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Condition Assessments for the Designated Features of Ardal Cadwraeth Arbennig Bae Caerfyrddin ac Aberoedd / Carmarthen Bay and Estuaries Special Area of Conservation

Report No: 906

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

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- Having a well resourced proactive programme of evidence work;
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Crynodeb Gweithredol

Er mwyn rheoli ein hardaloedd morol gwarchodedig yn effeithiol ac yn gynaliadwy, mae'n hanfodol deall cyflwr eu cynefinoedd a'u rhywogaethau gwarchodedig. Mae gwybod cyflwr nodweddion dynodedig yn caniatáu i ni dargedu rheolaeth ac adnoddau lle mae eu hangen i wella ac adfer cyflwr.

Mae'r adroddiad tystiolaeth hwn, a gyflwynwyd fel rhan o brosiect gwella cyngor cadwraeth forol (IMCA) a ariannwyd gan Lywodraeth Cymru, yn cyflwyno canfyddiadau asesiadau cyflwr Cyfoeth Naturiol Cymru ar gyfer Ardal Cadwraeth Arbennig (ACA) Bae Caerfyrddin ac Aberoedd. Mae adran un yn rhoi trosolwg o'r broses asesu ac mae adran dau yn rhoi disgrifiad o'r ACA a'i nodweddion.

Mae'r asesiadau'n seiliedig ar y dystiolaeth orau a oedd ar gael ar y pryd (e.e. 2024). Adroddir canlyniadau asesiadau gyda hyder cysylltiedig yn y casgliad. Gellir dod o hyd i esboniadau manwl o'r rhesymeg y tu ôl i gasgliadau, ac unrhyw resymau dros fethu, yn yr asesiad cyflwr llawn yn Adran 3. Gellir dod o hyd i adroddiad ar y broses asesu a ddefnyddiwyd yn adroddiad terfynol IMCA.

Crynodeb o asesiadau cyflwr ar gyfer nodweddion dynodedig ACA Bae Caerfyrddin ac Aberoedd.

Nodweddion ACA	Asesiad cyflwr	Hyder yn yr asesiad
Aberoedd	Anffafriol	Canolig
Gwastadeddau llaid neu dywod nas gorchuddir gan y môr ar lanw isel	Anffafriol	Canolig
Dolydd ar forfeydd arfordir y gorllewin *Glauco-Puccinellietalia maritimae*	Anffafriol	Isel
Salicornia a phlanhigion unflwydd eraill sy'n cytrefu llaid a thywod	Ffafriol	Isel
Cilfachau a baeau mawr bas	Anffafriol	Isel
Ponciau tywod sydd fymryn dan ddŵr y môr drwy'r amser	Ffafriol	Canolig
Herlyn *Alosa alosa*	Anffafriol	Canolig
Gwangen Alosa fallax	Anffafriol	Isel
Lamprai'r afon *Lampetra fluviatilis*	Ffafriol	Canolig
Lamprai'r môr *Petromyzon marinus*	Ffafriol	Canolig
Dyfrgi *Lutra lutra*	Anffafriol	Canolig

Executive summary

To manage our marine protected areas effectively and sustainably it is vital to understand the condition of their protected habitats and species. Knowing the condition of designated features allows management and resources to be targeted where it is needed to improve and restore condition.

This evidence report, which was delivered as part of the Welsh Government funded improving marine conservation advice (IMCA) project, presents the findings of NRW's condition assessments for the designated features of the Carmarthen Bay and Estuaries Special Area of Conservation (SAC). Section one gives an overview of the assessment process and section two provides a description of the SAC and its features.

The assessments are based on the best evidence available at the time (e.g. 2024). Assessment outcomes are reported with an associated confidence in the conclusion. Detailed explanations of the rationale behind conclusions, and any reasons for failure, can be found in the full condition assessment in Section 3. A report on the assessment process used can be found in the IMCA final report.

Summary of condition assessments for the designated features of Carmarthen Bay and Estuaries SAC.

Feature	Condition assessment	Confidence in assessment
Estuaries	Unfavourable	Medium
Mudflats and sandflats not covered by seawater at low tide	Unfavourable	Medium
Atlantic salt meadows *Glauco-Puccinellietalia maritimae*	Unfavourable	Low
Salicornia and other annuals colonising mud and sand	Favourable	Low
Large shallow inlets and bays	Unfavourable	Low
Sandbanks which are slightly covered by seawater all the time	Favourable	Medium
Allis shad *Alosa alosa*	Unfavourable	Medium
Twaite shad *Alosa fallax*	Unfavourable	Low
River lamprey *Lampetra fluviatilis*	Favourable	Medium
Sea lamprey *Petromyzon marinus*	Favourable	Medium
Otter *Lutra lutra*	Unfavourable	Medium

1. Introduction

It is important for NRW to understand the condition of designated features in marine protected areas (MPAs) to allow NRW to prioritise management actions and advise on activity in the marine environment.

Having robust, evidence-based assessments of feature condition will ultimately lead to better protection through better management. The improvements in condition brought about by implementing targeted management will ultimately improve the resilience of Wales' marine ecosystems. As MPAs in Wales cover extensive areas of sea and coast, it can be challenging and resource intensive to monitor them. This can make thorough assessments of feature condition difficult. The process used for these condition assessments builds on work undertaken to produce indicative condition assessments published in 2018.

The 2018 indicative assessments used all available data and expert judgement to assess features using a workshop approach with internal NRW specialists. The new full assessment process, which has been delivered through the Welsh Government funded improving marine conservation advice (IMCA) project, has been improved by using carefully chosen performance indicators judged to be the most appropriate to assess condition (see Section 3). The best available evidence has been used to conduct the assessments. Due to the differences in assessment methods between these full assessments and the indicative condition assessments, the results are not directly comparable.

1.1. Assessment process

Marine feature condition assessments in NRW consist of selecting performance indicators for the feature, gathering the best available evidence to assess those indicators and conducting the assessment.

Performance indicators have targets which have a primary, secondary or tertiary weighting. Failure of a primary target will mean the feature is classified as unfavourable, on a 'one out all out' basis. If all primary targets pass but two secondary targets fail, the feature would also be classified as unfavourable. Likewise, if all primary and secondary targets pass but three tertiary targets fail, the feature will also be unfavourable. Condition assessment outcomes are not strictly determined by target weightings and are also subject to expert judgement.

Each indicator result has an associated confidence which is determined by the quality and age of the evidence along with the confidence in the indicator itself and what it is telling us about condition of the feature. The confidence in the overall assessment is derived from the confidence in each target pass or failure, as well as expert judgment/ assessor consensus.

Each feature condition assessment will also identify reasons for indicator failure where known and any known threats to feature condition.

Table 1 summarises the steps taken in marine feature condition assessments. Details on the full condition assessment process, including indicator selection and target weighting can be found in the IMCA final report.

Table 1. The main steps of the marine feature condition assessment process.

Assessment Step	Process
Step 1: Preparation and evidence gathering.	Prepare site information. Source relevant evidence and any previous assessments. Evaluate quality of evidence according to suitability for use in assessments and carry out any analysis required.
Step 2: Indicator assessment.	A range of NRW specialists use all available evidence to assess the performance indicators and targets using a pass, fail or unknown. Record findings in the condition assessment form. Provide a confidence score for each target conclusion.
Step 3: Feature level assessments.	Combining the results from the assessment of feature indicators to provide an overall assessment of condition at the feature level.
Step 3.5. Complex features.	If the feature is a complex feature (i.e., estuaries or large shallow inlets and bays) consider the results of any nested feature assessments within the overall complex feature assessment.
Step 4: Condition pressures and threats.	Use the evidence gathered and information on management and activities to determine threats and pressures on feature condition.
Step 5: Finalise the assessments.	Ensure all required fields in the assessment have been completed and all assessed targets have an associated confidence. Circulate the reports to the relevant NRW specialists for review and comment. After issues have been resolved, the assessments will be signed off by the project task and finish group.
Step 6: Publish the assessments.	After signing off, the assessments will be published on the NRW website, and stakeholders and internal staff notified. Assessments are then ready to use by internal and external parties.

2. SAC description

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*

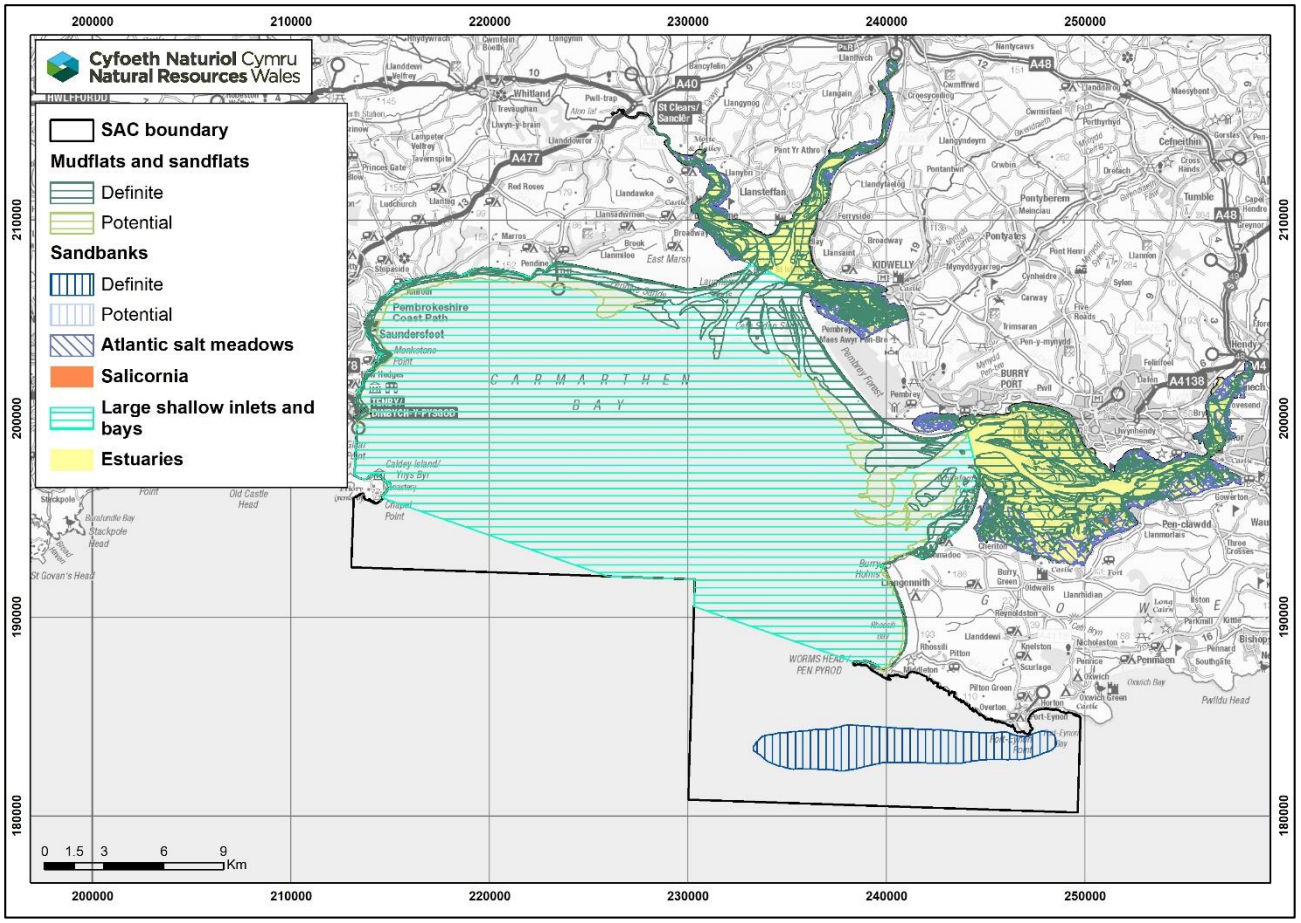
and supports a significant presence of:

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

Figure 1 is a map of the location of the designated features within Carmarthen Bay and Estuaries SAC. The feature maps in this document are for illustrative purposes only. Detailed maps for the features in Wales can be found on Data Map Wales.

More information on the SAC and its features can be found in NRW's conservation advice for the site on our website.

Figure 1. Map of the designated features of the Carmarthen Bay and Estuaries SAC.



3. Feature condition assessments for Carmarthen Bay and Estuaries SAC

This section contains assessments for the following designated features in Carmarthen Bay and Estuaries SAC:

- Estuaries
- Mudflats and sandflats not covered by seawater at low tide
- Atlantic salt meadows *Glauco-Puccinellietalia maritimae*
- *Salicornia* and other annuals colonising mud and sand
- Large shallow inlets and bays
- Sandbanks which are slightly covered by seawater all the time
- Allis shad *Alosa alosa*
- Twaite shad *Alosa fallax*
- River lamprey *Lampetra fluviatilis*
- Sea lamprey *Petromyzon marinus*
- Otter *Lutra lutra*

Each feature has been assessed against their own performance indicators using all available evidence. The performance indicators were assessed using a combination of data from NRW Habitats Regulations monitoring, Water Framework Directive (WFD) Regulations 2017 (WFD Regulations) monitoring, commissioned evidence reports, scientific literature, plan and project assessments, external monitoring databases (e.g. National Biodiversity Network) and expert judgement. The outcome of the assessment and reasons for failure are discussed in more detail in the sections below.

In these condition assessments, the WFD 2024 cycle 3 interim classification was the default information used for water quality, however other earlier cycles were referenced, as follows:

- 2009 cycle 1 classification
- 2015 cycle 2 classification
- 2018 cycle 2 interim classification
- 2021 cycle 3 classification

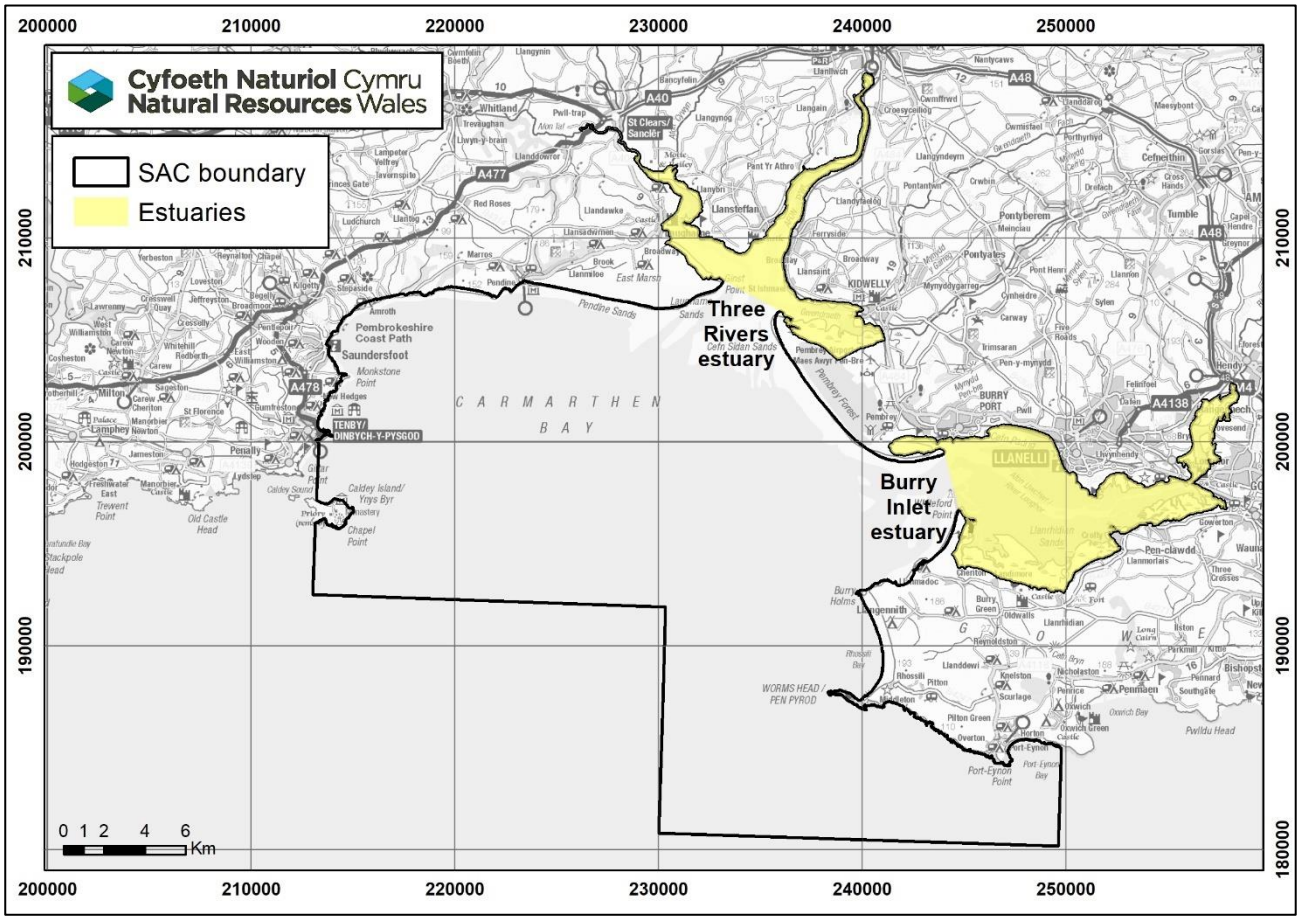
In the WFD classification, results are rolled forward from previous assessments where there is no new monitoring data to provide a new classification. It is used to gap fill and provide a more complete classification. A decision was made to limit roll forward to six years which has been applied to the 2024 cycle 3 interim classification.

Additional information on water quality can be found in the IMCA final report.

3.1. Estuaries condition assessment

The estuaries feature in the Carmarthen Bay and Estuaries SAC comprises two estuaries, the Three Rivers estuary complex (Tywi, Taf and Gwendraeth) and Loughor estuary commonly called the Three Rivers and Burry Inlet estuaries (Figure 2). The condition assessment was completed using information specific to estuaries in combination with any available data on the nested designated features contained within the estuaries feature.

Figure 2. Map of the estuaries feature in Carmarthen Bay and Estuaries SAC.



The estuaries feature in this SAC includes the nested features: mudflats and sandflats and Atlantic salt meadows (ASM). Estuarine fish communities were only broadly considered due to resource limitations but there is some information included in the detailed assessment section. Each estuary has been assessed separately for each indicator and then combined to produce a single target assessment outcome for the indicator. Table 2 has a summary of the assessment outcome. This outcome and reasons for failure are discussed in more detail in the sections below.

Table 2. Condition assessment of estuaries in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Feature extent	No significant decrease in extent of estuaries within the SAC, allowing for natural change. (P)	• Since designation in 2004, there are no anthropogenic impacts known to have significantly affected the extent of estuaries in the Carmarthen Bay and Estuaries SAC. • Confidence is medium as the assessment has not been based on comparison mapping of the feature and expert judgment was used.	**Pass**	Medium
Distribution of the feature	Maintain the distribution of the estuaries within the SAC, allowing for natural change and variation. (P)	• Since designation in 2004, there are no anthropogenic impacts known to have significantly affected the distribution of estuaries in the Carmarthen Bay and Estuaries SAC. • Confidence is medium as the assessment has been based on expert judgment.	**Pass**	Medium
Distribution and extent of habitats and communities	Maintain the distribution and extent of estuarine habitats and communities, allowing for natural change and variation. (P)	• Since designation in 2004, there are no anthropogenic impacts known to have significantly affected the distribution and extent of habitats and communities of estuaries and its nested features in the Carmarthen Bay and Estuaries SAC. • There are some concerns about overgrazing and spread of *Gracilaria vermiculophylla* within the nested habitat features in the estuaries that could impact the distribution and extent of habitats and communities. • Confidence is medium as the assessment has been based on expert judgment.	**Pass**	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Sediment composition and distribution	Maintain composition and distribution of sediment granulometry across the estuaries, allowing for natural change and variation. (P)	• Granulometric analysis of core samples in the condition assessment of the mudflats and sandflats feature in the Burry Inlet and Three Rivers estuaries indicated little variation in sediment composition across the monitoring period. However, there was a sudden and unexplained coarsening of sediments in 2019. • Granulometric analysis of grab samples in the Three Rivers estuary showed variation in sediment composition, but with no overall concerning trend. Some stations in Gwendraeth and Tywi had significant changes in silt content between years. This may be due to the dynamic nature of the estuary. • Confidence is medium due to the unexplained coarsening of sediments from core samples, and the large changes in silt content in the grab samples.	**Pass**	Medium
Sediment quality: oxidation-reduction profile (redox layer)	No decrease in the depth of the redox layer from the surface that is considered detrimental to estuarine infaunal communities, allowing for natural change and variation. (S)	• This assessment uses the results of the condition assessment from the mudflats and sandflats feature as a proxy as there were no other data available. The redox layer profile of the monitored mudflats and sandflats indicated no clear trend over the years. • Confidence is low because additional sampling is needed to improve temporal resolution and data continuity, which are required to understand ongoing processes and confirm overall trends.	**Pass**	Low

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Sediment quality: organic carbon content	No increase to the organic carbon content considered detrimental to infaunal communities, allowing for natural change. (P)	• Sediment sampling in the SAC has been assessed using sediment grab sample data at 22 stations in the Three Rivers estuary. • There has been an increase in carbon content in 2021 compared to earlier years in various stations, especially in the Taf. Two stations with the largest relative increases went from 0.13% and 0.25% in 2015 to 1.91% and 1.65% in 2021 respectively. • In the Taf, the intertidal habitat is highly variable within a small area, therefore repeat sampling is difficult. • For this reason and as there were only three years of data, the confidence is low.	**Fail**	Low
Sediment quality: contaminants	Sediment contaminants not to exceed the quality guidelines. (P)	• Sediment sampling in the SAC has been assessed using sediment grab sample data at 22 stations in the Three Rivers estuary (2015, 2018 and 2021). • Contaminants were below the most stringent guidelines in 2021 in all locations. • The concentration of various heavy metals has increased between 2018 and 2021 (most notable in chromium). Some polycyclic aromatic hydrocarbons (PAHs) and heavy metal concentrations were above less stringent guidelines in 2021. • The impact of the sediment contaminants on the estuaries feature is not fully understood. In addition, there were only three years of data. This, and as there were some contaminants above the less stringent ecological guidelines caused the confidence in the assessment to be low.	**Pass**	Low

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Morphological equilibrium	Maintain the characteristic physical form and flow of the estuary, allowing for natural change and variation. (P)	• Since designation in 2004, there are no anthropogenic impacts known to have significantly affected the morphological equilibrium of estuaries in the Carmarthen Bay and Estuaries SAC. • Confidence is medium as the assessment has been based on expert judgment.	**Pass**	Medium
Topography of the feature	No significant anthropogenic impacts to the small or large scale topography of the estuaries. (S)	• Since designation in 2004, there are no anthropogenic impacts known to have significantly affected the topography of estuaries in the Carmarthen Bay and Estuaries SAC. • Confidence is medium as the assessment has been based on expert judgment.	**Pass**	Medium
Hydrodynamic and sediment transport processes	Maintain hydrodynamic and sediment transport processes, including connectivity, allowing for natural variation and change. (P)	• Since designation in 2004, there are no anthropogenic impacts known to have significantly affected the hydrodynamic and sediment transport processes of the feature. • Confidence is medium as the assessment has been based on expert judgment.	**Pass**	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence

Water quality: nutrients (Dissolved Inorganic Nitrogen – DIN only)	The WFD classification achieved for winter DIN should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (P)	Within the SAC, Burry Inlet estuary comprises 68% of the feature, and Three Rivers estuary 32%.
		• Two WFD waterbodies overlap with the Burry Inlet estuary.
		  ○ The Burry Inlet Outer waterbody was Good status for DIN in the 2024 cycle 3 interim classification. This is an improvement from Moderate status in the 2021 cycle 3 classification. It overlaps with 55% of this estuary (38% of the whole feature).
		  ○ The Burry Inlet Inner waterbody was Moderate status for DIN. This waterbody overlaps with 17% of this estuary (12% of the whole estuaries feature).
		• One WFD waterbody overlaps with the Three Rivers estuary, which was Moderate status for DIN in Cycle 3 (Three Rivers Estuary). This waterbody overlaps with 70% of this estuary (22% of the whole feature).
		• WFD investigations have confirmed nutrient issues and / or biological responses in phytoplankton, however due to the improvement in the Burry Inlet Outer waterbody, confidence has been reduced to medium.
			Fail	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: phytoplankton	The WFD classification achieved for phytoplankton should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (S)	Within the SAC, Burry Inlet estuary comprises 68% of the feature, and Three Rivers estuary 32%. • Both WFD waterbodies in the Burry Inlet estuary were Moderate or Poor status for phytoplankton in the 2024 cycle 3 interim classification. Combined, these waterbodies overlap with 72% of this estuary (49% of the whole feature). • The WFD waterbody in the Three Rivers estuary was classified with a Good status for phytoplankton (Three Rivers Estuary). This id an improvement from Moderate status in the 2021 cycle 3 classification. It overlaps with 70% of the Three Rivers estuary (22% of the whole feature). • Confidence is medium due to the improvement in Three Rivers Estuary waterbody.	**Fail**	Medium
Water quality: opportunistic macroalgae	The WFD classification achieved for opportunistic macroalgae should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (S)	Within the SAC, Burry Inlet estuary comprises 68% of the feature, and Three Rivers estuary 32%. • None of the WFD waterbodies that overlap with the feature have been classified for the opportunistic macroalgae WFD element in the 2024 cycle 3 interim classification.	**Unknown**	N/A

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: dissolved oxygen	The WFD classification achieved for dissolved oxygen should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (P)	Within the SAC, Burry Inlet estuary comprises 68% of the feature, and Three Rivers estuary 32%. • All three WFD waterbodies that overlap with the feature have been classified with a High status for dissolved oxygen in the 2024 cycle 3 interim classification. • Confidence is medium due to samples being taken from the surface of the waterbody which may not detect issues for more demersal habitats within the estuaries feature.	**Pass**	Medium
Water quality: contaminants	Water column contaminants not to exceed the environmental quality standards (EQS). (S)	Within the SAC, Burry Inlet estuary comprises 68% of the feature, and Three Rivers estuary 32%. • All three WFD waterbodies that overlap with the feature have a pass for chemicals in the 2024 cycle 3 interim classification. However, some or all of the chemicals have not been classified in the 2024 cycle 3 interim classification and were rolled forward from previous cycles. • Confidence is medium due to the rolled forward classifications.	**Pass**	Medium
Water quality: turbidity	Maintain expected levels of turbidity, allowing for natural change and variation. (P)	• There are limited data on turbidity for the estuaries feature in the Carmarthen Bay and Estuaries SAC, therefore this target was assessed as unknown.	**Unknown**	N/A

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Abundance, distribution and species composition of communities	Maintain the abundance, distribution, and diversity of species within communities and component habitats, allowing for natural change and variation. (P)	• All three overlapping WFD waterbodies were classified as Good or High status for the Infaunal Quality Index (IQI) WFD element in the 2024 cycle 3 interim classification. Combined, these waterbodies represent 71% of the feature. • The abundance, distribution and species composition of communities indicator in the mudflats and sandflats condition assessment passed its target. This feature overlaps with 54% of the estuaries feature. • Analysis of grab sampled infaunal communities within the Three Rivers estuary showed high variability in communities during the monitoring period and the causes remain uncertain. • The species composition of communities indicator in the ASM condition assessment was assessed as unknown due to limited data and resources. Overgrazing, however, is widespread within the ASM feature and is likely to impact the species composition. This feature overlaps with 31% of the estuaries feature. • There have been no confirmed records of allis shad in the SAC and population numbers are thought to be very low. A large reduction of twaite shad returning to the River Severn was also observed. Both river and sea lamprey are common and widespread in the estuaries feature. • Confidence is low as there is limited information on the ASM feature, which overlaps with 31% of the estuaries feature, and there are some concerns with the low abundance of shad species and the lack of fish communities data.	**Pass**	Low

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Invasive non-native species (INNS)	Spread and impact of INNS caused by human activities should not adversely affect the condition of the feature. (P)	• The establishment of *Gracilaria vermiculophylla* within the last six years has been notably rapid in the Burry Inlet estuary. • This INNS causes sedimentation change and alterations to the topography of the mudflats and sandflats, and is changing mudflat into muddy habitats or mussel beds. It is likely to affect the cockle and mussel fisheries in the area. • Currently the species is impacting only a small proportion of the estuaries feature. Therefore confidence in the assessment is low.	**Fail**	Low
Non-native species (NNS)	No increase in the number of introduced NNS by human activities. (T)	• *G. vermiculophylla* has been recorded in the Burry Inlet estuary within the last six years, where the establishment has been notably rapid compared to other areas. • There have been targeted INNS surveys as part of the MarClim project and ad-hoc records from the NRW Habitats Regulations monitoring. • Confidence is high due to the arrival of NNS within the last six years, and good availability of records.	**Fail**	High

Assessment conclusions

The estuaries feature in Carmarthen Bay and Estuaries SAC has been assessed as being in **unfavourable** condition (medium confidence). There were a number of indicators with failing targets (Table 3). There were also limited or absent data for two key indicators to inform on the condition of the feature (see evidence gaps). Further investigation is needed to better understand all of the failures to be able to identify management options that can bring the feature back into favourable condition.

A summary of the assessment can be seen in Table 3 with more detail on each performance indicator, and any reasons for failure, provided in the sections below.

Table 3. Summary of the condition assessment for estuaries in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

Feature	Overall Condition Assessment	Indicator failures	Reason for indicator failure	Threats to condition
Estuaries	**Unfavourable (medium confidence)**	Sediment quality: organic carbon content (P) Water quality: nutrients (DIN only) (P) Invasive non-native species (P); non-native species (T) Water quality: phytoplankton (S)	• There has been an increase in carbon content in sediments in various stations, especially in the river Taf. • High nutrient levels have been recorded in the Burry Inlet Inner and Three Rivers Estuary waterbodies. • There has been rapid establishment of *G. vermiculophylla* in the Burry Inlet, which has started to alter the habitat present in the mudflats and sandflats. • Phytoplankton failed in the two Burry Inlet waterbodies.	• Unconsented infrastructure • INNS • Fly ash • Sediment quality: contaminants • Water quality: contaminants • Overgrazing • Management of coastal defences • Climate change

Detailed assessment information

Extent and distribution

Extent and Distribution of the feature

The feature extent and distribution indicators in the Carmarthen Bay and Estuaries SAC passed their target as there are currently no known anthropogenic impacts that have significantly affected the extent of the estuaries feature since designation in 2004. Comparison mapping has not been used to assess the extent and only expert judgment was used in the absence of recent data. This has reduced the confidence to medium.

Distribution and extent of habitats and communities

Grazing pressure within the SAC could possibly have an impact on the saltmarsh distribution and would be something to pay close attention to in the next assessment (see Section 3.3). In addition, the presence of the red seaweed worm wart weed *Gracilaria vermiculophylla* within the Burry Inlet has altered the type of habitat to become more muddy (see further detail in Invasive Non-Native Species). There is a need to fully understand the impact this species is causing on the mudflats and sandflats and the estuaries feature as a whole and if the change will be permanent. Evidence from WFD data of seagrass showed fluctuations in the intertidal seagrass *Zostera noltei* extent especially in the Burry Inlet Outer waterbody. Some decrease in extent of *Z. noltei* habitat in part of the Burry Inlet estuary resulted in a Moderate status in the two latest WFD classifications, but this is likely due to natural change (Section 3.2).

The indicator was assessed as passing the target but with a medium confidence as it was assessed by expert judgment and as there is an expansion of *G. vermiculophylla* and concerns about grazing.

Sediments

Composition and distribution

Sediment composition has been monitored within the mudflats and sandflats habitat and the subtidal sediments in the main channel within the estuaries feature. The granulometric analysis of the sediment core samples in the mudflats and sandflats habitat in the Burry Inlet and Three Rivers estuaries indicated little variation in sediment composition across the monitoring period. However, there was a sudden unexplained coarsening of sediments in 2019 across all stations (Section 3.2). Further investigation into the cause of this coarse sediment spike is needed.

Granulometric analysis from sediment grab samples in the Three Rivers estuary showed variation in sediment composition between monitoring years, but with no concerning trend overall. However, there were some stations in the Gwendraeth with significant fluctuation in silt content (<63 µm) between monitoring years which are a concern. In addition, significant decreases in silt content were observed in a few stations in the Tywi. These changes cannot be explained from the current analysis and could be a result of moving

channels or linked to the dynamic nature of the environment and require further investigations.

Overall, the sediment composition and distribution indicator met its target as changes seen were not deemed large enough to fail. Confidence was reduced to medium due to the changes in silt at some Three Rivers stations, and due to the sudden and unexplained coarsening of sediments found in the core samples.

Oxidation-reduction profile (redox layer)

For the redox layer indicator, only sediment data in the mudflats and sandflats feature were available. The mudflats and sandflats feature in the SAC overlaps with approximately 54% of the estuaries feature. It was therefore deemed acceptable to use the mudflats and sandflats condition assessment as a proxy for the redox layer indicator. The indicator met the target but with low confidence as further sampling is required to enhance the robustness and completeness of the dataset, especially important for assessing the redox layer (Section 3.2).

Organic carbon content and contaminants

The assessment of the organic carbon content and contaminants indicators within the Three Rivers estuary used data from NRW Habitats Regulations monitoring sediment sampling at 21 sites in the Three Rivers estuary (Tywi, Taf and Gwendraeth) in 2015, 2018 and 2021. There are no data available on carbon content in the Burry Inlet estuary.

Carbon content has increased over the monitoring period (Figure 3). This is especially notable in the Taf (Figure 3b). The locations with the highest carbon content in 2021 were in the middle sections of the Taf, where it increased from 0.13% in 2015 to 1.91% in 2021 at one location, and from 0.25% to 1.65% at another location (Figure 3b). The carbon levels are not as high as those in Pembrokeshire Marine SAC (maximum of 3.8% in the Milford Haven estuary), but compared to the levels in 2015 or 2018, the 2021 levels are concerning. The carbon content has not been compared against any defined ecological standard as it is highly variable by location, however increases in carbon can be an indicator of organic enrichment and reduced oxygen in the sediment. There are some stations where the carbon content has decreased over the three monitoring years. In the Tywi, two stations with three years of data have decreased (stations Tywi 12 and Tywi 15) (Figure 3a). These stations are in the middle of the central channel. In the Taf, one station (Taf 1) decreased in carbon content over the monitoring period (Figure 3b). This station is the most upstream station in the central channel.

Such increases in carbon content are typically related to agricultural practices (e.g. slurry runoff). This may therefore provide support for evidence of nutrient issues within the Three Rivers estuary (see further detail in the water quality section). The organic carbon content indicator failed to meet the target due to the substantial increases in carbon in some locations in the Three Rivers estuary, especially in the Taf. However, the confidence was reduced to low as the intertidal habitat in the Taf is highly variable within a small area, which makes repeat sampling difficult. In addition, because there were only three years of data available from the sampling.

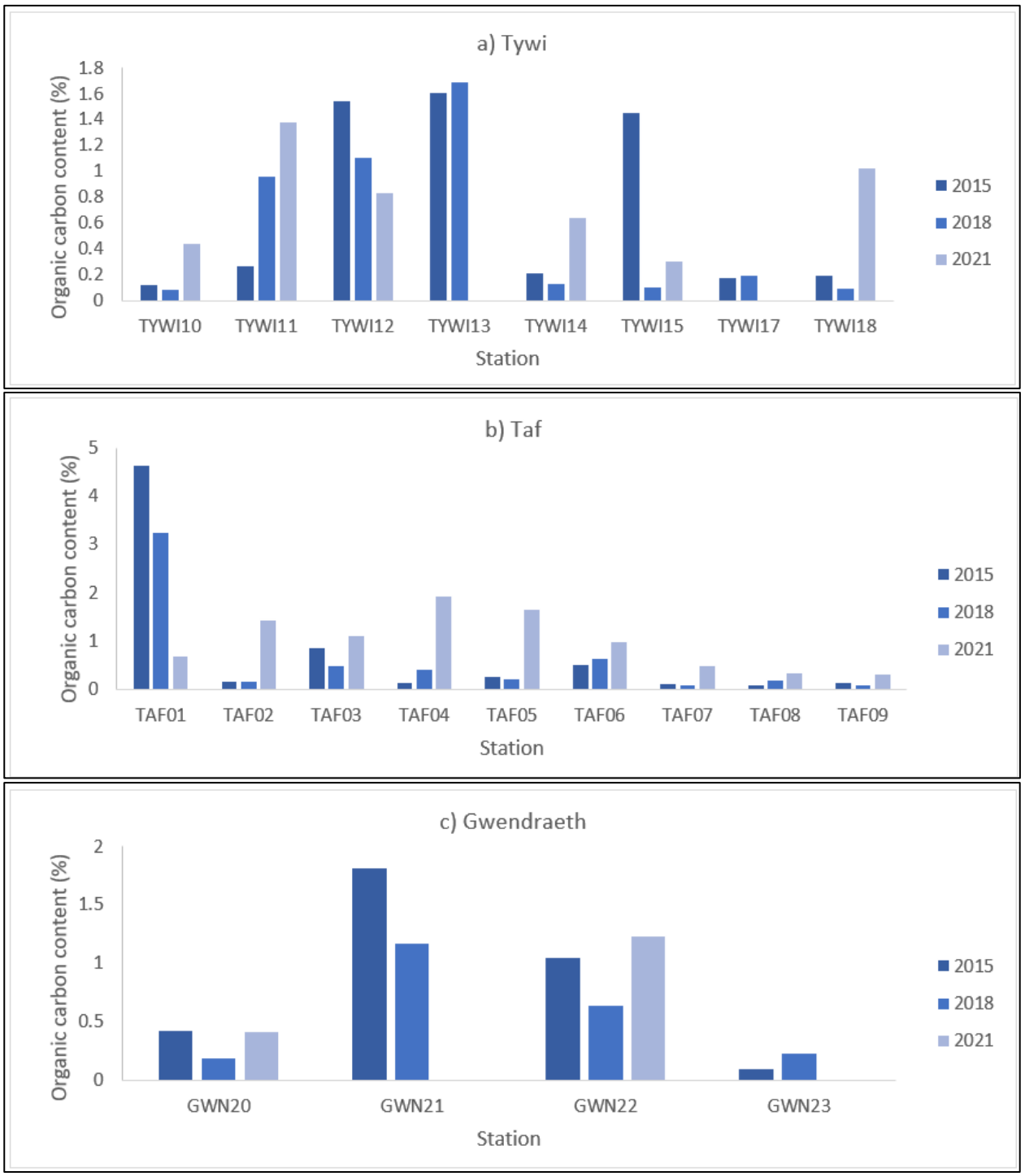
Within the Burry Inlet estuary, there are no available monitoring data on sediment contaminants. However, there may be some residual contamination present as a result of

the Llangennech freight train derailment and diesel spill that occurred higher up in the estuary in 2020. There was a large spike in hydrocarbons from the spilled diesel at that location, and high levels at some locations further seaward. The biological impact of the spill at the top of the estuary was large, with significant reductions in biota. Due to limited subsequent monitoring in the affected areas, the extent of recovery is unknown, but the residual oil contamination within cockles were within statutory limits (NRW unpublished data).

For the Three Rivers estuary data, the concentrations of chemical contaminants were compared against various ecological quality guidelines. There are no defined ecological standards for chemical contaminants within marine sediments agreed within the UK. The concentrations of chemical contaminants were therefore compared against ecological quality guidelines available including Oslo and Paris Conventions (OSPAR) guidelines, Canadian Environment Quality Guidelines (CEQG) and Centre for Environment, Fisheries and Aquaculture Science (Cefas) action levels. Further information is available in the IMCA final report.

The contaminants were below the most stringent ecological guidelines in 2021 at all of the locations. There was a concern in 2018 as the concentration of some polycyclic aromatic hydrocarbons (PAHs) were above the most stringent guidelines (OSPAR effects range low) at two of the Taf stations. However, these have since declined to levels below the less stringent guidelines in 2021. The concentrations of chromium, copper and zinc increased between 2018 and 2021, with some stations having concentrations above the less stringent guidelines (CEQG threshold effect level) in 2021. This is most notable in chromium and could be a threat to the feature if it continues to increase. Some of the concentrations of PAHs were above the less stringent guidelines (CEQG threshold effect level) in 2021. The sediment quality (contaminants) indicator was assessed as meeting the target as there were no contaminants with levels above the more stringent guidelines. The impact of the contaminants to the estuaries feature is not fully understood. In addition, there were only three years of data. These issues, and because there are some concentrations of contaminants above the less stringent guidelines reduced the confidence in the pass to low.

Figure 3. Average carbon content (±S.E.) from sediment grab samples in 2015, 2018 and 2021 in Carmarthen Bay and Estuaries SAC. Samples from the Rivers a) Tywi, b) Taf, and c) Gwendraeth in the Three Rivers estuary. There were no data in 2021 for some locations in the Tywi (13 and 17) and Gwendraeth (21 and 23).



Morphological equilibrium, topography and hydrodynamic and sediment transport processes

The morphological equilibrium, topography and hydrodynamic and sediment transport processes are not well researched. These targets passed with medium confidence based on the knowledge that there are currently no anthropogenic activities known to have had significant impact on the feature and its nested features since designation in 2004. The freshwater flow indicator could not be assessed due to limited resource.

Water quality

It has been estimated that 97% of the estuaries feature falls within four WFD waterbodies (Table 4, Figure 4). These are likely to be a good reflection of the overall effect of water quality on the feature. The Burry Inlet estuary comprises 68.4% of the estuaries feature by area, and the Three Rivers estuary comprises 31.6%

Figure 4. Map of the WFD waterbodies that overlap with the estuaries feature within Carmarthen Bay and Estuaries SAC.

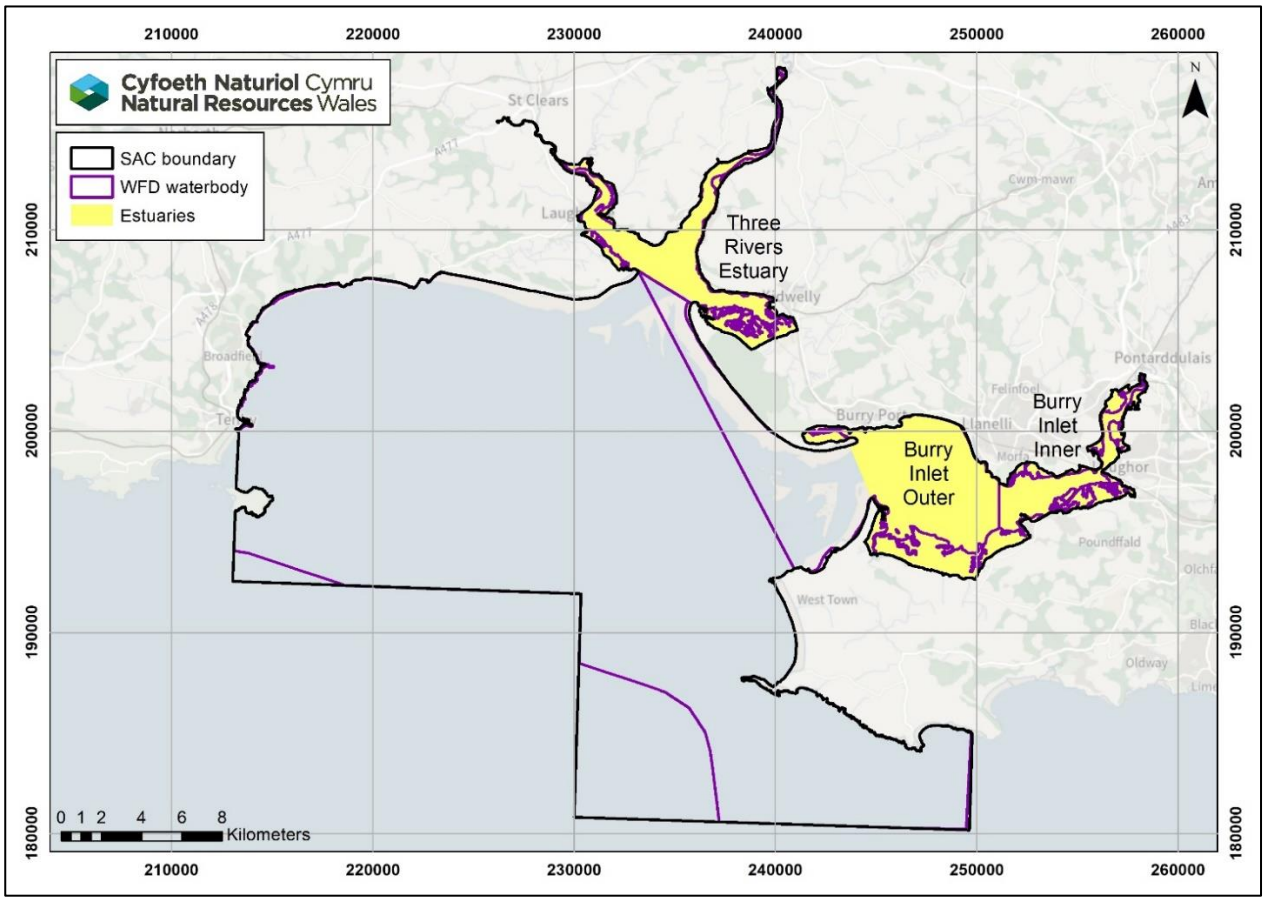


Table 4. Designated estuaries within the Carmarthen Bay and Estuaries SAC and the WFD waterbodies that overlap.

Estuary	WFD waterbody	Degree of overlap across indv. Estuary (%)	Degree of overlap across the estuaries feature (%)
Burry Inlet	Burry Inlet Outer	54.86	37.50
Burry Inlet	Burry Inlet Inner	16.84	11.50
Three Rivers	Three Rivers Estuary (Tywi & Taf & Gwendraeth)	70.13	22.20

Nutrients (Dissolved Inorganic Nitrogen - DIN only)

The Burry Inlet estuary comprises two WFD waterbodies: the Burry Inlet Outer waterbody and the Burry Inlet Inner waterbody (Table 4). The Burry Inlet Outer waterbody was previously Moderate status in the 2021 cycle 3 classification but has improved to Good status in the 2024 cycle 3 interim classification. The confidence of this improvement is quite certain (79%). The classification has fluctuated between Moderate and Good status over various cycles. The supporting biological element, phytoplankton, in the Burry Inlet Outer waterbody is still classified as Moderate status in the 2024 cycle 3 interim classification, despite the improved DIN classification. The WFD investigation report for this waterbody confirmed the DIN and phytoplankton failure in 2021 (Jones, 2021a). The second overlapping WFD waterbody, the Burry Inlet Inner waterbody was classified with a Moderate status for DIN in the 2024 cycle 3 interim classification. The DIN failure was confirmed by the 2021 WFD investigation report (Jones, 2021b). There is also a biological response to high nutrient levels in the Burry Inlet Inner waterbody, where phytoplankton was classified with a Moderate status.

The Three Rivers estuary comprises one WFD waterbody: the Three Rivers Estuary waterbody (Table 4). This waterbody was classified with a Moderate status for DIN in the 2024 cycle 3 interim classification. The DIN failure in this waterbody was confirmed by the 2021 WFD investigation report (Jopson and Newman, 2021).

The nutrients indicator (DIN only) failed to meet the target as high levels of DIN have been recorded within waterbodies in both estuaries in the SAC. The confidence in the fail was reduced to medium due to the improvement in DIN in the Burry Inlet Outer waterbody.

Phytoplankton

Both WFD waterbodies that overlap with the Burry Inlet estuary had failing classifications for the phytoplankton element in the 2024 cycle 3 interim classification. The Burry Inlet Outer waterbody was classified with a Moderate status, and the Burry Inlet Inner waterbody with a Poor status. Combined, these waterbodies overlap with 72% of the Burry Inlet estuary (49% of the whole estuaries feature) (Table 4). These waterbodies have had a Moderate or worse status in all cycles. The WFD investigation reports for these waterbodies confirmed the phytoplankton failures in 2021 (Jones, 2021a; 2021b).

Within the Three Rivers estuary, the one relevant WFD waterbody (Three Rivers Estuary) was Good status for phytoplankton in the 2024 cycle 3 interim classification. This is an improvement from Moderate status in the 2021 cycle 3 classification and cycles prior to

this. The previous failure was confirmed in the 2021 WFD investigation report (Jopson and Newman, 2021).

Overall, the phytoplankton indicator failed to meet the target due to the failing WFD waterbodies in the Burry Inlet estuary. The confidence in the fail was reduced to medium because there has been improvement in the Three Rivers Estuary waterbody, meaning the issues are localised to the Burry Inlet only.

Opportunistic macroalgae

None of the three WFD waterbodies that overlap with the feature in the SAC was classified for the opportunistic macroalgae element in the 2024 cycle 3 interim classification. Some WFD waterbodies are not assessed for opportunistic macroalgae as they do not have suitable substratum (i.e. areas of intertidal habitat for opportunistic macroalgal growth). The opportunistic macroalgae indicator was assessed as unknown as none of the waterbodies were classified for this element.

Dissolved oxygen

The dissolved oxygen indicator met its target as all three WFD waterbodies that overlap with the feature were classified with a High status for dissolved oxygen in the 2024 cycle 3 interim classification. The dissolved oxygen samples are taken at the water's surface. By the time oxygen depletion at the surface is recorded, oxygen throughout the water column could have been depleted for some time, especially as hypoxia or low oxygen levels, when present, typically occur in bottom water and sediments. Therefore surface sampling of dissolved oxygen may not detect issues for more demersal habitats within the estuaries feature. This reduced the confidence in the pass to medium.

Contaminants

The contaminants indicator met its target as all three WFD waterbodies have a pass for chemicals in the 2024 cycle 3 interim classification. However, some or all of the chemicals were not classified in the 2024 cycle 3 interim classification and were rolled forward from previous WFD cycles. This caused the confidence to be reduced to medium.

Turbidity and physicochemical properties

The turbidity indicator was assessed as unknown due to insufficient data. There were some data available from WFD Regulations sampling of suspended particulate matter. However, this is limited to only a few samples per year and therefore cannot be used to adequately assess the turbidity. The physicochemical indicator could not be assessed due to a lack of data.

Species and communities

All three overlapping WFD waterbodies were classified as Good or High status for the Infaunal Quality Index (IQI) element in the 2024 cycle 3 interim classification (Burry Inlet Outer, Burry Inlet Inner and Three Rivers Estuary). Combined, these waterbodies represent 71% of the feature.

The mudflats and sandflats feature overlap with 54% of the estuaries feature. The condition assessment for the mudflats and sandflats feature concluded that the abundance, distribution and species composition of communities meets the criteria for a pass. Infaunal analysis from core samples showed that communities associated with the surveyed mudflats and sandflats varied across the monitoring period, but with no clear pattern (Moore et al., 2021 and NRW unpublished data). Some concerns were raised, however, on the impact of mussel removal on infauna, the uncertainties around the moving river channel in Llansteffan, and large shifts observed in communities composition from the grab sample analysis in the Three Rivers estuary (Section 3.2). Some additional stations within the main river channel outside of the mudflats and sandflats feature but within the estuaries feature were analysed and indicated similar patterns. Overall, there are some concerns as the observed large shifts at these stations may not be natural.

Given the observed water quality issues within the Three Rivers estuary and the large shift seen in species composition at these stations, there are concerns that require further investigation. That said, the site is a naturally highly dynamic environment, and it is difficult to disentangle the natural from the anthropogenic causes of the changes to community composition. Consequently, at this stage, without further analysis and investigation on the grab survey and core survey data, it cannot be ruled out that the observed changes are natural.

The Atlantic salt meadows (ASM) feature overlaps with 31% of the estuaries feature. The condition assessment for the ASM feature shows that the species composition of the communities indicator was assessed as unknown due to limited data and available resources. However, evidence of overgrazing is widespread across the SAC and this is likely to have an impact on the species composition of the ASM feature (Section 3.3).

Although fish within the estuaries are an important part of the community, there are limited data and resources to conduct analysis on fish communities for the estuaries feature. Both allis and twaite shad feature have been assessed as being in unfavourable condition in Carmarthen Bay and Estuaries SAC (Sections 3.7 and 3.8). This was not deemed enough to fail the indicator for the estuaries feature because these species represent a small component of the estuarine fish community. In addition, shad indicator failures were related to the wider populations, not necessarily relevant for this feature. Both river and sea lamprey feature have been assessed as being in favourable condition in Carmarthen Bay and Estuaries SAC as they are widespread in the region (Sections 3.9 and 3.10). Data from wider Irish sea level studies such as International Council for the Exploration of the Sea (ICES) are difficult to relate to the assessment of condition at the SAC and feature level and some species that have been assessed by ICES may not even occur at the individual SAC level. However, populations of various larger-bodied bony fish species in the Irish Sea, such as bass, cod, herring, whiting, plaice and pollack, have declined in recent years (ICES, 2024a, 2024b, 2024c, 2024d, 2024e, 2024f). While there are limited data on the status of other species, the depletion of a number of larger, higher trophic level predatory species in the Irish Sea may have shifted the structure of the wider fish community to an overall lower trophic level with fewer larger predatory fish species. None of the WFD waterbodies that overlap with the estuaries feature in the SAC have been assessed using the fish tool in the 2024 cycle 3 interim classification.

Overall, the abundance, distribution and species composition of communities indicator has passed its target but with low confidence due to uncertainties around the mudflats and sandflats community changes; the overgrazing likely to impact the vegetation composition

of the ASM feature; and the concerns with the low abundance of shad species and the lack of fish communities data for the estuaries feature.

Invasive non-native species

G. vermiculophylla has rapidly established in the Burry Inlet (Loughor estuary) across the mudflats (Mercer and Brazier, 2023; Section 3.2). There have been confirmed records of the species since 2017, with the presence of a few scattered plants. In 2022, the extent and density of *G. vermiculophylla* was much greater. The rapid establishment of *G. vermiculophylla* has resulted in a fail for both the primary and tertiary targets for the invasive non-native species (INNS) and non-native species (NNS) indicators, but with varying confidence. Currently, the extent is thought to be limited to the Loughor estuary and is therefore affecting under 5% of the SAC, resulting in low confidence for the primary target of the INNS indicator. The confidence for the tertiary target of the NNS indicator is high due to the new NNS recorded in the estuaries feature within the last six years.

G. vermiculophylla species has the capacity to spread to other areas and there is a need to better understand the spread and impact of this species. This has been highlighted in the NRW marine evidence needs. The American slipper limpet *Crepidula fornicata* was found at Burry Port within the estuaries feature in 2008 but there has been no other record since.

Reasons for target failure

The assessment of the estuaries feature in the Carmarthen Bay and Estuaries SAC failed three primary targets, one secondary target, and one tertiary target. This resulted in the feature to be assessed as being in **unfavourable** condition. The failing indicators and reasons for failure, if known, are stated below.

Sediment quality: organic carbon content

This indicator target has a primary weighting. The carbon content has increased across the monitoring period at various monitoring locations in the Three Rivers estuary. This was especially notable in the river Taf. Increases in carbon are likely to be from an increase in the amount of organic material being deposited, which may be related to agricultural practices (e.g. slurry runoff).

Water quality: nutrients (DIN only)

This indicator target has a primary weighting. Two WFD waterbodies that overlap with the Burry Inlet and Three Rivers estuaries (Burry Inlet Inner and Three Rivers Estuary) had failing levels of DIN. The WFD investigation reports have confirmed elevated nutrients in these waterbodies, where it was concluded that major input of nutrients is likely to be derived from diffuse sources associated with farm infrastructure and probable losses from agricultural land for the Burry Inlet Inner waterbody (Jones 2021b; Jopson and Newman 2021). Point source continuous sewage discharge from the water industry were also confirmed as a source of nutrients linked to the DIN failures for both WFD waterbodies (Jones 2021b; Jopson and Newman 2021). Intermittent and domestic sewage are also suspected in the catchments. Further investigation locally is required to confirm these.

Invasive non-native species; non-native species

Both the primary INNS and tertiary NNS targets failed as there has been rapid establishment of *G. vermiculophylla* in the Loughor estuary within the last six years. This has led to the build-up of mud and is changing the mudflats and sandflats habitat within the estuary. The issue is currently limited to the Burry Inlet, but the species may spread to other areas in the future. Investigation into the management of spread of this species has not been done widely (Maggs and Magill, 2014). Targeted surveys of the species and investigation into its impact are required. A biosecurity plan for INNS has been developed for the SAC. The objective is to manage the key pathways by which marine INNS are introduced and spread at the SAC level through the use of good biosecurity.

Water quality: phytoplankton

This indicator target has a secondary weighting. The WFD waterbodies that overlap with the Burry Inlet estuaries feature were classified with a Moderate and Poor status for the phytoplankton element in the 2024 cycle 3 interim classification. The WFD investigation reports confirmed the phytoplankton failure in both of these waterbodies, where the sources of nutrients were associated with agriculture and rural land management and the water industry (as described in the nutrient reasons for failure) (Jones, 2021a; 2021b). The failure is only relevant to the Burry Inlet as the phytoplankton in the Three Rivers Estuary waterbody has improved.

Threats to condition

Part of the condition assessment is to identify threats to the condition of estuaries. A threat is defined as an activity that is currently not impacting condition but has the potential to do so over the next reporting cycle, if activity levels increase or are unmanaged. It is important to identify these threats to be able to put pre-emptive management in place to prevent declines in condition.

Activities that go through licencing and permission processes e.g. dredging whereby the impact of the activity on the feature would be assessed have not been included. The threats to the estuaries feature condition in the Carmarthen Bay and Estuaries SAC are stated below.

Unconsented infrastructure

New unconsented infrastructures such as private slipways and coastal defences, modify the coastal environment through changes to micro-topography and hydrodynamics and can lead to loss of the feature extent, and impact to the flora and fauna associated with it.

Invasive non-native species

The further establishment of *G. vermiculophylla* more widely in the Three Rivers estuaries is a real concern. This species has the potential to establish quickly in shallow soft-bottomed bays and estuaries as it has broad environmental tolerances (Maggs and Magill, 2014). *G. vermiculophylla* can alter the sedimentation and topography of estuaries and their associated nested habitat features and could alter the habitat in the long-term if it is in

high density (Maggs and Magill, 2014). The subsequent accumulation of mud and increasing anoxia can directly affect cockle density.

Further INNS were identified as potential threats to the UK and were listed in the latest horizon scanning exercise (Roy et al., 2019). There is a high likelihood for some of these species to be found in Wales in the future. This SAC could be at risk since there are a number of possible pathways of introduction. Further information on introduction pathways can be found on the GB non-native species secretariat website.

Fly ash

Fly ash (pulverised fuel ash) from the old power station at the west of Burry Port could pose a risk. The power station was immediately adjacent to the estuary and the fly ash was buried along with some asbestos. The shoreline where it is buried is now starting to erode. The impact of fly ash on the estuaries feature is not clear, but if released, fly ash could accumulate in the tissues of marine species, particularly invertebrates (Jenner and Bowmer, 1990 in Robbins, et al. 2023).

Sediment quality: contaminants

The concentration of some sampled PAHs and heavy metals were above the less stringent sediment quality guidelines in the most recent sampling years. The levels of chromium in particular have increased at various locations in the Three Rivers estuary. If the levels were to increase further to above the more stringent ecological guidelines this would cause the indicator to fail its target.

Water quality: contaminants

There is the potential for unregulated contaminants (such as per-and polyfluoroalkyl substances (PFAS)) to increase. This could affect some of the biota of the estuaries feature as PFAS has been shown to bioaccumulate in marine species, increasing up the trophic levels (Khan et al., 2023). However, the biological impact of PFAS on marine species is not well understood.

Some persistent chemicals are not measured in every WFD waterbody, and some of the relevant WFD waterbodies have not been classified for any chemicals.

Overgrazing

Overgrazing can result in a loss of structural diversity in saltmarsh vegetation, resulting in a short uniformly cropped marsh that may be detrimental to some taxa such as waders and invertebrates (Sherry and Douglas, in draft). As healthy vegetation helps reduce tidal and storm surge energy and can change currents within the estuary channels, any changes in vegetation can affect the flood risk, hydrodynamics and sediment transport within an estuary (Bennet et al., 2020; 2023). The impacts of grazing are more pronounced in smaller estuaries. Extensive grazing of some Welsh saltmarsh was found to have a large impact on wave attenuation with increases in wave height and current velocities resulting in erosion (Bennet et al., 2020; 2023).

Additionally, sheep grazing and the subsequent wash-off of faecal material from the intertidal saltmarsh may result in episodic events of high bacteria concentrations. A high

number of grazing sheep can result in poor water quality, even several kilometres from the grazed marsh (e.g. Burry Inlet).

Management of coastal defences

The State of the UK Climate 2023 Report highlights an observed acceleration in rates of climate induced sea-level rise which, along with storm surges can cause coastal erosion and flooding (Kendon et al, 2024). Shoreline Management Plans identify the preferred approach to coastal management in light of climate change, which includes maintaining or upgrading defences in some areas and adapting the approach to management in others. Where defences continue to be maintained, there are potential impacts on coastal processes and associated habitats and species. Intertidal habitats may also be lost as a result of coastal squeeze (Oaten et al, 2024).

Climate change

It is not yet clear what pressures we will see from climate change at the SAC level or how different pressures will counter act each other. However, threats from climate change may include (Kendon et al., 2023; Kendon et al., 2024; Gihwala et al., 2024; Oaten et al., 2024):

- Sea level rise.
- Changes to wave climate, especially storm frequency and intensity, which may change the topography.
- Changes to freshwater input and flow (i.e. from changes in rainfall).
- Changes in air and sea temperature.
- Changes in ocean acidification.
- Changes in species distribution.

Evidence gaps

There are gaps in the current evidence that NRW feel are needed to be filled to fully understand condition in this feature.

Listed below (Table 5) are current indicators that were either assessed as unknown, not assessed, or assessed with a lower confidence. This was due to either limited data availability, outdated data, or a lack of information. Some indicators are not currently monitored but should be ideally considered in future condition assessments. There are additional evidence gaps concerning the nested features, which can be found in the relevant sections of this report.

Table 5. Evidence gaps for the estuaries feature in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Assessed status	Comments
Freshwater inputs (P)	Not assessed	• The freshwater flow indicator could not be assessed in all SACs due to limited resource. There are data available on abstractions and flow levels in estuaries therefore this is something that should be used in future condition assessments.
Sediment quality: organic carbon content (P); contaminants (P)	Low confidence	• This indicator was assessed with a low confidence in the Carmarthen Bay and Estuaries SAC as there were some contaminants above the less stringent ecological guidelines. This will be something to pay attention to in the next condition assessments.
Abundance, distribution and species composition of communities (P)	Low confidence	• Fish communities were broadly discussed for all SACs using reports including ICES data. Although these reports provide an indication of fish numbers, they have certain limitations. The large area covered makes it unsuitable for estuaries or individual SAC. More data would be required to adequately assess fish communities in estuaries. • Further analysis on the life histories of species that are driving the observed changes in the infaunal community, the broad patterns of tolerant species change, and how these are related to natural versus anthropogenic pressures, would raise the confidence in the assessment and help to identify potential reasons for the failures.
Invasive non-native species (P)	Low confidence (limited data)	• The spread and impact of the NNS currently present on the estuaries feature at all of the SACs are not fully understood. More targeted surveys and investigation on the impact of NNS on estuaries are needed. • Investigation into the use of satellite and or aerial imagery for assessing the extent of *G. vermiculophylla* may be beneficial.

Indicator	Assessed status	Comments
Sediment quality: oxidation-reduction profile (redox layer) (S)	Low confidence (limited data)	• The redox layer of sediments was based on current monitoring, but the short time range and small spatial coverage available meant it was hard to confirm any trend. A larger spatio-temporal dataset is required to fully understand what is happening for all SACs.
Water quality: opportunistic macroalgae (S)	Unknown	• None of the WFD waterbodies that overlap with the estuaries feature in the SAC have been classified for the opportunistic macroalgae WFD element in the 2024 cycle 3 interim classification, leading to an unknown assessment. Some WFD waterbodies are not assessed for opportunistic macroalgae as they do not have suitable substratum.
Water quality: turbidity (S)	Unknown	• Turbidity is measured in WFD sampling. As this is limited to only a few samples per year it cannot be used to adequately assess the turbidity. • Investigation of the use of remote sensing data to assess turbidity could be carried out in the future. External data from other organisations could also be used.
Water quality: physicochemical properties (S)	Not assessed	• There were no temperature, salinity or pH loggers within the Carmarthen Bay and Estuaries SAC. • Remote sensing data on temperature, salinity and pH could be used in future.

3.2. Mudflats and sandflats condition assessment

The mudflats and sandflats feature in the Carmarthen Bay and Estuaries SAC is comprised of a number of mudflats and sandflats (Figure 5), but the Habitats Regulations monitoring has been focused on sampling points within mudflats in the River Loughor (including Burry Port West, Pwll, Machynys and Crofty), Three Rivers (including Black Scar, Llansteffan, Gwendraeth and Laugharne) and open coast locations (Ragwen Point, Wisemans Bridge, Waterwynch and Tenby). These mudflats and sandflats were surveyed between 2007 and 2022 using core sampling.

Figure 5. Map of the mudflats and sandflats feature in Carmarthen Bay and Estuaries SAC.

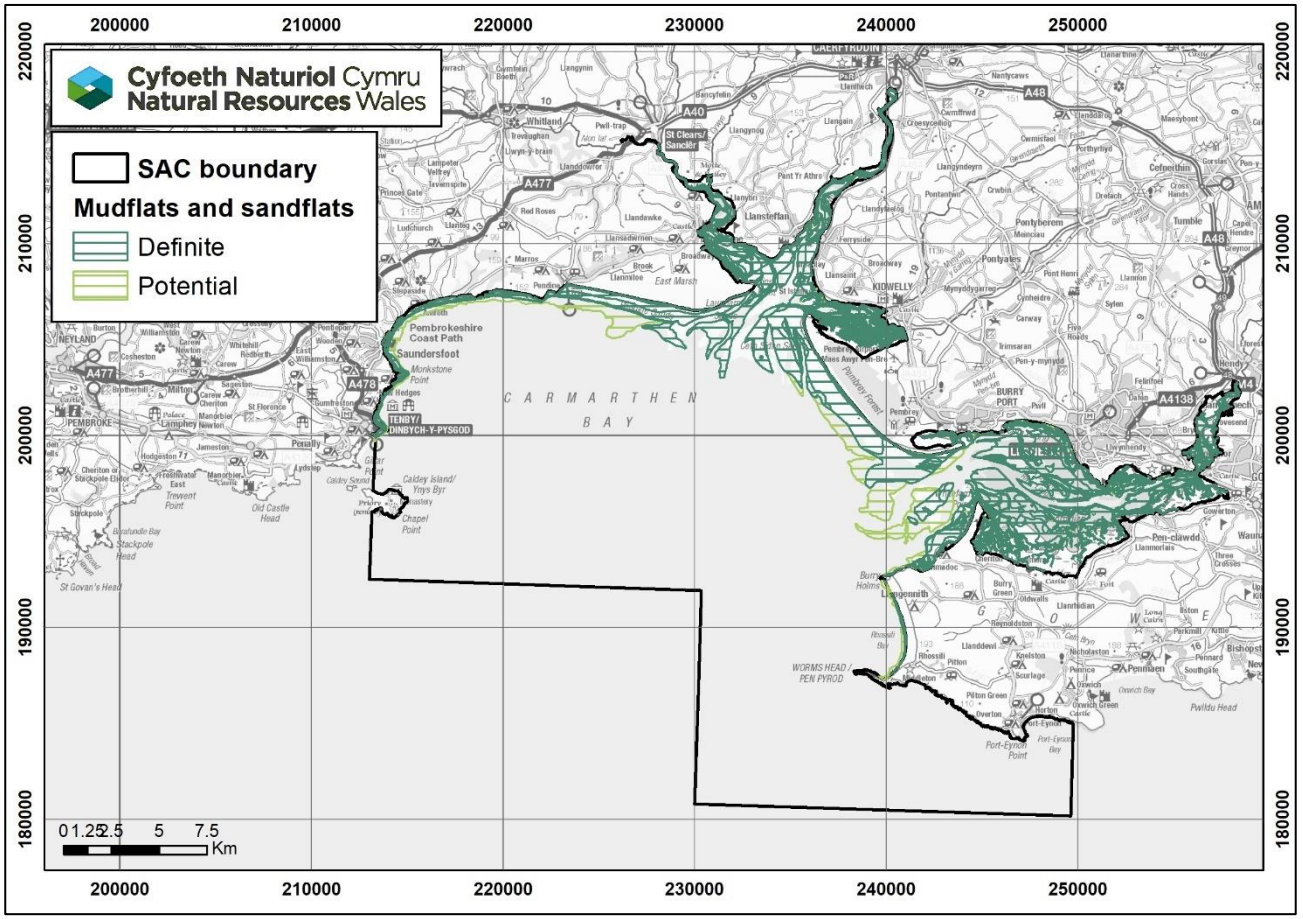


Table 6 has a summary of the assessment outcome. The assessment outcome and any reasons for failure are discussed in more detail in the sections below.

Table 6. Condition assessment of mudflats and sandflats in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Feature extent	No significant decrease in the extent of mudflats and sandflats within the SAC, allowing for natural change and variation. (P)	• There are currently no anthropogenic impacts known to be significantly affecting the extent of the mudflats and sandflats feature in the Carmarthen Bay and Estuaries SAC. • Confidence is medium as the assessment has not been based on comparison mapping of the feature and expert judgment was used.	**Pass**	Medium
Distribution and extent of habitats and communities	Maintain the distribution and extent of mudflats and sandflats habitats and communities, allowing for natural change and variation. (P)	• There are currently no anthropogenic impacts known to be significantly affecting the distribution and extent of habitats and communities of the mudflats and sandflats feature in the Carmarthen Bay and Estuaries SAC. • Confidence is medium as expert judgement has been used to assess this indicator in the absence of recent data.	**Pass**	Medium
Topography of the feature	No significant anthropogenic impacts to the small or large scale topography of the mudflats and sandflats. (S)	• There are currently no anthropogenic impacts known to be significantly affecting the topography of the mudflats and sandflats feature in the Carmarthen Bay and Estuaries SAC. • Confidence is medium as the assessment has been based on expert judgment.	**Pass**	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Hydrodynamic and sediment transport processes	Maintain hydrodynamic and sediment transport processes, including connectivity, allowing for natural variation and change. (P)	• There are currently no anthropogenic impacts known to be significantly affecting the hydrodynamic and sediment transport processes of the mudflats and sandflats feature in the Carmarthen Bay and Estuaries SAC. • Confidence is medium as the assessment has been based on expert judgment.	**Pass**	Medium
Sediment composition and distribution	Maintain composition and distribution of sediment granulometry across the mudflats and sandflats, allowing for natural change and variation. (P)	• Granulometric analysis of core samples in the mudflats and sandflats of the Burry Inlet and Three Rivers estuaries indicated little variation in sediment composition across the monitoring period. However, there was a sudden coarsening of sediments in 2019. • Granulometric analysis of grab samples in the Three Rivers estuary showed variation in sediment composition, but with no overall concerning trend. Some stations in the Gwendraeth and the Tywi had significant changes in silt content between years. This may be due to the dynamic nature of the estuary. • Confidence is medium due to the unexplained coarsening of sediments from core samples, and the large changes in silt content in the grab samples.	**Pass**	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Sediment quality: oxidation-reduction profile (redox layer)	No decrease in the depth of the redox layer from the surface that is considered detrimental to mudflats and sandflats infaunal communities, allowing for natural change and variation. (S)	• The redox layer indicated no clear trend over the years. • Confidence is low because additional sampling is needed to improve temporal resolution and data continuity, which are required to understand ongoing processes and confirm overall trends.	**Pass**	Low
Sediment quality: organic carbon content	No increase to the organic carbon content considered detrimental to mudflats and sandflats communities, allowing for natural change and variation. (P)	• Sediment sampling in the SAC has been assessed using sediment grab sample data at 21 stations in the Three Rivers estuary. • There has been an increase in carbon content in 2021 compared to earlier years in various stations, especially in the Taf. Two stations with the largest relative increases went from 0.13% and 0.25% in 2015 to 1.91% and 1.65% in 2021 respectively. • Confidence is medium as the sampling locations are within the Three Rivers estuary only, and as there are only three years of data.	**Fail**	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Sediment quality: contaminants	Sediment contaminants not to exceed the quality guidelines. (P)	• Sediment sampling in the SAC has been assessed using sediment grab sample data at 21 stations in the Three Rivers estuary (2015, 2018 and 2021). • The concentration of various heavy metals has increased between 2018 and 2021 (most notable in chromium). Some PAHs and heavy metal concentrations were above less stringent guidelines in 2021. • Contaminants were below the most stringent guidelines in 2021 in all locations. • The impact of the contaminants to the mudflats and sandflats feature is not fully understood. In addition, there were only three years of data, and the sampling locations are within the Three Rivers estuary only. This, and as there were some contaminants above the less stringent ecological guidelines reduced the confidence to low.	**Pass**	Low

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: nutrients (DIN only)	The WFD classification achieved for winter DIN should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (P)	• Two of the four WFD waterbodies that overlap with the mudflats and sandflats feature were classified as Good status for DIN in the 2024 cycle 3 interim classification (Burry Inlet Outer and Carmarthen Bay). Combined, these waterbodies overlap with 72% of the feature. ○ The Burry Inlet Outer waterbody was classified as Moderate status in the 2021 cycle 3 classification, and has fluctuated between Good and Moderate status in previous cycles. • The other two WFD waterbodies were classified with a Moderate status for DIN (Three Rivers Estuary and Burry Inlet Inner). Combined, these overlap with 24% of the feature. • Confidence is medium as a large proportion of the feature overlap with waterbodies that have passed for the DIN WFD element.	**Fail**	Medium
Water quality: phytoplankton	The WFD classification achieved for phytoplankton should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (S)	• Two of the four WFD waterbodies were classified with a Good status for phytoplankton in the 2024 cycle 3 interim classification (Carmarthen Bay and Three Rivers Estuary). These waterbodies have improved from Moderate status in the 2021 cycle 3 classification. Combined, they overlap with 38% of the feature. • The other two WFD waterbodies were classified with a Moderate and Poor status (Burry Inlet Outer and Burry Inlet Inner). Combined, these waterbodies overlap with 59% of the feature. • Confidence is medium because the ecological relationships between phytoplankton and the mudflats and sandflats are not fully understood.	**Fail**	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: opportunistic macroalgae	The WFD classification achieved for opportunistic macroalgae should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (S)	• None of the four WFD waterbodies that overlap with the feature have been classified for the opportunistic macroalgae WFD element in the 2024 cycle 3 interim classification.	**Unknown**	N/A
Water quality: dissolved oxygen	The WFD classification achieved for dissolved oxygen should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (S)	• All four WFD waterbodies that overlap with the feature were classified with a High status for dissolved oxygen in the 2024 cycle 3 interim classification (Burry Inlet Outer, Carmarthen Bay, Three Rivers Estuary and Burry Inlet Inner). • Confidence is medium due to samples being taken from the surface of the waterbodies.	**Pass**	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: contaminants	Water column contaminants not to exceed the EQS. (S)	• Three of the four WFD waterbodies have a pass for chemicals in the 2024 cycle 3 interim classification. In all waterbodies, some or all of the chemical classifications were rolled forward from previous cycles as they were not classified in the 2024 cycle 3 interim classification. • The other WFD waterbody has a fail for chemicals (Carmarthen Bay). It failed for mercury, polybrominated diphenyl ethers (PBDE) and cypermethrin and overlaps with 21% of the feature. • Confidence is medium as the human health standard has been used for PBDE, and due to the roll forward of some chemical classifications.	**Fail**	Medium
Water quality: turbidity	Maintain expected levels of turbidity, allowing for natural change and variation. (S)	• There are limited data on turbidity for Carmarthen Bay and Estuaries mudflats and sandflats, therefore this target was assessed as unknown.	**Unknown**	N/A

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Abundance, distribution and species composition of communities	Maintain the abundance, distribution, and diversity of species within communities and component habitats, allowing for natural change and variation. (P)	• All relevant WFD waterbodies were classified as Good or High status for the IQI WFD element in the 2024 cycle 3 interim classification. • Analysis of grab sampled macrobenthic infaunal communities within the Three Rivers estuary showed high variability in communities during the monitoring period and the causes remain uncertain. • Analysis of core sampled macrobenthic infaunal communities in the River Loughor, Three Rivers and Western part of the SAC were within the limits of natural variation. The infaunal community at Crofty tended to fluctuate and this observation could be due to the transient mussel bed. Some locations have only two stations making the assessment difficult. • Recent cockle stock assessment data indicated a slow recovery and possible longer life expectancy of *Cerastoderma edule*. • The distribution of *C. edule* is patchy but stable. There is some uncertainty on whether the current *C. edule* mortality is natural or not. • *Zostera noltei* cover tended to fluctuate within natural variability. • No clear patterns were observed in the abundance of *A. marina*, *C. edule* and *Corophium arenarium* derived from the limited information of the monitored core samples. • The mudflats and sandflats of the SAC are dynamic, which adds to the uncertainty regarding whether the observed changes in community composition are anthropogenic in origin. This has resulted in a low confidence.	**Pass**	Low

Indicator	Target	Assessment rationale	Target assessment	Target confidence

Species richness and diversity	Maintain the expected richness and diversity of mudflats and sandflats species, allowing for natural change and variation. (S)	• Some decline in species richness and or diversity was observed for the grab samples across the Three River estuary and the causes remain uncertain.
		• Overall species richness and diversity for the core samples in the monitored mudflats and sandflats in the Carmarthen Bay and Estuaries SAC were within the bounds of natural variation.
		  ○ A decrease of species richness was observed at Crofty, possibly linked with the mussel bed modifying the habitat.
		  ○ Fluctuation as the river channel in Llansteffan can make some stations muddier and could mask underlying impacts.
		  ○ Some locations had only two stations making the assessment difficult.
		• The mudflats and sandflats of the Carmarthen Bay and Estuaries SAC are dynamic, which adds to the uncertainty regarding whether the observed changes are anthropogenic in origin. This has resulted in a low confidence.
			Pass	Low

Taxonomic spread of species	Maintain the expected taxonomic spread of mudflats and sandflats species, allowing for natural change and variation. (S)	• Overall, the average taxonomic distinctness of the infaunal community of the monitored mudflats and sandflats in the Carmarthen Bay and Estuaries SAC remained stable and within the expected values over the monitoring period. • Confidence is high due to the availability of high quality monitoring data and lack of concerning patterns.	**Pass**	High

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Invasive non-native species (INNS)	Spread and impact of INNS caused by human activities is not adversely altering ecosystems. (P)	• The establishment of *Gracilaria vermiculophylla* has been notably rapid in the Loughor estuary (within mudflats and sandflats). • This NNS causes sedimentation change and alterations to the topography of mudflats and sandflats and is changing mudflat into muddy gravel or mussel beds. It is likely to affect the cockle and mussel fisheries in the area. • Confidence is low as the spread and impacts of the INNS present within the feature are not well understood.	**Fail**	Low
Non-native species (NNS)	No increase in the number of introduced NNS by human activities. (T)	• *G. vermiculophylla* has been recorded within the last six years in the Loughor estuary, where the establishment has been notably rapid compared to other areas. • Other NNS have been recorded previously including *C. fornicata* within the mudflats and sandflats feature. • Confidence is high due to the recent arrival of NNS within the last six years, and good availability of records.	**Fail**	High

Assessment conclusions

The mudflats and sandflats feature in Carmarthen Bay and Estuaries SAC has been assessed as being in **unfavourable** condition (medium confidence). There were a number of failing indicators (Table 7). Further investigation is needed to better understand all of the failures to be able to identify management options that can bring the feature back into favourable condition.

A summary of the assessment can be seen in Table 7 with more detail on each performance indicator, and any reasons for failure, provided in the sections below.

Table 7. Summary of the condition assessment for mudflats and sandflats in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

Feature	Overall Condition Assessment	Indicator failures	Reason for indicator failure	Threats to condition
Mudflats and sandflats	**Unfavourable (medium confidence)**	Sediment quality: organic carbon content (P) Water quality: nutrients (DIN only) (P) Invasive non-native species (P); non-native species (T) Water quality: phytoplankton (S) Water quality: contaminants (S)	• Carbon content in sediments has increased in various stations, especially in the river Taf. • High nutrient levels have been recorded in the Burry Inlet Inner, and Three Rivers Estuary waterbodies. • Phytoplankton failed in the two Burry Inlet waterbodies. • Levels of mercury, PBDE and cypermethrin in the Carmarthen Bay waterbody are is failing to meet their relevant EQSs. • There has been rapid establishment of *G. vermiculophylla* in the Loughor estuary, which has started to alter the habitat present in the mudflats and sandflats.	• Unconsented infrastructure • INNS • Fly ash • Sediment quality: contaminants • Water quality: contaminants • Management of coastal defences • Climate change

Detailed assessment information

Extent and distribution

The feature extent and the distribution and extent of habitats and communities indicators in the Carmarthen Bay and Estuaries SAC passed their target as there are currently no known anthropogenic impacts that would negatively affect the mudflats and sandflats feature. Comparison mapping has not been used to assess the extent and expert judgment was used to assess communities distribution in the absence of recent data. This has reduced the confidence to medium.

Sediment quality; topography; and hydrodynamic and sediment transport processes

Composition

Granulometric analysis within Carmarthen Bay and Estuaries SAC indicated little variation in sediment composition over the monitoring period. One station at Crofty showed an increase of silt in recent years, linked with the density of mussels, which are modifying the sediment. A sudden unexplained coarsening of sediment (250 – 500 µm increase) was observed in 2019 across all locations. Further investigation into the cause of this spike of coarse sediments is needed. While this was not deemed enough to fail, this reduced the confidence in the pass to medium. Annual dredging activities are occurring at Tenby Harbour since 2019 and while the impact is very localised and likely to be temporary, this will be something to pay close attention to when interpreting sediment data in future assessments.

Granulometric analysis from sediment grab samples in the Three Rivers estuary showed variation in sediment composition between monitoring years, but with no concerning trend overall. However, there were some stations in Gwendraeth with significant fluctuation in silt content (<63 µm) between monitoring years which are a concern. In addition, significant decrease in silt content were observed in a few stations in Tywi. These changes cannot be explained from the current analysis, and could be a result of moving channels or linked to the dynamic nature of the environment and require further investigation.

Overall, the sediment composition indicator met its target as there were not deemed large enough to fail. Confidence was reduced to medium due to the changes in silt at some Three Rivers stations, and due to the sudden and unexplained coarsening of sediments found in the core samples.

Redox layer

The redox layer indicated no clear trend over the years, resulting in a pass for this indicator. Analysis for the Pwll mudflats and sandflats indicated that the monitoring site was quite anoxic with a 1-5 cm black layer dominating across stations. Layers of green algal mats were observed in this area and could explain the lack of oxygen in the sediment layer. A long-term data series spanning from 2007 to 2022 is available, but for some monitoring sites, sampling has not been conducted consistently every year. Further

sampling is required to enhance the robustness and completeness of the dataset, especially important for assessing the redox layer. For this reason the confidence in the pass was reduced to low.

Carbon content

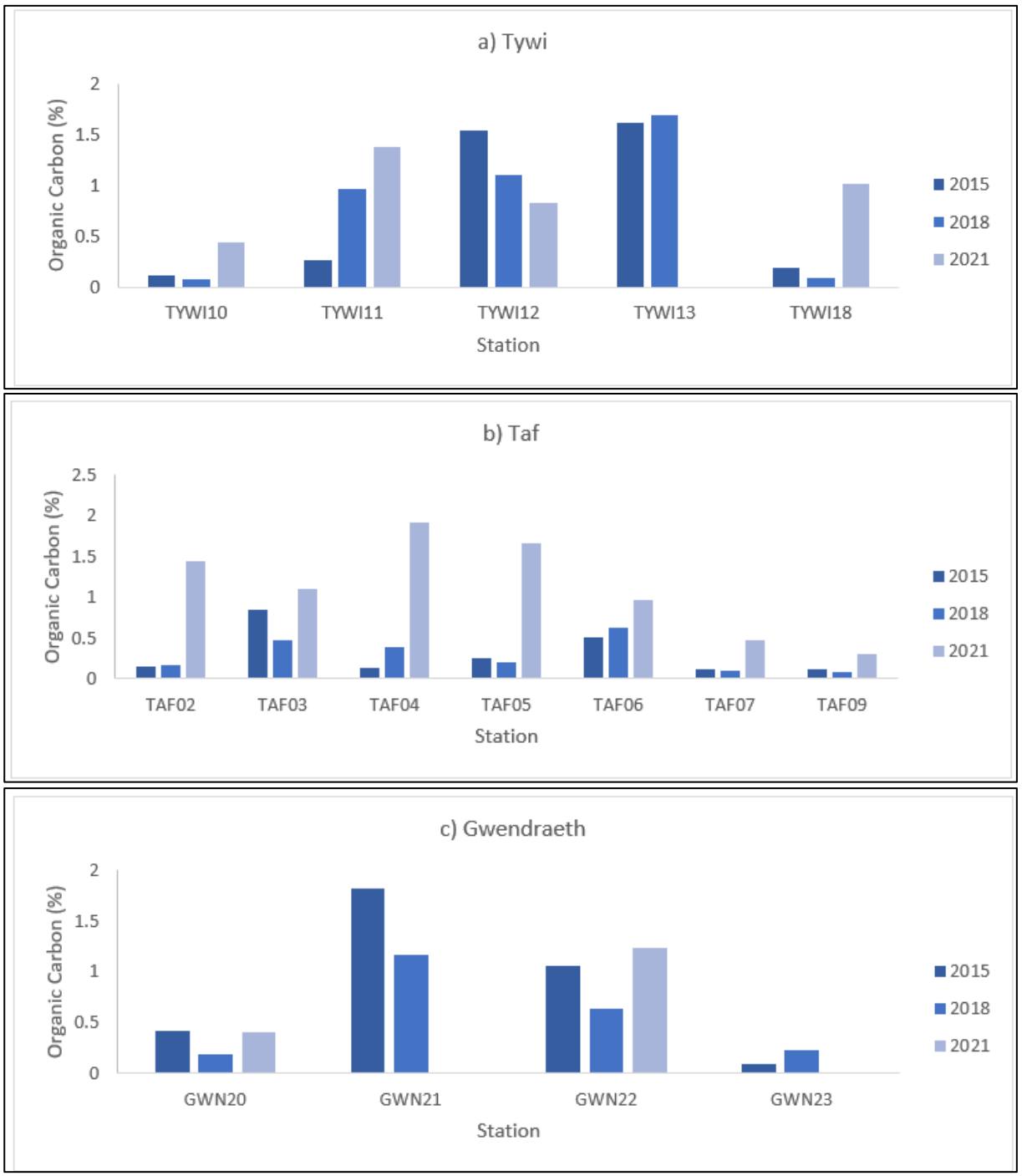
The assessment of the organic carbon and contaminants indicators used data from NRW Habitats Regulations monitoring sediment sampling at 16 sites in the Three Rivers estuary (Tywi, Taf and Gwendraeth) in 2015, 2018 and 2021.

Carbon content has increased over the monitoring period (Figure 6). This is especially notable in the Taf, where all stations that were within the mudflats and sandflats feature increased in carbon (Figure 6b).

The locations with the highest carbon content in 2021 were in the middle sections of the Taf, where it increased from 0.13% in 2015 to 1.91% in 2021 at one location, and 0.25% to 1.65% at another location (Figure 6b). The carbon levels are not as high as those in Pembrokeshire Marine SAC (maximum of 3.8% in Milford Haven Waterway), but compared to the levels in 2015 or 2018, the 2021 levels are concerning. The carbon content has not been compared against any defined ecological standard as it is highly variable by location, however increases in carbon can be an indicator of organic enrichment and reduced oxygen in the sediment. There was one station in the Tywi (station Tywi 12) where the carbon content has decreased over the three monitoring years (Figure 6a). This station is in the middle the river. It should be noted that one station in the Tywi and two in the Gwendraeth rivers only had carbon data in two years.

Such increases in carbon content are typically related to agricultural practices (e.g. slurry runoff). This may therefore provide support for evidence of nutrient issues within the Three Rivers estuary (see further detail in the water quality section). The organic carbon content indicator failed to meet its target due to the substantial increases in carbon in some locations in the Three Rivers estuary. Confidence was reduced to medium as there were only three years of data. There are no data available on carbon content in other parts of the feature.

Figure 6. Average carbon content (±S.E.) from sediment grab samples in 2015, 2018 and 2021 in Carmarthen Bay and Estuaries SAC. Samples at the Rivers a) Tywi, b) Taf, and c) Gwendraeth in the Three Rivers estuary. There were no data in 2021 for some locations in the Tywi (13 and 17) and Gwendraeth (21 and 23).



Sediment contaminants

The concentrations of chemical contaminants were compared against various ecological quality guidelines as outlined in Section 3.1. The contaminants were below the more stringent ecological guidelines in 2021 at all of the locations. There was a concern in 2018 as the concentration of some PAHs were above the most stringent guidelines (OSPAR effects range low) at two of the Taf stations. However, these have since declined to levels

below the less stringent guidelines in 2021. The concentrations of chromium, copper and zinc increased between 2018 and 2021, with some stations having concentrations above the less stringent guidelines (CEQG threshold effect level) in 2021. This is most notable in chromium and could be a threat to the feature if it continues to increase. Some of the concentrations of PAHs were above the less stringent guidelines (CEQG threshold effect level) in 2021. The sediment quality (contaminants) indicator was assessed as meeting the target as there were no contaminants with levels above the most stringent guidelines. The impact of the contaminants to the mudflats and sandflats feature is not fully understood. In addition, the sampling locations are within the Three Rivers estuary only and as there were only three years of data. These issues, and because there are some concentrations of contaminants above the less stringent guidelines reduced the confidence in the pass to low.

Within the Burry Inlet estuary, there are no available monitoring data on sediment contaminants. However, there may be some residual contamination present as a result of the Llangennech freight train derailment and diesel spill that occurred higher up in the estuary in 2020. There was a large spike in hydrocarbons from the spilled diesel at the location, and high levels at some locations further seaward. The biological impact of the spill at the top of the estuary was large, with significant reductions in biota. Due to limited subsequent monitoring in the affected areas, the extent of recovery is unknown, but the residual oil contamination within cockles were within statutory limits (NRW unpublished data).

Hydrodynamics and topography

The topography and hydrodynamic and sediment transport processes are not well researched for intertidal mudflats and sandflats. These targets passed with medium confidence based on the knowledge that there are currently no anthropogenic activities that are known to have a significant impact on the feature.

Water quality

It has been estimated that approximately 97% of the mudflats and sandflats feature within the SAC falls within four WFD waterbodies. These are therefore likely to be a good reflection of the overall effect of water quality on the feature. The Burry Inlet Outer waterbody overlaps with the largest proportion of the feature (51%).

Nutrients (DIN only), phytoplankton and opportunistic macroalgae

The nutrients indicator (DIN only) failed to meet its target as high levels of DIN have been recorded in two of the four WFD waterbodies that overlap with the mudflats and sandflats feature. Combined, these waterbodies (Three Rivers Estuary and Burry Inlet Inner) overlap with 24% of the feature. The Moderate status for DIN in these waterbodies were confirmed in the 2021 WFD investigation reports (Jones 2021b; Jopson and Newman, 2021). There is also a biological response to high nutrient levels in the Burry Inlet Inner waterbody, where phytoplankton was classified with a Moderate status. The other two WFD waterbodies were classified with a Good status for DIN in the 2024 cycle 3 interim classification. These are the Burry Inlet Outer and Carmarthen Bay waterbodies, which combined, overlap with 72% of the feature. The Burry Inlet Outer waterbody was classified as Moderate in the 2021 cycle 3 classification, but has improved to Good status in the

2024 cycle 3 interim classification. The confidence of this improvement is quite certain (79%). The classification of the Burry Inlet Outer waterbody has fluctuated between Moderate and Good status over various cycles. The supporting biological element, phytoplankton, in the Burry Inlet Outer waterbody is still classified as Moderate status in the 2024 cycle 3 interim classification, despite the improved DIN classification. The WFD investigation report for this waterbody confirmed the DIN and phytoplankton failure in 2021 (Jones, 2021a). Investigations have confirmed DIN failures and / or biological responses to elevated nutrients in phytoplankton in the relevant waterbodies, however due to the improvement in DIN in the Burry Inlet Outer waterbody, confidence in the fail was reduced to medium.

The phytoplankton indicator failed to meet its target. This element failed in two of the WFD waterbodies that overlap with the mudflats and sandflats feature. The Burry Inlet Outer and Burry Inlet Inner waterbodies were classified with a Moderate and Poor status respectively in the 2024 cycle 3 interim classification. These waterbodies have been Moderate or worse status for phytoplankton in all cycles, and overlap with a large proportion of the feature (59%). The other two WFD waterbodies, Carmarthen Bay and Three Rivers Estuary, were classified with a Good status in the 2024 cycle 3 interim classification, however they were both Moderate status in the 2021 cycle 3 classification. The 2021 WFD investigation reports for the Burry Inlet Outer, Burry Inlet Inner and the Three Rivers Estuary waterbodies confirmed the phytoplankton failures (Jones, 2021a; 2021b; Jopson and Newman, 2021). The failure in the Carmarthen Bay waterbody was uncertain in 2021 as the EQR was close to the Good status boundary (Lock, 2021). Medium confidence has been attributed to the failure of the target due to the improvement in two of the WFD waterbodies, and because the ecological relationships between phytoplankton and the mudflats and sandflats feature are not fully understood.

The indicator for opportunistic macroalgae was assessed as unknown. This was because none of the four WFD waterbodies were classified for the opportunistic macroalgae element in the 2024 cycle 3 interim classification, as no data has been collected for this element over the last six years. Some WFD waterbodies are not assessed for opportunistic macroalgae as they do not have suitable substratum (i.e. areas of intertidal habitat for opportunistic macroalgal growth).

Dissolved oxygen

The dissolved oxygen indicator met its target. By the time oxygen depletion at the surface is recorded, oxygen throughout the water column could have been depleted for some time, especially as hypoxia or low oxygen levels, when present, typically occur in bottom water and sediments. Therefore, surface sampling of dissolved oxygen may not detect issues for more demersal features. This reduced the confidence in the pass to medium.

Contaminants

The Carmarthen Bay waterbody has a fail for chemicals in the 2024 cycle 3 interim classification, where mercury, polybrominated diphenyl ethers (PBDE) and cypermethrin failed. This waterbody overlaps with 21% of the feature and therefore caused the contaminants indicator to fail. The environmental quality standards (EQS) for cypermethrin is very low, and in the previous lab methodology it was not possible to detect concentrations below the EQS. There has been a waterbody status change between the 2021 cycle 3 classification and 2024 cycle 3 interim classification due to this reason.

Cypermethrin is a synthetic pyrethroid insecticide and is highly toxic to some aquatic species (EA, 2019), but now has a restricted use in Wales. Mercury has failed in the waterbody since the 2015 cycle 2 classification. The EQS for mercury is based on the secondary poisoning protection goal (for wildlife). The PBDE failure was based on the value of the human health protection goal as it is the most stringent. This protection goal may be over precautionary as the effect of contaminants on the biota of mudflats and sandflats are not fully understood. The other three WFD waterbodies have a pass for chemicals in the 2024 cycle 3 interim classification. However, in all three waterbodies, some or all of the chemical classifications were rolled forward from previous cycles as they were not assessed in the 2024 cycle 3 interim classification. The confidence in the fail was reduced to medium due to this and because the human health standard has been used for PBDE. In addition, the impact of the failing contaminants on the feature are not fully understood.

Turbidity and physicochemical properties

The turbidity indicator was assessed as unknown due to insufficient data. There were some data available from WFD Regulations sampling of suspended particulate matter. However, this is limited to only a few samples per year and therefore cannot be used to adequately assess the turbidity. The physicochemical indicator could not be assessed due to a lack of data.

Species and communities

All four relevant WFD waterbodies were classified as Good or High status for the IQI element in the 2024 cycle 3 interim classification. Combined, these overlap with 97% of the feature.

Species composition

Infaunal analysis from core samples showed that communities associated with the surveyed mudflats and sandflats varied across the monitoring period, but with no clear pattern (Moore et al., 2021 and NRW unpublished data). Infaunal communities at Crofty tended to alternate between species with a mud-affinity such as oligochaetes, and species with a sand-affinity such as *Bathyporeia* spp., especially at the two stations furthest from shore. This variation in community composition could be linked with the blue mussel and its removal that occurred there occasionally. Mussels are known to be habitat modifiers by stabilising the substratum and modifying the sedimentary habitat. If the abundance of blue mussels is reduced, muddy substrate can revert back to more sandy substrate, thus impacting the infaunal communities, as seen in Crofty. The transient nature of mussel beds is in part due to its sporadic recruitment which means it is difficult to know if the change seen in the infaunal communities is natural or potentially due to anthropogenic removal. It is likely that both of these contribute to the fluctuations seen in the results. Although the variation in composition of communities for Crofty was judged to be part of natural cycle, this will be something to pay close attention to in the next assessment.

Infaunal communities at Llansteffan also indicated some variation in species composition. These variations are likely due to the impact of the river channel movement, increasing the occurrence of muddier substrate, and the subsequent change in the associated infaunal communities. This, however, creates some uncertainty as it could mask possible

underlying effect. There was a limited period of core sampling available for the other stations, making any inferences difficult.

Recent analysis of grab sampled infaunal communities in the Three Rivers estuary showed high variability in communities during the monitoring period of 2007-2021 (NRW unpublished data). Large changes in species composition were detected particularly for the stations in the River Taf. Communities sampled in the middle section of the River Taf, close to the town of Laugharne, were more dominated by species tolerant to pollution (AMBI group III - tolerant to organic enrichment and typically occur under conditions of moderate disturbance, Borja et al., 2000). In addition, some disturbance within the community composition and high levels of ammonia were observed in one of these middle stations, suggesting a possible point source input nearby. Similarly, large changes were observed in species composition in the Rivers Tywi and Gwendraeth, with large changes in species abundance. Abundance of opportunistic species (AMBI group V- species highly sensitive to organic enrichment and present only under severe disturbance, Borja et al., 2000) and overall species abundance appeared to decrease in recent years at Gwendraeth. The stations located in the mouth of the Three Rivers estuary are subject to a highly dynamic environment (e.g. wave exposure, moving sandbar, increase of sediment movement), and were therefore deemed not suitable to include in the assessment. Overall, there are some concerns as the observed large shifts at these stations may not be natural. Given the large shift seen in species composition at these stations and the observed water quality issues within the Three Rivers estuary, there are concerns that require further investigations. That said, the site is a naturally highly dynamic environment, and it is difficult to disentangle the natural from the anthropogenic causes of the changes to community composition. Consequently, at this stage, without further analysis and investigation on the grab survey and core survey data, it cannot be ruled out that the observed changes are natural.

Abundance of species

The limited information from the monitored core samples showed no clear pattern in the abundance of blow lugworm *Arenicola marina,* common cockle *Cerastoderma edule* and amphipod *Corophium arenarium*, but no cause for concern. Evidence from the WFD data of seagrass shows that *Zostera noltei* extent declined especially in 2017 in the Burry Inlet Outer waterbody, but increased again in the following years. The most recent WFD classifications in the 2021 cycle 3 and 2024 cycle 3 interim classifications were both Moderate status, however the fluctuations may be natural as some of the patches of *Z. noltei* that appear and disappear are known to be on or close to a moving sandbar. The more established patches of *Z. noltei* tended to remain more stable. The WFD seagrass classification in the Burry Inlet Inner waterbody has been High status since the 2018 cycle 2 interim classification. *Z. noltei* and *C. edule* distribution was patchy but likely due to sediment and topography. The stable populations of *C. edule* were observed all around and outside the Burry Inlet.

The cockle fishery collapsed in Burry Inlet in 2001-2002 with massive mortality of *C. edule* observed. The population grew up to the 1-year class, spawned and died afterward, never reaching larger classes. This decline in 1-year old *C. edule* was unusual and prevented multicohort population. Recent data analysis of the cockle fishery showed a slow recovery in abundance with fluctuations in the number of *C. edule* gathered. Data indicated that a higher proportion of *C. edule* have reached a larger size class (3+ years) compared to the previous decade, suggesting an improvement.

Overall, the abundance, distribution and species composition of communities indicator met its target. Confidence in the pass, however, was reduced to low due to the concern of the impact of mussel removal on infauna, the masking effect of the river channel in Llansteffan, the limited data for other locations, and the large shift in community composition observed from the grab sample analysis. Further analysis on the life histories of species that are driving the observed changes, the broad patterns of tolerant species change, and how these are related to natural versus anthropogenic pressures would raise the confidence in the assessment.

Species richness and diversity

There was a decline in species richness and diversity for the core sampled infauna at Crofty. However, this could be the result of sporadic mussel bed formation changing the habitat. In later years, the muddier stations changed to sand, similar to the rest of the stations and this could explain the loss of diversity. The impact of the river channel shifting in Llansteffan may also result in fluctuations in species richness and diversity. There were some concerning patterns of decline in species richness and or diversity and some spikes of abundance in few years across the grab monitoring period 2007-2021 for the middle stations of the River Taf. This could potentially be linked with intermittent organic input, but further analysis is required. Although a few stations appeared to have declined in 2021, no clear pattern was apparent but large changes in abundance were recorded for the River Tywi. The stations closer to the shore for Gwendraeth appeared to show declines in diversity in 2021 and large changes in abundance, as with the other rivers. As for abundance, distribution and species composition of communities indicator, it cannot be ruled out that the changes observed for the core and grab infauna diversity are natural, therefore the species richness and diversity indicator met its target with low confidence.

Taxonomic distinctness

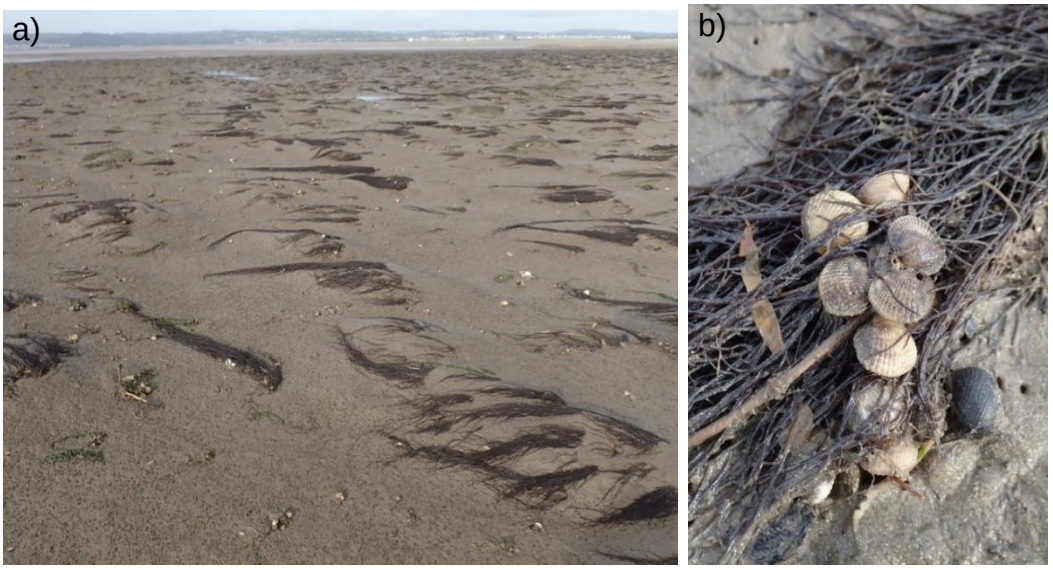
The average taxonomic distinctness indicator met its target as most of the stations were within the expected levels across the monitoring period indicating good mix of taxonomic diversity.

Invasive non-native species

Gracilaria vermiculophylla has rapidly established in the Loughor estuary across the mudflats (Mercer and Brazier, 2023). There have been confirmed records of the species since 2017, with the presence of a few scattered plants. In 2022, the extent and density of *G. vermiculophylla* was much greater (Figure 7). The high density of the species has caused the build-up of mud, and settlement of the blue mussel *Mytilus edulis* and *C. edule* spat onto the seaweed. This is transforming the habitat into a mussel bed (Mercer and Brazier, 2023). The build-up of mud in the habitat, the potential smothering effect on cockles, and the difficulty in raking and riddling cockles when mixed in with plant material has made the area unfishable for cockles. The rapid establishment of *G. vermiculophylla* within the last six years has resulted in a fail for both the primary and tertiary targets for the INNS and NNS indicator respectively. Currently, the extent is thought to be limited to the Loughor estuary and is therefore affecting under 5% of the SAC. However, the species has the capacity to spread to other areas. There is a need to better understand the spread and impact of this species. This has been highlighted in the NRW marine evidence needs. For this reason, the confidence in the fail for the primary target of the INNS indicator is low.

Other non-native species have been recorded previously (e.g. *Crepidula fornicata*) in the SAC, including some within the mudflats and sandflats feature.

Figure 7. Extensive coverage of the red seaweed worm wart weed *Gracilaria vermiculophylla* at Crofty, Loughor estuary, in 2022. a) *G. vermiculophylla* is established on the mudflats and sandflats, b) Example of cockles growing on *G. vermiculophylla*.



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Reasons for target failure

The assessment of the mudflats and sandflats feature in the Carmarthen Bay and Estuaries SAC found three indicators with a primary target, two indicators with a secondary target and one indicator with a tertiary target failed. This resulted in this feature to be assessed as being in **unfavourable** condition. The failing indicators and reasons for failure, if known, are stated below.

Sediment quality: organic carbon content

This indicator target has a primary weighting. The carbon content has increased across the monitoring period at various monitoring locations in the Three Rivers estuary. This was especially notable in the river Taf. Increases in carbon are likely to be from an increase in the amount of organic material being deposited, which may be related to agricultural practices (e.g. slurry runoff).

Water quality: nutrients (DIN only)

This indicator target has a primary weighting. High levels of DIN have been recorded in two of the WFD waterbodies that overlap with the mudflats and sandflats feature. The WFD investigation reports have confirmed elevated nutrients in these waterbodies, where it was concluded that major input of nutrients is likely to be derived from diffuse sources associated with farm infrastructure and probable losses from agricultural land for the Burry Inlet Inner waterbody (Jones 2021b; Jopson and Newman 2021). Point source continuous sewage discharge from the water industry were also confirmed as a source of nutrients linked to the DIN failures for both waterbodies (Jones 2021b; Jopson and Newman 2021).

Intermittent and domestic sewage are also suspected in the catchments. Further investigation locally is required to confirm these.

Invasive non-native species; non-native species

Both the primary INNS and tertiary NNS targets failed as there has been rapid establishment of *G. vermiculophylla* in the Loughor estuary within the last six years. This has led to the build-up of mud and is changing the mudflats and sandflats habitat. The issue is currently limited to the Loughor estuary, but the species may spread to other areas in the future. Investigation into the management of spread of *G. vermiculophylla* has not been done widely (Maggs and Magill, 2014). Targeted surveys of the species and investigation into its impact are required. A biosecurity plan for INNS has been developed for the SAC. The objective is to manage the key pathways by which marine INNS are introduced and spread at the SAC level through the use of good biosecurity.

Water quality: phytoplankton

This indicator target has a secondary weighting. Two of the WFD waterbodies that overlap with the feature were classified with a Moderate and Poor status for the phytoplankton element in the 2024 cycle 3 interim classification (Burry Inlet Outer and Burry Inlet Inner). The WFD investigation reports confirmed the phytoplankton failure in both of these waterbodies, where the sources of nutrients were associated with agriculture and rural land management and the water industry (as described in the nutrient reasons for failure) (Jones, 2021a; 2021b).

Water quality: contaminants

This indicator target has a secondary weighting. The mudflats and sandflats feature in the SAC is partly within a waterbody that failed for chemicals. The Carmarthen Bay waterbody failed due to mercury, PBDE and cypermethrin. Historically, the main source of PBDE is as flame retardants in a variety of materials (Viñas et al., 2022). Mercury has been used in many industries, but today the primary sources are burning of coal and artisan mining for mercury (Larsen and Hjermann, 2022). Cypermethrin is an insecticide used for plant protection in crops, in forestry, gardens, homes and businesses. It is also used in veterinary medicine to control pests in livestock and pets (EA, 2019). The application of cypermethrin has been restricted for some uses (sheep dipping and in forestry against the pine weevil).

Some of the contaminants in the water column may be derived from diffuse sources from atmospheric deposition and contaminated waterbody bed sediments, or point sources from continuous sewage discharge from wastewater treatment. However, a WFD investigation of the failure in the waterbody is yet to be undertaken. Mercury and PBDE are being managed in the UK and it is hoped that these levels will reduce in time.

Threats to condition

Part of the condition assessment is to identify threats to the condition of the mudflats and sandflats feature. A threat is defined as an activity that is currently not impacting condition but has the potential to do so over the next reporting cycle, if activity levels increase or are unmanaged. It is important to identify these threats to be able to put pre-emptive management in place to prevent declines in condition.

Activities that go through licencing and permission processes e.g. dredging whereby the impact of the activity on the feature would be assessed have not been included. The threats to the mudflats and sandflats feature condition in the Carmarthen Bay and Estuaries SAC are stated below.

Unconsented infrastructure

New unconsented infrastructures such as private slipways and coastal defences modify the coastal environment through changes to micro-topography and hydrodynamics and can lead to loss of the feature extent, and impact to the flora and fauna associated with it.

Invasive non-native species

The further establishment of *G. vermiculophylla* more widely in the Loughor (Three Rivers estuary) is a real concern. The subsequent accumulation of mud and increasing anoxia can directly affect cockle density (see further information in Section 3.1).

Further INNS were identified as potential threats to the UK and were listed in the latest horizon scanning exercise (Roy et al., 2019). There is a high likelihood for some of these species to be found in Wales in the future. This SAC could be at risk since there are a number of possible pathways of introduction. Further information on introduction pathways can be found on the GB non-native species secretariat website.

Fly ash

Fly ash (pulverised fuel ash) from the old power station at the west of Burry Port could pose a risk. The power station was immediately adjacent to the estuary and the fly ash was buried along with some asbestos. The shoreline where it is buried is now starting to erode. The impact of fly ash on the estuaries feature is not clear, but if released, fly ash could accumulate in the tissues of marine species, particularly invertebrates (Jenner and Bowmer, 1990 in Robbins, et al. 2023).

Sediment quality: contaminants

The concentration of some sampled PAHs and heavy metals were above the less stringent sediment quality guidelines in the most recent sampling years. The levels of chromium in particular have increased at various locations in the Three Rivers estuary. If the levels were to increase further to above the more stringent ecological guidelines this would cause the indicator to fail its target.

Water quality: contaminants

There is the potential for unregulated contaminants (such as PFAS) to increase. This could affect some of the biota of the mudflats and sandflats feature as PFAS has been shown to bioaccumulate in marine species, increasing up the trophic levels (Khan et al., 2023). However, the biological impact of PFAS on marine species is not well understood.

Some persistent chemicals are not measured in every WFD waterbody, and some of the relevant WFD waterbodies have not been classified for any chemicals.

Management of coastal defences

The State of the UK Climate 2023 Report highlights an observed acceleration in rates of climate induced sea-level rise which, along with storm surges can cause coastal erosion and flooding (Kendon et al., 2024). Shoreline Management Plans identify the preferred approach to coastal management in light of climate change, which includes maintaining or upgrading defences in some areas and adapting the approach to management in others. Where defences continue to be maintained, there are potential impacts on coastal processes and associated habitats and species. Intertidal habitats may also be lost as a result of coastal squeeze (Oaten et al., 2024).

Climate change

It is not yet clear what pressures we will see from climate change at the SAC level or how different pressures will counter act each other. However, threats from climate change may include (Gihwala et al., 2024; Oaten et al., 2024):

- Sea level rise.
- Changes to wave climate, especially storm frequency and intensity, which may change the topography.
- Changes in air and sea temperature.
- Changes in species distribution.

Evidence gaps

There are gaps in the current evidence that NRW feel are needed to be filled to fully understand condition in this feature.

Listed below (Table 8) are current indicators that were either assessed as unknown, not assessed, or assessed with a lower confidence. This was due to either limited data availability, outdated data, or a lack of information. Some indicators are not currently monitored but should be ideally considered in future condition assessments.

Table 8. Evidence gaps for the mudflats and sandflats feature in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Assessed status	Comments
Extent (P)	Medium confidence (proxy data used)	• Currently, the extent of mudflats and sandflat is not accurately measured at any of the SACs and there is no repeated measure taken.
Distribution and extent of habitats and communities (P)	Medium confidence (proxy data used)	• Without any recent biotope surveys undertaken, assessing changes in mudflats and sandflats in all SACs is difficult. A new survey is required.

Indicator	Assessed status	Comments
Topography of the feature (P); hydrodynamic and sediment transport processes (P)	Medium confidence (proxy data used)	• The topography and hydrodynamic regime of mudflats and sandflats is not currently monitored in all SACs. • The Wales Coastal Monitoring Centre monitor some sites and are working on a dashboard that will flag up locations with changes outside of natural variability. This could help in assessing in the next cycle of condition assessment.
Abundance, distribution and species composition of communities (P)	Low confidence (limited data)	• Further analysis on the infaunal species driving observed changes in the infaunal communities would raise the confidence in the assessment and help to identify potential reasons for the failures. • Available data on the distribution and population structure for some mudflats and sandflats associated species (e.g. cockles) were lacking or insufficient.
Invasive non-native species (P)	Low confidence (limited data)	• The spread and impact of the NNS currently present within the SAC on the mudflats and sandflats feature is not fully understood. More targeted surveys and investigation on the impact of NNS on mudflats and sandflats are needed. • Investigation into the use of satellite and or aerial imagery for assessing the extent of *G. vermiculophylla* may be beneficial.
Sediment quality: oxidation-reduction profile (redox layer) (S)	Low confidence (limited data)	• The redox layer of sediments was based on current monitoring, but the short time range and small spatial coverage available meant it was difficult to confirm any trend. A larger spatio-temporal dataset is required to fully understand what is happening.
Sediment quality: dissolved oxygen (S)	Not assessed	• Dissolved oxygen in sediments is not currently monitored in the mudflats and sandflats feature across Welsh SACs, but there is potential for this to be incorporated into granulometric analysis in future.

Indicator	Assessed status	Comments
Water quality: opportunistic macroalgae (S)	Unknown	• This indicator was assessed as unknown as all of the overlapping WFD waterbodies were not classified for the opportunistic macroalgae WFD element in the 2024 cycle 3 interim classification. Some WFD waterbodies are not assessed for opportunistic macroalgae as they do not have suitable substratum.
Water quality: turbidity (S)	Unknown	• Turbidity is measured in WFD sampling. As this is limited to only a few samples per year it cannot be used to adequately assess the turbidity. • Investigation of the use of remote sensing data to assess turbidity could be carried out in the future. External data from other organisations could also be used.
Water quality: physicochemical properties (S)	Not assessed	• There were no temperature, salinity or pH loggers within the Carmarthen Bay and Estuaries SAC. • Remote sensing data on temperature, salinity and pH could be used in future.

3.3. Atlantic salt meadows condition assessment

The Atlantic salt meadows (ASM) feature, also known as saltmarsh, in Carmarthen Bay and Estuaries SAC includes saltmarshes from the Burry Inlet, Loughor and the Three Rivers estuaries (Figure 8). The ASM feature has been assessed against the performance indicators and an overall condition was assigned for the feature.

Figure 8. Map of the ASM feature in Carmarthen Bay and Estuaries SAC.

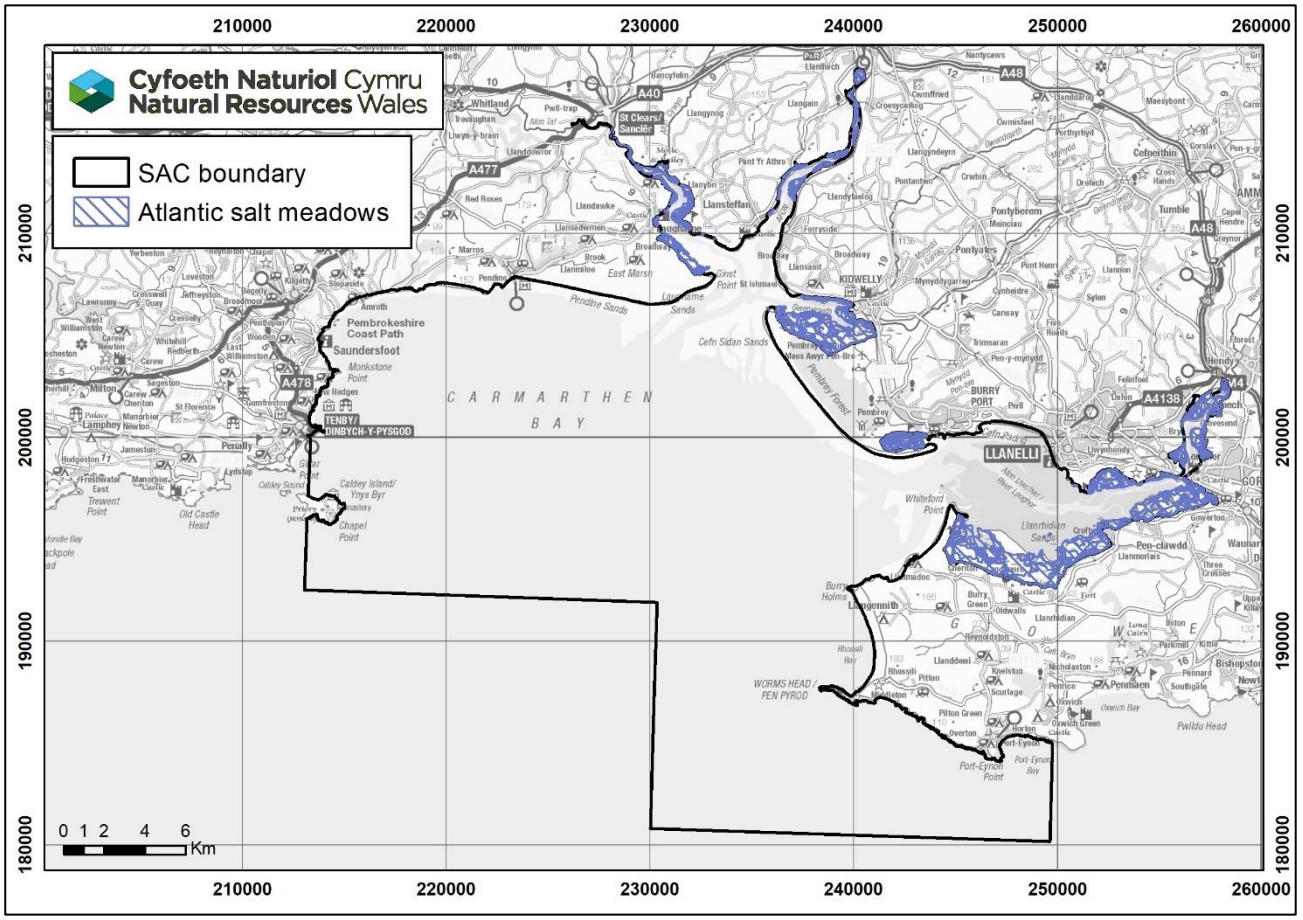


Table 9 has a summary of the assessment outcome against each performance indicator. The outcomes and any reasons for failure are discussed in more detail in the sections below.

Table 9. Condition assessment of the ASM feature in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Feature extent	The extent of the saltmarsh within the SAC should be stable or increasing, allowing for natural change and variation. (P)	• Between 2000 and 2020-2021, there has been a gain of 98.65 ha (3.5%) of saltmarsh extent. • The mapping is based on high quality imagery, however the changes in extent are indicative only, as there has been no ground truthing. Therefore the confidence associated with the pass is medium.	**Pass**	Medium
Distribution of feature	Maintain the distribution of saltmarsh throughout the SAC, allowing for natural change and variation. No significant loss from any of the defined sectors. Significant is defined as loss from any sector not to exceed 20%. (P)	• There has been no significant loss of saltmarsh extent in any of the defined sectors. • 5% loss in the Taf sector (Three Rivers). • The mapping is based on high quality imagery, however the changes in extent are indicative only, as there has been no ground truthing. This, and the possible coastal squeeze in the Taf sector has reduced the confidence in the pass to low.	**Pass**	Low
Distribution and extent of habitats and communities	Maintain the distribution and extent of saltmarsh habitats and communities, allowing for natural change. (P)	• The available NVC maps date from 1997-1998 and are too old to use for an assessment of distribution and extent.	**Unknown**	N/A

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Physical structure: creeks and pans	Maintain the expected patterns of creeks and pans throughout the SAC, allowing for natural change and variation (P). Artificial drainage channels adversely affecting hydrology are absent or rare. (P)	• Minor, localised creek damage has been historically recorded in some areas within the SAC. These small and localised impacts are not likely to lead to significant change in the structure and function of the creeks and pans across the feature. • Some of the damage to the creeks and pans includes creek in-filling with rubble for access for cockling or agricultural activities, creation of artificial drainage channels, and creek erosion from farming or grazing activity (trampling). The artificial drainage channels are not considered to be adversely affecting the hydrology within the saltmarsh. • Confidence is medium as these issues are small and localised within the large feature area in the SAC, but the full extent of these issues is unknown. In addition, the evidence is from an older survey (2012).	**Pass**	Medium
Hydrodynamic and sediment transport processes	Maintain hydrodynamic and sediment transport processes, including connectivity, allowing for natural variation and change. (T)	• There are currently no anthropogenic impacts known to be significantly affecting the hydrodynamic and sediment transport processes. • Confidence is medium as the assessment has been based on expert judgment.	**Pass**	Medium
Topography of the feature	No significant anthropogenic impacts to the small or large scale topography of the saltmarsh. (P)	• There are currently no anthropogenic impacts known to be significantly affecting the topography of the saltmarsh. • Confidence is medium as the assessment has been based on expert judgment.	**Pass**	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: contaminants	Water column contaminants not to exceed the EQS. (T)	• All three of the WFD waterbodies that overlap with the feature have a pass for chemicals in the 2024 cycle 3 interim classification (Burry Inlet Outer, Burry Inlet Inner and Three Rivers Estuary). In all WFD waterbodies, some or all of the chemical classifications were rolled forward from previous cycles as they were not classified in the 2024 cycle 3 interim classification. • Confidence is medium as the human health standard has been used for PBDE; some waterbodies have rolled forward classifications; and WFD water quality sampling is not focused on saltmarshes.	**Pass**	Medium
Water quality: nutrients (DIN only)	The WFD classification achieved for winter DIN should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (T)	• One of the three overlapping WFD waterbodies was classified as Good status for the DIN WFD element in the 2024 cycle 3 interim classification (Burry Inlet Outer). This waterbody overlaps with 8% of the feature. It was classified with a Moderate status in the 2021 cycle 3 classification, and has fluctuated between Good and Moderate status in previous cycles. • The other two WFD waterbodies were classified with a Moderate status for DIN (Burry Inlet Inner and Three Rivers Estuary). Combined, these overlap with 13% of the feature. • Confidence is medium as WFD water quality sampling is not focused on saltmarshes.	**Fail**	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: opportunistic macroalgae	The WFD classification achieved for opportunistic macroalgae should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (S)	• None of the three WFD waterbodies that overlap with the feature have been classified for the opportunistic macroalgae WFD element in the 2024 cycle 3 interim classification.	**Unknown**	N/A
Air quality	Nitrogen deposition should not exceed the critical load range of 10-20 kg N per ha^{-1} per year. (S)	• Nitrogen deposition within the SAC (where data were available) was under 17 kg N per ha per year for all saltmarshes and did not exceed the upper range of the critical load on average (UK air pollution information system (APIS)). • Confidence is medium as the pass is based on the upper range of the critical load of nitrogen deposition.	**Pass**	Medium
Abundance, distribution and species composition of communities	Maintain the abundance, distribution, structure and diversity of ASM plant communities within the sectors of the SAC, allowing for natural change and variation. (P)	• The analysis of WFD transect data showed that overall, ASM plant species richness was good for the Taf waterbody. • Species richness is only one element to assess the condition of saltmarsh communities across the feature. • No WFD sampling stations are available for the rest of the feature, therefore this indicator was assessed as unknown. • Heavy grazing in some areas within the ASM feature are likely to impact the species composition, however no information is available to confirm this.	**Unknown**	N/A

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Vegetation structure: sward height	Maintain the expected structural variation within the sward height, allowing for natural change and variation. The majority of plants should be able to produce flowers and set seed. (P)	• Heavy grazing occurs in various locations across the feature and particularly on the south side of the estuary. • Some areas are also under-grazed. • Confidence is high due to the extensive evidence of grazing issues within the feature.	**Fail**	High
Vegetation structure: zonation of vegetation	Maintain the expected range of saltmarsh zonation for the SAC, allowing for natural change and variation. (P)	• WFD data analysis indicated some changes in zonation, but it was judged to be from natural variation. • Confidence is medium as the changes in zonation were estimated by comparing 2011 and 2019 extents for two of the three relevant WFD waterbodies.	**Pass**	Medium
Invasive non-native species (INNS)	Spread and impact of INNS caused by human activities should not adversely affect the condition of the feature. (P)	• There is limited evidence of INNS presence within the ASM feature. • Confidence is medium as the spread and impacts of any INNS present within the SAC are not well understood, and there have been no targeted surveys of NNS within the ASM feature.	**Pass**	Medium
Non-native species (NNS)	No increase in the number of introduced NNS by human activities. (T)	• There are no known records of NNS within the ASM feature. • Confidence is medium as there have been no targeted surveys for NNS within the ASM feature.	**Pass**	Medium

Assessment conclusions

The Atlantic salt meadow (ASM) feature in Carmarthen Bay and Estuaries SAC has been assessed as being in **unfavourable** condition (low confidence). There were a couple of indicators with failing targets (Table 10). There were also limited or absent data for three key indicators to inform on the condition of the feature (see evidence gaps). This has reduced the confidence in the assessment conclusion. Further investigation is needed to better understand all of the failures to be able to identify management options that can bring the feature back into favourable condition.

A summary of the assessment can be seen in Table 10 with more detail on each performance indicator, and any reasons for failure, provided in the sections below.

Table 10. Summary of the condition assessment for the ASM feature in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

Feature	Overall Condition Assessment	Indicator failures	Reason for indicator failure	Threats to condition
Atlantic salt meadows	**Unfavourable (low confidence)**	Vegetation structure: sward height (P) Water quality: nutrients (DIN only) (T)	• There is heavy grazing by sheep in several locations across the feature. • High nutrient levels have been recorded in the Burry Inlet Inner and Three Rivers Estuary waterbodies.	• Unconsented infrastructure • Creek and pan infilling • Critical load for nitrogen deposition • Fly grazing • INNS • Coastal squeeze • Water quality: contaminants • Climate change

Detailed assessment information

Extent and distribution

Saltmarsh extent has been mapped using imagery from 2000 and 2020-2021. The total extent of saltmarsh was measured as 2914.41 ha in 2020-2021 compared to 2815.76 ha in 2000, indicating a total gain of 98.65 ha (3.5%). There has been no significant loss of more than 20% of saltmarsh extent in any of the defined sectors. The extent of the saltmarsh has increased in five of the six defined sectors. There has been a 5% loss of extent in the Taf sector (Three Rivers estuary). The loss at the lower marsh is caused by the river altering its course westward in the estuary causing erosion to the edge and showing possible signs of coastal squeeze effects. Both the feature extent and distribution of the feature indicators met their targets. The mapping is based on high quality imagery, however the changes in extent are indicative only, as there has been no ground truthing. This, and the possible coastal squeeze in the Taf location has reduced the confidence in the pass to low.

The distribution and extent of habitats and communities, a key indicator to inform on the condition of the feature, was assessed as unknown as the available NVC mapping date from 1997-1998 (Prosser and Wallace, 1998; 1999). These were deemed too old to be representative of the current situation. The lack of more up to date maps meant change could not be assessed.

Physical structure

Historically, localised impacts of creek damage have been recorded in various locations within the ASM feature in the Carmarthen Bay and Estuaries SAC. There have been recent reports (2023) of creek infilling with rubble for access for cockling at Crofty and Llandrhidian. There have also been historical reports of creek damage from a survey done in 2012. These include salt pan infilling and dumping of rock in creeks for cattle crossings in Penclawdd, dumping of rubble in creeks to create passes in Loughor, creation of livestock bridges in creeks and artificial drainage channels in Llangennech, extensive man-made drainage channels in Morfa Uchaf, and localised erosion of banks by horses in Bynea. The evidence of impacts are minor and localised, they are unlikely to be affecting the structure and function of the creeks and pans in the feature as a whole. In addition, the artificial drainage channels are not considered to be adversely affecting the hydrology within the saltmarsh. Therefore this indicator was assessed as passing the target. The confidence in the pass is reduced to medium because some of the evidence is from an old survey (2012), and because the full extent of the damage is unknown. Investigation into the cumulative scale and impact of reported management issues is needed to determine if the structure and function of the saltmarsh is being affected by these. It has therefore been highlighted as a threat.

Hydrodynamic processes and topography

The hydrodynamic and sediment transport processes, and the topography of the feature indicators were assessed as passing their targets as currently there are no known anthropogenic activities that would have significantly altered these aspects. This

assessment was based on expert judgement and knowledge of assessments of plans and projects in the SAC which has reduced the confidence in the assessment to medium, as it is difficult to be certain of impacts to the condition of the feature in the absence of data. In future, Lidar data could potentially be used to quantify changes in topography.

Water and air quality

It has been estimated that approximately 21% of the ASM feature within the SAC falls within four WFD waterbodies. The upper marsh areas are above the high-water mark and are therefore outside of the WFD waterbody boundary. However, marine water input to the upper marsh will be from these waterbodies therefore these waterbodies are likely to be a good reflection of the overall effect of water quality on the feature. However, as the WFD water quality sampling is not focused on saltmarshes, the confidence has been reduced in all of the relevant water quality assessments.

Contaminants

The contaminants indicator met its target as all three of the WFD waterbodies that overlap with the ASM feature have a pass for chemicals in the 2024 cycle 3 interim classification. However, in all three WFD waterbodies, some or all of the chemical classifications were rolled forward from previous cycles as they were not assessed in the 2024 cycle 3 interim classification. The confidence in the fail was reduced to medium due to this, and as WFD water quality sampling is not focused on saltmarshes. The impact of contaminants on the feature are not fully understood. The target weighting of the indicator is tertiary to reflect this.

Nutrients (DIN only) and opportunistic macroalgae

The nutrients indicator (DIN only) failed to meet the target as high levels of DIN have been recorded in two of the three WFD waterbodies that overlap with the ASM feature. These are the Burry Inlet Inner and Three Rivers Estuary waterbodies, which combined overlap with 13% of the feature. The Moderate status for DIN in these waterbodies was confirmed in the 2021 WFD investigation reports (Jones 2021b; Jopson and Newman, 2021). There is also a biological response to high nutrient levels in the Burry Inlet Inner waterbody, where phytoplankton was classified with a Moderate status.

The other overlapping WFD waterbody, Burry Inlet Outer, was classified with a Good status for DIN in the 2024 cycle 3 interim classification. This waterbody overlaps with 8% of the ASM feature. It was previously was classified as Moderate in the 2021 cycle 3 classification, but has improved to Good status in the 2024 cycle 3 interim classification. The confidence of this improvement is quite certain (79%). The classification for the Burry Inlet Outer waterbody has fluctuated between Moderate and Good status over various cycles. The supporting biological element, phytoplankton, in the Burry Inlet Outer waterbody is still classified as Moderate status in the 2024 cycle 3 interim classification, despite the improved DIN classification. The WFD investigation report for this waterbody confirmed the DIN and phytoplankton failure in 2021 (Jones, 2021a). Investigations have confirmed DIN failures and / or biological responses to elevated nutrients in phytoplankton in the relevant WFD waterbodies, however, due to the improvement in DIN in the Burry Inlet Outer waterbody, and as WFD water quality sampling is not focused on saltmarshes, confidence in the fail was reduced to medium. The nutrients indicator (DIN only) was given

a tertiary weighting as the effects of high nutrient levels on the ASM feature are not fully understood.

The indicator for opportunistic macroalgae was assessed as unknown. This was because none of the three WFD waterbodies were classified for the opportunistic macroalgae element in the 2024 cycle 3 interim classification, as no data has been collected for this element over the last six years. Some WFD waterbodies are not assessed or opportunistic macroalgae as they do not have suitable substratum (i.e. areas of intertidal habitat for opportunistic macroalgal growth).

Sheep grazing and the subsequent wash-off of faecal material from the intertidal saltmarsh on the Burry Inlet is believed to be responsible for episodic events of high bacteria concentrations. There was a pollution event in July and August in 2024 at Llangennith, in which there were spikes in *E. coli* (NRW). This was associated with high numbers of grazing sheep at the time.

Air quality

High levels of nitrogen (N) deposition from the atmosphere can have detrimental impact on saltmarsh since they are nitrogen limited. The nitrogen deposition within the SAC, where data were available, was under 17 kg N per ha per year for all saltmarshes and did not exceed the upper range of the critical load (20 kg N per ha per year, UK air pollution information system (APIS)). Confidence was reduced to medium as the critical load is based on a range. Nitrogen deposition values for some saltmarshes in the SAC were higher than the mid-range of the critical load. This is concerning and will be something to pay close attention to in the next assessment.

Species and communities

The analysis of transect data from WFD Regulations monitoring showed that overall, ASM plant species richness tended to be good for the Taf waterbody. This is a key indicator to inform on the condition of the feature. As more analysis is required to effectively assess the condition of saltmarsh communities across the feature, the abundance, distribution and species composition of communities indicator was assessed as unknown. Overgrazing is widespread within the feature (see vegetation structure). This is likely to have an impact on the species composition of the ASM feature, however no information is available to confirm it.

Vegetation structure

Sward height

While grazing by livestock play an important role in controlling rank vegetation and improving species diversity of the saltmarsh communities, too much of it can have deleterious effects on the saltmarsh communities. For instance, overgrazing can result in a loss of structural diversity in saltmarsh vegetation, resulting in a short uniformly cropped marsh that may be detrimental to some taxa such as waders and invertebrates (Sherry and Douglas, in draft). Overgrazing is widespread within the feature, especially with high sheep grazing pressure located in the south side of the Loughor / Burry estuary. Locations such as Whiteford Burrows, Llanrhidian, Penclawdd are all grazed and much of it being

grazed to a short sward of less than 5 cm in height. Heavy cattle grazing and localised poaching occur on the north of the Three Rivers estuary. There are also areas of the ASM feature that are largely ungrazed, that are now overgrown or have *Phragmites spp.* moving into the saltmarsh area. Most of the ungrazed areas were found on either the Tywi or Taf estuary. The sward height indicator therefore failed to meet its target with a high confidence due to the extensive evidence of grazing issues within the feature.

Zonation of vegetation

The analysis of WFD data showed that the zonation of vegetation was stable or increasing for the low-mid and upper zone, resulting in a pass for this indicator. The confidence in WFD data was reduced to medium as the changes in zonation were estimated by comparing 2011 and 2019 extents for two out of three WFD waterbodies. Further data and ground truthing investigations would be needed to increase the confidence.

Invasive non-native species

The saline conditions of saltmarshes prevent the common terrestrial non-native species (NNS) in Wales becoming established. There are no known records of NNS within the ASM feature, resulting in both the primary and tertiary targets for the INNS and NNS indicators to be met.

There were, however, some notable records of NNS within the SAC. *Gracilaria vermiculophylla* has been recorded in 2021 and 2022 in nearby mudflats and sandflats within the Burry Inlet, and has been found to form dense strands of up to 0.8 ha in the Loughor estuary during ad-hoc surveys. None were seen in the ASM feature. For this reason, *G. vermiculophylla* has been judged to not be having an impact on the condition of the ASM feature, but there is a risk of it being detrimental where present.

Both INNS and NNS targets passed with a medium confidence as there have been no targeted NNS surveys on saltmarshes, which would be required to fully understand the presence and impacts of any NNS species within the ASM feature.

Reasons for target failure

The assessment of the ASM feature in Carmarthen Bay and Estuaries SAC failed one primary target and one tertiary target. This resulted in the feature to be assessed as being in **unfavourable** condition. The failing indicators and reasons for failure, if known, are stated below.

Vegetation structure: sward height

This indicator target has a primary weighting. Heavy grazing occurs within the feature impacting on the structure and function of saltmarshes. This is due to high sheep numbers grazing in the marshes for example around Llanrhidian. These management issues have led to the loss of structural diversity in the saltmarsh vegetation with sward height as short as 1 cm in some places, particularly around Whiteford Burrows where there is no flowering except for *Armeria maritima,* and in some areas around Penclawdd. The heavy grazing in some areas is detrimental to the flowering plants, waders and many invertebrates, but

benefits wildfowl presenting a challenge for altering grazing patterns and stocking levels (Sherry and Douglas, in draft).

Water quality: nutrients (DIN only)

This indicator target has a tertiary weighting. High levels of DIN have been recorded in two of the WFD waterbodies that overlap with the ASM feature (Burry Inlet Inner and Three Rivers Estuary). The WFD investigation reports have confirmed elevated nutrients in these waterbodies, where it was concluded that major input of nutrients is likely to be derived from diffuse sources associated with farm infrastructure and probable losses from agricultural land for the Burry Inlet Inner waterbody (Jones 2021b; Jopson and Newman, 2021). Point source continuous sewage discharge from the water industry were also confirmed as a source of nutrients linked to the DIN failures for both WFD waterbodies (Jones 2021b; Jopson and Newman, 2021). Intermittent and domestic sewage are also suspected in the catchments. Further investigation locally is required to confirm these.

Sheep grazing and the subsequent wash-off of faecal material from the intertidal saltmarsh on the Burry Inlet is believed to be responsible for episodic events of high bacteria concentrations.

Threats to condition

Part of the condition assessment is to identify threats to the condition of the ASM feature. A threat is defined as an activity that is currently not impacting condition but has the potential to do so over the next reporting cycle, if activity levels increase or are unmanaged. It is important to identify these threats to be able to put pre-emptive management in place to prevent declines in condition. The threats to the condition of the ASM feature in Carmarthen Bay and Estuaries SAC are stated below.

Unconsented infrastructure

New unconsented infrastructure, such as private slipways and coastal defences, modify the coastal environment through changes to micro-topography and hydrodynamics and can lead to loss of the feature extent, and impacts to the flora and fauna associated with it.

Creek and pan infilling

Unconsented alterations to the creeks and pans in the saltmarsh have been reported in various locations within the SAC. Further investigation of these issues is needed, with work to determine if the structure and function of the saltmarsh is being affected and how extensive the impacts are.

Critical load for nitrogen deposition

The saltmarsh habitat is sensitive to nitrogen deposition from the atmosphere, so it is important that the current level of nitrogen deposition does not exceed the critical load of 10-20 kg N per ha per year. Although current critical load levels of nitrogen deposition were not exceeded for the ASM feature in the Carmarthen Bay and Estuaries SAC, the air quality indicator would fail if it was assessed against the lower range of the critical load (e.g. 10 kg N per ha per year).

Fly grazing

Horses that graze on land without the landowner's permission are frequently observed in the Carmarthen Bay and Estuaries SAC. If left unmanaged, horses can cause a lot of damaged to saltmarsh, as has been seen in Bynea.

Invasive non-native species

G. vermiculophylla has the capacity to turn saltmarsh pools anoxic, destroying the pool fauna and flora and can therefore have a detrimental impact on the feature (see further detail in Section 3.1).

Further INNS were identified as potential threats to the UK and were listed in the latest horizon scanning exercise (Roy et al., 2019). There is a high likelihood for some of these species to be found in Wales in the future. This SAC could be at risk since there are a number of possible pathways of introduction. Further information on introduction pathways can be found on the GB non-native species secretariat website.

Coastal squeeze

The presence of hard structures for coastal flood defence and erosion control within this SAC can prevent the natural landward migration of the saltmarsh, resulting in saltmarsh being squeezed between advancing sea levels and extant hard infrastructure.

Water quality: contaminants

There is the potential for unregulated contaminants (such as PFAS) to increase. This could affect some of the biota of the ASM feature as PFAS has been shown to bioaccumulate in marine species, increasing up the trophic levels (Khan et al., 2023). However, the biological impact of PFAS on marine species is not well understood.

Some persistent chemicals are not measured in every WFD waterbody, and some of the relevant WFD waterbodies have not been classified for any chemicals.

Climate change

It is not yet clear what pressures we will see from climate change at the SAC level or how different pressures will counter act each other. However, threats from climate change may include (Gihwala et al., 2024; Oaten et al., 2024):

- Sea level rise, leading to coastal squeeze and loss of extent.
- Changes in air temperature.
- Increases in wave exposure.
- Changes in species distribution.

Evidence gaps

There are gaps in the current evidence that NRW feel are needed to be filled to fully understand condition in this feature.

Listed below (Table 11) are current indicators that were either assessed as unknown, not assessed, or assessed with a lower confidence. This was due to either limited data availability, outdated data, or a lack of information. Some indicators are not currently monitored but should be ideally considered in future condition assessments.

Table 11. Evidence gaps for the ASM feature in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	**Assessed status**	**Comments**
Distribution and extent of habitats and communities (P)	Unknown	• There are no recent NVC surveys or monitoring aimed at assessing this target for ASM at any of the SACs. Additional fieldwork would be required to assess this indicator.
Topography of the feature (P)	Medium confidence (proxy data used)	• The topography of the ASM feature is not well monitored. Repeat Lidar surveys taken at mean low water springs for all saltmarshes within the SAC are required.
Abundance, distribution and species composition of communities (P)	Unknown	• Plant communities are not currently monitored. Therefore there is a lack of information on the abundance and distribution of plant communities of the ASM feature. • WFD Regulations data could potentially be used further in future assessments, however, additional analysis will be required.
Attributes of local distinctiveness (P)	Not assessed	• There is a lack of information on the named distinctive elements of the ASM feature**.** Additional fieldwork would be required to assess this indicator in all SACs.
Water quality: opportunistic macroalgae (S)	Unknown	• All of the overlapping WFD waterbodies were not classified for the opportunistic macroalgae WFD element in the 2024 cycle 3 interim classification. Some WFD waterbodies are not assessed for opportunistic macroalgae as they do not have suitable substratum.
Sediment quality: contaminants (T)	Not assessed	• Currently, there is no sediment monitoring within the ASM feature in all SACs.
Hydrodynamic and sediment transport processes (T)	Medium confidence (proxy data used)	• The hydrodynamic regime of the ASM feature is not currently monitored in all SACs.

3.4. *Salicornia* condition assessment

The *Salicornia* feature in Carmarthen Bay and Estuaries SAC includes *Salicornia* from the Burry Inlet, Loughor and the Three Rivers estuaries (Figure 9). The *Salicornia* feature has been assessed against the performance indicators and an overall condition was assigned for the feature.

Figure 9. Map of the *Salicornia* feature in Carmarthen Bay and Estuaries SAC.

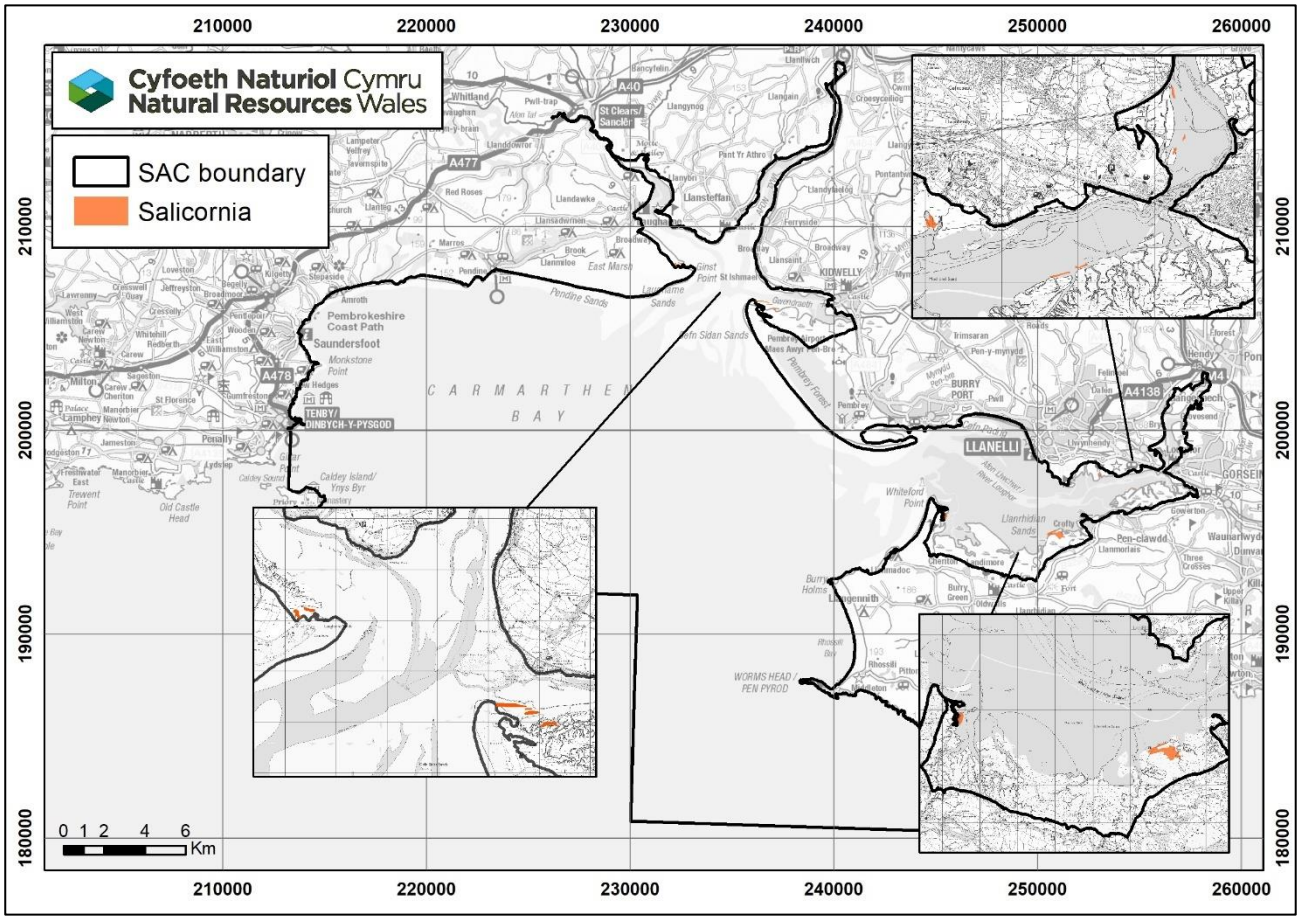


Table 12 has a summary of the assessment outcome against each performance indicator. The outcomes and any reasons for failure are discussed in more detail in the sections below.

Table 12. Condition assessment of the *Salicornia* feature in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Feature extent	The extent of *Salicornia* within the SAC should be stable or increasing, allowing for natural change and variation. (P)	• The baseline extent of *Salicornia* in Carmarthen Bay and Estuaries SAC has been measured as 34.14 ha (2003). • There is no current extent estimate as no up to date mapping of *Salicornia* exists. • There is no evidence to indicate a genuine change in extent of *Salicornia* and the extent of the adjacent ASM feature was maintained. • As there are limited recent data, this indicator was assessed as unknown.	**Unknown**	N/A
Distribution of feature	Maintain the distribution of *Salicornia* throughout the SAC, allowing for natural change and variation. (P)	• *Salicornia* is likely still present on all of the defined sectors of the feature, but due to its pioneer nature the distribution is variable. • Ther is no evidence to indicate a genuine change in range of *Salicornia.* • As there are limited recent data, this indicator was assessed as unknown.	**Unknown**	N/A

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Physical structure: creeks and pans	Maintain the expected patterns of creeks and pans throughout the SAC, allowing for natural change and variation. (P) Artificial drainage channels adversely affecting hydrology are absent or rare. (P)	• Minor localised creek damage has been historically recorded in some areas within the SAC. These small and localised impacts are not likely to be changing the structure and function of the creeks and pans across the whole feature. • Some of the damage to the creeks and pans includes creek in-filling with rubble for access for cockling or farming, creation of artificial drainage channels, and creek erosion from farming or grazing activity (trampling). The artificial drainage channels are not considered to be adversely affecting the hydrology within the saltmarsh. • Confidence is medium as these issues are small and localised within the large feature area in the SAC, but the full extent of these issues is unknown. In addition, the evidence is from an older survey (2012).	**Pass**	Medium
Hydrodynamic and sediment transport processes	Maintain hydrodynamic and sediment transport processes, including connectivity: allowing for natural variation and change. (T)	• There are currently no anthropogenic impacts known to be significantly affecting the hydrodynamic and sediment transport processes. • Confidence is medium as the assessment has been based on expert judgment.	**Pass**	Medium
Topography of the feature	No significant anthropogenic impacts to the small or large scale topography of *Salicornia*. (P)	• There are currently no anthropogenic impacts known to be significantly affecting the topography of the *Salicornia* feature. • Confidence is medium as the assessment has been based on expert judgment.	**Pass**	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: contaminants	Water column contaminants not to exceed the EQS. (T)	• All three of the WFD waterbodies that overlap with the feature have a pass for chemicals in the 2024 cycle 3 interim classification (Burry Inlet Outer, Burry Inlet Inner and Three Rivers Estuary). In all WFD waterbodies, some or all of the chemical classifications were rolled forward from previous cycles as they were not classified in the 2024 cycle 3 interim classification. • Confidence is medium as the human health standard has been used for PBDE, due to the roll forward of some chemical classifications, and as WFD water quality sampling is not focused on *Salicornia* areas.	**Pass**	Medium
Water quality: nutrients (DIN only)	The WFD classification achieved for winter DIN should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (T)	• One of the three overlapping WFD waterbodies was classified with a Good status for DIN in the 2024 cycle 3 interim classification (Burry Inlet Outer). This waterbody overlaps with 19% of the feature. It was classified as Moderate status in the 2021 cycle 3 classification, and has fluctuated between Good and Moderate status in previous cycles. • The other two WFD waterbodies were classified with a Moderate status for DIN (Three Rivers Estuary and Burry Inlet Inner). Combined, these overlap with 27% of the feature. • Confidence is medium as WFD water quality sampling is not focused on areas within the *Salicornia* feature.	**Fail**	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: opportunistic macroalgae	The WFD classification achieved for opportunistic macroalgae should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (S)	• None of the three WFD waterbodies that overlap with the feature have been classified for the opportunistic macroalgae WFD element in the 2024 cycle 3 interim classification.	**Unknown**	N/A
Air quality	Nitrogen deposition should not exceed the critical load range of 20-30 kg N per ha^{-1} per year. (S)	• Nitrogen deposition within the SAC (where data were available) was under 17 kg N per ha per year for all saltmarshes and did not exceed the critical load on average (APIS). • Confidence is high as the recorded nitrogen deposition is below the lower range of the critical load.	**Pass**	High
Vegetation structure: sward height	Maintain the expected structural variation within the sward height: allowing for natural change and variation. (P)	• While there is evidence of overgrazing within the saltmarsh in the SAC, overgrazing is less likely to occur in *Salicornia* as sheep appear to find *Salicornia* unpalatable. • Confidence is medium as it is based solely on expert judgement.	**Pass**	Medium
Vegetation structure: Zonation of vegetation	Maintain the expected range of saltmarsh zonation for the SAC, allowing for natural change and variation. (P)	• The *Salicornia* mapping is out of date and of poor quality and *Salicornia* is difficult to assess using aerial photography. This indicator was therefore assessed as unknown.	**Unknown**	N/A

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Invasive non-native species (INNS)	Spread and impact of INNS caused by human activities should not adversely affect the condition of the feature. (P)	• There is limited evidence of INNS presence within the *Salicornia* feature. • Confidence is medium as the spread and impacts of any INNS present within the SAC are not well understood, and there have been no targeted surveys of NNS within the *Salicornia* feature.	**Pass**	Medium
Non-native species (NNS)	No increase in the number of introduced NNS by human activities. (T)	• There are no known records of NNS within the ASM feature. • Confidence is medium as there are no targeted surveys for NNS in the *Salicornia* feature.	**Pass**	Medium

Assessment conclusions

The *Salicornia* feature in Carmarthen Bay and Estuaries SAC has been assessed as being in **favourable** condition (low confidence). Overall, the absence of any significant anthropogenic impact on the feature and the presence of *Salicornia* even in heavily grazed areas have contributed to this favourable assessment outcome. There was only one indicator with a failing target (Table 13). There were also limited or absent data for key primary indicators to inform on the condition of the feature (see evidence gaps). This has reduced the confidence in the assessment conclusion. Further investigation is needed to better understand all of the indicator failures to be able to identify management options.

A summary of the assessment can be seen in (Table 13) with more detail on each performance indicator, and any reasons for failure, provided in the sections below.

Table 13. Summary of the condition assessment for the *Salicornia* feature in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

Feature	Overall Condition Assessment	Indicator failures	Reason for indicator failure	Threats to condition
Salicornia	**Favourable (low confidence)**	Water quality: nutrients (DIN only) (T)	• High nutrient levels have been recorded in the Burry Inlet Inner and Three Rivers Estuary waterbodies.	• INNS • Coastal squeeze • Water quality: contaminants • Climate change

Detailed assessment information

Extent and distribution

The baseline extent of *Salicornia* in Carmarthen Bay and Estuaries SAC has been measured as 34.14 ha (2003). The current extent of *Salicornia* cannot be calculated as there is no up to date mapping. The extent and distribution of the feature indicators have therefore been assessed as unknown due to a lack of evidence. *Salicornia* is likely still present in all of the defined sectors of the feature, but due to its pioneer nature the distribution is variable. There is no evidence to indicate a genuine change in distribution or range of *Salicornia* in Wales since 2013, nor is one considered likely to have occurred. However, the lack of data resulted in the distribution and extent of habitats indicator not being assessed. These are key indicators to inform on the condition of the feature and the lack of data has influenced the overall confidence in the assessment.

Physical structure

The assessment of this indicator for the *Salicornia* feature has been based on the outcomes of the ASM feature assessment by proxy. Localised impacts of creek damage have been recorded in various locations within the saltmarsh in the SAC. The evidence of impacts are minor and localised, they are unlikely to be affecting the structure and function of the creeks and pans in the feature as a whole. In addition, the artificial drainage channels are not considered to be adversely affecting the hydrology within the saltmarsh. Therefore this indicator was assessed as passing the target with medium confidence. See assessment conclusions in Section 3.3 for further information.

Hydrodynamic processes and topography

The hydrodynamic and sediment transport processes, and the topography of the feature indicators were assessed as passing their targets as currently there are no known anthropogenic activities that would have significantly altered these aspects. This assessment was based on expert judgement and knowledge of assessments of plans and projects in the SAC which has reduced the confidence in the assessment to medium, as it is difficult to be certain of impacts in the absence of data. In future, Lidar data could potentially be used to quantify changes in topography.

Water and air quality

It has been estimated that approximately 46% of the *Salicornia* feature within the SAC falls within four WFD waterbodies. There is no up to date mapping of *Salicornia* therefore this overlap figure may not be completely accurate. Due to this and as the WFD water quality sampling is not focused on areas close to the *Salicornia* feature, the confidence has been reduced in all of the relevant water quality assessments.

Contaminants

The contaminants indicator met its target as all three of the WFD waterbodies that overlap with the *Salicornia* feature have a pass for chemicals in the 2024 cycle 3 interim classification. However, in all three WFD waterbodies, some or all of the chemical classifications were rolled forward from previous cycles as they were not assessed in the 2024 cycle 3 interim classification. The confidence in the fail was reduced to medium due to this, and as WFD water quality sampling is not focused on areas within the *Salicornia* feature. The impact of contaminants on the feature are not fully understood. The target weighting of the indicator is tertiary to reflect this.

Nutrients (DIN only) and opportunistic macroalgae

The nutrients indicator (DIN only) failed to meet the target as high levels of DIN have been recorded in two of the three WFD waterbodies that overlap with the *Salicornia* feature. These are the Burry Inlet Inner and Three Rivers Estuary waterbodies, which combined overlap with 27% of the feature. The Moderate status for DIN in these waterbodies were confirmed in the 2021 WFD investigation reports (Jones 2021b; Jopson and Newman, 2021). There is also a biological response to high nutrient levels in the Burry Inlet Inner waterbody, where phytoplankton was classified with a Moderate status. The other overlapping WFD waterbody, Burry Inlet Outer, was classified with a Good status for DIN in the 2024 cycle 3 interim classification. This waterbody overlaps with 19% of the *Salicornia* feature. This is an improvement from the 2021 cycle 3 classification of Moderate status. See further detail in Section 3.3. Confidence in the fail was reduced to medium as WFD water quality sampling is not focused on areas within the *Salicornia* feature*,* and due to the improvement in DIN in the Burry Inlet Outer waterbody. The nutrients indicator (DIN only) was given a tertiary weighting as the effects of high nutrient levels on the *Salicornia* feature are not fully understood.

The indicator for opportunistic macroalgae was assessed as unknown. This was because none of the three WFD waterbodies were classified for the opportunistic macroalgae element in the 2024 cycle 3 interim classification, as no data has been collected for this element over the last six years. Some WFD waterbodies are not assessed for opportunistic macroalgae as they do not have suitable substratum (i.e. areas of intertidal habitat for opportunistic macroalgal growth).

Sheep grazing and the subsequent wash-off of faecal material from the intertidal saltmarsh on the Burry Inlet is believed to be responsible for episodic events of high bacteria concentrations. There was a pollution event in July and August in 2024 at Llangennith, in which there were spikes in *E. coli* (NRW)*.* This was associated with high numbers of grazing sheep at the time.

Air quality

High levels of nitrogen deposition from the atmosphere can have detrimental impact on saltmarsh since they are nitrogen limited. The nitrogen deposition within the SAC, where data were available, was under 17 kg N per ha per year for all saltmarshes and did not exceed the critical load of 20 kg N per ha per year (APIS), resulting in this indicator to pass with high confidence.

Vegetation structure

While overgrazing is happening across the feature, it is less likely to occur within the *Salicornia* areas as sheep appear to find *Salicornia* unpalatable. The sward height target was therefore met but the confidence was reduced to medium as it is based solely on expert judgement.

The zonation of vegetation indicator has been assessed as unknown. *Salicornia* is difficult to assess by aerial imagery as its density can be sparse. True extent measurement is unrealistic with this sampling technique. Further investigation with ground truthing evidence will be needed to adequately assess the extent of *Salicornia* in future.

Invasive non-native species

The saline conditions of saltmarshes prevent the common terrestrial non-native species (NNS) in Wales becoming established. There are no known records of NNS within the *Salicornia* feature in Carmarthen Bay and Estuaries SAC, resulting in both the primary and tertiary targets for the INNS and NNS indicators to be met.

There were, however, some notable records of NNS within the SAC. *Gracilaria vermiculophylla* has been recorded in 2021 and 2022 in nearby mudflats and sandflats habitat within the Burry Inlet. None were seen in the saltmarsh. For this reason, *G. vermiculophylla* has been judged to not be having an impact on the condition of the *Salicornia* feature, but with no evidence of whether it would be detrimental, where present.

Both INNS and NNS targets passed with a medium confidence as there have been no targeted NNS surveys within *Salicornia*, which would be required to fully understand the presence and impacts of any NNS species within the *Salicornia* feature.

Reasons for target failure

The *Salicornia* feature in Carmarthen Bay and Estuaries SAC has been assessed as being in **favourable** condition. However, one tertiary target failed to be met and needs to be kept under review.

Water quality: nutrients (DIN only)

This indicator target has a tertiary weighting. High levels of DIN have been recorded in two of the WFD waterbodies that overlap with the *Salicornia* feature (Burry Inlet Inner and Three Rivers Estuary). The WFD investigation reports have confirmed elevated nutrients in these waterbodies, where it was concluded that major input of nutrients is likely to be derived from diffuse sources associated with farm infrastructure and probable losses from agricultural land for the Burry Inlet Inner waterbody (Jones 2021b; Jopson and Newman, 2021). Point source continuous sewage discharge from the water industry were also confirmed as a source of nutrients linked to the DIN failures for both WFD waterbodies (Jones 2021b; Jopson and Newman, 2021). Intermittent and domestic sewage are also suspected in the catchments. Further investigation locally is required to confirm these.

Sheep grazing and the subsequent wash-off of faecal material from the intertidal saltmarsh on the Burry Inlet is believed to be responsible for episodic events of high bacteria concentrations.

Threats to condition

Part of the condition assessment is to identify threats to the condition of the *Salicornia* feature. A threat is defined as an activity that is currently not impacting condition but has the potential to do so over the next reporting cycle, if activity levels increase or are unmanaged. It is important to identify these threats to be able to put pre-emptive management in place to prevent declines in condition. The threats to the condition of the *Salicornia* feature in Carmarthen Bay and Estuaries SAC are stated below.

Invasive non-native species

G. vermiculophylla has the capacity to smother *Salicornia* plants, reducing the density of *Salicornia* and can therefore have a detrimental impact on the feature (see further detail in Section 3.1).

Further INNS were identified as potential threats to the UK and were listed in the latest horizon scanning exercise (Roy et al., 2019). There is a high likelihood for some of these species to be found in Wales in the future. This SAC could be at risk since there are a number of possible pathways of introduction. Further information on introduction pathways can be found on the GB non-native species secretariat website.

Coastal squeeze

The presence of hard structures for coastal flood defence and erosion control can prevent the natural landward migration of the saltmarsh, resulting in saltmarsh being squeezed between advancing sea levels and extant hard infrastructure.

Water quality: contaminants

There is the potential for unregulated contaminants (such as PFAS) to increase.

Some persistent chemicals are not measured in every WFD waterbody, and some of the relevant WFD waterbodies have not been classified for any chemicals.

Climate change

It is not yet clear what pressures we will see from climate change at the SAC level or how different pressures will counter act each other. However, threats from climate change may include (Gihwala et al., 2024, Oaten et al., 2024):

- Sea level rise, leading to coastal squeeze and loss of extent.
- Changes in air temperature.
- Increases in wave exposure.
- Changes in species distribution.

Evidence gaps

There are gaps in the current evidence that NRW feel are needed to be filled to fully understand condition in this feature.

Listed below (Table 14) are current indicators that were either assessed as unknown, not assessed, or assessed with a lower confidence. This was due to either limited data availability, outdated data, or a lack of information. Some indicators are not currently monitored but should be ideally considered in future condition assessments.

Table 14. Evidence gaps for the *Salicornia* feature in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

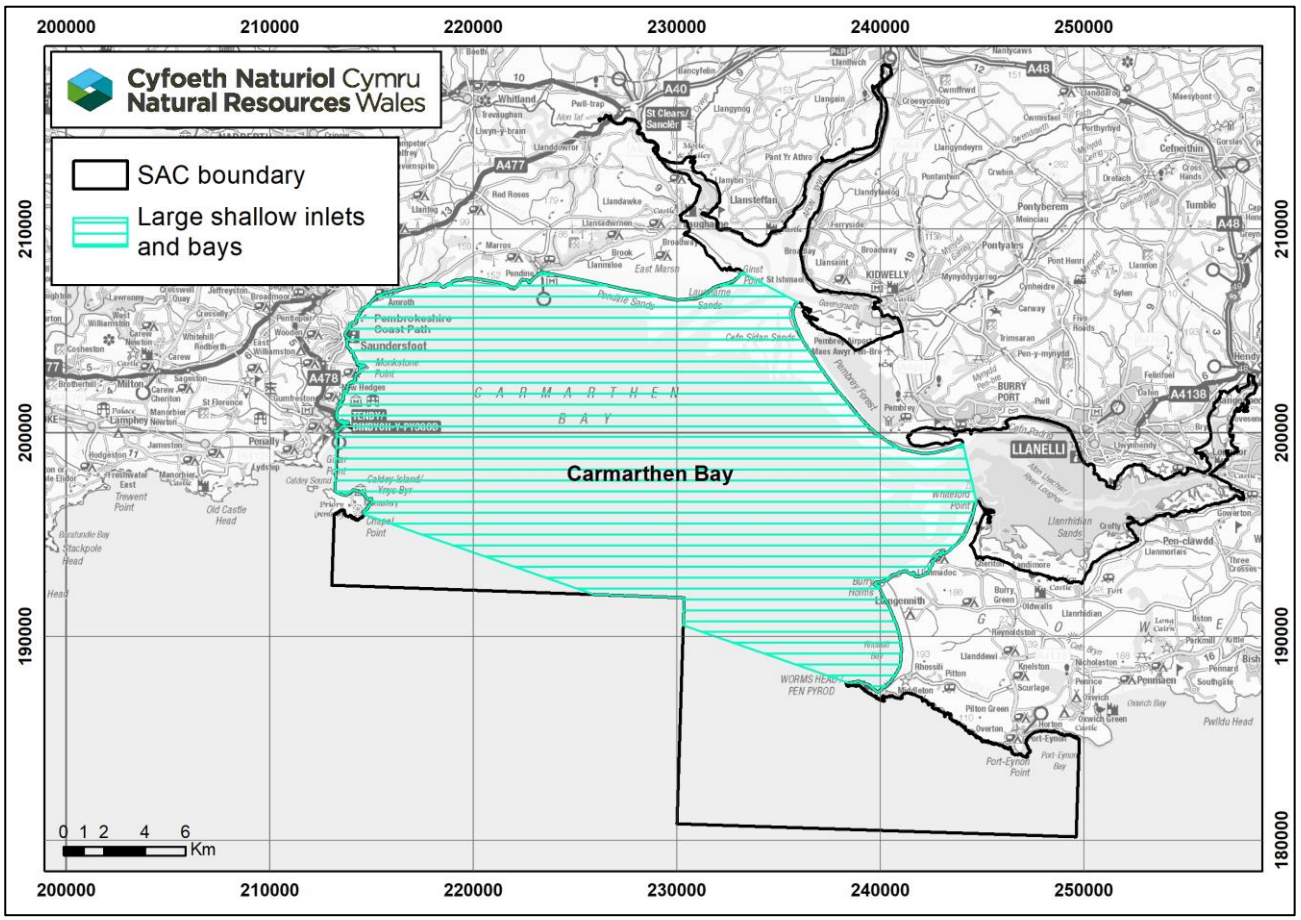
Indicator	Assessed status	Comments
Feature extent (P); distribution of feature (P); vegetation structure: zonation of vegetation (P)	Unknown	• The *Salicornia* mapping is out of date and of poor quality in all SACs. *Salicornia* is difficult to assess using aerial photography. More detailed mapping, possibly using drones, in combination with ground truthing is required.
Distribution and extent of habitats and communities (P)	Not assessed	• There is a lack of information on the distribution and extent of habitats and communities for *Salicornia* in all SACs. More detailed mapping, possibly using drones, in combination with ground truthing is required.
Topography of the feature (P)	Medium confidence (proxy data used)	• The topography of the *Salicornia* feature is not well monitored in any of the SACs. Repeat Lidar surveys taken at mean low water springs for all saltmarshes within the SAC are required.
Attributes of local distinctiveness (P)	Not assessed	• There is a lack of information on the named distinctive elements of the *Salicornia* feature**.** Additional fieldwork would be required to assess this indicator in all SACs. For further information on what is locally distinctive see relevant Regulation 37 advice packages.
Water quality: opportunistic macroalgae (S)	Unknown	• All of the overlapping WFD waterbodies were not classified for the opportunistic macroalgae WFD element in the 2024 cycle 3 interim classification. Some WFD waterbodies are not assessed for opportunistic macroalgae as they do not have suitable substratum.
Sediment quality: contaminants (T)	Not assessed	• Currently, there is no sediment monitoring within the *Salicornia* feature in all SACs.

Indicator	Assessed status	Comments
Hydrodynamic and sediment transport processes (T)	Medium confidence (proxy data used)	• The hydrodynamic regime of the *Salicornia* feature is not currently monitored in all SACs.

3.5. Large shallow inlets and bays condition assessment

The large shallow inlets and bays (LSIB) feature in Carmarthen Bay and Estuaries SAC is Carmarthen Bay (Figure 10). The condition assessment was completed using information specific to the LSIB in combination with any available data on the nested designated features contained within the LSIB.

Figure 10. Map of the LSIB feature in Carmarthen Bay and Estuaries SAC.



The LSIB includes one nested feature: mudflats and sandflats. Fish communities were only broadly considered due to resource limitations but there is some information included in the detailed assessment section. Table 15 has a summary of the assessment outcome. This outcome and reasons of failure are discussed in more detail in the sections below.

Table 15. Condition assessment of LSIB in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Feature Extent	No significant decrease in extent of LSIB within the SAC, allowing for natural change. (P)	• LSIB are a physiographic feature and the extent of the LSIB feature would be unlikely to change. • There are currently no anthropogenic impacts known to be significantly affecting the extent of LSIB in the SAC. • Confidence is medium as the assessment has not been based on comparison mapping of the feature and expert judgment was used.	**Pass**	Medium
Distribution and extent of habitats and communities	Maintain the distribution and extent of LSIB habitats and communities, allowing for natural change and variation. (P)	• There are currently no anthropogenic impacts known to be significantly affecting the distribution and extent of habitats and communities of LSIB and its nested features in the Carmarthen Bay and Estuaries SAC. • *Gracilaria vermiculophylla* has been recorded within the Burry Inlet estuary but not yet within the LSIB feature. There are some concerns that this species could negatively impact the distribution and extent of habitats and communities of the LSIB feature if it spreads further. • Confidence is medium as the assessment has been based on expert judgment	**Pass**	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Sediment composition and distribution	Maintain composition and distribution of sediment granulometry across the LSIB, allowing for natural change and variation. (P)	• No issues were identified for the overlapping nested feature mudflats and sandflats. • The NRW monitoring analysis of the sublittoral soft sediment in Carmarthen Bay from 2008 to 2023 indicated that the sediments were remarkably homogenous both spatially and temporally. • Confidence is high due to the availability of long term monitoring data.	**Pass**	High
Sediment quality: oxidation-reduction profile (redox layer)	No decrease in the depth of the redox layer from the surface that is considered detrimental to LSIB infaunal communities, allowing for natural change and variation. (S)	• This assessment uses the results of the condition assessment from the mudflats and sandflats feature as a proxy as there were no other data available. The redox layer profile of the monitored mudflats and sandflats indicated no clear trend over the years. • Confidence is low due to the use of proxy data, and as a large proportion of the mudflats and sandflats is not within the LSIB. Additional sampling is needed to improve temporal resolution and data continuity, which are required to understand ongoing processes and confirm overall trends.	**Pass**	Low
Sediment quality: organic carbon content	No increase to the organic carbon content considered detrimental to LSIB communities, allowing for natural change and variation. (S)	• Latest data from the sediment sampling in the SAC are within the Three Rivers Estuary only. One of these stations is within the LSIB feature. This was not deemed enough to assess this feature. • There are no recent data for organic carbon content within the Carmarthen Bay.	**Unknown**	N/A

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Sediment quality: contaminants	Sediment contaminants not to exceed the quality guidelines. (S)	• Latest data from the sediment sampling in the SAC are within the Three Rivers Estuary only. One of these stations is within the LSIB feature. This was not deemed enough to assess this feature. • There are no recent data for contaminants within the Carmarthen Bay.	**Unknown**	N/A
Topography of the feature	No significant anthropogenic impacts to the small or large scale topography of the LSIB. (S)	• There are currently no anthropogenic impacts known to be significantly affecting the topography of the feature. • Confidence is medium as the assessment has been based on expert judgment.	**Pass**	Medium
Hydrodynamic and sediment transport processes	Maintain hydrodynamic and sediment transport processes, including connectivity, allowing for natural variation and change. (P)	• There are currently no anthropogenic impacts known to be significantly affecting the hydrodynamic and sediment transport processes of the feature. • Confidence is medium as the assessment has been based on expert judgment.	**Pass**	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: nutrients (DIN only)	The WFD classification achieved for winter DIN should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (P)	• One of the three WFD waterbodies that overlap with the feature was classified with a Moderate status for DIN in the 2024 cycle 3 interim classification (Three Rivers Estuary), however it overlaps with <1% of the feature. • The other two WFD waterbodies were classified with a Good status for DIN (Carmarthen Bay and Burry Inlet Outer). Combined, these overlap with nearly 100% of the feature. ○ The Burry Inlet Outer waterbody was previously classified as Moderate status in the 2021 cycle 3 classification, and has fluctuated between Good and Moderate status in previous cycles. • Confidence is medium as the Burry Inlet Outer waterbody was Moderate status in the 2021 cycle 3 classification.	**Pass**	Medium
Water quality: phytoplankton	The WFD classification achieved for phytoplankton should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (S)	• Two of the three WFD waterbodies were classified with a Good status for phytoplankton in the 2024 cycle 3 interim classification (Carmarthen Bay and Three Rivers Estuary). These waterbodies have improved from Moderate status in the 2021 cycle 3 classification. • The other WFD waterbody was classified with a Moderate status for the phytoplankton WFD element (Burry Inlet Outer). It overlaps with 10% of the feature. • Confidence is low as a small proportion of the feature is within a failing waterbody.	**Fail**	Low

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: opportunistic macroalgae	The WFD classification achieved for opportunistic macroalgae should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (S)	• None of the three WFD waterbodies that overlap with the feature have been classified for the opportunistic macroalgae WFD element in the 2024 cycle 3 interim classification.	**Unknown**	N/A
Water quality: dissolved oxygen	The WFD classification achieved for dissolved oxygen should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (P)	• All three WFD waterbodies that overlap with the feature have been classified with a High status for dissolved oxygen in the 2024 cycle 3 interim classification. • Confidence is medium due to samples being taken from the surface of the waterbody which may not detect issues for more demersal habitats within the LSIB feature.	**Pass**	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: contaminants	Water column contaminants not to exceed the EQS. (S)	• Two of the three WFD waterbodies have a pass for chemicals in the 2024 cycle 3 interim classification. In both waterbodies the classifications were rolled forward from previous cycles as they were not classified in the 2024 cycle 3 interim classification. • The other WFD waterbody has a fail for chemicals (Carmarthen Bay). It failed for mercury, PBDE and cypermethrin and overlaps with 90% of the feature. • Confidence is medium as the human health standard has been used for PBDE, and due to the roll forward of some chemical classifications.	**Fail**	Medium
Water quality: turbidity	Maintain expected levels of turbidity, allowing for natural change and variation. (P)	• There are limited data on turbidity for the LSIB feature in the Carmarthen Bay and Estuaries SAC, therefore this target was assessed as unknown.	**Unknown**	N/A
Abundance, distribution and species composition of communities	Maintain the abundance, distribution, and diversity of species within communities and component habitats, allowing for natural change and variation. (P)	• The three overlapping WFD waterbodies were classified as Good status for the IQI WFD element in the 2024 cycle 3 interim classification. • No issues were identified for the overlapping nested feature mudflats and sandflats • Analysis of the sublittoral soft sediment infaunal communities indicated no concerning patterns of change observed. Community structure has been stable and within the bounds of natural variation • Confidence was medium due the lack of data on fish communities.	**Pass**	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Invasive non-native species (INNS)	Spread and impact of INNS caused by human activities should not adversely affect the condition of the feature. (P)	• There is limited evidence to suggest that INNS are currently impacting the condition of LSIB in the SAC. • Confidence is low as the spread and impacts of any INNS present within the feature are not understood.	**Pass**	low
Non-native species (NNS)	No increase in the number of introduced NNS by human activities. (T)	• There was a new record of *Ensis leei* in 2018 within the LSIB feature. However, this is an unconfirmed record and has therefore not led to the failure of this indicator. • Other records of NNS have been previously recorded within the feature including *Caulacanthus okamurae*, *Dasiphonia japonica* and *Sargassum muticum*. • There have been targeted INNS surveys as part of the MarClim project ad-hoc records from the NRW Habitats Regulations monitoring. • Confidence is low due to the uncertainty of the NNS record.	**Pass**	Low

Assessment conclusions

The large shallow inlets and bays (LSIB) feature in Carmarthen Bay and Estuaries SAC has been assessed as being in **unfavourable** condition (low confidence). There were a couple of indicators with failing secondary targets (Table 16). Further investigation is needed to better understand all of the failures to be able to identify management options that can bring the feature back into favourable condition.

A summary of the assessment can be seen in Table 16 with more detail on each performance indicator, and any reasons for failure, provided in the sections below.

Table 16. Summary of the condition assessment for LSIB in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

Feature	Overall Condition Assessment	Indicator failures	Reason for indicator failure	Threats to condition
Large shallow inlets and bays	**Unfavourable (low confidence)**	Water quality: phytoplankton (S) Water quality: contaminants (S)	• Phytoplankton failed in the Burry Inlet Outer waterbody. • Levels of mercury, PBDE and cypermethrin in the Carmarthen Bay waterbody are failing to meet their relevant EQSs.	• Unconsented infrastructure • INNS • Fly ash • Water quality: contaminants • Management of coastal defences • Climate change

Detailed assessment information

Extent and distribution

Extent of the feature

The feature extent indicator in the Carmarthen Bay and Estuaries SAC passed its target as there are currently no known anthropogenic impacts that would significantly affect the extent of the LSIB feature. LSIB are a physiographic feature and the extent of the LSIB feature would be unlikely to change. Comparison mapping has not been used to assess the extent and only expert judgment was used in the absence of recent data. This has reduced the confidence to medium.

Distribution and extent of habitats and communities

The presence of *Gracilaria vermiculophylla* within the Burry Inlet has altered the type of habitat to become more muddy (see further detail in invasive non-native species). Although a small part of the Burry Inlet estuary (the mouth of the estuary) is within the LSIB feature, *G. vermiculophylla* has not been found within the LSIB feature. There are some concerns about future expansion of *G. vermiculophylla* that could negatively impact the condition of feature. There is a need to fully understand the impact this species is causing on the mudflats and sandflats and the LSIB feature as a whole and if the change will be permanent. Evidence from WFD data of seagrass showed fluctuations in *Zostera noltei* extent especially in the Burry Inlet Outer waterbody. Some decrease in extent of *Z. noltei* habitat in part of the Burry Inlet estuary resulted in a Moderate status in the two latest WFD classifications, but this is likely due to natural change (Section 3.2). The distribution and extent of habitats and communities indicator was assessed as passing the target but with a medium confidence as expert judgment was used.

Sediments

Composition and distribution

The sediment composition and distribution indicator in the condition assessment of the mudflats and sandflats feature passed its target. This feature overlaps with approximately 17% of the LSIB feature.

The monitoring analysis of the sublittoral soft sediment in Carmarthen Bay from 2008 to 2023 indicated that the sediments were remarkably homogenous both spatially and temporally (Marshall et al., in draft). The majority of sampling stations showed negligible change between years. Stations which did show change did not show a consistent direction of change, which indicated only small-scale heterogeneity of the sediment, and was within bounds of natural variation.

Oxidation-reduction profile (redox layer)

The redox layer of intertidal sediments has been monitored within the mudflats and sandflats habitat. This habitat feature in the SAC overlaps with approximately 17% of the LSIB feature. It was therefore deemed acceptable to use the mudflats and sandflats

condition assessment as a proxy for the sediment redox layer indicator. The indicator met its target as the redox layer from the mudflats and sandflats data indicated no clear trend over the surveyed years (Section 3.2). The confidence was reduced to low because the assessment uses the mudflats and sandflats condition assessment as a proxy and a large proportion of the mudflats and sandflats feature is outside the LSIB feature. Further sampling is also required to enhance the robustness and completeness of the dataset, especially important for assessing the redox layer. The subtidal sediments within Carmarthen Bay are unlikely to be anoxic based on their sandy composition.

Organic carbon content and contaminants

Sediment contaminants and organic carbon content has been monitored within the Three Rivers Estuary only. One of these monitoring stations is within the LSIB feature, which is not enough to assess the targets for this feature. There are no recent data for sediment organic carbon content or contaminants within the Carmarthen Bay therefore these indicators were assessed as unknown.

Topography and hydrodynamics

The topography and hydrodynamic and sediment transport processes are not well researched for LSIBs. These targets passed with medium confidence based on the knowledge that there are currently no anthropogenic activities that are known to have a significant impact on the feature.

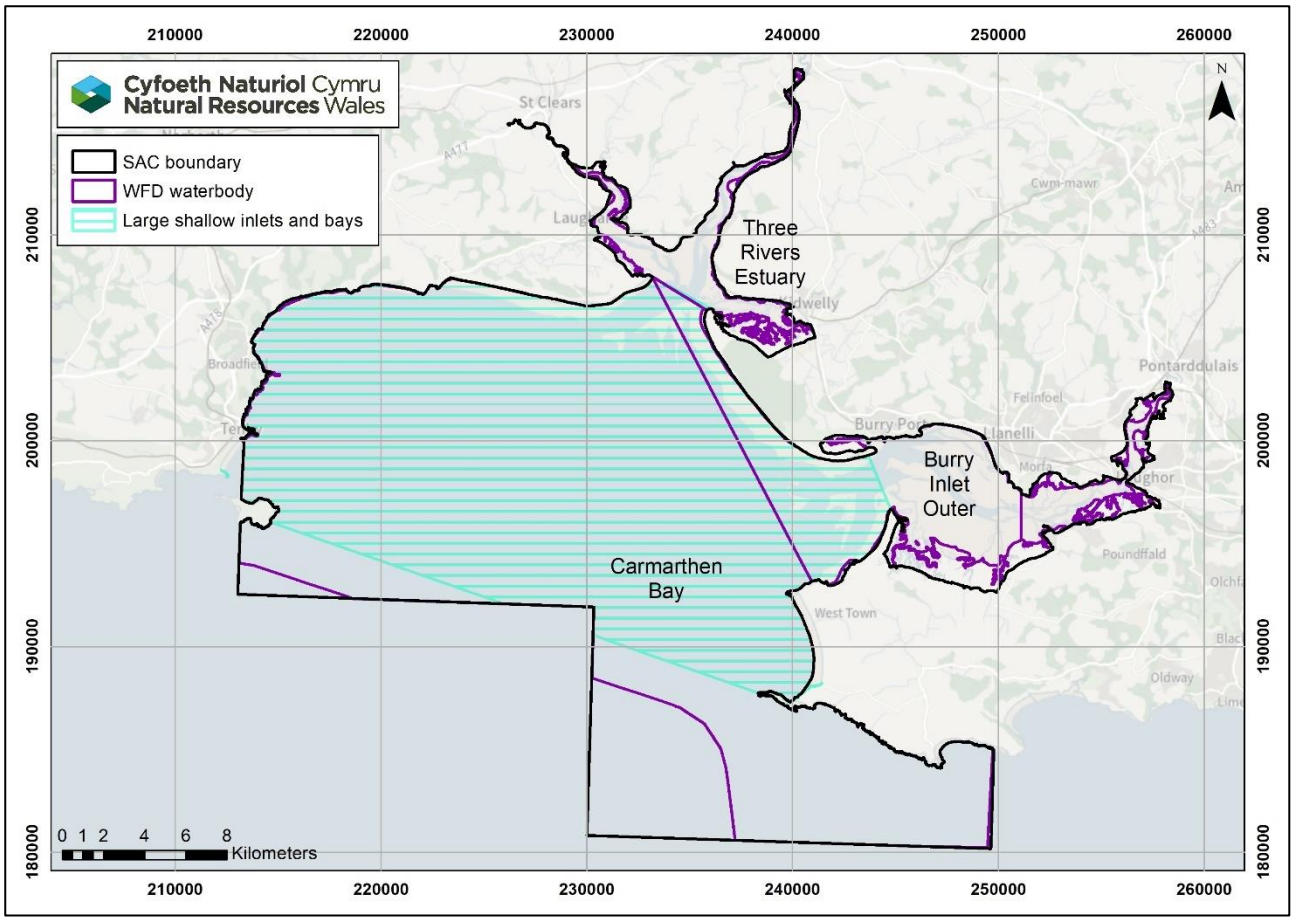
Water quality

It has been estimated that nearly 100% of the LSIB feature within the SAC falls within three WFD waterbodies (Figure 11), therefore these are likely to be a good reflection of the overall effect of water quality on the feature. The Carmarthen Bay waterbody overlaps with the largest proportion of the feature (90%), and the Burry Inlet Outer waterbody overlaps with a smaller proportion (10%). The Three Rivers Estuary waterbody overlaps with a very small proportion of the feature (0.1%) (Figure 11).

Nutrients (DIN only)

The nutrients indicator (DIN only) met its target as the two WFD waterbodies that overlap with the largest proportion of the feature, Carmarthen Bay and Burry Inlet Outer, were classified with a Good status for DIN in the 2024 cycle 3 interim classification. The Burry Inlet Outer waterbody was previously classified as Moderate in the 2021 cycle 3 classification, but has improved to Good status. The confidence of this improvement is quite certain (79%). The classification of the Burry Inlet Outer waterbody has fluctuated between Moderate and Good status over various cycles. In this waterbody, the supporting biological element phytoplankton was still classified as Moderate status in the 2024 cycle 3 interim classification, despite the improved DIN classification. The WFD investigation report for the Burry Inlet Outer waterbody confirmed the DIN and phytoplankton failure in 2021 (Jones, 2021a). This reduced the confidence in the assessment. The Three Rivers Estuary waterbody was classified as Moderate status for DIN, but this was not considered in the condition assessment.

Figure 11. Map of the WFD waterbodies that overlap with the LSIB feature within Carmarthen Bay and Estuaries SAC.



Phytoplankton

The phytoplankton indicator failed to meet its target. This element failed in one of the WFD waterbodies that overlaps with the LSIB feature in the SAC. The Burry Inlet Outer waterbody was classified with a Moderate status for the phytoplankton element in the 2024 cycle 3 interim classification. This waterbody has been Moderate or worse status for phytoplankton in all cycles. The other two WFD waterbodies, Carmarthen Bay and Three Rivers Estuary, were classified with a Good status in the 2024 interim classification, however they were both Moderate status in the 2021 cycle 3 classification. The 2021 WFD investigation reports for the Burry Inlet Outer and Three Rivers Estuary waterbodies confirmed the phytoplankton failures (Jones, 2021a; Jopson and Newman, 2021). The failure in the Carmarthen Bay waterbody was uncertain in 2021 as the EQR was close to the Good status boundary (Lock, 2021). Low confidence has been attributed to the failure of the target as only 10% of the feature is within a failing waterbody, and due to the improvement in two of the WFD waterbodies.

Opportunistic macroalgae

The indicator for opportunistic macroalgae was assessed as unknown. This was because none of the three WFD waterbodies were classified for the opportunistic macroalgae element in the 2024 cycle 3 interim classification as there were no data collected on this element over the last six years. Some WFD waterbodies are not assessed for opportunistic

macroalgae as they do not have suitable substratum (i.e. areas of intertidal habitat for opportunistic macroalgal growth).

Dissolved oxygen

The dissolved oxygen indicator met its target. The dissolved oxygen samples are taken at the water's surface. By the time oxygen depletion at the surface is recorded, oxygen throughout the water column could have been depleted for some time, especially as hypoxia or low oxygen levels, when present, typically occur in bottom water and sediments. Therefore, surface sampling of dissolved oxygen may not detect issues for more demersal habitats within the LSIB feature. This reduced the confidence in the pass to medium.

Contaminants

The Carmarthen Bay waterbody has a fail for chemicals in the 2024 cycle 3 interim classification, where mercury, PBDE and cypermethrin failed. This waterbody overlaps with the largest proportion of the feature and therefore caused the contaminants indicator to fail. The EQS for cypermethrin is very low, and in the previous lab methodology it was not possible to detect concentrations below the EQS. There has been a waterbody status change (pass to fail) between the 2021 cycle 3 classification and 2024 cycle 3 interim classification due to this reason. Cypermethrin is a synthetic pyrethroid insecticide and is highly toxic to some aquatic species (EA, 2019), but now has a restricted use in Wales. Mercury has failed in the waterbody since the 2015 cycle 2 classification. The EQS for mercury is based on the secondary poisoning protection goal (for wildlife). The PBDE failure was based on the value of the human health protection goal as it is the most stringent. This protection goal may be over precautionary as the effect of contaminants on the biota of LSIB are not fully understood.

The other two overlapping WFD waterbodies have a pass for chemicals in the 2024 cycle 3 interim classification. However, in both waterbodies the classifications were rolled forward from previous cycles as they were not assessed in the 2024 cycle 3 interim classification. The confidence in the fail was reduced to medium due to this and because the human health standard has been used for PBDE. In addition, the impact of the failing contaminants on the feature are not fully understood.

Turbidity and physicochemical properties

The turbidity indicator was assessed as unknown due to insufficient data. There were some data available from WFD Regulations sampling of suspended particulate matter. However, this is limited to only a few samples per year and therefore cannot be used to adequately assess the turbidity. The physicochemical indicator could not be assessed due to a lack of data.

Species and communities

The three overlapping WFD waterbodies were classified as Good status for the IQI element in the 2024 cycle 3 interim classification (Carmarthen Bay, Burry Inlet Outer and Three Rivers Estuary). Combined, these waterbodies overlap with 99.6% of the whole feature.

The mudflats and sandflats feature overlaps with approximately 17% of the LSIB feature. The condition assessment for the mudflats and sandflats feature concluded that the abundance, distribution and species composition of communities indicator met the criteria for a pass (Section 3.2).

The Carmarthen Bay sublittoral soft sediment infaunal communities have been surveyed from 1996 to 2023. The analysis indicated the bay was in consistent good health with no concerning patterns of change observed. The community composition has been stable across the majority of the survey period, with a remarkably static broad-scale community structure, and was within the bounds of natural variation one would expect to see in such environments (Marshall et al., in draft).

Although fish within the LSIB are an important part of the community, there are limited data and resources to conduct analysis on fish communities for the LSIB feature. Data from wider Irish sea level studies such as International Council for the Exploration of the Sea (ICES) are difficult to relate to the assessment of condition at the SAC and feature level and some species that have been assessed by ICES may not even occur at the individual SAC level. However, populations of various larger-bodied bony fish species in the Irish Sea, such as bass, cod, herring, whiting, plaice and pollack, have declined in recent years (ICES, 2024a, 2024b, 2024c, 2024d, 2024e, 2024f). While there are limited data on the status of other species, the depletion of a number of larger, higher trophic level predatory species in the Irish Sea may have shifted the structure of the wider fish community to an overall lower trophic level with fewer larger predatory fish species.

Overall, the abundance, distribution and species composition of communities indicator for the LSIB feature in Carmarthen Bay and Estuaries SAC met its target. However confidence was reduced to medium due to the lack of fish communities data for the LSIB feature.

Invasive non-native species

There was a new record of the American razor clam Jack knife *Ensis leei* within the LSIB feature, off Saundersfoot Bay, found in 2018. However, as this record has not been confirmed and as there have been no subsequent records of the species, this did not fail the indicator. The tertiary target was therefore met but with a low confidence due to the uncertainty of this record.

Other non-native species are known to be present within the feature, including the pom-pom weed *Caulacanthus ustulatus (okamurae)*, siphoned Japan weed *Dasysiphonia japonica* and wireweed *Sargassum muticum*. *Crepidula fornicata* was found at Burry port in 2008 but this was outside of the LSIB feature and there has been no other records since. There has also been a rapid establishment of *G. vermiculophylla* elsewhere in the SAC but currently not within the LSIB feature.

It is not fully understood how some of these species may spread and impact the condition of the LSIB feature and the nested habitat features within the feature, and effects on the species diversity and composition have not yet been observed. As there is no current impact from any INNS present the primary target of the INNS indicator passed. Confidence is low as the impacts of any INNS present within the feature are not well understood.

Reasons for target failure

The assessment of the LSIB feature in the Carmarthen Bay and Estuaries SAC failed two secondary targets. This resulted in the feature to be assessed as being in **unfavourable** condition. The failing indicators and reasons for failure, if known, are stated below.

Water quality: phytoplankton

This indicator target has a secondary weighting. The Burry Inlet Outer waterbody was classified with a Moderate status for the phytoplankton element in the 2024 cycle 3 interim classification. The 2021 WFD investigation report confirmed the phytoplankton failure in this waterbody (Jones, 2021a). In this investigation it was concluded that major input of nutrients is likely to be derived from diffuse sources associated with farm infrastructure, and from point source continuous sewage discharge from the water industry. Intermittent and domestic sewage are also suspected as minor nutrient inputs in the catchment. Further investigation locally is required to confirm these.

Water quality: contaminants

This indicator target has a secondary weighting. The LSIB feature in the SAC is partly within a WFD waterbody that failed for chemicals. The Carmarthen Bay waterbody failed due to mercury, PBDE and cypermethrin. Historically, the main source of PBDE is as flame retardants in a variety of materials (Viñas et al., 2022). Mercury has been used in many industries, but today the primary sources are burning of coal and artisan mining for mercury (Larsen and Hjermann, 2022). Cypermethrin is an insecticide used for plant protection in crops, forestry, gardens, homes and businesses. It is also used in veterinary medicine to control pests in livestock and pets (EA, 2019). The application of cypermethrin has been restricted for some uses (sheep dipping and in forestry against the pine weevil).

Some of the contaminants in the water column may be derived from diffuse sources from atmospheric deposition and contaminated waterbody bed sediments, or point sources from continuous sewage discharge from wastewater treatment. However, an investigation into the failure in the waterbody is yet to be undertaken. Mercury and PBDE are being managed in the UK and it is hoped that these levels will reduce in time.

Threats to condition

Part of the condition assessment is to identify threats to the condition of the LSIB. A threat is defined as an activity that is currently not impacting condition but has the potential to do so over the next reporting cycle, if activity levels increase or are unmanaged. It is important to identify these threats to be able to put pre-emptive management in place to prevent declines in condition.

Activities that go through licencing and permission processes e.g. cable laying and maintenance whereby the impact of the activity on the feature would be assessed have not been included. The threats to the LSIB feature condition in the Carmarthen Bay and Estuaries SAC are stated below.

Unconsented infrastructure

New unconsented infrastructures such as private slipways and coastal defences, modify the coastal environment through changes to micro-topography and hydrodynamics and can lead to loss of the feature extent, and impact to the flora and fauna associated with it.

Invasive non-native species

The further establishment of *G. vermiculophylla* more widely in the Three Rivers estuaries is a real concern. This species is not currently within the LSIB feature, but has the potential to establish quickly in shallow soft-bottomed bays and estuaries and can have a detrimental impact on the feature (see further detail in Section 3.1).

Further INNS were identified as potential threats to the UK and were listed in the latest horizon scanning exercise (Roy et al., 2019). There is a high likelihood for some of these species to be found in Wales in the future. This SAC could be at risk since there are a number of possible pathways of introduction. Further information on introduction pathways can be found on the GB non-native species secretariat website.

Fly ash

Fly ash (pulverised fuel ash) from the old power station at the west of Burry Port could pose a risk. The power station was immediately adjacent to the inlet and the fly ash was buried along with some asbestos. The shoreline where it is buried is now starting to erode. The impact of fly ash on the LSIB feature is not clear, but if released, fly ash could accumulate in the tissues of marine species, particularly invertebrates (Jenner and Bowmer, 1990 in Robbins, et al. 2023).

Water quality: contaminants

There is the potential for unregulated contaminants (such as PFAS) to increase. This could affect some of the biota of the LSIB feature as PFAS has been shown to bioaccumulate in marine species, increasing up the trophic levels (Khan et al., 2023). However, the biological impact of PFAS on marine species is not well understood.

Some persistent chemicals are not measured in every WFD waterbody, and some of the relevant WFD waterbodies have not been classified for any chemicals.

Management of coastal defences

The State of the UK Climate 2023 Report highlights an observed acceleration in rates of climate induced sea-level rise which, along with storm surges can cause coastal erosion and flooding (Kendon et al, 2024). Shoreline Management Plans identify the preferred approach to coastal management in light of climate change, which includes maintaining or upgrading defences in some areas and adapting the approach to management in others. Where defences continue to be maintained, there are potential impacts on coastal processes and associated habitats and species. Intertidal habitats may also be lost as a result of coastal squeeze (Oaten et al, 2024).

Climate change

It is not yet clear what pressures we will see from climate change at the SAC level or how different pressures will counter act each other. However, threats from climate change may include (Gihwala et al., 2024, Oaten et al., 2024):

- Sea level rise.
- Changes to wave climate, especially storm frequency and intensity, which may change the topography.
- Changes in air and sea temperature.
- Changes in ocean acidification.
- Changes in species distribution.

Evidence gaps

There are gaps in the current evidence that NRW feel are needed to be filled to fully understand condition in this feature.

Listed below (Table 17) are current indicators that were either assessed as unknown, not assessed, or assessed with a lower confidence. This was due to either limited data availability, outdated data, or a lack of information. Some indicators are not currently monitored but should be ideally considered in future condition assessments. There are additional evidence gaps concerning the nested features, which can be found in the relevant sections of this report.

Table 17. Evidence gaps for the LSIB feature in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

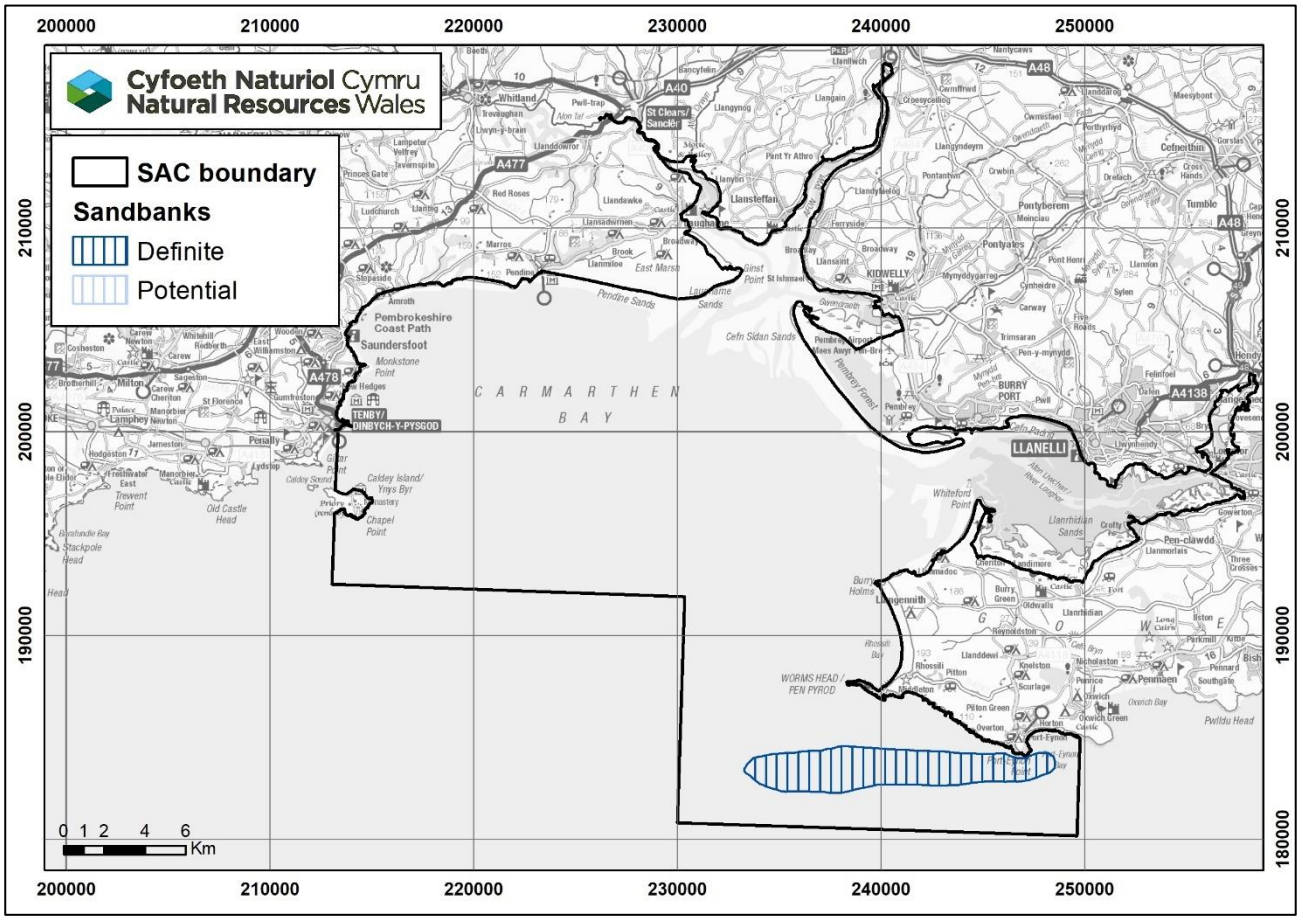
Indicator	Assessed status	Comments
Abundance, distribution and species composition of communities (P)	The fish community element did not contribute to the condition outcomes.	• Fish communities were broadly discussed for all SACs using reports including ICES data. Although these reports provide an indication of fish numbers, they have certain limitations. The large area covered makes it unsuitable for specific LSIB or individual SACs. More data would be required to adequately assess fish communities in LSIB.
Invasive non-native species (P)	Low confidence (limited data)	• The spread and impact of the NNS currently present on the LSIB feature within the SAC is not fully understood. More targeted surveys and investigation on the impact of NNS on LSIB are needed. • Investigation into the use of satellite and or aerial imagery for assessing the extent of *G. vermiculophylla* may be beneficial.

Indicator	Assessed status	Comments
Sediment quality: contaminants (S); organic carbon content (S)	Unknown	• Within the Carmarthen Bay and Estuaries SAC, the latest data from the sediment sampling are within the Three Rivers Estuary only. One of these stations is within the LSIB feature which is not enough to assess this feature. There are no recent data for organic carbon content within the Carmarthen Bay and Estuaries SAC.
Sediment quality: oxidation-reduction profile (redox layer) (S)	Low confidence (limited data)	• The redox layer of sediments was based on current monitoring, but the short time range and small spatial coverage available meant it was difficult to confirm any trend. A larger spatio-temporal dataset is required to fully understand what is happening for all SACs.
Water quality: opportunistic macroalgae (S)	Unknown	• All of the overlapping WFD waterbodies were not classified for the opportunistic macroalgae WFD element in the 2024 cycle 3 interim classification. Some WFD waterbodies are not assessed for opportunistic macroalgae as they do not have suitable substratum.
Water quality: turbidity (S)	Unknown	• Turbidity is measured in WFD sampling. As this is limited to only a few samples per year it cannot be used to adequately assess the turbidity. • Investigation of the use of remote sensing data to assess turbidity could be carried out in the future. External data from other organisations could also be used.
Water quality: physicochemical properties (S)	Not assessed	• There were also no temperature, salinity or pH loggers within Carmarthen Bay and Estuaries SAC. • Remote sensing data on temperature, salinity and pH could be used in future.

3.6. Sandbanks condition assessment

The sandbanks feature in Carmarthen Bay and Estuaries SAC consists of a single sandbank, Helwick Bank (Figure 12). This sandbank has been assessed against the performance indicators and an overall condition was assigned for the feature.

Figure 12. Map of the sandbanks feature in Carmarthen Bay and Estuaries SAC.



The summary of the assessment outcome is provided in Table 18. These outcomes and reasons of failure are discussed in more detail in the sections below.

Table 18. Condition assessment of sandbanks in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Extent	No significant decrease in the extent of sandbank within the SAC, allowing for natural change and variation. (P)	• There are currently no anthropogenic impacts known to be significantly affecting the extent of sandbanks in the Carmarthen Bay and Estuaries SAC. • Confidence is medium as the assessment has not been based on comparison mapping of the feature and expert judgment was used.	**Pass**	Medium
Sediment composition and distribution	Maintain composition of sediment granulometry across the sandbank, allowing for natural change and variation. (P)	• Granulometric analysis for the monitored sandbank showed some changes in sediment composition but this is likely to be natural. • There are currently no known anthropogenic impacts on the sediment composition. • Confidence is medium due to the presence of the unusual clumps of clay during the 2022 monitoring survey.	**Pass**	Medium
Topography of the feature	No significant anthropogenic impacts to the small or large scale topography of the sandbanks. (P)	• Scientific evidence suggested that the bank volume may be naturally reducing. • Confidence is medium because the evidence used was from a relatively old report, and there are no recent survey data.	**Pass**	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Hydrodynamic and sediment transport processes	Maintain hydrodynamic and sediment transport processes, including connectivity, allowing for natural variation and change. (P)	• Modelled data indicated that hydrodynamic and sediment transport processes are functioning as expected. • Confidence is medium as the available data are inferred from models.	**Pass**	Medium
Water quality: nutrients (DIN only)	The WFD classification achieved for winter DIN should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (S)	• The one WFD waterbody that overlaps with the sandbanks feature has been classified as Good status for DIN in the 2024 cycle 3 interim classification (Carmarthen Bay). This waterbody overlaps with 76% of the sandbanks feature and has improved from Moderate status in previous cycles. • Confidence is high as there were no WFD waterbodies that overlap with the feature that were not classified or failed for the DIN element.	**Pass**	High
Water quality: phytoplankton	The WFD classification achieved for phytoplankton should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (T)	• The Carmarthen Bay waterbody was classified with a Good status for the phytoplankton WFD element in the 2024 cycle 3 interim classification. This waterbody has improved from Moderate status in the 2021 cycle 3 classification. • Confidence is low as the sampling locations for phytoplankton were not close to the sandbanks feature, due to the previous phytoplankton failure in the Carmarthen Bay waterbody in the 2021 cycle 3 classification, and because the ecological relationships between phytoplankton and the sandbanks feature are not well understood.	**Pass**	Low

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: dissolved oxygen	The WFD classification achieved for dissolved oxygen should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (S)	• The Carmarthen Bay waterbody that overlaps with the sandbanks feature was classified as High status for dissolved oxygen in the 2024 cycle 3 interim classification. • Confidence is medium due to samples being taken from the surface of the waterbody.	**Pass**	Medium
Water quality: contaminants	Water column contaminants not to exceed the EQS. (S)	• The Carmarthen Bay waterbody has a fail for chemicals in the WFD interim Cycle 3 assessment, due to mercury, PBDE and cypermethrin. • Confidence is reduced as the human health standard has been used for PBDE.	**Fail**	Medium
Water quality: turbidity	Maintain expected levels of turbidity, allowing for natural change and variation. (S)	• There are limited data on turbidity for the sandbanks feature in the Carmarthen Bay and Estuaries SAC, therefore this target was assessed as unknown.	**Unknown**	N/A

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Abundance, distribution and species composition of communities	Maintain the abundance, distribution, and diversity of species within communities and component habitats, allowing for natural change and variation. (P)	• The overlapping WFD waterbody was classified as Good status for the IQI WFD element in the 2024 cycle 3 interim classification (Carmarthen Bay). This waterbody overlaps with 76% of the sandbanks feature. • Analysis of macrobenthic infaunal communities for Helwick bank indicated variation across monitoring period, which were consistent across stations. • Confidence is medium as there was a degree of change seen in infaunal communities but reasons are unknown.	**Pass**	Medium
Species richness and diversity	Maintain the expected richness and diversity of sandbank species, allowing for natural change and variation. (S)	• There was an increase of taxa richness since 2013. • There was a sudden drop in diversity in 2016 possibly caused by an unexpected large mussel settlement which is likely to be natural • Confidence is high due to the availability of long term monitoring data and lack of concerning patterns.	**Pass**	High
Taxonomic spread of species	Maintain the expected taxonomic spread of sandbank species, allowing for natural change and variation. (S)	• The average of taxonomic distinctness improved over time, but the years were all below the level of expectation. • Confidence is medium because all sampling years were below the expected level.	**Pass**	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Invasive non-native species (INNS)	Spread and impact of INNS caused by human activities should not adversely affect the condition of the feature. (P)	• There is limited evidence to suggest that INNS (e.g. *Crepidula fornicata*) are currently impacting the condition of sandbanks in the SAC. • Confidence is low as the spread and impacts of the INNS present within the feature are not well understood and there have been no targeted surveys on NNS.	**Pass**	Low
Non-native species (NNS)	No increase in the number of introduced NNS by human activities. (T)	• *C. fornicata* was recorded for the first time in 2019 and has now increased from one individual to seven in 2022 on the sandbank. • Confidence is high due to the arrival of NNS within the last six years, and good availability of records.	**Fail**	High

Assessment conclusions

The sandbanks feature in Carmarthen Bay and Estuaries SAC has been assessed as being in **favourable** condition (medium confidence). Overall, the lack of any significant anthropogenic impact on this feature in terms of extent, hydrodynamic processes, topography, sediment composition and its associated community, have contributed to this favourable assessment outcome. There was a failure for one secondary and one tertiary target (Table 19) and there were limited or absent data for one key indicator to inform on the condition of the feature (see evidence gaps). This reduced the confidence in the assessment.

A summary of the assessment can be seen in Table 19 with more detail on each performance indicator, and any reasons for failure, provided in the sections below.

Table 19. Summary of the condition assessment for sandbanks in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

Feature	Overall Condition Assessment	Indicator failures	Reason for indicator failure	Threats to condition
Sandbanks	**Favourable (medium confidence)**	Water quality: contaminants (S) Non-Native Species (T)	• Levels of mercury, PBDE and cypermethrin in the Carmarthen Bay waterbody are failing to meet their relevant EQSs. • There has been an increase in the number of *C. fornicata* in the SAC.	• INNS • Water quality: contaminants • Climate change

Detailed assessment information

Helwick Bank, which is part of the sandbanks feature in the Carmarthen Bay and Estuaries SAC, has been monitored in 2001 and every three years between 2013-2022 using grab sampling surveys.

Extent and distribution

The indicator for extent of the sandbanks feature in Carmarthen Bay and Estuaries SAC met its target as there are currently no known anthropogenic impacts that would significantly affect the feature. The current mapped extent of sandbank is not highly accurate as the sandbank was mapped in the past with a generalised shape, but bathymetry data indicates that it is more complex. Differences in the data collection methods makes comparison difficult. There was also no recent bathymetry for Helwick Bank. These factors have reduced the confidence in the target assessment to medium. More resources are needed to accurately and regularly map sandbanks using bathymetry techniques. The distribution of the feature target is not applicable to this SAC as there is only one sandbank in the Carmarthen Bay and Estuaries SAC.

Sediment, topography and hydrodynamics

Sediment composition varied across stations and over the monitoring period, but no trend was detected. Sediment composition was positively correlated to the abundance of infauna, indicating that communities are to some extent determined by sediment characteristics. An ad-hoc mussel dredging operation was conducted in 2015 but no changes in sediment composition were observed. There were some unusual observations of clay clumps among clean fine and medium sand during the 2022 monitoring survey. This were not captured in the samples for the sediment composition analysis. Such clay clumps could be an indication of disturbance since they could be deposited from anthropogenic activity. It is unlikely these clumps of clay were a relic of dredging activities since they were relatively limited on a small area of the bank and the dredging stopped in 2005. The clumps could originate from possible erosion of boulder clay nearby further transported as bedload, but no previous records have shown this process to occur. These clay clumps will be something to pay close attention to in the next assessment. Variation in sediment composition was judged to be natural based on the granulometric analysis. Therefore the sediment composition and distribution indicator target was met. However, the presence of the unusual clumps of clay has reduced the confidence in the pass to medium.

Helwick Bank has been historically dredged but after a public enquiry (2005), the permitted extraction rate and time period was significantly reduced from that proposed. The new licence was not used and was eventually relinquished by the applicant. Scientific research found that the reduction in volume through time was greater than reduction from dredging (Lewis et al., 2015). Since there are currently no known anthropogenic activities that could significantly impact the sandbanks feature, the topography of sandbank indicator has been judged to pass the target. The confidence in the target assessment was reduced to medium due to the lack of recent surveys.

Models also indicated that the hydrodynamic and sediment transport processes were typical of a sandbank with no concern, resulting in a pass for the hydrodynamic and sediment transport processes indicator. A medium confidence was attributed to the pass due to the inferred nature of the output model.

Water quality

It has been estimated that approximately 76% of the sandbanks feature within the SAC falls within one WFD waterbody (Carmarthen Bay), therefore this is likely to be a good reflection of the overall effect of water quality on the feature.

Nutrients (DIN only) and phytoplankton

The nutrients (DIN only) and phytoplankton indicators met the targets. A high confidence was attributed to the pass for the nutrients indicator as the one WFD waterbody that overlaps with the feature was classified with a Good status for DIN in the 2024 cycle 3 interim classification.

The Carmarthen Bay waterbody was classified with a Good status for the phytoplankton element in the 2024 cycle 3 interim classification, however it was Moderate status in the 2021 cycle 3 classification. The failure in this waterbody was uncertain in 2021 as the EQR was close to the Good status boundary (Lock, 2021). The confidence in the pass for the phytoplankton indicator was reduced to low to reflect this recent failure, and because the sampling locations for phytoplankton were not close to the sandbanks feature. In addition ecological relationships between phytoplankton and the sandbanks feature are not well understood.

Dissolved oxygen

The dissolved oxygen indicator met its target. The dissolved oxygen samples were taken at the water's surface. By the time oxygen depletion at the surface is recorded, oxygen throughout the water column could have been depleted for some time, especially as hypoxia or low oxygen levels, when present, typically occur in bottom water and sediments. Therefore, surface sampling of dissolved oxygen may not detect issues for more demersal features. This reduced the confidence in the pass to medium.

Contaminants

The Carmarthen Bay waterbody has a fail for chemicals in the 2024 cycle 3 interim classification, where mercury, PBDE and cypermethrin failed, causing the contaminants indicator to fail. The EQS for cypermethrin is very low, and in the previous lab methodology it was not possible to detect concentrations below the EQS. There has been a waterbody status change (pass to fail) between the 2021 cycle 3 classification and 2024 cycle 3 interim classification due to this reason. Cypermethrin is a synthetic pyrethroid insecticide and is highly toxic to some aquatic species (EA, 2019), but now has a restricted use in Wales. Mercury has failed in the waterbody since the 2015 cycle 2 classification. The EQS for mercury is based on the secondary poisoning protection goal (for wildlife). The PBDE failure was based on the value of the human health protection goal as it is the most stringent. This protection goal may be over precautionary as the effect of contaminants on the biota of mudflats and sandflats are not fully understood. This has reduced the

confidence in the fail to medium. In addition, the impact of the failing contaminants on the feature are not fully understood.

Turbidity and physicochemical properties

The turbidity indicator was assessed as unknown due to insufficient data. There were some data available from WFD Regulations sampling of suspended particulate matter. However, this is limited to only a few samples per year and therefore cannot be used to adequately assess the turbidity. The physicochemical indicator could not be assessed due to a lack of data.

Species and communities

The Carmarthen Bay waterbody was classified as Good status for the IQI element in the 2024 cycle 3 interim classification. This waterbody overlaps with 76% of the sandbanks feature.

Infaunal analysis showed that the species comprising the communities present in Helwick Bank vary widely across the monitoring period, but these variations were consistent across stations. There was some degree of change especially after 2001 and some form of recovery but the cause of this is unexplained and was not deemed large enough to fail the abundance, distribution and species composition of communities indicator. The confidence in the assessment, however, was reduced to medium.

There was a minor decrease of taxa richness after 2001, with a significant drop in 2016. This was possibly due to the unusual high abundance of mussel *Mytilidae* (inc. juvenile) in that year. Diversity increased again in 2019 and 2021 to levels similar to those observed in 2001 and 2013. The taxa richness has increased over the monitoring period. The species richness and diversity indicator therefore met its target with a high confidence as there have been no concerning declines in richness or diversity over the whole monitoring period.

The taxonomic distinctiveness analysis showed that the recent years were high in terms of number of species with a relatively high average distinctiveness. This indicates an improvement over time and resulted in a pass for this target. However, all sampling years were below the expected level, which may be explained by the sediment composition of Helwick Bank (e.g. mostly sandy), compared to more varied sandbanks that would have cause an increase of species, boosting the baseline level. For this reason, the assessment confidence has been reduced to medium.

Invasive non-native species

Crepidula fornicata was recorded for the first time in 2019 and has now increased from one large individual in 2019 to seven small individuals in 2022. The specimens recorded were found at two stations around the base of the sandbanks feature which have similar sediment types (e.g. mixed). The presence of this species in the sandbanks feature has resulted in a fail for the tertiary target of the non-native species (NNS) indicator. Confidence is high as this is a new NNS recorded in the feature within the last six years.

It is not fully understood how this species may spread and impact the condition of the sandbanks feature within the SAC, and effects on the species diversity and composition have not yet been observed. As there is no current impact from the INNS present the primary target of the INNS indicator passed. Confidence is low as the spread and impacts of the INNS present within the feature are not well understood and there has been no targeted survey of NNS on sandbanks.

Reasons for target failure

The sandbanks feature in Carmarthen Bay and Estuaries SAC has been assessed as being in **favourable** condition. However, one secondary target and one tertiary target failed to be met and need to be kept under review.

Water quality: contaminants

This indicator target has a secondary weighting. A large proportion of the sandbanks feature in the SAC overlaps with one WFD waterbody, Carmarthen Bay, that failed for chemicals. This waterbody failed due to mercury, PBDE and cypermethrin. Historically, the main source of PBDE is as flame retardants in a variety of materials (Viñas et al., 2022). Mercury has been used in many industries, but today the primary sources are burning of coal and artisan mining for mercury (Larsen and Hjermann, 2022). Cypermethrin is an insecticide used for plant protection in crops, in forestry, gardens, homes and businesses. It is also used in veterinary medicine to control pests in livestock and pets (EA, 2019). The application of cypermethrin has been restricted for some uses (sheep dipping and in forestry against the pine weevil).

Some of the contaminants in the water column may be derived from diffuse sources from atmospheric deposition and contaminated waterbody bed sediments, or point sources from continuous sewage discharge from wastewater treatment. However, a WFD investigation of the failure in the waterbody is yet to be undertaken. Mercury and PBDE are being managed in the UK and it is hoped that these levels will reduce in time.

Non-native species

This indicator failed to meet its tertiary target of no increase in the number of introduced NNS by human activities. This is due to records of *C. fornicata* found in the sandbanks feature within the last six years. The full extent of the impact that this species, along with other NNS present within the SAC, may have on the condition of the feature is currently unknown. For this reason it did not fail the primary target of the INNS indicator

Threats to condition

Part of the condition assessment is to identify threats to the condition of sandbanks. A threat is defined as an activity that is currently not impacting condition but has the potential to do so over the next reporting cycle, if activity levels increase or are unmanaged. It is important to identify these threats to be able to put pre-emptive management in place to prevent declines in condition.

Activities that go through licencing and permission process whereby the impact of the activity on the feature would be assessed have not been included. The threats to the sandbanks feature condition in the Carmarthen Bay and Estuaries SAC are stated below.

Invasive non-native species

INNS are not currently having an impact on the feature but high numbers in the future may pose a risk to its condition.

The abundance of *C. fornicata*, at two stations on the sandbanks feature has increased from 2019 to 2022. At high densities, this species could cause an impact on the feature as it has been shown to alter habitats if it settles in large numbers (Blanchard, 2009). It can also compete with native species for space and food (Frésard and Boncoeur, 2006; Mineur et al., 2012). It may therefore pose a threat to the sandbanks feature. However, the spread and impact of this species on the feature is not fully understood.

Further INNS were identified as potential threats to the UK and were listed in the latest horizon scanning exercise (Roy et al., 2019). There is a high likelihood for some of these species to be found in Wales in the future. This SAC could be at risk since there are a number of possible pathways of introduction. Further information on introduction pathways can be found on the GB non-native species secretariat website.

Water quality: contaminants

There is the potential for unregulated contaminants (such as PFAS) to increase. This could affect some of the biota of the sandbanks feature as PFAS has been shown to bioaccumulate in marine species, increasing up the trophic levels (Khan et al., 2023). However, the biological impact of PFAS on marine species is not well understood.

Some persistent chemicals are not measured in every WFD waterbody, and some of the relevant WFD waterbodies have not been classified for any chemicals.

Climate change

It is not yet clear what pressures we will see from climate change at the SAC level or how different pressures will counter act each other. However, threats from climate change may include (Gihwala et al., 2024):

- Changes in sea temperature and salinity.
- Ocean acidification.
- Changes in species distribution.

Evidence gaps

There are gaps in the current evidence that NRW feel are needed to be filled to fully understand condition in this feature.

Listed below (Table 20) are current indicators that were either assessed as unknown, not assessed, or assessed with a lower confidence. This was due to either limited data

availability, outdated data, or a lack of information. Some indicators are not currently monitored but should be ideally considered in future condition assessments.

Table 20. Evidence gaps for the sandbanks feature in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Assessed status	Comments
Distribution and extent of habitats and communities (P)	Not assessed	• Biotopes are not well established for sandbanks. There is a lack of any recent information on biotopes classification for sandbanks therefore this indicator was not assessed in any of the SACs.
Topography of the feature (P)	Medium confidence (proxy data used)	• The topography of sandbanks is not well monitored in all SACs. More bathymetry surveys for all sandbanks are required in future.
Hydrodynamic and sediment transport processes (P)	Medium confidence (proxy data used)	• The hydrodynamic regime of sandbanks is not currently monitored in all SACs.
Invasive non-native species (P)	Low confidence (limited data)	• The spread and impact of the NNS currently present within the SAC on the sandbanks feature is not fully understood. More targeted surveys and investigation on the impact of NNS on sandbanks are needed.
Sediment quality: oxidation-reduction profile (S); volume (S); organic carbon content (S); contaminants (S)	Not assessed	• These aspects are not currently monitored in sandbank sediment particle size analysis (PSA), but could be incorporated into analysis in future.
Water quality: turbidity (S)	Unknown	• Turbidity is measured in WFD sampling. As this is limited to only a few samples per year it cannot be used to adequately assess the turbidity. • Investigation of the use of remote sensing data to assess turbidity could be carried out in the future. External data from other organisations could also be used.
Water quality: physicochemical properties (S)	Not assessed / unknown	• There were no temperature, salinity or pH loggers within the Carmarthen Bay and Estuaries SAC. • Remote sensing data on temperature, salinity and pH could be used in future.

3.7. Allis shad condition assessment

Allis shad *Alosa alosa* has been designated as a qualifying feature in Carmarthen Bay and Estuaries SAC as it is considered an important coastal migration route or feeding ground, and as the upstream catchment (River Tywi SAC) has historically supported a substantial spawning population. There may be other relevant rivers that contribute to the SAC population. A summary of the condition assessment for allis shad in Carmarthen Bay and Estuaries SAC can been seen in Table 21. The overall feature condition, a detailed summary of the assessment and threats to condition are discussed in more detail in the sections below.

Table 21. Condition assessment of allis shad in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Population variables and data	The population of allis shad relevant to the SAC should be stable or increasing in the long-term. (P)	• There have been no confirmed recent records of allis shad within the River Tywi SAC. • There have also been no confirmed recent records of allis shad in the Carmarthen Bay and Estuaries SAC. Population numbers are thought to be very low. • Records of the species in the Rivers Severn, Wye and Usk have been considered as allis shad could migrate between the SAC and these spawning grounds. The historical collapse of the allis shad population in the River Severn was linked to weir construction. Barriers in the Severn and its tributaries are still present and are thought to be limiting the upstream migration of allis shad within this catchment. • Although this indicator was assessed, data on allis shad are very limited and there have been no targeted surveys of the species in any of the marine SACs, therefore confidence is medium.	**Fail**	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Habitat connectivity	Maintain safe passage and movement of allis shad in the marine environment into, within and away from the SAC, including to and from the connected spawning locations. (P)	• There are no known barriers to marine migration within or into the Carmarthen Bay and Estuaries SAC. • There are no known barriers to migration in the Severn Estuary SAC and in the Bristol Channel that could impact allis shad in the Carmarthen Bay and Estuaries SAC. • Confidence is high as in depth site knowledge was used.	**Pass**	High
Freshwater flow	Maintain freshwater flow to the estuary / estuaries within the SAC. Regulated rivers meet their minimum flow targets. (P)	• There are no known issues affecting the freshwater flow to the Carmarthen Bay and Estuaries SAC that would affect allis shad migration. • There are no known issues within the River Tywi SAC catchment affecting freshwater flow to the Three Rivers estuary. • Licenced abstractions on the River Tywi SAC have gone through the Review of Consents (RoC) process to ensure designated features are adequately protected. • Flow data were not analysed for this assessment therefore confidence is medium.	**Pass**	Medium
Invasive non-native species (INNS)	Spread and impact of INNS caused by human activities is not having a detrimental impact at the population level. (P)	• There are no known records of the INNS that are of particular concern for allis shad within Carmarthen Bay and Estuaries SAC and associated River Tywi SAC. • Confidence is high due to the availability of long term monitoring data on the species of concern to allis shad.	**Pass**	High

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Anthropogenic mortality: targeted exploitation	There should be no targeted exploitation of the species. (S)	• No targeted exploitation of allis shad is understood to be occurring. • Under the Wildlife & Countryside Act 1981 (as amended) it is illegal to take, kill or disturb (including fishing for) allis shad without a license. • Confidence is high as the assessment was based on expert judgement and knowledge that there are no fisheries that could capture the species in the SAC.	**Pass**	High
Anthropogenic mortality: abstraction and entrapment	Abstraction and entrapment should not adversely affect the viability of the population. (S)	• All licenced abstractions have previously been assessed through the Habitats Regulations (RoC) process, Eel Regulations, or Salmon and Freshwater Fisheries Act (SAFFA)1975. • All new abstractions are required to go through permitting processes to comply with screening requirements for fish. • There are no major operations within the SAC or rivers draining into the SAC known to be causing entrapment of allis shad. • Confidence is high as all operations go through permitting processes and as the assessment has been based on up-to-date specialist knowledge and data.	**Pass**	High
Anthropogenic mortality: bycatch	Bycatch of the species should not adversely affect the viability of the population. (S)	• Bycatch of allis shad is thought to be low for the SAC population. • Pelagic fisheries in the Celtic Sea may have bycatch of allis shad but there are no data on the potential impact of this. • The indicator was assessed as unknown as there are no data to assess the extent and impact of bycatch of allis shad.	**Unknown**	N/A

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Fish Community	The WFD Estuarine Fish tool is at least good. (T)	• The estuarine fish WFD element is assessed in transitional WFD waterbodies only. • Neither of the two transitional WFD waterbodies in the SAC (Burry Inlet Inner and Three Rivers Estuary) were assessed for the estuarine fish WFD element in the 2024 cycle 3 interim classification. • The indicator was therefore assessed as unknown.	**Unknown**	N/A
Water quality: contaminants	Water column contaminants not to exceed the EQS. (S)	• Three of the four WFD waterbodies in the SAC have a pass for chemicals in the 2024 cycle 3 interim classification (Burry Inlet Inner, Burry Inlet Outer and Three Rivers Estuary). In all waterbodies, some or all of the chemical classifications were rolled forward from previous cycles as they were not classified in the 2024 cycle 3 interim classification. • The other WFD waterbody has a fail for chemicals (Carmarthen Bay). It failed for mercury, PBDE and cypermethrin. • Confidence is low as: the human health standard has been used for PBDE; some chemical classifications were rolled forward; and contaminants are not directly monitored in this species.	**Fail**	Low

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: dissolved oxygen	The WFD classification achieved for dissolved oxygen should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (P)	• All four WFD waterbodies in the SAC have been classified as High status for dissolved oxygen in the 2024 cycle 3 interim classification. • All WFD waterbodies that have been assessed overlap with an extensive area within the SAC and are therefore considered to be representative of the area that allis shad would use in the SAC. • Confidence is medium as samples have been taken from the surface of waterbodies.	**Pass**	Medium

Assessment conclusions

The allis shad feature in Carmarthen Bay and Estuaries SAC has been assessed as being in **unfavourable** condition (medium confidence). There were two indicators with failing targets (Table 22). The reason for low populations of allis shad in the SAC and across Wales is not known. The species is currently classified as Critically Endangered (presumed extinct) in Wales. The confidence was reduced to medium as the assessment was based on expert judgement as there are limited data within the marine SAC. Further investigation is needed to better understand the failure to be able to identify management options that can bring the feature back into favourable condition.

A summary of the assessment can be seen in Table 22 with more detail on each performance indicator, and any reasons for failure, provided in the sections below.

Table 22. Summary of the condition assessment for allis shad in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

Feature	Overall Condition Assessment	Indicator failures	Reason for target failure	Threats to condition
Allis shad *Alosa alosa*	**Unfavourable (medium confidence)**	Population variables and data (P) Water quality: contaminants (S)	• There are critically low populations of allis shad across Wales. • Levels of mercury, PBDE and cypermethrin in the Carmarthen Bay waterbody are failing to meet their relevant EQSs.	• Industry • INNS • Water quality: contaminants • Climate change

Detailed assessment information

Population variables

Allis shad are classified 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 twaite shad probably means that allis shad are functionally extinct in Wales (Nunn et al., 2023). NRW has records of shad eggs which show that shad are spawning on a regular basis in the relevant river catchments. However, it is not possible to determine which species the eggs are from.

The River Tywi is one of the only three rivers in Wales where there are substantial spawning populations of shad. It should be noted that the shad population on the Tywi shows an unusually high proportion of allis shad haplotypes (72%), likely indicating past hybridisation with allis shad (Hardouin et al., 2013). For the purposes of these assessments, these individuals are considered to be twaite shad as allis shad numbers are very low across Wales. Hardouin et al. (2013) found that in the River Wye, 1% of the eggs studied were assigned to allis shad, compared to 70% for twaite shad, with 29% being hybrids. The Rivers Usk and Tywi had 0% proportions of allis shad. There have been no confirmed records of allis shad in the Carmarthen Bay and Estuaries SAC and River Tywi SAC, and population numbers are thought to be very low. Detection is hampered by the lack of targeted surveys for this species in the marine environment.

As the SAC is designated as a migration route for the species, in addition to being directly connected to a historical spawning population in the River Tywi SAC, records of the species in the River Severn and its tributaries have been considered as allis shad could migrate between the SAC and these spawning grounds. Weir construction was thought to have been a primary reason for the collapse of the allis shad population in the River Severn in England (Aprahamian et al., 1998). The Unlocking the Severn Project has constructed a series of fish passes that open up 254 km of previously inaccessible river to shad, greatly improving the area of available habitat on the river and allowing access along the main Severn as far as Stourport. However, this only amounts to approximately half the distance of river that would previously have been available. Barriers in the Severn, and upstream tributaries in the Usk are still present and are thought to be limiting the upstream migration of allis shad within this catchment. Improvements are planned or in progress at the two weirs on the Usk to progress fish easement as part of the Four Rivers for LIFE project, and works have also been carried out on some of the weirs on the Severn in England as part of the Unlocking the Severn Project.

The indicator linked to population failed to meet its set target, primarily due to the low number of records of the species within the Carmarthen Bay and Estuaries SAC, and connected River Tywi SAC. The assessment was based on expert judgement, therefore confidence of the fail was reduced to medium. Although this indicator was assessed, data on allis shad are very limited and there have been no targeted surveys of the species in the marine SAC or upstream rivers. Surveys of allis shad are therefore required within the SAC.

Habitat connectivity and freshwater flow

There are no known marine barriers within the Carmarthen Bay and Estuaries SAC and from the Severn Estuary SAC, or along the coast in between that could impact allis shad in the Carmarthen Bay and Estuaries SAC. The indicator therefore passed its target with high confidence as there are no known issues with connectivity within the marine migration routes into and through the SAC.

All licenced abstractions on the River Tywi SAC went through the Review of Consents (RoC) process which ensured that designated features, including migratory shad, were adequately protected. This indicator in the Carmarthen Bay and Estuaries SAC does not include a specific freshwater flow target. Flow data are available at some locations within the contributing rivers. The freshwater flow indicator therefore passed the target as there are no known issues with flow to the Three Rivers estuary or River Tywi SAC that drains into the Carmarthen Bay and Estuaries SAC. Confidence in the pass is medium as flow data were not used for the assessment.

Invasive non-native species

The INNS that could significantly impact the allis shad are Chinese mitten crab and Signal crayfish. There have been a small number records of signal crayfish near Llandelio, and there is a population in the Nant Gurrey Fach that may have spread into neighbouring areas. These are tributaries that drain into the River Tywi SAC. There are no other known records of these species within the Carmarthen Bay and Estuaries SAC or the River Tywi SAC catchment. The INNS indicator therefore passed the target with a high confidence.

Anthropogenic mortality

There is no known targeted exploitation of allis shad within Carmarthen Bay and Estuaries SAC therefore this indicator passed its target. Under the Wildlife & Countryside Act 1981 (as amended) it is illegal to take, kill or disturb (including fishing for) allis shad without a license. Any specimens caught unintentionally must be released alive. High confidence was attributed to the indicator pass as it was based on expert judgement and knowledge that there are no fisheries that could capture the species in the site, especially given the low population numbers.

In Wales, all licenced abstractions have been assessed through Habitats Regulations RoC process, Eel Regulations, or Salmon and Freshwater Fisheries Act (SAFFA) 1975 to ensure that all permitted abstractions are screened to minimise entrainment of fish. There are no major operations such as power stations within the Carmarthen Bay and Estuaries SAC or rivers draining into the SAC known to be causing entrapment of allis shad. The abstraction and entrapment target was therefore assessed as passing with high confidence as all operations go through regulated screening permitting processes and as the assessment has been based on up-to-date specialist knowledge and data. There were power stations in the Bristol channel which may have impacted the allis shad that originate in the Severn. These are no longer operational and abstraction has significantly reduced therefore they are no longer considered a threat to allis shad.

Bycatch of allis shad within the Carmarthen Bay and Estuaries SAC is thought to be low, particularly given the population levels. There may be some bycatch of allis shad in the pelagic fisheries in the Celtic Sea, however there are no data on the potential impact of this on the SAC population. As there are no data to assess the extent and impact of bycatch of allis shad, the indicator was assessed as unknown.

Fish community

The fish community indicator was assessed as unknown for allis shad in the Carmarthen Bay and Estuaries SAC due to an absence of data. The WFD estuarine fish tool is used as a proxy for habitat quality for fish in general in estuaries. If this element is classified as Good status it is likely that the conditions for fish, and therefore allis shad, are favourable. The estuarine fish element is assessed in the transitional WFD waterbodies only. Within the SAC there are two transitional WFD waterbodies, the Burry Inlet Inner and Three Rivers Estuary waterbodies, and neither has been assessed in the 2024 cycle 3 interim classification. The Three Rivers Estuary waterbody was previously assessed with a Moderate status in the 2009 cycle 1 classification but it has not been assessed since. The methodology used in the WFD fish classification has changed since the 2009 cycle 1 classification. As the cycle 1 information is not comparable to the current methodology, it has not be used.

Water quality

There are four WFD waterbodies within the Carmarthen Bay and Estuaries SAC: Carmarthen Bay, Burry Inlet Outer, Burry Inlet Inner, and the Three Rivers Estuary (Tywi, Taf and Gwendraeth). The water quality indicator conclusions also apply to twaite shad.

Contaminants

The Carmarthen Bay waterbody has a fail for chemicals in the 2024 cycle 3 interim classification, where mercury, PBDE and cypermethrin failed. The EQS for cypermethrin is very low, and in the previous lab methodology it was not possible to detect concentrations below the EQS. There has been a waterbody status change (pass to fail) between the 2021 cycle 3 classification and 2024 cycle 3 interim classification due to this reason. Cypermethrin is a synthetic pyrethroid insecticide and is highly toxic to some aquatic species (EA, 2019), but now has a restricted use in Wales. Mercury has failed in the waterbody since the 2015 cycle 2 classification. The EQS for mercury is based on the secondary poisoning protection goal (for wildlife). The PBDE failure was based on the value of the human health protection goal as it is the most stringent. This protection goal may be over precautionary as the effect of contaminants on the allis shad feature are not fully understood. The Carmarthen Bay waterbody overlaps with a large area in the SAC, therefore the chemical failure there has resulted in the failure for the contaminants indicator. The other three WFD waterbodies have a pass for chemicals in the 2024 cycle 3 interim classification. However, in all three waterbodies, some or all of the chemical classifications were rolled forward from previous cycles as they were not assessed in the 2024 cycle 3 interim classification.

Overall, a low confidence was assigned to the failure of the contaminants indicator because the human health standard has been used for PBDE, and due to the roll forward in some chemical classifications. In addition, the effect of the chemical failure on the

species is uncertain, and the contaminants have not been directly monitored in this species.

Dissolved oxygen

The dissolved oxygen indicator passed its target as all four WFD waterbodies in the SAC were classified as High status for the dissolved oxygen element in the 2024 cycle 3 interim classification. These WFD waterbodies overlap with an extensive area in the coastal part of the SAC and are therefore considered to be representative of the areas potentially used by the allis shad feature in the Carmarthen Bay and Estuaries SAC. The dissolved oxygen samples are taken at the water's surface. By the time oxygen depletion at the surface is recorded, oxygen throughout the water column could have been depleted for some time, especially as hypoxia or low oxygen levels, when present, typically occur in bottom water and sediments. Therefore surface sampling of dissolved oxygen may not detect issues throughout the water column or for more demersal features. This reduced the confidence in the pass to medium.

Physicochemical properties

The physicochemical indicator could not be assessed due to a lack of data.

Reasons for target failure

The assessment of allis shad in Carmarthen Bay and Estuaries SAC failed one primary target and one secondary target. This resulted the allis shad feature to be assessed as being in **unfavourable** condition. The failing indicators and reasons for failure, if known, are stated below.

Population variables and data

The population indicator target was not met as there have been no confirmed records of allis shad within the SAC. In the wider region, allis shad are classified as Critically Endangered (presumed extinct) in Wales. Data on allis shad are very limited and there have been no targeted surveys of the species in any of the marine SACs. On the River Severn in England, weir construction was thought to have been a primary reason for the historical collapse of the allis shad population in the river (Aprahamian et al., 1998).

Water quality: contaminants

This indicator failed to meet its secondary target due to the failure of chemical status in the Carmarthen Bay waterbody, which failed for mercury, PBDE and cypermethrin. Historically, the main source of PBDE is as flame retardants in a variety of materials (Viñas et al., 2022). Mercury has been used in many industries, but today the primary sources are burning of coal and artisan mining for mercury (Larsen and Hjermann, 2022). Cypermethrin is an insecticide used for plant protection in crops, in forestry, gardens, homes and businesses. It is also used in veterinary medicine to control pests in livestock and pets (EA, 2019). The application of cypermethrin has been restricted for some uses (sheep dipping and in forestry against the pine weevil).

Some of the contaminants in the water column may be derived from diffuse sources from atmospheric deposition and contaminated waterbody bed sediments, or point sources from

continuous sewage discharge from wastewater treatment. However, a WFD investigation of the failure in the Carmarthen Bay waterbody is yet to be undertaken. Mercury and PBDE are being managed in the UK and it is hoped that these levels will reduce in time.

Threats to condition

Part of the condition assessment is to identify threats to the condition of the allis shad feature. A threat is defined as an activity that is currently not impacting condition but has the potential to do so over the next reporting cycle, if activity levels increase or are unmanaged. It is important to identify these threats to be able to put pre-emptive management in place to prevent declines in condition. The threats to the allis shad feature in Carmarthen Bay and Estuaries SAC are stated below.

Industry

Any planned installations and projects which could impinge or entrap allis shad, and therefore have the potential to impact the species at a population level, need to be considered carefully, given the low population levels.

Invasive non-native species

There have been some records of signal crayfish in the tributaries that drain into the River Tywi SAC. Signal crayfish would predate on eggs of the allis shad. There are currently no records of Chinese mitten crab in the Carmarthen Bay and Estuaries or River Tywi SACs. There is a threat that these could be introduced to the area.

Further INNS were identified as potential threats to the UK and were listed in the latest horizon scanning exercise (Roy et al., 2019). There is a high likelihood for some of these species to be found in Wales in the future. This SAC could be at risk since there are a number of possible pathways of introduction. Further information on introduction pathways can be found on the GB non-native species secretariat website.

Water quality: contaminants

There is the potential for unregulated contaminants (such as PFAS) to increase. This could affect allis shad as PFAS has been shown to bioaccumulate in marine species, increasing up the trophic levels (Khan et al., 2023). However, the biological impact of PFAS on marine species is not well understood.

Some persistent chemicals are not measured in every WFD waterbody, and some of the relevant WFD waterbodies have not been classified for any chemicals.

Climate change

It is not yet clear what pressures we will see from climate change at the SAC level or how different pressures will counteract each other. However, threats from climate change that could impact the species may include:

- Increasing sea surface and river temperature.

- Changes in precipitation impacting riverine flow in spring and summer, affecting the ability of adults to pass partial barriers and causing washout of eggs and juveniles.
- Changes to prey availability and abundance.

Evidence gaps

There are gaps in the current evidence that NRW feel are needed to be filled to fully understand condition in this feature.

Listed below (Table 23) are current indicators that were either assessed as unknown, not assessed, or assessed with a lower confidence. This was due to either limited data availability, outdated data, or a lack of information. Some indicators are not currently monitored but should be ideally considered in future condition assessments.

Table 23. Evidence gaps for the allis shad feature in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Assessed status	Comments
Population variables and data (P)	Medium confidence (limited data)	• Although this indicator was assessed, data on allis shad in the marine environment are limited and there have been no targeted surveys of the species within the marine SACs.
Anthropogenic mortality: bycatch (S)	Unknown	• The extent of bycatch of allis shad in fisheries is uncertain.
Fish community (S)	Unknown	• The WFD Regulations monitoring of the estuarine fish community element is only carried out in some transitional WFD waterbodies therefore this does not cover the full extent of the SACs (coastal WFD waterbodies). • In this SAC, neither of the transitional WFD waterbodies have been assessed for the estuarine fish element in the 2024 cycle 3 interim classification.
Water quality: physicochemical properties (T)	Not assessed / unknown	• There were no temperature, salinity or pH loggers within the Carmarthen Bay and Estuaries SAC. • Remote sensing data on temperature, salinity and pH could be used in future.

3.8. Twaite shad condition assessment

Twaite shad *Alosa fallax* has been designated as a qualifying feature in the Carmarthen Bay and Estuaries SAC. Twaite shad migrate through the Carmarthen Bay and Estuaries SAC to reach spawning sites in the River Tywi SAC, and are likely to use the inshore coastal waters of Carmarthen Bay for feeding, and the Three Rivers estuary for nursery areas. Populations from other regions (Rivers Severn, Wye and Usk) have also been considered in the assessment as they are likely to contribute to the Carmarthen Bay and Estuaries SAC population of twaite shad. There may be other relevant rivers that contribute to the SAC population. A summary of the condition assessment for twaite shad in Carmarthen Bay and Estuaries SAC can been seen in Table 24. The overall feature condition, a detailed summary of the assessment and threats to condition are discussed in more detail in the sections below.

Table 24. Condition assessment of twaite shad in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Population variables and data	The population of twaite shad relevant to the SAC should be stable or increasing in the long-term. (P)	• The population size of twaite shad in the River Tywi catchment is unknown. However, there has been anecdotal evidence of spawning in the catchment and populations were thought to be strong in 2023. • Telemetry studies evidence that twaite shad from the Rivers Severn, Wye and Tywi use embayment's such as Bridgwater Bay and Swansea Bay. These have therefore been considered in the assessment. Modelling of River Severn populations (1991-2023) showed large reductions in the number of twaite shad returning. The indicator failed the target based on this declining population. • Confidence is low as the contribution of each river population into the SAC is unknown and as some angler data and limited egg counts indicate that the twaite shad population in the Tywi, Usk and Wye may be stable. The absence of population counts on these rivers reduced the confidence.	**Fail**	Low

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Habitat connectivity	Maintain safe passage and movement of twaite shad in the marine environment into, within and away from the SAC, including to and from the connected spawning locations. (P)	• There are no known barriers to marine migration within or into the Carmarthen Bay and Estuaries SAC. • There are no known barriers to migration in the Severn Estuary SAC and in the Bristol Channel that could impact twaite shad in the Carmarthen Bay and Estuaries SAC. • Confidence is high as in depth site knowledge was used.	**Pass**	High
Freshwater flow	Maintain freshwater flow to the estuary / estuaries within the SAC. Regulated rivers meet their minimum flow targets. (P)	• There are no known issues affecting the freshwater flow to the Carmarthen Bay and Estuaries SAC that would affect twaite shad migration. • There are no known issues within the River Tywi SAC catchment affecting flow to the Three Rivers estuary. • Licenced abstractions on the River Tywi SAC have gone through the RoC process ensure designated features are adequately protected. • Flow data were not analysed for this assessment therefore confidence is medium.	**Pass**	Medium
Invasive Non-Native Species (INNS)	Spread and impact of INNS caused by human activities is not having a detrimental impact at the population level. (P)	• There are no known records of the INNS that are of particular concern for twaite shad within Carmarthen Bay and Estuaries SAC and associated River Tywi SAC. • Confidence is high due to the availability of long term monitoring data on the species of concern to twaite shad.	**Pass**	High

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Anthropogenic mortality: targeted exploitation	There should be no targeted exploitation of the species. (S)	• No targeted exploitation of twaite shad is understood to be occurring. • Under the Wildlife & Countryside Act 1981 (as amended) it is illegal to fish for twaite shad without a license. • Confidence is high as the assessment was based on expert judgement and knowledge that there are no fisheries that could capture the species in the SAC.	**Pass**	High
Anthropogenic mortality: abstraction and entrapment	Abstraction and entrapment should not adversely affect the viability of the population. (S)	• All licenced abstractions have previously been assessed through the Habitats Regulations RoC process, Eel Regulations, or SAFFA 1975. • All new abstractions are required to go through permitting processes to comply with screening requirements for fish. • There are no major operations within the SAC or rivers draining into the SAC known to be causing entrapment of twaite shad. • Confidence is high as all operations go through permitting processes and as the assessment has been based on up-to-date specialist knowledge and data.	**Pass**	High
Anthropogenic mortality: bycatch	Bycatch of the species should not adversely affect the viability of the population. (S)	• Bycatch of twaite shad is thought to be low for the SAC population. • Pelagic fisheries in the Celtic Sea may have bycatch of twaite shad but there are no data on the potential impact of this. • The indicator was assessed as unknown as there are no data to assess the extent and impact of bycatch of twaite shad.	**Unknown**	N/A

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Fish Community	The WFD Estuarine Fish tool is at least good. (T)	• The estuarine fish WFD element is assessed in transitional WFD waterbodies only. • Neither of the two transitional WFD waterbodies in the SAC (Burry Inlet Inner and Three Rivers Estuary) were assessed for the estuarine fish WFD element in the 2024 cycle 3 interim classification. • The indicator was therefore assessed as unknown.	**Unknown**	N/A
Water quality: contaminants	Water column contaminants not to exceed the EQS. (S)	• Three of the four WFD waterbodies in the SAC have a pass for chemicals in the 2024 cycle 3 interim classification Burry Inlet Inner, Burry Inlet Outer and Three Rivers Estuary). In all waterbodies, some or all of the chemical classifications were rolled forward from previous cycles as they were not classified in the 2024 cycle 3 interim classification. • The other WFD waterbody has a fail for chemicals (Carmarthen Bay). It failed for mercury, PBDE and cypermethrin. • Confidence is low as: the human health standard has been used for PBDE; some chemical classifications have been rolled forward; and contaminants are not directly monitored in this species.	**Fail**	Low

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: dissolved oxygen	The WFD classification achieved for dissolved oxygen should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (P)	• All four WFD waterbodies in the SAC have been classified as High status for dissolved oxygen in the 2024 cycle 3 interim classification. • All WFD waterbodies that have been assessed overlap with an extensive area within the SAC and are therefore considered to be representative of the area that twaite shad would use in the SAC. • Confidence is medium as samples have been taken from the surface of waterbodies.	**Pass**	Medium

Assessment conclusions

The twaite shad feature in Carmarthen Bay and Estuaries SAC has been assessed as being in **unfavourable** condition (low confidence). There were two indicators with failing targets (Table 25). The confidence was reduced to low as the contribution of twaite shad from the Severn to the SAC population is unknown, and because the state of the twaite shad population in the Tywi, Usk and Wye are unknown but may be stable. Further investigation is needed to better understand the failure to be able to identify management options that can bring the feature back into favourable condition.

A summary of the assessment can be seen in Table 25 with more detail on each performance indicator, and any reasons for failure, provided in the sections below.

Table 25. Summary of the condition assessment for twaite shad in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

Feature	Overall Condition Assessment	Indicator failures	Reason for target failure	Threats to condition
Twaits shad *Alosa fallax*	**Unfavourable (low confidence)**	Population variables and data (P) Water quality: contaminants (S)	• The population of twaite shad in the Severn catchment is declining, which is likely to contribute to the Carmarthen Bay and Estuaries SAC population, and may be reflective of wider shad population trends. • Levels of mercury, PBDE and cypermethrin in the Carmarthen Bay waterbody are failing to meet their relevant EQSs.	• Industry • INNS • Water quality: contaminants • Climate change

Detailed assessment information

Population variables

The River Tywi is one of the only three rivers in Wales where there are substantial spawning populations of shad. It should be noted that the shad population on the Tywi shows an unusually high proportion of allis shad haplotypes (72%), likely indicating past hybridisation with allis shad (Hardouin et al., 2013). For the purposes of these assessments, these individuals are considered to be twaite shad as allis shad numbers are very low across Wales.

The River Tywi is the main contributing river to the Carmarthen Bay and Estuaries SAC population of twaite shad. There has been anecdotal evidence of twaite shad spawning throughout the River Tywi catchment below Llandeilo, and it is reasonably certain that populations were strong in 2023. However, quantification of the population size in the River Tywi has not been possible using the counter data available. This is because twaite shad migrate in shoals and are therefore difficult to count, and as fish were found to move both up and downstream at the counter location.

Shad telemetry studies conducted by Swansea University have provided evidence of movements of twaite shad from the Severn, Wye and Tywi within the Bristol Channel. Shad from all these rivers have been shown to utilise embayment's such as Bridgwater Bay and Swansea Bay within the Bristol Channel at different points during the year, with a significant degree of mixing within the Bristol Channel. Therefore, it is likely that twaite shad from the Usk, Wye and Severn use the Carmarthen Bay and Estuaries SAC. Records of the species in the River Severn and its tributaries have therefore been considered in the assessment.

In the River Severn catchment, the population of twaite shad has been modelled from 1991 to 2024, and monitored as part of the Unlocking the Severn project. These have shown a significant decline in the number of returning adult shad (EA, 2020), with the current data indicating that there has been a decline to less than 10% of the pre-2017 adult population (EA, unpublished). The cause of this decline is unclear, and it is also not known whether it is a river-specific issue or is also occurring in the Rivers Wye, Usk and Tywi.

Good juvenile recruitment is heavily dependent on warm, stable flow conditions in the spawning rivers (Aprahamian et al., 2010; Knights, 2014). More extreme weather events such as flooding, especially in summer months, in the last 20 years may have limited the recruitment of twaite shad (EA, 2020). The current British population of twaite shad is substantially lower than it has been historically (Nunn et al., 2023). The spawning run estimates in the Severn Estuary have been considered to be appropriate to use as an index site to assess any changes in the population size regionally. These estimates found that the three-generation percentage change was approximately 41% (Nunn et al., 2023). NRW has records of shad eggs which show that shad are spawning on a regular basis in the relevant river catchments. However, it is not possible to determine what species the eggs are.

Historically, twaite shad ascended the Severn as far as Welshpool (Aprahamian et al., 1998). On the Severn, the Unlocking the Severn Project has constructed a series of fish

passes that open up 254 km of previously inaccessible river to shad, greatly improving the area of available habitat on the river and allowing access along the main Severn as far as Stourport. However, this only amounts to approximately half the distance of river that would previously have been available. Barriers in the River Severn, and upstream tributaries in the Usk are still present and are thought to be limiting the upstream migration of shad within this catchment. Improvements are planned or in progress at the two weirs on the Usk to progress fish easement as part of the Four Rivers for LIFE project, and works have also been carried out on some of the weirs on the Severn in England as part of the Unlocking the Severn Project.

The River Tywi twaite shad population was surveyed in 2013 and 2015 using egg surveys (a measure of spawning extent). On these occasions, the Tywi met its target (Garrett, 2015). No comparable surveys are available for the Usk and Wye.

The indicator linked to population was assessed as failing the set target due to the decline of twaite shad in the River Severn population. The contribution of this population into the Carmarthen Bay and Estuaries SAC population is not known, and it is not certain if the declines seen in the Severn are due to localised impacts or broader effects such as more extreme weather events which are likely to affect other rivers as well. There has been angler data from the Wye and Usk and egg counts in the three rivers (Tywi, Usk and Wye) which indicate that the population of twaite shad may be stable (NRW, in prep). However, quantification of the population size in these rivers has not been possible using the counter data available. This is because twaite shad migrate in shoals and are therefore difficult to count, and as fish were found to move both up and downstream at the counter location. The lack of direct count data of the twaite shad populations in the Tywi, Usk and Wye reduced the confidence, leading to an overall low confidence assessment. Data on twaite shad in the Carmarthen Bay and Estuaries SAC are very limited and there have been no targeted surveys of the species in any of the marine SACs, therefore surveys of the species within the SAC are required.

Habitat connectivity and freshwater flow

There are no known marine barriers in the Carmarthen Bay and Estuaries SAC and from the Severn Estuary SAC, and along the coast in between that could impact twaite shad in the Carmarthen Bay and Estuaries SAC. The indicator therefore passed its target with high confidence as there are no known issues with connectivity within the marine migration routes into and through the SAC.

The freshwater flow indicator passed its target as there are no known issues with flow to the Three Rivers estuary or River Tywi SAC that drains directly into the Carmarthen Bay and Estuaries SAC. This conclusion was based on the RoC process (see further information in Section 3.7). Confidence in the pass is medium as flow data were not used for the assessment.

Invasive non-native species

The INNS that could significantly impact the twaite shad are Chinese mitten crab and Signal crayfish. There are no known records of these species within the Carmarthen Bay and Estuaries SAC nor the River Tywi SAC catchment. There have been a very small number of records of Signal crayfish in the Usk management catchment, but these are

unlikely to be affecting twaite shad at the population level. The INNS indicator therefore passed its target with a high confidence.

Anthropogenic mortality

There is no known targeted exploitation of twaite shad within Carmarthen Bay and Estuaries SAC therefore this indicator passed its target. Under the Wildlife & Countryside Act 1981 (as amended) it is illegal to fish for twaite shad without a license. Any specimens caught unintentionally must be released alive. High confidence was attributed to the indicator pass as it was based on expert judgement and knowledge that there are no fisheries that could capture the species in the site.

In Wales, all licenced abstractions have been assessed through Habitats Regulations RoC process, Eel Regulations, or SAFFA 1975 to ensure that all permitted abstractions are screened to minimise entrainment of fish. There are no major operations such as power stations within the Carmarthen Bay and Estuaries SAC or rivers draining into the SAC known to be causing entrapment of twaite shad. The abstraction and entrapment target was therefore assessed as passing with high confidence as all operations go through regulated screening permitting processes and as the assessment has been based on up-to-date specialist knowledge and data. There were power stations in the Bristol channel which are no longer operational, and abstraction has significantly reduced therefore they are no longer considered a threat to twaite shad.

Bycatch of twaite shad within the Carmarthen Bay and Estuaries SAC is thought to be low. There may be some bycatch of twaite shad in the pelagic fisheries in the Celtic Sea, however there are no data on the potential impact of this on the SAC population. As there are no data to assess the extent and impact of bycatch of twaite shad, the indicator was assessed as unknown.

Fish community

The fish community indicator was assessed as unknown for twaite shad in the Carmarthen Bay and Estuaries SAC due to an absence of data. The estuarine WFD fish tool is used as a proxy for habitat quality in the estuaries. If this element is classified as Good status it is likely that the conditions for fish, and therefore twaite shad, are favourable. The estuarine fish element is assessed in the transitional WFD waterbodies only. Within the SAC there are two transitional WFD waterbodies, the Burry Inlet Inner and Three Rivers Estuary waterbodies, and neither has been assessed in the 2024 cycle 3 interim classification. The Three Rivers Estuary waterbody was previously assessed with a Moderate status in the 2009 cycle 1 classification but it has not been assessed since. The methodology used in the WFD fish classification has changed since the 2009 cycle 1 classification. As the cycle 1 information is not comparable to the current methodology, it has not be used.

Water quality

See allis shad water quality in Section 3.7 as it also applies to twaite shad.

Reasons for target failure

The assessment of twaite shad in Carmarthen Bay and Estuaries SAC failed one primary target and one secondary target. This resulted the twaite shad feature to be assessed as being in **unfavourable** condition. The failing indicators and reasons for failure, if known, are stated below.

Population variables and data

Twaite shad migrate between the Carmarthen Bay and Estuaries SAC and spawning rivers directly upstream in the Tywi, and also between the Usk, Wye and Severn. However, the degree of the contributions of these other spawning rivers to the SAC population is not fully understood. Modelling and recent monitoring of twaite shad in the Severn catchment using data from the putcher ranks sampling, Hinkley Point B impingement records and Unlocking the Severn run counts depict a long-term decline of twaite shad. The Unlocking the Severn monitoring has shown a further significant reduction in the population since 2020. The long-term decline is likely linked to an increase in more extreme weather events, such as summer flooding (EA, 2020). The condition of the twaite shad population in the Tywi, Usk and Wye may be stable.

Water quality: contaminants

See allis shad reasons for failure in Section 3.7 as it also applies to twaite shad.

Threats to condition

Part of the condition assessment is to identify threats to the condition of the twaite shad feature. A threat is defined as an activity that is currently not impacting condition but has the potential to do so over the next reporting cycle, if activity levels increase or are unmanaged. It is important to identify these threats to be able to put pre-emptive management in place to prevent declines in condition. The threats to the twaite shad feature in Carmarthen Bay and Estuaries SAC are stated below.

Industry

Any planned installations and projects which could impinge or entrap twaite shad, and therefore have the potential to impact the species at a population level, need to be considered carefully, given the low population levels.

Invasive non-native species

There have been a very small number of records of Signal crayfish in the Usk management catchment, but these are unlikely to be affecting twaite shad at the population level. There are currently no records of Chinese mitten crab in the Carmarthen Bay and Estuaries or River Tywi SACs. There is a threat that these could be introduced to the area.

Further INNS were identified as potential threats to the UK and were listed in the latest horizon scanning exercise (Roy et al., 2019). There is a high likelihood for some of these species to be found in Wales in the future. This SAC could be at risk since there are a

number of possible pathways of introduction. Further information on introduction pathways can be found on the GB non-native species secretariat website.

Water quality: contaminants

At the time of the assessment, twaite shad are thought not to be adversely impacted by contaminants at the population level. There is the potential for unregulated contaminants (such as PFAS) to increase. This could affect twaite shad as PFAS has been shown to bioaccumulate in marine species, increasing up the trophic levels (Khan et al., 2023). However, the biological impact of PFAS on marine species is not well understood.

Some persistent chemicals are not measured in every WFD waterbody, and some of the relevant WFD waterbodies have not been classified for any chemicals.

Climate change

It is not yet clear what pressures we will see from climate change at the SAC level or how different pressures will counteract each other. However, threats from climate change that could impact the species may include:

- Increasing sea surface and river temperature.
- Changes in precipitation impacting riverine flow in spring and summer, affecting the ability of adults to pass partial barriers and causing washout of eggs and juveniles.
- Changes to prey availability and abundance.

Evidence gaps

There are gaps in the current evidence that NRW feel are needed to be filled to fully understand condition in this feature.

Listed below (Table 26) are current indicators that were either assessed as unknown, not assessed, or assessed with a lower confidence. This was due to either limited data availability, outdated data, or a lack of information. Some indicators are not currently monitored but should be ideally considered in future condition assessments.

Table 26. Evidence gaps for the twaite shad feature in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Assessed status	Comments
Population variables and data (P)	Low confidence (limited data)	• Although this indicator was assessed, data on twaite shad in the Tywi, Usk and Wye are limited, and there have been no targeted surveys of the species within the marine SACs.

Indicator	Assessed status	Comments
Anthropogenic mortality: bycatch (S)	Unknown	• The extent of bycatch of twaite shad in fisheries is uncertain.
Fish community (S)	Unknown	• The WFD Regulations monitoring of the estuarine fish community element is only carried out in some transitional WFD waterbodies therefore this does not cover the full extent of the SACs (coastal WFD waterbodies). • In this SAC, neither of the transitional WFD waterbodies have been assessed for the estuarine fish element in the 2024 cycle 3 interim classification.
Water quality: physicochemical properties (T)	Not assessed / unknown	• There were no temperature, salinity or pH loggers within the Carmarthen Bay and Estuaries SAC. • Remote sensing data on temperature, salinity and pH could be used in future.

3.9. River lamprey condition assessment

River lamprey *Lampetra fluviatilis* has been designated as a qualifying feature in Carmarthen Bay and Estuaries SAC as it has been considered an important coastal migration route or feeding ground for this species, and as it is adjacent to an important freshwater site for the species (River Tywi SAC). The River Tywi was therefore considered as the primary upstream spawning location for the SAC in this assessment. Other rivers that input into the SAC population (Tâf, Gwendreath and Loughor) have also been considered in the assessment. There may be other relevant smaller rivers that contribute to the SAC population. A summary of the condition assessment for river lamprey in Carmarthen Bay and Estuaries SAC can been seen in Table 27. The overall feature condition, a detailed summary of the assessment and threats to condition are discussed in more detail in the sections below.

Table 27. Condition assessment of river lamprey in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Population variables and data	The population of river lamprey relevant to the SAC should be stable or increasing in the long-term. (P)	• Based on expert judgement, river lampreys are common and widespread in the Carmarthen Bay and Estuaries SAC and within the relevant upstream spawning rivers. • There are a limited amount of high-quality data on river lampreys therefore confidence in the pass is medium. • There have been no targeted surveys of river lampreys in the Carmarthen Bay and Estuaries SAC.	**Pass**	Medium
Habitat connectivity	Maintain safe passage and movement of river lamprey in the marine environment into, within and away from the SAC, including to and from the connected spawning locations. (P)	• There are no known barriers to marine migration within or into the Carmarthen Bay and Estuaries SAC. • There are no known major man-made barriers in the River Tywi SAC, and the other contributing rivers that could impact river lamprey migration. • Confidence is high as in depth site knowledge has been used.	**Pass**	High

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Freshwater flow	Maintain freshwater flow to the estuary / estuaries within the SAC. Regulated rivers meet their minimum flow targets. (P)	• There are no known issues affecting the freshwater flow to the Carmarthen Bay and Estuaries SAC that would affect river lamprey migration. • There are no known issues within the River Tywi SAC affecting flow to the Three Rivers estuary. • Licenced abstractions on the River Tywi SAC have gone through the RoC process to ensure designated features are adequately protected. • Flow data were not analysed for this assessment therefore confidence is medium.	**Pass**	Medium
Invasive Non-Native Species (INNS)	Spread and impact of INNS caused by human activities is not having a detrimental impact at the population level. (P)	• There are no known records of INNS which would adversely the condition of the affect river lamprey feature within Carmarthen Bay and Estuaries SAC and associated River Tywi SAC. • Confidence is high due to the availability of long term monitoring data on the species of concern to river lamprey.	**Pass**	High
Anthropogenic mortality: targeted exploitation	There should be no targeted exploitation of the species. (S)	• No targeted exploitation of river lampreys is understood to be occurring in the SAC population. • Confidence is high as the assessment was based on expert judgement and knowledge that there are no fisheries that could capture the species in the SAC.	**Pass**	High

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Anthropogenic mortality: abstraction and entrapment	Abstraction and entrapment should not adversely affect the viability of the population. (S)	• All licenced abstractions have previously been assessed through the Habitats Regulations RoC process, Eel Regulations, or SAFFA 1975. • All new abstractions are required to go through permitting processes to comply with screening requirements for fish. • There are no major operations within the SAC or rivers draining into the SAC known to be causing entrapment of river lamprey. • Confidence is high as all operations go through permitting processes and as the assessment has been based on up-to-date specialist knowledge and data.	**Pass**	High
Anthropogenic mortality: bycatch	Bycatch of the species should not adversely affect the viability of the population. (S)	• Bycatch of river lamprey is understood to be low for the SAC population. • Confidence is medium as there are limited data on bycatch.	**Pass**	Medium
Fish Community	The WFD Estuarine Fish tool is at least good. (T)	• The estuarine fish WFD element is assessed in transitional WFD waterbodies only. • Neither of the two transitional WFD waterbodies in the SAC (Burry Inlet Inner and Three Rivers Estuary) were assessed for the estuarine fish WFD element in the 2024 cycle 3 interim classification. • The indicator was therefore assessed as unknown.	**Unknown**	N/A

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: contaminants	Water column contaminants not to exceed the EQS. (S)	• Three of the four WFD waterbodies in the SAC have a pass for chemicals in the 2024 cycle 3 interim classification (Burry Inlet Inner, Burry Inlet Outer and Three Rivers Estuary). In all waterbodies, some or all of the chemical classifications were rolled forward from previous cycles as they were not classified in the 2024 cycle 3 interim classification. • The other WFD waterbody has a fail for chemicals (Carmarthen Bay). It failed for mercury, PBDE and cypermethrin. • Confidence is low as: the human health standard has been used for PBDE; some waterbodies have rolled forward classifications; and contaminants are not directly monitored in this species.	**Fail**	Low
Water quality: dissolved oxygen	The WFD classification achieved for dissolved oxygen should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (P)	• All four WFD waterbodies in the SAC have been classified as High status for dissolved oxygen in the 2024 cycle 3 interim classification. • All WFD waterbodies that have been assessed overlap with an extensive area within the SAC and are therefore considered to be representative of the area that river lampreys would use in the SAC. • Confidence is low as samples have been taken from the surface of waterbodies.	**Pass**	Low

Assessment conclusions

The river lamprey feature in Carmarthen Bay and Estuaries SAC has been assessed as being in **favourable** condition (medium confidence). Overall, river lamprey in the SAC and relevant upstream spawning rivers are thought to be common and widespread, with no known significant barriers to migration present, which has contributed to this favourable assessment outcome. There was one indicator with a failing target (Table 28). Confidence was reduced to medium overall as the data available on river lampreys in the region, and data on water chemistry are limited, and conclusions have been drawn largely using expert judgement.

A summary of the assessment can be seen in Table 28 with more detail on each performance indicator, and any reasons for failure, provided in the sections below.

Table 28. Summary of the condition assessment for river lamprey in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

Feature	Overall Condition Assessment	Indicator failures	Reason for target failure	Threats to condition
River lamprey *Lampetra fluviatilis*	**Favourable (medium confidence)**	Water quality: contaminants (S)	• Levels of mercury, PBDE and cypermethrin in the Carmarthen Bay waterbody are failing to meet their relevant EQSs.	• INNS • Water quality: contaminants • Climate change

Detailed assessment information

Population variables

River lampreys are widely distributed in Wales including in the River Tywi SAC. There are a limited amount of high-quality data on river lampreys, however there have been some records of the species in the Carmarthen Bay and estuaries SAC and the relevant upstream spawning locations. River lampreys are considered by experts to be common and widespread in the region. It is not possible to distinguish between the two *Lampetra* species (river lamprey and brook lamprey) at the ammocoete stage, however there are many records of these from NRW monitoring. This indicates that there is a lot of suitable habitat available for juvenile lampreys in the rivers. The indicator linked to population was therefore considered to pass the set target. This assessment was based mostly on expert judgement therefore the confidence in the pass was medium. Adaptive resolution imagine sonar (ARIS) tracking would be beneficial in the monitoring of river lampreys in rivers for future condition assessments.

Habitat connectivity and freshwater flow

There are no known barriers to marine migration within the Carmarthen Bay and Estuaries SAC that would limit river lamprey migration between spawning rivers and along the coast. The River Tywi is the principal spawning location for the population of river lamprey in the Carmarthen Bay and Estuaries SAC. The Tâf, Gwendraeth and Loughor rivers also contribute to the marine SAC population. Various man-made barriers (mostly weirs) have been identified within these rivers, however they are not currently known to be significant obstacles to migration of river lamprey. The habitat connectivity indicator therefore passed its target with high confidence.

The freshwater flow indicator passed its target as there are no known issues with flow to the Three Rivers estuary or River Tywi SAC that drains directly into the Carmarthen Bay and Estuaries SAC. This conclusion was based on the RoC process (see further information in Section 3.7). Confidence in the pass is medium as flow data were not used for the assessment.

Invasive non-native species

The INNS that could significantly impact the river lamprey population in the river and estuary are Chinese mitten crab and signal crayfish. There have been a small number records of signal crayfish near Llandelio, and there is a population in the Nant Gurrey Fach that may have spread into neighbouring areas. These are tributaries that drain into the River Tywi SAC. There are no other known records of these species within the Carmarthen Bay and Estuaries SAC or River Tywi SAC catchment. The INNS indicator was therefore assessed as passing its target with a high confidence.

Anthropogenic mortality

There is no known targeted exploitation of river lamprey within Carmarthen Bay and Estuaries SAC therefore this indicator passed its target. High confidence was attributed to the indicator pass as it was based on expert judgement and knowledge that there are no fisheries that could capture the species in the SAC.

In Wales, all licenced abstractions have been assessed through Eel Regulations, Habitats Regulations RoC process, or SAFFA 1975 to ensure that all permitted abstractions are screened to minimise entrainment of fish. There are no major operations such as power stations within the Carmarthen Bay and Estuaries SAC or rivers draining into the SAC known to be causing entrapment of river lamprey. The abstraction and entrapment target was therefore assessed as passing with high confidence as all operations go through regulated screening permitting processes and as the assessment has been based on up-to-date specialist knowledge and data. There were power stations in the Bristol channel which are no longer operational and abstraction has significantly reduced therefore they are no longer a concern for river lampreys.

Bycatch of river lamprey within the Carmarthen Bay and Estuaries Marine SAC is understood to be low therefore this indicator passed its target. Confidence in this assessment is reduced to medium as there are limited data on bycatch, especially for unregulated fishing.

Fish community

The fish community indicator could not be assessed for river lamprey in the Carmarthen Bay and Estuaries SAC due to an absence of data. The WFD estuarine fish tool is used as a proxy for habitat quality for fish in general in estuaries. If this element is classified as Good status it is likely that the conditions for fish, and therefore river lamprey, are favourable. The estuarine fish element is assessed in the transitional WFD waterbodies only. Within the SAC there are two transitional WFD waterbodies, Burry Inlet Inner and the Three Rivers Estuary, and neither has been assessed in the 2024 cycle 3 interim classification. The Three Rivers Estuary waterbody was previously assessed with a Moderate status in the 2009 cycle 1 classification but it has not been assessed since. The methodology used in the WFD fish classification has changed since the 2009 cycle 1 classification. As the cycle 1 information is not comparable to the current methodology, it has not be used.

Water quality

There are four WFD waterbodies within the Carmarthen Bay and Estuaries SAC: Carmarthen Bay, Burry Inlet Outer, Burry Inlet Inner, and the Three Rivers Estuary (Tywi, Tâf and Gwendraeth). The water quality indicator conclusions also apply to sea lamprey.

Contaminants

The Carmarthen Bay waterbody has a fail for chemicals in the 2024 cycle 3 interim classification, where mercury, PBDE and cypermethrin failed. The EQS for cypermethrin is very low, and in the previous lab methodology it was not possible to detect concentrations

below the EQS. There has been a waterbody status change (pass to fail) between the 2021 cycle 3 classification and 2024 cycle 3 interim classification due to this reason. Cypermethrin is a synthetic pyrethroid insecticide and is highly toxic to some aquatic species (EA, 2019), but now has a restricted use in Wales. Mercury has failed in the waterbody since the 2015 cycle 2 classification. The EQS for mercury is based on the secondary poisoning protection goal (for wildlife). The PBDE failure was based on the value of the human health protection goal as it is the most stringent. This protection goal may be over precautionary as the effect of contaminants on the river lamprey feature are not fully understood. The Carmarthen Bay waterbody overlaps with a large area in the SAC, therefore the chemical failure there has resulted in the failure for the contaminants indicator. The other three WFD waterbodies have a pass for chemicals in the 2024 cycle 3 interim classification. However, in all three waterbodies, some or all of the chemical classifications were rolled forward from previous cycles as they were not assessed in the 2024 cycle 3 interim classification.

Overall, a low confidence was assigned to the failure of the contaminants indicator because the human health standard has been used for PBDE, and due to the roll forward in some chemical classifications. In addition, the effects of the chemical failure on the species is uncertain, and the contaminants have not been directly monitored in this species.

Dissolved oxygen

The dissolved oxygen indicator passed its target as all four WFD waterbodies in the SAC were classified as High status for the dissolved oxygen element in the 2024 cycle 3 interim classification. These waterbodies overlap with an extensive area in the coastal part of the SAC and are therefore considered to be representative of the areas potentially used by the river lampreys in the Carmarthen Bay and Estuaries SAC.

The dissolved oxygen samples are taken at the water's surface. By the time oxygen depletion at the surface is recorded, oxygen throughout the water column could have been depleted for some time, especially as hypoxia or low oxygen levels, when present, typically occur in bottom water and sediments. Therefore surface sampling of dissolved oxygen may not detect issues throughout the water column or for more demersal features. This reduced the confidence in the pass to low.

Physicochemical properties

The physicochemical indicator could not be assessed due to a lack of data.

Reasons for target failure

The river lamprey feature in Carmarthen Bay and Estuaries SAC has been assessed as being in **favourable** condition. However, one secondary target failed to be met and needs to be kept under review.

Water quality: contaminants

This indicator failed to meet its secondary target due to the failure of chemical status in the Carmarthen Bay waterbody, which failed for mercury, PBDE and cypermethrin. Historically, the main source of PBDE is as flame retardants in a variety of materials (Viñas

et al., 2022). Mercury has been used in many industries, but today the primary sources are burning of coal and artisan mining for mercury (Larsen and Hjermann, 2022). Cypermethrin is an insecticide used for plant protection in crops, in forestry, gardens, homes and businesses. It is also used in veterinary medicine to control pests in livestock and pets (EA, 2019). The application of cypermethrin has been restricted for some uses (sheep dipping and in forestry against the pine weevil).

Some of the contaminants in the water column may be derived from diffuse sources from atmospheric deposition and contaminated waterbody bed sediments, or point sources from continuous sewage discharge from wastewater treatment. However, a WFD investigation of the failure in the waterbody is yet to be undertaken. Mercury and PBDE are being managed in the UK and it is hoped that these levels will reduce in time.

Threats to condition

Part of the condition assessment is to identify threats to the condition of the river lamprey feature. A threat is defined as an activity that is currently not impacting condition but has the potential to do so over the next reporting cycle, if activity levels increase or are unmanaged. It is important to identify these threats to be able to put pre-emptive management in place to prevent declines in condition. The threats to the river lamprey feature in Carmarthen Bay and Estuaries SAC are stated below.

Invasive non-native species

There have been some records of signal crayfish in the tributaries that drain into the River Tywi SAC. Signal crayfish would predate on eggs and possibly ammocetes of the river lamprey. There are currently no records of Chinese mitten crab in the Carmarthen Bay and Estuaries or River Tywi SACs. There is a threat that these species could be introduced to the area.

Further INNS were identified as potential threats to the UK and were listed in the latest horizon scanning exercise (Roy et al., 2019). There is a high likelihood for some of these species to be found in Wales in the future. This SAC could be at risk since there are a number of possible pathways of introduction. Further information on introduction pathways can be found on the GB non-native species secretariat website.

Water quality: contaminants

There is the potential for unregulated contaminants (such as PFAS) to increase. This could affect river lampreys as PFAS has been shown to bioaccumulate in marine species, increasing up the trophic levels (Khan et al., 2023). However, the biological impact of PFAS on marine species is not well understood.

Some persistent chemicals are not measured in every WFD waterbody, and some of the relevant WFD waterbodies have not been classified for any chemicals.

Climate change

It is not yet clear what pressures we will see from climate change at the SAC level or how different pressures will counteract each other. However, threats from climate change that could impact the species may include:

- Increasing sea surface and river temperature.
- Changes in precipitation impacting riverine flow in spring and summer, affecting the ability of adults to pass partial barriers and causing washout of eggs and juveniles.
- Changes to prey availability and abundance.

Evidence gaps

There are gaps in the current evidence that NRW feel are needed to be filled to fully understand condition in this feature.

Listed below (Table 29) are current indicators that were either assessed as unknown, not assessed, or assessed with a lower confidence. This was due to either limited data availability, outdated data, or a lack of information. Some indicators are not currently monitored but should be ideally considered in future condition assessments.

Table 29. Evidence gaps for the river lamprey feature in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Assessed status	Comments
Population variables and data (P)	Medium confidence (limited data)	• Data on river lampreys are very limited and there have been no targeted surveys on the species in any of the marine SACs. There is currently no agreed method of assessment of river lamprey in marine environments.
Fish community (S)	Unknown	• The WFD Regulations monitoring of the estuarine fish community element is only carried out in some transitional WFD waterbodies therefore this does not cover the full extent of the SACs (coastal WFD waterbodies). • In this SAC neither of the transitional WFD waterbodies have been assessed for the estuarine fish element in the 2024 cycle 3 interim classification.
Water quality: physicochemical properties (T)	Not assessed	• There were no temperature, salinity or pH loggers within the Carmarthen Bay and Estuaries SAC. • Remote sensing data on temperature, salinity and pH could be used in future.

3.10. Sea lamprey condition assessment

Sea lamprey *Petromyzon marinus* has been designated as a qualifying feature in Carmarthen Bay and Estuaries SAC as it has been considered an important coastal migration route or feeding ground for this species, and as it is adjacent to an important freshwater site for the species (River Tywi SAC). The River Tywi was therefore considered as the primary upstream spawning location for the SAC in this assessment. Other rivers that input into the SAC population (Tâf, Gwendeaeth and Loughor) have also been considered in the assessment. There may be other relevant smaller rivers that contribute to the SAC population. A summary of the condition assessment for sea lamprey in Carmarthen Bay and Estuaries SAC can been seen in Table 30. The overall feature condition, a detailed summary of the assessment and threats to condition are discussed in more detail in the sections below.

Table 30. Condition assessment of sea lamprey in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Population variables and data	The population of sea lamprey relevant to the SAC should be stable or increasing in the long-term. (P)	• Sea lamprey adults in the River Tywi are generally in the thousands and all of the catchment is suitable for spawning and is easily accessible. • Sea lamprey tracking in the River Tywi has been carried out regularly since 2009. The annual run estimates are strong when compared to data collected in other catchments, however they potentially show a decline in sea lamprey numbers. Further investigation is required to verify this decline. • Confidence is low because of the potential decline in adult sea lamprey numbers. • There have been no targeted surveys of sea lampreys in the Carmarthen Bay and Estuaries SAC.	**Pass**	Low

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Habitat connectivity	Maintain safe passage and movement of sea lamprey in the marine environment into, within and away from the SAC, including to and from the connected spawning locations. (P)	• There are no known barriers to marine migration within or into the Carmarthen Bay and Estuaries SAC. • There are no known major man-made barriers in the River Tywi SAC, and the other contributing rivers that could impact sea lamprey migration. • Confidence is high as in depth site knowledge has been used.	**Pass**	High
Freshwater flow	Maintain freshwater flow to the estuary / estuaries within the SAC. Regulated rivers meet their minimum flow targets. (P)	• There are no known issues affecting the freshwater flow to the Carmarthen Bay and Estuaries SAC that would affect sea lamprey migration. • There are no known issues within the rivers in the River Tywi SAC affecting flow to the Three Rivers estuary. • Licenced abstractions on the River Tywi SAC have gone through the RoC process to ensure designated features are adequately protected. • Flow data were not analysed for this assessment therefore confidence is medium.	**Pass**	Medium
Invasive Non-Native Species (INNS)	Spread and impact of INNS caused by human activities is not having a detrimental impact at the population level. (P)	• There are no known records of INNS which would adversely affect the condition of the sea lamprey feature within Carmarthen Bay and Estuaries SAC and associated River Tywi SAC. • Confidence is high due to the availability of long term monitoring data on the species of concern to sea lamprey.	**Pass**	High

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Anthropogenic mortality: targeted exploitation	There should be no targeted exploitation of the species. (S)	• No targeted exploitation of sea lamprey is understood to be occurring in the SAC population. • Confidence is high as the assessment was based on expert judgement and knowledge that there are no fisheries that could capture the species in the SAC.	**Pass**	High
Anthropogenic mortality: abstraction and entrapment	Abstraction and entrapment should not adversely affect the viability of the population. (S)	• All licenced abstractions have previously been assessed through the Habitats Regulations RoC process, Eel Regulations, or SAFFA 1975. • All new abstractions are required to go through permitting processes to comply with screening requirements for fish. • There are no major operations within the SAC or rivers draining into the SAC known to be causing entrapment of sea lamprey. • Confidence is high as all operations go through permitting processes and as the assessment has been based on up-to-date specialist knowledge and data.	**Pass**	High
Anthropogenic mortality: bycatch	Bycatch of the species should not adversely affect the viability of the population. (S)	• Bycatch of sea lamprey is understood to be low for the SAC population. • Confidence is medium as there are limited data on bycatch.	**Pass**	Medium
Fish Community	The WFD Estuarine Fish tool is at least good. (T)	• The estuarine fish WFD element is assessed in transitional WFD waterbodies only. • Neither of the two transitional WFD waterbodies in the SAC (Burry Inlet Inner and Three Rivers Estuary) were assessed for the estuarine fish WFD element in the 2024 cycle 3 interim classification. • The indicator was therefore assessed as unknown.	**Unknown**	N/A

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: contaminants	Water column contaminants not to exceed the EQS. (S)	• Three of the four WFD waterbodies in the SAC have a pass for chemicals in the 2024 cycle 3 interim classification (Burry Inlet Inner, Burry Inlet Outer and Three Rivers Estuary). In all waterbodies, some or all of the chemical classifications were rolled forward from previous cycles as they were not classified in the 2024 cycle 3 interim classification. • The other WFD waterbody has a fail for chemicals (Carmarthen Bay). It failed for mercury, PBDE and cypermethrin. • Confidence is low as: the human health standard has been used for PBDE; some chemical classifications were rolled forward; and contaminants are not directly monitored in this species.	**Fail**	Low
Water quality: dissolved oxygen	The WFD classification achieved for dissolved oxygen should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (P)	• All four WFD waterbodies in the SAC have been classified as High status for dissolved oxygen in the 2024 cycle 3 interim classification. • All WFD waterbodies that have been assessed overlap with an extensive area within the SAC and are therefore considered to be representative of the area that sea lampreys would use in the SAC. • Confidence is low as samples have been taken from the surface of waterbodies.	**Pass**	Low

Assessment conclusions

The sea lamprey feature in Cardigan Bay SAC has been assessed as being in **favourable** condition (medium confidence). Overall, sea lamprey numbers in the River Tywi are generally in the thousands, with much of the catchment suitable for spawning and being easily accessible, which has contributed to this favourable assessment outcome. There was one indicator with a failing target (Table 31). Confidence was reduced to medium overall as the data available on sea lampreys in the region, and data on water chemistry are limited, and conclusions have been drawn largely using expert judgement.

A summary of the assessment can be seen in Table 31 with more detail on each performance indicator, and any reasons for failure, provided in the sections below.

Table 31. Summary of the condition assessment for sea lamprey in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

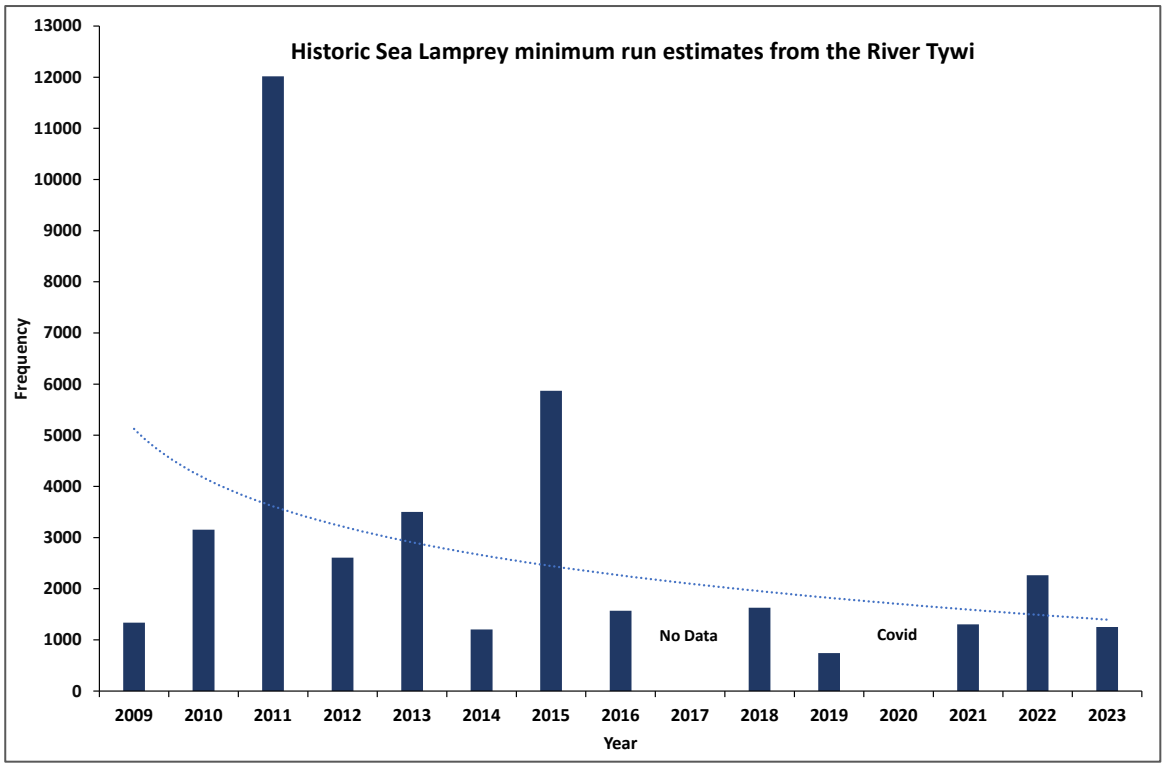
Feature	Overall Condition Assessment	Indicator failures	Reason for target failure	Threats to condition
Sea lamprey *Petromyzon marinus*	**Favourable (medium confidence)**	Water quality: contaminants (S)	• Levels of mercury, PBDE and cypermethrin in the Carmarthen Bay waterbody are failing to meet their relevant EQSs.	• Industry • INNS • Water quality: contaminants • Climate change

Detailed assessment information

Population variables

Sea lampreys in the River Tywi SAC catchment are generally in the thousands and all of the catchment is suitable for spawning and easily accessible. Tracking of adult sea lampreys has been carried out in the River Tywi SAC within NRW since 2009 (using a dual frequency identification sonar (DIDSON) in earlier years and an adaptive resolution imagine sonar (ARIS) in recent years), which has identified high numbers of adults in upstream and downstream areas of the catchment. Sea lamprey numbers were highest in 2011 compared to any other year (Figure 13). Numbers were also high in 2015 (approximately 5,800) (Figure 13). Sea lamprey numbers have been highly variable on the River Tywi throughout the monitoring period, however a general decline in numbers can be observed since the start of deployment in 2009 (Griffiths, in draft) (Figure 13). The most recent provisional sea lamprey counts (2021-2023) range from approximately 1,250 to 2,250 (Figure 13). Further evidence is needed to substantiate any potential decline in estimates. The data from this study showed that run timings may be fluid depending on environmental conditions, therefore the start of the deployment may not coincide with the start of the run time. This may be reducing the accuracy of the estimates. Environmental factors may be causing a shift in the timings of migration, which will need to be investigated in future deployments (Griffiths, in draft). The annual run estimates in the Tywi are strong when compared to data collected in other catchments. As sea lampreys do not show homing behaviour to their natal river for spawning, abundance within a spawning river can fluctuate largely between years.

Figure 13. Historical sea lamprey minimum run estimations from 2009-2023 (Griffiths, in draft).



There are some gaps in the data collection due to methodology change, high flow periods, and the COVID pandemic. The indicator linked to population was considered to pass the set target as the sea lamprey numbers in the River Tywi SAC are considered to be strong, especially compared to other regions. The confidence in the pass was reduced to low due to the possible decrease in overall numbers of sea lamprey recorded in the River Tywi. Further evidence is required to investigate the potential decline. Other rivers also contribute to the marine SAC population (Tâf, Gwendeaeth and Loughor), however there are limited data available on sea lamprey numbers elsewhere. ARIS tracking will be important in the monitoring of sea lampreys in rivers for future condition assessments. Although this indicator was assessed, there are currently no data available on sea lampreys either in the transitional or coastal areas of the SAC.

Habitat connectivity and freshwater flow

There are no known barriers to marine migration within the Carmarthen Bay and Estuaries SAC that would limit sea lamprey migration between spawning rivers and along the coast. The River Tywi is the principal contributor to the population of sea lamprey in the Carmarthen Bay and Estuaries SAC. The Tâf, Gwendraeth and Loughor rivers also contribute to the marine SAC population. Various man-made barriers (mostly weirs) have been identified within these rivers, however they are not currently known to be significant obstacles to migration of sea lamprey. The habitat connectivity indicator was therefore assessed as passing its target with high confidence.

The freshwater flow indicator passed the target as there are no known issues with flow to the Three Rivers estuary or River Tywi SAC that drains directly into the Carmarthen Bay and Estuaries SAC. This conclusion was based on the RoC process (see further information in Section 3.7). Confidence in the pass is medium as flow data were not used for the assessment.

Invasive non-native species

The INNS that could significantly impact the sea lamprey population in the river and estuary are Chinese mitten crab and signal crayfish. There have been a small number records of signal crayfish near Llandelio, and there is a population in the Nant Gurrey Fach that may have spread into neighbouring areas. These are tributaries that drain into the River Tywi SAC. There are no other known records of these species within the Carmarthen Bay and Estuaries SAC or the River Tywi SAC catchment. The INNS indicator therefore passed the target with a high confidence.

Anthropogenic mortality

There is no known targeted exploitation of sea lamprey within Carmarthen Bay and Estuaries SAC therefore this indicator passed its target. High confidence was attributed to the indicator pass as it was based on expert judgement and knowledge that there are no fisheries that could capture the species in the SAC.

In Wales, all licenced abstractions have been assessed through Eel Regulations, Habitats Regulations RoC process, or SAFFA 1975 to ensure that all permitted abstractions are screened to minimise entrainment of fish. There are no major operations such as power

stations within the Carmarthen Bay and Estuaries SAC or rivers draining into the SAC known to be causing entrapment of sea lamprey. The abstraction and entrapment target was therefore assessed as passing with high confidence as all operations go through regulated screening permitting processes and as the assessment has been based on up-to-date specialist knowledge and data. There were power stations in the Bristol channel which are no longer operational and abstraction has significantly reduced therefore they are no longer a concern for to sea lampreys.

Bycatch of sea lamprey within the Carmarthen Bay and Estuaries SAC is understood to be low therefore this indicator passed its target. Confidence in this assessment is reduced to medium as there are limited data on bycatch, especially for unregulated fishing.

Fish community

The fish community indicator was assessed as unknown for sea lamprey in the Carmarthen Bay and Estuaries SAC due to an absence of data. The WFD estuarine fish tool is used as a proxy for habitat quality for fish in general in estuaries. If this element is classified as Good status it is likely that the conditions for fish, and therefore sea lamprey, are favourable. The estuarine fish element is assessed in the transitional WFD waterbodies only. Within the SAC there are two transitional WFD waterbodies, Burry Inlet Inner and the Three Rivers Estuary, and neither has been assessed in the 2024 cycle 3 interim classification. The Three Rivers Estuary waterbody was previously assessed with a Moderate status in the 2009 cycle 1 classification but it has not been assessed since. The methodology used in the WFD fish classification has changed since the 2009 cycle 1 classification. As the cycle 1 information is not comparable to the current methodology, it has not be used.

Water quality

See river lamprey water quality in Section 3.9 as it also applies to sea lamprey.

Reasons for target failure

The sea lamprey feature in Carmarthen Bay and Estuaries SAC has been assessed as being in **favourable** condition. However, one secondary target failed to be met and needs to be kept under review.

Water quality: contaminants

See river lamprey reasons for failure in Section 3.9 as it also applies to sea lamprey.

Threats to condition

Part of the condition assessment is to identify threats to the condition of the sea lamprey feature. A threat is defined as an activity that is currently not impacting condition but has the potential to do so over the next reporting cycle, if activity levels increase or are unmanaged. It is important to identify these threats to be able to put pre-emptive management in place to prevent declines in condition. The threats to the sea lamprey feature in Carmarthen Bay and Estuaries SAC are stated below.

Industry

Any planned installations and projects which could impinge or entrap sea lamprey, and therefore have the potential to impact the species at a population level, need to be considered carefully.

Invasive non-native species

There have been some records of signal crayfish in the tributaries that drain into the River Tywi SAC. Signal crayfish would predate on eggs and possibly ammocetes of the sea lamprey. There are currently no records of Chinese mitten crab in the Carmarthen Bay and Estuaries or River Tywi SACs. There is a threat that these could be introduced to the area.

Further INNS were identified as potential threats to the UK and were listed in the latest horizon scanning exercise (Roy et al., 2019). There is a high likelihood for some of these species to be found in Wales in the future. This SAC could be at risk since there are a number of possible pathways of introduction. Further information on introduction pathways can be found on the GB non-native species secretariat website.

Water quality: contaminants

There is the potential for unregulated contaminants (such as PFAS) to increase. This could affect sea lampreys as PFAS has been shown to bioaccumulate in marine species, increasing up the trophic levels (Khan et al., 2023). However, the biological impact of PFAS on marine species is not well understood.

Some persistent chemicals are not measured in every WFD waterbody, and some of the relevant WFD waterbodies have not been classified for any chemicals.

Climate change

It is not yet clear what pressures we will see from climate change at the SAC level or how different pressures will counteract each other. However, threats from climate change that could impact the species may include:

- Increasing sea surface and river temperature.
- Changes in precipitation impacting riverine flow in spring and summer, affecting the ability of adults to pass partial barriers and causing washout of eggs and juveniles.
- Changes to prey availability and abundance.

Evidence gaps

There are gaps in the current evidence that NRW feel are needed to be filled to fully understand condition in this feature.

Listed below (Table 32) are current indicators that were either assessed as unknown, not assessed, or assessed with a lower confidence. This was due to either limited data availability, outdated data, or a lack of information. Some indicators are not currently monitored but should be ideally considered in future condition assessments.

Table 32. Evidence gaps for the sea lamprey feature in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Assessed status	Comments
Population variables and data (P)	Low confidence (limited data)	• Tracking data on adult sea lampreys in the River Tywi SAC, which is directly upstream of the Carmarthen Bay and Estuaries SAC, shows a potential decline in numbers over the monitoring period. This may be related to the run timings or changes in environmental conditions leading to a shift in the timing of migration periods. Further evidence is needed to substantiate any potential decline in estimates.
Fish community (S)	Unknown	• The WFD Regulations monitoring of the estuarine fish community element is only carried out in some transitional WFD waterbodies therefore this does not cover the full extent of the SACs (coastal WFD waterbodies). • In this SAC neither of the transitional WFD waterbodies have been assessed for the estuarine fish element in the 2024 cycle 3 interim classification.
Water quality: physicochemical properties (T)	Not assessed	• There were no temperature, salinity or pH loggers within the Carmarthen Bay and Estuaries SAC. • Remote sensing data on temperature, salinity and pH could be used in future.

3.11. Otter condition assessment

A summary of the condition assessment for otter *Lutra lutra* in Carmarthen Bay and Estuaries SAC can be seen in Table 33. The overall feature condition, a detailed summary of the assessment and threats to condition can be found in the detailed assessment information.

Table 33. Condition assessment of otter in Carmarthen Bay and Estuaries Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Otter population health (hydrometric areas)	Relevant hydrometric areas used for the Otter Survey of Wales have 80% positive sites. (P)	• The Tywi and the Loughor are the relevant hydrometric areas. • The Tywi had 73% positive sites, a statistically significant 22.32% decrease since the last survey. • The Loughor had 63% positive sites, a statistically significant 37.21% decrease since the last survey. • Both relevant areas failed to meet the target. Confidence is medium due to the age of the data.	**Fail**	Medium
Otter population health (wider population)	The wider otter population relevant to the SAC is stable or increasing. (P)	• The relevant wider population is the southwest and mid-eastern sub-populations which includes the hydrometric areas the Cleddau, Teifi, Tywi, Loughor, Taf, Usk, and Mid Glamorgan. • All have seen more than a 10% decline in positive otter sites. The biggest was the at Teifi 47.9%. • These declines failed the wider population target. • Confidence in the fail is medium due to the age of the survey data.	**Fail**	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Presence within the SAC	Positive signs otters using sites within the SAC. (P)	• Local Records Centre (LERC) recorded 48 observations of otter presence (live sightings, roadkill, spraint, tracks, etc.) within the SAC boundary or up to 1km inland between 2013-2023. • The last record in the LERC at the time of the assessment was from 2022. • Of these 48 records less than half (17) were recorded in the last five years (2018-2022). • No comment can be made on numbers of otter as multiple record signs may have been left by the same otter. • However, there is strong evidence to suggest that otter were using this SAC up until at least 2022. • Confidence is medium as there have been no targeted surveys of use of the SAC and the last sign was record in 2022.	**Pass**	Medium
Habitat connectivity	No evidence of barriers that impact the safe passage and movement of otters into, within and away from the SAC. (P)	• No major barriers identified have been from development related plans or projects. • No major road schemes planned or under construction. • Confidence is low as there have been no surveys to map barriers.	**Pass**	Low

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: contaminants	Contaminants within the water column do not exceed the Environmental Quality Standard (EQS). (S)	• Three of the four WFD waterbodies in the SAC have a pass for chemicals in the 2024 cycle 3 interim classification (Burry Inlet Outer, Burry Inlet Inner and Three Rivers Estuary). In all waterbodies, some or all of the chemical classifications were rolled forward from previous cycles as they were not classified in the 2024 cycle 3 interim classification. • The other WFD waterbody has a fail for chemicals (Carmarthen Bay). It failed for mercury, PBDE and cypermethrin. Otters within the SAC use this waterbody. • Confidence is low as the human health standard has been used for PBDE, due to the roll forward of some chemical classifications.	**Fail**	Low

Assessment conclusions

The otter feature in Carmarthen Bay and Estuaries has been assessed as being in **unfavourable** condition (medium confidence). There were two failing indicators (Table 34). Further investigation is needed to better understand all of the failures to be able to identify management options that can bring the feature back into favourable condition.

A summary of the assessment can be seen in Table 34 with more detail on each performance indicator, and any reasons for failure, provided in the sections below.

Table 34. Summary of the condition assessment for otter in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

Feature	Overall Condition Assessment	Indicator failures	Reason for indicator failure	Threats to condition
Otter *Lutra lutra*	**Unfavourable (medium confidence)**	Otter population health (P) Water quality: contaminants (S)	• Declining population adjacent to the SAC. Declining wider otter population. • Levels of PBDE, mercury and cypermethrin in the Carmarthen Bay waterbody are failing to meet EQS.	• Road traffic collisions • Water quality: contaminants

Detailed assessment information

Otters are a mobile species travelling between resting, foraging and breeding sites over large home ranges. Male otters have larger home ranges than females. 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. The latest report was published in 2021 with the surveys taking place over 2015-2018. Each survey consists of sites across all river catchments (hydrometric areas) in Wales. This equates to 1108 sites over 15 hydrometric areas (see Figure 14). The same sites are revisited during each survey creating a data set currently spanning 40-years of otter occurrence in Wales. Professional surveyors or trained volunteers look for positive signs of otter (e.g. spraints or footprints) at each site. If they are found the site is recorded as positive; if they are not the site is recorded as negative. Comparisons across surveys can then be made to see if there has been a change in the number of positive sites in a hydrometric area. Surveying in this way is considered a good proxy for assessing population size.

In the fifth Otter Surveys of Wales and England (Strachan, 2015 and Crawford, 2010 respectively) the baseline target for favourable condition was set at 80% positive sites for two consecutive surveys. This was assumed to be the maximum population size any given habitat could support (carrying capacity). Although there is lack of evidence for this figure, this target was chosen as the performance indicator on population health in the relevant hydrometric areas for this condition assessment of the otter SAC marine sites.

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 Hobbs study recommended each subpopulation be treated as a management unit. The basis for this is that management of the otter population needs to consider gene flow between subregions by understanding what barriers (landscape or anthropogenic features) are creating the population structure within each of the regions. Ideally, gene flow should be re-established between the regions. Therefore, the second target, ‘otter population health’ performance indicator has been set to look at the wider population relevant to the SAC. Any declines in the wider population are likely to impact the number of otters using the SAC.

Local Environmental Records Centres (LERCs) hold records of otter signs (sightings, spraints, footprints, roadkill) and these records include those made as part of the Otter Survey of Wales as well as those submitted by members of the public. These records allow an insight into otter usage of the SACs. LERC records held on file by NRW were filtered to the ten years before and including the assessment year (2013-2023). From those, records that were located within the SAC boundary or within 1km were selected and mapped. The 1km buffer was chosen as it is assumed otters this close to the coast will be likely to use it in some way, be it travelling via the coast, feeding or resting.

Otter in Carmarthen Bay and Estuaries SAC have been assessed against the chosen performance indicators using the Otter Survey of Wales, Local Records Centre (LERC) data, WFD data, licenced activities assessments and expert knowledge.

Otter population health

The latest Otter Survey of Wales was published in 2021 with the surveys taking place over 2015-2018. The same sites are revisited every seven years allowing comparisons between surveys to see if there has been a change in the number of sites with positive signs of otter in a hydrometric area (river catchment).

The relevant hydrometric areas for a SAC are those whose boundaries border the SAC boundary. For the Carmarthen Bay and Estuaries SAC the relevant hydrometric areas are the Tywi and the Loughor (See Figure 14).

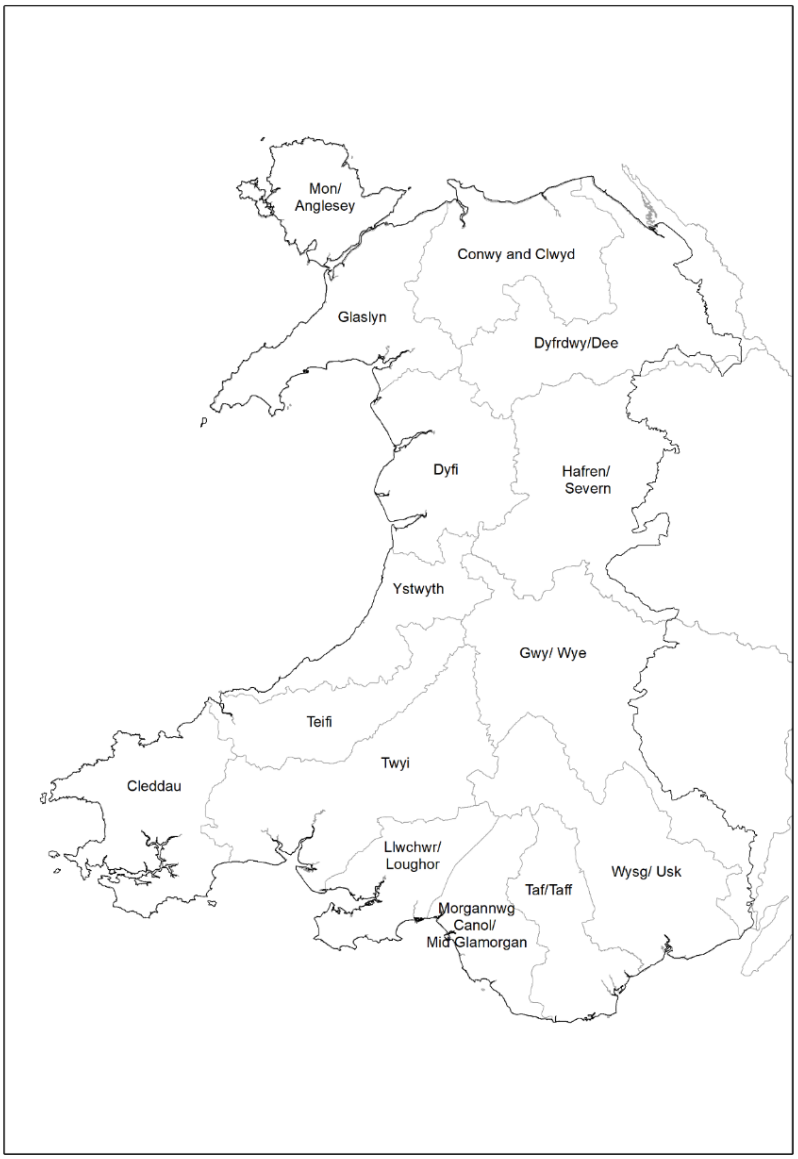
Both the Tywi and the Loughor hydrometric areas have seen a decline in positive sites in the 6th Otter Survey of Wales compared to the 5th Otter Survey of Wales (Kean and Chadwick, 2021). The 90 sites in the Tywi area were surveyed between 2015-2017, where 73% of sites (66) showed positive signs of otter. This was a statistically significant decrease of 22% since the last survey. Of the 43 sites surveyed in the Loughor between 2017-2018, 63% (27) sites were positive. This was a significant decrease of 37% since the last survey where 100% of sites were positive and is a real cause for concern. It should be noted that there were six fewer sites surveyed in the 6th Otter Survey of Wales due to difficult conditions.

Due to these steep declines the Loughor was resurveyed in 2019-2020 to assess whether volunteer skill in the 6th Otter Survey of Wales was a cause of the decline. This survey assessed 49 sites (one less than 5th Otter Survey of Wales) and found 57% (28 sites) were positive for otter signs. As this was close to the 6th Otter Survey of Wales results it was deemed volunteer surveying skill were not behind the decline (Kean and Chadwick, 2021).

As neither relevant hydrometric area met the 80% positive site target by quite some way, the indicator target failed. However, as the survey is 8 years old at the time of publication the confidence, the confidence in this failure is reduced to medium, as recovery in declining sites may have occurred.

The second indicator for the population heath indicator is around the wider otter population. A genetic study found that otters in Wales are comprised of three genetically distinct sub-groups; southwest Wales, northwest Wales and mid-east Wales (Hobbs et al., 2011). Therefore, the performance indicator target has been set to look at the wider population relevant to the SAC for the assessment, as any declines in the wider population are likely to impact the number of otters using the SAC.

Figure 14. Hydrometric areas of Wales. Map taken from the 6th Otter Survey of Wales (Kean and Chadwick, 2021).



Due to its position in central south Wales, Carmarthen Bay could be frequented by otters that fall into the mid-eastern genetic population as well as the southwest. The hydrometric sites relevant to Carmarthen Bay are the Cleddau, Teifi, Tywi, Loughor, Taf, Usk, and Mid Glamorgan. All areas have seen declines in the number of positive sites. The largest decline was seen in the Teifi at 48%, followed by the Loughor 37%, Mid Glamorgan 28%, the Usk 26%, the Tywi 22%, the Taf 15%, and the Cleddau 14%. All except the Taf were statistically significant.

The decline on the Teifi was of particular concern as it was nearly a 50% reduction. The area was resurveyed in 2019-2020 where the surveyor found 74% of sites were positive. This suggested some recovery but was still lower than expected. It should be noted that in many cases during the resurvey it was necessary to survey considerable distances to find signs and those that were found were old spraint. It was concluded that the results did not indicate a population at or near carrying capacity (Kean and Chadwick, 2021). The resurvey still showed a significant decline since the 5th Otter Survey of Wales when 95% of sites in the Teifi were positive.

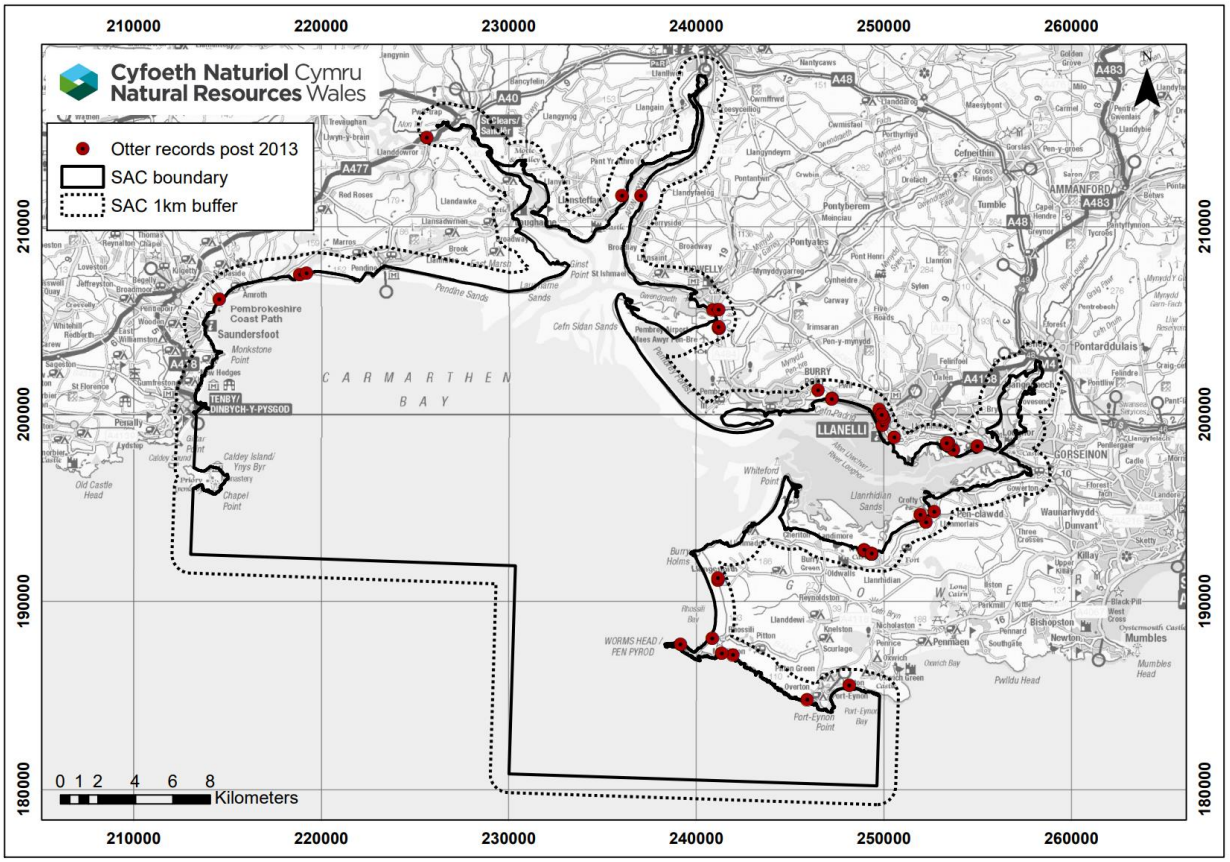
Due to the large declines in these hydrometric areas the wider population was not deemed to be stable or increasing, so the target failed. The fact the survey data ranges from 8-10 years old reduces the confidence in the failure to medium. The population may have recovered or may have declined further. The next Otter Survey of Wales is due to take place in 2024-2025.

Otter presence in the SAC

Otter presence in the SAC has not been directly surveyed. Some sites in the Otter Survey of Wales are close to the coast (within 500 m). LERCs hold records of otter signs (sightings, spraints, footprints, roadkill) and these records include those made as part of the Otter Survey of Wales as well as those submitted directly to the LERC.

For Carmarthen Bay and Estuaries SAC signs of otter were recorded with 48 observations of otter presence (live sightings, roadkill, spraint, tracks, etc.) over the last 10 years within the SAC and 1 km inland (Figure 15). Some of these were likely taken as part of the 6th Otter Survey of Wales. No comparisons can be made on numbers as a single otter may have left multiple signs. However, all sightings can be considered as positive signs that otter are using the SAC. At the time of the assessment the last recorded sign in the database (a live sighting) was in 2022 (database accessed in November 2023). The target for this indicator is met but confidence in the target pass is reduced to medium as the LERC records are a proxy. More targeted surveys of otter use of coast are needed.

Figure 15. Otter signs in the Carmarthen Bay and Estuaries SAC between 2013-2023.



Habitat quality and connectivity

It is known that coastal sites are important to otter in terms of travelling between sites, foraging for food and resting. Therefore, it is important that the habitat quality and functionality is maintained within and around the SAC. In the Tywi hydrometric area a survey of 10 previously identified potential breeding sites found only 5 were still viable (Parry and Liles, 2023). This indicated a concerning reduction in the habitat quality and function in a relevant hydrometric area to the SAC. There is a lack of information on habitat quality and function along the coast in the SAC itself and the survey in the Tywi was just a subset of the breeding sites and only indicative. Therefore, there is not enough information to assess the habitat quality and function indicator. This has been noted as an evidence gap to try and fill before the next assessment.

As otters are a highly mobile species that have large home ranges, unimpeded movement across their range is vital. Looking at developments in the area, assessors found no evidence of obvious barriers to otter movement within the SAC or the wider area, therefore the habitat connectivity indicator met its target. However, as there has been no specific surveys of more localised barriers to movement the confidence in the pass is low.

Water quality

Many contaminants are known to persist and bioaccumulate in top predators through the food chain. As well as this past declines in otter populations have been linked to persistent organic pollutants (POPs). For this reason water quality was chosen as a performance indicator for otter.

The water quality target failed to be met for PBDE, mercury and cypermethrin in one WFD waterbody, Carmarthen Bay, in the 2024 cycle 3 interim classification. The EQS for cypermethrin is very low, and in the previous lab methodology it was not possible to detect concentrations below the EQS. There has been a waterbody status change between the 2021 cycle 3 classification and 2024 cycle 3 interim classification due to this reason. Cypermethrin is a synthetic pyrethroid insecticide and is highly toxic to some aquatic species (EA, 2019), but now has a restricted use in Wales. Mercury has failed in the waterbody since the 2015 cycle 2 classification. The EQS for mercury is based on the secondary poisoning protection goal (for wildlife). The PBDE failure was based on the value of the human health protection goal as it is the most stringent. This protection goal may be over precautionary as the effect of contaminants on otters are not fully understood. The Carmarthen Bay waterbody overlaps with a large area in the SAC, therefore the chemical failure there has resulted in the failure for the contaminants indicator. The other three waterbodies have a pass for chemicals in the 2024 cycle 3 interim classification. However, in all three waterbodies, some or all of the chemical classifications were rolled forward from previous cycles as they were not assessed in the 2024 cycle 3 interim classification.

Overall, a low confidence was assigned to the failure of the contaminants indicator because the human health standard has been used for PBDE, and due to the roll forward in some chemical classifications. Further to this, even though historic declines in otter populations have been linked to POPs, otters in Wales reached 90% sites occupied in the 2009-2010 national survey when POPs levels were high. Since the POPs use has been banned under the Stockholm Convention (2001), this makes it is unlikely that POPs are

responsible for the declines recorded in the 2015-2018 survey (Kean and Chadwick, 2021), lowering confidence in the fail.

Otters are exposed to a variety of pollutants, not only those monitored as part of WFD, but there is a lack of information on otter health implications to priority substance exposure. As otter numbers were at record highs when PBDE and mercury levels were also high the available evidence suggests these specific chemicals are not restricting populations (Kean and Chadwick, 2021). It is not known if other contaminants not currently monitored are having an impact on otter populations either directly or through their prey. Contaminants in general should not be ruled out as a caused of the declines seen in otters across Wales.

Reasons for target failure

The assessment of the Carmarthen Bay and Estuaries SAC otter feature failed two primary targets, and one secondary target. This resulted in feature to be assessed as being in **unfavourable** condition. The failing indicators and reasons for failure, if known, are summarised below.

Otter population health

The primary targets of 80% positive sites in relevant hydrometric areas and the wider population is stable or increasing failed to be met. The two hydrometric areas that border the SAC had both seen declines in the most recent survey. The Loughor saw the largest decline in positive sites at 37% followed by the Tywi at 22%.

The wider otter population relevant to the SAC had also seen declines in all relevant hydrometric areas. All seven of which saw declines over 10% of which six were statistically significant. The Teifi had an almost 50% decline since the previous survey.

It is not yet clear what has caused the declines seen in the otter population. In the previous Otter Survey of Wales (2009-2010) the population was at record high levels (average of 90% of sites had positive signs across Wales). It may be that the population had reached carrying capacity and the declines seen in the most recent survey are the population naturally settling out. However, some of the steep declines seen are cause for concern. Further investigation is needed, and a full resurvey of Wales's otter population is a priority and should provide more clarity.

Water quality: contaminants

This secondary target failed due to PBDE, mercury and cypermethrin exceeding their EQS in one WFD waterbody that otters are likely to use frequently (Carmarthen Bay). Historically, the main source of PBDE is as flame retardants in a variety of materials (Viñas et al., 2022). Mercury has been used in many industries, but today the primary sources are burning of coal and artisan mining for mercury (Larsen and Hjermann, 2022). Cypermethrin is an insecticide used for plant protection in crops, in forestry, gardens, homes and businesses. It is also used in veterinary medicine to control pests in livestock and pets (EA, 2019). The application of cypermethrin has been restricted for some uses (sheep dipping and in forestry against the pine weevil).

Some of the contaminants in the water column may be derived from diffuse sources from atmospheric deposition and contaminated waterbody bed sediments, or point sources from continuous sewage discharge from wastewater treatment. However, a WFD investigation

of the failure in the Carmarthen Bay waterbody is yet to be undertaken. The impact of these chemicals on otter are not understood and further investigation as to the impact of these at a population level is needed. Mercury and PBDE are being managed in the UK and it is hoped that these levels will reduce in time.

Threats to condition

Part of the condition assessment is to identify threats to the condition of the otter feature. A threat is defined as an activity that is currently not impacting condition but has the potential to do so over the next reporting cycle, if activity levels increase or are unmanaged. It is important to identify these threats to be able to put pre-emptive management in place to prevent declines in condition. The threats to the otter feature condition in the Carmarthen Bay and Estuaries SAC are stated below.

Road traffic collisions

Otters can travel several miles in a night, and often cross roads where rivers are culverted or bridged. Road traffic accidents cause a large number of casualties.

The Cardiff Otter Project typically receives around 200 otters per year, of which 80-90% have been killed as a result of road traffic accidents. The death of otters on roads can have a serious impact on populations, particularly where population densities are low or where danger-spots impact on breeding females (Cardiff Otter Project).

Water quality: contaminants

There is the potential for unregulated contaminants (such as PFAS) to increase. This could affect the otter feature as PFAS has been shown to bioaccumulate in marine species, increasing up the trophic levels (Khan et al., 2023). However, the biological impact of PFAS on marine species is not well understood.

Some persistent chemicals are not measured in every WFD waterbody, and some of the relevant waterbodies have not been classified for any chemicals. It is possible that WFD contaminants that are not monitored, or emergent contaminants, are present and impacting the otter population.

Evidence gaps

There are gaps in the current evidence that NRW feel are needed to be filled to fully understand condition in this feature.

Listed below (Table 35) are current indicators that were either assessed as unknown, not assessed, or assessed with a lower confidence. This was due to either limited data availability, outdated data, or a lack of information. Some indicators are not currently monitored but should be ideally considered in future condition assessments.

Table 35. Evidence gaps for the otter feature in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Assessed status	Comments
Presence in SAC (P)	Medium confidence	• There has been no targeted survey of otter use in the Carmarthen Bay and Estuaries SAC. • Sites in the Otter Survey of Wales have not been selected based on their proximity to the coast and other records rely on public sightings. • Work has been done to survey otter SAC use in Pembrokeshire Marine SAC. The assessment of Carmarthen Bay and Estuaries SAC would benefit from similar work.
Habitat quality and function (P)	Not assessed	• No surveys of the habitat quality for otter have been done in the Carmarthen Bay and Estuaries SAC. • Work has been done to survey otter habitat in Pembrokeshire Marine SAC and future assessments of Carmarthen Bay and Estuaries SAC would benefit from similar work.
Water quality: contaminants (S)	Low confidence	• Impacts of contaminants at a population level are not understood • it is not clear if other chemicals not currently monitored are present and having an impact. More research is needed.
Prey availability (S)	Not assessed	• There is a lack of understanding on the diet of otters foraging in coastal SACs. • This make it difficult to assess if food sources are sufficient to sustain the population. Further research is needed for all SACs.

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