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Condition Assessments for Large Shallow Inlets and Bays in Welsh Special Areas of Conservation

Report No: 897

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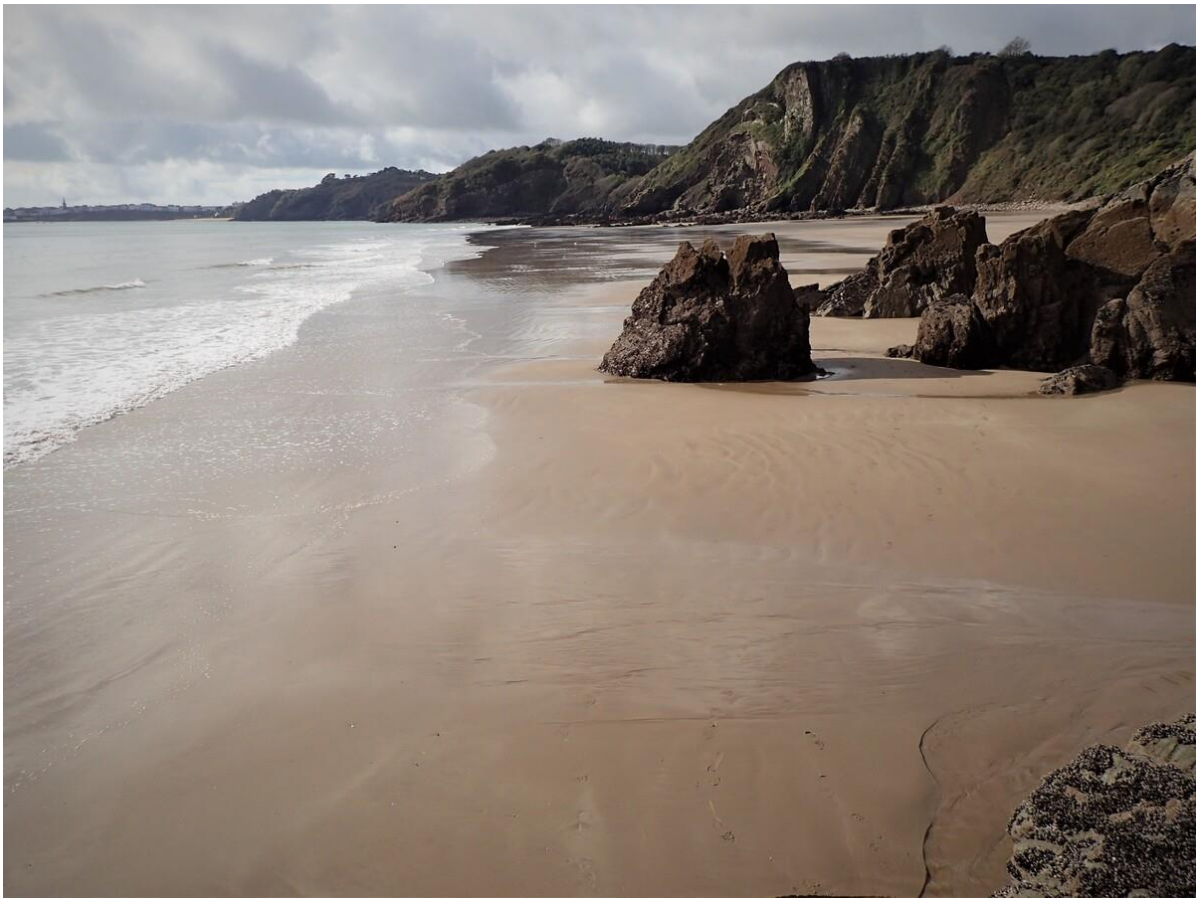

Carmarthen Bay, © NRW

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Contents

List of Figures

List of Tables

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 cilfachau a baeau mawr bas o fewn ardaloedd cadwraeth arbennig dynodedig (ACA) ledled Cymru. Mae Adran 1 yn rhoi trosolwg o'r broses asesu ac mae Adran 2 yn darparu disgrifiad a lleoliad y nodwedd(ion).

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 yr IMCA.

Crynodeb o asesiadau cyflwr ar gyfer cilfachau a baeau mawr bas mewn ACAau ledled Cymru

Lleoliad y nodwedd ACA	Asesiad cyflwr	Hyder yn yr asesiad
Y Fenai a Bae Conwy	Anffafriol	Canolig
Pen Llŷn a'r Sarnau	Ffafriol	Canolig
Sir Benfro Forol	Anffafriol	Canolig
Bae Caerfyrddin ac Aberoedd	Anffafriol	Isel

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 large shallow inlets and bays (LSIB) within designated special areas of conservation (SACs) across Wales. Cross-border sites are not included in this report but will hopefully be considered in future. Section 1 gives an overview of the assessment process and Section 2 provides a description and location of the feature(s).

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 large shallow inlets and bays in SACs across Wales.

SAC feature occurs in	Condition assessment	Confidence in assessment
Menai Strait and Conwy Bay	Unfavourable	Medium
Lleyn Peninsula and the Sarnau	Favourable	Medium
Pembrokeshire Marine	Unfavourable	Medium
Carmarthen Bay and Estuaries	Unfavourable	Low

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. Cross-border sites are not included in the assessment report due to resource limitations, but NRW hopes to take forward cross-border sites condition assessments in the future.

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. Feature description

The following text is the habitat description from the JNCC list of Annex I marine, coastal and halophytic habitats.

“Large shallow inlets and bays (LSIB) are habitat complexes which comprise an interdependent mosaic of subtidal and intertidal habitats. Several of these habitat types (1140 Mudflats and sandflats not covered by sea water at low tide, 1110 Sandbanks which are slightly covered by sea water all the time and 1170 Reefs) are listed as Annex I habitats in their own right.

LSIB are large indentations of the coast, generally more sheltered from wave action than the open coast. They are relatively shallow (with water less than 30 m over most of the area), and in contrast to 1130 estuaries, generally have much lower freshwater influence.

LSIB vary widely in habitat and species diversity according to their geographic location, size, shape, form and geology. There is considerable variation between hard (rock) and soft (sediment) coasts. The degree of wave exposure is a critical factor in determining habitat and species diversity, affecting communities both on the shore and in the sublittoral zone. The range of plants and animals associated with this habitat type is therefore very wide. The issue of site size is also important, as larger sites tend to encompass the greatest variety of constituent habitats and have the greatest potential for maintenance of ecosystem integrity”

3. Large shallow inlets and bays condition assessments

This section contains assessments for the large shallow inlets and bays (LSIB) in Welsh only marine ardal cadwraeth arbennig (ACA) / special areas of conservation (SAC) that are wholly in Wales. The feature is designated in five SACs in Wales (Figure 1):

- Y Fenai a Bae Conwy / Menai Strait and Conwy Bay
- Pen Llŷn a'r Sarnau / Lleyn Peninsula and the Sarnau
- Sir Benfro Forol / Pembrokeshire Marine
- Caerfyrddin ac Aberoedd / Carmarthen Bay and Estuaries

More information on the SACs and their features can be found in NRW's conservation advice on our website.

LSIB are a physiographic feature that hosts a great variety of habitats. These include other designated features such as reefs, mudflats and sandflats, sandbanks and Atlantic salt meadows (ASM) and *Salicornia,* within this report they are called nested features. The LSIB was assessed as a feature in its own right but the results of the relevant nested features were also taken into consideration. Any gaps in evidence that would improve the assessment of condition have been identified for each SAC (Section 4).

The performance indicators were assessed using a combination of data from nested features, NRW Habitats Regulations monitoring, Water Framework Directive (WFD) Regulations 2017 (WFD Regulations) monitoring, commissioned evidence reports, plan and project assessments, scientific literature, 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:

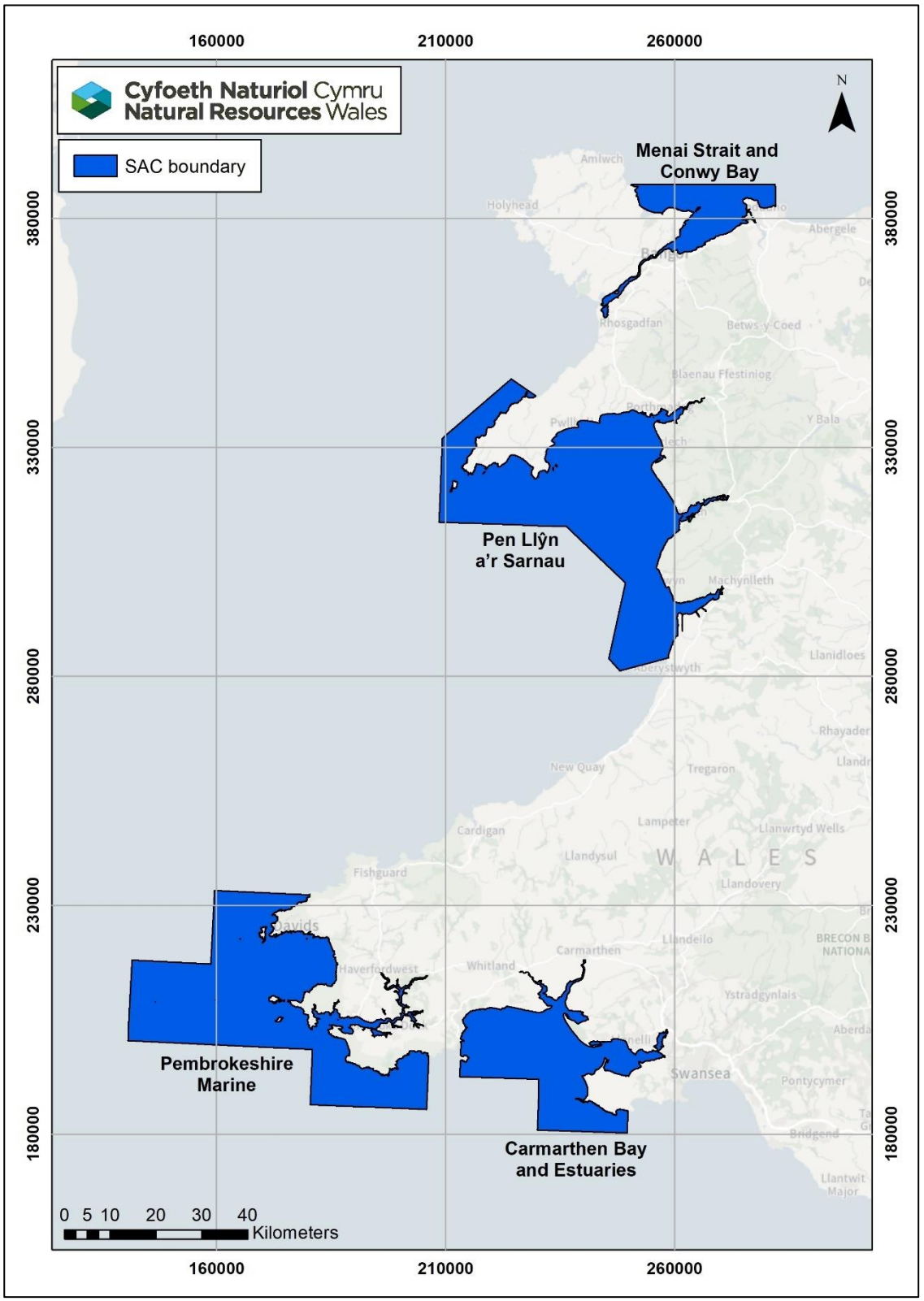
- 2009 cycle 1 classification
- 2015 cycle 2 classification
- 2018 cycle 2 interim classification
- 2021 cycle 3 classification

In the WFD classification, results are rolled forward from previous assessments where there are 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.

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.

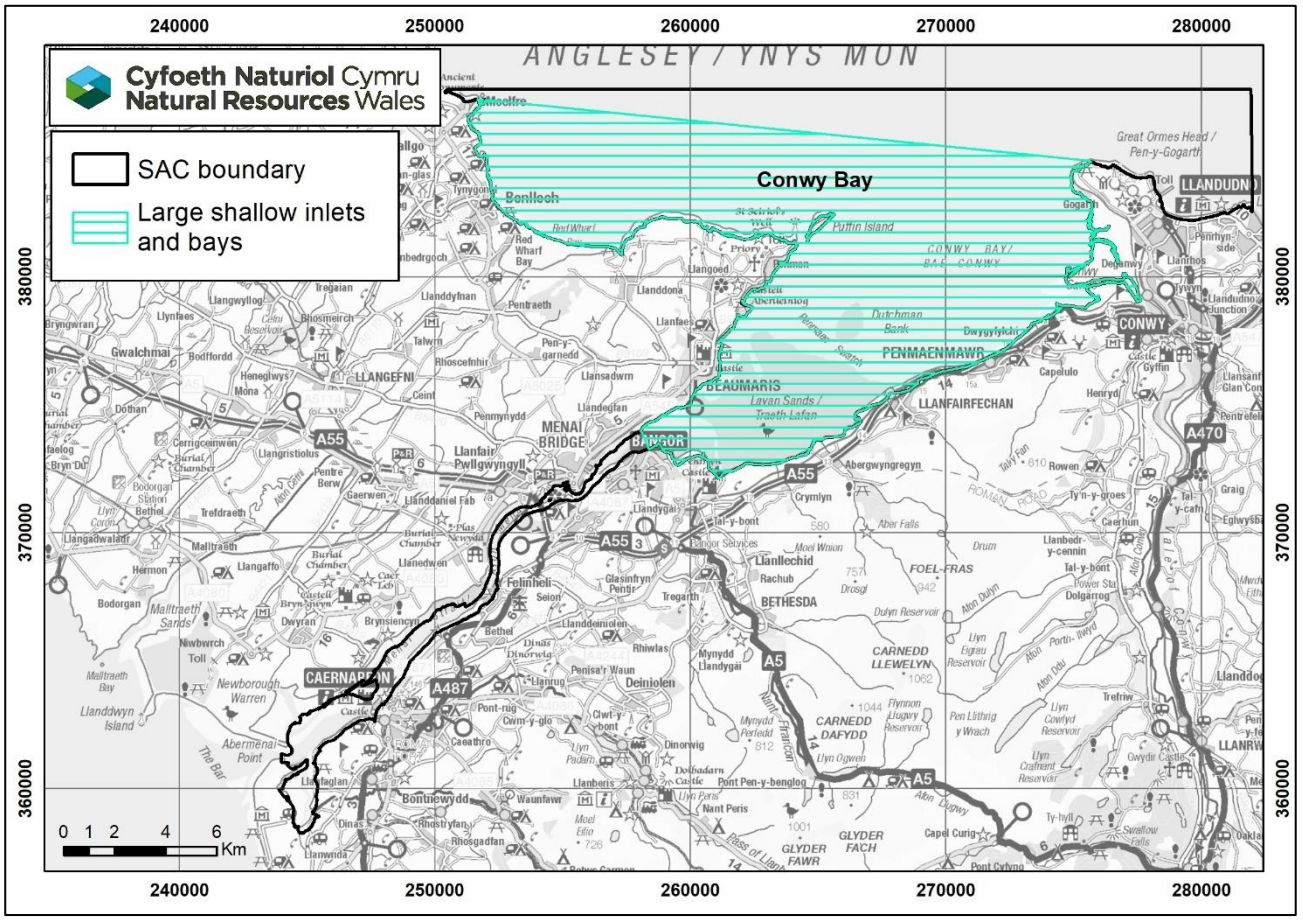
Figure 1. Location of SACs assessed for the LSIB feature.



3.1. Menai Strait and Conwy Bay SAC condition assessment

The large shallow inlets and bays (LSIB) feature in Menai Strait and Conwy Bay SAC is Conwy Bay and this also includes other smaller bays for example Red Wharf Bay (Figure 2). 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 2. Map of the LSIB feature in Menai Strait and Conwy Bay SAC.



The LSIB includes some nested features: sandbanks, mudflats and sandflats and reefs. Fish communities were only broadly considered due to resource limitations but there is some information included in the detailed assessment section. Table 2 has a summary of the assessment outcome. This outcome and reasons of failure are discussed in more detail in the sections below.

Table 2. Condition assessment of LSIB in Menai Strait and Conwy Bay 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 Menai Strait and Conwy Bay SAC. • 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 features: sandbanks, and mudflats and sandflats. • The NRW monitoring of the sublittoral soft sediment in Red Wharf Bay from 2007 to 2022 indicated no concerns. • The monitoring analysis of the sublittoral soft sediment in Conwy Bay from 2007 to 2019 indicated that sediment composition was relatively stable across the monitoring period. • However, analysis showed evidence of silt increase in one of the surveillance sites and in the eastern part of Conwy Bay. This resulted in a medium confidence pass for this target.	**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 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
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

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 feature. • Confidence is medium as the assessment has been based on expert judgment.	**Pass**	Medium
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)	• One of the five WFD waterbodies that overlap with the feature was not classified for DIN in the 2024 cycle 3 interim classification (Anglesey North). It overlaps with 32% of the feature. • The other four WFD waterbodies were classified as Good or High status for DIN (Conwy Bay, Menai Strait, North Wales and Conwy). Combined, these overlap with 55% of the feature. • Confidence is medium due to the one unclassified waterbody.	**Pass**	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)	• One of the five WFD waterbodies was classified with a Moderate status for phytoplankton in the 2024 cycle 3 interim classification (North Wales). However, it overlaps with <1% of the feature. • One WFD waterbody was not classified for this WFD element (Anglesey North). It overlaps with 32% of the feature. • The other three WFD waterbodies were classified with Good or High status for phytoplankton (Conwy Bay, Menai Strait and Conwy). Combined, these overlap with 55% of the feature. ○ The Menai Strait waterbody classification was rolled forward from the 2018 cycle 2 interim classification. • Confidence is medium due to one unclassified waterbody, and rolled forward classification.	**Pass**	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)	• One of the five WFD waterbodies was classified with a High status for opportunistic macroalgae in the 2024 cycle 3 interim classification (Conwy). It overlaps with 2% of the feature. • The other four WFD waterbodies have not been classified for opportunistic macroalgae in any cycles. Combined, these overlap with 85% of the feature. • This indicator was assessed as unknown as a large proportion of the feature overlap with waterbodies that have not been classified for this WFD element.	**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)	• All five WFD waterbodies that overlap with the feature were 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
Water quality: contaminants	Water column contaminants not to exceed the environmental quality standards (EQS). (S)	• Two of the five WFD waterbodies have a pass for chemicals in the 2024 cycle 3 interim classification (Menai Strait and North Wales). In both of these waterbodies the classifications were rolled forward from previous cycles as they were not classified in the 2024 cycle 3 interim classification. • The other three WFD waterbodies have a fail for chemicals (Anglesey North, Conwy Bay and Conwy). Combined, these overlap with 60% of the feature. Chemicals that failed were mercury, polybrominated diphenyl ethers (PBDE), polycyclic aromatic hydrocarbons (PAH) and cypermethrin. • Confidence is medium as the human health standard has been used for PBDE, and due to the roll forwards in some chemical classifications.	**Fail**	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: turbidity	Maintain expected levels of turbidity, allowing for natural change and variation. (S)	• There are limited data on turbidity for the LSIB feature in the Menai Strait and Conwy Bay SAC, therefore this target was assessed as unknown.	**Unknown**	N/A
Water quality: physicochemical properties of the water column	Maintain expected physicochemical properties of the water, allowing for natural change and variation. (S)	• Data from subtidal temperature loggers from within the SAC were available. Loggers at one monitoring site indicated a potential increase in temperature in recent years. It is not clear if this is a localised change or in line with global trends. Loggers at the other monitoring site were missing a large amount of data between 2016 and 2021. • An external report from Bangor University indicates that annual mean sea surface temperature is gradually rising in their Menai Strait temperature logger. • It is not understood if the observed increases in temperature are localised to the SAC, or if they are consistent with the effects of climate change. • This indicator was assessed as unknown due to a lack of understanding of the cause of the temperature patterns, and because there are currently insufficient data on other physicochemical parameters (e.g. salinity and pH).	**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)	• No issues were identified for the overlapping nested mudflats and sandflats feature. • The indicator failed for the sandbanks. This nested feature overlaps with 49% of the LSIB feature. • Spatial variability in infaunal community composition across monitoring stations in Red Wharf Bay was considered within the limits of natural variation. • Analysis of monitoring data in Conwy Bay indicated some disturbance from opportunistic species especially in the eastern part of the bay, southwest of the Great Orme's Head. Opportunistic species included the polychaetes *Lagis koreni, Mediomastus fragilis* and the oligochaete *Tubificoides pseudogaster,* which were dominant over the monitoring period, possibly indicating stressed environmental conditions. • Three of the five WFD waterbodies were classified as Good or High status for the Infaunal Quality Index (IQI) WFD element in the 2024 cycle 3 interim classification (Anglesey North, Menai Strait and Conwy). Combined, these overlap with 61% of the feature. However, the Conwy Bay waterbody, which overlaps with 26% of the feature was classified with a Moderate status. • The confidence has been set as medium due to the localised failure and the lack of understanding around the impact that failure may have on LSIB.	**Fail**	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. the red seaweed worm wart weed *Gracilaria vermiculophylla*) are currently impacting the condition of LSIB in the SAC. • Confidence is low as the spread and impacts of the 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)	• *G. vermiculophylla* has been recorded within the last six years in the Traeth Lafan sandflats in the Menai Strait, which is within the LSIB feature. • Other NNS have been recorded previously including the Pacific oyster *Magallana gigas* and wireweed *Sargassum muticum* within the LSIB feature. • Confidence is high due to the arrival of NNS within the last six years, and good availability of records.	**Fail**	High

Assessment conclusions

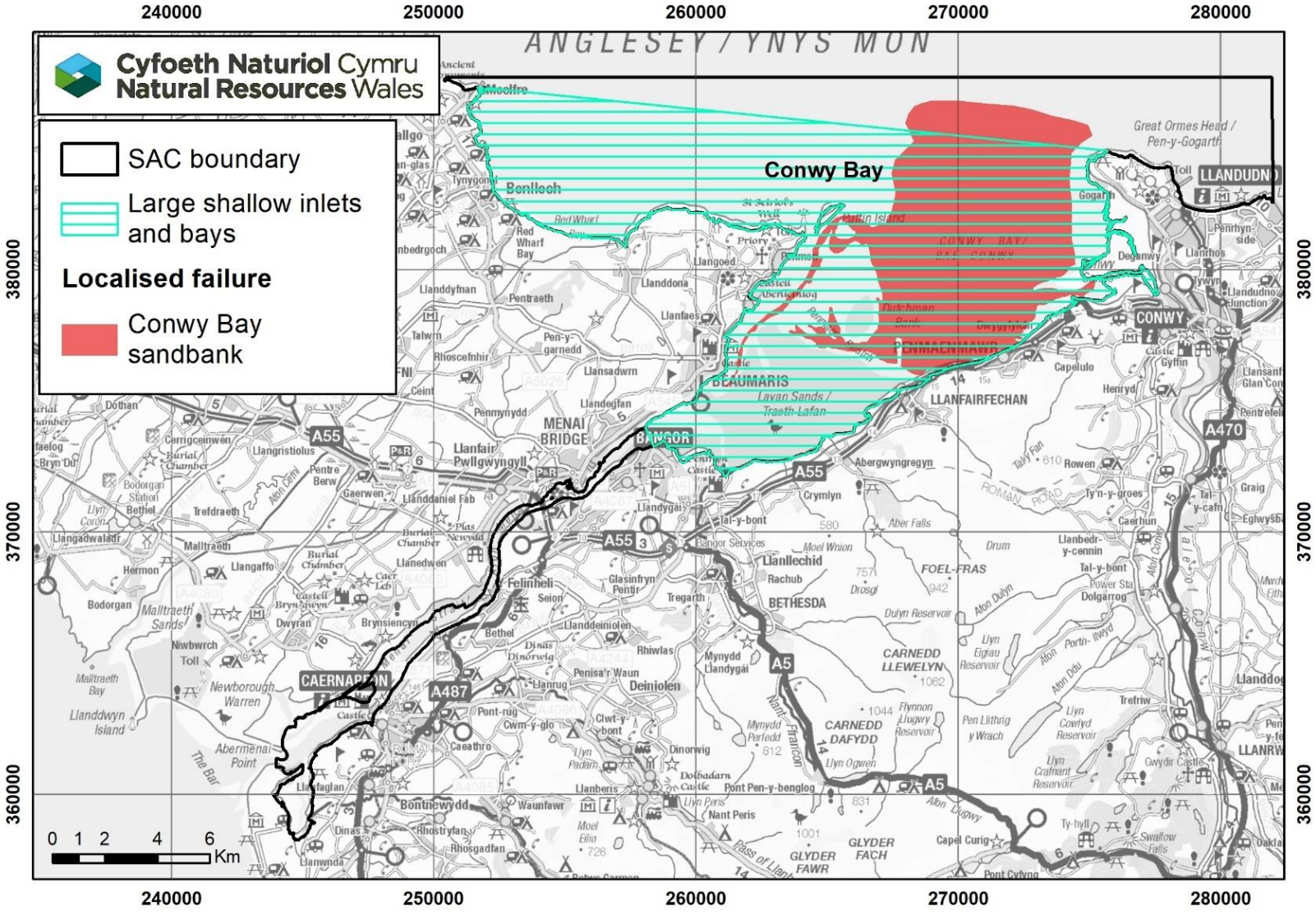
The LSIB feature in Menai Strait and Conwy Bay SAC has been assessed as being in **unfavourable** condition (medium confidence). There were a number of indicators with failing targets (Table 3). Further investigation is needed to better understand all of the failures to be able to identify management options that can bring the feature back into favourable condition. As the primary failure was localised, it has been mapped to help focus management effort (Figure 3).

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 LSIB in Menai Strait and Conwy Bay SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

SAC	Overall Condition Assessment	Indicator failures	Reason for indicator failure	Threats to condition
Menai Strait and Conwy Bay	**Unfavourable (medium confidence)**	Abundance, distribution and species composition of communities (P) Water quality: contaminants (S) Non-native species (T)	• There is an IQI failure for the Conwy Bay waterbody, and localised elevated numbers of opportunistic species, indicating stressed environmental conditions. • Levels of mercury, PBDE, PAH and cypermethrin in the Anglesey North, Conwy Bay and Conwy waterbodies are failing to meet their relevant environmental quality standards (EQS). • There are recent records of *G. vermiculophylla* within the LSIB feature.	• Unconsented infrastructure • INNS • Water quality: contaminants • Management of coastal defences • Climate change • Recreational access and collection

Figure 3. Map of the localised failure in the LSIB feature in Menai Strait and Conwy Bay SAC.



Detailed assessment information

Extent and distribution

The feature extent indicator in the Menai Strait and Conwy Bay 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. The distribution and extent of habitats and communities indicator also met its target for this reason, and because there are no known impacts to the distribution and extent of the nested features. Comparison mapping has not been used to assess the extent and only expert judgment was used to assess communities distribution in the absence of recent data. This has reduced the confidence to medium.

Sediments

Composition and distribution

In the condition assessments of the sandbanks feature and mudflats and sandflats features, the sediment composition and distribution indicators passed their targets. These features overlap with approximately 49% and 17% of the LSIB feature, respectively.

The NRW monitoring analysis of the sublittoral soft sediment in Red Wharf Bay from 2007 to 2016 showed small changes in sediment composition that were within the bounds of natural variation (Clark et al., in draft). Additional data up to 2022 further supports this with no concerning changes in sediment composition (NRW unpublished data).

The NRW monitoring analysis of the sublittoral soft sediment in Conwy Bay from 2007 to 2019 indicated that sediment composition was relatively stable across the monitoring period (Cappelli et al., in draft). There were some concerns, however, with the increase of silt in the eastern part of Conwy Bay (also observed in one of the surveillance sites), which may be related to the changes in infaunal community composition observed. However, this is yet to be confirmed.

Overall, the sediment composition and distribution indicator met its target as there have been no concerning changes in sediments over the monitoring periods. Confidence was reduced to medium to account for the concerns over the increase in silt in a localised part of Conwy Bay.

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 profile from the mudflats and sandflats data indicated no clear trend over the surveyed years (Jackson-Bué et al. 2025a). 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.

Organic carbon content and contaminants

There is no monitoring of sediment contaminants or organic carbon content within the SAC. These indicators were therefore not assessed.

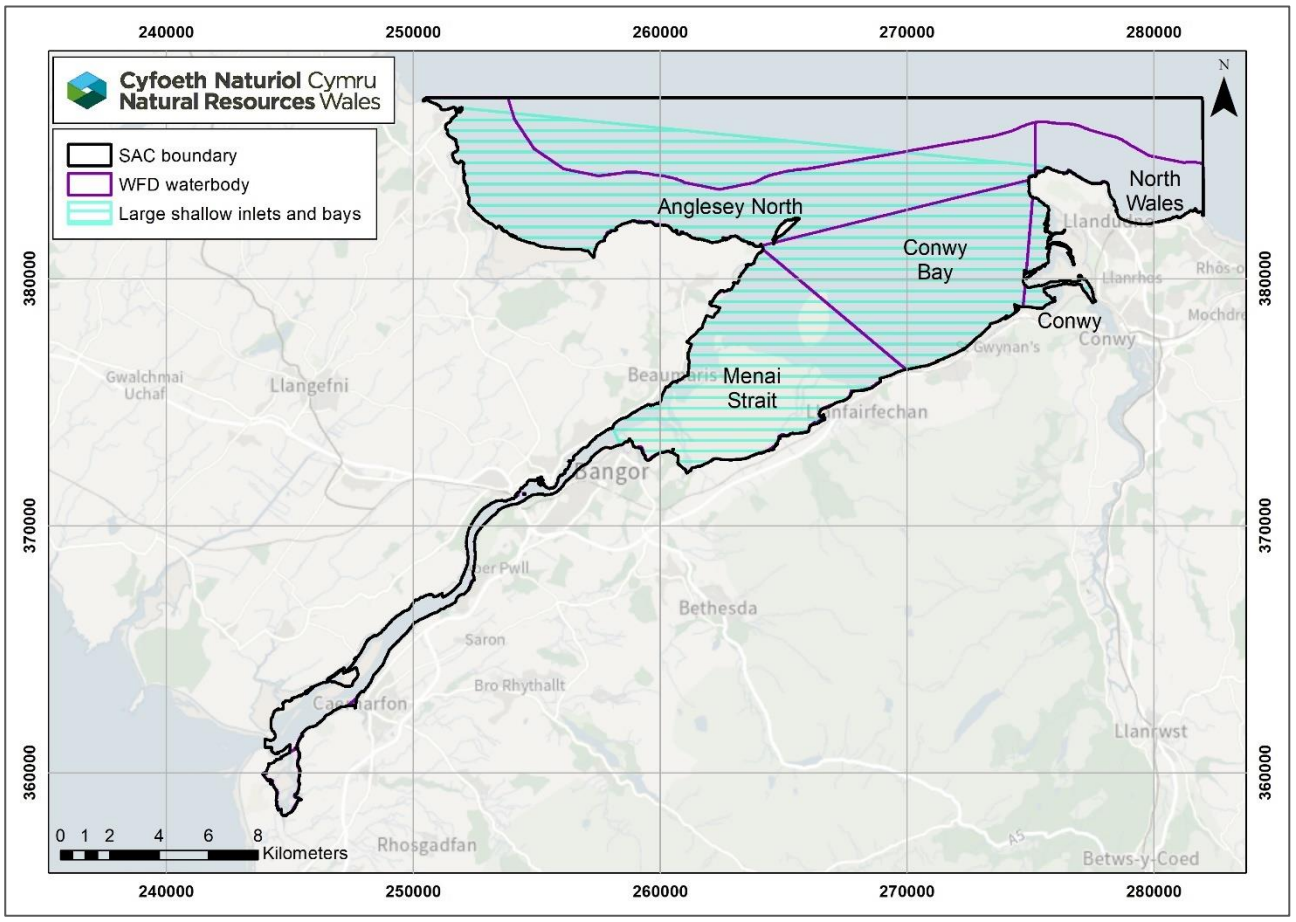
Topography and hydrodynamics

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 within the SAC.

Water quality

It has been estimated that approximately 87% of the LSIB feature within the SAC falls within five WFD waterbodies (Figure 4), therefore these are likely to be a good reflection of the overall effect of water quality on the feature. The Anglesey North, Menai Strait and Conwy Bay waterbodies overlap with the largest proportion of the feature (32%, 27% and 26% respectively). The other two WFD waterbodies overlap with a very small proportion of the feature.

Figure 4. Map of the WFD waterbodies that overlap with the LSIB feature within Menai Strait and Conwy Bay SAC.



Nutrients (DIN only)

The nutrients (Dissolved Inorganic Nitrogen - DIN only) indicator met its target as a large proportion of the feature (55%) overlaps with WFD waterbodies that were classified as Good or High status for DIN in the 2024 cycle 3 interim classification. The other WFD waterbody, Anglesey North, which overlaps with 32% of the feature, was not classified for the DIN element in the 2024 cycle 3 interim classification as there were no data collected on this element over the last six years (see Section 3). This waterbody overlaps with the largest proportion of the feature, therefore the confidence in the assessment was reduced to medium.

Phytoplankton

The phytoplankton indicator met its target as a large proportion of the feature (55%) overlaps with WFD waterbodies that were classified as Good or High status for the phytoplankton element in the 2024 cycle 3 interim classification. The other WFD waterbody (Anglesey North) was not classified for the element in any WFD cycles. Classification of some of these waterbodies may not be suitable or possible for this element due to WFD classification methodology, or due to the nature of the waterbodies (e.g. turbidity levels). The North Wales waterbody which overlaps with the smallest proportion (0.04%) of the feature was classified with a Moderate status for phytoplankton, but this was not considered in the condition assessment. The confidence in the pass was reduced to medium due to the unclassified waterbody and as one waterbody with a High status classification was rolled forward from a previous cycle.

Opportunistic macroalgae

The opportunistic macroalgae indicator was assessed as unknown as a large proportion of the feature (85%) is within WFD waterbodies that have not been classified for the opportunistic macroalgae element in the 2024 cycle 3 interim classification. It should be noted that 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 one WFD waterbody that was classified as High status was the Conwy waterbody, which overlaps with only 2% of the feature.

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

Three of the five WFD waterbodies that overlap with the LSIB feature in the SAC have a fail for chemicals in the 2024 cycle 3 interim classification. Combined, these waterbodies overlap with approximately 60% of the feature. This caused the contaminants indicator to fail. The failures were for the Anglesey North (mercury and polybrominated diphenyl ethers

(PBDE)), Conwy Bay (polycyclic aromatic hydrocarbons (PAH)), and Conwy (PBDE, mercury, PAH and cypermethrin) waterbodies.

There has been a waterbody status change from pass to fail in the Conwy Bay waterbody between the 2021 cycle 3 classification and the 2024 cycle 3 interim classification, however the failing contaminant (PAH) was not assessed in previous cycles. Similarly, in the Conwy waterbody, two of the failing contaminants (PAH and cypermethrin) were not previously classified. With the exception of the 2021 cycle 3 classification, mercury has failed in this waterbody in all classifications since the 2015 cycle 2 classification. The waterbody status changes for mercury between cycles are likely due to changes in WFD classification methodology. Cypermethrin is a synthetic pyrethroid insecticide and is highly toxic to some aquatic species (EA, 2019), but now has a restricted use in Wales. The EQS for cypermethrin is very low, and in the previous laboratory methodology, it was not possible to detect concentrations below the EQS. There was an additional failure for zinc in the 2021 cycle 3 classification the Conwy waterbody, but this no longer fails in the 2024 cycle 3 interim classification. In the Anglesey North waterbody, mercury has failed since the 2015 cycle 2 classification. The EQS for mercury is based on the secondary poisoning protection goal (for wildlife). The PBDE failures were 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 confidence in the fail was reduced to reflect this.

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 classified in the 2024 cycle 3 interim classification. This also contributed to the reduced confidence. 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.

Data from NRW monitored subtidal temperature loggers from two monitoring sites within the SAC were available. However, as loggers from one of the sites had a large amount of missing data, the observed patterns in temperature are based on data from only one site which overlaps with the feature. These loggers showed an increase in temperature in more recent years. An external report (Smyth et al., 2022) also found that the annual mean sea surface temperature was gradually rising in the Menai Strait. It is not understood if the observed increases in temperature are localised to the SAC, or if they are consistent with the effects of climate change. The physicochemical indicator was assessed as unknown due to a lack of understanding of the cause of the temperature patterns, and because there are currently insufficient data on other physicochemical parameters (e.g. salinity and pH).

Species and communities

WFD classifications

Three of the five WFD waterbodies that overlap with the LSIB feature were classified as Good or High status for the Infaunal Quality Index (IQI) element in the 2024 cycle 3 interim classification (Anglesey North, Menai Strait and Conwy). Combined, these waterbodies overlap with 61% of the feature. One of these waterbodies, Conwy, has deteriorated from High status in the 2021 cycle 3 classification to Good status in the 2024 cycle 3 interim classification. However, this waterbody overlaps with a small proportion of the feature (2%). The Conwy Bay waterbody, which overlaps with 26% of the feature was classified with a Moderate status for the IQI element, but with an uncertain confidence. The WFD investigation report for this waterbody (Moore and Green, in draft) concluded that the Moderate classification in the 2018 cycle 2 interim and 2021 cycle 3 classifications are a fair representation of the waterbody and thus Conwy Bay coastal waterbody is failing to meet Good Ecological Status for IQI. The final overlapping WFD waterbody has a very small overlap with the feature (0.04%) and has not been classified for the IQI element.

Species and communities in nested features

The mudflats and sandflats feature overlaps with approximately 17% of the LSIB feature. The condition assessment of the mudflats and sandflats feature concluded that the abundance, distribution and species composition of communities indicator met the criteria for a pass (Jackson-Bué et al., 2025a).

The reefs feature overlaps with approximately 4% of the LSIB feature. The abundance, distribution and species composition of communities indicator met its target for the intertidal reefs part of the condition assessment of the reefs feature. The indicator failed for subtidal reefs due the decline in sponge communities. The failure, however, is localised to Coleg Normal monitoring site in the Menai Strait, which is outside of the LSIB feature and therefore was not relevant to the LSIB feature (Jackson-Bué et al., 2025c).

The sandbanks feature overlaps with approximately 49% of the LSIB feature. The abundance, distribution and species composition of communities indicator failed to meet its target in the condition assessment of the sandbanks feature(Jackson-Bué et al., 2025b). The information for the infaunal community composition for both sandbanks and LSIB feature were based on the monitoring of soft sediment within Conwy Bay (Cappelli et al., in draft).

Species and communities in LSIB feature

Analysis of the infaunal community composition at monitoring stations within Conwy Bay indicated spatial variability in diversity, quality indices and infaunal community structure which is likely to be linked to sediment composition across monitoring stations in Conwy Bay (Cappelli et al., in draft). There was a notable change in faunal composition and recorded sediment type at many samples from 2007 compared with later years (2010-2019), which corresponded with a shift in sediment from 2007 (sand to a more muddy sand). Many of the stations within the Conwy Bay waterbody were characterised by higher numbers of opportunistic species such as *Lagis koreni*, *Mediomastus fragilis* and *Tubificoides pseudogaster* (agg), especially in the middle eastern part of Conwy bay. Generally lower Shannon-Weiner diversity, lower Warrick statistic and higher numbers of

individuals were observed in the middle eastern part of Conwy Bay, possibly suggesting the dominance of a few taxa and perhaps stressed conditions. This seems to have got worse since 2007, although long-term data analysis showed 2007 to be an exceptional year (Moore and Green, in draft).

While there has been spatial variability in diversity and quality indices, and infaunal community composition across monitoring stations in Red Wharf Bay, these were considered to be within the limits of natural variation (Clarke et al., in draft; M. Green (NRW), pers. comm.). One monitoring site (station 11) had an elevated number of opportunistic species which could be caused by a nearby sewage discharge (Clarke et al., in draft; M. Green (NRW), pers. comm.), and will be something to pay close attention to in the next assessment. The abundance of the polychaete *Leitoscoloplos mammosus* has increased unexpectedly in recent years in most of the inshore stations and it would be interesting to see if this trend continues in the future (M. Green (NRW), pers. comm.). This species is listed as a second-order opportunistic species present in slight to pronounced unbalanced conditions in response to stress (ICES, 2004).

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 IQI failure in Conwy Bay waterbody and the elevated opportunistic species in the eastern part of Conwy Bay resulted in the failure of the abundance, distribution and species composition of communities indicator. The confidence has been set as medium due to the localised failure and the lack of understanding around the impacts that failure may have on LSIB.

Invasive non-native species

The red seaweed worm wart weed *Gracilaria vermiculophylla* was recorded within the last six years in the sandflats at Traeth Lafan (Mercer and Brazier, 2023), within the LSIB feature (Conwy Bay). Therefore, the tertiary target of the non-native species (NNS) indicator failed with high confidence due to the new NNS recorded in the LSIB feature within the last reporting cycle.

Other NNS are known to be present in the Conwy Bay including the Pacific oyster *Magallana gigas* and wireweed *Sargassum muticum*. The cover of *S. muticum* is thought to be extensive in the SAC, however this species is not consistently recorded. In addition there are records of other NNS at the boundary of the LSIB feature, including the American jack knife clam *Ensis leei* and the Chilean oyster *Ostrea chilensis*. Limited records have been produced for *O. chilensis,* but it has been known to be present in the Menai Strait for about 30 years. The American slipper limpet *Crepidula fornicata* has become established since 2019 in the Menai Strait following a presumed successful eradication in 2006.

Although this species has not currently been recorded within the LSIB feature, there is a risk of the species becoming established in other parts of the SAC.

It is not fully understood how some of these species may spread and impact the condition of LSIB 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 the invasive non-native species (INNS) present the primary target of the INNS indicator passed. Confidence is low as the impacts of the INNS present within the feature are not well understood.

Reasons for target failure

The assessment of the LSIB feature in the Menai Strait and Conwy Bay SAC failed one primary target, 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.

Abundance, distribution and species composition of communities

This indicator has a primary weighting. The LSIB feature is partly within Conwy Bay waterbody which has been classified with a Moderate status for the IQI element. There was an IQI failure in the Conwy Bay waterbody in the 2015 cycle 2, 2021 cycle 3 and 2024 cycle 3 interim classifications. There were also elevated numbers of small opportunistic species within the community in the eastern part of the bay, southwest of the Great Orme's Head, through the monitoring period, which indicates stressed environmental conditions. A significant shift in the composition of benthic species could result in various undesirable disruptions within the marine ecosystem, including impacts on food webs. It is not fully understood how some of these opportunistic species may impact the LSIB biota and the nested habitat features within the feature. From the evidence it is not clear what is causing this disturbance. The elevated number of opportunistic species such as *L. koreni*, *M. fragilis* and oligochaetes, may be related to localised changes in nutrients and increased deposition. Work is ongoing to determine the impact of local water discharges and other factors. Further investigation will be needed to understand the reasons for this failure and allow management measures to be implemented.

Water quality: contaminants

This indicator target has a secondary weighting. The LSIB feature is partly within three WFD waterbodies (Anglesey North, Conwy Bay and Conwy) which have been classified with a fail for chemicals due to mercury, PBDE, PAH 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). PAHs can be produced through natural processes, but also arise from anthropogenic sources, for example during combustion of fossil fuels and organic material (Webster and Fryer, 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 including atmospheric deposition or contaminated waterbody bed sediments. However, WFD investigations of the failures in all three waterbodies are yet to be undertaken. Mercury and PBDE are being managed in the UK and it is hoped that these levels will reduce over time. There is currently no specific management in place for PAH in Wales. The PAH EQS is based on the most sensitive taxa and may not be applicable to all of the LSIB biota. The impacts of PAH on the LSIB feature are not fully understood.

Non-native species

This indicator failed to meet its tertiary target of no increase in the number of introduced NNS by human activities. *G. vermiculophylla* has been recorded within the last six years in the Traeth Lafan sandflats which is within the LSIB feature. 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. There have also been some records of *C. fornicata* within the Menai strait and Conwy Bay SAC but outside the LSIB feature with establishment of the species in the southwestern end of the Menai Strait within the last reporting cycle. There is a risk that the species will become established in other areas including within Conwy Bay.

The spread and full extent of the impact that these 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. 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.

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 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 Menai Strait and Conwy Bay 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

G. vermiculophylla has been found at Traeth Lafan sandflats within the SAC. 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 have a detrimental impact on the feature as seen in mudflats and sandflats feature in Carmarthen

Bay and Estuaries SAC (Jackson-Bué et al., 2025a). The species can alter the sedimentation and topography and could alter the habitat in the long-term if at high densities (Maggs and Magill, 2014).

There have been recent records of *C. fornicata* in the SAC. This species is commonly found in areas of muddy habitat. At high density, 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 LSIB feature. However, the spread and impact of this species on the feature is not fully understood.

Future increases in air and water temperatures that are expected with climate change may result in increased occurrence of conditions suitable for spawning and settlement of *M. gigas*. Northward recruitment may be expected (Smyth et al., 2022).

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 Per- and polyfluoroalkyl substances (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.

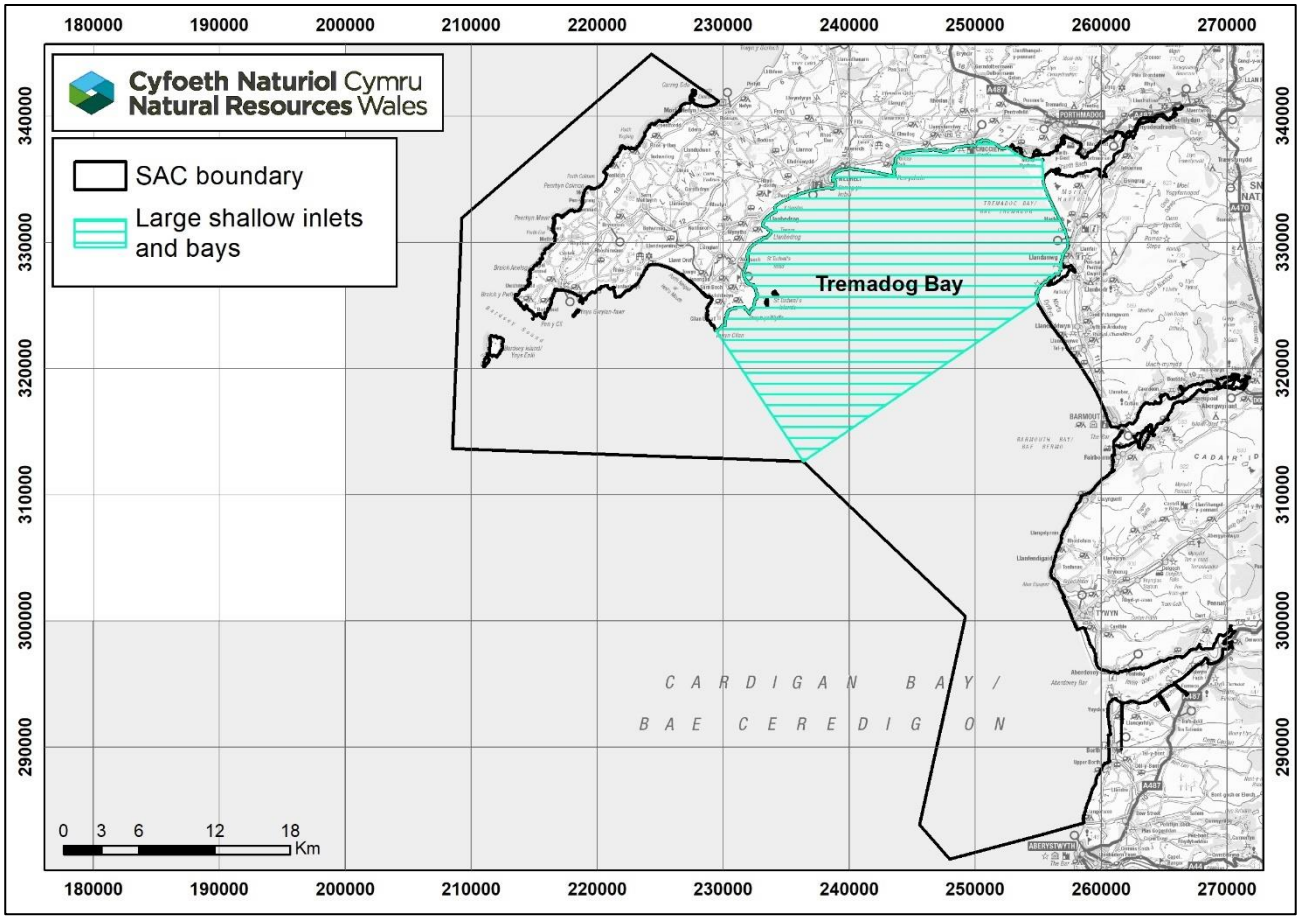
- Changes in air and sea temperature.
- Changes in ocean acidification.
- Changes in species distribution.

Further threats are associated with the nested features and can be found in the relevant feature reports.

3.2. Pen Llŷn a’r Sarnau SAC condition assessment

The large shallow inlets and bays (LSIB) feature in Pen Llŷn a’r Sarnau SAC is Tremadog Bay (Figure 5). 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 5. Map of the LSIB feature in Pen Llŷn a'r Sarnau SAC.



The LSIB includes some nested features: reefs and 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 4 has a summary of the assessment outcome. This outcome and reasons of failure are discussed in more detail in the sections below.

Table 4. Condition assessment of LSIB in Pen Llŷn a'r Sarnau 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 Pen Llŷn a'r Sarnau 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 LSIB, allowing for natural change and variation. (P)	• No issues were identified for the overlapping nested mudflats and sandflats feature. • The NRW monitoring analysis of the sublittoral soft sediment in Tremadog Bay from 2007 to 2018 indicated that sediment composition was relatively stable across the monitoring period. • Confidence is medium due to the lack of more recent data analysis and the low level of overlap of the mudflats and sandflats feature with the LSIB.	**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 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)	• There are no recent data for organic carbon content for the estuaries within Pen Llyn a'r Sarnau SAC, as the Clean Seas Environment Monitoring Programme (CSEMP) data have not been collected here since 2015. • For this reason, this indicator was assessed as unknown.	**Unknown**	N/A
Sediment quality: contaminants	Sediment contaminants not to exceed the quality guidelines. (S)	• There are no recent data for sediment contaminants for the estuaries within Pen Llyn a'r Sarnau SAC, as the CSEMP data have not been collected here since 2015. • For this reason, this indicator was assessed as unknown.	**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

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 feature. • Confidence is medium as the assessment has been based on expert judgment.	**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. (P)	• One of the three WFD waterbodies that overlap with the feature was not classified for DIN in any WFD cycles (Tremadog Bay). It overlaps with the largest proportion of the feature (57%). • The other two WFD waterbodies were classified as High status for DIN in the 2024 cycle 3 interim classification (Cardigan Bay North and Glaslyn). Combined, these overlap with 42% of the feature. • Confidence is medium due to the one unclassified waterbody.	**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 not classified for the phytoplankton WFD element in the 2024 cycle 3 interim classification (Tremadog Bay and Glaslyn). Combined, these waterbodies overlap with 58% of the feature. • The other WFD waterbody was classified with a High status for phytoplankton (Cardigan Bay North). It overlaps with 41% of the feature. • Confidence is medium as a large proportion of the feature overlaps with waterbodies that have not been classified for the relevant WFD element.	**Pass**	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 were classified for opportunistic macroalgae 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)	• Two of the three WFD waterbodies that overlap with the feature were not classified for dissolved oxygen in the 2024 cycle 3 interim classification (Tremadog Bay and Glaslyn). They overlap with 57% and 1% of the feature respectively. • The other WFD waterbody was classified with a High status for dissolved oxygen in the 2024 cycle 3 interim classification (Cardigan Bay North). It overlaps with 41% of the feature. • 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, and as a large proportion of the feature has not been classified.	**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 were not classified as the chemicals have not been assessed within the last six years (Tremadog Bay and Glaslyn). • The other WFD waterbody has a fail for chemicals (Cardigan Bay North). It failed mercury and PBDE and overlaps with 41% of the feature. • Confidence is medium as the human health standard has been used for PBDE, and due to the unclassified waterbodies.	**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 Pen Llŷn a'r Sarnau SAC, therefore this target was assessed as unknown.	**Unknown**	N/A
Water quality: physicochemical properties of the water column	Maintain expected physicochemical properties of the water, allowing for natural change and variation. (S)	• Data from the six subtidal temperature loggers from within the SAC were available. Some of the loggers indicated an increase in the number of days with higher temperatures, and some showed no clear pattern. • It is not understood if the observed increases in temperature are localised to the SAC, or if they are consistent with the effects of climate change. • This indicator was assessed as unknown due to a lack of understanding of the cause of the temperature patterns, and because there are currently insufficient data on other physicochemical parameters (e.g. salinity and pH).	**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 IQI WFD element in the 2024 cycle 3 interim classification (Tremadog Bay, Cardigan Bay North and Glaslyn). Combined, these waterbodies overlap with 99% of the feature. • No issues were identified for the overlapping nested features: reefs and mudflats and sandflats. • The sublittoral habitats in Tremadog Bay appeared to be in good ecological health and have remained relatively consistent and within the limits of natural variation throughout the monitoring period. • Confidence is medium as the data time frame of the detailed report analysis only extends up to 2018 and the lack of fish communities data.	**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 to suggest that INNS (e.g. *Crepidula fornicata*) are currently impacting the condition of LSIB in the SAC. • Confidence is low as the spread and impacts of the INNS present within the feature are not well understood.	**Pass**	Low

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Non-native species (NNS)	No increase in the number of introduced NNS by human activities. (T)	• There are recent records (2023-2024) of *C. fornicata* within the feature (close to St Tudwal's Islands). • Other records of NNS have been previously recorded within the feature including *Sargassum muticum* and *Magallana gigas*. • 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 LSIB feature in Pen Llŷn a'r Sarnau SAC has been assessed as being in **favourable** condition (medium confidence). Overall, the lack of any significant anthropogenic impacts on this feature in term of extent, hydrodynamic processes, topography, sediment composition and its associated community, have contributed to this favourable assessment outcome. There were two indicators with failing targets (Table 5). 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 5 with more detail on each performance indicator, and any reasons for failure, provided in the sections below.

Table 5. Summary of the condition assessment for LSIB in Pen Llŷn a'r Sarnau SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

SAC	Overall Condition Assessment	Indicator failures	Reason for indicator failure	Threats to condition
Pen Llŷn a'r Sarnau	**Favourable (medium confidence)**	Water quality: contaminants (S) Non-native species (T)	• Levels of mercury and PBDE in the Cardigan Bay North waterbody are failing to meet their relevant EQSs. • There has been a recent increase in the number of records of *C. fornicata* in the feature.	• Unconsented infrastructure • INNS • Water quality: contaminants • Management of coastal defences • Climate change

Detailed assessment information

Extent and distribution

The extent of the feature indicator in the Pen Llŷn a'r Sarnau 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. The distribution and extent of habitats and communities indicator also met its target for this reason, and because there are currently no known impacts to the distribution and extent of the nested features. Comparison mapping has not been used to assess the extent and only expert judgment was used to assess communities distribution in the absence of recent data. This has reduced the confidence to medium.

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 only 2% of the LSIB feature.

The monitoring analysis of the sublittoral soft sediment in Tremadog Bay from 2004 to 2018 indicated that sediment composition was relatively stable across the monitoring period (Kirby et al., in draft). Sediment types at almost all stations have been consistent across years where sediment type fell into one or two categories over the entire monitoring period.

Overall, the sediment composition and distribution indicator met its target as there have been no concerning changes in sediments over the monitoring periods. However, confidence was reduced to medium as the Tremadog Bay data goes up to 2018 only.

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 only 2% of the LSIB feature. Despite the small spatial overlap, it was deemed acceptable to use the mudflats and sandflats condition assessment as a proxy for the sediment redox layer indicator as there are no known anthropogenic impacts that would affect the redox layer of sediments within Tremadog Bay. The indicator met its target as the redox layer profile from the mudflats and sandflats data indicated no clear trend over the surveyed years (Jackson-Bué et al. 2025a). 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.

Organic carbon content and contaminants

Sediment contaminants and organic carbon content were previously monitored at two stations in the SAC by the Clean Seas Environment Monitoring Programme (CSEMP), however the monitoring ceased in 2015. The data were deemed to be out of date and these indicators were assessed as unknown.

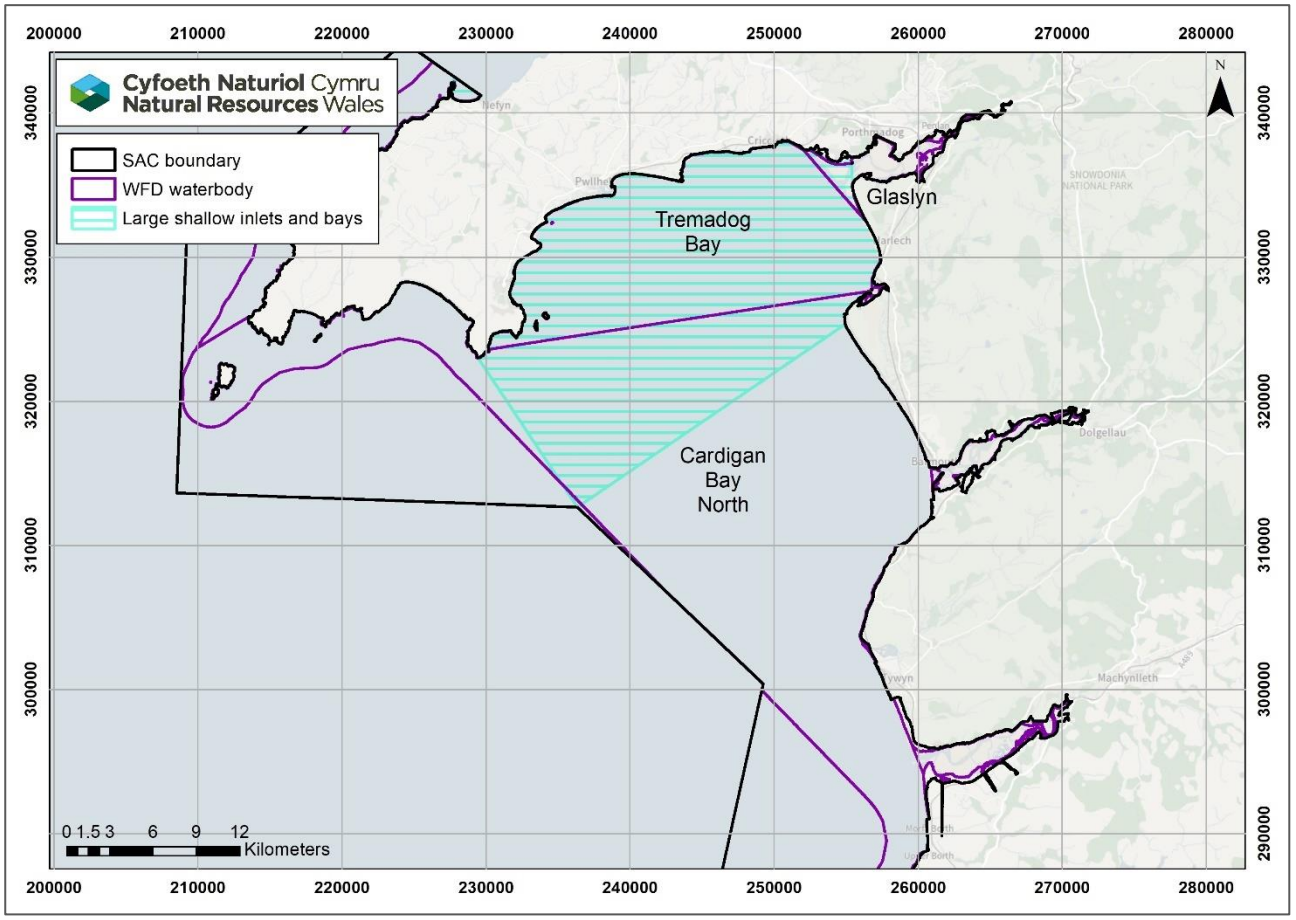
Topography and hydrodynamics

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 within the SAC.

Water quality

It has been estimated that approximately 99% of the LSIB feature within the SAC falls within three WFD waterbodies (Figure 6), therefore these are likely to be a good reflection of the overall effect of water quality on the feature. The Tremadog Bay and Cardigan Bay North waterbodies overlap with the largest proportion of the feature (57% and 41% respectively). The Glaslyn waterbody overlaps with a small proportion of the feature (1%) (Figure 6).

Figure 6. Map of the WFD waterbodies that overlap with the LSIB feature within Pen Llŷn a'r Sarnau SAC.



Nutrients (DIN only)

The nutrients (DIN only) indicator met the target as two of the three WFD waterbodies that overlap with the feature were classified as High status for DIN in the 2024 cycle 3 interim classification. These were Cardigan Bay North and Glaslyn waterbodies. Confidence was reduced to medium because one WFD waterbody, Tremadog Bay, has never been classified for DIN. This waterbody overlaps with the largest proportion of the feature.

Phytoplankton

The phytoplankton indicator met the target. One of the overlapping WFD waterbodies, Cardigan Bay North, was classified with a High status for phytoplankton in the 2024 cycle 3 interim classification. The other two WFD waterbodies have not been classified for phytoplankton in any WFD cycles. Classification of some WFD waterbodies is not suitable or possible for this element due to WFD classification methodology, or due to the nature of the waterbodies (e.g. turbidity levels). Confidence in the pass was reduced to medium as a large proportion of the feature overlaps with waterbodies that have not been classified for the phytoplankton element.

Opportunistic macroalgae

None of the three WFD waterbodies were classified for the opportunistic macroalgae element in the 2024 cycle 3 interim classification, therefore this indicator was assessed as unknown. 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. Confidence in the pass was reduced to medium because surface sampling of dissolved oxygen may not detect issues for more demersal habitats within the LSIB feature (see further detail in Section 3.1), and because a large proportion of the feature has not been classified for this element. However, these WFD waterbodies are not deemed to be at risk from failing this element.

Contaminants

One of the WFD waterbodies that overlaps with the LSIB feature in the SAC has a fail for chemicals in the 2024 cycle 3 interim classification. This was the Cardigan Bay North waterbody which failed for mercury and PBDE, and therefore caused the contaminants indicator to fail. The EQS for mercury is based on the secondary poisoning protection goal (for wildlife). The human health protection goal that is used for PBDE may be considered as over precautionary as the effect of contaminants on the biota of LSIB are not fully understood. The other two WFD waterbodies were not classified as the chemicals have not been assessed within the last six years. The confidence in the failure 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.

Data from six NRW monitored subtidal temperature loggers within the SAC were available. Three of the loggers overlap with or are close to the LSIB feature. Some of the loggers indicated an increase in the number of days with higher temperatures, and some showed no clear pattern. It is not understood if the observed increases in temperature are localised to the SAC, or if they are consistent with the effects of climate change. The physicochemical indicator was assessed as unknown due to a lack of understanding of the cause of the temperature patterns, and because there are currently insufficient data on other physicochemical parameters (e.g. salinity and pH).

Species and communities

All three of the overlapping WFD waterbodies were classified as Good or High status for the IQI element in the 2024 cycle 3 interim classification (Tremadog Bay, Cardigan Bay North and Glaslyn). Combined, these waterbodies overlap with 99% of the feature. One of these overlapping waterbodies, Tremadog Bay, has deteriorated from High status in the 2021 cycle 3 classification to Good status in the 2024 cycle 3 interim classification.

The mudflats and sandflats feature overlaps with approximately 2% 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 (Jackson-Bué et al., 2025a).

The reefs feature overlaps with approximately 31% of the LSIB feature. The abundance, distribution and species composition of communities indicator met its target for the intertidal reefs and subtidal reefs where it occurs within the LSIB feature. (Jackson-Bué et al., 2025c).

The sublittoral habitats in Tremadog Bay appeared to be in good ecological health and have remained relatively consistent throughout the monitoring period of 2004 to 2018 (Kirby et al., draft). The spatial and temporal variation evident in the analysis is considered to be within the limits of natural variation. Some concerns were raised about the deterioration of the infaunal composition at one of the monitoring sites (station 13, near the mouth of the Glaslyn/Dwyryd). As this is very localised, it was not deemed large enough to fail the indicator but will require further attention in the future.

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 Pen Llŷn a'r Sarnau SAC met its target. However confidence was reduced to medium because the data only extends up to 2018 and due to the lack of fish communities data for the LSIB feature.

Invasive non-native species

There has been an increase in the number of records for *C. fornicata* identified in various locations within the SAC, including two records in 2023 and 2024 within the LSIB feature for the first time, close to St Tudwal's Islands. Therefore, the tertiary target of the NNS indicator failed with high confidence due to the new NNS recorded in the LSIB feature within the last reporting cycle.

Other NNS are known to be present within the LSIB feature, including *S. muticum* and *M. gigas*.

It is not fully understood how some of these species may spread and impact the condition of LSIB 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 the INNS present the primary target of the INNS indicator passed. Confidence is low as the impacts of the INNS present within the feature are not well understood.

Reasons for target failure

The LSIB feature in Pen Llŷn a'r Sarnau 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. The LSIB feature in the SAC is partly within one WFD waterbody (Cardigan Bay North) that has a fail for chemicals due to PBDE and mercury. 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).

The exact sources of mercury and PBDE into the Cardigan Bay North waterbody are unknown as a WFD investigation of the failure in this 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 LSIB feature within the last six years. The spread and full extent of the impact that these 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. 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.

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 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 Pen Llŷn a'r Sarnau 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

There have been recent records of *C. fornicata* in the SAC including two records within the LSIB feature, close to St Tudwal's Islands. At high density, this species may cause an impact on the feature (see further detail in Section 3.1).

G. vermiculophylla has been found in the SAC. 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 as seen in mudflats and sandflats feature in Carmarthen Bay and Estuaries SAC (Jackson-Bué et al., 2025a) (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.

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

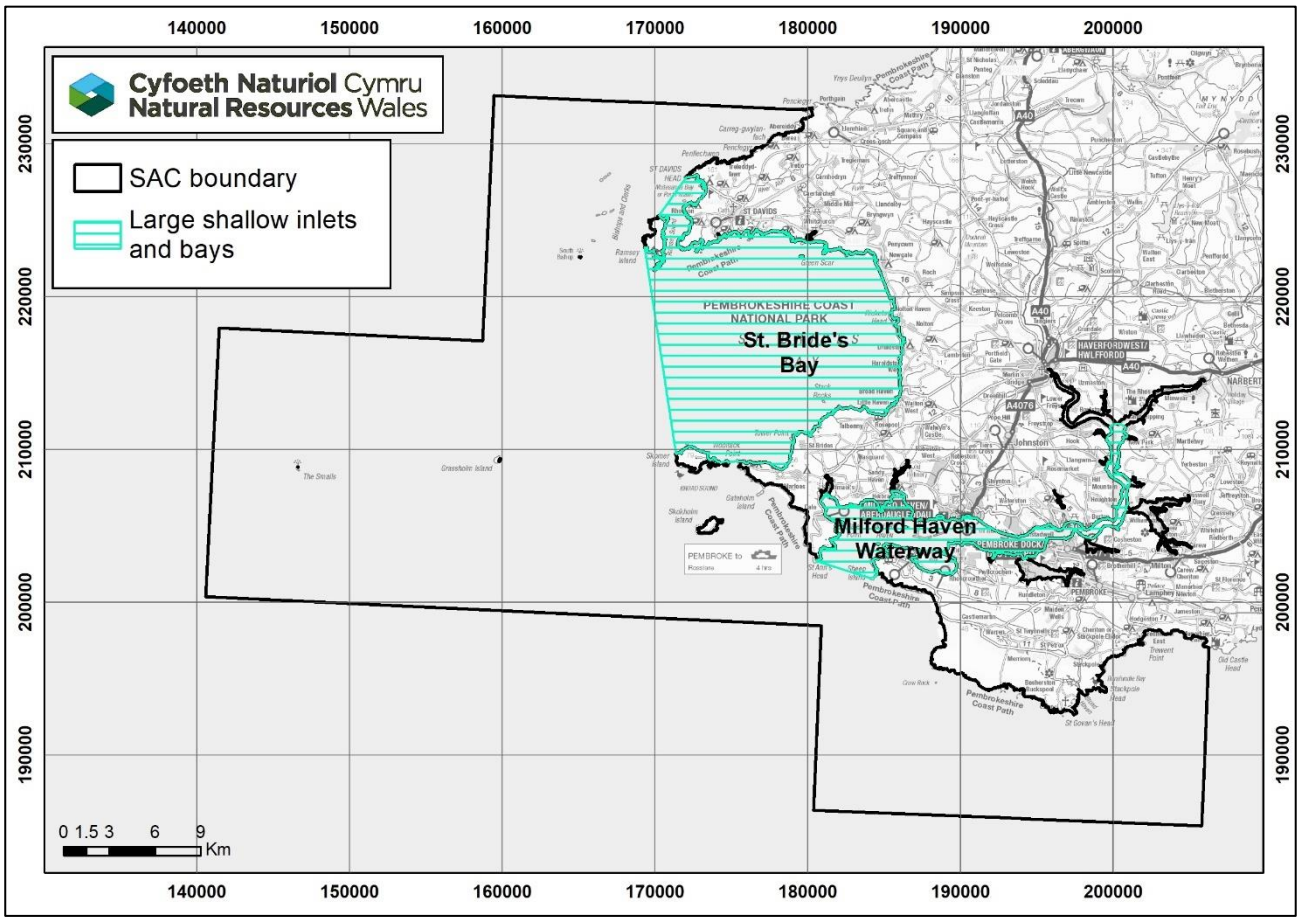
It is not yet clear what pressures we will see from climate change at the SAC level or how different pressures will counter act each other. However, threats from climate change may include (Gihwala et al., 2024, Oaten et al., 2024):

- 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.

3.3. Pembrokeshire Marine SAC condition assessment

The large shallow inlets and bays (LSIB) feature in Pembrokeshire Marine SAC is made of two bays, St Brides Bay and Milford Haven Waterway (Figure 7). 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 7. Map of the LSIB feature in Pembrokeshire Marine SAC.



The LSIB includes some nested feature: reefs, estuaries, mudflats and sandflats, sandbanks and Atlantic salt meadows (ASM). Fish communities were only broadly considered due to resource limitations but there is some information included in the detailed assessment section.

Each bay has been assessed separately for each indicator and then combined to produce a single indicator target assessment outcome for the feature. Table 6 has a summary of the assessment outcome. This outcome and reasons of failure are discussed in more detail in the sections below.

Table 6. Condition assessment of LSIB in Pembrokeshire Marine 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 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)	• The extent of the Milford Haven maerl bed within the feature has reduced dramatically between 2005 and 2023 causing the failure of the target. • There are currently no anthropogenic impacts known to have significantly affected the distribution and extent of other habitats and communities of LSIB and its nested features in the Pembrokeshire Marine SAC since designation in 2004. • Confidence is high as the long term monitoring data shows a significant decline in the extent of the maerl bed.	**Fail**	High

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)	Within the SAC, St Brides Bay comprises 81% of the feature. • The NRW monitoring analysis of the sublittoral soft sediment in St Brides Bay from 2000 to 2022 indicated no concerning change in sediment composition and changes were within bounds of natural variation. Within the SAC, Milford Haven Waterway comprises 19% of the feature. • The Milford Haven inlet sediment monitoring (2007-2021) showed some variation which was deemed likely to be natural. • The maerl bed investigations, and licenced activities assessments within the Milford Haven Waterway indicated no concerns. • Although an issue was identified for sediment composition in the Gann, the overlapping nested mudflats and sandflats feature passed for this indicator. • Post consent monitoring from the Neyland Yacht Haven marina found that the silt content increased significantly across the survey area between 2003 and 2019. This large change in silt content is concerning. • The silt content increase within Milford Haven Waterway has resulted in the fail. • Confidence is low as it is not clear why the silt content has increased and how widespread the issue is within the waterway.	**Fail**	Low

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 LSIB infaunal communities, allowing for natural change and variation. (S)	• The stations assessed for the redox layer are all located within Angle Bay. The redox layer indicated no clear trend over the years. • A greater spatial coverage is needed to understand ongoing processes and confirm overall trends. • Opportunistic macroalgae cover has caused anoxic layers in the Milford Haven Waterway sediments. This has led to the indicator failure. However there are limited quantitative data to confirm this. • Confidence is low as the assessment was based on visual observations and expert judgement.	**Fail**	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)	• Organic carbon content has declined within the monitoring period at the CSEMP station in the Milford Haven Waterway. • The carbon content at both NRW monitored inlets in the Milford Haven Waterway (Angle Bay and the Gann) has increased across the monitoring period. • The indicator failed to meet the target due to the increase in carbon at the Milford Haven inlet locations. • The confidence has been reduced to low as the assessment has been based on data from a small number of locations.	**Fail**	Low

Indicator	Target	Assessment rationale	Target assessment	Target confidence

Sediment quality: contaminants	Sediment contaminants not to exceed the quality guidelines. (S)	• Within Milford Haven Waterway:
		  ○ Polycyclic aromatic hydrocarbons (PAHs) were recorded in various sampling locations. In the most recent years some PAHs were above the most stringent ecological guidelines.
		  ○ Some heavy metal concentrations were above the less stringent guidelines in monitored grab sampling locations in most recent years. Mercury was above the most stringent ecological guideline in 2018 in one NRW monitored grab sampling site (in the maerl bed).
		• Within St Brides Bay, at the Skomer Marine Conservation Zone (MCZ) site, the concentrations of chromium and lead were above the most stringent ecological guidelines, and arsenic and copper were above the less stringent ecological guidelines in the most recent sampling years.
		• The impact of the sediment contaminants on the LSIB feature is not fully understood. In addition, the assessment has been based on data from a small number of locations, leading to a low confidence.
			Fail	Low

Topography of the feature	No significant anthropogenic impacts to the small or large scale topography of the LSIB. (S)	• Various anthropogenic activities occurring within the LSIB feature have caused changes to the small or large scale topography of the feature. • This includes anchoring in St Brides Bay and other activities such as bait digging at the Gann. • Confidence is low as the damage from anchoring is still under investigation, and there is no recent quantitative measure of the potential damage of this issue.	**Fail**	Low

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 no new anthropogenic impacts known to be significantly affecting the hydrodynamic and sediment transport processes of the LSIB feature in the Pembrokeshire Marine SAC. • However, historic activities may be continuing to have an effect on the sediment transport, which may have contributed to an increase in siltation within the waterway. Levels of silt in the maerl bed are currently under investigation by NRW but no conclusions have been reached yet. • Confidence in this pass is low due to concerns about increased siltation and as the assessment has been based on expert judgment.	**Pass**	Low
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)	Within the SAC, St Brides Bay comprises 81% of the feature, and Milford Haven Waterway comprises 19%. • The one WFD waterbody that overlaps with St Brides Bay was classified with a High status for DIN in the 2024 cycle 3 interim classification (Pembrokeshire South). This classification was rolled forward from the 2018 cycle 2 interim classification. The Pembrokeshire South waterbody overlaps with 99% of St Brides Bay • Both WFD waterbodies that overlap with the Milford Haven Waterway were classified with a Poor status for DIN (Milford Haven Inner and Outer). Combined, these waterbodies overlap with 96% of the Milford Haven Waterway (18% of the whole feature). • The failure is localised to the Milford Haven Waterway and confidence is high due to the significant DIN issues there.	**Fail**	High

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)	• All three WFD waterbodies that overlap with the LSIB feature in the SAC were High status for phytoplankton in the 2024 cycle 3 interim classification (Pembrokeshire South, Milford Haven Outer and Milford Haven Inner). Combined these represent 98% of the whole feature. • Confidence is high as the waterbodies that overlap with a large proportion of the feature were classified with a High status for the phytoplankton element.	**Pass**	High

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)	Within the SAC, St Brides Bay comprises 81% of the feature, and Milford Haven Waterway comprises 19%. • The one WFD waterbody that overlaps with St Brides Bay was not classified for the opportunistic macroalgae WFD element in the 2024 cycle 3 interim classification (Pembrokeshire South). • One WFD waterbody in the Milford Haven Waterway was classified with a Moderate status for this WFD element (Milford Haven Inner). This waterbody overlaps with 20% of the Milford Haven Waterway (4% of the whole feature). • The other WFD waterbody in the Milford Haven Waterway was classified as Good status for this WFD element (Milford Haven Outer). It overlaps with 76% of the waterway (14% of the whole feature). There has been localised growth of opportunistic macroalgae recorded in some of the bays and inlets of the waterbody. • Confidence is medium because the worst affected areas in the Milford Haven Waterway are outside of the LSIB feature, and as the waterbody in St Brides Bay has not been classified for this WFD element.	**Fail**	Medium

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 three overlapping WFD waterbodies were classified with a High status for dissolved oxygen in the 2024 cycle 3 interim classification (Pembrokeshire South, Milford Haven Outer and Milford Haven Inner). • 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
Water quality: contaminants	Water column contaminants not to exceed the EQS. (S)	Within the SAC, St Brides Bay comprises 81% of the feature, and Milford Haven Waterway comprises 19%. • The one WFD waterbody that overlaps with St Brides Bay was not classified as the chemicals have not been assessed within the last six years (Pembrokeshire South). • One WFD waterbody in the Milford Haven Waterway has a fail for chemicals, where it fails for PBDE and PAH (Milford Haven Inner). This waterbody overlaps with 20% of the Milford Haven Waterway (4% of the whole feature). ○ The other WFD waterbody has a pass for chemicals (Milford Haven Outer). This waterbody has improved since earlier cycles. • Confidence is low as the human health standard has been used for PBDE, and as the waterbody that overlaps with a large proportion of the feature was not classified for any relevant chemicals.	**Fail**	Low

Indicator	Target	Assessment rationale	Target assessment	Target confidence
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 Pembrokeshire Marine SAC, therefore this target was assessed as unknown.	**Unknown**	N/A
Water quality: physicochemical properties of the water column	Maintain expected physicochemical properties of the water, allowing for natural change and variation. (S)	• Data from intertidal and subtidal temperature loggers were available. Some temperature loggers in the SAC showed an increase in the number of days with higher temperatures, and potential step change in temperature. • Pembroke Power Station report indicated a localised increase in temperature, which was deemed unlikely to be of wider ecological significance. • This indicator was assessed as unknown due to a lack of understanding of the cause of the temperature patterns, and because there are currently insufficient data on other physicochemical parameters (e.g. salinity and pH).	**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)	St Brides Bay comprises 81% of the feature. • The overlapping WFD waterbody was classified with a Good status for the IQI WFD element in the 2024 cycle 3 interim classification. • The infaunal community in Skomer MCZ was reported to be healthy and species-rich. There were no concerns identified for *Zostera marina* (North Haven) and *Pecten maximus* (Skomer MCZ). • In the nested reefs feature, the indicator failed due to the decline in some subtidal species in the Skomer MCZ. Milford Haven Waterway comprises 19% of the feature. • The IQI, estuarine fish and intertidal seagrass WFD elements in the overlapping WFD waterbodies were assessed with Good or High status in the 2024 cycle 3 interim classification. • A recent study indicated that subtidal benthic communities of the Milford Haven Waterway were in a healthy state. • The indicator failed for the nested mudflats and sandflats and reefs features (see detailed text). • The shoot density of the subtidal seagrass *Z. marina* has declined in Littlewick Bay since 1999. • Percentage cover of live maerl has declined by nearly 80% over the monitoring period. Changes in epibiota, infaunal community composition and species richness have been observed over the survey period. • The herring population in the waterway is in decline. • Confidence is high given the large number of species declines.	**Fail**	High

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)	• *Crepidula fornicata* has been recorded in various locations in the SAC starting in 1960 and now reach a high density in some areas, mostly within the Milford Haven Waterway. • *C. fornicata* has previously been found in superabundant aggregations across various intertidal and subtidal habitats within the Milford Haven Waterway. Where the species dominates, natural habitats have been altered. *C. fornicata* is also found in sensitive habitats (maerl) within the waterway. • Although no recent survey for *C. fornicata* has been carried out, this species has been found in large numbers during habitat monitoring activities. • For these reasons the indicator failed to meet its target. Confidence is medium as there are limited data on the density and distribution of *C. fornicata* within the last six years.	**Fail**	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Non-native species (NNS)	No increase in the number of introduced NNS by human activities. (T)	• The carpet sea squirt *Didemnum vexillum* has been recorded at Carr Rocks and on Barnlake Point (Neyland) for the first time, just within the LSIB feature in 2023. • Other NNS have been recorded previously in the SAC within the reefs feature including: brown kelp Wakame *Undaria pinnatifida,* red ripple bryozoan *Watersipora subatra* and San Diego sea squirt *Botrylloides diegensis.* • There have been targeted INNS surveys at intertidal reef sites as part of the MarClim project, 'Rapid Assessment Survey' of marinas 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 LSIB feature in Pembrokeshire Marine SAC has been assessed as being in **unfavourable** condition (medium confidence). There were a number of indicators with failing targets and most of these are localised within Milford Haven Waterway, the smaller of the two LSIB of the SAC (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 LSIB in Pembrokeshire Marine SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

SAC	Overall Condition Assessment	Indicator failures	Reason for indicator failure	Threats to condition
Pembrokeshire Marine	**Unfavourable (medium confidence)**	Distribution and extent of habitats and communities (P) Sediment composition and distribution (P) Water quality: nutrients (DIN only) (P) Abundance, distribution and species composition of communities (P) Invasive non-native species (P); non-native species (T) Topography of the feature (S) Sediment quality: oxidation-reduction profile (redox layer) (S) Sediment quality: organic carbon content (S) Sediment quality: contaminants (S) Water quality: opportunistic macroalgae (S) Water quality: contaminants (S)	• There has been a large reduction in live maerl cover. • Silt content has increased in some areas of the Milford Haven Waterway. • There are high nutrient levels in Milford Haven Outer and Inner waterbodies. • There has been an increase in infaunal opportunistic species; declines in live maerl, *Z. marina* shoot density, herring population and sponge thickness; and disturbed reef communities within Milford Haven Waterway; and in some subtidal benthic populations in the Skomer MCZ. • There is an increasing number of *C. fornicata* which has altered habitats. There is an increasing number of other NNS (e.g. *D. vexillum*). • There is evidence of seabed disturbance and changes to the topography of the LSIB feature. • Organic carbon content of sediments has increased in the Milford Haven inlet monitoring locations. • Levels of PAHs and heavy metals in sediments are exceeding sediment quality guidelines within Milford Haven Waterway and St Brides Bay. • Opportunistic macroalgae is present in the Milford Haven Inner waterbody, which has led to anoxic layers in sediments. • Levels of PBDE and PAH in the water column in the Milford Haven Inner waterbody are failing to meet their relevant EQSs.	• Unconsented infrastructure • INNS • Water quality: contaminants • Management of coastal defences • Climate change • Recreational access and collection • Unconsented infrastructure • Siltation

Detailed assessment information

Extent and distribution

Extent of the feature

The extent of the feature indicator in the Pembrokeshire Marine 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 to assess communities distribution in the absence of recent data. This has reduced the confidence to medium.

Distribution and extent of habitats and communities

Investigations on the Milford Haven maerl bed were carried out using a combination of dive surveys and drop-down videos between 2004 and 2023. Results have shown a large reduction in the extent of the maerl bed since 2005 (Mercer et al., 2025). There are concerns that the South Hook jetty refurbishment (2005-2007) have contributed to this decline (Ratcliffe, 2025). There are currently no known anthropogenic impacts that would significantly affect the extent of the LSIB feature and its nested features in other parts of the SAC. Overall, the large decline in the maerl bed extent was deemed enough to fail the distribution and extent of habitats and communities indicator target with high confidence.

Sediments

Composition and distribution

St Brides Bay

The monitoring analysis of the sublittoral soft sediment in St Brides Bay from 2000 to 2014 indicated stable conditions with little variation in sediment composition over time for the stations located in the inner bay. The stations located in the outer bay, however, displayed marked changes between monitoring years. These changes are likely due to natural fluctuations as a result of physical disturbance from exposed prevailing weather systems (Griffin and Clarke, in draft). Additional data up to 2022 further support this with no concerning changes in sediment composition (NRW unpublished data).

Milford Haven Waterway

The sediment composition and distribution indicator in the condition assessment of the nested mudflats and sandflats feature passed its target. Some issues were identified at the Gann, with apparent changes in sediment composition particularly between 2012 and 2018, with an increase of silt and pebble but reduction of fine sand. Although this potentially indicates some disturbance there, this alone was not deemed a large enough impact to fail the nested mudflats and sandflats feature (Jackson-Bué et al., 2025a). This feature overlaps with approximately 3% of the LSIB feature.

Granulometric analysis within the Milford Haven inlets monitoring locations (2007-2021) indicated little variation in sediment composition. The majority of stations within the LSIB sediments remained fairly stable across the monitoring period.

The subtidal soft sediments within the LSIB have also been monitored as part of the Milford Haven Waterway Environmental Surveillance Group (MHWESG) surveys, through the maerl bed investigations, and from licenced activities assessments within the Milford Bay. The MHWESG surveys found that sediments are poorly sorted, with the highest silt or clay content in the middle of the estuary channel (Warwick, 2017; Warwick et al., in prep). Due to the methodology used, there was no information on the temporal patterns for these stations, therefore they were considered temporally stable in the report.

Surveys at the maerl bed stations were carried out in 2005, 2010, 2016 and 2023. There was no difference in particle size distribution between years, however it did differ between monitoring sites (Bunker and Ratcliffe, 2025) and diver observations indicated a possible increase in silt at the maerl site.

There is a general concern from NRW experts that the silt content has increased in the Milford Haven estuary. As part of the monitoring for the Neyland Yacht Haven marina, subtidal sediment particle sizes were assessed between 2003 and 2008. Past NRW analyses showed significant increases in silt levels over time from January 2004 to April 2007 at most monitored stations (Camplin, 2005; 2008). Further monitoring was carried out in 2010, 2013, 2016 and 2019. This monitoring further supports the finding of a significant silt content increase across the survey area as a whole (Preen and Mazik, 2019). This large change in silt content is concerning.

The siltation increase within the Milford Haven Waterway contributed to the fail of the sediment composition and distribution indicator for the LSIB feature. A low confidence was attributed to the fail as it is not clear why the silt content has increased and how widespread the issue is within the waterway.

Oxidation-reduction profile (redox layer)

Quantitative data on the redox layer of sediments has been analysed in the Angle Bay sites only. These data indicated no clear trend over the monitoring period. In the wider Milford Haven Waterway, there is evidence of opportunistic algae within the SAC (Lock, 2021a). Excessive growth of opportunistic algal mats will quickly smother the sediment, causing anoxic conditions. This has been observed where extensive areas of opportunistic macroalgae growth has been recorded within the Milford Haven inlets, for example within Sandy Haven, where anoxic layers have been observed beneath algal mats (Figure 8). This had led to a failure for the redox layer indicator. The confidence attributed to the failure has been reduced to low as the conclusion has been based on data from a limited spatial coverage, visual observations and expert judgement. The stations assessed for the redox layer are all located within Angle Bay, which is outside of the opportunistic macroalgae sampling locations and may explain why there was no clear trend there. This indicator also failed for the estuary and mudflats and sandflats features, which overlap with the LSIB Waterway feature. The failure is localised to the Milford Haven Waterway. There are no data on the redox layer within St Brides Bay.

Figure 8. Anoxic layers of sediment beneath opportunistic macroalgae on mudflats in Sandy Haven in 2008, Milford Haven Waterway.

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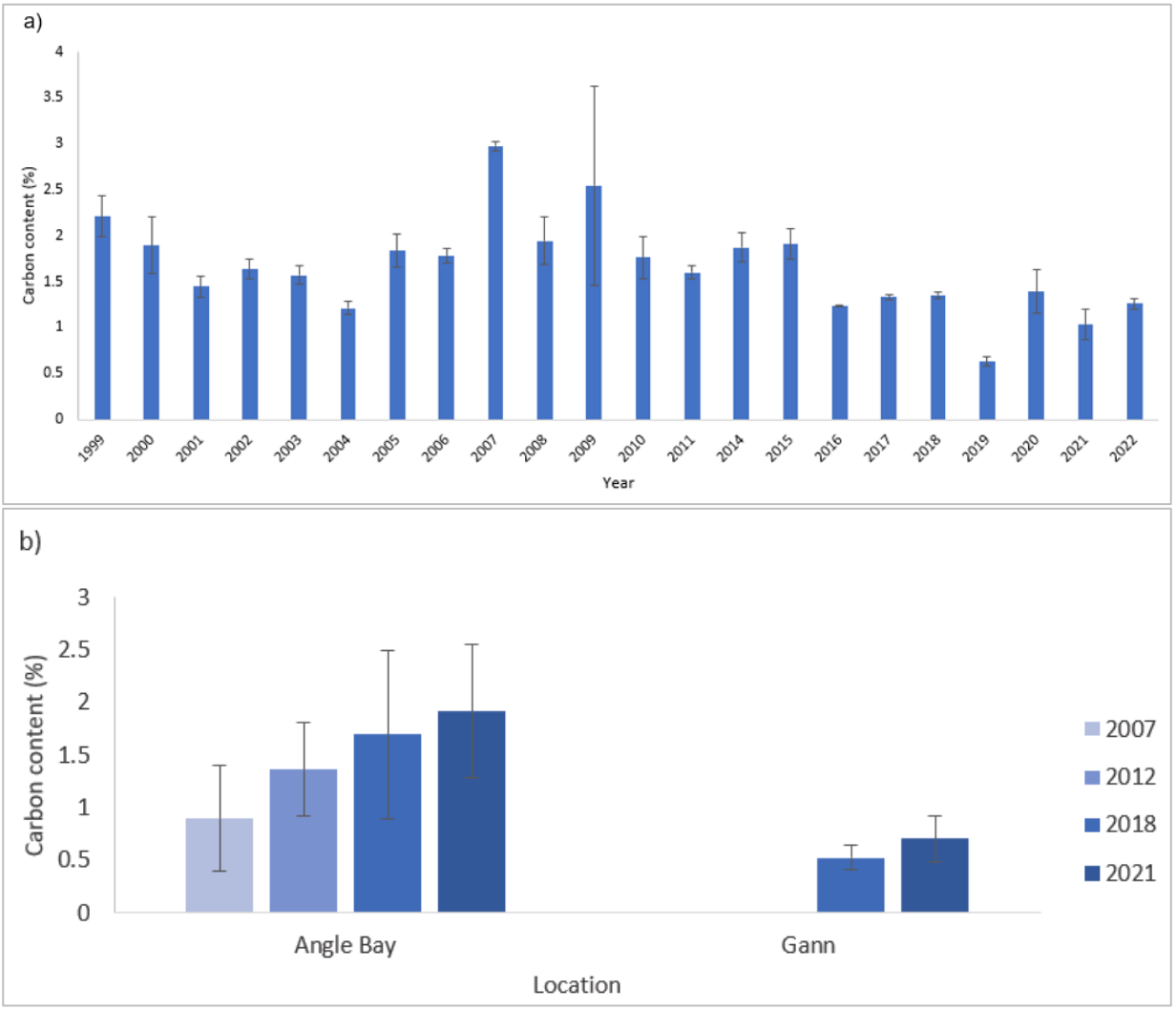
Organic carbon content

The assessment of the sediment quality organic carbon and contaminants indicators used data from NRW monitored sediment contaminants as part of the CSEMP sampling in one location in the Milford Haven Waterway in various years up to 2023. This location is considered to be representative of the Milford Haven Waterway as it is upstream of the main industrial areas. Additional sediment grab sampling has been carried out in Milford Haven Waterway over four years (2007, 2012, 2018 and 2021). These were grouped into bay locations for analysis. There were two sampling locations that overlap with the LSIB feature which were considered for the assessment of these sediment quality indicators.

At the subtidal CSEMP location the carbon content has decreased over the monitoring period from 2.2% in 1999 to 1.3% in 2022 (Figure 9a). However, the organic carbon content at both of the grouped inlet locations has increased over the monitoring period (Figure 9b). At Angle Bay, the average carbon content has doubled, going from 0.9% in 2007 to 1.9% in 2021 (Figure 9b). 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.

The indicator failed to meet the target due to the increase in carbon at various monitoring locations within the Milford Haven inlets. While the failure has been based on data from only two stations, evidence from the estuaries condition assessment, which used data from a larger number of monitoring stations, indicates a wider issue with carbon within the Milford Haven Waterway. Additionally, initial outputs of deep cores from the MHWESG show that total organic carbon content has increased over a longer historical time period (i.e. several decades) at some locations in the Milford Haven inlets (e.g. Pembroke River, Boulston and Cosheston Pill) (MHWESG, pers. comm.). The more recent observed increases in carbon are therefore likely a continuation of a long-term trend of increasing carbon at these locations. This will be something to look into in the next assessment when the analysis has been completed. A low confidence was assigned to the failure of the target due to the low number of sampling stations used for the assessment.

Figure 9. Average carbon content (±S.E.) from sediment grab samples in the Milford Haven Waterway. Samples from a) the CSEMP location from 1999 to 2022, and b) the grouped inlet locations in Milford Haven Waterway in 2007, 2012, 2018 and 2021.



Contaminants

Historically, there have been various peaks in hydrocarbons and metals in sediments in the Milford Haven Waterway, including as a result of the Sea Empress spill in 1996 (Little, 2017). Sediment contaminant levels have also been moderately high through periods of dredging or construction in the later 2000s (up to 2014) (Little, 2017; Warwick, 2017; Warwick et al., in prep).

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 various 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.

Within the Milford Haven Waterway, levels of polycyclic aromatic hydrocarbon (PAH) compounds were recorded at the CSEMP location. Here, the average concentration of Benzo(g,h,i)perylene was above the most stringent ecological guideline (OSPAR effects

range low) in all years including 2023. The concentration of this PAH has not changed substantially since earlier years. There were significant spikes in various PAH concentrations in 2008 and 2011 at the CSEMP site. These peaks are likely due to an increase in dredging activities (Little, 2017; Warwick, 2017). Following these years the concentrations returned to levels similar to those seen before 2008 (NRW unpublished data). Various other PAH concentrations were above the less stringent ecological guidelines (CEQG threshold effect levels) in both the CSEMP and grab sampling locations in the most recent years. In addition, various PAHs were above the most stringent guidelines in 2018 at some of the grab sampling locations over the maerl bed in the Milford Haven Waterway. It is not known if these levels remain high at these monitoring sites as they have not been sampled since 2018.

Heavy metal concentrations were also recorded at various locations within the Milford Haven Waterway. The concentration of mercury was above the most stringent guideline (OSPAR effects range low) in 2018 at one of the grab sampling locations over the maerl bed in the Milford Haven Waterway. The concentrations of other heavy metals (chromium, arsenic, copper and zinc) were above the less stringent guidelines in some of the sampling locations (CSEMP and grab sampling) in most recent years. There are no OSPAR or CEQG sediment quality guidelines for Tributyltin (TBT) however the average concentration of TBT at the CSEMP location has been above its most stringent ecological guideline (Cefas action level 2) in all years up to 2023. Polychlorinated biphenyls (PCBs) have mostly declined at both the CSEMP and grab sampling stations since earlier years, and all are below the more stringent guidelines in the most recent year of sampling.

At the one sediment trap sampling location within St Brides Bay (Skomer Island), only heavy metals have been monitored. The concentrations of chromium and lead are both above the most stringent ecological guidelines (CEQG probable effect levels for chromium or OSPAR effects range low for lead) at this monitoring site in the most recent years. In addition, the concentrations of arsenic and copper were above the less stringent ecological guidelines (CEQG threshold effect levels) in the most recent years.

The sediment quality (contaminants) indicator failed to meet the target due to levels exceeding sediment quality guidelines in various contaminants in both the Milford Haven Waterway and St Brides Bay. The impact of the contaminants on the LSIB feature is not fully understood. This reduced the confidence in the assessment. Confidence was further reduced to low as the assessment has been based on data from a small number of locations.

Topography and hydrodynamics

Large vessels commonly use St Brides Bay to anchor whilst awaiting entry to the Milford Haven Waterway. Recently, there has been more frequent anchoring in the south of the bay and areas near Skomer island MCZ. There is some evidence of seabed disturbance and changes to the topography of the seabed from large vessels within St Brides Bay from drop-down video and side scan data in 2008 and 2009 (e.g. Keenan et al., 2012). Research is ongoing to determine the intensity of anchoring events and preliminary results indicated a high number of anchoring events happening within the bay in the last five years. Recreational anchoring occurs within Milford Haven Waterway, which may also affect the topography of the feature. In addition, there have been small scale changes to the topography in the nested mudflats and sandflats feature within the Gann flats in the Milford Haven Waterway. These changes are due to bait digging activities. A national code

of conduct for bait collectors has been developed for Wales (code of conduct). It will take time to see if these measures are effective in reducing small scale topography alteration.

The topography indicator failed to meet its target due to the various activities occurring within the LSIB which have altered the topography of the feature at both large and small scale. The confidence has been reduced to low because there is no quantitative measure of the anchoring disturbance in St Brides Bay, and limited information on longevity and extent of any anchoring disturbance, and its impact on the biota within the bay. Investigations into the long term impacts to the seabed and the potential effects of anchoring on biota are required.

The hydrodynamic and sediment transport processes indicator met its target as there are no new anthropogenic impacts known to be significantly affecting the hydrodynamic and sediment transport processes of the LSIB feature in the Pembrokeshire Marine SAC. However, historic activities may be continuing to have an effect on the sediment transport, which may have contributed to an increase in siltation within the Milford Haven waterway. A NRW investigation is ongoing to determine whether an increase in silt may have impacted the maerl bed and whether this is of anthropogenic origin (Ratcliffe, 2025). The confidence in the indicator pass was reduced to low due to this concern, and as the assessment was based on expert judgment.

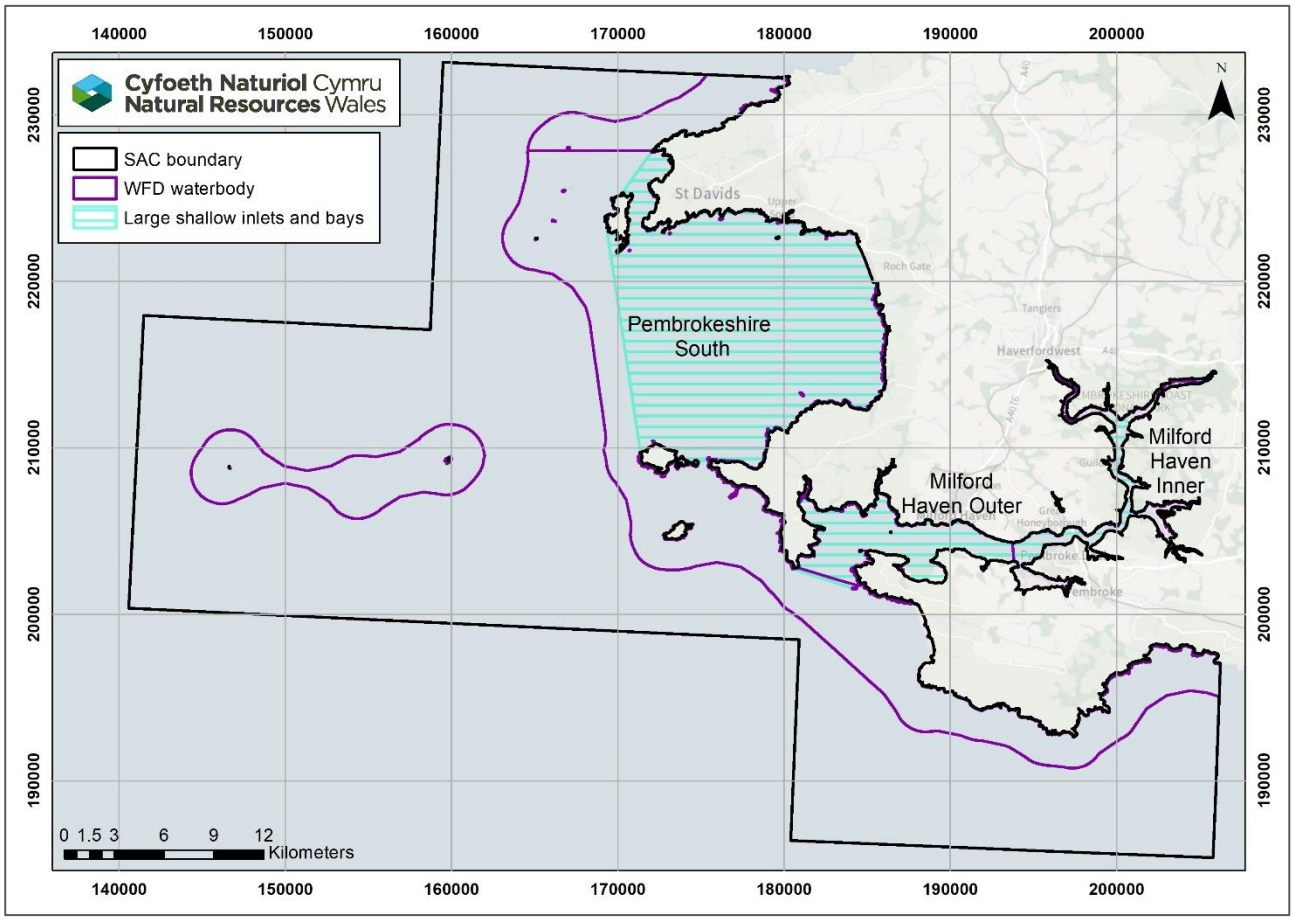
Water quality

It has been estimated that 98% of the LSIB feature falls within three WFD waterbodies (Table 8, Figure 10), therefore these are likely to be a good reflection of the overall effect of water quality on the feature. St Brides Bay is the largest of the two bays within the SAC (81% of the feature across the SAC), then the Milford Haven Waterway (19%) (Figure 10).

Table 8. Designated LSIB within the Pembrokeshire Marine SAC and the WFD waterbodies that overlap.

Bay	WFD waterbody	Degree of overlap across indv. bay (%)	Degree of overlap across whole feature (%)
St Brides Bay	Pembrokeshire South	98.83	80.42
Milford Haven Waterway	Milford Haven Outer	75.82	14.12
Milford Haven Waterway	Milford Haven Inner	20.39	3.80

Figure 10. Map of the WFD waterbodies that overlap with the LSIB feature within Pembrokeshire Marine SAC.



Nutrients (DIN only)

St Brides Bay comprises one WFD waterbody, the Pembrokeshire South waterbody (Table 8). This waterbody was classified with a High status for the DIN element in the 2024 cycle 3 interim classification.

The Milford Haven Waterway comprises two WFD waterbodies, the Milford Haven Outer waterbody and the Milford Haven Inner waterbody (Table 8). Both of these waterbodies were classified with a Poor status for the DIN element in the 2024 cycle 3 interim classification. Combined, these overlap with 96% of the Milford Haven Waterway. The Milford Haven Inner and Outer waterbodies also failed in previous cycles, and the Milford Haven Outer waterbody has deteriorated from Moderate status in the 2021 cycle 3 classification. The WFD investigation reports of these waterbodies confirmed the DIN failures in the 2018 cycle 2 interim and the 2021 cycle 3 classifications (Lock, 2021a; Lock, 2021b). The Milford Haven Inner waterbody has also been designated by Welsh Government as a sensitive area (eutrophic) under the Urban Wastewater Treatment Regulations.

The nutrients indicator (DIN only) failed to meet the target as high levels of DIN have been recorded in the Milford Haven Waterway. High confidence was attributed to the failure as the failing waterbodies overlap with a large proportion of the LSIB feature within the Milford Haven Waterway, and as the investigations have confirmed nutrient issues in these waterbodies. Confidence was also increased due to the biological response to high

nutrient levels in the Milford Haven Inner waterbody, where opportunistic macroalgae was classified with a Moderate status. There are no recorded issues with nutrients in St Brides Bay, and the nutrients failure is localised to the Milford Haven Waterway only.

Phytoplankton

The phytoplankton indicator passed its target as all three WFD waterbodies that overlap with the feature (Pembrokeshire South, Milford Haven Outer and Milford Haven Inner) were classified with a High status for the phytoplankton element in the 2024 cycle 3 interim classification. Combined, these waterbodies represent 98% of the whole LSIB feature (Table 8). The Milford Haven Outer waterbody improved between the 2021 cycle 3 and the 2024 cycle 3 interim classifications, from Good status to High status. Confidence in the pass is high as the waterbodies that overlap with a large proportion of the feature were classified with a High status for the phytoplankton element.

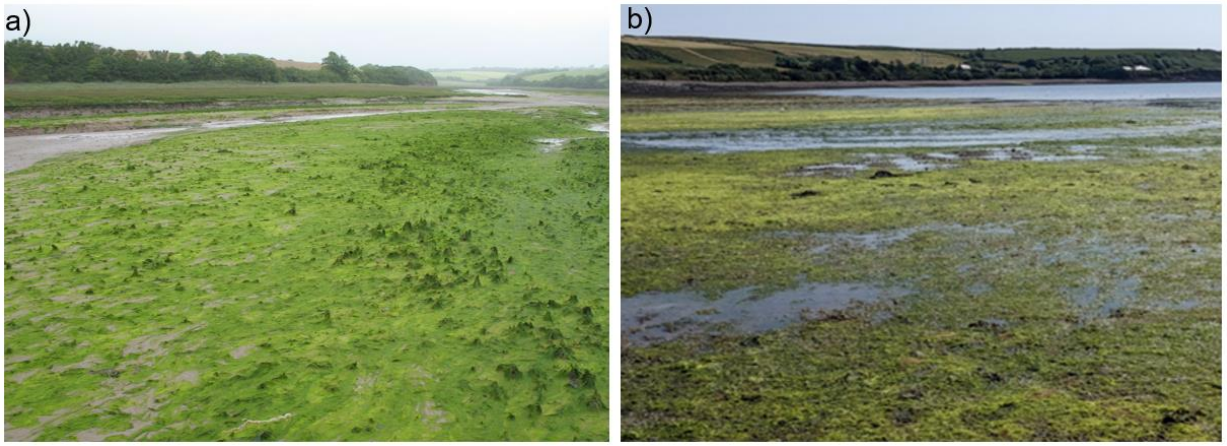
Opportunistic macroalgae

The one WFD waterbody that overlaps with St Brides Bay, Pembrokeshire South, was not classified for the opportunistic macroalgae element in the 2024 cycle 3 interim classification. It should be noted that 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).

Within the Milford Haven Waterway, one of the two WFD waterbodies was classified with a Moderate status for the opportunistic macroalgae element in the 2024 cycle 3 interim classification. This was the Milford Haven Inner waterbody, which overlaps with 20% of the Milford Haven Waterway, and represents 4% of the whole feature across the SAC (Table 8). The WFD investigation report confirmed the opportunistic macroalgae failure, in which extensive and recurring coverage has been recorded in various inlets including Cosheston Pill, Garon Pill, and Carew and Cresswell rivers (Lock, 2021a). There has been evidence of opportunistic macroalgae growth since 2007, indicating that this has been a long-lasting issue within the Milford Haven Inner waterbody. The worst areas affected by opportunistic macroalgae are in the inlets of the Milford Haven Waterway, which are not within the LSIB feature. However, the effects of the opportunistic macroalgae may affect downstream areas, and there are also recorded areas with dense macroalgae growth further up the waterway, at Llangwm Pill and Sprinkle Pill which are within the LSIB feature. The Milford Haven Outer waterbody that also overlaps with the Milford Haven Waterway, was classified with a Good status for opportunistic macroalgae in the 2024 cycle 3 interim classification. Although it is not a failing element for this waterbody, there have been localised issues recorded in the more sheltered bays and inlets including Angle Bay, Sandy Haven and Dale Gann, which are within the LSIB feature (Figure 11) (Lock, 2021b).

Overall, the opportunistic macroalgae indicator failed to meet the target due to the Moderate status WFD classification for this element in the Milford Haven Inner waterbody. Confidence in the fail was reduced to medium because, although there is extensive evidence of opportunistic macroalgae in the Milford Haven Inner waterway, the worst affected areas are outside of the LSIB feature.

Figure 11. Opportunistic macroalgae on saltmarsh and mudflats. a) Sandy Haven in 2008 and b) Dale in 2023, Milford Haven Waterway.



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Dissolved oxygen

The dissolved oxygen indicator met its target. Confidence in the pass was reduced to medium because surface sampling of dissolved oxygen may not detect issues for more demersal habitats within the LSIB feature (see further detail in Section 3.1).

Contaminants

The one WFD waterbody within St Brides Bay, Pembrokeshire South, was not classified as the chemicals have not been assessed within the last six years.

One of the WFD waterbodies within the Milford Haven Waterway, the Milford Haven Inner waterbody has a fail for chemicals in the 2024 cycle 3 interim classification, where PBDE and PAH failed. This caused the contaminants indicator to fail. PBDE has failed in this waterbody in all previous cycles of the WFD assessments. The human health protection goal that is used for PBDE may be considered as over precautionary as the effect of contaminants on the biota of LSIB are not fully understood. This reduced the confidence in the fail. The Milford Haven Outer waterbody failed for mercury and TBT in previous cycles. This waterbody now passes for chemicals in the 2024 cycle 3 classification, however TBT, which was previously a failing chemical, is no longer assessed. In addition, mercury was not classified in the 2024 cycle 3 interim classification. The confidence was reduced further to low as a large proportion of the feature overlaps with a waterbody that has not been classified for any chemicals within the last six years. 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.

Data from seven NRW monitored subtidal temperature loggers and six NRW monitored intertidal monitoring sites at various shore heights (12 temperature loggers in total) within

the SAC were available. Most of these loggers (18 out of the 19) overlap with the LSIB feature. Some of the loggers showed an increase in the number of days with higher temperatures, and a potential step change in temperature. This is more apparent in the loggers within the Milford Haven Waterway. An external report (Sutton, 2023) found localised increase in temperature near the Pembroke Power Station. However, they concluded that this is unlikely to be of wider ecological significance. While localised, warming water can provide a safe haven for NNS, which could then spread further. This will be something to pay close attention to in the next assessment.

The physicochemical indicator was assessed as unknown due to a lack of understanding of the cause of the temperature patterns, and as further evidence on the apparent temperature change is needed for a comprehensive assessment. In addition because there are currently insufficient data on other physicochemical parameters (e.g. salinity and pH).

Species and communities

The assessment of the abundance, distribution and species composition of communities indicator considers data from the Milford Haven Waterway and to a lesser extent St Brides Bay with some reports from the Skomer MCZ. St Brides Bay is the largest of the two bays within the SAC (81% of the feature across the SAC), then the Milford Haven Waterway (19%).

St Brides Bay

There are important intertidal and subtidal reefs within St Brides Bay. The data from the Skomer MCZ monitoring surveys showed that the intertidal reef communities were stable over the monitoring period and in a favourable condition typical of the area. Some subtidal reef species, however, were in decline. There was a decline of the red sea fingers *Alcyonium glomeratum* colony and large loss of the pink sea fan *Eunicella verrucosa* (Jackson-Bué et al., 2025c). This was not deemed large enough to contribute to the overall failure of the feature.

The sublittoral soft sediment infaunal communities of the Skomer MCZ have been surveyed between 1993 and 2020 and showed no concerning change. The last five surveys indicated that the communities were healthy and species rich (Lock et al., 2022). Other species within the boundary of the Skomer MCZ were also reported to be in good condition. This includes the king scallop *Pecten maximus*, surveyed six times since 2020, for which populations appeared healthy with increasing densities (Massey et al., 2023). *Z. marina* was also surveyed every four years since 2006 in North Haven and was also in good condition, as evidenced by an increase in shoot density and stable extent across the monitoring period (Massey et al., 2024).

St Brides Bay sublittoral soft sediment infaunal communities have been surveyed between 2000 and 2016. The report stated that the habitats in St Brides Bay were in good ecological health and have broadly remained so throughout the monitoring period (Griffin and Clarke, in draft). Further analysis using recent data is required to assess the current state of these communities. In addition, the WFD waterbody that overlaps with 99% of the LSIB feature within St Brides Bay (Table 8) was classified as Good status for the IQI element in the 2024 cycle 3 interim classification (Pembrokeshire South). The impacts to the biota from the anchoring of large vessels of St Brides Bay are not currently known.

Milford Haven Waterway

Nested features

The mudflats and sandflats feature overlaps with approximately 3% of the LSIB feature. Infaunal analysis sampled with cores for intertidal Angle Bay infauna showed that communities fluctuated within natural variations (Moore et al., 2021 and NRW unpublished data). In addition, a recent survey by ABPmer has shown no significant impact of bait digging on infaunal communities at Angle Bay (West et al., 2025), but further work is required to confirm this. Although no concern was observed for Angle Bay, the condition of mudflats and sandflats in other part of the SAC were poor with an increase in opportunistic species which are typically associated with anthropogenic disturbance (e.g. pollution) at several locations of the infaunal Milford Haven inlet monitoring. This included two within the LSIB feature (the Gann and Angle Harbour) (Jackson-Bué et al., 2025a). These locations are known to be impacted by elevated nutrient levels in the Milford Haven Outer waterbody (Jackson-Bué et al., 2025a). In addition, bait digging activities in the Gann have been linked with changes in species composition in this area. The observed disturbance was not deemed to be due to natural change. 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 help to identify potential reasons for these failures. This resulted in the failure of the abundance, distribution and species composition of communities indicator in the nested mudflats and sandflats feature.

There are important intertidal and subtidal reefs within Milford Haven Waterway. The reefs feature overlaps with approximately 20% (which includes intertidal and subtidal reefs) of the LSIB feature. NRW monitoring data indicated that the intertidal reef communities in the Milford Haven Waterway and open coast sites remained stable over time. There was a decline of knotted wrack *Ascophyllum nodosum* at the Lawrenny Quay and Pembroke Power Station monitoring locations in Milford Haven Waterway which is concerning and warrants further investigation. This decline was not large enough to fail the abundance, distribution and species composition of communities indicator for intertidal reefs, and the indicator was therefore passed. However, the indicator failed with high confidence for subtidal reefs, due in part to a 50% decrease in mean thickness of cushion and crustose sponge and a small decrease in circumference and height for the mermaid's glove *Haliclona oculata* at Warrior reef, which is within the LSIB feature. In addition, two out of five monitoring sites (Warrior Reef and Beggars Reef) for the subtidal reef-associated communities showed a change over time, suggesting possible disturbance.

Maerl

The NRW investigation showed that the maerl bed in the Milford Haven Waterway is in poor condition (Ratcliffe, 2025). The cover of live maerl has decreased by nearly 80% from 2005 to 2017 (Mercer et al., 2025). This has resulted in a large shift in epibiota and infauna community composition and changes in infaunal species richness (Bunker and Ratcliffe, 2025).

Subtidal benthic communities

A recent study on the subtidal benthos in the main channel of the Milford Haven estuary indicated that the benthic communities were in a healthy state (Warwick et al., in prep). In addition, the two WFD waterbodies that overlap with 96% of the Milford Haven Waterway,

part of the LSIB feature (Table 8) were both classified with a High status for the IQI element in the 2024 cycle 3 interim classification (Milford Haven Outer and Milford Haven Inner). Additional analysis further supports this with no concerning changes in IQI (NRW unpublished data).

Seagrass

The intertidal seagrass *Zostera noltei* within the waterway has increased in extent in recent years and has been assessed as High status in the 2024 cycle 3 interim classification of seagrass in both Milford Haven Inner and Outer waterbodies and particularly in Angle Bay. There are five known subtidal *Zostera marina* seagrass beds in the Milford Haven Waterway, the largest of which is the bed in Littlewick Bay. The subtidal seagrass *Z. marina* has been surveyed between 1986 and 2018 at Littlewick Bay in the Milford Haven Waterway. These surveys indicate that shoot density in 2018 has decreased by 57% since 1986 with a significant decrease since 1999, suggesting localised conditions have changed (Unsworth et al., 2017; Bertelli, 2021a, 2021b). In 2017, *Z. marina* was observed to no longer be continuous and largely fragmented into numerous small, isolated patches. Shoot density within *Z. marina* meadows is a good bioindicator of environmental disturbance, and long-term data at Littlewick Bay indicate anthropogenic impact there (Bertelli, 2021a; 2021b). Poor water quality resulting in hypertrophication or eutrophication has been raised as a possible cause for the decline observed (Bertelli, 2021a, 2021b). Changes in turbidity may also be a cause for declines in shoot density as *Z. marina* is light limited (Bertelli, 2021a; 2021b). Turbidity has not been investigated at Littlewick Bay due to the loss of loggers (Bertelli, 2021a). However, the area is now dominated by the alga *Laminaria saccharina*, and the coverage of attached epiphytic algae was found to be very high, suggesting the potential for *Z. marina* to be light limited at the monitoring site (Unsworth et al., 2017). Epiphytes on *Z. marina* have decreased by 39% since 1999, and wasting disease has increased by approximately 387% since 1999 (Bertelli, 2021a, 2021b). Compared to other monitoring sites surveyed in Wales, wasting disease and algae cover was significantly higher in Littlewick Bay. It has been concluded that there may be a system shift from a seagrass dominated to macroalgae-dominated community in Littlewick Bay (Bertelli, 2021a), and reports indicate the seagrass is under light and nutrient stress in the Milford Haven Waterway for the majority of the year (Unsworth et al., 2017). There are other known beds of *Z. marina* within the Milford Haven Waterway (e.g. in Dale and Angle Point), however long-term data are not available for these other beds of the subtidal seagrass therefore their condition is unknown.

Fish

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.

The Milford Haven Inner waterbody, which overlaps with the upper Milford Haven Waterway (and represents 3.8% of the whole LSIB feature), was classified as Good status for the WFD estuarine fish tool in the 2024 cycle 3 interim classification. No other WFD waterbodies that overlap with the feature were classified for this element. However, the ability of the WFD fish tool to inform the condition of the LSIB feature is unknown and needs further analysis.

The herring population appears to be in decline in the Milford Haven Waterway. There has been a noticeable decrease in the number of spawning fish since the 1980’s, with higher mortality rates and younger age structure observed in 2018 compared to 1980-1982

(Davies et al., 2020). In addition, no eggs and very few larvae were found on the historic spawning ground despite the presence of spawning adults, supporting the apparent observed decline (Davies et al., 2020). There is an ongoing NRW investigation into this decline.

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.

Operational monitoring of fish impingement and entrainment is carried out at Pembroke Power Station's cooling water intake system in the Milford Haven Waterway. Further monitoring of the fish community of the Milford Haven commissioned by the operators of the Pembroke Power Station includes subtidal trawls, intertidal seine nets and ichthyoplankton sampling. From the operational monitoring programme data and analysis, decreases, and a negative trend, in impingement numbers of numerous species within the fish community have been observed. The species in question include clupeids, gobies, gadoids, flatfish and sandeels and form over 80% of the recorded impingement abundance. A similar decreasing trend in fish catches was observed in the subtidal trawls. Data from the intertidal seine nets showed variable results with an overall increase in marine juvenile and estuarine resident species in summer but low abundance in winter catches and no trend was observed for the icthyoplankton community composition, which remained similar throughout the monitoring period (A. Scorey (NRW), pers. comm.). Further investigation is needed into the fish community abundance and structure across the LSIB feature in the Milford Haven Waterway.

Overall, the poor condition of the maerl bed and certain areas within the Milford Haven inlets, along with concerns over the decline of sponge communities at Warrior Reef, disturbance to subtidal reef-associated communities at Beggars Reach Reef, and the decline in spawning herring and decrease in shoot density of *Z. marina* in Milford Haven Waterway contributed to the abundance, distribution and species composition of communities indicator to fail with high confidence. Most of the issues are localised in the Milford Haven Waterway.

Invasive non-native species

There has historically been a high number of NNS in the Milford Haven Waterway. *C. fornicata* has been recorded in various locations within the SAC for many years. The species has been found in superabundant aggregations across various intertidal and subtidal habitat types within the Milford Haven Waterway (Figure 12) (Bohn, 2012; 2014), and natural habitats within the waterway have changed where the species dominates (M. Camplin (NRW), pers. comm.). Although no recent survey for *C. fornicata* has been carried out, this species has been found in large numbers during habitat monitoring activities.

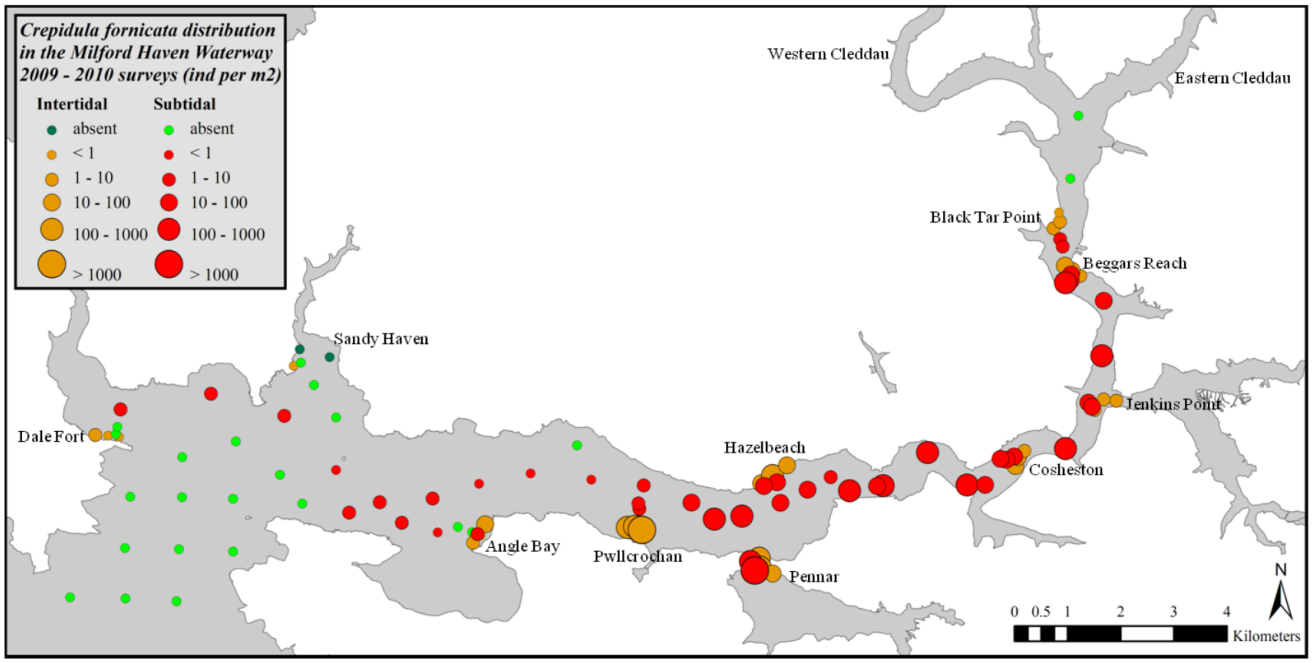
The species has also been found within the maerl bed in Milford Haven Waterway, which may have a potential smothering effect on the maerl (Mercer et al., 2025). Given the high

density of *C. fornicata*, including its presence in sensitive habitats (i.e. maerl) and its impact on natural habitats within the Milford Haven Waterway, the primary target of the INNS indicator has failed. Confidence is medium as there are limited data on the density and distribution of *C. fornicata* within the last six years.

The carpet sea squirt *Didemnum vexillum* was recorded for the first time within the Milford Haven Waterway near to Neyland marina on boulder and cobble reefs at Carr Rocks and on Barnlake Point in 2023 and 2024 within the LSIB feature. The impact of this species on the condition of the LSIB feature is not known, however it is possible for this species to have far reaching implications on native communities (Tillin et al., 2020). The arrival of this species in the LSIB feature within the last reporting cycle has resulted in a fail with high confidence for the tertiary target of the NNS indicator.

Other NNS are known to be present in Pembrokeshire Marine SAC, within the LSIB feature. The large brown kelp wakame *Undaria pinnatifida* has also been recorded within the Milford Haven Waterway since 2014, and elsewhere in the SAC including at Skomer and Skokholm islands. First found in 2016, the red ripple bryozoan *Watersipora subatra* has been recorded in large areas in Dale at Jetty Beach in 2023 (Mieszkowska and Sugden, 2023; 2024). *W. subatra* is also known from South Hook Point and Pembroke Power station. Records of the San Diego sea squirt *Botrylloides diegensis,* initially found in 2014, has also been found at Pembroke Power station, Pembroke Dock and Neyland (Wood et al., draft). The other NNS previously recorded in the LSIB feature or nearby are the siphoned Japan weed *Dasysiphonia japonica*, pom-pom weed *Caulacanthus ustulatus (okamurae),* fanworm *Ficopomatus enigmaticus*, red alga harpoon weed *Asparagopsis armata*, wireweed *Sargassum muticum.* The purple fan worm *Bispira polyoma* has been found for the first time in 2023 in the SAC but it is not within the LSIB feature. The spread and full extent of the impact of the NNS recorded in the LSIB feature are currently unknown.

Figure 12. Densities of *Crepidula fornicata* in intertidal and subtidal sites in the Milford Haven Waterway, surveyed in 2009 and 2010 (Bohn, 2012).



Reasons for target failure

The assessment of LSIB feature in the Pembrokeshire Marine SAC failed five primary targets, six secondary targets 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.

Distribution and extent of habitats and communities

This indicator target has a primary weighting. There has been a dramatic reduction in the extent of maerl since 2005 (Mercer et al., 2025). The clear causes of this observed decline are not yet confirmed. However, from the ongoing NRW investigation it is likely due to the cumulative effects of a combination of pressures. These include disturbance of the seabed surface, sedimentation, pollution and chemical changes, and INNS (Ratcliffe, 2025). There are concerns that the South Hook jetty refurbishment (2005-2007) have contributed to the decline of maerl (Ratcliffe, 2025). The failure is localised to the small maerl bed within the Milford Haven Waterway.

Sediment composition and distribution

This indicator target has a primary weighting. There has been a significant increase in silt content between 2014 and 2019 in some areas within the Milford Haven Waterway. Further investigation is required to determine the causes of this increase and how widespread the issue is within the waterway. Additionally, some changes in sediment composition were identified at the Gann, likely a result of bait digging activities. A national code of conduct for bait collectors has been developed for Wales (code of conduct). The objective is to reduce impacts from bait collection on relevant protected features. The failure of this indicator is localised to some areas within the Milford Haven Waterway.

Water quality: nutrients (DIN only)

This indicator target has a primary weighting. Two WFD waterbodies that overlap with the Milford Haven Waterway (Milford Haven Outer and Inner) had failing levels of DIN. These waterbodies were classified with a Poor status for the DIN element in the 2024 cycle 3 interim classification. The Milford Haven Inner waterbody has also been designated by Welsh Government as a sensitive area (eutrophic) under the Urban Wastewater Treatment Regulations. Failure of the supporting water quality elements opportunistic macroalgae in Milford Haven Inner waterbody further supports the nutrient issues present in this waterbody.

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 (Haines and Edwards, 2016; Lock, 2021a; Lock, 2021b). Further investigation is required to determine the breakdown of nutrient sources from specific agricultural practices and activities into the catchments. Point source continuous sewage discharge from the water industry was confirmed as minor source of nutrients linked to the DIN failures (Haines and Edwards, 2016; Caprez, 2020; Lock, 2021a; Lock, 2021b). Intermittent and domestic sewage are also suspected in the catchments. Further investigation locally is required to confirm these. The failure is localised to the Milford Haven Waterway, and there are no recorded nutrient issues within St Brides Bay.

Abundance, distribution and species composition of communities

This indicator did not meet its primary target for several reasons. These were the poor condition of the maerl bed and its associated epibiota, and large variation in the intertidal infaunal communities within the Milford Haven inlets. In addition, there were the concerns over the decline of sponge communities at Warrior reef, disturbance to subtidal reef-associated communities at Beggars Reach reef, the decline of herring, and a decrease in shoot density of *Z. marina* in the Milford Haven Waterway. There was also a large loss of *E. verrucosa* and decline in *A. glomeratum* colony in the Skomer MCZ, which is within St Brides Bay.

Elevated levels of nutrients and contaminants are likely contributing to the observed changes in the species composition of communities within the Milford Haven Waterway. Other localised issues, e.g. bait digging activities in the Gann, has also contributed to the observed changes in infauna communities. Further investigation is now needed to confirm what the reasons behind these failures are. Identification of the reasons causing these failures will allow management measures to be identified and implemented to allow improvement in the Milford Haven Waterway.

Invasive non-native species; non-native species

The INNS and NNS indicators failed to meet their primary and tertiary targets. The primary INNS target failure is due to the increasing number of *C. fornicata*, which has been found in superabundant aggregations across various intertidal and subtidal habitats in the Milford Haven Waterway (Bohn, 2012; 2014). This species has altered natural habitats and is present in sensitive habitats in the waterway (maerl bed) (Mercer et al., 2025). The failure of the primary target is localised to the Milford Haven Waterway.

The failure of the tertiary NNS target is due to the recent arrival of *D. vexillum* introduced in the LSIB feature. 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.

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.

Topography of the feature

This indicator failed to meet its secondary target due to visual evidence and preliminary results showing damage to the topography of the seabed from anchoring of large vessels in St Brides Bay. Seabed disturbance can result when the anchor drops into the substratum and disturbs sediments within its footprint; whilst at anchor if the vessels move or rotate in different tidal and weather regimes causing the anchor chain to drag; and during anchor retrieval, leaving an anchorage scar. Currently there are no quantitative measures of the damage, and there is a limited understanding of the longevity and extent of any anchoring disturbance, and its potential impact on the biota within the bay. In addition, there have been small scale changes to the topography in the nested mudflats and sandflats feature within the Gann flats in the Milford Haven Waterway. These changes are due to bait digging activities.

Sediment quality: oxidation-reduction profile (redox layer)

This indicator failed its secondary target due to the extensive opportunistic macroalgae growth within the Milford Haven Waterway, and the subsequent anoxic conditions this causes in the sediments. This has been observed where areas of opportunistic macroalgae growth has been recorded within the Milford Haven Waterway. The assessment of this indicator has been based on imagery and expert judgement, with a lack of a long-term quantitative data series. Quantification of the redox layers beneath opportunistic macroalgae would be required to raise the confidence of the failure. The failure is localised to the Milford Haven Waterway.

Sediment quality: carbon

This indicator target has a secondary weighting. The carbon content has increased across the monitoring period at the two Milford Haven inlet monitoring locations within the LSIB feature. Increases in carbon are likely to be from an increase in the amount of organic material being deposited and can be indicative of eutrophication and reduced oxygen in the sediment. The failure is localised to the Milford Haven Waterway.

Sediment quality: contaminants

This indicator target has a secondary weighting. Levels exceeding sediment quality guidelines of PAH compounds and heavy metals have been recorded in sediment samples within both bays in the SAC. Contaminants with levels above the most stringent ecological guidelines in some of the most recent sampling years were benzo(g,h,i)perylene, chromium, lead, mercury and TBT. Various other contaminants including metals had concentrations above the less stringent guidelines in the most recent years of sampling. Investigations into the sources of these contaminants, and the full impact on the feature have not been carried out.

Water quality: opportunistic macroalgae

This indicator target has a secondary weighting. The Milford Haven Inner waterbody was classified as Moderate status for the opportunistic macroalgae element in the 2024 cycle 3 interim classification. The WFD investigation report confirmed the opportunistic macroalgae failure in this waterbody. Major input of nutrients was found to be from diffuse sources associated with farm infrastructure and probable losses from agricultural land (Haines and Edwards, 2016; Lock, 2021a). In addition, point source continuous sewage discharge from the water industry were confirmed as a major source of nutrients linked to the opportunistic macroalgae failure, but only a minor source for the DIN failure (Haines and Edwards, 2016; Caprez, 2020; Lock, 2021a). Intermittent and domestic sewage are also suspected in the catchment. Further investigation locally is required to confirm these. The failure is localised to the Milford Haven Waterway, and there are no recorded nutrient issues within St Brides Bay.

Water quality: contaminants

This indicator target has a secondary weighting. The Milford Haven Inner waterbody has a fail for chemicals in the 2024 cycle 3 interim classification. The failing chemicals were PBDE and PAH. Historically, the main source of PBDE is as flame retardants in a variety of materials (Viñas et al., 2022). PAHs can be produced through natural processes, but

also arise from anthropogenic sources, for example during combustion of fossil fuels and organic material (Webster and Fryer, 2022).

The contaminants in the water column may be derived from diffuse sources from contaminated waterbody bed sediments, or point sources from continuous sewage discharge from wastewater treatment. However, an investigation into the failure in Milford Haven Inner waterbody is yet to be undertaken. PBDE is being managed in the UK and it is hoped that these levels will reduce in time. There is currently no specific management in place for PAH in Wales. The PAH EQS is based on the most sensitive taxa and may not be applicable to all of the LSIB biota. The impacts of PAH on the LSIB feature are not fully understood. The failure is localised to the Milford Haven Waterway.

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 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 Pembrokeshire Marine SAC are stated below.

Unconsented infrastructure

New unconsented infrastructures especially in the Pembrokeshire Marine SAC, 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

G. vermiculophylla has been found close to the SAC, in the Nevern. This species is not currently within the LSIB feature, but has the potential to establish quickly in shallow soft-bottomed bays and can have a detrimental impact on the feature as seen in mudflats and sandflats feature in Carmarthen Bay and Estuaries SAC (Jackson-Bué et al., 2025a) (see further detail in Section 3.1).

*D. vexill*um, native from the western Pacific near Japan, is an extremely invasive and harmful species as it can reproduce quickly, has the ability to cover extensive areas of the substratum, outcompete native species and inflict considerable economic damage particularly in relation to mariculture (McKenzie et al., 2017; Tillin et al., 2020). The recent establishment of *D. vexillum* near to Neyland marina and Pembroke Port in Pembrokeshire Marine SAC poses a threat to the reefs and other features as it could outcompete native species and alter habitats. Currently, effects on the species diversity and composition have not yet been observed, however as it has the potential to impact the reefs and therefore the LSIB feature.

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 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.

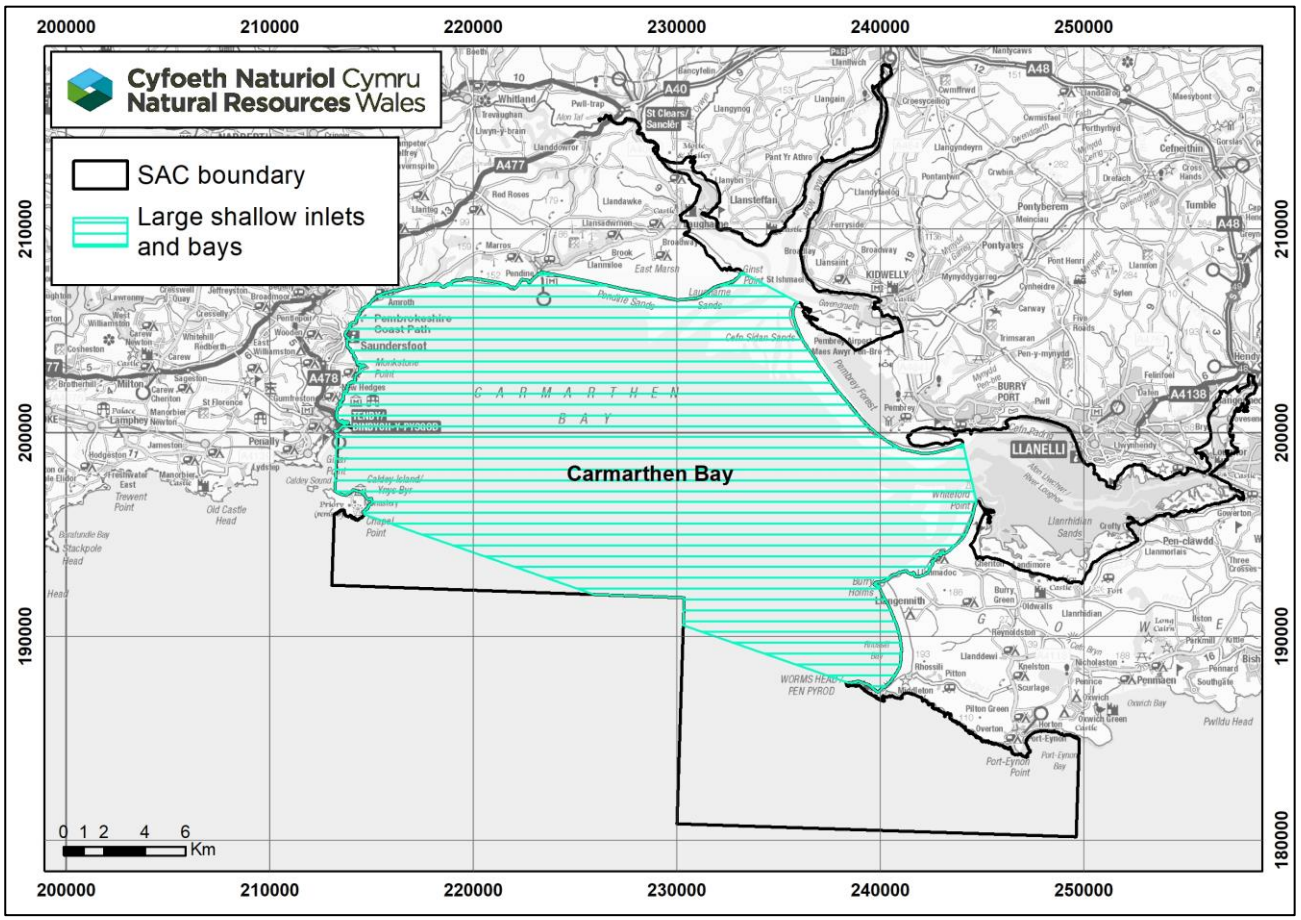
Further threats are associated with the nested features and can be found in the relevant feature reports.

- Recreational access and collection (Jackson-Bué et al., 2025c)
- Seabed disturbance (Jackson-Bué et al., 2025c)

3.4. Carmarthen Bay and Estuaries SAC condition assessment

The large shallow inlets and bays (LSIB) feature in Carmarthen Bay and Estuaries SAC is Carmarthen Bay (Figure 13). 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 13. 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 9 has a summary of the assessment outcome. This outcome and reasons of failure are discussed in more detail in the sections below.

Table 9. 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
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

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 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
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

Indicator	Target	Assessment rationale	Target assessment	Target confidence
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
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

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)	• 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
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

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 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
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

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 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
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 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 10). 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 large shallow inlets and bays in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

SAC	Overall Condition Assessment	Indicator failures	Reason for indicator failure	Threats to condition
Carmarthen Bay and Estuaries	**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 *G. 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 *Z. 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 (Jackson-Bué et al., 2025a). 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 (Jackson-Bué et al. 2025a). 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.

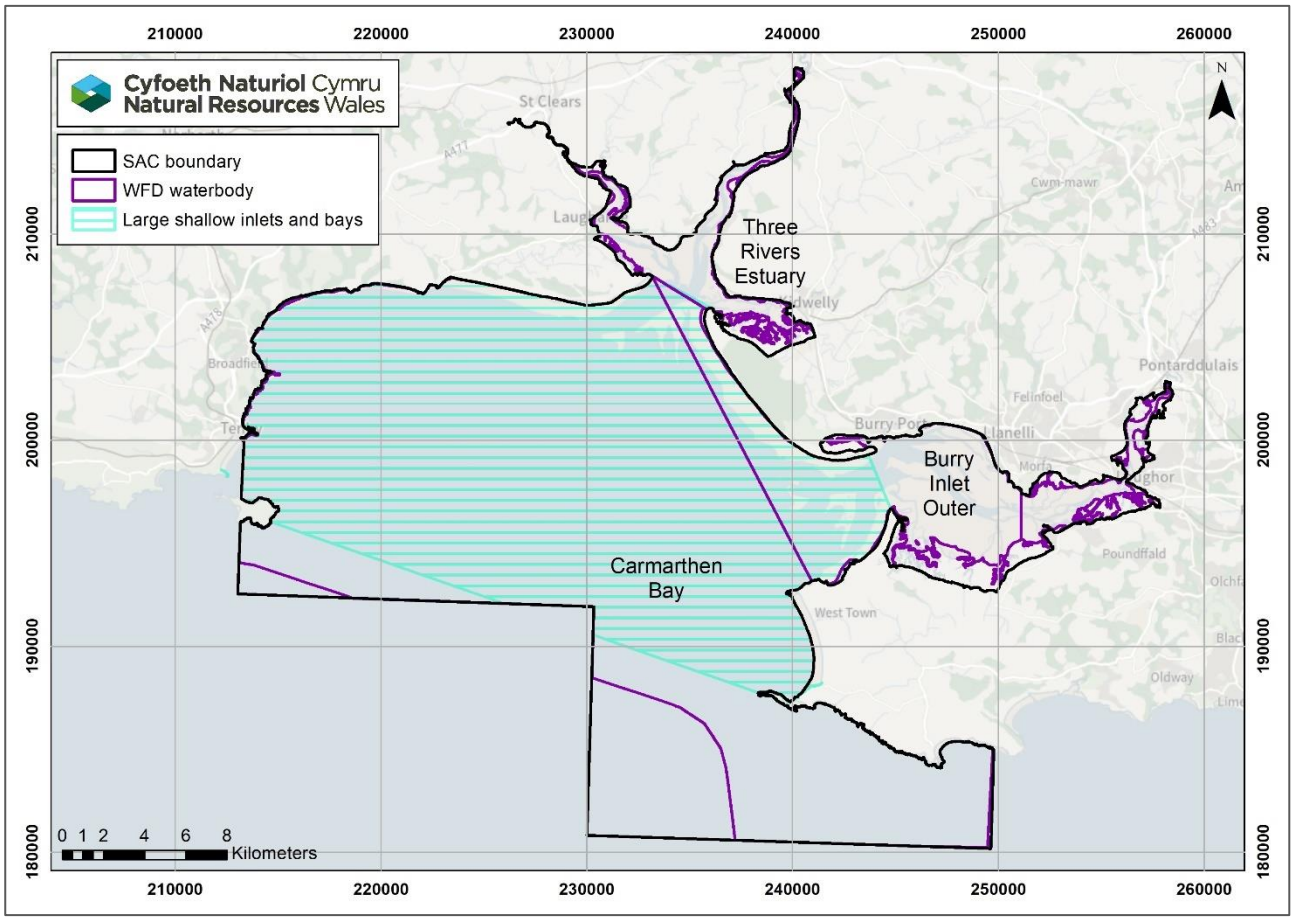
Water quality

It has been estimated that nearly 100% of the LSIB feature within the SAC falls within three WFD waterbodies (Figure 14), 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 14).

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, 2021). 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 14. 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, 2021; 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, 2021c). 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 (see Section 3). 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. Confidence in the pass was reduced to medium because surface sampling of dissolved oxygen may not detect issues for more demersal habitats within the LSIB feature (see further detail in Section 3.1).

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 (Jackson-Bué et al., 2025a).

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 *E. 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 NNS are known to be present within the feature, including *C. okamurae*, *D. japonica* and *S. muticum*. *C. 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, 2021). 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 as seen in mudflats and sandflats feature (Jackson-Bué et al., 2025a) (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.

4. Evidence gaps for the LSIB feature

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

Listed below 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 condition assessment reports. Not all evidence gaps apply to every SAC, see Table 11 for details.

Table 11. Evidence gaps for the LSIB feature in Welsh SACs. 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 at all of the SACs 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.
Sediment quality: contaminants (S); organic carbon content (S)	Not assessed / unknown	• Currently, there is no sediment monitoring within the Menai Strait and Conwy Bay SAC. • Within the Pen Llŷn a'r Sarnau SAC, the sediment monitoring within the SAC ceased in 2015. These data was deemed to be out of date and there are no recent data available. • Within the Carmarthen Bay and Estuaries SAC, the 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 which is not enough to assess this feature. There are no recent data for organic carbon content within the Carmarthen Bay and Estuaries SAC.

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 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	• This indicator was assessed as unknown in the Menai Strait and Conwy Bay, Pen Llŷn a'r Sarnau, and Carmarthen Bay and Estuaries SACs due to some or all of the overlapping WFD waterbodies not being 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 in any of the SACs. • 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 also no temperature, salinity or pH loggers within Carmarthen Bay and Estuaries SAC. • Further evidence on temperature change is required to adequately assess this indicator in other SACs. Some physicochemical parameters such as salinity and pH have not been assessed in any SACs. These could be considered in future as some monitoring data are available. • Remote sensing data on temperature, salinity and pH could be used in future.

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