Cyfoeth Naturiol Cymru
Natural Resources Wales

# Ardal Cadwraeth Arbennig Bae Caerfyrddin ac Aberoedd / Carmarthen Bay and Estuaries 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

Whiteford Light House on the Burry Inlet. © Sian Cuthbertson (NRW).

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# Crynodeb Gweithredol

Mae'r ddogfen hon yn cynnwys cyngor Cyfoeth Naturiol Cymru ar gyfer ardal cadwraeth arbennig (ACA) Bae Caerfyrddin ac Aberoedd a gyhoeddwyd o dan Reoliad 37(3) o Reoliadau Cadwraeth 2017. Sef amcanion cadwraeth a chyngor ar weithrediadau.

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 | Modweddion Dynodedig | Cysylltiad â'r Amcanion cadwraethol |
|---|---|---|
| Bae Caerfyrddin ac Aberoedd | • Aberoedd<br>• Gwastadeddau llaid neu dywod nas gorchuddir gan y môr ar lanw isel<br>• Dolydd ar forfeydd arfordir y gorllewin *Glauco-Puccinellietalia maritimae*<br>• *Salicornia* a phlanhigion unflwydd eraill yn cytrefu llaid a thywod<br>• Cilfachau a baeau mawr bas<br>• Ponciau tywod sydd fymryn dan ddŵr y môr drwy'r amser<br>• Herlyn *Alosa Alosa*.<br>• Gwangen *Alosa fallax*<br>• Lamprai neu lysywen bendoll yr afon *Lampetra fluviatilis*<br>• Lamprai neu lysywen bendoll yr afon *Petromyzon marinus*<br>• Dyfrgi *Lutra lutra* | Amcanion cadwraethol |

# Executive Summary

This document contains NRW's advice for Carmarthen Bay and Estuaries special area of conservation (SAC) issued under Regulation 37(3) of the Conservation Regulations 2017. Namely conservation objectives and advice on operations.

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, and Section 3 outlines each features conservation objectives and supporting information. Advice on operations in relation to this site is found in Section 4. Further information on the SAC 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 SAC features and link to conservation objectives.

| SAC Name | Designated Features | Link to Conservation Objectives |
|---|---|---|
| Carmarthen Bay and Estuaries | • Estuaries<br>• Mudflats and sandflats not covered by seawater at low tide<br>• Atlantic salt meadows *Glauco-Puccinellietalia maritimae*<br>• *Salicornia* and other annuals colonising mud and sand<br>• Large shallow inlets and bays<br>• Sandbanks which are slightly covered by sea water all the time<br>• Allis shad *Alosa Alosa*<br>• Twaite shad *Alosa fallax*<br>• River lamprey *Lampetra fluviatilis*<br>• Sea lamprey *Petromyzon marinus*<br>• Otter *Lutra lutra* | Conservation objectives |

# 1. Introduction

The ardal cadwraeth arbennig Bae Caerfyrddin ac Aberoedd / Carmarthen Bay and Estuaries special area of conservation (SAC) is a large site in south Wales, encompassing four estuaries. The River Loughor, a coastal plain estuary, that flows into the Burry Inlet. The three rivers of the Taf, Tywi (coastal plain estuaries) and the Gwendraeth (a bar-built estuary) make up the Three Rivers estuary complex that join together before emptying into Carmarthen Bay itself.

There are extensive areas of intertidal mudflats and sandflats with large areas of these flats dominated by bivalves. There is a complete sequence of saltmarsh vegetation, from pioneer vegetation through to upper saltmarsh transitions. The SAC is also important for transitions from saltmarsh to sand dune and other habitats. Carmarthen Bay is an extensive shallow bay with a wide variety of seabed types, including mud, sand and rock, although the majority of the seabed is sandy. The SAC includes Helwick Bank, a linear shallow subtidal sandbank that is unusual in being highly exposed to wave and tidal action. The Burry Inlet and Three Rivers system (the Taf, Tywi and Gwendraeth) provide a migratory route for salmonids, lampreys and shad.

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 six habitat features under Annex I, and four species features under Annex II. It is one of the best areas in the UK for the features,

- Estuaries
- Mudflats and sandflats not covered by seawater at low tide (abbreviated to mudflats and sandflats)
- Atlantic salt meadows *Glauco-Puccinellietalia maritimae* (abbreviated to ASM)
- *Salicornia* and other annuals colonising mud and sand (abbreviated to *Salicornia*)
- Large shallow inlets and bays (abbreviated to LSIB)
- Sandbanks which are slightly covered by sea water all the time (abbreviated to sandbanks)
- Allis shad *Alosa alosa*
- Twaite shad *Alosa fallax*

and supports a significant presence of:

- River lamprey *Lampetra fluviatilis*
- Sea lamprey *Petromyzon marinus*
- Otter *Lutra lutra*

Carmarthen Bay and Estuaries SAC overlaps the Bristol Channel Approaches SAC as well as the Carmarthen Bay and Burry Inlet Special Protection Areas (SPAs). The SAC also

wholly or partly overlaps 11 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 feature within the SAC is shown before its conservation objectives. All maps in this document are for indicative purposes only. Detailed maps for this feature in Wales can be found on Data Map Wales.

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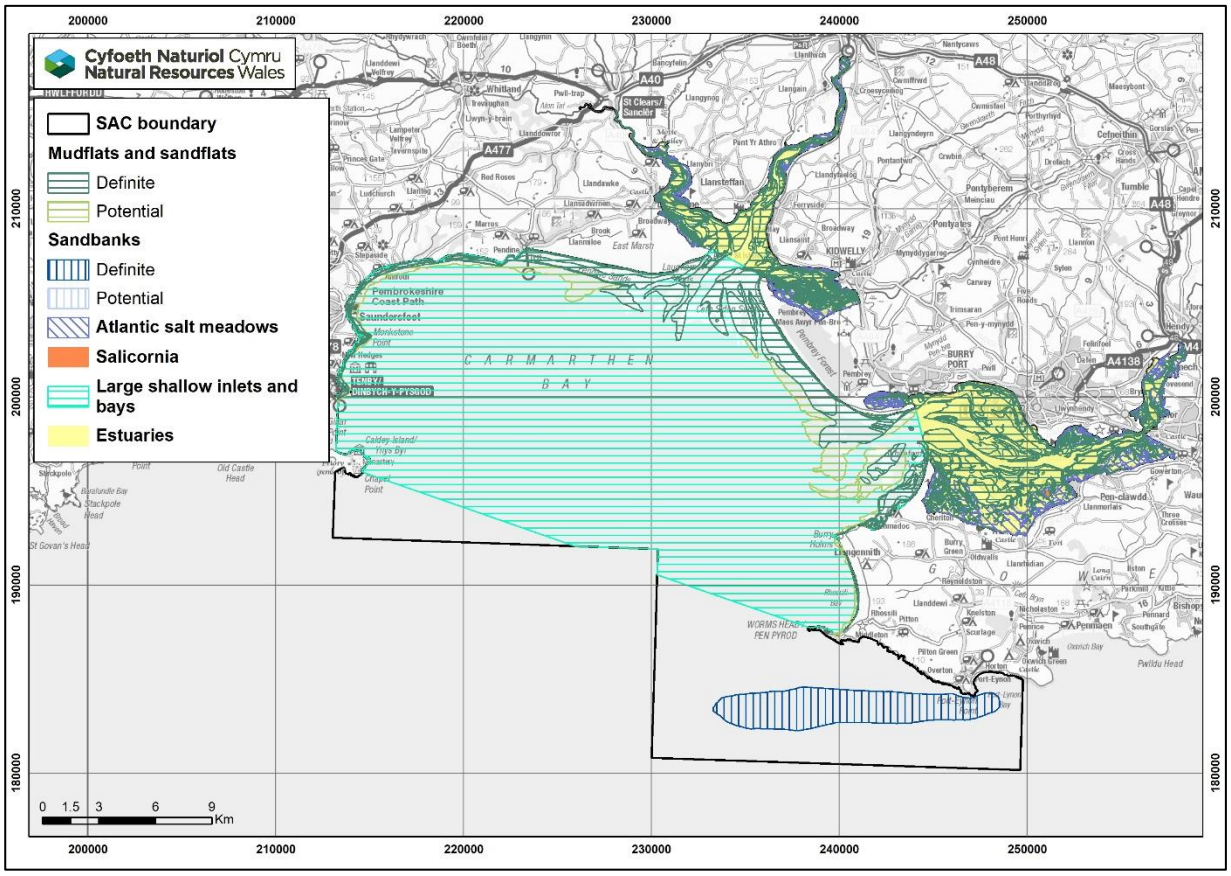
© Crown copyright and database rights 2025 Ordnance Survey AC0000849444

**Figure 1.** Map showing the site boundary and designated features of Carmarthen Bay and Estuaries 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 Carmarthen Bay and Estuaries 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 SAC 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 and all are subject to natural change.

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 Carmarthen Bay and Estuaries 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 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.

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 under an RCP 8.5 scenario – 2049 (Gihwala et al., 2024).

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.

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
- Vegetated shingle.

The affected habitats for this SAC are saltmarsh and mudflats and sandflats. 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 Carmarthen Bay and Estuaries 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 mudflat and sandflats (use full feature title).

**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.

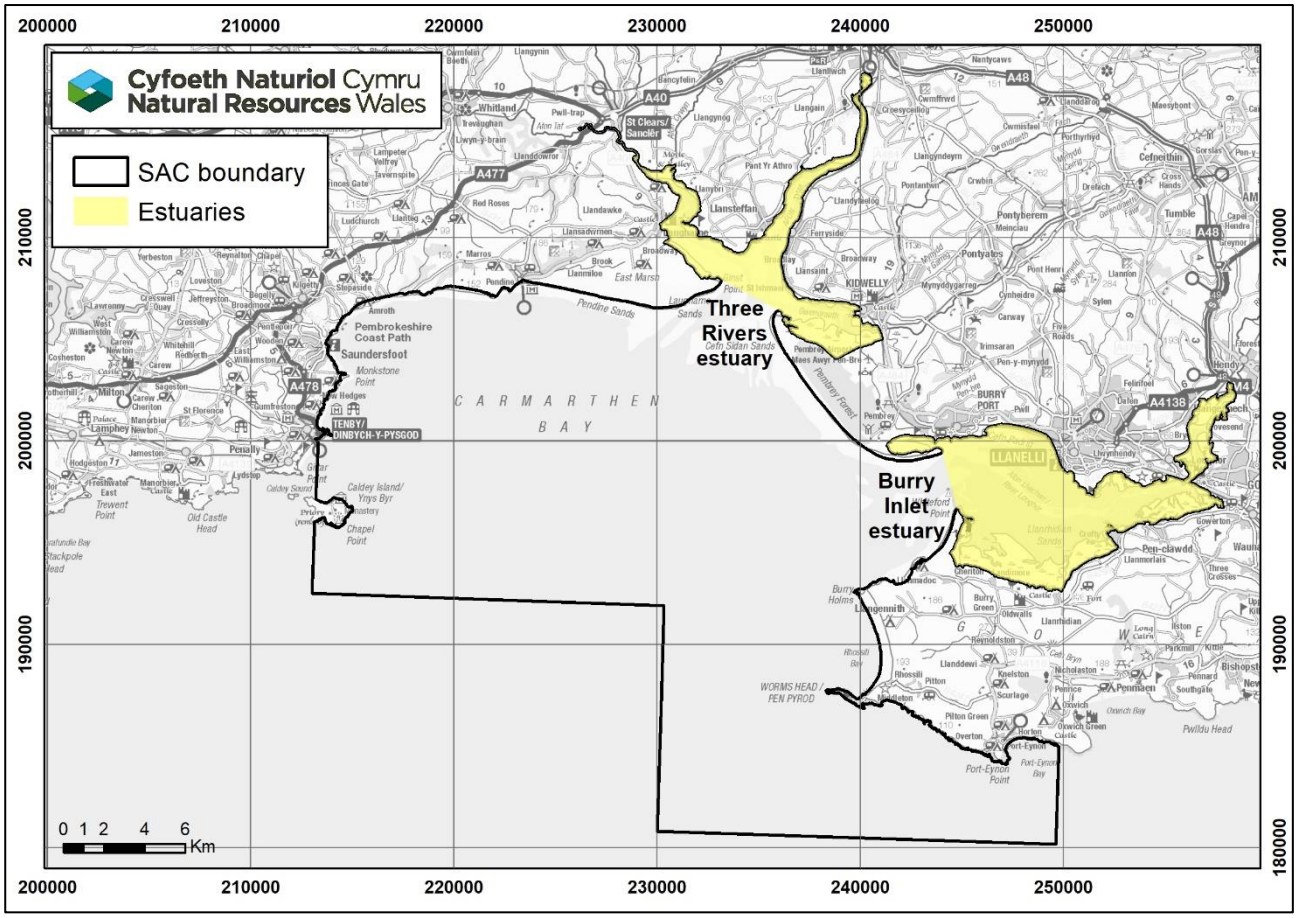
**Unknown:** Where there is not enough suitable evidence to conduct a condition assessment the feature is assigned an unknown condition.

## 3.1. Feature 1: Estuaries

The estuaries feature within Carmarthen Bay and Estuaries 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 estuaries feature within Carmarthen Bay and Estuaries 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 estuaries feature within Carmarthen Bay and Estuaries 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 | Maintain 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 feature across the whole site. The distribution describes the more detailed locations and patterns of different habitats that comprise the feature across the site. Carmarthen Bay and Estuaries SAC encompassing the estuaries of the Rivers Taf, Tywi, Gwendraeth (the Three Rivers system) and the Loughor (Burry Inlet). Together these four estuaries form the estuaries feature.

The Tywi and Taf are coastal plain estuaries, though the Taf below Laugharne is bar-built, due to the easterly growth of Pendine and Laugharne sands. Above Laugharne it can be considered a coastal plain estuary. The Gwendraeth is a typical bar-built estuary that was created by the north westerly extension of the dune/ beach coastal barrier, of which Cefn Sidan sands forms the seaward part. The southern part of the Gwendraeth estuary drains extensive areas of saltmarsh. The Loughor (Burry Inlet) is a typical bar-built estuary. The Loughor is tidal as far as Pontarddulais, approximately 6km from the Loughor. There are extensive areas of high saltmarsh and brackish marsh on both sides of the estuary, much of which remains un-embanked. The lower intertidal zone is mostly sandy except near the head of the estuary.

The estuaries 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., 2025b).

### 1b. Component habitat extent and distribution

The estuaries of Carmarthen Bay form a complex functional system with important interchanges of sediment and biota. All are comprised of different component habitats, some of which are designated Annex I features. Extensive areas of intertidal mudflats and sandflats, Atlantic salt meadow and *Salicornia* occur throughout the feature. Annex II species allis and twaite shad, river and sea lamprey, and otter all use the feature for passage and feeding.

Overall the variety and distribution of intertidal sediments extends from well-sorted fine to medium sands at the mouths of the estuaries to muddy sand in their middle reaches and mud in the upper reaches and the back of the shores. Saltmarsh fringes the intertidal

sediments in the majority of the estuaries, apart from the northern side of the Burry Inlet where sea defences form the back of the shore. At the confluence of the three rivers, bedrock and boulders can be found at Wharley Point, with shingle areas from the north of the Gwendraeth to Ferryside on the eastern side of the Tywi. The subtidal channels are dominated by mobile sands. This site has a variety of undisturbed transitions to coastal habitats.

All four estuaries are considered important nursery areas for juvenile fish (Ellis et al., 2012; 2024), which are presumed to use all of the subtidal habitats during the summer months. The estuaries also provide a means by which migratory fish species make the transition between the marine and freshwater environments.

In the intertidal and subtidal sediments, there are communities of worms, crustaceans and molluscs. The communities are determined by the substrate, salinity gradient, degree of exposure to wave action and tidal streams. Where there is rocky habitat, green and brown seaweeds develop with some communities being characteristic of the variable salinity conditions. Cobble and mixed substrata areas are often colonised by blue mussels, barnacles and littorinid molluscs. Transitions from saltmarsh to brackish, maritime and freshwater communities support their own particular assemblages of plants and animals. Commercial cockle beds *Cerastoderma edule* are present within the Burry Inlet. Other ephemeral cockle beds are found within the Taf and Tywi.

Component habitats of the feature need to be maintained by sustaining suitable environmental conditions and limiting activities 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.

The estuaries 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 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.<br><br>Nutrients are at levels not detrimental to the structure and function of the estuaries feature.<br><br>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 estuaries necessary for the structure and function of the feature are sustained. |

## Supporting Information

### 2a. Water and sediment quality

Various contaminants are known to affect species living in the water column and in or on the surface of sediments. The biological effect of a contaminant will vary depending on the nature of the contaminant. Contaminants include heavy metals (e.g. mercury and zinc), poly-aromatic hydrocarbons, poly-chlorinated biphenyls (PCBs), 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 influence habitats alone or in combination to 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.

Some water and sediment quality issues have been identified for this feature. For more information see the latest condition assessment (Jackson- Bué et al., 2025b).

### 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 in turn can change the waves and 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.

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 feature.

Generally in the estuaries of the site, intertidal flats are fairly extensive, stable and flat above mid-shore. Below mid-shore the extensive sandflats are very mobile with frequent large sand waves and ripples. Sandbanks in the entrances of the estuaries are particularly mobile. Saltmarsh is prevalent in the upper intertidal (around mean high water neaps and above) and plays an important role in dissipating waves and tidal currents therefore affecting the hydrodynamics of the wider estuary, particularly under storm and surge conditions. Changes to saltmarsh can impact the hydrodynamics of an estuary (Bennett et al., 2020; 2023).

No hydro-morphology issues have been identified for this feature. For more information see the latest condition assessment (Jackson- Bué et al., 2025b). 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 estuaries is variable throughout and between the sites, 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 in the same way that muddy sediments will. Activities that disturb sediments can release contaminants back into the water column. Sediment moves along the shores by longshore drift to supply recurved

spits at Ginst Point, Tywyn Point, Pembrey Burrows / Burry port and Whiteford Point. Information on sediment transport in the SAC can be found in Appendix 1.

No sediment supply issues have been identified for this feature. For more information see the latest condition assessment (Jackson- Bué et al., 2025b).

### 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. The Afon Loughor and Afon Llan that flow into the Burry Inlet have mean freshwater flows that are minor compared to the tidal prism and therefore salinity stratification in the Burry Inlet is vertically and sectionally homogeneous (Robins, 2015). Similarly, freshwater flow from the Taf (Three rivers complex) is very small compared to the tidal prism (Bennet et al., 2023).

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

## **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 | Maintain 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

The estuaries in Carmarthen Bay And Estuaries SAC contain both subtidal and intertidal habitats, although the latter are a lot more extensive in this SAC. Extensive areas of the designated Annex I habitat features mudflats and sandflats, Atlantic salt meadow and *Salicornia* are present throughout the feature. While all the habitats and communities within the estuaries contribute to the overall condition of the feature, there are some which are of particular conservation importance.

Intertidal sediments can include communities with polychaete and oligochaete worms and areas with extensive cockle beds and other bivalve molluscs (see mudflats and sandflats).

Burrowing fish species (e.g. sandeels) may also be present within the estuaries. Blue mussel beds are present within the estuaries where suitable cobble and mixed substrata is found. They can also colonise areas of dead shell. These can be relatively small areas at Black Scar in the Taf and more extensive areas at Salmon Point Scar at the confluence of the Tywi and Gwendraeth and to the north of Ginst Point in the Taf. Within the Burry extensive beds can be found on the south and northern shores of the estuary, and at Penrhyngwyn. Where mussels are absent the areas are often colonised by barnacles and littorinid molluscs.

A species assemblage characterised by hydroids, ephemeral seaweeds and the winkle *Littorina littorea* in shallow eulittoral mixed substrata pools is unusual due to its limited geographic distribution, and because it is typically only found associated with mussel beds. It occurs on Salmon Point Scar, east of Burry Port, Whiteford Point, west of Penclacwydd and Loughor Bridge.

Relatively undisturbed saltmarsh zonation of the upper marsh occur including more brackish systems through to the terrestrial transition. These include swamp, mire, mesotrophic grassland and open vegetation communities. These mostly occur in the mid and upper reaches of the Taf and Tywi Estuaries, around the Gwendraeth Estuary, west Pembrey Burrows, west Landimore Marsh, west and upstream of the bridge in the Loughor estuary. Dwarf eelgrass *Zostera noltei* also occurs in the Loughor estuary (see mudflats and sandflats feature).

In addition to the diadromous fish species which are designated features (sea lamprey, river lamprey, allis shad and twaite shad), European eel *Anguilla Anguilla* and sea trout *Salmo trutta* form an important component of the Three Rivers estuarine fish community during their marine residency phases. More information on estuary habitats and communities found in the SAC can be found in Appendix 1 and in the conservation objectives for the nested Annex I features.

The estuaries habitats and communities attribute is being met, allowing a maintain target to be set for objective 3a. See the latest condition assessment for more information (Jackson-Bué et al., 2025b).

### 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, 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 American slipper limpet *Crepidula fornicata* was noted within the SAC just outside Burry Port in 2008. It was recorded more recently around Tenby in 2023 and near Pembrey in 2024. The red alga *Agarophyton vermiculophyllum* has been found in the Loughor estuary, where it was first recorded in 2017. Since then establishment has been notably rapid (Mercier and Brazier, 2023). This INNS is causing sedimentation change and changes to topography having a detrimental impact on the mudflats and sandflats and the estuary feature as a whole. For more information see the latest condition assessment (Jackson-Bué et al., 2025b).

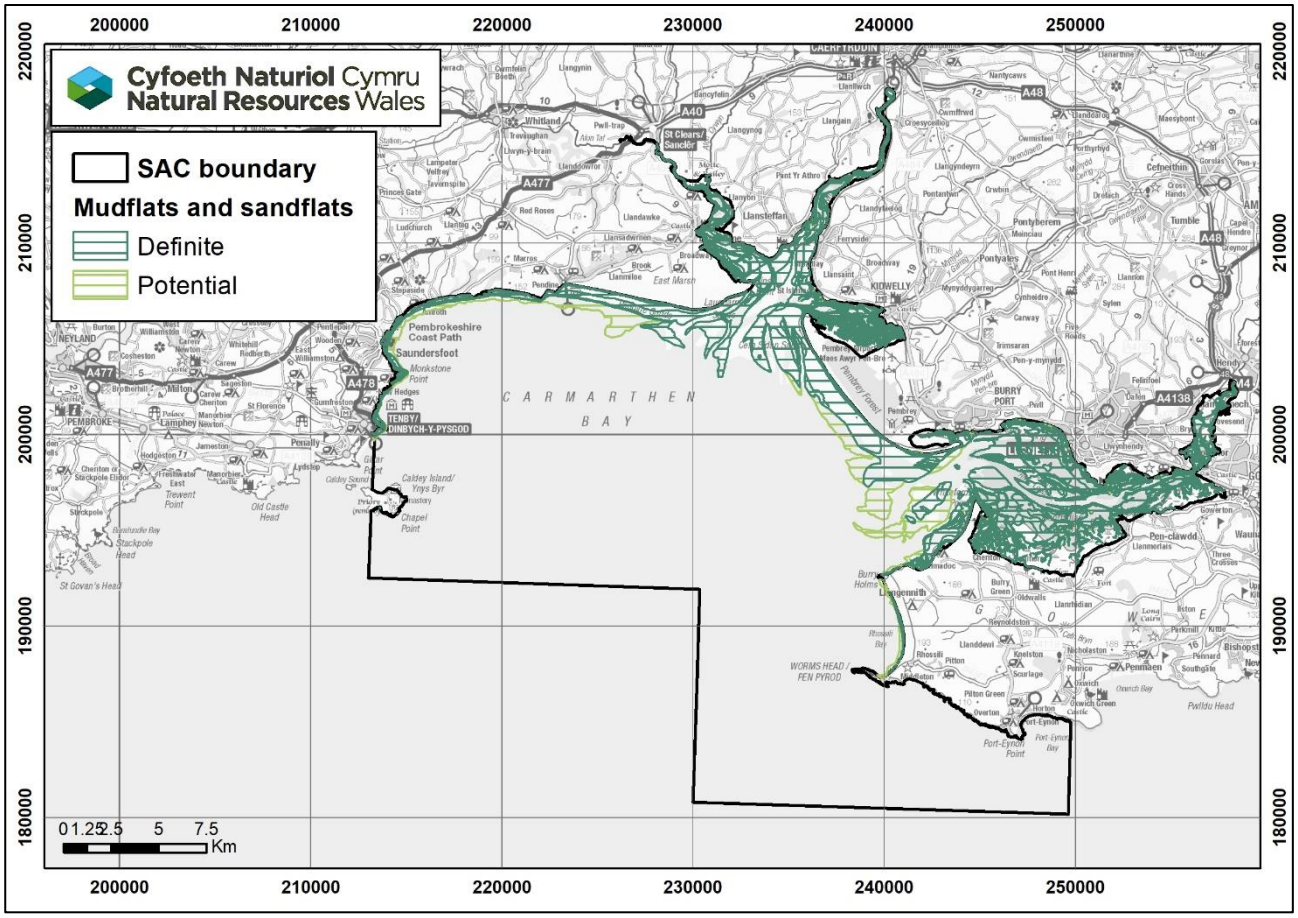
Information on INNS in the SAC as a whole can be seen in Appendix 1.

## 3.2. Feature 2: 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 Carmarthen Bay and Estuaries 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 definite and potential mudflats and sandflats feature within Carmarthen Bay and Estuaries 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 mudflats and sandflats feature within Carmarthen Bay and Estuaries 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, subject to natural change. |
| 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 feature across the whole site, even where its patchy. The distribution describes the more detailed locations and patterns of different habitats that comprise the feature across the site.

The SAC includes large areas of mudflats and sandflats. These range from open coast sandy beaches at Tenby and eastwards towards Worms Head, including the wide beaches of Pendine Sands, Cefn Sidan Sands and Whiteford Burrows. The most extensive areas of mudflats and sandflats within the estuaries are the wide expanses of Llanrhidian Sands, Cefn Padrig and Dafon Sands, in the lower and middle estuary of the Burry Inlet.

The mudflats and sandflats extent and distribution attribute 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

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. The mudflats and sandflats occur as narrow bands as well as very expansive areas. Sediment types range from mobile fine and medium sands, muddy sands, sandy and silty muds, and pure muds, to limited areas of exposed immobilised sandy and / or muddy gravel pavements.

There is a gradation within the distribution of sediments, from mud in the upper, more sheltered regions of the estuaries, to sand at the more wave-exposed mouths of the estuaries. The sandy shores of South beach (Tenby), Waterwynch Bay, Monkstone Beach and Cefn Sidan Sands, consist mainly of mobile fine and medium sands. These can also be found to the south of the Burry Inlet at Whiteford Burrows.

The mudflats and sandflats of the Three Rivers system and that of the Burry Inlet and River Loughor are mostly sandy gravel or muddy sand. Sheltered sandy gravel shores are found from the edge of Pendine Sands, stretching around into the mouth of the Three Rivers system, where a variety of different sediment types are found. The mouth of the

Three Rivers system is dominated by moderately mobile fine sands that are continually shifted by waves and tidal action. The intertidal flats of the estuaries are predominantly sandy, although the upper reaches of the rivers are muddy, and each of the tributaries has areas of saltmarsh.

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.

The mudflats and sandflats extent and distribution of component habitats and communities 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., 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.<br><br>Nutrients are at levels not detrimental to the structure and function of the mudflats and sandflats feature.<br><br>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 in the water column and in or on the surface of sediments. The biological effect of a contaminant will vary depending on the nature of the contaminant. Contaminants include heavy metals (e.g. mercury and zinc), poly-aromatic hydrocarbons, poly-chlorinated biphenyls (PCBs), 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 influence habitats alone or in combination to 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.

Some water quality issues have been identified for this feature. For more information on water and sediment quality see 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 in turn can change the waves and 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.

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 forces 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. Maintaining the wave and tidal forces as well as maintaining the broad shape (e.g. beach type classification) of the feature 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 mudflats and sandflats. 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.

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 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 | Maintain the abundance, distribution and diversity of component habitats and communities necessary for the structure and function of the mudflats and sandflats 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 mudflats and sandflats feature. |

## Supporting information

### 3a. Habitats and communities

While all the habitats and communities within the mudflats and sandflats contribute to the overall condition of the feature, there are some which are of particular conservation importance. Changes to the spatial distribution of communities across the feature could highlight changes to the overall feature.

Large areas of the intertidal mudflats and sandflats are dominated by bivalves. In areas of fine sand cockles *Cerastoderma edule* are abundant. Other bivalves, amphipods and worms, as well as burrowing fish species, can also be found in high numbers. In the Burry Inlet SPA and in the Three Rivers system cockles are the main food source for oystercatcher.

The lower Loughor Estuary is one of the few places in the UK where the worm *Ophelia bicornis* has been found. There are also beds of the nationally scarce dwarf eelgrass *Zostera noltei* along the Great Pill, between Berges Island and Landimore Marsh, and on Llanrhidian Sands and at Penrhyn Gwyn. Areas of mobile fine and medium sands such as South Beach and Cefn Sidan sands support large populations of burrowing amphipods and polychaetes. The communities at the mouth of the Three Rivers system are characterised by bivalves and polychaetes. Species assemblages characterised by the common heart urchin *Echinocardium cordatum* and razor shells *Ensis sp*. occur along Carmarthen Bay on the shallow lower shore. Grazing fish species (e.g. mullet) are also associated with the saltmarshes in the Three Rivers and Burry Inlet.

More information on mudflat and sandflat habitats and communities found in the SAC can be found in Appendix 1. The mudflats and sandflats habitats and communities attribute is being met, allowing a maintain target to be set for objective 3a. See the latest condition assessment for more information (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, 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 red alga *Agarophyton vermiculophyllum* has been found in the Loughor estuary, where it was first recorded in 2017. Since then, establishment has been notably rapid (Mercer and Brazier, 2023). This INNS is causing sedimentation change and changes to topography which is having a detrimental impact on the mudflats and sandflats feature. For more information see the latest condition assessment (Jackson-Bué et al., 2025a).

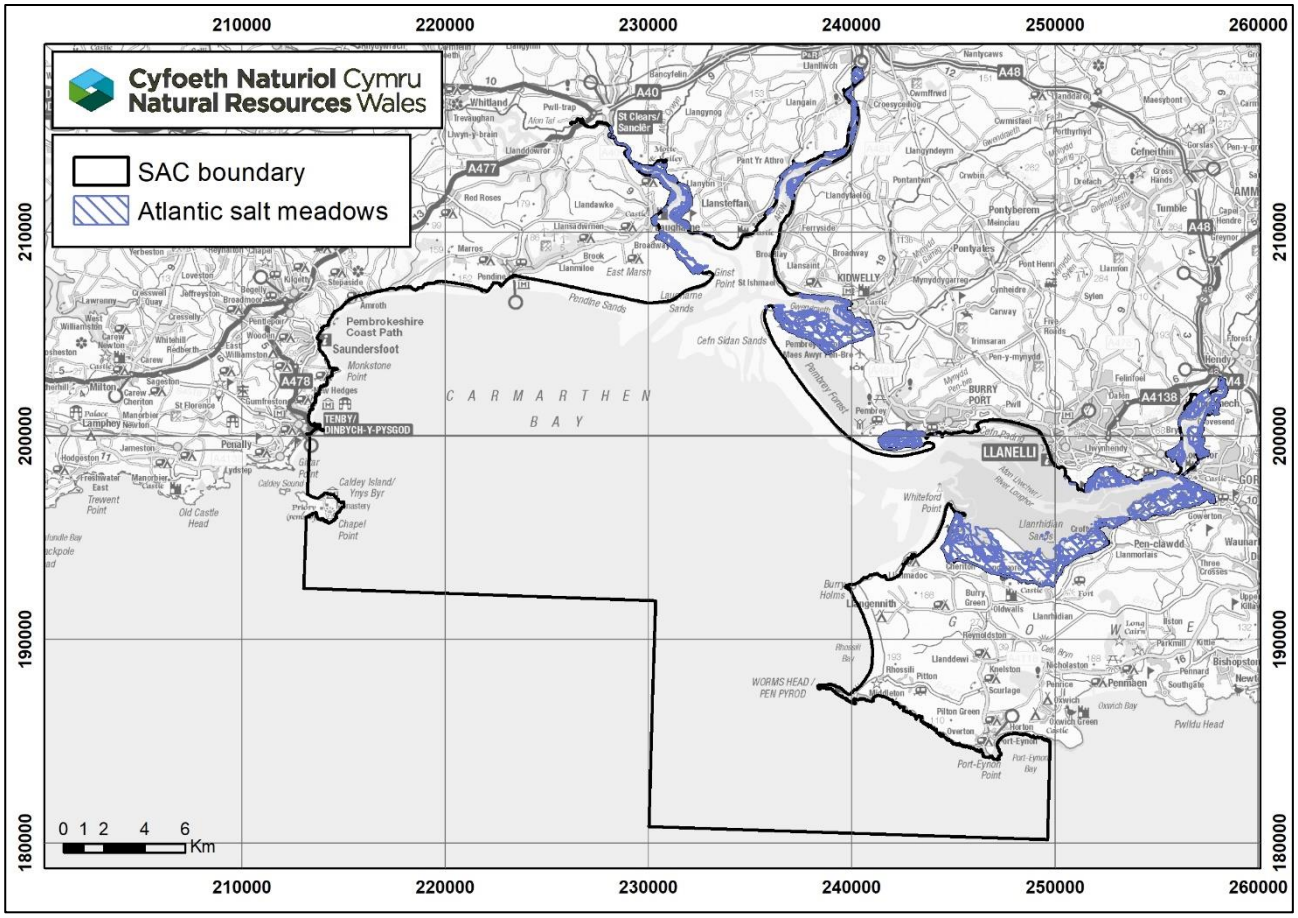
Information on INNS in the SAC as a whole can be seen in Appendix 1.

## 3.3. Feature 3: Atlantic salt meadows *Glauco-Puccinellietalia maritimae*

The Atlantic salt meadows *Glauco-Puccinellietalia maritimae* (ASM) feature within Carmarthen Bay and Estuaries 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 4 is a map of the location the Atlantic salt meadows feature within Carmarthen Bay and Estuaries 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 Atlantic salt meadows feature within Carmarthen Bay and Estuaries 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<br><br>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

The Carmarthen Bay and Estuaries SAC includes the largest expanse of saltmarsh in Wales. The Atlantic salt meadows (ASM) feature is present together with the pioneer saltmarsh *Salicornia* and other annuals colonising mud and sand feature, as well as adjacent natural transitions. Saltmarsh transitions include freshwater marsh and broadleaved woodland found throughout the SAC.

The estuarine systems also have exceptionally well developed saltmarsh-sand dune transitions, where blown sand has modified the upper saltmarsh vegetation. The saltmarsh-sand dune transitional vegetation is mainly distributed in the Burry Inlet at Pembrey Burrows, but is also recorded from west Taf and Tywi estuaries, west Penrhyn Gwyn and Penclacwydd (Burry Inlet).

Particularly noteworthy transitions occur between saltmarsh and dune slacks within semi-fixed dune systems located near Ginst Point at the mouth of the Taf. Further transitional noteworthy vegetation is present at a small scale at Morfa Uchaf and Llansteffan on the Tywi and most impressively, at the western end of the Gwendraeth saltmarsh. At the latter location, conservation value is enhanced by the associated transitions from mid-marsh to tall mesotrophic inundation grassland.

The largest area of ASM is in the Burry inlet is between Llanrhidian and Landimore, followed by Penclawdd and the Loughor estuary. In the Three Rivers complex the Gwendraeth estuary has the largest area of ASM followed by the Taf estuary and then the Tywi estuary.

Saltmarsh is a naturally dynamic habitat which can change with coastal processes such as channel movement therefore, some natural change in extent and distribution is acceptable. 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 Carmarthen Bay and Estuaries 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, Gwendraeth, Llangennech, Loughor, Tywi and the Burry Inlet complex. The total extent of saltmarsh for Carmarthen Bay has been measured as 2914.41 ha and there has been no significant loss of more than 20% of saltmarsh extent in any of the defined sectors. There has been an overall increase in extent (Jackson-Bué et al., 2025e).

The ASM extent and distribution attributes have been met, allowing maintain targets to set for objective 1a. See the latest condition assessment for more information (Jackson-Bué et al., 2025e).

### 1b. Zonation extent and distribution

A feature of saltmarsh is the zonation of different vegetation communities with increasing elevation from the sea. Zonation is generally displayed as bands that run parallel to the shoreline, although in many sites this is more complex. If the expected zonation is not maintained, it can be a sign that 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, can form a characteristic zone adjacent to the ASM. Sustaining suitable environmental conditions and limiting pressures to which ASM may be sensitive to will help ASM zones to maintain themselves within their natural variation.

The ASM zonation extent and distribution attribute has been met, allowing a maintain target to be set for objective 1b. 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 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.<br><br>Nutrients are at levels not detrimental to the structure and function of the Atlantic salt meadow feature.<br><br>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 meadow 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 absorbed 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). Large numbers of grazing animals on a marsh can significantly increase nutrient levels and bacterial load in the surrounding water. 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 impacts (Wasson et al., 2017 and references therein).

Some water quality issues have been identified for this feature. For information on water and sediment quality see the latest condition assessment (Jackson- Bué et al., 2025e).

### 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.

Overall atmospheric N deposition is likely to be of low importance for these systems as inputs are probably significantly below the large nutrient loadings from river and tidal inputs. A review by Boorman and Hazelden (2012) suggested pioneer low to mid saltmarsh areas are more resilient to N deposition than the mature upper areas. These more mature areas may also be subject to direct run-off from the surrounding catchment. Saltmarshes under a strong marine influence may show a lower sensitivity to additional (aerial) N but sensitivity 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 deposition critical range for saltmarsh habitat was updated in 2022 and is set at 10-20 kg N $ha^{-1}$ $yr^{-1}$ per ha per year for mid and upper saltmarsh on the recommendation of an expert working group, based on expert judgement and a 25-year Dutch monitoring study (Bobbink et al., 2022). The load is a conservative estimate. Evidence of exceedance of the deposition critical load would be indicated by increases in late successional species, increased productivity and increased dominance of graminoids (grasses) (Bobbink et al., 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., 2025e).

### 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 in turn can change the waves and 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.

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. Four elements are necessary for growth of 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. The marshes on the southern side of the Burry Inlet between Whiteford Point and Loughor are of national significance for their variety of geomorphological features, including creeks, saltpans, erosion cliffs and a variety of sediment types.

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., 2025e). 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, 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 often operate 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., 2025e). Information on sediment transport within 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 Atlantic salt meadow feature are stable or improving, subject to natural variability.

| Objective attribute | Site specific target(s) |
|---|---|
| 3a. Plant communities | Restore the abundance, distribution, structure and diversity of Atlantic salt meadows plant communities within the sectors of the SAC.<br><br>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 vegetation communities within the SAC, including transition vegetation communities in the upper most reaches of the marsh, contribute to the overall condition of the feature. Species composition of ASM vegetation communities are influenced by numerous factors such as tidal inundation, morphology, sediment type, physical processes operating at a site and grazing management past and present. Changes to the species that make up communities and structure are a good indication of changes to influencing processes and management practices.

The grazed saltmarshes include upper margins with sea rush *Juncus maritimus* and marsh-mallow *Althaea officinalis* which are a particularly distinctive ecological features of the site. Notable saltmarsh species and communities include stands containing good populations of *Althaea officinalis* that were extensive at Llanrhidian-Landimore, and also present on Loughor and Penrhyn Gwyn and stands of Sea wormwood *Artemisia maritima (*previously named *Seriphidium maritimum)* which were well represented at Penclawdd, and also occurred on the other sites, although in lesser quantity. Good populations of *Limonium vulgare* have been recorded at all sites, and were particularly well represented at Llanrhidian-Landimore. Two nationally scarce plant species also occur on the Taf Estuary, namely the rock sea-lavender *Limonium procerum* and bulbous foxtail *Alopecurus bulbosus*. Three known populations of the nationally rare bryophyte *Bryum marratii* are located on upper saltmarsh transitions where there is freshwater flushing at Landimore marsh and on the Tywi and Gwendraeth Estuaries. More information on ASM habitats and communities found in the SAC can be found in Appendix 1.

While saltmarsh plant diversity and structure can also benefit from grazing under appropriate management regimes, heavy grazing can have negative effects on saltmarsh communities. Over grazing can also increase erosion on the marsh further reducing its structure and degrade water quality through added nutrients from grazing animals.

The latest condition assessment found overgrazing is widespread within the SAC feature, especially from sheep. Locations such as Whiteford Burrows, Llanrhidian, Penclawdd and Bynea are all grazed and much of it being grazed to a short sward of less than 5 cm in height (Jackson-Bué et al., 2025e). Therefore, a restore target has been set for objective 3a due to overgrazing negatively impacting the sward and therefore the structure of the ASM feature. See the latest condition assessment for further information.

There is currently no monitoring of locally distinctive plants in the SAC. Therefore a maintain has been set for this target. For more information see the latest condition assessment (Jackson- Bué et al., 2025e).

### 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, 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.

Saline conditions in ASM habitats prevent the more common terrestrial invasive non-native species in Wales becoming established. The red seaweed *Agarophyton vermiculophyllum* has been recorded in the Loughor estuary and has been found to form dense stands of up to 0.8 ha. However, it has yet to be recorded in saltmarsh (Jackson-Bué et al., 2025e).

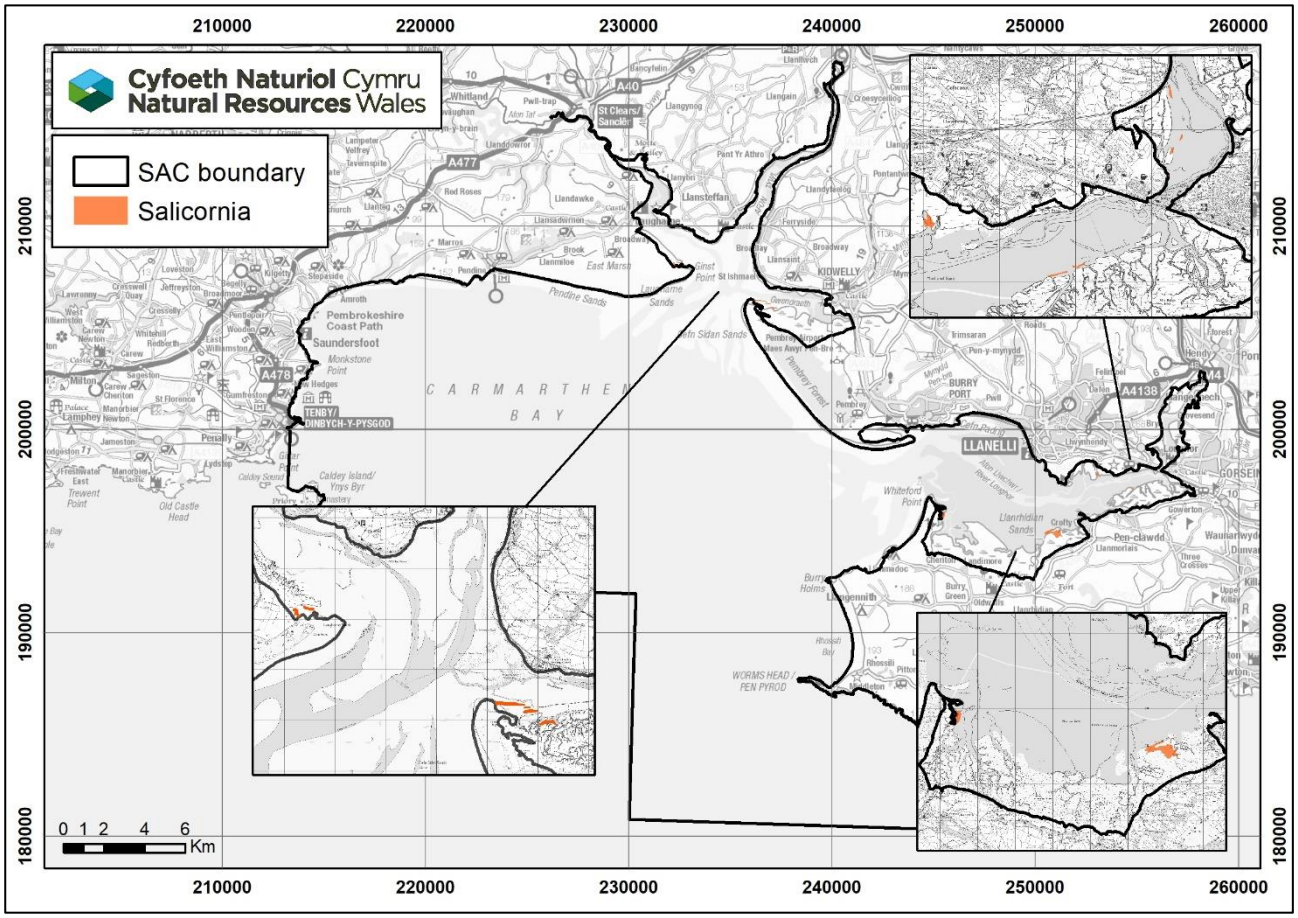
Information on INNS in the SAC as a whole can be seen in Appendix 1.

## 3.4. Feature 4: *Salicornia* and other annuals colonising mud and sand

*Salicornia* and other annuals colonising mud and sand (*Salicornia*) feature within Carmarthen Bay and Estuaries SAC is currently in **favourable** 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 the *Salicornia* feature within Carmarthen Bay and Estuaries 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 Salicornia feature within Carmarthen Bay and Estuaries SAC.




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

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

| Objective attribute | Site specific target |
|---|---|
| 1a. Feature extent and distribution | Maintain the extent and distribution of *Salicornia* habitats within the sectors of the SAC, subject to natural change. |

## Supporting information

### 1a. Feature extent and distribution

The *Salicornia* feature is pioneer saltmarsh that develops on intertidal mud and sandflats in areas protected from strong wave action and where the elevation is high enough to enable colonisation by annual plants. The majority of this feature is dominated by Glassworts *Salicornia sp.* however, stands of pioneer marsh can also be dominated by Annual Sea-blite *Suaeda maritima* which is much less common. This pioneer marsh develops at the lower reaches of the saltmarsh where the plants are frequently inundated by the tide. It can also colonise open creek sides, depressions or pans within saltmarshes, as well as disturbed areas of upper saltmarsh.

The *Salicornia* feature is relatively scarce in the Burry Inlet but well represented on the Landimore to Llanrhidian marshes, where sizeable stands form good sequences between pioneer marsh and Atlantic salt meadows. These communities are scarce within the Three Rivers complex with small but representative stands of *Salicornia* exist on both the Taf and the Gwendraeth.

The overall extent of the *Salicornia* feature across the site should be maintained. There should be no significant loss of extent within each sector. *Salicornia* in Carmarthen Bay and Estuaries SAC is divided into sectors to aid monitoring. The sectors of the site are, Gwendraeth, Llangennech, Loughor, Tywi and Burry Inlet complex.

The current extent of the Salicornia feature is unknown, however as of the latest condition assessment, there is no evidence to suggest a change in extent (Jackson-Bué et al., 2025e). Therefore, the target has defaulted to maintain for objective 1a. For more information see the latest condition assessment.

## **Objective 2:** The hydro-morphological and chemical elements necessary for the structure and function of the *Salicornia* 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 *Salicornia* feature.<br><br>Nutrients are at levels not detrimental to the structure and function of the *Salicornia* feature.<br><br>Physicochemical characteristics are at levels not detrimental to the structure and function of the *Salicornia* feature. |
| 2b. Air quality | Maintain nitrogen (N) deposition on the *Salicornia* 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 *Salicornia* feature are sustained. |
| 2d. Sediment supply | The sediment type, size distribution and budget necessary for the structure and function of the *Salicornia* feature are sustained, subject to natural change. |

## 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 absorbed 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).

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 that 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 impacts (Wasson et al., 2017 and references therein).

Some water quality issues have been identified for this feature. For information on water and sediment quality within the SAC see the latest condition assessment (Jackson-Bué et al., 2025 e).

### 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.

Overall atmospheric N deposition is likely to be of low importance for these systems as inputs are probably significantly below the large nutrient loadings from river and tidal inputs. A review by Boorman and Hazelden (2012) suggested pioneer low to mid saltmarsh areas are more resilient to N deposition than the mature upper areas. These more mature areas may also be subject to direct run-off from the surrounding catchment. Saltmarshes under a strong marine influence may show a lower sensitivity to additional (aerial) N but sensitivity 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 deposition critical range for saltmarsh habitat is set at 10-20 kg N per ha per year (Bobbink et al., 2022). The load is a conservative estimate. Evidence of exceedance of the deposition critical load would be indicated by increased productivity and increase in late successional species (Bobbink et al., 2022).

At the time of the last condition assessment the N deposition within *Salicornia* in the SAC is not exceeding the critical load, allowing a maintain target to be set for objective 2b. See the latest condition assessment for more information (Jackson-Bué et al., 2025e).

### 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 in turn can change the waves and currents; meaning there is two-way feedback between the hydrodynamics and the morphology. Hydro-morphology plays an important role in determining the species and communities present.

*Salicornia,* growing at the lowest edge of the saltmarsh, is extremely tolerant of regular flooding . As a halophyte, *Salicornia* is tolerant to high salinity, drought or a combination of both. Populations on the lower shore need to be more tolerant of prolonged submergence, tidal scour and water-logging, whereas those at high elevations may experience hyper-salinity in summer.

Four elements are necessary for growth of 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 saltmarsh 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 like *Salicornia* to be established along their banks higher into the saltmarsh system.

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

### 2d. Sediment supply

The sediment structure of *Salicornia* habitat is predominantly muds and clays, though can grow on mixed muddy gravels and shelly sand. Although an early colonist of soft, unconsolidated sediments, the densest stands tend to be on firm silts and clays.

The sediment supply into and through *Salicornia* is influenced by the saltmarsh morphology, which dictates water flow, energy dissipation and hence sediment deposition. 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.

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

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

| **Objective attribute** | **Site specific target** |
|---|---|
| 3a. Communities | Maintain the abundance and distribution of the communities of the *Salicornia* feature within 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 *Salicornia* feature. |

## Supporting information

### 3a. Communities

All communities present in the *Salicornia* feature contribute to its overall condition. Both of the *Salicornia* feature vegetation community types are present within this site; Annual *Salicornia* saltmarsh and *Suaeda maritima* saltmarsh. The *Salicornia* feature is naturally species poor. The dominant species *Salicornia sp.* and *Suaeda maritima* are able to colonise areas of high salinity and tolerate higher frequency tidal inundation than almost all other plants are able to, with the exception of Cord grasses *Spartina* species and Sea grass *Zostera* species.

Surveys have recorded the *Salicornia* feature in the Three Rivers complex where Annual *Salicornia* saltmarsh has been mapped on the Taf and the Gwendraeth estuary whilst *Sueada maritima* saltmarsh is restricted to a single location on the Gwendraeth. Within the Burry Inlet the Annual *Salicornia* saltmarsh is widespread with the most extensive stands in the Llanrhidian and Landimore areas. However, it has been recorded as fragmentary elsewhere in the site. S*uaeda maritima* saltmarsh has only been recorded in one stand at Llanrhidian.

A reduced marine fauna is usually present which may include the amphipods, the ragworm and gastropods. There are often algal films, including diatoms, and algal mats over the substrate surface, but vascular companions are usually very few. Grazing fish species (e.g. mullet) are also associated with the saltmarshes in the Three Rivers and Burry Inlet. More information on *Salicornia* habitats and communities found in the SAC can be found in Appendix 1.

There is no information on the current abundance and distribution of communities in the *Salicornia* feature. Therefore, the target has defaulted to maintain for objective 3a.

### 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, 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.

Saline conditions in *Salicornia* habitats prevent the more common terrestrial invasive non-native species in Wales becoming established.

The red sea weed *Agarophyton vermiculophyllum* has been recorded on the Loughor estuary and has been found to form dense stands of up to 0.8 ha. However, it has yet to be recorded in saltmarsh (Jackson-Bué et al., 2025e).

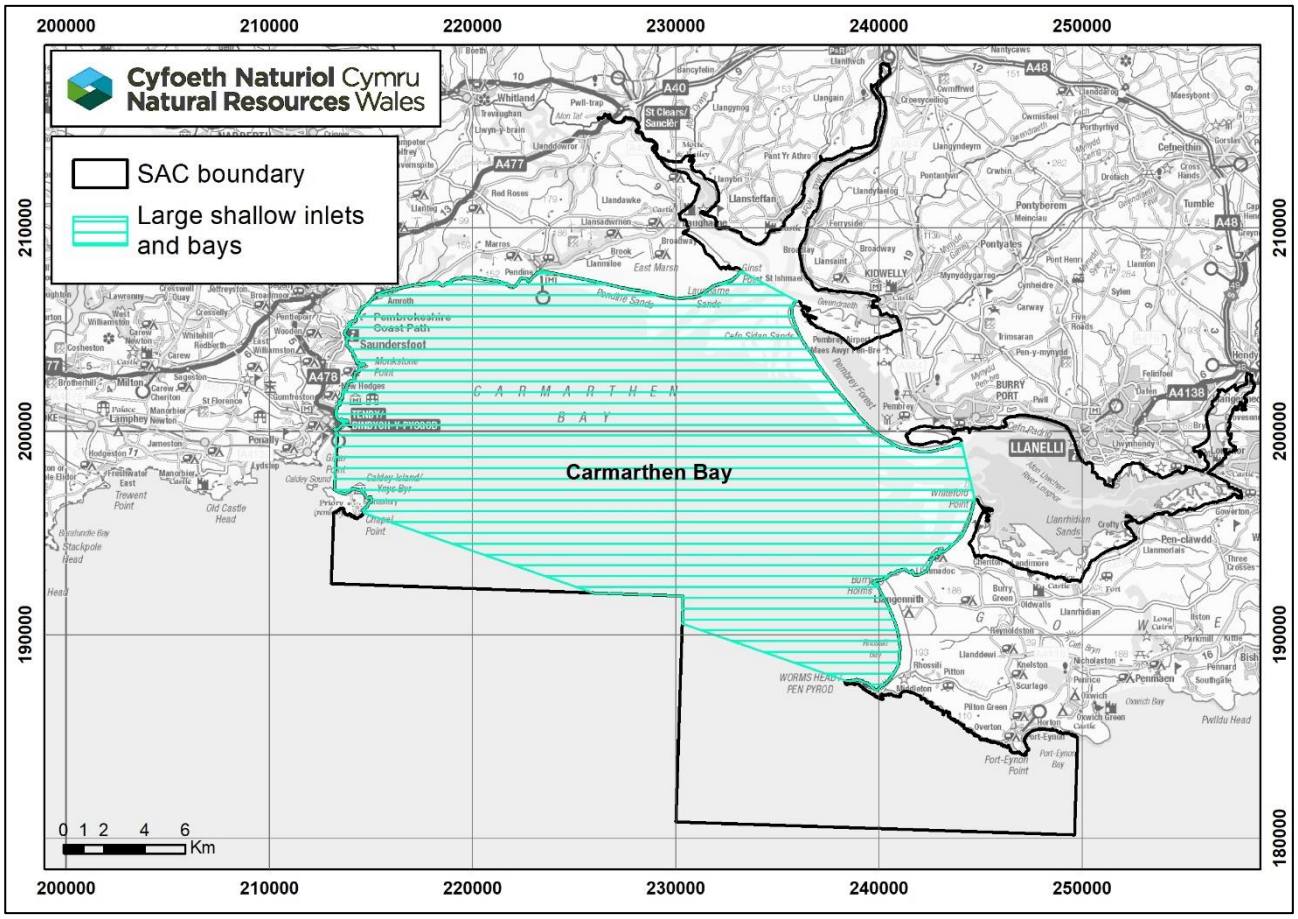
Information on INNS in the SAC as a whole can be seen in Appendix 1.

## 3.5. Feature 5: Large shallow inlets and bays

The large shallow inlets and bays feature within Carmarthen Bay and Estuaries SAC feature 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 the large shallow inlets and bays feature within Carmarthen Bay and Estuaries 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 large shallow inlets and bays feature within Carmarthen Bay and Estuaries 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 inlet 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 |
|---|---|
| 1a. Feature extent and distribution | Maintain the extent and distribution of large shallow inlets and bays, subject to natural change. |
| 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. |

## 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.

The large shallow inlets and bays feature (LSIB) of the SAC is Carmarthen Bay, a large shallow bay partially bound by rocky outcrops, mostly occupied by soft sediments. It extends from Tenby and Caldy Island in the West to Worm's Head on the Gower peninsula in the east.

There is a variety of component habitats within Carmarthen Bay. This includes the habitats within the Annex I feature intertidal mudflats and sandflats, which has a significant presence in the bay. Annex II species also occur within the feature (shad, lamprey and otter).

The LSIB 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., 2025c).

### 1b. Component habitat extent and distribution

There is a variety of component habitats within the LSIB. The seafloor of Carmarthen Bay consists of a mixture of sediments although mostly fine sand. The outer / seaward side of the feature is more medium sand with occasional areas of coarse sand and muddy silt. A few rocky outcrops are present, the largest being off Small Ord Point, near Caldey Island. Mid-Flandrian peat beds are exposed as ledges at times along the northern and north-eastern boundary of the large shallow bay. The rocky intertidal areas around the bay vary from steep cliffs at Tenby to bedrock platforms at Saundersfoot and areas of mixed rock and sediment at Salmon Point Scar, Whiteford Point and Telpyn Point which are exposed to wave action and sand scour.

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 can be found in Appendix 1. All nested Annex I features are described in more detail under their individual feature conservation objectives.

The LSIB component habitats and communities 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., 2025c).

## **Objective 2:** The hydro-morphological and chemical elements necessary for the structure and function of the large shallow inlet 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.<br><br>Nutrients are at levels not detrimental to the structure and function of the large shallow inlets and bays feature.<br><br>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 inlet 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 inlet and bays feature are sustained. |

## Supporting information

### 2a. Water and sediment Quality

Various contaminants are known to affect species living in the water column and in or on the surface of sediments. The biological effect of a contaminant will vary depending on the nature of the contaminant. Contaminants include heavy metals (e.g. mercury and zinc), poly-aromatic hydrocarbons, poly-chlorinated biphenyls (PCBs), 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 influence habitats alone or in combination to 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.

Some water quality issues have been identified for this feature. For information on water and sediment quality see 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 in turn can change the waves and 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.

The types of sediment and hard substrata habitats within the LSIB 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 inlets and bays is often high as a result of wide habitat variety, the wide range of wave exposure, current strength, depth, light and substrate type, and presence of habitats that support high diversity.

A change in these environmental conditions could detrimentally affect the quality and variety and therefore functions of the various habitats of the LSIB feature.

No hydro-morphology issues have been identified for this feature. For more information see the latest condition assessment (Jackson- Bué et al., 2025c). Information on hydro-morphology within 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 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 in the same way muddy sediments. Activities that disturb sediments can release contaminates back into the water column.

No sediment supply issues have been identified for this feature. For more information see the latest condition assessment (Jackson- Bué et al., 2025c). Information on sediment transport within 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 large shallow inlets and bays 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 within 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 inlet and bays feature. |

## Supporting information

**3a. Habitats and communities**

The wide variety of sediments and hydro-morphological conditions across Carmarthen Bay create high species diversity that varies greatly between and within component habitats. The main sublittoral biotope is associated with sand and non-cohesive muddy sand and generally dominated by bivalves. Rich epifaunal communities occur throughout the feature. While all the habitats and communities within the LSIB contribute to the overall condition of the feature, there are some which are of particular conservation importance.

Bedrock fringes the shore along most of the open coast in the west of the bay. Bedrock platforms extend down the shore in places with barnacles, mussels and brown seaweeds. Dunes backing the shore for most of the bay from Pendine to Whiteford Burrows Limestone bedrock areas along Tenby Cliffs and St Catherine's Island supports communities of rock boring bivalves (piddocks) and sponges with diverse overhang communities and underboulder communities.

Piddocks with blue mussels are found in the clay and peat exposures along the Marros and Pendine coast and at Whiteford burrows. Extensive blue mussel beds can be found at Whiteford Point consolidating cobbles and mixed substrata. Large pools dominated by hydroids can be found within these mussel beds. More information on the sediment communities can be found in the mudflats and sandflats feature and in Appendix 1.

Carmarthen Bay supports many migratory fish species, including designated shad and lamprey species (see Sections 3.7 and 3.8), as well as sea trout and European eel during their marine residency phases. It is also an important nursery and feeding area for several fish species including burrowing fish species such as sandeels, and is a nursery area for flat fish and elasmobranch species (Coull et al., 1998; Ellis et al., 2012; 2024).

The LSIB habitats and communities attribute is being met, allowing a maintain target to be set for objective 3a. See the latest condition assessment for more information (Jackson-Bué et al., 2025e).

### 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, 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.

Those present within Carmarthen Bay and Estuaries SAC include the High risk species the American slipper limpet *Crepidula fornicata* which was noted within the SAC just outside Burry Port in 2008. It was recorded more recently around Tenby in 2023 and near Pembrey in 2024. The orange striped anemone *Diadumene lineata* has been found just south of Saundersfoot at Monkstone Point in the LSIB feature. This is close to another medium risk species, the Atlantic jackknife clam *Ensis leei* which was recorded just offshore from Saundersfoot beach in 2018. For more information see the latest condition assessment (Jackson- Bué et al., 2025e).

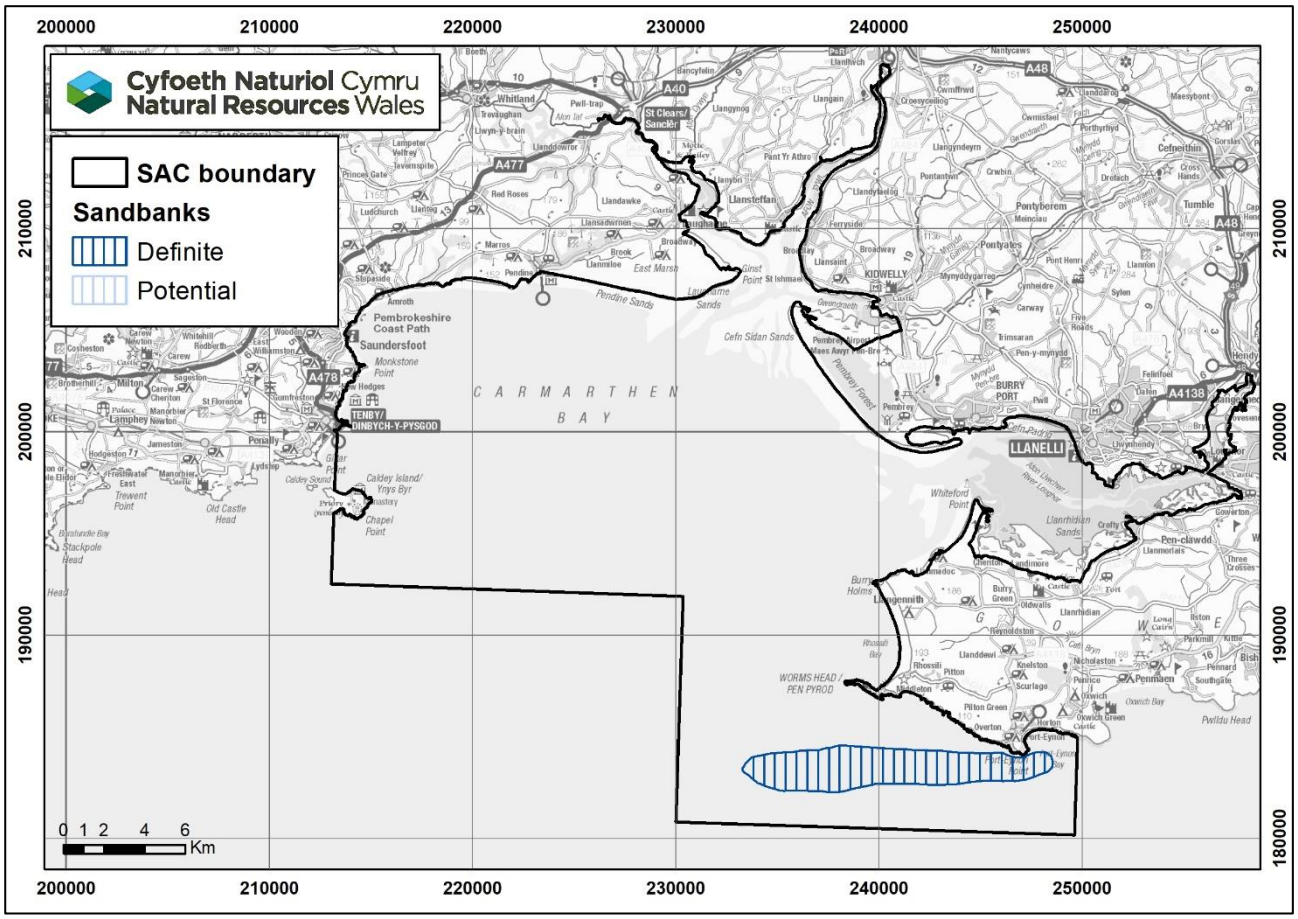
Information on INNS in the SAC as a whole can be seen in Appendix 1.

## 3.6. Feature 6: 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 Carmarthen Bay and Estuaries 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 7 is a map of the location the sandbanks feature within Carmarthen Bay and Estuaries 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 sandbanks feature within Carmarthen Bay and Estuaries 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. The distribution describes the more detailed locations and patterns of different habitats that comprise the feature across the site.

Carmarthen Bay And Estuaries SAC includes the sandbank of Helwick Bank which is located in open water to the south of Worm's Head off the Gower Peninsula. It is a linear, very shallow, subtidal sandbank that is one of the most highly exposed to wave and tidal action of all the Welsh sandbanks. The seabed sediments of the Helwick Bank area are predominantly uniform, medium fine sands with little or no fine or organic material. The more landward side of Helwick Bank is comprised of finer sands. To the south of the Bank, in deeper water, there are some uniform gravelly sands with no bedforms, and areas of irregular sand patches on gravel.

The sandbanks 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., 2025d).

## **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.<br><br>Nutrients are at levels not detrimental to the structure and function of the sandbanks feature.<br><br>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).

Much of the sandbanks feature lies outside of the 1 nautical mile sampling regime. Dilution effects of chemicals are likely. While it is not known how contaminants accumulate in sandbank sediment, it is likely to be minimal due to the coarse and mobile nature of the sand.

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.

Some water quality issues have been identified for this feature. For information on water and sediment quality see 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 in turn can change the waves and 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.

Helwick Bank is a linear, very shallow, subtidal sandbank that is one of the most highly exposed to wave and tidal action of all the Welsh sandbanks. The Bank is oriented in an east-west direction and is approximately 12 km in length. It is closely associated with the coastal headland of Port Eynon Point and the current flows around it. The sandbank is primarily maintained by residual tidal currents; activities that affect these could affect the morphology of the bank.

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. For more information see the latest condition assessment (Jackson-Bué et al., 2025d). 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.

The sediment making up the Helwick Bank was largely laid down in the last glaciation and there is little sediment of modern origin on the bank. 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. 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.

No sediment supply issues have been identified for this feature. For more information see the latest condition assessment (Jackson-Bué et al., 2025d). Information on sediment transport within 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 within habitats and communities within the sandbanks 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 sandbanks feature. |

## Supporting information

### 3a. Habitats and communities

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

The animal communities found in and on Helwick Bank are mostly characteristic of mobile sands and gravels with the exception of those to the south of the bank and many species spend most of their time wholly or partly buried in the sediment. Communities are dominated by polychaetes. The sandbanks show an increasing species richness in deeper water where the sediments are more stable. Fish, including burrowing fish species (e.g. sandeels), use the Helwick Bank in a number of ways including spawning, nursery and feeding. More information on this and sandbank communities can be found in Appendix 1.

The sandbanks habitats and communities attribute is being met, allowing a maintain target to be set for objective 3a. See the latest condition assessment for more information (Jackson-Bué et al., 2025d).

### 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, 2004; Levin et al., 2002), as well as changes to biotope and habitat type. The introduction of INNS to the SAC, or spread of INNS 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 abundance of *Crepidula fornicata* has increased from one individual in 2019 to seven in 2022. This is a high impact species but the impact on the sandbank feature is unknown. For more information see the latest condition assessment (Jackson-Bué et al., 2025d). Information on INNS in the SAC as a whole can be seen in Appendix 1.

## 3.7. Feature 7 and 8: Allis shad *Alosa alosa* and Twaite shad *Alosa Fallax*

The allis shad *Alosa alosa* and twaite shad *Alosa Fallax* features within Carmarthen Bay and Estuaries SAC are 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 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 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 population of allis shad and twaite shad in the Carmarthen Bay and Estuaries SAC is made up predominantly of fish from rivers Tywi, Wye, Usk and Severn and as the nearest known major spawning populations of the species. Smaller contributions to the population of both species in the Carmarthen Bay and Estuaries 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).

The River Tywi has a substantial spawning populations of twaite shad. Although shad spawning in tidal waters has been recorded elsewhere, tidal spawning has not been recorded in the SAC. All shad that spawn in the Afon Tywi SAC must pass through the Carmarthen Bay and Estuaries SAC to spawn. It is therefore also assumed that most of the juvenile shad using the site are from in the upstream Afon Tywi SAC. However, it is also possible that older juveniles from the Wye, Usk and Severn use the Carmarthen Bay and Estuaries SAC as nursery habitat. There is good evidence that twaite shad from the River Severn enter Swansea Bay and Bridgwater Bay to feed on the way to and from the Celtic Sea (Clarke et al. 2023), and twaite shad tagged in the River Severn have also been detected in Ireland (Davies et al. 2020).

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. However, there have been recent records of allis shad caught in fisheries surveys in the Celtic Sea, so they are likely to remain present in Carmarthen Bay and Estuaries SAC.

The number of allis and twaite shad are not considered to be stable. The population relevant to the SAC attribute is not being met, resulting in a restore objective being set for objective 1a. For more information on water quality 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.

Detrimental impacts on the population may include, but are 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 Carmarthen Bay and Estuaries SAC, or in the river populations which contribute to the Carmarthen Bay and Estuaries SAC population. Bycatch of twaite and allis shad within the Carmarthen Bay and Estuaries SAC is understood to be low. However, there are 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 are no data on the potential impact of this (Wynter et al., 2025a).

In Wales, all major abstractions have been assessed through the Eels (England and Wales) Regulations 2009, the Review of Consents (RoC) process for the Conservation of Habitats and Species Regulations 2017, or the Salmon and Freshwater Fisheries Act 1975. In addition, minor abstractions are required to go through screening to ensure compliance. There are no major operations within the Carmarthen Bay and Estuaries SAC known to be causing entrapment of shad. For more information on water quality see the latest condition assessment (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 to complete their life cycle.

| Objective attribute | Site specific target |
|---|---|
| 2a. Habitat connectivity | Maintain the connectivity and continuity of marine migration routes into and through the SAC for allis and twaite shad, allowing for natural change and variation. |
| 2b. Disturbance | Allis and twaite shad populations that use the SAC are not subject to significant anthropogenic disturbance. |

## Supporting information

### 2a. Habitat connectivity

Shad migrate though the waters of the SAC to reach spawning sites in the River Tywi. The Taf-Tywi-Gwendraeth Estuary is also important as a nursery area and it is likely that shad feed in the inshore waters of Carmarthen Bay. Juvenile shad have also been recorded from the Burry Inlet. The population of twaite and allis shad within the Carmarthen Bay and Estuaries SAC also originate from other areas including predominantly the Rivers Wye, Usk and Severn as discussed in Objective 1a, and they will use the Carmarthen Bay and Estuaries 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 Carmarthen Bay and Estuaries 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. It is also important that there are sufficient freshwater flows in rivers, and in to estuaries, to provide freshwater flow cues for migration, as shad are natal homing species, and to allow upstream migration to spawning grounds.

There are no known major man-made barriers in the Carmarthen Bay and Estuaries SAC and associated River Tywi SAC. Therefore, the habitat connectivity attribute is being met, allowing a maintain to be set for objective 2a. For more information on water quality see the latest condition assessment (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 and/or electromagnetic fields. There are no known sources of significant anthropogenic disturbance to shad in the Carmarthen Bay and Estuaries presently. For more information on water quality see the latest condition assessment (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.<br><br>Dissolved oxygen levels are at levels not detrimental to the condition of allis and twaite shad populations that use the SAC.<br><br>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 and 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 sufficient 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 importance of the SAC for feeding, the feeding requirements, 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.

There are currently no INNS present in Carmarthen Bay and Estuaries SAC that are a cause for concern for allis or twaite shad (Wynter et al., 2025a). Information on INNS in the SAC as a whole can be seen in Appendix 1.

## 3.8. Features 9 and 10: River lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus*

The river lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus* features within Carmarthen Bay and Estuaries SAC are 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 river and sea lamprey populations that use the SAC are maintained in favourable condition and are stable or increasing in the long-term.

| Objective attribute | Site specific target |
|---|---|
| 1a. Population | Maintain the river and sea lamprey populations relevant to the SAC in 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**

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 Carmarthen Bay and Estuaries SAC are based on monitoring of the Afon Tywi SAC.

The population of river and sea lamprey in the Carmarthen Bay and Estuaries SAC will be made up predominantly of fish from the Tywi, Taf, Gwendraeth and Loughor rivers. The population of sea lamprey in the River Tywi within the Carmarthen Bay and Estuaries SAC is generally in the thousands and all of the catchment is suitable for spawning and easily accessible. There is a limited amount of high-quality data on river lamprey, however there have been some records of the species in the Carmarthen Bay and Estuaries SAC and the relevant freshwater catchments, and they are considered to be common and widespread in the region (Wynter et al., 2025b).

River lampreys from other rivers nearby to the Carmarthen Bay and Estuaries SAC (such as the Tawe, Neath, Afan and Ogmore in Swansea Bay and Eastern and Western Cleddau in the Milford Haven), may also provide a limited contribution to the river lamprey population of the SAC given their relatively small home range during their marine residency phase.

Sea lampreys from other rivers along the South Wales coastline are also quite likely to be present in the Carmarthen Bay and Estuaries SAC given their wider home range during their marine residency and feeding phase, and so are likely to provide a greater contribution to the SAC population than for river lamprey, but still with the rivers draining into the Carmarthen Bay and Estuaries SAC representing the largest contributing rivers to the SAC population of sea lamprey

The populations of river and sea lamprey are considered stable. Therefore a maintain target has been set for objective 1a. For more information on water quality 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.

Detrimental impacts on 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 Carmarthen Bay and Estuaries SAC, or in the river populations which contribute to the Carmarthen Bay and Estuaries SAC population (Wynter et al., 2025b). Bycatch of river and sea lamprey within the Carmarthen Bay and Estuaries SAC is understood to be low. However, there are limited data on bycatch, especially for unregulated fishing (Wynter et al., 2025b).

In Wales, all licenced abstractions have been assessed through Habitats Regulations Review of Consents (RoC) process, 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 Carmarthen Bay and Estuaries SAC known to be causing entrapment of river or sea lamprey. For more information on water quality see the latest condition assessment (Wynter et al., 2025b).

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

| Objective attribute | Site specific target |
|---|---|
| 2a. Habitat connectivity | Maintain the connectivity and continuity of migration routes throughout the SAC and connected spawning locations for river and sea lamprey, allowing for natural change and variation. |
| 2b. Disturbance | River and sea lamprey that use the SAC are not subject to significant anthropogenic disturbance. |

## Supporting information

**2a. Habitat connectivity**

Adult river lampreys migrate through the Carmarthen Bay and Estuaries SAC on their spawning migration to reach the Afon Tywi SAC as well as the Taf, Gwendraeth and Loughor rivers. 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 Carmarthen Bay and Estuaries SAC (such as the Tawe, Neath, Afan and Ogmore in Swansea Bay and Eastern and Western Cleddau in the Milford Haven) may also provide a limited contribution to the river lamprey population of the SAC given their relatively small home range during their marine residency phase. 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.

Adult sea lampreys migrate through the Carmarthen Bay and Estuaries SAC again on their spawning migration to reach the Afon Tywi SAC as well as the Taf, Gwendraeth and Loughor rivers. 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 are also quite likely to be present in the Carmarthen Bay and Estuaries 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.

It is also important that there are sufficient freshwater flows in rivers, and into 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.

There are no known major man-made barriers in the Carmarthen Bay and Estuaries SAC and associated River Tywi SAC, and the other contributing rivers that could impact river and sea lamprey migration. Therefore, the habitat connectivity attribute is being met, allowing maintain target to be 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.

There are no known sources of significant anthropogenic disturbance to shad in the Carmarthen Bay and Estuaries SAC presently. For more information on water quality see the latest condition assessment (Wynter et al., 2025b).

## **Objective 3:** The quality of habitat and abundance of food supply is sufficient to maintain the populations of river and sea lamprey that use the SAC in 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.<br><br>Dissolved oxygen levels are at levels not detrimental to the condition of river and sea lamprey populations that use the SAC.<br><br>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 and 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 diphenyl 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 importance of the SAC for feeding, the feeding requirements, 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 on water quality 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.

There are currently no INNS present in Carmarthen Bay and Estuaries SAC that are a cause for concern for sea or river lamprey (Wynter et al., 2025b). Information on INNS in the SAC as a whole can be seen in Appendix 1.

## 3.9. Feature 11: Otter *Lutra lutra*

The otter *Lutra lutra* feature within Carmarthen Bay and Estuaries 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 |
|---|---|
| 1a. Otter Population health | Restore the otter population relevant to the SAC to favourable condition. The wider population should 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 around Carmarthen Bay, 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 and mid-east population.

In Wales otters have been monitored through the Otter Survey of Wales since the 1970s. The first report was published in 1978 and repeated every 7 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 to the SAC are the Tywi and the Loughor. In the 6$^{th}$ Otter Survey of Wales there was a statistically significant 22% and 37% decline in positive sites respectively (Kean and Chadwick 2021). The latest survey also showed a decline in positive survey sites in the wider regions relevant to the SAC. This led to the conclusion that the population using the SAC is in unfavourable condition and the wider population is not stable or increasing. Therefore, a restore target is set for objective 1a. Further detail can be found in the latest condition assessment (Cuthbertson et al., 2025).

## **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

Little is known about otter activity in the site. However, the coast within the SAC is well supplied with rivers and streams and it is highly likely that otters travel from one watercourse to another along the coast. Otters living on the coast must have access to freshwater streams and pools for drinking and washing.

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 that otters that use the SAC are significantly constrained from accessing necessary habitats. For more information see the latest condition assessment (Cuthbertson et al., 2025).

### 2b. Habitat connectivity

Otters in Wales primarily use riverine habitats to feed, rest and breed. However, 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. They also use the coast to rest. It is therefore essential that unimpeded access into, within and away from the site is maintained. Barriers should not block otter movement or threaten otter movement through increased risk of incidental injury or killing.

There is no evidence of barriers to movement of otter within the SAC. The habitat connectivity attribute has been met, allowing a maintain target to be set for objective 2b. See the latest condition assessment for more information (Cuthbertson et al., 2025).

## **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

Coastal habitat in the SAC is important to otters for foraging, resting and as an access corridor to their primary habitat up steam. It is important that the functionality and quality of the SAC habitat is maintained to support the population. No otter breeding, resting or foraging site should be subject to a level of disturbance that could have an adverse effect on the population. Where necessary, potentially harmful levels of disturbance must be managed.

The coast within the SAC is well supplied with rivers and streams and it is highly likely that otters travel from one watercourse to another along the coast. While the estuaries of the Taf, Tywi and Loughor are well used by otters, habitat availability (both resting and breeding sites) on coastal and estuarine freshwater streams is generally poor (Liles, 2010).

In the Tywi hydrometric area a survey of 10 previously identified potential breeding sites found only 5 were still usable as breeding sites (Parry and Liles, 2023). This indicated a concerning reduction in the habitat quality and function in a relevant hydrometric area to the SAC. An earlier study noted a lack of suitable resting sites within the SAC (Liles, 2010). However, there is a lack of information on habitat quality and function along the coast in the SAC and the survey on the Tywi was just a subset of the breeding sites and only indicative.

Due to the lack of understanding on the quality and function of habitat in the SAC attribute, 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., 2025).

# 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 Carmarthen Bay and Estuaries 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 Carmarthen Bay and Estuaries SAC.

| Operation/Activity | Occurrence in SAC |
|---|---|
| Dredging: construction and maintenance, including disposal. | There are small to medium-scale harbour facilities at Burry Port, Tenby and Saundersfoot, with some approaches and navigations channels being maintenance-dredged intermittently. |
| Shipping: Vessel traffic and maintenance (including antifouling). | Large vessel traffic passes outside of Carmarthen Bay. Commercial boats are fishing vessels and tourist boats. |
| Shipping: anchoring (commercial). | Not occurring. |
| Shipping: Conventional and accidental discharges. (Including ballast water discharge, refuse, sewage, operational, petrochemical, cargo losses and salvage). | Possibly occurs in the waters adjacent to SAC, likely to be at low levels as not on main shipping routes.<br>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). | Land claim has predominantly taken place in the inner Loughor estuary on the northern side around the Millenium Coastal Park. |
| Coast protection: Hard defences (including sea walls, breakwaters, railways and foreshore deposit of rock, rubble etc.). | Present in the site, including sea walls, rock armour, gabions and groynes They bound significant stretches of the bay and its estuaries. In addition, protection of coastal railway tracks that straddle the north coast of the Burry Inlet between Llanelli and Burry Port, and between Kidwelly and Ferryside, also act as coastal defences. |
| Coast protection: Soft defences (including groynes, beach replenishment etc). | Present in the site. Beach replenishment primarily at Tenby and dredge material from Burry Port is deposited on the beach to the east of the harbour. |
| Coast protection: Barrages (including storm surge, tidal and amenity). | Not currently present in the SAC. |
| Artificial reef. | Not currently present in the SAC. |
| Hard-engineered freshwater watercourses. | Widespread on coast adjacent to SAC boundary. |

| Operation/Activity | Occurrence in SAC |
|---|---|
| Power station. | Not currently present in the SAC. |
| Pipelines. | Widespread throughout the SAC. |
| Power / communication cables. | Widespread throughout the SAC. |
| Effluent disposal by vessels at sea: disposal of sewage, chemical, thermal and sludge dumping. Not CSOs. | NRW and DCWW datasets available on locations and inputs on the coast adjacent to the SAC.<br>No known thermal or sludge disposal. |
| Miscellaneous wastes and debris (including refuse and litter). | Litter present from various sources.<br>On the north side of the Burry Inlet contaminated land from past industrial activity is being eroded and deposited in the estuary, predominantly in the Burry Port area. |
| Run-off: Agricultural, urban and industrial run-off. | Urban and industrial run-off is widespread and common around coastal populations and industry.<br>All forms of run off from the coast into the waters of the SAC. |
| Fishing: All trawling (Including beam, otter, toothed and any trawled gear). | May occur within the SAC. Location and Intensity information is unknown. |
| Fishing: All dredging (including toothed, bladed, mechanical, hydraulic and any other great not listed). | May occur within the SAC. Location and Intensity information is unknown. Though the SAC is closed to scallop dredging. |
| Fishing: All netting (including gill, tangle, trammel, seine, fyke and any other fishing with netted gear). | May occur within the SAC. Location and Intensity information is unknown. |
| Fishing: All potting (including lobster, crab, prawn and any other fishing with potted gear). | Occurs in the site. Location and Intensity information is unknown. |
| Fishing: All line fishing (including long-line and handline). | May occur within the SAC. Location and Intensity information is unknown. |

| Operation/Activity | Occurrence in SAC |
|---|---|
| Fishing: All methods of hand gathering (including cockles, Mussels, mussel seed, razor clam, bivalves, winkles, crustaceans, shellfish, algae and plants four human consumption and chemical extraction and biomass (excluding access issues). | A regulated cockle fishery operates within the boundary of the SAC.<br>Mussel fishery and mussel seed collection, both in and around Whiteford.<br>Razor clams and laver bread are gathered intertidally. |
| Fishing: Bait collection commercial and recreational (including digging, pump, boulder turning etc). | May occur within the SAC. Intensity, location and effort information is unknown. |
| Aquaculture: All forms of aquaculture (including algae, sea cages, impoundments, ranching, shellfish ropes and trestles and enclosed recirculation). | Native oyster aquaculture permission has been given but is not operational.<br>Potential for seaweed aquaculture in the future. |
| Livestock grazing: Grazing of saltmarsh. | Overgrazing is widespread within the SAC feature, especially from sheep. Locations such as Whiteford Burrows, Llanrhidian, Penclawdd and Brynea are all grazed and much of it being grazed to a short sward of less than 5 cm in height. Livestock grazing also elevates nutrients in the waters of the estuaries. |
| Water abstraction. | Occurs adjacent to SAC in the Loughor estuary. |
| Aggregate extraction (including mineral and biogenic sands and gravels). | Occurs adjacent to SAC. |
| Oil and gas exploration: All oil and gas exploration activity (including seismic survey, drilling and discharges both operational and accidental). | Not currently present in the SAC. |
| Renewable energy generation: All forms of renewable energy (including tidal barrage and impoundments, tidal and wave energy, offshore wind both fixed and floating). | Not currently present in the SAC. |

| Operation/Activity | Occurrence in SAC |
|---|---|
| Oil spill response: All activities of responding to oil spills at sea and on shore (including chemical, physical and access). | Reactive in case of emergencies. |
| Recreation: Fishing (e.g. angling and spearfishing). | Widespread throughout the SAC. Locations and Intensity information is unknown. |
| Recreation: Boating (e.g. power craft, sailing, canoeing, surfing, kite surfing, paddle boarding, etc). | Widespread throughout the SAC. Jet skis have been reported disturbing and deliberately targeting birds on the Burry Inlet side of the bay. |
| Recreation: Coastal activities (e.g. Scuba diving, snorkelling, dog walking, coasteering etc). | Widespread throughout the SAC. Location and Intensity information is unknown. |
| Recreation: Coastal access. | Widespread throughout the SAC. Location and Intensity information is unknown. |
| Recreation: Light aircraft. | Numerous airstrips in the surrounding area, with light aircraft flying over the SAC. Drones possible. |
| Recreation: Wildfowling. | Five licenced wildfowling clubs in operation in the SAC. Reports of wildfowling on private land outside but adjacent to SPA. |
| Recreation: Marine wildlife watching / eco-tourism. | Tourist boats operate out of Tenby. |
| Military activity: All forms of military activity (including ordnance ranges, marine exercises, aircraft etc). | Pendine Ministry of Defence firing range is within the SAC. |
| Marine archaeology and salvage. | No data available. Potential to occur in the SAC. |
| Science and outreach: Education. | Occurs within the SAC. Locations and intensity information is unknown. |
| Science and outreach: Animal welfare operations and sanctuaries. | Occurs within the SAC. Locations and intensity information is unknown. |
| Science and outreach: Science research. | Occurs within the SAC. Locations and intensity information is unknown. |

# 5. Climate change

## 5.1. Climate 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. 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.

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.

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 Carmarthen Bay SAC. ASM = Atlantic Salt Meadows, LSIB = Large shallow Inlets and Bays, MF&SF = Mudflats and sandflats. H = high vulnerability, M = medium vulnerability, L= low vulnerability, N/V = not vulnerable.

| Climate change pressure | Sandbanks | MF&SF | Estuaries | LSIB | ASM |
|---|---|---|---|---|---|
| Air temperature | N/V | M | H | L | H |
| Deoxygenation | L | L | L | L | N/V |
| Ocean acidification | L | L | L | M | N/V |
| Salinity | L | L | L | L | L |
| Sea level rise | N/V | M | M | L | H |
| Sea temperature | L | M | M | M | M |
| Wave exposure | N/V | L | L | L | M |

## 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 3% of its intertidal habitats (saltmarsh, mudflats and sandflats) due to coastal squeeze by 2155 under a RCP 8.5 95$^{th}$ percentile sea-level rise scenario. There are significant opportunities for habitat gain adjacent to this SAC if shoreline management plan policies of managed realignment and

no active intervention are implemented. If defences continue to be maintained, the opportunities for habitat gain are significantly reduced.

In this SAC saltmarsh is expected to come under particular pressure but where saltmarsh is lost it is expected to be replaced with mudflat and sandflat habitat, which reduces the net losses overall.

## Saltmarsh

The term saltmarsh encompasses both Atlantic salt meadow and Salicornia habitat features. The predicted change in the extent of this habitat due to coastal squeeze is a loss of 1% (40 ha) by 2055, and 10% (266 ha) by 2155 under a RCP 8.5 95th percentile scenario, assuming that defences are managed in line with shoreline management plan policies.

For the same management and sea-level rise scenario, natural gains may occur in the short term, but by 2155 an additional 9% (251 ha) of saltmarsh habitat is expected to be lost to natural squeeze.

If all current defences are maintained into the future, a significant increase in both coastal and natural squeeze (a combined figure of up to 39%, 1071 ha by 2155) is predicted (Oaten et al., 2024).

## Mudflats and sandflats

The predicted change in the extent of this habitat due to coastal squeeze is a modest loss of 0.5% (30 ha) by 2055, reducing to 0.1% (7 ha) by 2155 under a RCP 8.5 95th percentile scenario, assuming that defences are managed in line with shoreline management plan policies.

For the same management and sea-level rise scenario, natural gains may occur over both the short and longer term.

The opportunity for natural gains reduces significantly if current defences are maintained into the future (Oaten et al., 2024).

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# Appendix 1: Additional Supporting information

## Site Description

The Carmarthen Bay and Estuaries SAC encompasses areas of sea, coast and estuary that support a wide range of different marine habitats and wildlife, some of which are unique in Wales.

The SAC covers an area from St. Catherine's Island in Tenby to just west of Oxwich Bay, encompassing the Three Rivers area (Rivers Taf, Tywi and Gwendraeth), the Burry Inlet and Loughor Estuary, and the northern and western parts of the Gower peninsula. It extends out into Carmarthen Bay and includes the Helwick Bank which lies within the Bristol Channel.

The features for which the site was selected are distributed throughout the SAC, with no single feature occupying the entire SAC and with some features overlapping in certain locations.

## Geology

Carmarthen Bay was created primarily by the underlying geological features and then infilled with the prevailing mobile substrata and modified by the hydrographic regime. The Bay is underlain and partially bound by Carboniferous and Devonian limestones and sandstones. There are small areas of natural hard substrata in the intertidal zone including bedrock (Wharley Point), scars of cobbles and boulders (Wharley Point, Ferryside, Salmon Point Scar, Whiteford) and mussel beds on cobbles (Salmon Point Scar, Ginst Point, Whiteford Point), but these are poorly represented compared with other inlets in Wales.

## Sedimentology

The shores of South Beach (Tenby), Waterwynch Bay, Monkstone beach and Cefn Sidan Sands, between the Three River system and the Burry Inlet, are mainly mobile fine and medium sands while the mudflats and sandflats of the Three Rivers system and that of the Burry Inlet and River Loughor are mostly sandy gravel or muddy sand. Sheltered sandy gravel shores are found from the edge of Pendine Sands, stretching around into the mouth of the Three Rivers system, where a variety of different sediment types are found. The mouth of the Three Rivers system is dominated by moderately mobile fine sands that are continually shifted by waves and tidal action and Mid-Flandrian peats and clays are present intertidally and subtidally in this system.

Sediment types range from mobile fine and medium sands, muddy sands, sandy and silty muds, and pure muds, to limited areas of exposed immobilised sandy and / or muddy gravel pavements of glacial provenance. There is a gradation within the distribution of sediments, from mud in the upper, more sheltered regions of the estuaries, to sand at the more wave-exposed mouths of the estuaries. Inputs of fine sediments from rivers into all of the estuaries are small, compared to other sources such as inward migration from the sea.

The seabed sediments of the Helwick Bank area are predominantly uniform, medium fine sands with little or no fine or organic material. The more landward side of Helwick Bank is

comprised of finer sands. To the south of the Bank, in deeper water, there are some uniform gravelly sands with no bedforms, as well as irregular sand patches on gravel.

## Geomorphology

Carmarthen Bay is an excellent example of a coastline whose outline was moulded by marine and sub-aerial processes throughout the Quaternary period, but where the shoreline and its detail is much more recent in origin. The modern shoreline is a very dynamic one, as a result of the growth of spits, dune and saltmarsh development, changes in intertidal and deeper water bathymetry and erosion of both beaches and cliffs (Geological Conservation Review). There are four estuaries in the SAC formed by the rivers Tywi, Taf, Gwendraeth and Loughor. They form a single functional unit with important interchanges of sediment and biota especially within the 'Three Rivers' which converge and exit into Carmarthen Bay through a common mouth. There has been considerable sedimentation in the Three Rivers and Burry Inlet during and since the rise in sea level in the post-glacial era. The intertidal and subtidal sediments are thought to be derived largely from Carmarthen Bay.

The mudflats and sandflats range from narrow beaches to very expansive areas of gently sloping, almost horizontal, flats, to steeply inclined levees. Many of the saltmarshes are dissected by small creeks and channels, which provide microhabitats within more uniform areas of marsh. Saltpans and small pools add diversity to the site and are an intrinsic part of many marshes. An important feature of the site is the undisturbed transition to coastal habitats in some areas. The marshes on the southern side of the Burry Inlet between Whiteford Point and Loughor in particular are of national significance in respect of a variety of geomorphological features.

Helwick sandbank is located in open water to the south of Worm's Head off the Gower Peninsula. The feature is a linear, very shallow, subtidal sandbank that is one of the most highly exposed to wave and tidal action of the Welsh sandbanks.

## Hydrography and meteorology

The SAC is characterised by largely mixed, variable salinity water typical of macrotidal estuaries, and in Carmarthen Bay salinity varies from low to fully marine. During spring tides the tidal range is around 7.5 m at Burry Port, whereas during neap tides it is around 3.6 m. At Ferryside on the Tywi the tidal rage at spring tides is 6.6 m and 2.7 m during neap tides. The tidal range decreases up the estuary and the bathymetry of the Loughor Estuary causes a lag time in the progression of the flood tide up the estuary. In the Burry the tidal wave is symmetrical near the mouth but increasingly asymmetrical away from the mouth with the ebb becoming increasingly longer than the flood tide. This results in greater velocities on the flood than the ebb which affects sediment transport. The shallow gradients within the estuary result in large areas of intertidal flats and saltmarsh.

## Water and sediment chemistry

Available nitrogen and phosphorus levels are in excess of the criterion indicating hyper nutrification in the upper estuary which has been linked to high numbers of algal cells and chlorophyll *a* concentrations. In addition, there have been inputs of heavy metals from industry and redundant coalmines in the estuaries. The status of the water bodies within the SAC including levels of nutrients and chemicals is available on Water Watch Wales.

## Sediment processes

Within the Burry Inlet the extensive sandflats above the mid-shore are fairly stable and flat. Below this the sandflats up to and beyond Loughor bridge are very mobile with large sandwaves and ripples. Sandbanks in the entrance are particularly mobile.

In the Taf estuary (the westernmost of the Three Rivers complex), there is normally one channel through the intertidal sandbanks in the lower estuary and two or more in the upper estuary: the number and position of these channels can evolve quickly and episodically (Bennet et al., 2020)

The Helwick bank sandbank is maintained by residual tidal currents. Bedload sediment transport circulates the bank in a clockwise direction under these currents. It has been suggested that storm events can reverse sediment transport direction over the crest of the bank and alter patterns of erosion and deposition (Fairley et al., 2016)

Sediment trend analysis has been used to establish sources and pathways of sediment in Carmarthen Bay (McLaren and Cooper, 2002). Sediment sources within the wider Carmarthen Bay are largely confined to the bay itself. There is little evidence for significant fluvial sources of sediment. Some small quantity of sediment does enter the bay from the Bristol Channel, particularly around the Helwick sandbank area and some sediment is derived from coastal erosion. In general, the sediment can be considered as in dynamic equilibrium, with overall volumes stable and the sediment being constantly recycled through wave and tidal forcing. Around Tenby, average sediment transport is variable depending on the orientation of the various small embayments. Average sediment transport is from west to east along the coastline from Saundersfoot to Pembrey, with a balance of sediment in and out of the Three Rivers complex. Derived sediment transport pathways are largely into the Burry Inlet. A sediment transport gyre is noted in Rhossili Bay. Further offshore pathways are described between three sediment parting meeting and three sediment meeting points. The same study (McLaren and Cooper, 2002) suggests that the seabed is generally featureless, with the occasional patch of mega-ripples.

Shoreline and near shore sediment process have been studied in more detail and are described within the South of Wales Shoreline Management Plan.

## Species

A variety of intertidal and sublittoral biotopes are present reflecting the range of physiographic conditions. The estuaries of this site support a range of subtidal and intertidal sediments that grade from sand at the mouth to mudflats in the upper estuary. The fauna of the sediments varies, but includes communities with polychaete and oligochaete worms and areas with extensive cockle beds. The populations of the cockle *Cerastoderma edule* in the Burry Inlet and the Three Rivers are very large compared with other similar estuaries such as the Taw/Torridge and Camel.

The intertidal rock biotopes are subject to sand scour resulting in low species diversity but support barnacles and mussels as well as brown seaweeds on more sheltered cobble areas. Limestone areas along Tenby Cliffs and St Catherine's Island support more diverse communities indicative of soft rock areas. Some areas of soft sediment, such as in the Burry Inlet support marine communities characterised by the dwarf seagrass *Zostera noltii*. Seagrass stabilises the sediment and is an important source of organic matter as well as providing shelter and surface for attachment by other species and food for wildfowl. The

intertidal soft sediment coastline of Carmarthen Bay is characterised by extensive and substantial strandlines with a wealth of invertebrate fauna.

Subtidal habitats are of limited extent due to the estuaries largely draining at low tide. The mobile, sandy sediments are characterised by the presence of low numbers of amphipods, isopods and robust, mobile polychaetes. Species found on the Helwick sandbank are mostly characteristic of mobile sands and gravels.

The estuary systems have exceptionally well developed saltmarsh to sand dune transitions, with a complete sequence of saltmarsh vegetation, including transitions to upper salt meadow and to important sand dune habitats.

## Invasive non-native species

Based on NRW records, there are relatively few noteworthy INNS species (those listed as High or Medium on the Marine Invasive Non-native Species Priority Monitoring and Surveillance List) in this SAC, especially within the Three Rivers area. Those present include the High risk species the American slipper limpet *Crepidula fornicata* which was noted within the SAC just outside Burry Port in 2008. It was recorded more recently around Tenby in 2023 and near Pembrey in 2024. The orange striped anemone *Diadumene lineata* has been found just south of Saundersfoot at Monkstone Point in the LSIB feature. This is close to another medium risk species, the Atlantic jackknife clam *Ensis leei* which was recorded just offshore from Saundersfoot beach in 2018. Japanese wireweed *Sargassum muticum* is present in a number of locations, mainly in the rocky intertidal and infralittoral fringe areas around Caldy Island, Monkstone, Pendine, Burry Port in the west and at Worms Head and Port Eynon in the east.

The medium risk species, the red alga *Agarophyton vermiculophyllum* has been found in the Loughor estuary, where it was first recorded in 2017. Since then establishment has been notably rapid (Mercier and Brazier, 2023). This INNS is causing sedimentation change and changes to topography having a detrimental impact on the mudflats and sandflats and the estuary feature as a whole (Jackson-Bué et al., 2025a). Occurrence records can be found on the Wales INNS portal.

# 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.

## Estuaries

### Habitats

The Carmarthen Bay and Estuaries SAC includes coastal plain and bar built estuaries. The rivers in the SAC, the Taf, Tywi, Gwendraeth and Loughor, together form a single functional unit around the Burry Inlet. There are important interchanges of sediment and biota and they represent approximately 3.4 % of the UK SAC “estuaries” resource. The total extent of the intertidal mudflats and sandflats, intertidal hard substrate, subtidal sediment and hard substrate communities, *Salicornia* communities, Atlantic salt meadows and transitional saltmarsh communities is around 9,500 ha.

The Carmarthen Bay estuaries were created primarily by the underlying geological features and then infilled with the prevailing mobile substrata and modified by the hydrographic regime. The area is underlain and partially bound by Carboniferous and Devonian limestones and sandstones. Overall the variety and distribution of intertidal sediments extends from well-sorted fine to medium sands at the mouths of the estuaries to muddy sand in their middle reaches and mud in the upper reaches and the back of the shores. The subtidal channels are dominated by mobile sands. This site has a variety of undisturbed transitions to coastal habitats.

Barrier beaches at the mouths of the estuaries and adjacent coast are a fundamental feature of the estuaries because they absorb wave energy and protect the lower estuary, which allows fine grained suspended sediments to be deposited on saltmarshes within the relatively sheltered estuaries. Sediment moves along the shores by longshore drift to supply recurved spits at Ginst Point, Tywyn Point, Morfa Heli and Whiteford Point. An exposure of subtidal peat to the south of Salmon Scar may have an important influence on the morphology of the Three Rivers estuaries however, further work is required to evaluate its importance. Further exposures of peat and clay occur intertidally at Marros Sands and Whiteford Point

The feature is characterised by largely mixed, variable salinity water typical of macrotidal estuaries. The mean tidal range for the estuaries is 5.5 m and the typical salinity range is from 33 - 2$^{o}/_{oo}$. The tidal curve of these west facing macrotidal estuaries is asymmetric with an ebb duration of almost 10 hours on a spring tide and flood duration of 2-3 hours, the tidal range is at least 6.6m on spring tides. The annual average freshwater flow is 5.6m$^3$/s from the Loughor, 7.4m$^3$/s on the Taf, 43.4m$^3$/s on the Tywi and 4.8m$^3$/s on the Gwendraeth. Total flow into the Burry Inlet is 10.2 m$^3$/s.

The different physiographies and hydrodynamic regimes of the estuaries provide for a wide range of combinations of wave exposure and tidal streams. Generally, above mid-shore the extensive intertidal flats are fairly stable and flat. Below mid-shore the extensive sandflats, are very mobile with frequent large sand waves and ripples. Sandbanks in the entrances of the estuaries are particularly mobile. The estuaries continue to be filled in, driven by a rise in relative sea level, superimposed by changes in wind-wave climate.

## Communities

The estuaries contain both subtidal and intertidal habitats, although the latter are a lot more extensive in this SAC. In addition to the truly marine habitats and associated wildlife, a wealth of coastal and terrestrial habitats are all part of the estuary complex with, in undisturbed or unmodified situations, transitions from marine communities to brackish, maritime, freshwater and terrestrial habitats.

The mosaic of habitats within the estuaries supports a large variety of different wildlife communities. In the intertidal and subtidal sediments, there are communities of worms, crustaceans and molluscs depending on the type of sediment, the salinity gradient and degree of exposure of the sediment to wave action and tidal streams. Where there is rocky habitat, green and brown seaweeds generally develop with some communities being characteristic of the variable salinity conditions. Transitions from saltmarsh to brackish, maritime and freshwater communities support their own particular assemblages of plants and animals. Blue mussel beds can be found in areas of cobble and mixed substrata and can also establish where mussel spat binds together dead shell in sediment flats (mussel crumble). The estuaries also support an assemblage of mobile species. Estuaries can

provide important nursery areas for fish species and also provide a means by which migratory fish species make the transition between the marine and freshwater environments.

The range of benthic communities in the Three Rivers is strongly influenced by the geology, topography and tidal currents, whilst in the Burry Inlet the major factors are salinity, sediment stability and substratum composition. The mobile, sandy sediments are characterised by the presence of low numbers of amphipods, isopods and robust, mobile polychaetes.

Intertidal sediment communities range from polychaete and oligochaete worms and extensive cockle beds on intertidal sediments as well as barnacle and mussel dominated communities in areas of sand scoured intertidal rock.

# Mudflats and sandflats not covered by seawater at low tide

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.

## Habitats

There is a gradation within the distribution of sediments, from mud in the upper, more sheltered regions of the estuaries, to sand at the more wave-exposed mouths of the estuaries. The sandy shores of South beach (Tenby), Waterwynch Bay, Monkstone beach and Cefn Sidan sands, between the Three River system and the Burry Inlet, consist mainly of mobile fine and medium sands.

The mudflats and sandflats of the Three Rivers system and that of the Burry Inlet and River Loughor are mostly sandy gravel or muddy sand. Sheltered sandy gravel shores are found from the edge of Pendine Sands, stretching around into the mouth of the Three Rivers system, where a variety of different sediment types are found. The mouth of the Three Rivers system is dominated by moderately mobile fine sands that are continually shifted by waves and tidal action. The intertidal flats of the estuaries are predominantly sandy, although the upper reaches of the rivers are muddy, and each of the tributaries has areas of saltmarsh.

## Communities

Large areas of the intertidal mudflats and sandflats are dominated by bivalves. In areas of fine sand cockles *Cerastoderma edule* are abundant, along with other bivalves, amphipods and worms. In muddier sediments the sand-gaper *Mya arenaria*, peppery furrow-shell *Scrobicularia plana* and mud-snail *Peringia ulvae* are also found in large numbers. The lower Loughor Estuary is one of the few places in the UK where the worm *Ophelia bicornis* has been found. There are also beds of the nationally scarce dwarf eelgrass *Zostera noltei*.

Areas of mobile fine and medium sands such as South Beach and Cefn Sidan Sands support large populations of burrowing amphipods and polychaetes. The polychaetes

*Nephtys cirrosa* and lug worm *Arenicola marina*, the amphipod *Bathyporeia pelagica* and the isopod *Eurydice pulchra* are the most abundant species.

The communities at the mouth of the Three Rivers system are characterised by the Baltic tellin *Macoma balthica*, thin tellin *Angulus tenuis* and polychaetes *Nephty*s spp.. Stable sandflats are present in the lower estuary, generally on the upper middle shores. Here tidal streams and salinity fluctuations are reduced, resulting in greater species richness than in the lower shore areas. The communities support typical bivalve / polychaete and amphipod assemblages.

The sediments of Llanrhidian Sands, Cefn Padrig and Dafon Sands are moderately stable, fine and very fine sands. The cockle *Cerastoderma edule* is one of its most characteristic species. In the more stable areas with a higher mud content, the sand gaper *Mya arenaria*, peppery furrow shell *Scrobicularia plana*, the mud snail *Peringia ulvae* and amphipods *Corophium* spp. are found in increasing numbers, as are the amphipods *Bathyporeia pilosa* and *Corophium* spp. Nearer the channel muddy areas are dominated by polychaetes and the Baltic tellin *Macoma baltica*.

Along the high wave energy exposed coastlines of Saundersfoot to Telpyn, Marros to Pendine and along the Pembrey Coast, extensive and complete sequences of exposed sand zonations are present. Species assemblages characterised by the common heart urchin *Echinocardium cordatum* and razor shells *Ensis sp*. occur along Carmarthen Bay on the shallow lower shore where conditions are fully marine. Other associated species include the otter shell *Lutraria lutraria* and the bivalve mollusc *Pharus legumen.* Sites include North Tenby beach, Monkstone Beach, between Monkstone Point and Saundersfoot Harbour, at Marros and Pendine Sands and between Towyn Point and Pembrey Burrows.

The intertidal soft sediment coastline of Carmarthen Bay has extensive and substantial strandlines. A wealth of invertebrate fauna has been identified at locations including Pendine, Pembrey and Whiteford, most notably high abundance of the nationally scarce strandline beetle *Nebria complanata*. Sandhoppers are the dominant order of marine invertebrates with three of the five genera found regularly feeding on the algae deposits.

The unusual angiosperm wigeongrass *Ruppia maritima* is recorded from one location in the middle reaches of the Tywi Estuary at Morfa Uchaf. This species grows in soft sediments in sheltered shallow coastal waters, from full salinity to nearly freshwater, but mainly in brackish waters, including those of estuaries. *Ruppia maritima* attracts in particular waterfowl and fish to feed and rear their young. The currently considered nationally rare polychaete worm *Ophelia bicornis* has been recorded from the sand bars and flats of mobile sand along the Burry Inlet / Loughor Estuary. *Ophelia bicornis* feeds on particles of organic material in the sediment and produces swimming planktonic larvae that are very particular about the quality of the sediment that they will colonise.

## Atlantic salt meadow *Glauco-Puccinellietalia maritimae*

Atlantic salt meadows develop when plants able to tolerate saline and brackish conditions colonise soft intertidal sediments of mud and sand in areas protected from strong wave action generally at elevations above Mean High Water Neap tides. The vegetation forms the middle and upper reaches of saltmarshes, where tidal inundation still occurs but with decreasing frequency and duration than areas nearer to the low water mark in estuaries and coastal locations.

The Carmarthen Bay and Estuaries SAC includes the largest expanse of saltmarsh in Wales covering 2478 ha. The extensive saltmarshes of the Carmarthen Bay estuaries have a complete sequence of saltmarsh vegetation, from pioneer vegetation through to upper saltmarsh transitions. The area is also important for transitions from saltmarsh to sand dune and to freshwater and terrestrial vegetation. These are important features of the local saltmarshes and of great biodiversity value.

## Habitats

The estuarine systems have exceptionally well developed saltmarsh to sand dune transitions, where blown sand has modified the upper saltmarsh vegetation in some areas. The transitional communities are mainly distributed in the Burry Inlet at Pembrey Burrows, but are also recorded from west Taf and Tywi estuaries, west Penrhyn Gwyn and Penclacwydd (Burry Inlet). Particularly noteworthy transitions occur between saltmarsh and dune slacks within semi-fixed dune systems located near Ginst Point at the mouth of the Taf. Further transitional noteworthy vegetation is present at a small scale at Morfa Uchaf and Llansteffan on the Tywi and most impressively, at the western end of the Gwendraeth saltmarsh. At the latter location, conservation value is enhanced by the associated transitions from mid-marsh to tall mesotrophic inundation grassland.

The feature has a variety of relatively undisturbed transitions between saltmarsh and brackish systems. These include swamp, mire, mesotrophic grassland and open vegetation communities, totalling 98.0 ha. The transition communities are largely distributed in the mid and upper reaches of the Taf and Tywi estuaries, around the Gwendraeth Estuary, west Pembrey Burrows, west Landimore Marsh, west and upstream of the bridge in the Loughor estuary. Transitions to freshwater inundation communities are especially prominent at the western extremity of the Gwendraeth Estuary.

The grazed saltmarshes include upper margins with sea rush *Juncus maritimus* and marsh-mallow *Althaea officinalis*, which are a particularly distinctive ecological feature of this site. The area is also important for transitions from saltmarsh to sand dune and other habitats.

Transitional low-marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Sueda maritima* is present over significant areas of the Llanrhidian-Landimore marshes, and also occurs in moderately extensive areas at Penclawdd. Elsewhere stands were small and with the exception of the lower Loughor estuary, poorly developed. Rayed *Aster tripolium* communities are scarce in the Burry Inlet, being present only at Loughor and Pembrey, and even here they are not well developed. In comparison, grazed and ungrazed stands of *P. maritima* communities were noted at all sites, although ungrazed stands are only extensive at the Loughor Estuary where it accounts for around 20% of all saltmarsh vegetation.

*Halimione portulacoides* saltmarsh communities are relatively poorly represented in the Burry Inlet. Sizeable ungrazed stands are restricted to Penrhyn Gwyn, where they formed good transitions with other units and grazed stands were well developed at Loughor. *Festuca rubra* communities are the second most widespread unit of the Inlet, with extensive (>100 ha) cohesive stands mapped at the Llanrhidian-Landimore site and with sizeable areas (ca. 50 ha) also mapped at Penclawdd and Loughor. *Artemisia maritima* communities was recorded at the Pembrey site, with particularly well developed stands along the more inland creek edges and extending towards the lower marsh, at Penclawdd. The area of *Juncus maritimus* saltmarsh community along the Burry Inlet is 276.97 ha.

Within the Three Rivers complex transitional low-marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Sueda maritima* is present over a significant area (*ca.* 50 ha) on the Gwendraeth, but has only fragmentary representation on the Taf, and on the Tywi is restricted to a small but good quality stand at Morfa Uchaf. Rayed *Aster tripolium* communities are widespread with good stands on all three estuaries. Both grazed and ungrazed types of *P. maritima* communities are present, although ungrazed expressions are uncommon on the Tywi and the Taf. In contrast *Halimione portulacoides* communities are present in large quantities and of good quality on both the lower Taf and the Gwendraeth. Many of the saltmarshes are dissected by small creeks and channels, which provide microhabitats within more uniform areas of marsh. Saltpans and small pools add diversity to the site and are an intrinsic part of many marshes. The marshes on the southern side of the Burry Inlet between Whiteford Point and Loughor are of national significance in respect of a variety of geomorphological features, including creeks, saltpans, erosion cliffs and a variety of sediment types.

The dendritic creek systems of the Burry Inlet and the Gwendraeth are the very well developed and are the most extensive, followed by the Pembrey saltings. Short, but still profusely dendritic saltmarsh creeks, are also characteristic features of the smaller saltmarsh expanses along the Taf and the Tywi. Near Clomendy Farm on the middle Tywi Estuary, the predominantly linear pattern of tidal creeks is the result of the excavation of drainage ditches.

Landimore, Llanrhidian and Berthlwyd marshes have developed in sequence from east to west. The mature marshes at Berthlwyd display well developed terraces and an eroding marsh cliff while at Llanrhidian both pans and creeks are present and the marsh is heavily dissected. At Landimore an intricate and deep creek network is present. This sequence of marshes forms a key area for the understanding of saltmarsh dynamics, sediment transport and sea level changes.

*Juncus maritimus-Triglochin maritimus* saltmarsh, is poorly represented, but the associated *J. maritimus* is a conspicuous feature of the estuary system with a total cover well in excess of 50 ha and all three sub-communities are well represented, Morfa Uchaf supports a small patch of *Eleocharis uniglumis* with halophytic associates which may be a relic of a former stand now subsumed within the surrounding inundation vegetation.

## Communities

This extensive site has a complete sequence of saltmarsh vegetation, from pioneer vegetation through to upper saltmarsh transitions. The grazed saltmarshes include upper margins with sea rush *Juncus maritimus* and marsh-mallow *Althaea officinalis* which are a particularly distinctive ecological features of the site. The area is also important for transitions from saltmarsh to sand dune and other habitats.

Notable saltmarsh species and communities include stands containing good populations of *Althaea officinalis* that were extensive at Llanrhidian-Landimore, and also present on Loughor and Penrhyn Gwyn and stands of *Artemisia maritima* which were well represented at Pen-clawdd, and also occurred on the other sites, although in lesser quantity. Good populations of *Limonium vulgare* have been recorded at all sites, and were particularly well represented at Llanrhidian-Landimore. Two nationally scarce plant species also occur on the Taf Estuary, namely the rock sea-lavender *Limonium procerum* and bulbous foxtail *Alopecurus bulbosus*. Three known populations of *Bryum marratii,* a bryophyte listed as Vulnerable in the UK Red Data List (Hodgetts, 2011) and Endangered

in the Welsh Red Data List (Bosanquet and Dines, 2001), are located on upper saltmarsh transitions where there is freshwater flushing at Landimore marsh and on the Tywi and Gwendraeth Estuaries.

The majority of saltmarsh insects are sap-sucking aphids, while deposit feeders such as *Limecola baltica, Corophium volutator* and *Arenicola marina* and predators like *Hediste diversicolor* and *Nephtys hombergii* are likely to be present. *Peringia ulvae* grazes the microflora from sediment grains and epiphytes. Areas with high structural and plant diversity, particularly where freshwater seepages provide a transition from fresh to brackish conditions, are particularly important for invertebrates.

Saltmarshes are an important resource for wading birds and wildfowl. They act as high tide refuges for birds feeding on adjacent mudflats, as breeding sites for waders, gulls and terns and as a source of food for passerine birds particularly in autumn and winter. In winter, grazed saltmarshes are used as feeding grounds by large flocks of wild ducks and geese.

## *Salicornia* and other annuals colonising mud

Formations composed mostly or predominantly of annuals, in particular Chenopodiaceae of the genus *Salicornia* or grasses, colonising periodically inundated muds and sands of marine or interior salt marshes. Four different plant communities are represented by this SAC habitat in the UK of which two are present within the Carmarthen Bay and Estuaries SAC.

Of the listed sub-types the Carmarthen Bay and Estuaries SAC includes examples of glasswort swards *Thero-Salicornietalia* and Annual sea-blite stands. This form of saltmarsh is widely distributed throughout coastal areas of the EU. In the UK it is widespread in the saltmarshes of England and Wales, but the area of this habitat type is restricted in Scotland and Northern Ireland because of a lack of new sediment for saltmarsh development.

### Habitats

*Salicornia* grows on a wide variety of marine sediments in intertidal habitats, ranging from gravels and shelly sands, through silts to fine clays, and is invariably associated with saline, brackish or alkaline substrates. Although an early colonist of soft, unconsolidated sediments, the densest stands tend to be on firm silts and clays. The substrates of *Salicornia* span the tidal range at elevations above Mean High Water Neap tides and are often waterlogged for much of the time, depending on elevation and drainage conditions. The saturated sediments are typically hypoxic and may develop low redox potentials, even in the surface layers and the plants may avoid root hypoxia by relatively shallow rooting. One consequence is that hydraulic forces generated by tidal flow, perhaps associated with scouring of the sediment and wave action, can be a major source of mortality for *Salicornia* seedlings at lower elevations on a saltmarsh.

*Salicornia* is extremely tolerant of regular flooding although growth of *S. europaea* is reduced by cultivation under continuous water-logging, in comparison with free drainage at the same salinity. As a halophyte, *Salicornia* is tolerant of exceptionally low water potentials in its root environment, whether they arise from salinity, drought or a combination of both.

Individual populations and taxa of *Salicornia* may be very sensitive to elevational variations associated with microtopography on the gradient from land to sea of tidal saltmarshes. Populations on the lower shore need to be more tolerant of prolonged submergence, tidal scour and water-logging, whereas those at high elevations may experience hyper salinity in summer.

Few grazers feed on the saltmarsh plants directly. In spring and summer, *Salicornia* spp. are highly productive and in autumn die back and decompose. Therefore, the majority of *Salicornia* spp. productivity, and presumably other vascular plant (*i.e. Suaeda maritima*) productivity, enter the food web as detritus. Benthic algae and microphytobenthos play an important role in cycling nutrients, and hundreds of species of bacteria, fungi, and microalgae may be attached to surfaces of vascular plants and sediment. These are grazed by meiofauna (*e.g*. protozoa, foraminifera, nematodes). Mature stands of *Salicornia* and their seeds can be an important food resource for passerine birds and geese. This pioneer saltmarsh habitat also provides sheltered nursery sites for several species of fish.

## Communities

The site is selected as representative of pioneer glasswort *Salicornia* spp. saltmarsh in the south-west of the UK. It forms an integral part of the estuarine system, supporting extensive pioneer communities and contributing to a complete sequence of saltmarsh vegetation, including to low, mid and upper saltmarsh and to important transitional vegetation including transitions to sand dune habitats.

Both of the *Salicornia* feature vegetation community types present within this site. Annual *Salicornia* saltmarsh and *Suaeda maritima* saltmarsh contribute to the overall 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 *Salicornia* feature is naturally species poor as the dominant species *Salicornia sp.* and *Suaeda maritima* as few plants are able to colonise such high salinity and length of tidal inundation.

Surveys have recorded the *Salicornia* feature in the Three Rivers complex where annual *Salicornia* saltmarsh has been mapped on the Taf and the Gwendraeth estuary whilst *Sueada maritima* saltmarsh is restricted to a single location on the Gwendraeth. Within the Burry Inlet the Annual *Salicornia* saltmarsh was widespread with the most extensive stands in the Llanrhidian and Landimore areas however, it was recorded as fragmentary elsewhere in the site. S*uaeda maritima* saltmarsh was only recorded in one stand at Llanrhidian.

The *Salicornia* spp. present in the Carmarthen Bay and Estuaries SAC reputedly includes the nationally scarce *Salicornia pusilla* at unknown location(s). Also of note is *Spartina anglica* which is presently spreading along the north Gower coastline, occupying increasingly the niche vacated by *Salicornia*, because the southward migration of the channel has increased energy levels. Dunlin, for instance, prefers *Salicornia* to *Spartina* for foraging.

No information is currently available on the composition of fauna and other flora associated with pioneer saltmarsh communities although there are descriptions of species that are typically associated with *Salicornia* marshes.

A reduced marine fauna is usually present which may include the amphipod *Corophium volutator*, the ragworm *Hediste* (*Nereis*) *diversicolor* and often the mud snail *Peringia ulvae*. There are often algal films, including diatoms, and algal mats over the substrate

surface, but vascular companions are usually very few. Scattered plants of *Puccinella maritima* and *Spartina anglica* occur frequently.

# Large shallow inlets and bays

Carmarthen Bay is a large shallow bay partially bound by rocky outcrops, with soft sediment communities occupying most of the Bay. It extends from Tenby and Caldy Island in the West to Worm's Head on the Gower peninsula in the east and covers approximately 43,492ha, comprising 6.5% of the UK resource and around 66% of the Carmarthen Bay and Estuaries SAC.

## Habitats

The seafloor of Carmarthen Bay consists of a mixture of sediments although mostly fine sand. The outer / seaward side of the feature is more medium sand with occasional areas of coarse sand and muddy silt. A few rocky outcrops are present, the largest being off Small Ord Point, near Caldey Island. Mid-Flandrian peat beds are exposed as ledges at times along the northern and north-eastern boundary of the large shallow bay. The rocky intertidal areas around the bay vary from steep cliffs at Tenby to bedrock platforms at Saundersfoot and areas of mixed rock and sediment at Whiteford and Telpyn which are exposed to wave action and sand scour.

The physical conditions vary considerably throughout the bay with salinity ranging from low at the estuaries to fully marine. There are also gradients in wave action from sheltered to exposed, and in tidal currents which are strong around exposed headlands and sheltered elsewhere. There is an exchange of sediments with mudflat, sandflats, saltmarsh and dunes, all of which are dynamic environments.

## Communities

The main sublittoral biotope is associated with sand and non-cohesive muddy sand and generally dominated by small bivalve mussels. At the western end of Carmarthen Bay the fine sand supports abundant marine life, much of it buried. This included the brittlestar *Amphiura filiformis*, the necklace shell *Euspira catena*, the burrowing crab *Corystes cassivelaunus*, and the anemone *Sagartiogeton undatus*. There were also bivalve molluscs such as razor shells *Ensis* sp., gapers *Mya* sp., venus shells *Venus* sp. and otter shells *Lutraria lutraria*. Surface life included starfish *Astropecten irregularis*, brittlestars *Ophiura ophiura* and *O. albida*, the common whelk *Buccinum undatum*, reticulated dog whelk *Nassarius reticulatus,* small flatfish and gobies.

The most abundant group of organisms found within Carmarthen Bay sediments are polychaetes (accounting for over 50% of infauna), with molluscs and crustaceans also being abundant. Pembrey Sands at the mouth of the Loughor is dominated by the polychaete *Lanice conchilega*, but the polychaete *Spiophanes bombyx* is also found in large numbers in other areas of the bay. Other polychaetes commonly found are *Magelona filiformis*, *Nephtys cirrosa* and *Chaetozone setosa*. A number of molluscs are widespread in the sandy sediments of the Bay, including *Kurtiella bidentata*, *Abra alba* and *Chamelea gallina*.

Also occurring in the bay are amphipods and echinoderms such as the heart urchin *Echinocardium cordatum* and various brittlestars, including *Ophiura ophiura* that is found in large numbers in the bay. Starfish are also present throughout the bay, as are molluscs

such as the small opisthobranch *Philine aperta* and the whelks *Buccinum undatum* and *Nassarius* sp.

The more varied stable areas of cobble and boulders just west of Woolhouse Rocks are colonised by large numbers of mussels *Mytilus edulis* and sea squirts *Molgula manhattensis*. Where sand scouring occurs, hydroids such as *Sertularia argentea*, *Abietinaria abietina*, *Halecium halecinum*, *Hydrallmania falcata* and *Obelia longissima* dominate. At The Yowan there was a wide variety of other attached life including branching sponges such as *Haliclona oculata* and barnacles as well as crustaceans and fish such as bib and poor cod.

In the intertidal zone the cliffs at Tenby and north to Saundersfoot are dominated by lichens such as *Caloplaca* spp. and *Verrucaria* spp., barnacles *Semibalanus balanoides*, and mussels *Mytilus edulis* with patches of fucoid algae *Fucus serratus* and kelps *Laminaria digitata* where the cliffs extend onto the lower shore. Sponges *Grantia compressa* and *Leuconia* sp. and shade-tolerant red seaweeds *Palmaria palmata*, *Plumaria plumosa* and coralline algal crusts occupy overhanging areas of bedrock on the lower shore.

The bedrock platforms from Saundersfoot to Amroth are also exposed to wave action and sand scour and are dominated by lichens, barnacles and mussels but also coralline rock pools with daisy anemone *Cereus pedunculatus* on the mid shore, and sponges and anemones in overhangs, on the lower shore.

At Whiteford Point, much of the shore is dominated by a dense cover of *Mytilus edulis*, consolidating cobbles, pebbles and small boulders in some places together with a few large hydroid pools and numerous small pools are found in depressions. These beds can be ephemeral because of winter storms. The piddock communities are present in intertidal zones either within soft (Carboniferous) limestone along Tenby Cliffs and St Catherine's Island or in mid-Flandrian clays, along the Marros and Pendine coast and at Whiteford Burrows.

Rare and scarce species found within the large shallow inlet and bay feature include *Acanthocardia aculeata* (rare cockle), *Achaeus cranchii* (crab), *Atrina fragilis* (fan shell), sponge crab *Dromia personata*, *Ostrea edulis* (native oyster), and peacocks tail *Padina pavonica* (brown alga). However, the records of *Atrina fragilis, Ostrea edulis, Dromia personata* and *Padina pavonica* date back to pre-1950, with no records since.

Carmarthen Bay is a known hotspot for the leatherback turtle and there are regular sightings. This has been linked to the abundance of their prey species the jellyfish *Rhizostoma octopus* which can reach large numbers in summer months.

Atlantic salmon *Salmo salar* and sea trout *Salmo trutta* are present in many of the rivers and coastal areas of the Bristol Channel with salmon runs in a number of watercourses draining into Carmarthen Bay, including the Rivers Taf, Tywi and Gwendraeth. The migratory European eel *Anguilla anguilla* is commonly found throughout Carmarthen Bay and its estuaries and the SAC appears to be an important nursery and feeding area for a number of fish, including Dover sole *Solea solea*, bass *Dicentrarchus labrax*, plaice *Pleuronectes platessa* and the dab *Limanda limanda*.

# Sandbanks which are slightly covered by sea water all the time

Helwick Bank is a linear, very shallow, subtidal sandbank that is one of the most highly exposed to wave and tidal action of all the Welsh sandbanks. The Bank is oriented in an east-west direction and is approximately 12 km in length. It consists of two shoal areas (East and West Helwick), with a slightly deeper area between known as Helwick Swatch. The Bank is closely associated with the coastal headland of Port Eynon Point and the current flows around it. The local geology underlying and adjacent to the Helwick Bank, in particular the Carboniferous limestone bedrock of Port Eynon Point close to the bank, and the underlying flat surface of Lias bedrock, are important in determining the hydrodynamic regime, sediment dispersal and deposition and morphological evolution of the sandbank.

## Habitats

The seabed south of the Bank rises from around 32 m to between 3-4 m on the crests of the East and West Helwick shoals and around 6 m on Helwick Swatch. To the north of the Bank, the seabed falls away to a shallow flat area before rising once again to the coast. To the northwest, the Bank grades into the slightly deeper sand sheet of Carmarthen Bay, and to the south and east, the seabed deepens between 20 and 30 m.

The seabed sediments of the Helwick Bank area are predominantly uniform, medium fine sands with little or no fine or organic material. The more landward side of Helwick Bank is comprised of finer sands. To the south of the Bank, in deeper water, there are some uniform gravelly sands with no bedforms, and areas of irregular sand patches on gravel. There are sand waves along the flanks of the Bank indicating large-scale sand transport and an area of megaripples to the south of the Bank that merges to the west with an area of sand waves and gravelly sand. These ripples are superimposed on larger bedforms. The asymmetry of these sand waves (plus textural analysis and current modelling) indicate that all the bank has a clockwise sediment bedload circulation pattern, with flood dominant movement on its northern inshore side and ebb dominant movement on its southern offshore side. This circulation pattern is important in maintaining the overall geomorphology of the bank.

## Communities

The animal communities found in and on Helwick Bank are mostly characteristic of mobile sands and gravels with the exception of those to the south of the bank and many species spend most of their time wholly or partly buried in the sediment.

The sublittoral coarse sediments, mobile sand and gravels on the toe of the bank, the southern part of West Helwick and main part of East Helwick have communities dominated by *Hesionura elongata, Nephtys cirrosa and Protodriloides chaetifer*. The communities on the north of the bank and in Helwick Channel are characteristic of those on sublittoral sand and non-cohesive muddy sand, with sparse fauna in infralittoral mobile clean sand. They include *Gastrosaccus spinifer, Nephtys cirrosa* and *Pontocrates arenarius*. The sublittoral coarse sediments, on the south of the bank are dominated by *Bodotria arenosa, Lanice conchilega, Lagis koreni, Mediomastus fragilis*.

The sandbanks show an increasing species richness in deeper waters. The polychaetes *Hesionura elongata* and *Nephtys cirrosa*, and the archiannelid *Protodriloides chaetifer* are all common across the Helwick Bank, and the sediments are dominated in sections by

*Nephtys cirrosa* and the mysid *Gastrosaccus spinifer*. All four species are common to fine-medium sand habitats, particularly those subject to high water and sediment movements and where species richness is low. Infaunal samples found an average of 41 species per grab on the Helwick Bank (East) and 37 species per grab on the Helwick Bank (West). Species numbers from two stations on the seaward side of the Helwick Bank were highest, i.e. 102 and 103 species for Helwick Bank (East) and Helwick Bank (West) respectively. These two stations in deeper water, with more stable sandy substrates, are therefore considerably more species rich than the shallow water, high energy, sites.

Fish use the Helwick Bank in a number of ways including spawning, nursery and feeding. Nine species of fish were caught during a 2001 survey with the catch dominated by weaver fish *Echiichthys vipera*, spotted ray *Raja montagui*, grey gurnard *Eutrigla gurnardus*, and sand sole *Pegusa lascaris*, followed by plaice *Pleuronectes platessa*, and turbot *Scophthalmus maximus* (Kaiser et al., 2001). Blonde ray *Raja brachyura*, and cuckoo ray *Leucoraja naevus*, are also caught in this area (South Wales Sea Fisheries Committee, pers. comm.). Some ray species are likely to spawn on the sandbank, for instance thornback ray *Raja clavata*, blonde ray *Raja brachyura*, small-eyed ray *Raja microoculata* and spotted ray *Raja montagui* (Ellis et al., 2012). The area is also used as a nursery ground, possibly by thornback, small-eyed and spotted rays, because they all favour inshore nursery areas. The extent of the area used by rays is unknown, although research has shown that juvenile thornback rays appear to be highly site-specific, remaining close to the coast for several years, and thornback rays are probably ubiquitous in sand and gravel coastal waters.

Sandeels *Ammodytes tobianus* are also thought to spawn on Helwick Bank and the surrounding, seabed. They are a common inshore species and are likely to occur along the length of the Bank and surrounding sandy substrates to a depth of around 30 m. They play a fundamental role in the local marine food web: bass *Dicentrarchus labrax*, whiting *Merlangius merlangus*, cod *Gadus morrhua*, sole *Solea* spp., plaice *Pleuronectes platessa*, brill *Scophthalmus rhombus*, and flounder *Platichthys flesus*, are all known to feed on sandeels. These in turn attract larger predators. Notable species include the southern cumacean *Cumopsis fagei* which has been identified from several stations on Helwick Bank and which is not frequently recorded from British waters, the bryozoan *Odontoporella lata* at the northernmost limit of its distribution, the gastropod *Parthenina interstincta* which is rare in the region, and the polychaete *Thoracophelia flabellifera* which has a limited number of recordings from UK waters. Some of these species may be under-recorded, rather than truly rare and therefore the information should be treated with caution, until further evidence is available.

# Appendix 2: Additional conservation interest

**SPAs that are partly or wholly within the SAC:**

- Bae Caerfyrddin/Carmarthen Bay
- Burry Inlet

**SACs that are partly or wholly within the SAC:**

- Dynesfeydd Môr Hafren MPA /Bristol channel approaches

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

- Tenby Cliffs and St.Catherine's Island
- Waterwynch Bay to Saundersfoot Harbour
- Arfordir Saundersfoot – Telpyn/Saundersfood – Telypyn Coast
- Afordir Marros – Pentywyn/Marros – Pendine Coast
- Twyni Lacham – Pentywyn/Laugharne – Pendine Burrows
- Whitehill Down
- Aber Taf/Taf Estuary
- Afon Tywi
- Arfordir Pen-bre/Pembrey Coast
- Burry Inlet and Loughor Estuary
- Twyni Chwitffordd, Morfa Landimor a Bae Brychdwn/Whiteford Burrows, Landimore Marsh and Broughton Bay

**Section 7 and OSPAR threatened and declining habitats and species**

- Estuarine rocky habitats
- Intertidal mudflats
- Mussel beds
- Seagrass beds
- *Pleuronectes platessa*
- *Raja clavata*
- *Raja montagui*
- *Solea solea*