	Anthropogenic mortality is not having a detrimental impact on the allis and twaite shad populations that use the SAC.

Supporting information

1a. Population

The SAC was designated for both species for use as a migration route. The populations of allis and twaite shad using the SAC are thought to migrate from spawning grounds in the Rivers Tywi, Severn, Usk and Wye. Smaller contributions to the population of both species in the Pembrokeshire Marine SAC may come from other, smaller shad populations. For example in Cardigan Bay, the Taw, Torridge and Tamar rivers in England, or from rivers in Ireland, France and Belgium given the known migration range of these species (Davies et al., 2020). There are no known historical allis and twaite shad spawning grounds in the freshwater catchments directly upstream of the Pembrokeshire Marine SAC (Cleddau Rivers SAC).

NRW has records of shad eggs which show that shad are spawning on a regular basis in the relevant river catchments. However, it is not possible to determine what species the eggs are. The International Union for Conservation of Nature classifies allis shad as "Critically Endangered (Presumed Extinct)" in Wales. Although it is possible that allis shad spawn in Wales, numbers are likely to be extremely small and hybridisation with (the more abundant) twaite shad probably means allis shad is functionally extinct in Wales.

Twaite shad populations have been declining particularly in the Severn and data of twaite shad in Pembrokeshire Marine SAC is limited (Wynter et al., 2025a).

The latest condition assessment found the wider shad population to not be stable. There are a lack of shad records within the Pembrokeshire Marine SAC, and low numbers of both species in the historical spawning populations in the Rivers Tywi and Severn. Therefore the population attribute is not being met and a restore objective has been set for objective 1a. For more information see the latest condition assessment (Wynter et al., 2025a).

1b. Anthropogenic mortality

Anthropogenic mortality may include but is not limited to:

- Entrapment - fish entering water intake systems of water abstractions or dredgers and either being trapped on screens (impingement) or passing through screens and the works and re-entering the environment in water discharge outfalls (entrainment);
- Targeted exploitation – fisheries catching specific species intentionally, and using specific methods, fishing areas and times to do so;
- By-catch – fisheries catching specific species unintentionally, through use of methods, fishing areas and times which aim to catch other species but for which there remains a risk of catching the specific species.

Adversely affecting the population may include, but is not limited to, changes in numbers of fish or mortality rates in the population, changes in recruitment, productivity, spawning success or migration success across the population, and changes in age structures or size structures of the population.

There is no targeted exploitation of twaite and allis shad known to be taking place within the Pembrokeshire Marine SAC, or in the river populations which contribute to the Pembrokeshire Marine SAC population. Bycatch of twaite and allis shad species within the Pembrokeshire Marine SAC is understood to be low. However, there is limited data on bycatch, especially for unregulated fishing. In addition, the pelagic fisheries in the Celtic Sea may have significant bycatch of shad species given the fishing locations, methods and species targeted but there is no data on the potential impact of this (Wynter et al., 2025).

In Wales, all licenced abstractions have been assessed through Habitats Regulations Review of Consents process, the Eel Regulations, or Salmon and Freshwater Fisheries Act 1975 to ensure that all permitted abstractions are screened to minimise entrainment of fish. There are no major operations within the Pembrokeshire Marine SAC known to be causing entrapment of shad.

The latest condition assessment did not identify any causes of anthropogenic mortality that could adversely affect the populations (Wynter et al., 2025a).

Objective 2: The allis and twaite shad population that use the SAC continue to have unimpeded access to the habitats necessary for the marine phase of their migration.

Objective attribute	**Site specific target**
2a. Habitat connectivity	Maintain safe passage and movement of allis and twaite shad in the marine environment into, within and away from the SAC.
2b. Disturbance	Allis and twaite shad populations that use the SAC are not subject to significant anthropogenic disturbance.

Supporting information

2a. Habitat connectivity

There are no spawning populations of twaite or allis shad within the eastern or western Cleddau rivers. The population of twaite and allis shad within the Pembrokeshire Marine SAC originate from other areas including predominantly the Rivers Severn, Tywi, Wye and Usk as discussed in Objective 1a, and they will use the Pembrokeshire Marine SAC as a coastal feeding ground during their marine residency phase and on migration to and from their spawning rivers.

The marine habitat requirements of shad in the Pembrokeshire Marine SAC have not been studied, but data from elsewhere indicate that important habitats include the salt wedge at the head of the tide (Maitland and Hatton-Ellis, 2003) and warm shallow inshore waters and estuaries (Aprahamian et al., 2002), both of which are extensive within the SAC. There are no known impediments to migration of shad in the Pembrokeshire Marine SAC presently.

There are also no known marine barriers from the Severn Estuary SAC and Carmarthen Bay and Estuaries SAC, and along the coast and in the Bristol Channel that could impact twaite shad in the Pembrokeshire Marine SAC (Wynter et al., 2025a).

2b. Disturbance

Significant anthropogenic disturbance in this context is defined as activities which change the behaviours of shad in the short-term or long-term, at a level which could cause changes in numbers of fish or mortality rates in the population, changes in recruitment, productivity, spawning success or migration success across the population, and changes in age structures or size structures of the population. Disturbance could come from, for example, noise and vibration, water quality changes, structures or electromagnetic fields.

The latest condition assessment did not identify any sources of significant anthropogenic disturbance to shad in the Pembrokeshire Marine SAC (Wynter et al., 2025a).

Objective 3: The quality of habitat and abundance of food supply is sufficient to restore the population of allis and twaite shad that use the SAC to favourable condition.

Objective attribute	**Site specific target(s)**
3a. Water quality	Contaminants are at levels not detrimental to the condition of allis and twaite shad populations that use the SAC. Dissolved oxygen levels are at levels not detrimental to the condition of allis and twaite shad populations that use the SAC. Physicochemical characteristics are at levels not detrimental to the condition allis and twaite shad populations that use the SAC.
3b. Prey availability	Maintain the quality, abundance and diversity of prey needed for the allis and twaite shad populations that use the SAC to be in favourable condition.
3c. invasive non-native species	Invasive non-native species are not detrimental to the condition of allis and twaite shad populations that use the SAC.

Supporting information

3a. Water quality

Various contaminants are known to affect species living within the water column and in or on the surface of sediments. The biological effect of a contaminant will vary depending on its nature, but can lead to reductions in fitness or changes in olfactory senses. Contaminants include, but are not limited to, heavy metals (e.g. mercury and zinc), Polybrominated dipheynol ethers (PBDEs), poly-aromatic hydrocarbons (PAHs), poly-chlorinated biphenyls (PCBs) and organotin and pesticides such as hexachlorobenzene. (OSPAR Commission, 2012).

Water quality issues have been identified for this feature. For more information on water quality see the latest condition assessment (Wynter et al., 2025a).

3b. Prey availability

Adult allis shad feed predominantly on marine crustaceans such as mysids, whereas adult twaite shad predominantly take small fish such as sprats. Juveniles of both species feed on zooplankton when small and larger crustaceans such as mysids as they grow.

Suitable habitats must include abundant, suitable prey of suitable quality to support the populations. The water column throughout the site is assumed to be suitable habitat and the water quality to be of sufficiently high quality in open coastal water.

The status of preferred prey species within the SAC, and any potential contamination load of prey species is unknown. Therefore a default maintain target has been set for objective 3b. For more information see the latest condition assessment (Wynter et al., 2025a).

3c. invasive non-native species

Non-native species (NNS) may become invasive non-native species (INNS) and displace native species by predating them or out-competing them for food, space or both. This can lead to the loss of indigenous species from certain areas or changes to community structure (JNCC, 2004; Levin et al., 2002), as well as changes to biotope and habitat type. The introduction or spread of NNS within the SAC can occur through various regulated and unregulated pathways. Further information on introduction pathways can be found on the GB non-native species secretariat website.

The invasive non-native species that could significantly impact the allis shad are Chinese mitten crab and Signal crayfish. There have been no known records of these species within the Pembrokeshire Marine SAC (Wynter et al., 2025a). Information on INNS in the SAC as a whole can be seen in Appendix 1.

3.11. Features 12 and 13: River lamprey *Lampetra fluvaitilis* and Sea lamprey *Petromyzon marinus*

The river lamprey *Lampetra fluvaitilis* and sea lamprey *Petromyzon marinus* features in the Pembrokeshire Marine SAC are currently in **unfavourable** condition (high confidence). NRW published the latest condition assessment in June 2025. NRW will review these conservation objectives when new condition assessment information is available.

Below are the attributes and targets for each conservation objective alongside supporting information.

Objective 1: The river and sea lamprey population that use the SAC are maintained in favourable condition and the sea lamprey population are restored to favourable condition. Both populations are stable or increasing in the long-term.

Objective attribute	Site specific target(s)
1a. Population	Maintain the river lamprey populations relevant to the SAC in favourable condition. Restore the sea lamprey populations relevant to the SAC to favourable condition.
1b. Anthropogenic mortality	Anthropogenic mortality is not having a detrimental impact on the river and sea lamprey populations that use the SAC.

Supporting information

1a. Population

The population of river and sea lamprey in the Pembrokeshire Marine SAC will be made up predominantly of fish from the Cleddau rivers. Other nearby rivers may also contribute to the population using the SAC. The Pembroke river has the potential to support river and sea lampreys too, but existing barriers are likely to be significantly limiting the population on this river.

River and sea lampreys are difficult to sample in the marine environment. Inferences about the status of the river and sea lamprey populations in the Pembrokeshire Marine SAC are based on condition monitoring of the Cleddau Rivers SAC, which assesses the extent and density of juvenile lampreys, augmented by other data if available.

There have been no targeted surveys of river lamprey in the Cleddau Rivers SAC and Pembrokeshire Marine SAC so the population is unknown (Wynter et al., 2025b). There has been no evidence of sea lamprey on the Eastern Cleddau in the last 10 years, with no redds observed in the reaches upstream of the Canaston weir. Acoustic monitoring on the western Cleddau in 2014 identified a very small number of migrating adult sea lamprey compared to other regions. It is likely there were more present due to sampling restrictions, however numbers would still be very low (Wynter et al., 2025b).

The population of river lamprey relevant to the SAC is unknown. Therefore river lamprey have been set a default maintain target for objective 1a. The population of sea lamprey is not considered to be stable or increasing. Therefore the population attribute for sea lamprey is not being met and a restore target has been set for objective 1a. For more information see the latest condition assessment (Wynter et al., 2025b).

1b. Anthropogenic mortality

Anthropogenic mortality may include but is not limited to:

- Entrapment - fish entering water intake systems of water abstractions or dredgers and either being trapped on screens (impingement) or passing through screens and the works and re-entering the environment in water discharge outfalls (entrainment);
- Targeted exploitation – fisheries catching specific species intentionally, and using specific methods, fishing areas and times to do so;
- By-catch – fisheries catching specific species unintentionally, through use of methods, fishing areas and times which aim to catch other species but for which there remains a risk of catching the specific species.

Adversely affecting the population may include, but is not limited to, changes in numbers of fish or mortality rates in the population, changes in recruitment, productivity, spawning success or migration success across the population, and changes in age structures or size structures of the population.

There is no targeted exploitation of river or sea lamprey known to be taking place within the Pembrokeshire Marine SAC, or in the river populations which contribute to the Pembrokeshire Marine SAC population. Bycatch of river and sea lamprey within the Pembrokeshire Marine SAC is understood to be low. However, there is limited data on bycatch, especially for unregulated fishing.

In Wales, all licenced abstractions have been assessed through Habitats Regulations Review of Consents process, the Eel Regulations, or Salmon and Freshwater Fisheries Act 1975 to ensure that all permitted abstractions are screened to minimise entrainment of fish.

Pembroke Power Station, which is a major water abstractor within the SAC, has recorded impingement of sea lamprey. For more information see the latest condition assessment (Wynter et al., 2025b).

Objective 2: The river and sea lamprey that use the SAC have unimpeded access to the habitats necessary to complete their life cycle restored.

Objective attribute	**Site specific target**
2a. Habitat connectivity	Restore safe passage and movement of river and sea lamprey into, within and away from the SAC, including to and from the connected spawning locations.
2b. Disturbance	River and sea lamprey that use the SAC are not subject to significant anthropogenic disturbance.

Supporting information

2a. Habitat connectivity

Adult river and sea lampreys migrate through the Pembrokeshire Marine SAC on their spawning migration to reach the Cleddau Rivers SAC, which covers the eastern and western Cleddau rivers. It is important that there are sufficient freshwater flows in rivers, and in to estuaries, to provide freshwater flow cues for migration, as migrating lampreys are understood to be attracted to the pheromones from other lampreys in freshwater, and to allow upstream migration to spawning grounds.

Juvenile river lampreys generally migrate into estuaries and inshore coastal waters after a period of growth as ammocoetes in freshwater. River lampreys from other rivers nearby to the Pembrokeshire Marine SAC may also provide a limited contribution to the river lamprey population of the SAC. Since river lampreys feed and grow in estuaries and inshore waters, it should be assumed that juveniles and sub-adults are present in the SAC throughout the year.

Juvenile sea lampreys migrate downstream after a period of growth as ammocoetes in freshwater and spend some time feeding in the estuary and inshore waters, with some moving offshore in search of larger prey. Sea lampreys from other rivers along the South Wales coastline and throughout Cardigan Bay are also quite likely to be present in the Pembrokeshire Marine SAC given their wider home range during their marine residency and feeding phase. Accordingly, various stages of sea lamprey should be assumed to be present in the SAC throughout the year.

While there are no known barriers to migration of lamprey within the Pembrokeshire Marine SAC itself, there are two structures that are currently impeding passage of both lamprey species between the marine SAC and the connected spawning rivers (Cleddau Rivers SAC). Barriers to fish migration are also present on the Pembroke river and could benefit river lamprey if removed. Until work has taken place to improve the passage through these structures and the effects have been observed, access will continue to be impeded (Wynter et al., 2025b).

Therefore, the habitat connectivity attribute is not being met and a restore target has been set for objective 2a. For more information see the latest condition assessment (Wynter et al., 2025b).

2b. Disturbance

Significant anthropogenic disturbance in this context is defined as activities which change the behaviours of shad in the short-term or long-term, at a level which could cause changes in numbers of fish or mortality rates in the population, changes in recruitment, productivity, spawning success or migration success across the population, and changes in age structures or size structures of the population. Disturbance could come from, for example, noise and vibration, water quality changes, structures and/or electromagnetic fields.

The latest condition assessment did not identify any sources of significant anthropogenic disturbance to lamprey in the Pembrokeshire Marine SAC (Wynter et al., 2025b).

Objective 3: For the populations that use the SAC, the quality of habitat and abundance of food supply is sufficient to maintain river and sea lamprey in favourable condition and restore sea lamprey to favourable condition.

Objective attribute	**Site specific target(s)**
3a. Water quality	Contaminants are at levels not detrimental to the condition of river and sea lamprey populations that use the SAC. Dissolved oxygen levels are at levels not detrimental to the condition of river and sea lamprey populations that use the SAC. Physicochemical characteristics are at levels not detrimental to river and sea lamprey populations that use the SAC.
3b. Prey availability	Maintain the quality, abundance and diversity of prey needed for the river and sea lamprey populations that use the SAC to be in favourable condition.
3c. Invasive non-native species	Invasive non-native species are not detrimental to the condition of river and sea lamprey populations that use the SAC.

Supporting information

3a. Water quality

Various contaminants are known to affect species living within the water column and in or on the surface of sediments. The biological effect of a contaminant will vary depending on its nature but can lead to reductions in fitness or changes in olfactory senses. Contaminants include, but are not limited to, heavy metals (e.g. mercury and zinc), Polybrominated dipheynol ethers (PBDEs), poly-aromatic hydrocarbons (PAHs), poly-chlorinated biphenyls (PCBs) and organotin and pesticides such as hexachlorobenzene (OSPAR Commission, 2012).

Some water quality issues have been identified for this feature. For more information on water quality see the latest condition assessment (Wynter et al., 2025b).

3b. Prey availability During their marine phase, river lampreys are predominantly an estuarine and inshore coastal species, feeding parasitically. They feed on a wide array of freshwater and marine fish including Atlantic herring ,smelt and sprat (Renaud and Cochran, 2019).

Sea lampreys are much larger and more oceanic, feeding in the same way as river lamprey, initially on similar species before switching to larger prey, including sharks and cetaceans (Silva et al., 2014). Juvenile sea lampreys have been suggested to prefer migratory species as prey in freshwater and estuarine environments, perhaps due to their larger size (Silva et al., 2013), and prey selection is positively correlated with lamprey size (Silva et al., 2014). At sea they appear not to be very selective and have been recorded feeding on at least 54 different species. They are not thought to be restricted to any specific habitat and are likely to follow prey: however, a preference for demersal species and sheltered locations has been suggested (Silva et al., 2014).

The status of preferred prey species within the SAC, and any potential contamination load of prey species, is unknown. Therefore a default maintain target has been set for objective 3b. For more information see the latest condition assessment (Wynter et al., 2025b).

3c. Invasive non-native species

Non-native species (NNS) may become invasive non-native species (INNS) and displace native species by predating them or out-competing them for food, space or both. This can lead to the loss of indigenous species from certain areas or changes to community structure (JNCC, 2004; Levin et al., 2002), as well as changes to biotope and habitat type. The introduction or spread of NNS within the SAC can occur through various regulated and unregulated pathways. Further information on introduction pathways can be found on the GB non-native species secretariat website.

The INNS that could significantly impact the sea lamprey are Chinese mitten crab and Signal crayfish. There have been a small number records of signal crayfish in south Pembrokeshire, but not within the Cleddau Rivers SAC and tributaries. There are no other known records of these species within the Pembrokeshire Marine SAC or the Cleddau Rivers SAC catchment (Wynter et al., 2025b).

3.12. Feature 14: Otter *Lutra lutra*

The otter *Lutra lutra* feature within Pembrokeshire Marine SAC is currently in **unfavourable** condition (medium confidence). NRW published the latest condition assessment in June 2025. NRW will review these conservation objectives when new condition assessment information is available.

Below are the attributes and targets for each conservation objective alongside supporting information.

Objective 1: The otter population that use the SAC is restored to favourable condition and stable or increasing in the long term.

Objective attribute	Site specific target(s)
1a. Otter Population health	Maintain the otter population relevant to the SAC in favourable condition. Restore the wider population to be stable or increasing in the long term.

Supporting information

1a. Otter Population health

Otters present within the SAC are part of a wider population living around freshwater habitats in Pembrokeshire, which itself is not completely isolated but extends further afield and between which there are movements and exchanges. A genetic study found that otters in Wales are comprised of three genetically distinct subregions; southwest Wales, northwest Wales and mid-east Wales (Hobbs et al., 2011). The relevant wider region to the SAC is the southwest population though it is not clear what proportion of this wider population is using the site.

In Wales otters have been monitored through the Otter Survey of Wales (OSW) since the 1970s. The first report was published in 1978 and repeated every seven years since. Each survey consists of sites across all river catchments (hydrometric areas) in Wales. This equates to 1108 sites over 16 hydrometric areas. The number of positive sites in a hydrometric area are used as a proxy for population size.

Relevant hydrometric areas are those that border the SAC boundary. For Pembrokeshire Marine this is the Cleddau hydrometric area. In the 6th Otter Survey of Wales there was a statistically significant 13.8% decrease in the percentage of positive sites in the Cleddau, but 83% of sites were still positive (Kean and Chadwick, 2021). Therefore, the otter population relevant to the SAC within the otter population health attribute has been set a maintain target.

The latest survey showed this wider population has seen large declines across the southwest region and as a result the wider population is not stable or increasing (Kean and Chadwick, 2021). Therefore the wider population is not meet the attribute target and a restore has been set. This sets a restore target within the otter population health attribute and the overarching object 1. Further information can be found in the latest condition assessment (Cuthbertson et al., 2025b).

Objective 2: The otter population that use the SAC continue to have access to, and be able to utilise habitats necessary to restore the population to favourable condition.

Objective attribute	Site specific target
2a. Accessibility to habitat used by otters	Otter that use the SAC should not be significantly constrained from accessing necessary habitats within or outside of the site.
2b. Habitat connectivity	Maintain safe passage and movement of otters into, within and away from the SAC.

Supporting information

2a. Accessibility to habitat used by otters

Evidence of anthropogenic barriers within the SAC need to be considered when assessing this a conservation objective. Otters are widespread on, and close to, the coastline throughout the SAC, both on the open coast and within the Milford Haven Waterway, particularly within the Daugleddau and Cleddau Rivers. Spraint records and analysis and distribution of suitable feeding locations indicate a wide feeding range. Distribution is mostly associated with foreshore access via small river and stream valleys with sufficient scrub or tree cover, suitable feeding locations (rock-pools, sheltered boulder shores, with freshwater pools/streams for washing off salt) and ease of access to and along the shore.

It is vital that otters continue to have unimpeded access to habitats within and outside of the SAC that are necessary to restore the population that use the SAC to favourable condition. It is not only physical barriers or constraints that could reduce access to their habitat, noise and visual stimuli could also prevent otter from accessing an area. Whether an activity is causing significant constraint will be judged on a case by case basis.

While otters are elusive, records of otter sightings (which can include live sightings as well as footprints, spraints and roadkill), can provide evidence that otters are able to access suitable habitat in the SAC. There is currently no evidence otters that use the SAC are significantly constrained from accessing necessary habitats. For more information see the latest condition assessment (Cuthbertson et al., 2025b).

Otters in Wales primarily use riverine habitats to feed, rest and breed, however, a study in Pembrokeshire (Liles, 2009) showed that otters are heavily reliant on the marine habitat that comprises the Pembrokeshire Marine SAC. Signs of otters (mainly spraints) were found at coastal streams that lie within the marine SAC close to or at the point the stream meets the shore. See the latest condition assessment for further detail.

2b. Habitat connectivity

There remains much to understand of the extent to which otters use the coast and sea in Wales, however there have been reliable records of otters in the sea with one being seen 300m out. Therefore, it can be assumed that the coast and adjacent seas of the SAC contribute to supporting the otter population as a foraging area and corridor to movement between their primary riverine habitats. It is therefore essential that unimpeded access into, within and away from the SAC is maintained. Barriers should not block otter movement or threaten otter movement through increased risk of incidental injury or killing.

The latest condition assessment found no evidence of barriers to otter passage and movement of otters into, within and away from the SAC. Therefore, the otter habitat connectivity attribute is being met, allowing a maintain target to be set for objective 2b. Further information can be found in the latest condition assessment (Cuthbertson et al., 2025b).

Objective 3: The otter population that use the SAC have high quality habitat and sufficient food supply to support and restore the population to favourable condition.

Objective attribute	Site specific target
3a. Habitat quality and function	Maintain the quality and functionality of habitat to support the otter population that use the SAC.
3b. Water quality	Contaminants are at levels not detrimental to the otter population using the SAC.

Supporting information

3a. Habitat quality and function

As coastal habitat in the SAC is important to otters for foraging, resting and as an access corridor it is important that the SAC habitat is maintained in sufficient quality to support the population.

Coastal fringes where suitable prey habitat is readily accessible to otters is widespread throughout the SAC; i.e. sheltered shallow water such as rock-pools, lagoons and estuary shallows, accessible from freshwater habitat which otters need to wash saltwater from their coats.

Otter diet can be highly varied, though is normally focused on favoured prey species and a reflection of local prey availability. Fourteen marine species (mostly fish) were recorded from spraint collected within the SAC in 2002; European (freshwater) eels were the most important single component of their diet, present in 67% spraint samples (Liles, 2003). A wider variety of marine species were present in spraint from the Milford Haven Waterway than those from open coast sites.

Due to the lack of understanding on the quality and function of habitat in the SAC, a default maintain target has been set for objective 3a.

3b. Water quality

As a top predator, otters are vulnerable to accumulation of toxic contaminants present within their food chains, particularly those that are persistent and /or bioaccumulate and biomagnify (Kean et al., 2021). This is particularly the case for persistent organic pollutants (POPs) like polychlorinated biphenyls (PCBs) which are lipid soluble and heavy metals like mercury. The status of contamination of most likely prey species is unknown, although European eels are known to be substantially impacted by a range of contaminants (Jürgens et al., 2015). PCB contamination of otter prey species has been an issue elsewhere in the UK.

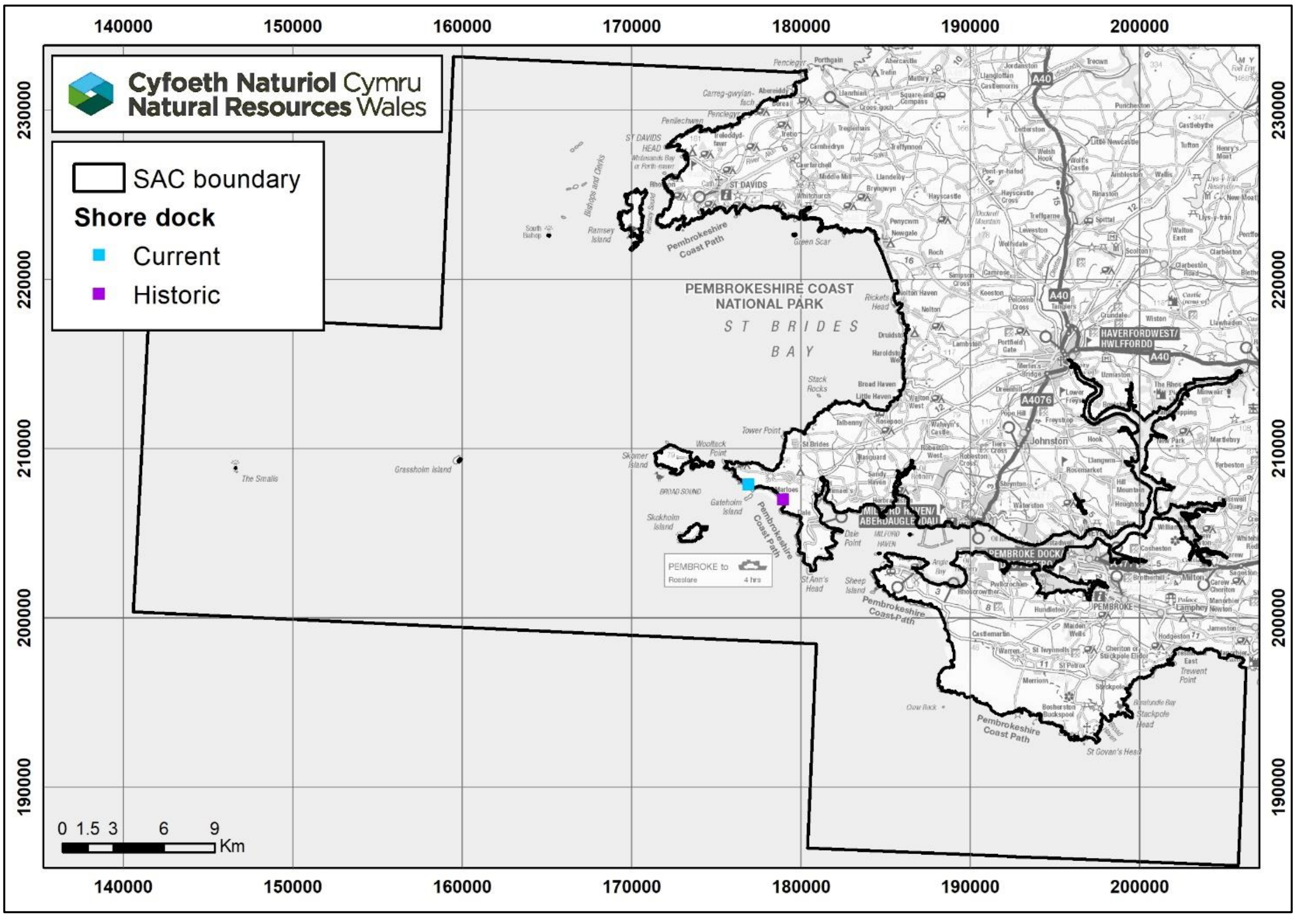
Contaminants have been identified as an issue for otter in this SAC. It is not clear what the impact of these chemicals could be on the otter population, either directly or through their prey. Information on water quality in the SAC can be seen in the latest condition assessment (Cuthbertson et al., 2025b).

3.13. Feature 15: Shore dock *Rumex rupestris*

The shore dock *Rumex rupestris* feature within Pembrokeshire Marine SAC is currently in **unfavourable** condition (medium confidence). NRW published the latest condition assessment in June 2025. NRW will review these conservation objectives when new condition assessment information is available.

Figure 10 is a map of the location of the shore dock feature within Pembrokeshire Marine SAC (current and historic). The map is for illustrative purposes only. Detailed maps for this feature in Wales can be found on Data Map Wales.

Figure 10. Map of the shore dock feature within Pembrokeshire Marine SAC.



Below are the attributes and targets for each conservation objective alongside supporting information.

Objective 1: The shore dock population in the SAC is maintaining itself on a long-term basis.

Objective attribute	**Site specific target(s)**
1a. Presence and abundance in the SAC	Maintain the presence and number of shore dock plants within the SAC.
1b. Reproductive success	Maintain level of reproduction needed to sustain the population in the long term. There should be no barriers to seed dispersal.

Supporting information

1a. Presence and abundance in the SAC

The shore dock Rumex rupestris is one of Europe's most threatened endemic vascular plants. The species is locally extinct in former parts of its range and only present in three locations in Wales. Colonies supporting 50 -100 individuals are considered large as most, especially those on rocky shores, generally hold fewer than ten individuals.

For this objective to be met there should be continued presence of shore dock within the SAC and the colony should continue to support the number of plants that reflect the minimum viable population size of the established colony. Detail on the number of plants required to maintain the colony can be found in the condition assessment.

NRW monitoring data from 2000-2024 indicates a stable population is present in the Watery Bay colony. As of the latest condition assessment, the health of the population in Watery Bay is not considered to be significantly compromised. Therefore, the presence and abundance in the SAC attribute is being met, allowing a maintain target to be set for objective 1a. For more information see the latest condition assessment (Jackson-Bué et al., 2025g).

1b. Reproductive success

Fruiting bodies and seedlings are needed as evidence that the population can maintain itself. A multi-stemmed shore dock plant can produce 20 flowering stems a year. A stem can produce over 500 fruits, so one plant can produce 10,000 fruits. A small single-spike plant will produce 50-100 fruits (King, 2006). A plant with 10-15 flowering stems can potentially produce large quantities of seed (5,000-20,000 seeds on a large multi-stemmed plant).

Due to the need for constant fresh water, poor weather conditions, such as prolonged dry weather, can limit seed production in any one year. However, poor fruiting in 2 or 3 years in every 5 is unlikely to be a problem (Bioret and Daniels, 2005). Detail on the number of reproductive plants required to maintain the colony can be found in the condition assessment.

It is thought that marine dispersal is the principal mechanism by which shore dock recolonizes new sites. Seeds have been shown to remain viable after floating in seawater for 181 days (King, 2006). Therefore, it is essential that seed dispersal is not constrained in anyway. There are currently no known anthropogenic barriers to seed dispersal (Jackson-Bué et al., 2025g).

In 2024 there were 97 fruiting plants recorded, with seedlings present. The shore dock in Pembrokeshire Marine was assessed to be maintaining levels of reproduction needed to sustain the population in the SAC. Therefore, the reproductive success attribute is being met, allowing a maintain target to be set for objective 1b. For more information see the latest condition assessment (Jackson-Bué et al., 2025g).

It is thought that marine dispersal is the principal mechanism by which shore dock recolonizes new sites. Seeds have been shown to remain viable after floating in seawater for 181 days (King 2006). Therefore, it is essential that seed dispersal is not constrained in anyway. There are currently no known anthropogenic barriers to seed dispersal (Jackson-Bué et al., 2025g).

Objective 2: The shore dock population within the SAC is such that the natural range of the population is not being reduced or likely to be reduced for the foreseeable future.

Objective attribute	**Site specific target(s)**
2a. Shore dock distribution	Shore dock should be present in two colonies in Watery Bay **AND** present in at least one other location within the SAC.
2b. Disturbance	The coastline should not be over-stabilised, nor over-eroded. There should be no evidence of anthropogenic disturbance to shore dock colonies.

Supporting information

2a. Shore dock distribution

Historically shore dock has been present at more than one location within the SAC. The most significant location outside of Watery Bay was at Hoopers point on the Marloes peninsular. However, severe storms in 2013/14 washed out and destroyed the satellite population at Hoopers point. No colonies outside of Watery Bay have been observed since. Without satellite colonies the feature is vulnerable to extinction in the site. For more information see the latest SAC condition assessment (Jackson-Bué et al., 2025g).

Shore dock occurs on cliff faces and within a relatively narrow zone above the high-water mark, in the presence of fresh water, often where dynamic processes of coastal erosion constantly create new bare ground. It is a poor competitor and acts like a pioneer plant.

Natural erosion and storm events help to maintain and create new colonisation niches. If a cliff was over stabilised, it could prevent this process. However, repeated intense storms or increased erosion would not allow new colonies to establish.

There should be no anthropogenic change by sea defence work, or development that over stabilises the shore dock environment in the SAC. It should be recognised that coastal defence works outside a site could also impact on sedimentary processes within the SAC.

2b. Disturbance

There is some circumstantial evidence to suggest that visitor pressure may be limiting population size on some sites around the UK (especially those with beach-head colonies). Proposed tourist developments within or close to existing sites should be carefully scrutinised regarding potential increases in visitor numbers. There have been instances of plants / colonies being lost due to dried fruiting stems and whole plants being used as kindling for beach bonfires. Trampling and litter also damaging and killing individuals (King, 2006). However the threat of this is low in Pembrokeshire Marine SAC as shore dock colonies are in a remote location that is hard to access on foot. There is currently no evidence of impacts to the coastline or anthropogenic disturbance to shore dock in the SAC. For more information see the latest SAC condition assessment (Jackson-Bué et al., 2025g).

Objective 3: There should be sufficient habitat, of sufficient quality, to support the shore dock population in the long term.

Objective attribute	Site specific target(s)
3a. Main colony supporting habitat	Maintain continual presence of freshwater with lateral water movement across the SAC. Maintain adequate presence of suitable habitat, with no coarse dominating vegetation. Spread and impact of invasive non-native species caused by anthropogenic activities is not adversely impacting current colonies or suitable habitat within the SAC.
3b. Satellite colony supporting habitat	Maintain continual presence of freshwater with lateral water movement across the SAC. Maintain adequate presence of suitable habitat within the SAC to allow satellite colonies to form.

Supporting information

3a. Main colony supporting habitat

Shore dock require constant freshwater. Anything that limits or removes that supply could be detrimental (e.g. lowering of water table, re-direction of surface watercourses or flow rate reduction). At Watery Bay the water supply is mostly from the Marloes Mere wetland, with some possibly from lateral flow off of fields above (which slope towards the ditch from the Mere. Any works on the Mere should consider the impact on the water flow out of the Mere and how this could impact the colony of shore dock at Watery Bay. The presence of freshwater attribute target is being met, allowing a maintain to be set. For more information see the latest condition assessment (Jackson-Bué et al., 2025g).

3b. Satellite colony supporting habitat

Shore dock occurs on a cliff face, with water flow down it and can occur within a relatively narrow zone above high-water mark, in the presence of fresh-water and in bare areas where there is a lack of competition (King, 2006). The aim should be to maintain open vegetation, so any shift towards more closed / tall / rank communities should be avoided as far as possible. The presence of suitable habitat target is being met, allowing a maintain to be set. For more information see the latest condition assessment (Jackson-Bué et al., 2025g).

Invasive non-native species (NNS) that could occupy the same niche as shore dock could be a threat to the populations long term survival due to the plants lack of ability to compete with other species (King, 2006). No INNS are currently threatening the population (Jackson-Bué et al., 2025g).

Satellite colonies in Pembrokeshire Marine were previously found at beach head locations, including Hoopers Point on the Marloes Peninsula. On some beach-head colonies freshwater may be hidden (i.e. below the surface). This means freshwater seepages lie within rooting distance of the plants. As a constant supply of freshwater is crucial, anything that limits or removes that supply could be detrimental (e.g. lowering of water table, re-direction of surface watercourses or flow rate reduction. The presence of suitable habitat target is being met, allowing a maintain to be set. For more information see the latest condition assessment (Jackson-Bué et al., 2025g).

It is plausible, that populations extinct as a result of coastal erosion events and winter storms, can be recolonized from other nearby populations when conditions become suitable again (King, 2006). An adequate presence of suitable habitat within the SAC is required to maximise the chances of satellite colonies forming. The presence of suitable habitat target is being met, allowing a maintain to be set. For more information see the latest condition assessment (Jackson-Bué et al., 2025g).

4. Advice on operations

NRW must provide advice to relevant authorities about operations that may cause,

- deterioration of designated natural habitats
- deterioration of the habitats of designated species
- the disturbance of designated species

This is statutory advice required by regulation 37(3b) of the Habitats Regulations.

This advice is to help relevant authorities direct and prioritise their management of activities that are of greatest threat to the features of the site. The advice given here is without prejudice to any advice provided in relation to the consideration of plans or projects within the meaning of Part 6 of the Habitat Regulations.

Activities operating at distance from the site may cause pressures that travel into the site. These external pressures may affect features within the SAC.

4.1. Operations which may cause deterioration or disturbance to the features of the site

Table 2 lists activities that have the potential to deteriorate or disturb the designated features of Pembrokeshire Marine SAC and if they are known to occur within the SAC.

This list of operations is not exhaustive. If an operation or activity is not listed in Table 2 it may still have the potential to deteriorate the features of the site. Activities occurring outside of the site may still have the potential to impact the features within the SAC. The occurrence information was correct at time of publication, but activities may have ceased or started since. Advice on individual operations should be sought on a case-by-case basis.

Additional information can be found on the Natural England's designated sites website and Marine Scotland's Feature Activity Sensitivity Tool (FEAST). It is important to note that NRW has not agreed sensitivity thresholds with either Natural England or Nature Scot and the information should be used as a general guide. Specific advice on operations should be sought from NRW on a case-by-case basis. Table 2. Operations and associated activities that have the potential to deteriorate or disturb the features of the SAC and information on where they currently occur.

Table 2. Advice on operations for Pembrokeshire Marine SAC.

Operation/Activity	Occurrence in SAC
Dredging: construction and maintenance, including disposal.	Mainly in the Milford Haven waterway. Former disposal site immediately outside Milford Haven; routine disposal of Milford Haven waterway spoil at licensed offshore disposal sites adjacent to site; trickle-feed disposal of Neyland Marina authorised within waterway
Shipping: Vessel traffic and maintenance (including antifouling).	Widespread and common in the SAC (notably in the Milford Haven Waterway).
Shipping: anchoring (commercial).	Widespread and common in the SAC. St Brides Bay is an important anchorage for large ships waiting to enter the Milford Haven Waterway.
Shipping: Conventional and accidental discharges. (Including ballast water discharge, refuse, sewage, operational, petrochemical, cargo losses and salvage).	Area at risk due to high volume of shipping traffic. Ballast water convention now in force.
Land claim (gain of land from the sea or coastal wetlands e.g. for agricultural purposes, industrial use and harbour expansions).	Lots of historical land claim in the SAC. See the relevant shoreline management plans.
Coast protection: Hard defences (including sea walls, breakwaters, railways and foreshore deposit of rock, rubble etc.).	Ongoing flood defence works. See the relevant shoreline management plans.
Coast protection: Soft defences (including groynes, beach replenishment etc).	No data available. See the relevant shoreline management plans.
Coast protection: Barrages (including storm surge, tidal and amenity).	Historical and recent structures at extremities of and immediately out with tributary estuaries (Carew, Neyland, Cleddau rivers). No major barrages within main waterbodies.
Hard-engineered freshwater watercourses.	Occasional throughout site, mainly in bays and inlets.

Power station.	Pembroke Power Station - Combined cycle gas turbine power station at West Pennar, Pembroke in Milford Haven Waterway.
Pipelines.	Present mainly in the Milford Haven Waterway.
Power / communication cables.	Present in the SAC.
Effluent disposal: disposal of sewage, chemical, thermal and sludge dumping.	NRW and DCWW datasets available on locations and inputs. No sludge disposal. Pembroke power station has a permitted discharge for heated cooling water.
Miscellaneous wastes and debris (including refuse and litter).	Litter present in the sea from various sources.
Run-off: Agricultural, urban and industrial run-off.	widespread and common around coastal populations and industry..
Fishing: All trawling (Including beam, otter, toothed and any trawled gear).	Low levels of trawling in small boats around St Brides Bay and surrounding areas in the SAC.
Fishing: All dredging (including toothed, bladed, mechanical, hydraulic and any other great not listed).	Dredging is widespread and common offshore; limited within site. Anecdotal reports of hydraulic dredging in St Bride's Bay.
Fishing: All netting (including gill, tangle, trammel, seine, fyke and any other fishing with netted gear).	Widespread and common (inshore waters).
Fishing: All potting (including lobster, crab, prawn and any other fishing with potted gear).	Potting is widespread within the SAC inshore waters.
Fishing: All line fishing (including long-line and handline).	Occasional hand fishing (bass/salmonids), occasional long-lining offshore.
Fishing: All methods of hand gathering (including cockles, Mussels, mussel seed, razor clam, bivalves, winkles, crustaceans, shellfish, algae and plants for human consumption and chemical extraction and biomass (excluding access issues).	Widespread. Commercial winkle collection in Milford Haven waterway.
Fishing: Bait collection commercial and recreational (including digging, pump, boulder turning etc).	Bait digging occurs within the SAC, particularly at the Gann Flats and Angle Bay within the Milford Haven Waterway.

Aquaculture: All forms of aquaculture (including algae, sea cages, impoundments, ranching, shellfish ropes and trestles and enclosed recirculation).	Pacific Oyster and Native Oyster aquaculture (trestles) in Angle bay only. Car-y-Mor multi-trophic aquaculture project in Ramsey Sound. Includes seaweed and native oyster. commercial seaweed gathering taking place in multiple locations
Livestock grazing: Grazing of saltmarsh.	Occasional on upper reaches of Milford Haven Waterway
Water abstraction.	Abstraction regularly occurs in the upper reaches of tributaries to the Milford Haven waterway
Aggregate extraction (including mineral and biogenic sands and gravels).	Not occurring in the SAC.
Oil and gas exploration: All oil and gas exploration activity (including seismic survey, drilling and discharges both operational and accidental).	Gas exploration in west of site.
Renewable energy generation: All forms of renewable energy (including tidal barrage and impoundments, tidal and wave energy, offshore wind both fixed and floating).	Marine Energy Test Area (META) is within the Milford Haven Waterway testing renewable energy technology. DeltaStream tidal energy conversion unit device is located on the seabed in Ramsey Sound.
Oil spill response: All activities of responding to oil spills at sea and on shore (including chemical, physical and access).	Reactive only. No recent activity.
Recreation: Fishing (e.g. angling and spearfishing).	Widespread and common within the SAC but occurrence and activity levels are unknown. Some activity monitoring in Pembrokeshire is available from the Pembrokeshire Coastal Forum.
Recreation: Boating (e.g. power craft, sailing, canoeing, surfing, kite surfing, paddle boarding, etc).	Widespread and common within the SAC. Boating is seasonally skewed to Apr-Oct. Mooring and anchoring widespread in Milford Haven and sheltered locations.

Recreation: Coastal activities (e.g. Scuba diving, snorkelling, dog walking, coasteering etc).	Widespread and common within the SAC but occurrence and activity levels are unknown. Some activity monitoring in Pembrokeshire is available from the Pembrokeshire Coastal Forum.
Recreation: Coastal access.	Widespread and common within the SAC but occurrence and activity levels are unknown. Some activity monitoring in Pembrokeshire is available from the Pembrokeshire Coastal Forum.
Recreation: Light aircraft.	Small airfields at Haverfordwest and Aberporth mean light aircraft fly over SAC. Possible drone use.
Recreation: Wildfowling.	May be occurring on private land in upper reaches of Milford Haven waterway. 2 licenced clubs in the SAC.
Recreation: Marine wildlife watching / eco-tourism.	Wildlife watching tour within the SAC operate around Skomer, Skokholm and Grassholm.
Military activity: All forms of military activity (including ordnance ranges, marine exercises, aircraft etc).	Regular activity at the Castlemartin Military firing range.
Marine archaeology and salvage.	Regular visits to wrecks by recreational divers.
Science and outreach: Education.	Occurs within the SAC. There is a field studies council at Dale as well as school and university trips. Regular use of favoured sites.
Science and outreach: Animal welfare operations and sanctuaries.	Regularly operating in Pembrokeshire.
Science and outreach: Science research.	Scientific research is common and widespread throughout the SAC.

5. Climate change vulnerability

5.1. Climate Change vulnerability

Marine intertidal habitats are most at risk from climate change. Marine ecosystems will be impacted by climate change through both direct and indirect effects on the distribution and abundance of biotopes and species. Climate change pressures include, rising sea surface temperatures, sea level rise, ocean acidification, air temperature increases, Deoxygenation, changes in salinity and increasing wave exposure.

Climate induced changes could include irreversible impacts to ecosystems from loss of species, degradation of carbon sequestrating habitats (blue carbon habitats) leading to carbon being released and exacerbating the problem. For cold water corals and maerl beds, ocean acidification has potential to cause significant corrosion damage.

Below is a climate change profile for each Annex I habitat in the SAC. The profile summarises the climate change pressures each habitat is vulnerable to in this site, excluding sea caves although sea caves are likely to have similar vulnerabilities to both intertidal and subtidal reefs.

The summary of impacts for all features can be seen in Table 3.

Table 3. Climate change summary indicating the climate change vulnerabilities for the features of the Pembrokeshire Marine SAC. ASM = Atlantic Salt Meadows, LSIB = Large shallow Inlets and Bays. H = High, M = Medium, L = Low, N/V = Not vulnerable.

Climate change pressure	Mudflats and sandflats	Coastal lagoon	Intertidal reefs	Subtidal reefs	Sandbanks	Estuaries	ASM	LSIB
Air temperature	M	M	H	N/V	N/V	M	H	L
Deoxygenation	L	N/V	L	L	L	L	N/V	L
Ocean acidification	L	L	L	H	L	M	N/V	M
Salinity	L	L	L	L	L	L	L	L
Sea level rise	H	H	L	L	N/V	M	H	L
Sea temperature	L	L	L	L	L	L	L	L
Wave exposure	L	L	H	L	N/V	L	M	L

5.2. Coastal squeeze

Extensive work has been carried out (Oaten et al., 2024) regarding the extent to which sea-level rise may cause coastal squeeze and natural squeeze, an issue which affects intertidal habitats. Overall, this SAC is projected to lose 65% of its intertidal habitats (reef) by 2155 under an RCP 8.5 95th percentile sea-level rise scenario. In this SAC, the majority of the losses are due to natural squeeze rather than coastal squeeze because a significant proportion of the coast is natural rather than defended and land often rises quite steeply from the coast causing a natural constraint.

Mudflats and sandflats not covered by sea water at low tide

The predicted change in the extent of this habitat due to both coastal squeeze and natural squeeze is a small short term gain of 1% (11ha) by 2055, as saltmarsh habitat is replaced by intertidal sand and mud. This then becomes a loss of 4% (52 ha) by 2155 under a RCP 8.5 95th percentile scenario, assuming that defences are managed in line with shoreline management plan policies (Oaten et al., 2024) .

Intertidal Reefs

The predicted change in the extent of this habitat due to both coastal squeeze and natural squeeze is a loss of 5% (19 ha) by 2055, and a loss of 18% (63 ha) by 2155 under a RCP 8.5 95th percentile scenario, assuming that defences are managed in line with shoreline management plan policies (Oaten et al., 2024) .

Atlantic salt meadow *Glauco-Puccinellietalia maritimae*

The predicted change in the extent of saltmarsh habitat due to both coastal squeeze and natural squeeze is a loss of 6% (14 ha) by 2055, and a loss of 65% (147 ha) by 2155 under a RCP 8.5 95th percentile scenario, assuming that defences are managed in line with shoreline management plan policies (Oaten et al., 2024) .

Coastal lagoons

Carew

Carew Castle Millpond lagoon is situated behind a structure which currently protects it from coastal or natural squeeze, but if that structure was not maintained then the lagoon would become vulnerable. Shoreline Management Plan policy is not available for Carew Castle Millpond, as the plan does not extend this far upstream. Therefore, medium to long term management intent for the structure protecting the lagoon is unknown. According to Oaten et al. (2024), Carew Castle Millpond may be vulnerable to coastal or natural squeeze as a result of high ground in the hinterland, which means that there is limited space for this lagoon to migrate in response to sea-level rise.

Neyland

According to Oaten et al. (2024), Neyland weir pool is not expected to be vulnerable to coastal or natural squeeze, although this is based on an assumption that the structure is maintained. If this structure is not maintained then the lagoon would become vulnerable.

Pickleridge

According to Oaten et al. (2024), Pickleridge lagoon is not subject to coastal squeeze because it is located landward of a mostly natural shingle ridge (with some defences present and some intermittent management undertaken to maintain access). However, the lagoon is vulnerable to pressure from climate change and sea-level rise because the natural ridge fronting the lagoon has a Shoreline Management Plan policy of ‘managed realignment’ with an intent to allow the ridge to evolve naturally. In this scenario, the ridge may migrate landwards, and may experience more overtopping or breaching which would change the conditions within the lagoon.

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Appendix 1: Additional information

Site description

The seas around Pembrokeshire have long been recognised for their marine conservation importance. The area around Skomer Island and the adjacent Marloes peninsula was designated a marine nature reserve (MNR) in 1991 and is currently Wales' only marine conservation zone (MCZ). Many characteristics have been identified as being important in the Pembrokeshire Marine environment, including the:

- extremely wide range of physical habitats and environmental processes;
- high species diversity;
- presence of specific habitats and species judged to be of particular importance because of their rarity, ecological importance or isolated position at the edge of population ranges.

The habitat features are characterised by complex interrelationships with and between environmental processes and species populations. It is the combination of all these components together which gives the overall importance to the habitat features of the site. Each of these individual components contributes to the integral, national importance of each feature, and each of the features contributes to the importance of the site.

Geology

The site has a rich and complex geology. The northern part is dominated by both sedimentary and igneous precambrian, cambrian and ordovician rocks. The southern part by old red sandstone and carboniferous rocks, notably the limestone block of the Castlemartin coast, and the silurian volcanics of the Marloes Peninsula, Skomer and offshore rocks and islands.

The coastal cliffs of highly faulted Cambrian (northern St Brides Bay shoreline) and old red sandstone (southern St Brides Bay, West Dale, Freshwater West) shorelines have extensive sublittoral extension. Softer, more recent rocks form cliffs behind and underlying sediment on the lower shores on eastern shorelines.

Sedimentology

There are a wide range of sediments within the SAC from the very fine muds in sheltered areas of the Milford Haven Waterway through all grain sizes to consolidated and unconsolidated pebbles and cobbles in deep subtidal areas subject to strong tidal currents. Sediment structures vary from uniform to very heterogeneous.

Geomorphology

The SAC is dominated by the two major westward projecting peninsulas of St David's and Marloes with their associated series of offshore rocks and islands. The large, square shaped St Brides Bay lies between these two peninsulas. The deep ria (drowned river-valley) of Milford Haven lies between the broad limestone peninsula of the Castlemartin coast and St Annes head.

The Milford Haven ria was formed at the confluence of Daugleddau, Cresswell, Carew and Pembroke rivers. The combined forces of these rivers eroded soft limestone, resulting in the deep channel. This channel was subsequently flooded as sea levels rose at the end of the last Ice Age. An east-west band of Silurian sandstone forms the opening to the Milford Haven, with several isolated rocky outcrops and foreshores. Thin bands of carboniferous limestone break through the sandstone formation creating distinctively banded cliffs. The floor of the ria comprises glacially eroded sand and gravels on top of the mudstone and sandstone bedrock (adapted from Marine Character Area 21).

St Brides Bay has quite varied geomorphology. Most of the coastline is comprised of hard rock cliffs, fronted by steep shore platforms that erode slowly, producing little sediment. The next most dominant features of the bay are the long sandy beaches fringing the eastern boundary. The largest of these is Newgale Sands, which is in the northeast corner. In most places these are backed by cliffs or seawalls. Further information can be found in Annex C of the shoreline management plan for the area (Page 53-54).

The coasts are dominated by rugged headlands of hard igneous rock, interspersed by bays and inlets situated on fault lines and where less resistant rocks have been eroded. Many bays are characterised by shores of pebbles, cobbles and boulders of size ranges reflecting the exposure to wave energy while the larger expanses of sands are confined to lower shores.

The topography of the seabed within the SAC is dominated by rugged, mainly igneous, but also sandstone and limestone, rocky reefs. Many rise to considerable heights above the surrounding deep seabed, some forming islands and islets. Sandbanks formed in the lee of rocky reefs and in other tidal conditions are also prominent seabed features. Between the elevated areas of seabed are extensive undulating areas of rock, such as west of the Dale peninsula, and plains and gentle slopes of sediments. The geomorphology of this areas is described in more detail within the West of Wales (St Anne’s Head to the Great Orme) and the South Wales (Lavernock Point to St Anne’s Head) Shoreline Management Plans.

Hydrography and meteorology

The range and times of high and low water varies considerably throughout the site. The maximum mean spring tide range at Dale Roads, in the entrance to the Milford Haven, is around 7.8m compared to around 4.4m in Ramsey Sound. This creates an extensive intertidal zone with broad and high shores. Spring tide low water occurs during the middle of the day which is of significance to littoral organisms, exposing them to maximum sunlight and temperature.

Strong tidal streams are a characteristic of the SAC, particularly around the islands, islets and headlands and narrows, including parts of the Milford Haven Waterway, with maximum speeds reaching c 5 m/sec through Jack and Ramsey Sounds during spring tides. There are huge variations in the tidal stream patterns and timing over very short distances and, in some areas, tidally induced overfalls and standing waves. Areas of weaker and negligible tidal streams are widespread, particularly in embayments. There are also unusual tidal conditions, such as the modified salt wedge in Milford Haven and rotary tides in central St Brides Bay.

The open coast is exposed to a considerable amount of wave action and to swell from a prevailing south-westerly direction. The west and south-west coasts are most exposed to the frequently large, long period oceanic swell, that also penetrates into the outer Milford Haven waterway. There are areas of open coastline sheltered from all but the most energetic swells and the offshore islands add to the complexity in wave exposure. Milford Haven has a wide range of wave exposure from the exposed mouth to the almost totally sheltered tributary estuaries. The impact of waves on the seabed depends on both water depth and wavelength, with longer wavelength waves being able to impact deeper into the water column.

The water masses in and around the SAC are partly of coastal origin with an oceanic input through the Celtic Sea. Water circulation is seasonally modified as a result of summer heating and stratification in the Celtic and Irish Seas but waters are generally well mixed. The Celtic Sea front forms during summer months and extends west-north-west from the site.

Water and sediment chemistry

Suspended particulate concentrations are highly variable with season, wave action, tidal conditions and freshwater discharge. As a consequence water clarity and seabed and water column light intensity are also highly spatially and seasonally variable. The site is very wind exposed, but variable depending on location and topography.

There is a complex, dynamic salinity regime within Milford Haven Waterway. Published data suggests that offshore salinity remains at a constant 34.5-35‰, although water column data collected around Skomer from 1992 indicates that inshore salinity is more variable, falling to 33.5‰ during winter months and rising to 36‰ in summer months.

Available data suggests water column dissolved oxygen is generally 100% saturation. Interstitial sediment dissolved oxygen varies with a variety of factors including sedimentology, infaunal biological activity and macroalgal cover. Levels within the estuarine inlets of the Milford Haven are of concern as a consequence of the current levels of excessive green algal overgrowth during summer months. A seasonal oxycline (and thermo- and haloclines) develops in Abereiddy quarry lagoon in summer months; during this period the deeper waters are anoxic. The status of the water bodies within the SAC including levels of nutrients and chemicals is available in the latest condition assessments.

Sediment processes

Detailed sediment processes in St George’s Channel are poorly known but inferred to be dominated by tidal current action on mainly coarse, relict or locally derived sediments (from glacial and glacio-fluvial beds) where strong currents have prevented the accumulation of fine sediment. Long period wave action also has a major local modifying effect.

There is a net westward transport of sediments from the Bristol Channel across and into southern Irish Sea although possibly different transport paths for the sand compared to the muddier fractions in suspension. The presence of major sandy bed-forms indicates the transport of large volumes of material.

Deposition, erosion and redistribution of sediments in the site are variable and complex. Detail of local sediment processes is not well known with information limited to Milford Haven where studies indicate a complex of transport paths with inshore transport in a net northerly direction, determined by tidal streams strongly modified by wave action. Areas of medium to long-term sediment deposition are present in the tidal lee of islands and headlands. Sediment processes have been studied in more detail and are described within the west of Wales and south Wales Shoreline Management Plans.

Species

The different rock and sediment types present throughout the SAC provide marine plants and animals various substrata for colonisation. These along with, tidal current, degree of wave exposure, turbidity and temperature have a strong influence over the species that will become established in any one location. Both intertidally and subtidally. Species records in the site primarily describe visible macro- and megafauna and macroalgae. With very few exceptions, cryptic macrofauna and meiofauna, microfauna and flora have not been described. Demersal species are also poorly documented.

A major factor in the nature conservation importance of the Milford Haven Waterway is the range of ecological variation within the system. Of particular importance is the transition from the exposed, fully saline conditions near the entrance, through to the sheltered fully saline conditions of the central section and up to the variable or low salinity and extremely sheltered conditions in the upper reaches. Subtidal marine communities penetrate deeply into the Haven, well beyond the central section. With a significant reduction in subtidal species and community diversity caused by decreasing salinity and increasing turbidity not occurring until upstream of Pembroke Dock. The transition in environmental conditions up the Haven has similar effects on subtidal and intertidal communities.

The variety of species is better known in some habitats and locations than others (e.g. the Skomer MCZ area and the Milford Haven Waterway). Quantitative time series data are available for several long-lived reef species and species assemblages in the Skomer MCZ. Details on the species and communities in the different habitat features of the site can found in the sections below.

Invasive non-native species

Based on NRW records (to 2021), noteworthy invasive non-native species (INNS) already present within the Pembrokeshire Marine SAC as a whole include the slipper limpet *Crepidula fornicata*, which is widespread and often in high numbers especially in Milford Haven Waterway, with occasional records near Skomer and in St Brides Bay. Other species within Milford Haven include the Red ripple bryozoan *Watersipora subatra*, Devil's tongue weed *Grateloupia turuturu*, Compass sea squirt *Asterocarpa humilis*, American jack knife clam *Ensis leei* and Pacific oyster *Magallana gigas*. Outside of Milford Haven, the Trumpet tubeworm *Ficopomatus enigmaticus* is also found in Abereiddi, Wakame *Undaria pinnatifida* is recorded on Skomer and Skokholm and the Leathery sea squirt *Styela clava* on Skomer / Marloes. The seaweed *Sargassum muticum* is widespread within the SAC.

The carpet sea squirt *Didemnum vexillum* was found in Milford Haven in 2023 (NRW 2023). This INNS is of significant concern as it can spread rapidly, growing over and smothering benthic habitats. It may threaten extensive areas of reef habitat in the site.

More information on impacts of INNS species can be found in the latest condition assessments.

There are also significant INNS present in Wales but not currently recorded within the SAC. These species are a threat to the condition of the SAC features.

The Chinese mitten crab *Eriocheir sinensis* has been recorded in North Wales. This species may have major impacts on habitats through competition for space and prey, although impacts are likely to be further upstream in brackish and freshwater areas. The red algae *Agarophyton vermiculophyllum*, is already present in Carmarthen Bay and Estuaries SAC and is having a negative impact on the mudflats and sandflats feature there.

Other species not yet recorded but have the potential to arrive and cause impacts include the Rapa Whelk *Rapana venosa*. This species has not yet been recorded in the UK but is noted as a probable predator of shellfish, which has the potential to impact this site. Other species of note with the potential to arrive include the American Sting Winkle *Urosalpinx cinerea*, the nearest record being north Devon and the Asian date mussel *Arcuatula senhousia*, currently in the Southampton Water.

Additional information for features of the site

General feature descriptions and ecological characteristics can be found on the JNCC habitats list and species list. Habitat definitions can be found in the European Union Interpretation Manual of Annex I habitats.

Large shallow inlets and Bays

Habitats

The types of sediment and hard substrata habitats within the large shallow inlets and bays (LSIBs) feature are largely determined by the underlying geology and sedimentology. They are also influenced by the dominant physical conditions, such as the degree of exposure to wave action and tidal currents. The variety of species in LSIBs is often high as a result of wide habitat variety and environmental conditions.

The Milford Haven LSIB supports a wide variety of habitats due to the varying physical and geomorphological conditions that are present in the waterway from wave exposed conditions towards the mouth of the waterway, extreme shelter further upstream, strong currents and varying salinity.

Near the entrance to Milford Haven there are dynamic, predominately sandy, shores exposed to wave action. Upstream from Dale Point and Thorn Island, sediment shores range from coarse cobbles and shingle, through mixed shelly gravels, to fine sands and muds that characteristically become increasingly stable with increasing shelter from wave action. Mixed sediments include coarse stony and shell debris substrates at the sediment surface and are particularly extensive in narrow subtidal channels. A bed of calcareous algal maerl deposits is present in the lower waterway.

Rocky reefs form the intertidal particularly to the mouth of the waterway and the edges of the sediment flats further up the estuary. Intertidal mudflats and sandflats vary according to exposure and hydrodynamics, with sandier sediments towards the mouth and increasingly muddy sediments as distance from the entrance to the bay increases. Subtidally, where reef is absent, there are an exceptionally wide range of sediment habitats within the waterway.

There is an extremely wide range and complex mosaic of sediment habitats in St Brides Bay LSIB. This includes, moderately sorted medium to very fine sands in shallow and near-shore areas in the northern half of the bay; fine sands inshore; well sorted muddy sediments in deep central areas of the bay; poorly sorted muddy gravel / shell in sheltered near-shore areas in the southern part of the bay. Broad intertidal sediment flats extend widely around the coasts of the inlets and bays, particularly on the eastern shore. The extent of exposed reef surface varies with sediment movement. Extensive areas of near-shore and intertidal reef extend along the northern and southern shores, with large isolated reef and islet immediately present off both the north and south coast.

Communities

The variety of intertidal sediments across the two LSIBs that comprise the feature support different characterising species, depending on the conditions. The predominately sandy shores exposed to wave action in the lower Milford Haven Waterway, for example, typically support a small number of specialised hardy species. This is in contrast to stable infaunal populations within moderately wave-sheltered, sandy-mud fully saline shores of the waterway (e.g. Gann Flats, Dale Beach, Angle Bay, Gelliswick and Pwllcrochan), that support a wide variety of species. Areas of deep, wave sheltered, sands are also particularly species rich, as are stable, relatively wave and current sheltered mixed muddy sediments that support a wide variety of species including long-lived macrofauna.

Strong tidal currents allow a high diversity of epifaunal filter feeding species on hard substrates. Areas of coarse, current exposed, shelly gravel are unusual, supporting a low variety of physically resilient species and are a contrast to sheltered fine sands and muds; e.g. shallow fine sands in North Haven, Skomer (including a small bed of eelgrass *Zostera marina* with high epifloral variety). Enough native oyster are present to be considered oyster beds in some areas of the Milford Haven. NRW has been carrying out and supporting restoration of native oyster populations in the Milford Haven through the Wales Native Oyster Restoration Project and Natur am Byth! Môr project, mostly upstream of the Cleddau Bridge.

Infauna of the sheltered sandy and muddy sediments of Milford Haven includes populations of long-lived and/or rare and scare species including bivalve molluscs (e.g. *Ensis* sp., *Arctica islandica*); anthozoans (e.g. *Mesacmaea mitchellii, Peachia cylindrica and Capnea sanguinea*), tube living polychaetes and echinoderms. Records of fan mussels *Atrina fragilis* have been found in the sediments within Milford Haven. Sediment epifauna includes a relatively isolated population of king, or great, scallop *Pecten maximus* and a wide variety of species characteristic of reefs living on and in stony material, molluscan shell debris and in association with species consolidating mobile substrates, e.g. ross coral *Pentapora folicea*. In St Brides Bay there is some evidence of burrowing megafauna in muddy sediments.

St Brides Bay and the Milford Haven Waterway support an important, diverse and productive fish community. The fish community is dominated by mullet, flounder, sand smelt and goby species with notable parts of the community include Clupeidae populations present in the Milford Haven including a genetically distinct spring-spawning stock of

Atlantic herring *Clupea harengus* which spawn in the upper estuary (ICES, 2024), and Ammodytidae populations present in sandy habitats of St Brides Bay (Ellis et al., 2012) are important prey species for various bird and marine mammal species in Welsh waters. The only confirmed records of both native species of seahorse *Hippocampus hippocampus*; *Hippocampus guttulatus* in Welsh waters have been made in St Brides Bay and the Milford Haven Waterway. These species are often associated with seagrass beds and sheltered estuaries and embayments, indicating the value of the feature at supporting a species-rich fish community. In addition to the diadromous fish species listed as features of Pembrokeshire Marine SAC, St Brides Bay and the Milford Haven Waterway are also important areas supporting other diadromous fish species such as sea trout *Salmo trutta* and European eel *Anguilla anguilla* in their marine residency and feeding phases. The Milford Haven Waterway is also the migratory route of Atlantic salmon *Salmo salar* populations of the eastern and western Cleddau rivers.

The spatial range of most species characteristic of the habitats within LSIBs is extensive; the habitat range of some highly specialised species is restricted in distribution and/or extent. Because of the hydrodynamic regime and the continuous throughput of water masses of distant and varied origins, species are inferred likely to be both capable of recruiting from and contributing to recruitment, from both nearby and distant populations. True ranges of apparently rare or scarce species are unknown.

All the communities within the LSIB feature contribute to the overall representation, range and condition of the feature within the SAC. However, there are some notable habitats and their associated assemblages of marine plants and animals are of particular conservation importance. Due to overlap of features, the habitats and communities listed below occur in both the LSIB and estuaries feature:

- Subtidal seagrass beds of *Zostera marina* are found in various locations within the Milford Haven Waterway and at North Haven, Skomer (noted for its high epifloral diversity). Restoration of Seagrass, *Zostera marina* has been trialled in Dale Bay where sparse plants were present.
- Intertidal seagrass beds of *Zostera noltei* are extensive within the Milford Haven Waterway (see the mudflats and sandflats feature for more detail).
- The maerl bed within the Milford Haven Waterway supports a diverse community of algae and invertebrates that live on or within the structure created by the maerl nodules. Even when dead it continues to be a distinct niche, although the persistence of this habitat relies on live maerl being present. A number of red algal species are endemic to maerl beds and are not found in other habitats.
- Tideswept channels create diverse communities of filter feeding organisms and can be found at Ramsey Sound, in the north of St Brides Bay, and within Milford Haven. Part of Jack Sound at Skomer also falls within the LSIB feature (see reefs feature).
- Sheltered muddy gravels communities are found on the shore at the Gann and Pwllcrochan. (see intertidal mudflats and sandflats feature).
- Blue mussel beds (*Mytilus edulis*), supporting high levels of biodiversity, are found in mostly in the upper reaches of Milford Haven, with very discreet beds in St Brides Bay (see reefs feature for more detail).

- Native oyster beds of *Ostrea edulis* also increase biodiversity, can be reef forming and can be considered a temperate equivalent to a tropical coral reef (Beck et al., 2011). Native oyster provide important ecosystem services such as enhancing water quality through their filter feeding behaviour and may also play a role in protecting other coastal features from smothering and erosion (Beck et al., 2011). Native oysters are relatively sparse within the Milford Haven and are currently are not in the concentrations for them to be considered part of the reefs feature.

- Communities of fragile sponges and anthozoans, notably pink sea fans, and bryozoans within the LSIB feature are found along the north side of Skomer and there are a few records within Milford Haven, mostly at the mouth of the waterway. (see reefs feature for more detail).

Estuaries

Habitats

Sediment structure varies in a continuum along the major gradient of wave exposure, modified by gradients in tidal stream strength and salinity. The axes of these gradients are both along and across the main axis of the waterway.

Due to the geomorphology of the ria estuary, deep water penetrates far along the central channel of the waterway with large areas more than 20 metres deep and extensive areas more than 12m deep even 23 km from the entrance. Subtidal sediments show an exceptionally wide variation and include large quantities of coarse, stony and (molluscan) shell debris material in both the intertidal and subtidal and areas of fully marine mixed muddy sediments. Wide intertidal and subtidal sediment flats flank the main deep-water channel and form a large proportion of embayments such as Dale Roads, Sandy Haven and Angle Bay. The topographical variability of intertidal sediment flats is increased by sinuous freshwater drainage channels and there is evidence of ancient river drainage channels in subtidal sediment plains.

Wide, relatively level sublittoral seabed sediment plains dominate the floor of the channel and typically extend from the intertidal mud and sandflats towards the main tidal channel where the increasing tidal flow tends to result in coarser sediments in the channel's base and on its often steep slopes. The topography of many areas of sediment flats and saltmarsh is complicated by sinuous drainage channels, isolated patches of saltmarsh and pools.

Areas of reef and banks of boulders, cobbles, shell and sediments rise above the flatter sediment areas. These intertidal and subtidal reefs are discontinuous and topographically varied with their morphology constrained by the adjacent cliff, reef, hinterland, main estuary channels and other structural forms. The microtopography of the reefs, sediments and saltmarshes is also variable.

Communities

At Pwllcrochan and other shores on the central waterway the generally stable sediments enable the recruitment and survival of a variety of long-lived and slow growing infaunal species. Coarse stony and shelly substrates at the sediment surface also enables epibiotic species of both algae and animals to occur in the same habitat. Variety is highest in areas of shore subject to moderate tidal flow.

The range of sediment structure along and across the seabed of the waterway creates suitable habitat for a wide variety of sediment-living species with varying distributions. Except in the most exposed area, sediment communities are species rich. The infauna includes widely distributed burrowing anemones, polychaetes, crustaceans and echinoderms. Fine, moderately wave sheltered, sediments support eelgrass *Zostera marina*, which in turn supports a wide variety of epifloral algal species.

On rocky substrate there is a higher species diversity where there are crevices, overhangs, rock-pools and boulders (and thus under boulder surfaces). Wave sheltered shores support a particularly wide variety of algae. Tidal-stream exposed lower shore bedrock and boulder shores support good assemblages of sponges and ascidians. For example, the stable, tidally swept, consolidated stony / shingle / shell shores at Wear Spit, supports a wide variety of algal species, including several rare species, and sponges.

In the upper waterway and areas such as the Daugleddau there are stable, consolidated stony and shell substrates with sediment pockets in fully or near fully saline, wave sheltered, tidal-stream swept conditions. These areas support a wide variety of sponges, burrowing and tube dwelling species of worms and anemones, crustaceans, ascidians and, in shallow water, a wide variety of algae, particularly fine filamentous red algae.

The intertidal sediment infauna is an important food source that supports large numbers of overwintering waders and wildfowl. Many species populations in lower shore mud banks have high biomass, particularly in the Pembroke River and at Pwllcrochan. These intertidal sediment communities contribute to the importance of the Milford Haven estuary as a wintering area for waders and wildfowl.

The fish community in the Milford Haven estuary is the same community as the LSIB as the features overlap. It is dominated by mullet, flounder, sand smelt and goby species. Notable species in the community include a spawning population of Atlantic herring *Clupea harengus*, which spawn in the upper estuary (ICES, 2024). See the [LSIB additional information]

All the communities within the estuaries feature contribute to the overall representation, range and condition of the feature within the SAC. However, there are some notable habitats and their associated assemblages of marine plants and animals are of particular conservation importance. As the majority of the Estuaries feature overlaps with the LSIBs feature, only those notable habitats and communities that do not occur in the LSIB are listed below. See the LSIB additional information for further notable habitats and communities.

- Wide, horizontal intertidal mudflats fringing the estuaries draining into the main waterway support abundant and productive invertebrate (mainly annelid and mollusc) communities (see mudflats and sandflats feature).
- Muds typically supporting a greater biomass than other intertidal sediments, the abundance of bivalve and polychaete species being particularly high.

- In addition to the blue mussel beds within the LSIB feature, are also found in a number of the tributary estuaries such as Pembroke River and within the Carew River and mouth with the Cresswell River (see reefs feature for more detail).

- See the LSIB additional information for further notable habitats and communities that occur in the Milford Haven estuary.

Reefs

Habitats

Reefs within the SAC are subject to an exceptional variation in strength of tidal streams and wave exposure, with many extending onto the shore. They provide examples of both the most exposed and the most sheltered intertidal rock communities in southern Britain.

The extent of exposed reefs varies substantially due to covering and uncovering by sediment. The linear extent of intertidal reef is large, but the overall area restricted because of the high proportion of steeply sloping shore. The extent of sublittoral reef is large but not known precisely, though bathymetric work was carried out in 2016 to refine knowledge of habitats and reef extent within the SAC.

Reef habitat diversity is increased by caves, tunnels and surge gullies in both subtidal and intertidal zones and the wide range of rock surface microtopography as well as the depth range over which they occur, including extensive areas of deep (>30m) reef.

Geographically defined areas of reefs that may be considered recognisable within the SAC include,

- Offshore, extremely exposed, Grassholm to The Smalls and the Bishops and Clerks reef complexes;

- Skomer / Marloes Peninsula;

- Ramsey / St David's Peninsula;

- Skokholm – St Anne's Head and south St Brides Bay;

- Milford Haven (reefs at entrance contiguous with above);

- South Pembrokeshire limestone.

The site has a wide range of different degrees of wave exposure and strengths of tidal streams. Specific broadly defined combinations include:

- Reefs exposed to both strong to very strong tidal streams and exposed to strong wave action (Grassholm, The Smalls, Bishops and Clerks, Hats and Barrels reef). Extensive areas of open coast reef, offshore complexes of pinnacles and islets, and the west coasts of islands exposed to extreme wave and tide-swept conditions.

- Reefs exposed to strong to very strong tidal streams and sheltered from wave action (Milford Haven). Extensive areas of deep, offshore reef sheltered from prevailing swell; Milford Haven Waterway.

- Reefs sheltered from tidal streams and exposed to strong to very strong wave action and surge. Many long, narrow or tapered inlets and sea-caves, (particularly inlets and caves on Ramsey and Skomer islands and Castlemartin coast).

- Reefs sheltered from strong water movement. Deep sheltered reef off north and east coasts of islands and within bays; Milford Haven Waterway. The deep, lagoonal, former slate quarry at Abereiddy is an extreme example. Ultra-sheltered from water movement. Water exchange, mixing and flushing are exceptionally limited, resulting in establishment of seasonal thermoclines, oxyclines and haloclines.

Communities

The wide range of substrate type, topography, depth, wave and tidal current exposures, and light are major contributors to high species diversity on the reefs. This diversity is supported by species migration and the potential for recruitment of reproductive products from a wide area.

Limestone and other architecture and / or crumbly rock support a variety of rock boring and crevice-dwelling species, including species restricted to limestone. Specialised micro-habitats such as surge gullies and crevices support a rich variety of many species including encrusting sponges, ascidians and anemones as does the fully saline, extremely wave-sheltered, tidal stream-swept bedrock and consolidated boulder / cobble reef (e.g. Milford Haven sponge populations).

As described there is a variety of exposed and sheltered subtidal bedrock reefs and rocky substrates. Species typical of exposed open coastal reefs including soft corals, echinoderms, bryozoans and hydroids. Species typical of wave-sheltered are tolerant of reduced salinity or water clarity such as sponges. The deep, fully or near fully saline, tidal-stream swept, wave-sheltered rock and consolidated stony cliffs and steep slopes in locations such as Dockyard Bank, Burton Reach, and Castle Reach support a particularly wide variety of sponge species some of which are inferred from their size and growth forms to be a substantial age.

Other physical, chemical and biological factors are also an important influence on reef communities, such as depth, clarity of the water and salinity. Whether there is a lot of sediment nearby or held in suspension in the water can have a scouring effect and impact the available food supply. Temperature also has an important influence and in the UK, there is a marked biogeographical trend in species composition related to temperature, with warm, temperate species such as the pink sea-fan *Eunicella verrucosa* occurring in the south, and cold-water species, such as the deeplet sea anemone *Bolocera tuediae* in the north.

Biogenic reefs are not extensive within the Pembrokeshire Marine SAC but are often highly productive and may be important ecologically as feeding, settlement, breeding and nursery areas for many other species.

Fish communities of the reefs in Pembrokeshire Marine SAC often contain species which directly feed on prey items on the reef such as gastropods, decapods, sea urchins, echinoderms, as well as kelp and other vegetation. Fish species which are associated with feeding on reefs of the Pembrokeshire Marine SAC include Mugilidae and Labridae spp. Reefs also offer breeding and nursery areas for benthic spawners abundant in the Pembrokeshire Marine SAC such as Gobiidae spp.

Within the upper reaches of the Milford Haven Waterway, bedrock and boulders can fringe and form the shore. The areas often support dense stands of fucoid seaweeds due to the absence of wave action. Egg wrack *Ascophyllum nodosum* is very long lived, the holdfasts can live for decades and they produce a bladder a year. The shore clearly shows zonation of seaweeds of channelled wrack, spiral wrack, egg wrack and the lower shore dominated by serrated wrack leading into kelp species. The upper shore is often shaded by trees, enabling species that like damp conditions to thrive.

All the communities within the reefs feature contribute to the overall representation, range and condition of the feature within the SAC. However, there are some notable habitats and their associated assemblages of marine plants and animals are of particular conservation importance.

- **Kelp beds (forests and parks)**. Kelp refers to a range of large brown seaweeds that grow from the lower intertidal to the subtidal. Depth is dependent on light availability in the water column. Kelp beds (forests and park) are extremely productive and biodiverse environments. They provide shelter and food for hundreds of species as well as playing an important role in nutrient cycling and carbon sequestration (Smale et al., 2013). Within Pembrokeshire Marine SAC there is a wide variety of kelp species depending on the conditions. In areas of greater exposure to the swell and prevailing winds – dabberlocks *Alaria esculenta* is the dominant kelp. Oarweed *Laminaria digitata* and Cuvie *Laminaria hyperborea*) are found in less exposed open coast areas. In areas where there is mobility furbelows *Saccorhiza polyschides* dominates. Within the Haven, mixed areas of cobble and sediment support sugar kelp *Saccharina latissima*. In very sheltered areas the cape forms of *Laminaria hyperborea* can be found.

- **Intertidal boulder communities**. In areas of boulders, mostly within the lower reaches of the Haven, on the mid to lower shore where there is sufficient water movement, distinct communities of animals can be found under the boulders. The community is often distinguished by mat forming sea squirts like the star seaquirt *Botryllus sc*hlosseri, sea mats, porcelain crabs, saddle oysters and sponges.

- **Fragile sponge and anthozoan communities**. These can be found in areas of tidal movement, but less wave action mostly in the open coast areas around islands e.g. Skomer and Skokholm. The communities contain branching and non-branching sponges (*Axinella* spp.,elephants ear sponge *Pachymatisma johnstonii, polymastia boletiformis*) pink sea fan *Eunicella verrucosa*, yellow trumpet anemone *Aiptasia couchii* and various sea mats and sea firs

- **Tide swept channels and communities**. These habitats create conditions that allow for rich biodiversity, including filter feeding, epifaunal and seaweed communities. Tideswept communities are found within the Milford Haven waterway where there is bedrock and hard substrata on the mid to lower shore and into the subtidal. The strong current flow enables filter feeding animals to colonise the fronds of seaweeds and hard surfaces. Fucoid algae and kelps are heavily colonised by seasquirts, sea mats and sea firs, with hard surfaces also covered in sponges. The tidal stream at Ramsey Sound can be felt down to 30m due to the deeper water between the island and the mainland. This provides conditions for a distinctive community, unrecorded elsewhere in south-west Britain (BRIG, 2011).

- **Estuarine rocky habitats.** Milford Haven is unusual in Wales as it has extensive areas of the of sheltered rock, boulder and cobble that is subject to varying salinity. Found mostly in the upper reaches of Milford Haven Waterway and in its tributaries.
- **Ross worm *Sabellaria spinulosa* reefs and stony reef.** These reefs have been identified through development planning in the approaches to the mouth of Milford Haven. The extent and quality of these areas are unknown**.**
- **Blue Mussels *Mytilus edulis* beds.** These beds are found on sediment and areas of mixed substrata and provides food and crevices for other animals to live. These occur mostly within the Milford Haven waterway and its tributaries.

Mudflats and sandflats not covered by sea water at low tide

Habitats

The open coast embayment sediment shores of the SAC are characteristically comprised of well-sorted sands while the sediment flats within the Milford Haven Waterway range from well sorted fine sands to fine muddy sediments. Many of the latter contain varying amounts of stony material (gravel, shingle and shell) which increases habitat diversity. The extensive lower shore flats in moderately sheltered embayments within the waterway are predominantly composed of fine, in places muddy, sands.

The wide range of sediment topography, particularly slope and associated bathymetry, is a major contribution to sediment flats biodiversity within the SAC. The overall species diversity is high but varies considerably between and within communities, sediment types and individual sediment flats. The exposed, coarser sandflats typically have low diversity of species highly adapted to dynamic mobile substratum. Homogeneous mudflats also characteristically support a relatively low variety of species. Other sediment flats, depending on habitat complexity and stability are typically very rich in species, including worms, burrowing crustaceans and bivalve molluscs. Whilst macroalgae are limited to coarser sheltered sediments, *Zostera noltei*, pioneer saltmarsh and unicellular algal species are important photosynthesising components of the intertidal sediment flat habitat.

Naturally mobile sediments typically support rapidly reproducing and recruiting or extremely hardy species. The population sizes of rapidly recruiting species are inherently very variable so, for example, those characteristic of mudflats tend to be highly dynamic, frequently productive and with high biomass. Many species populations inhabiting relatively stable sediments also have high biomass but are relatively long lived and slow growing. Sediment flat populations with high biomass are a rich food source for birds and fish.

Communities

Although the biology of many species characteristic of sediment flats is reasonably well known, the dynamics of most sediment flat species populations within the SAC have not been studied. Time series data for several, differing sediment flat shores in the Milford Haven Waterway indicate considerable spatial, seasonal and inter-annual variation in population size and distribution for many species.

Population structure, physiological health and the reproductive capability is unknown or poorly known for most species. Many invertebrate species have planktonic juvenile stages and may be at least partly dependant on recruitment from outside the site and certainly outside the local discrete intertidal sediment flats. Biomass is highly variable between the different sediment flat habitats. Flats with high organic input typically support high species biomass, contributing significantly to the maintenance of typical predatory species such as nationally and internationally important populations of waders and wildfowl.

The range of most species characteristic of sediment flats is extensive. Species are likely to be both capable of recruiting from and contributing to recruitment in populations both within and outside the site. While there is good information on the distribution of many species within the SAC, particularly the most widely distributed and frequent, the spatial and temporal resolution of the data is mostly insufficient to show precise distribution or temporal variation.

The fish community of the intertidal mudflats and sandflats feature of the Pembrokeshire Marine SAC are important grazers and bioturbators. In particular, Mugilidae and Ammodytidae species form major components of the fish community, with Ammodytidae burrowing into the sediments.

All the communities within the intertidal mudflats and sandflats feature contribute to the overall representation, range and condition of the feature within the SAC. However, there are some notable habitats and their associated assemblages of marine plants and animals are of particular conservation importance:

- Sheltered muddy gravels. Milford Haven has some of the richest muddy gravel communities in Wales. The mixture of muddy sediments and gravels enables a wide variety of animals to live including bivalves, a variety of polychaetes such as king rag and peacock worms, and crustaceans. These can be found at Gann Flats, Pwllcrochan, near Sawden point and Pennar Gut.

- Seagrass (*Zostera noltei*) beds. *Z. noltei* beds are found in numerous of locations within Milford Haven Waterway. Extensive beds can be found within Angle Bay, Pembroke River, Garron Pill and Foxborough Point, with smaller discreet beds found in other locations.

Submerged or partially submerged sea caves

Habitats

Caves can vary in size, from only a few metres to more extensive systems, which may extend hundreds of metres into the rock. There may be tunnels or caverns with one or more entrances, in which vertical and overhanging rock faces provide the principal marine habitat. The UK has the most varied and extensive sea-caves on the Atlantic coast of Europe.

Cave morphology and topography is strongly determined by the underlying geology and erosion processes and has an important influence on qualities as a substratum for plants and animals. The microtopography, derived as a result of rock type and exposure to physical, chemical and biological processes also strongly influences niche diversity within caves. Localised protection from scour provided by microtopographical features for example, often strongly influences the distribution of sessile organisms within caves.

Physical conditions, such as inclination, wave surge, scour and shade, change rapidly from the cave entrance to the inner parts of a cave and this often leads to a marked zonation in the communities present. The combined effects of scour from suspended particulates and sediment and food particle supply is particularly important to the development, survival and diversity of cave species populations, especially in caves adjacent to sediment or with sediment floors.

Caves on the shore and in the shallow sublittoral zone are frequently subject to conditions of strong wave surge and tend to have floors of coarse sediment, cobbles and boulders. These materials are often highly mobile and scour the cave walls. Caves that occur in deeper water are subject to less water movement from the surrounding sea, and silt may accumulate on the cave floor. Intertidal sea cave communities and species ecology and function are strongly influenced by humidity and air temperature, mediated by air movement. Although overall air movement is climatic, movement may be reduced in sea caves depending on their structure and exposure to wave action. Air temperatures may be buffered as a result of restricted airflow, seawater and / or underground rock temperatures, and incident sunlight, compared to the adjacent external environments. Humidity may also be elevated as a result of reduced airflow as well as use by grey seals. In combination, these conditions in intertidal sea caves tend to favour species sensitive to desiccation.

Some of the Welsh sea caves are used as pupping sites and resting by grey seals *Halichoerus grypus.* Particularly tall sea caves with dry ceilings are used as bat hibernation sites. All the sea caves in Welsh SACs are considered to be of significant conservation value

Communities

The wide range of rock type, cave morphology, topography, depth and exposures to water movement, scour and light contribute to the high species diversity in sea caves within the SAC. Sea caves also typically support species that seem out of place, because caves provide environmental conditions which differ from those immediately outside, for example sponges typical of deep-water in intertidal caves and mud dwelling anemones in sediments on the floor of caves in exposed rocky areas.

The number of marine algal and invertebrate species associated with sea caves can be high, but highly variable between and within sea caves. Species populations in sea caves include those tolerant of scour, of extreme wave surge and cryptic, apparent cave specialist species.

On the south coast of the SAC the caves are in Limestone. This provides a hard and stable surface for attached marine species and it is also burrowed into by several animals such as the red nose piddock *Hiatella arctica*, the boring sponge *Cliona celata* and the white horseshoe worm *Phoronis hippocrepia*.

Skomer Island is dominated by volcanic rock with sea caves found on virtually every part of its coast, with the highest concentration occurring on the south coast of the Neck and around the Deer Park. Large sponge growths including *Thymosia guernei*, *Pachymatisma johnstonia*, *Dercitus bucklandi* and *Stryphnus ponderosus* occur in the Wick and Wendy's Gully.

On Ramsey Island wide variety of caves are present ranging from large to small and scoured to non-scoured with both littoral and sublittoral communities. Extensive areas of un-scoured habitat occur in some caves and this, together with the occurrence of several rarely recorded species makes the caves of Ramsey of special note (Bunker and Holt, 2003).

Detailed information on communities recorded in sea caves in Pembrokeshire Marine SAC can be found in a CCW monitoring report from 2003 (Bunker and Holt, 2003).

The range of few cave-dwelling species is constrained by habitat requirements with most species living in sea caves are part of wider populations in nearby suitable habitats. Their distribution is mostly a determined by recruitment from populations with widespread distributions both within and outside caves. A few cave specialists have a restricted distribution and are only known from a few locations but it is unclear whether this is a function of survey effort or a truly limited distribution. Species with genuinely restricted distribution are more vulnerable than those that may recruit from large, widespread populations.

Sandbanks which are slightly covered by water all the time

Habitats

Most sediment processes involve movement of bed load, local high strength tidal streams result in the suspension and transport of a wide size range of sediment grains. Suspended fine particulates affect faunal feeding and respiration and coarse sediments cause abrasion.

The limited time series data for the south St Brides Bay bank and Turbot Bank indicate species richness is spatially and temporally highly variable, in part determined by variation in sedimentology. Samples from the shallowest areas of Turbot Bank indicate a possibly seasonally related variation in numbers of taxa of an order of magnitude. Epifaunal species richness is generally lower in distinct (from surrounding sediments) sandbanks and generally higher in sandbanks forming extensions of near-shore sediments.

Communities

The only information on species population dynamics for sandbanks within the SAC is for Bais Bank in southern St Brides Bay. Species abundances are very low on Bais Bank, and strongly influenced by ephemeral species populations at other locations. It is therefore inferred that species populations of all sandbanks are likely to be dynamic and a reflection of recent hydrographic conditions and species recruitments.

Population structure, physiological health and biomass is unknown or poorly known for most species. Many invertebrate species have planktonic juvenile stages and may be at least partly dependant on recruitment from outside the site and certainly from beyond each individual sandbank. Biomass is likely to be highly variable between the different sandbank habitats and species.

The species typical of the sandbanks have a wide range both within and outside the site especially as there is a large extent of suitable habitat near-shore and deep sandy-gravel sediment habitats within the SAC, and large tidal sand ridges in the Celtic Sea. The spatial and temporal resolution of the data is mostly insufficient to show precise distribution or temporal variation in distribution.

Sandeels burrow in the sandbanks diurnally and during their winter hibernation. Other benthic fish species such as gobies, some flatfish, skates and rays and weevers inhabit sandbanks and form an important part of the epifauna and food web of the sandbanks feature of the site.

Appendix 2: Additional conservation interest

Marine Conservation Zones partly or wholly within the SAC:

- Skomer

SACs partly or wholly within the SAC:

- West Wales Marine / Gorllewin Cymru Forol
- Bristol Channel Approaches / Dynesfeydd Môr Hafren
- Limestone Coast of South West Wales / Arfordir Calchfaen De Orllewin Cymru

SPAs partly or wholly within the SAC:

- Ramsey and St.David’s Peninsula coast
- Grassholm / Ynys Gwales
- Skomer, Skokholm and the Seas off Pembrokshire
- Castlemartin Coast

Sites of Special Scientific Interest partly or wholly within the SAC:

- Arfordir Abereiddi
- St. David’s Peninsula Coast
- The offshore islets of Pembrokeshire/Ynysoedd Glannau Penfro
- Ramsey/Ynys Dewi
- Arfordir Niwgwl – Aber Bach/Newgale to Little Haven Coast
- De Porth Sain Ffraid/St Bride’s Bay South
- Skomer Island and Middleholm
- Grassholm/Ynys Gwales
- Skokholm
- Dale and south Marloes coast
- Milford Haven Waterway
- Hook Wood
- Afon Cleddau Gorllewinol/Western Cleddau River
- Slebech Stable Yard Loft, Cellars and Tunnels
- Afon Cleddau Dwyreiniol/Eastern Cleaddau River
- Minwear Wood
- Carew Castle
- Arfordir Penrhyn Angle/Angle Peninsula coast
- Broomhill Burrows

- Castlemartin Cliffs and Dunes
- Stackpole
- Stackpole Quay – Trewent Point
- Freshwater East Cliffs to Skrinkle Haven

Section 7 and OSPAR threatened and declining habitats and species:

- *Anguilla anguilla*
- *Arctica islandica*
- *Clupea harengus*
- *Cruoria cruoriaeformis*
- *Dipturus batis*
- Estuarine rocky habitats
- *Eunicella verrucosa*
- Fragile sponge and anthozoan communities on subtidal rocky habitats
- *Haliclystus auricula*
- *Hippocampus guttulatus*
- Intertidal mudflats
- Intertidal underboulder communities
- Intertidal mudflats
- *Lucernariopsis campanulate*
- *Lithothamnion corralioides*
- Maerl
- Mud habitats in deep water
- *Musculus discors* beds
- Mussel beds
- *Ostrea edulis*
- *Ostrea edulis* beds
- *Padina pavonica*
- *Palinurus elephas*
- *Phymatolithon calcareum*
- *Pleuronectes platessa*
- *Raja clavate*
- *Raja montagui*
- Seagrass beds

- Seapens and burrowing megafauna
- Sheltered muddy gravels
- *Solea solea*
- Subtidal mixed muddy sediments
- Tide swept channels