



Condition Assessments for the Designated Features of Ardal Cadwraeth Arbennig Bae Ceredigion / Cardigan Bay Special Area of Conservation

Report No: 904

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Bottlenose dolphin Tursiops truncatus in Cardigan Bay © Peter Evans.

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Crynodeb Gweithredol

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

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

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

Nodweddion ACA	Asesiad cyflwr	Hyder yn yr asesiad
Dolffin trwyn potel Tursiops truncatus	Ffafriol	Canolig
Riffiau	Anffafriol	lsel
Ogofâu môr sy'n danforol neu'n lleddanforol	Anhysbys	Ddim yn berthnasol
Morlo llwyd Halichoerus grypus	Ffafriol	Isel
Ponciau tywod sydd fymryn dan ddŵr y môr drwy'r amser	Ffafriol	Canolig
Lamprai'r afon Lampetra fluviatilis	Ffafriol	Canolig
Lamprai'r môr Petromyzon marinus	Ffafriol	Canolig

Crynodeb o asesiadau cyflwr ar gyfer nodweddion dynodedig ACA Bae Ceredigion.

Executive summary

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

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

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

Summary of condition assessments for the designated features of Cardigan Bay SAC.

Feature	Condition assessment	Confidence in assessment	
Bottlenose dolphin Tursiops truncatus	Favourable	Medium	
Reefs	Unfavourable	Low	
Submerged or partially submerged sea caves	Unknown	Not applicable	
Grey seal Halichoerus grypus	Favourable	Low	
Sandbanks which are slightly covered by seawater all the time	Favourable	Medium	
River lamprey Lampetra fluviatilis	Favourable	Medium	
Sea lamprey Petromyzon marinus	Favourable	Medium	

1. Introduction

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

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

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

1.1. Assessment process

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

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

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

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

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

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

2. SAC description

The ardal cadwraeth arbennig Bae Ceredigion/ Cardigan Bay special area of conservation (SAC) is located on the west coast of Wales. Cardigan Bay is one of the largest bays in the British Isles. It measures over 100km (60 miles) across its westernmost extent from the Llŷn Peninsula to St. David's Head. Cardigan Bay is one of the very few areas around the UK where significant numbers of coastal bottlenose dolphins are known to occur regularly and is the primary reason the area was first selected as a SAC.

The site was designated in 2004 under Article 4.2 of the conservation of natural habitats and of wild fauna and flora directive (92/42/EEC) for three habitat features under Annex I and four species under Annex II. It is one of the best areas in the UK for the feature,

• Bottlenose dolphin *Tursiops truncatus*

And supports a significant presence of,

- Reefs
- Submerged or partially submerged sea caves
- Grey seal Halichoerus grypus
- Sandbanks which are slightly covered by seawater all the time
- River lamprey Lampetra fluviatilis
- Sea lamprey *Petromyzon marinus*

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

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

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Figure 1. Map of the designated features of the Cardigan Bay SAC.

3. Cardigan Bay SAC feature condition assessments

This section contains assessments for the following designated features in Cardigan Bay SAC:

- Bottlenose dolphin *Tursiops truncatus*
- Reefs
- Submerged or partially submerged sea caves
- Grey seal Halichoerus grypus
- Sandbanks which are slightly covered by seawater all the time
- River lamprey Lampetra fluviatilis
- Sea lamprey Petromyzon marinus

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

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

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

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

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

3.1. Bottlenose dolphin condition assessment

Monitoring of the bottlenose dolphin *Tursiops truncatus* population in Cardigan Bay SAC began in 2001 using a combination of photo ID and boat based transect surveys. A summary of the condition assessment can be seen in Table 2. The assessment conclusion, a detailed summary of the assessment and any reasons for failure can be found in the sections below.

Table 2. Condition assessment of bottlenose dolphin in Cardigan 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
Population size: Number of bottlenose dolphins using the SAC in the long term	A stable or increasing number of bottlenose dolphins using the SAC over the long term, allowing for natural change and variation. (P)	 Long term is defined as 20 years or more. The bottlenose dolphins in the Cardigan Bay SAC are part of the larger population residing in the whole of Cardigan Bay and the Irish Sea Management Unit. The population using the SAC has fluctuated over the monitored period (2001 - 2024). However, the population has been stable over the long term. Confidence in the pass is high due to quality of the long term data set in the SAC. 	Pass	High

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Population size: Number of bottlenose dolphins using the SAC in the short term	A stable or increasing number of bottlenose dolphins using the SAC over the short term, allowing for natural change and variation. (P)	 Short term is defined as five years or less. There are some gaps in monitoring in the last five years for line transect derived estimates in the SAC and all methods in the wider Cardigan Bay region. However, apart from 2020 (Covid), there is a complete dataset for the SAC using Capture Mark Recapture (CMR) methods, which we consider to be the most relevant for this indicator. Overall, abundance estimates of bottlenose dolphins appear to show an increase in recent years (short term). The confidence in the pass is high due to the high quality data set 	Pass	High
Reproductive success: crude birth rate.	A stable or increasing crude birth rate over the short term, allowing for natural change and variation. (S)	 Crude birth rate is a measure of the proportion of newborns in the population Crude birth rate data shows large inter annual variation over the monitoring period but seems to follow a pattern; years with a high crude birth rates (baby booms) are followed by a couple of years of low rates. Data over the short term (five years) seem to be following this same pattern but appear to be lower when compared to the long term data series, and when compared to other coastal bottlenose dolphin populations. This warrants further investigation. Confidence in the fail is low due to the difficulty in collecting birth rate data accurately, small sample size of mother-calf pairs as well as whether the change is part of a natural cycle. Further data and analyses are required. 	Fail	Low

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Reproductive success: calf	Calf survival in each of their first 3 years	 Bottlenose dolphin calves that survive to their 4th year are considered to be independent. 	Pass	Low
survival	should be no less than 80%, allowing for natural change and	 Data from the wider Cardigan Bay show the proportion of calves surviving to three years old (i.e. their 4th year) fluctuates annually but with no significant trend. 		
	variation. (S)	• When comparing recent values to those from previous reports, the ratios are similar.		
		 From 2001 to 2019 (latest available analyses), average calf survival for the population in each assessment year was: 1st year (0-1 year old) = 87%, 2nd year (1-2 years old) = 80%, and 3rd year (2-3 years old) = 92% 		
		• Confidence is low due to the lack of recent data and the inherently difficult nature of studying this indicator.		
SAC Residency	No significant decline in the proportion of	 Monitoring data indicate the proportion of residents is stable. 	Pass	High
	the dolphin population considered to be resident to the SAC, allowing for natural	 Based on long term monitoring the residency should remain above 35%. 		
		CMR evidence shows net movement outside of the SAC fluctuates over the years.		
	(P)	 Based on the latest data the population resident to Cardigan Bay SAC is around 37%. 		
		• Confidence in the pass is high due to the high-quality data for SAC monitoring.		

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Accessibility to habitat used by bottlenose dolphins	No evidence of significant anthropogenic constraints on access of bottlenose dolphin using the SAC to	• There is some evidence of both short and long-term negative relationships with recreational activities in Cardigan Bay SAC, therefore any unregulated increase in tourism could lead to bottlenose dolphins avoiding the area in the future	Pass	Low
	necessary habitat within or associated with the site. (S)	 Marine developments are routinely assessed for impacts to bottlenose dolphins, but such developments are largely absent at present from Cardigan Bay and so are not likely to be limiting access to habitat. 		
		• There is currently no compelling evidence that bottlenose dolphins are avoiding any areas of necessary habitat due to anthropogenic drivers and are thus not being significantly constrained in accessing necessary habitats.		
		• Confidence is low due to uncertainties around the population level impacts that activities have on bottlenose dolphins and the difficulty in defining when accessibility has been constrained.		
		 This indicator has been assessed primarily on expert judgment which also impacted the confidence. 		

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Anthropogenic disturbance	No significant anthropogenic disturbance affecting the bottlenose dolphin population associated	• There is some evidence of both short and long-term negative relationships with recreational activities in Cardigan Bay SAC. Compliance with marine codes of conduct is generally good, although improvements are needed for compliance from some users.	Unknown	N/A
	with the SAC. (S)	• It is known that some disturbance is occurring to bottlenose dolphin in the SAC through recreational boat use, but the extent and consequences are currently not well understood.		
		• Marine developments are routinely assessed for disturbance impacts to bottlenose dolphins, but such developments are largely absent at present from Cardigan Bay.		
		 However, while anthropogenic disturbance can have consequences such as adverse behavioural reactions even if it does not reach the level of resulting in displacement from an area, there is a lack of understanding on the population level impact. 		
		• Therefore this indicator has been assessed as unknown.		

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water, sediment and prey contaminants	Ensure water, sediment and prey contaminants are at levels not detrimental to the bottlenose dolphin population	 The Cardigan Bay Central waterbody failed for chemicals (mercury and polybrominated diphenyl ethers (PBDE)) in the 2024 cycle 3 interim classification. OSPAR report that mercury and lead are above ecological guidelines in the North East Atlantic region, as is one concepts of polycelorinated biphonyls (PCR). 	Pass	Low
	(S)	 OSPAR report that the PCB range in 2010-2020 was lower than the 1980s but still above marine mammal toxicity thresholds. 		
		 A study of marine mammals found that 80% of stranded bottlenose dolphins were above toxicity thresholds for PCBs. Several of these were found in Welsh waters. 		
		 PCBs are at levels that would be expected to have a physiological impact on bottlenose dolphins. Birth rates are low in recent years, but it is not possible to attribute this to PCBs. 		
		 As the population is stable and both mercury and PBDE are being managed, contaminants are deemed not to be having a detrimental impact on bottlenose dolphins at present. 		
		 Confidence is low as the impact of the levels of contaminants on the bottlenose dolphin population using the SAC is not clear. 		

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Prey availability	Maintain the quality, abundance and diversity of prey species needed to support the bottlenose dolphin population. (S)	 Bottlenose dolphin feed on a wide variety of prey. The population is stable in the long term with a slight increase in recent years, suggesting prey is, at least in part, not limiting population growth. There is insufficient evidence to suggest that bottlenose dolphins are prey limited or that there has been a reduction in the diversity or abundance of available species. However, changes in habitat use and the decline in birth rates could indicate the population may be adapting to a change in resource availability Confidence in the pass is low due to the potential link between prey availability and declining birth rate, the presence of several depleted fish stocks in the region and as the assessment is based largely on expert judgement. 	Pass	Low

Assessment conclusions

Bottlenose dolphin in Cardigan Bay SAC have been assessed to be in **favourable** condition (medium confidence). Overall the stable population of bottlenose dolphins using the SAC in the long and short term as well as no significant evidence of reduction in habitat quality led to the favourable assessment. However, one indicator with a secondary target failed due to an apparent decline in birth rate (Table 3). One indicator was also assessed as unknown. This reduced the confidence in the overall favourable assessment to medium. Further investigation is required to see why the crude birth rate is in decline. For further information see the <u>threats</u> section.

Table 3. Condition assessment summary for bottlenose dolphin in Cardigan Bay SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

Feature	Overall Condition Assessment	Indicator failures	Reason for indicator failure	Threats to condition	
Bottlenose dolphin	Favourable (medium confidence)	Reproductive success: crude birth rate (S)	 Declining crude birth rates in the short term. 	 Recreational disturbance Contaminants Prey availability 	

Detailed assessment information

Population

Cardigan Bay SAC is a key area for semi-resident coastal bottlenose dolphins, the largest of two such populations in the UK (Evans and Waggitt, 2023). Dedicated monitoring with photo-identification of bottlenose dolphins commenced in 2001 in Cardigan Bay SAC and was expanded in 2005 to include the wider Cardigan Bay, including a large part of the Pen Llŷn a'r Sarnau SAC. Bottlenose dolphins identified in Cardigan Bay have been recorded ranging from north Pembrokeshire to Anglesey, Liverpool Bay and the Isle of Man, though none have been matched to individuals seen outside of the Irish Sea (Feingold and Evans, 2012; Lohrengel et al., 2018). Numbers in Cardigan Bay are highest in the summer with many moving out of Welsh waters to the Isle of Man and Liverpool Bay to the north in the winter (Lohrengel et al., 2018; Evans and Waggitt, 2023).

A combination of boat-based line transect surveys and photo identification have been carried out since 2001. These were used to produce bottlenose dolphins population abundance estimates through distance sampling along a line transect and capture-mark-recapture (CMR) analysis of photo-identified individuals (Lohrengel et al., 2018). The CMR data are fed into two types of models: a closed model that assumes an unchanged population between sampling, and a robust design model which takes into account the population being open to births, death and individuals entering and leaving the population (Lohrengel et al., 2018). NRW recommend that estimates derived from the closed CMR model are used preferentially, owing to their overall robustness.

The Cardigan Bay SAC abundance estimate for 2024, based on distance sampling, was 232 individuals (95% CI = 119 - 451; CV = 0.341). Using the CMR closed model, the population estimate for Cardigan Bay SAC was 213 bottlenose dolphins (95% CI = 85 - 535; CV = 0.497), although model fit for this particular year was poor (Figure 2). The CMR robust model resulted in a lower estimate of 117 bottlenose dolphins (no CV was possible for this estimate due to the distribution of recapture events (Lohrengel et al., in draft). While closed and open models gave rather different results, smoothed trend lines had similar trajectories across both models, showing a peak in the population around 2008 followed by a gradual decline until an upswing in recent years (Lohrengel et al., in draft). The smoothed trend line for Cardigan Bay SAC from distance sampling also shows similarities to the CMR smoothed trend lines but with a steeper increase in recent years. The wider Cardigan Bay abundance estimate for 2024, based on distance sampling, resulted in a larger than usual estimate of 734 (95% CI = 403 - 1383; CV = 0.34), in which we have low confidence

Figure 2. Population estimates for bottlenose dolphins in Cardigan Bay SAC from 2001 to 2024 (solid line) obtained from CMR using a closed population model including 95% confidence intervals (dashed lines), excluding 2020 when no data were collected (Lohrengel et al., in draft).



The CMR model estimates for the wider Cardigan Bay area are typically larger than those of the SAC alone because they include individuals in the SAC as well as those in the whole of the Bay. However, the closed estimate for the wider Cardigan Bay in 2024 is lower than for Cardigan Bay SAC, likely due to the poor fit of the model for Cardigan Bay SAC for that year. The Closed model CMR estimate for the wider Cardigan Bay area was 211 animals (95% CI = 107 - 414; CV = 0.355) in 2024, while the robust model was again lower at 143 individuals (no CV available) (Lohrengel et al., in draft). While the closed and open models for the wider Cardigan Bay area gave different results, the smoothed trend lines followed a similar pattern to those from the SAC analyses. As before, the smoothed trend line for the wider Cardigan Bay from distance sampling also show similarities to the CMR trend except for a steeper increase in recent years.

Over the whole monitoring period (2001-2024), numbers using the SAC and the wider Cardigan Bay are variable but are deemed to be broadly stable overall. This meant the indicator of the number of bottlenose dolphins using the SAC in the long term passed with high confidence, especially when utilising the preferential CMR closed model data for the SAC. A decline since the peak of the population in the medium term (10 years) may be part of a naturally fluctuating cycle or may indicate individuals moving out of the area, rather than a decline in the overall population of bottlenose dolphin. In the last three years, however, the population appears to have increased slightly. More monitoring data are needed to track this.

It is important to also consider bottlenose dolphin population in the short term as declines detected in this time frame would allow management to be implemented to prevent further decline. Short term has been defined as five years for the purposes of these condition assessments. The data from both Cardigan Bay SAC and the wider Cardigan bay show an increase in bottlenose dolphin numbers in the most recent years for both models. This meant the indicator of the number of bottlenose dolphins using the SAC in the short term passed. Due to the covid-19 pandemic and funding constraints, there were only four years of data (2021-2024) in the last five years (at the time of the assessment) using CMR in the SAC, and three years (2022-2024) in the wider Cardigan Bay. The confidence in the pass was high due to the robust monitoring data.

Reproduction

Cardigan Bay SAC has historically been considered an important nursery ground for bottlenose dolphins (Feingold and Evans, 2014; Lohrengel et al., 2018). In the wider Cardigan Bay area the majority of newborn bottlenose dolphin calves have been recorded in Cardigan Bay SAC in the last 10 years, and only within the SAC for several of those years (Lohrengel et al. in draft). This suggests Cardigan Bay SAC remains an important area for calving bottlenose dolphins.

Female bottlenose dolphins in Cardigan Bay can give birth in any month of the year but most births are in the summer, with 75% of births between July and September (Lohrengel et al 2018). The mean calving interval is 3.4 years (range 2-8 years) (Lohrengel et al in draft).

Crude birth rate

NRW recommend crude birth rates based on population sizes calculated using closed CMR models. Crude birth rate data show large inter annual variation over the monitoring period but seem to follow a pattern: High crude birth rate years (baby booms) are followed by a couple of years of low rates. However, the average crude birth rate in the SAC and wider Cardigan Bay has declined in each of three 8-year time periods since 2001 (see Table 4) and the birth rates appear to have continued to decline in the short term (Lohrengel et al., in draft).

Due to this apparent decline in birth rate in the SAC, the Reproductive Success: Crude Birth Rate indicator failed to meet its target. Confidence in the failure was low due to the challenge of estimating this parameter and further investigation is required. **Table 4.** Crude birth rates over time in Cardigan Bay SAC and the wider Cardigan Bay area (data from Lohrengel et al., in draft).

Monitoring period	Cardigan Bay SAC crude birth rate (%)	Wider Cardigan Bay crude birth rate (%)
2001-2008	5.1	6.51
2009-2016	4.64	5.11
2017-2024	3.06	2.96

Calf Survival

Another measure of reproductive success is calf survival. Calves are considered to be independent in their 4th year, so it is important to track their survival over the first three years of their life while they are reliant on their mother. This is a difficult metric to measure as mother calf pairs need to be identified and then continually tracked over three years. Calf survival is calculated for wider Cardigan Bay area only rather than the SAC.

Between 2009 and 2019 the 1st year calf survival (0-1 year) is 87%, 2nd year survival (1-2 years) is 80%, and 3rd year survival (2-3 years) is 92% (Lohrengel et al., in draft.). Between 2017 and 2023, only five mother and calf pairs were observed sufficiently to determine survival, all of which survived the first three years of life. Sample size since 2019 was low due to no data in 2020 (Covid) and calves born after 2021 were excluded from analysis as survival to their third year of life could not yet be determined. Calf survival data were deemed sufficient to allow the Reproductive Success: Calf Survival indicator to pass. Confidence was reduced to medium due to the lack of recent data and the inherently difficult nature of studying this indicator.

Residency

The bottlenose dolphin population in Cardigan Bay is one of only two major semi-resident populations of coastal bottlenose dolphins in the UK. It is this resident nature that was a primary reason for designating the SAC. Detecting residency in a mobile species is difficult and requires long term intensive monitoring with photo identification, ideally over the entire range of the population. Photo identification of bottlenose dolphin has taken place in the Cardigan Bay SAC since 2001, allowing residency to be determined. A bottlenose dolphin is deemed to be a resident if it is seen within the SAC for a minimum of seven years or on 12 separate occasions (Pesante et al. 2008; Feingold and Evans, 2012; 2014; Lohrengel et al., 2018).

Analysis of data between 2001 and 2024 showed that 'residents' made up 37% of animals sighted in the SAC. This was similar to the previous 38% estimate from data collected between 2001-2016, using the same methodology (Lohrengel et al., in draft). Within the wider Cardigan bay 67% of individuals were classed as resident. This was approximately a 10% increase on the 2016 analysis (Lohrengel et al., in draft). The proportion of residents appears to be stable over the monitoring period and as such we expect residency to be no less than 35%.

There is nothing in the most recent monitoring data to suggest that the proportion of residency has changed. The majority of individuals resident in wider Cardigan Bay were Page **25** of **122**

also considered resident in Cardigan Bay SAC, highlighting that the SAC continues to be the most important area for bottlenose dolphins within the bay, although they are using the wider area extensively as well (Lohrengel et al., in draft). Therefore the SAC residency indicator has passed. Despite detection of residency being difficult, the length and quality of photo ID data mean the confidence in the pass is high.

Habitat accessibility and disturbance

The mobile nature of bottlenose dolphins means that they utilise a wide area for their functional needs (e.g. feeding, breeding). While presence of bottlenose dolphin at a particular location is likely to indicate some degree of reliance on the habitat associated with the location of that sighting, there is a lack of understanding on what constitutes suitable habitat for the species. Suitable habitat, however, is likely to be strongly correlated with prey availability. Repeated sightings of animals over time in particular areas are likely to indicate the habitat in that area is important for the species. An analysis of 30 years of sightings data and modelling with various factors representing habitat features, confirm that the wider Cardigan Bay area, especially Cardigan Bay SAC, the Llŷn Peninsula and west coast of Anglesey are persistently important areas for the regional coastal bottlenose dolphin population (Evans and Waggitt, 2023). For this reason it is vital that bottlenose dolphins continue to have unimpeded access to the whole of the SAC and areas beyond it.

It is not only physical barriers that could reduce access to the SAC and areas beyond it that are considered to be functionally important/linked (i.e. necessary). Noise and visual stimuli could also disturb bottlenose dolphins and prevent them from accessing an area. Bottlenose dolphins that move away from an area due to disturbance (physical or otherwise) are said to be displaced. However, disturbance can occur at levels that does not cause bottlenose dolphins to leave an area but can still lead to negative outcomes. It is important to distinguish between activity and physical barriers that may displace bottlenose dolphins using the SAC from necessary habitats, with disturbance that may lead to adverse behavioural changes.

Bottlenose dolphins are known to forage and breed outside of the SAC boundaries. Therefore, we need to ensure functionally linked (i.e. necessary) habitats are available to them and their use of them is not constrained in such a way that the population that uses the SAC is adversely affected.

Habitat accessibility

Studies have suggested both short and long-term negative relationships with recreational activities in Cardigan Bay SAC. This may be as a result of recreational vessel users that do not comply with marine codes of conduct, causing increases in negative (i.e. avoidance and escaping) behaviour responses of bottlenose dolphins compared to those vessels adhering to the code (Koroza and Evans, 2022). Negative responses tended to be more pronounced in transient bottlenose dolphins compared to residents, suggesting some habituation is occurring (Koroza and Evans, 2022). While this is of concern, there is currently a lack of evidence that this activity is significantly constraining access for bottlenose dolphins to an extent that would impact the population associated with the SAC.

Projects and activities taking place outside of the SAC can pose a risk of preventing the bottlenose dolphins that use or are associated with Cardigan Bay SAC from accessing the

SAC (i.e. from offsite impacts). These risks mainly come from marine industrial developments and associated activities, especially in relation to collision and underwater noise. However, there is currently no evidence from developments or specialist knowledge that bottlenose dolphins are being significantly constrained in accessing the SAC from activity outside of it.

At the time of assessment, accessibility to habitat in the SAC used by bottlenose dolphins was not considered to be significantly constrained, allowing the indicator to pass. The confidence was reduced to low as there are uncertainties around the impacts that recreational activities are having on the ability of bottlenose dolphins to access the site, and the difficulties in defining when accessibility has been constrained.

Disturbance

Bottlenose dolphins, like all cetaceans, are sensitive to disturbance, particularly from underwater noise, as they rely heavily on sound to understand their surroundings and to communicate (Evans, 1996). Disturbance to bottlenose dolphin comes largely from underwater noise associated with boat traffic as well as noise from construction of industrial developments e.g. windfarms.

Disturbance can lead to behaviour changes such as reduced foraging and may have energetic and fitness costs that have negative consequences on populations (e.g. Chudzińska et al., 2024). One of the main sources of noise in Cardigan Bay is from vessel traffic. Boat noise has been shown to mask cues, affect the behaviour of bottlenose dolphins and their prey and cause stress (Pirotta et al., 2015 and references therein). An increase in tourist boats was shown to lead to a decrease in bottlenose dolphin abundance in Australia (Bejder et al., 2006); while this decrease in abundance was not thought to endanger that large genetically diverse population, such a decrease in smaller, resident populations could be damaging.

It is known that there is a moderate amount of disturbance occurring to bottlenose dolphin in Cardigan Bay SAC through recreational vessel use. As mentioned above, recreational users that were observed not to follow the marine codes of conduct, caused negative changes to bottlenose dolphin behaviour compared to those vessels adhering to the codes (Koroza and Evans, 2022). However, there is a lack of understanding on the impact that this level of disturbance is having on the bottlenose dolphin at a population level. For this reason this indicator has been assessed as unknown. Monitoring of disturbance is a gap in evidence (see <u>evidence gaps</u>).

Habitat quality

Contaminants

As top predators, marine mammals are vulnerable to contaminants, particularly those which biomagnify and / or bioaccumulate, such as persistent organic pollutants (POPs). Example of POPs include various pesticides, polychlorinated biphenyls (PCBs) that were historically used in manufacturing, and polybrominated diphenyl ethers (PBDEs) that were used as flame retardants in a variety of products. While many POPs have been banned in Europe since the 1970s and 80s, they take a very long time to degrade, resulting in the

term 'persistent'. Despite their use now being prohibited, they continue to enter the marine environment via use and disposal of products made before bans were introduced.

POPs pose a risk to bottlenose dolphins, which bioaccumulate and biomagnify these contaminants over their long life spans and store these lipophilic contaminants in their fat tissue (e.g. blubber) (Williams et al., 2023, and references therein). High levels of PCBs continue to be found in dolphins and cetaceans in European waters (Jopson and Law, 2016; Williams et al., 2023; Zanuttini et al., 2019).

POPs are known to cause a variety of negative health implications in marine mammals such as anaemia, endocrine disruption (Tanabe et al., 1994; Vos et al., 2003; Schwacke et al., 2012), immune system suppression (Tanabe et al., 1994) and the subsequent increased vulnerability to infectious disease (Aguilar and Borrell, 1994; Jepson et al., 2005), and reproductive impairment and developmental abnormalities (Tanabe et al., 1994; Schwacke et al., 2002, Vos et al., 2003). However, the impacts of these chemicals at the population level are not well understood.

In this condition assessment, the coastal Cardigan Bay Central waterbody has a fail for chemicals in the 2024 cycle 3 interim classification, where mercury and PBDE failed. The human health protection goal that is used for PBDE may be considered as over precautionary as the effect of contaminants on bottlenose dolphins are not fully understood. The environmental quality standard (EQS) for mercury is based on the secondary poisoning protection goal (for wildlife), which may be more relevant to bottlenose dolphins and is sampled from biota they may eat. Of the other two relevant WFD waterbodies within the SAC, one waterbody (Cardigan Bay South) was not classified as the chemicals have not been assessed within the last six years. The other waterbody (Teifi) has a pass for chemicals; however, the chemical classifications were rolled forward from the 2018 cycle 2 interim classification. It is also an estuarine waterbody, unlikely to be used by the bottlenose dolphins.

The Convention for the Protection of the Marine Environment of the North-East Atlantic or OSPAR, assess the state of the seas in the region. The latest quality report published in 2023 states that hazardous substances are still a cause for concern across the region, including the Irish Sea. Both mercury and lead are above ecological guidelines in the North-East Atlantic region, as is the most toxic congener (CB118) of PCB when measured in sediments and biota (fish, shellfish, birds and mammals) (Larsen and Hjermann, 2022; Webster and Fryer, 2022). Overall, PCBs in 2010-2020 were lower than the 1980s, but concentrations in some areas are still at levels that may cause adverse effect to marine life (Webster and Fryer, 2022). A recent UK study of 11 marine mammal species found 80% of stranded bottlenose dolphins were above toxicity thresholds for PCBs, with several washed up in Welsh waters (Williams et al., 2023).

Despite PCBs persisting in the Irish sea and being found in bottlenose dolphins at levels that would be expected to have a physiological impact on them, the population using the SAC remains stable. As there is no evidence that contaminants are having a detrimental impact to the population, the indicator passed. However, confidence is low for this indicator because the link to population level effects is unclear, and it is not certain whether those stranded bottlenose dolphins with measured levels of PCBs represent the coastal bottlenose dolphin population using the SAC. It is also not clear what the PCB levels are in live animals. Contaminants remain a threat to the coastal bottlenose dolphin population from both historical POPs and new emerging contaminants. There is an evidence need to

better understand the impacts of POPs on the population and to measure levels in live bottlenose dolphins. This is especially important given the apparent reduction in crude birth rate in Cardigan Bay bottlenose dolphins and the known impacts of contaminants on reproductive parameters seen in some marine mammal populations (Murphy et al., 2018; Tanabe et al., 1994; Schwacke et al., 2002, Vos et al., 2003).

Prey availability

Bottlenose dolphins are generalist and opportunistic feeders, eating a wide range of pelagic and benthic (demersal) fish, crustaceans and molluscs (i.e. squid and octopus), both within and outside of the SAC. From visual observations of the surface behaviour of bottlenose dolphins in Cardigan Bay, it is known that they catch pelagic fish (such as sea trout and bass), bottom dwelling fish (e.g. flatfish) and invertebrates (e.g. squid) (unpublished data from NRW, Sea Watch Foundation and the Wildlife Trusts). Hernadez-Milian et al., (2015) analysed stomach content of bottlenose dolphins stranded on the west coast of Ireland and indicated a wide variety of both benthic and pelagic prey was consumed. However, this study may better represent the offshore ecotype rather than coastal bottlenose dolphin associated with the Irish Sea and Cardigan Bay.

Prey availability is likely to be a key factor in determining the abundance and distribution of bottlenose dolphins in the Irish Sea, Cardigan Bay and the SAC. Recent analyses suggest that there have been changes in habitat use by Cardigan Bay bottlenose dolphins and an observed decline in birth rates (Lohrengel et al., in draft). Such declines have been linked to changes in prey availability in other marine mammal populations (Vermeulen et al., 2023; Wild et al., 2019; Williams et al., 2013) and could indicate the Cardigan Bay population may be adapting to a change in resource availability (Lohrengel et al., in draft). A recent study in the <u>Celtic Sea ecoregion</u> found evidence of a decline in the nutritional health of common dolphin *Delphinus delphis* through measuring ventral blubber thickness, which is potentially linked to shifts or declines in prey availability (Albrecht et al., 2024).

However, there is currently insufficient robust evidence to suggest that bottlenose dolphin prey is limited in terms of abundance or diversity, although some key prey species are thought to be depleted in the Irish and Celtic Seas (ICES, 2024a, 2024b, 2024c, 2024d, 2024e, 2024f). The stability of the overall population and number of bottlenose dolphins using the SAC suggest prey availability within the SAC and wider areas are sufficient to sustain them. For this reason, the indicator passed. However, confidence was reduced to low due to several factors: the lack of understanding and targeted surveys on prey availability, the presence of several depleted fish stocks in the region and the potential links with the observed decline in crude birth rate. The assessment of the indicator was largely based on expert judgment.

Reason for target failure

The bottlenose dolphin feature in the Cardigan Bay SAC has been assessed as being in **favourable** condition. However, a secondary target failed to be met and needs to be kept under review.

Reproductive success: crude birth rate

This indicator target has a secondary weighting. Crude birth rate data show large inter annual variation over the monitoring period. However, birth rates appear to have declined over the longer term. Due to this apparent decline in birth rate in the SAC, the indicator failed its target. The reasons for the decline in crude birth rate are not clear. Low birth rates have been linked to changes in prey availability in other populations. It is also known that high levels of contaminants in a population can suppress the birth rate. Further investigation is needed to understand why the birth rate is declining and if management can be put in place to help rates recover.

Threats to condition

Part of this condition assessment process is to identify threats to the condition of the bottlenose dolphin feature. A threat is defined as an activity that has the potential to have a negative impact on feature condition over the next reporting cycle, if activity levels increase or are unmanaged to the point that the activity is regarded as damaging. It is important to identify these threats to, where relevant, be able to put pre-emptive management in place to prevent declines in condition. The threats to the bottlenose dolphin feature condition in the Cardigan Bay SAC are stated below.

Disturbance

Recreational disturbance when users do not adhere to marine codes of conduct has been shown to produce negative behavioural responses in the bottlenose dolphins of Cardigan Bay (Koroza and Evans, 2022). If this recreational disturbance was to increase it could have a detrimental impact on the population, and may result in bottlenose dolphins not using or being displaced from the SAC. There is also a lack of understanding around the long term impacts the current level of recreational disturbance is having on the population.

Underwater noise from construction, operation or decommissioning of marine developments may disturb cetaceans. However, environmental impacts from these developments are routinely assessed and managed; for example, mitigation measures are sometimes used to reduce or remove underwater noise. Noisy developments are, however, largely absent from Cardigan Bay at present.

Contaminants

At the time of the assessment, bottlenose dolphins are not thought to be detrimentally impacted by contaminants at the population level. However, the levels of some contaminants exceeding ecological guidelines within the SACs are cause for concern and could potentially be linked to the declining crude birth rate observed. While some contaminants like, PCBs mercury and PBDE are under management and will not increase, there is the potential for unregulated contaminants (such as Per- and polyfluoroalkyl substances (PFAS) and pharmaceuticals) to potentially increase in the future. Bioaccumulation potential of POPs means the levels in top predators such as bottlenose dolphins, may still be of some concern. Many contaminants have been shown to have a detrimental impact on bottlenose dolphins (Tanabe et al., 1994; Schwacke et al., 2002; Vos et al., 2003).

Prey availability

Prey availability is likely to be a key factor in determining the abundance and distribution of bottlenose dolphins in the Irish Sea, Cardigan Bay and the SACs. There is currently insufficient robust evidence to suggest that bottlenose dolphin prey is limited in terms of abundance or diversity, although some key prey species are thought to be depleted in the Irish and Celtic Seas (ICES, 2024). The stability of the overall population and number of bottlenose dolphins using the bay and SACs suggests prey is sufficient to sustain them. However, with incomplete understanding of prey availability, limited targeted surveys on prey, and presence of several depleted fish stocks in the region, more research is needed.

Evidence gaps

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

Listed below (Table 5) are current indicators that were either assessed as unknown, not assessed, or assessed with a lower confidence. This was due to either limited data availability, outdated data, or a lack of information. Some indicators are not currently monitored but should be ideally considered in future condition assessments.

Table 5. Evidence gaps for bottlenose dolphins in Cardigan Bay SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Assessed status	Comments
Accessibility to habitat used by bottlenose dolphins (S)	Low confidence	• Lack of understanding on what constitutes necessary habitats for bottlenose dolphins that use the SAC and the impacts of recreational boats use on habitat use.
Anthropogenic disturbance (S)	Unknown	• Lack of understanding on the population level impacts of disturbance from recreational vessels on bottlenose dolphins that use both SACs.
Water, sediment and prey contaminants (S)	Low confidence	• Lack of understanding on the population level impacts of contaminants and the levels found within live bottlenose dolphins that use both SACs.
Prey availability (S)	Low confidence	• Lack of data on the diversity and abundance of dolphin prey in SACs. More targeted surveys on key prey species are needed.

3.2. Reefs condition assessment

Intertidal reefs

The reefs feature in the Cardigan Bay SAC comprises a number of intertidal reefs (Figure 3). The NRW Habitats Regulations monitoring of intertidal reefs has focused on sampling sites within the rockpool communities at Aberporth and Cei Bach, the *Sabellaria alveolata* reefs at Aberaeron and Cei Bach, and the turf algae communities at Aberporth. These locations were surveyed between 2007 and 2022 using quadrat sampling, scrapes and fixed rockpools as part of the NRW Habitat Regulations monitoring survey.



Figure 3. Map of the intertidal reefs in Cardigan Bay SAC.

The summary of the assessment outcome for intertidal reefs is provided in Table 6. The outcome and reasons for failure are discussed in more detail in the sections below.

Table 6. Condition assessment of intertidal reefs in Cardigan Bay SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

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

Indicators	Target	Assessment rationale	Target assessment	Target confidence
Bathymetry of the feature	Maintain bathymetry of the reef(s), allowing for natural change and variation. (P)	 There are currently no anthropogenic impacts known to be significantly affecting the bathymetry of intertidal reefs in this SAC. Confidence is medium as expert judgement has been used to assess this indicator in the absence of recent data. 	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 intertidal reefs in this SAC. Confidence is medium as expert judgement has been used to assess this indicator in the absence of recent data. 	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. (S)	 Two of the three WFD waterbodies that overlap with intertidal reefs were classified with a High status for DIN in the 2024 cycle 3 interim classification (Cardigan Bay Central and Cardigan Bay South). Combined, these waterbodies overlap with 70% of intertidal reefs. The other WFD waterbody was classified with a Poor status for DIN (Teifi Estuary). It overlaps with 9% of intertidal reefs. This caused the failure of the target, but with low confidence due to the small spatial overlap. 	Fail	Low

Indicators	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 three WFD waterbodies was not classified for phytoplankton in the 2024 cycle 3 interim classification (Cardigan Bay South). This waterbody overlaps with 14% of intertidal reefs in the SAC. The other two WFD waterbodies were classified with High status for phytoplankton (Cardigan Bay Central and Teifi Estuary). These waterbodies overlap with 56% and 9% of intertidal reefs. The Teifi Estuary waterbody classification was rolled forward from the 2021 cycle 3 classification. This classification may not be a true reflection of phytoplankton in the Teifi Estuary waterbody. Confidence is low due to the unclassified waterbody, and 	Pass	Low
		the uncertainty and rolled forward classification in the Teifi Estuary waterbody.		
Water quality: opportunistic macroalgae	The WFD classification achieved for opportunistic macroalgae should be Good or High status in	• Two of the three overlapping WFD waterbodies has not been classified for opportunistic macroalgae in the 2024 cycle 3 interim classification (Cardigan Bay Central and Cardigan Bay South). Combined, these waterbodies overlap with 70% of intertidal reefs.	Pass	Low
	WFD waterbodies that overlap with the feature, and there	• The other overlapping WFD waterbody was classified with a Good status (Teifi Estuary). This waterbody overlaps with 9% of intertidal reefs.		
	should be no deterioration between	 The confidence of this classification is uncertain due to outdated available intertidal habitat layers. 		
	SIGIUS UDSSES. (3)	• Confidence is low as the passing waterbody overlaps with a small proportion of the feature, and as there is some uncertainty in this classification.		

Indicators	Target	Assessment rationale	Target assessment	Target confidence
Water quality: dissolved oxygen	The WFD classification achieved for dissolved oxygen should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (S)	 All three WFD waterbodies that overlap with intertidal reefs 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. 	Pass	Medium
Water quality: contaminants	Water column contaminants not to exceed the environmental quality standards (EQS). (S)	 One of the three WFD waterbodies was not classified in the 2024 cycle 3 interim classification as the chemicals have not been assessed within the last six years (Cardigan Bay South). This waterbody overlaps with 14% of intertidal reefs. One WFD waterbody has a pass for chemicals, however the chemical classifications were rolled forward from the 2018 cycle 2 interim classification (Teifi Estuary). This waterbody overlaps with 9% of intertidal reefs. The other WFD waterbody has a fail for chemicals in the 2024 cycle 3 interim classification (Cardigan Bay Central). This waterbody failed for mercury and PBDE and overlaps with 56% of intertidal reefs. Confidence is medium as the human health standard has been used for PBDE, and due to unclassified waterbodies or rolled forward classifications. 	Fail	Medium
Indicators	Target	Assessment rationale	Target assessment	Target confidence
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Water quality: turbidity	Maintain expected levels of turbidity, allowing for natural change and variation. (S)	• There are limited data on turbidity for the reefs feature in the Cardigan Bay SAC, therefore this target was assessed as unknown.	Unknown	N/A
Abundance, distribution and species composition of communities	Maintain the abundance, distribution, and diversity of species within communities and component habitats, allowing for natural change and variation. (P)	 The percentage cover and extent of Sabellaria alveolata has fluctuated over the monitoring period at Cei Bach and Aberaeron sites. There was initially a decline in <i>S. alveolata</i> cover from 2017 to 2022, which has subsequently increased in 2023 and 2024. Analysis of the <i>S. alveolata</i> reef communities indicated a gradual progressive change over the course of the monitoring programme at both sites. This was considered natural. The occurrence of green algae at Cei Bach site increased in later years, which has raised some concerns. Analysis of rockpool communities for Aberporth and Cei Bach sites showed natural variation in communities composition across the monitoring period. Analysis of turf algae at Aberporth site showed no distinct pattern, with sample composition being extremely variable but considered within bounds of natural variation. The percentage cover of the blue mussel <i>Mytilus edulis</i> has fluctuated over the monitoring period which is likely to be part of a natural cycle. 	Pass	Medium
		• The percentage cover of <i>Fucus serratus</i> has increased in recent years at both rockpool and <i>S. alveolata</i> reef sites.		
		• Confidence is medium due to the presence of green algae at Cei Bach site within the <i>S. alveolata</i> reef.		

Indicators	Target	Assessment rationale	Target assessment	Target confidence
Species richness and diversity	Maintain the expected richness and diversity of reef species, allowing for natural change and variation. (S)	• Recorded changes in species richness for both <i>S. alveolata</i> reef communities in Aberaeron and Cei Bach sites did not indicate any trends of concern and were considered natural.	Pass	High
		• Similarly, the species richness for rockpool communities at Aberporth site appear to be within the normally recorded range of such fluctuations and considered natural.		
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. <i>Sargassum muticum</i>) are currently impacting the condition of intertidal reefs in the SAC.	Pass	Low
		• Confidence is low as the spread and impacts of the INNS present within the feature are not well understood.		
Non-native species (INNS)	No increase in the number of introduced NNS by human activities. (T)	• No new NNS were identified within the last six years within the reefs feature of Cardigan Bay SAC.	Pass	Low
		 S. muticum has been previously identified in low abundance in the SAC. 		
		 Confidence is low as there have been no targeted INNS surveys in the SAC. 		

Subtidal reefs

The reefs feature in the Cardigan Bay SAC comprises a number of subtidal reefs (Figure 4). There is currently no NRW Habitats Regulation monitoring programme for the subtidal reefs within the Cardigan Bay SAC, therefore some indicators could not be assessed for subtidal reefs.



Figure 4. Map of the subtidal reefs in Cardigan Bay SAC.

The summary of the assessment outcome for subtidal reefs is provided in Table 7. The outcome and reasons for failure are discussed in more detail in the sections below.

Table 7. Condition assessment of subtidal reefs in Cardigan Bay SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

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

Indicators	Target	Assessment rationale	Target assessment	Target confidence
Bathymetry of the feature	Maintain bathymetry of the reef(s), allowing for natural change and variation. (P)	 There are currently no anthropogenic impacts known to be significantly affecting the bathymetry of subtidal reefs in this SAC. Confidence is medium as expert judgement has been used to assess this indicator in the absence of recent data. 	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 subtidal reefs in this SAC. Confidence is medium as expert judgement has been used to assess this indicator in the absence of recent data. 	Pass	Medium
Water quality: nutrients (DIN only)	The WFD classification achieved for winter DIN should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (S)	 One of the three WFD waterbodies that overlaps with subtidal reefs was classified with a Poor status for DIN in the 2024 cycle 3 interim classification (Teifi Estuary). It overlaps with only 1% of subtidal reefs, and therefore did not cause the indicator to fail. The other two WFD waterbodies were classified with a High status for DIN (Cardigan Bay Central and Cardigan Bay South). These waterbodies overlap with 24% of subtidal reefs. Confidence is low due to the failure of the Teifi Estuary waterbody. 	Pass	Low

Indicators	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 three WFD waterbodies was not classified for phytoplankton in the 2024 cycle 3 interim classification (Cardigan Bay South). This waterbody overlaps with 7% of subtidal reefs. The other two WFD waterbodies were classified with High status for phytoplankton (Cardigan Bay Central and Teifi Estuary). Combined, these waterbodies overlap with 17% and 1% of subtidal reefs. The Teifi Estuary classification was rolled forward from the 2021 cycle 3 classification. Confidence is medium due to the unclassified waterbody and rolled forward classification. 	Pass	Medium
Water quality: dissolved oxygen	The WFD classification achieved for dissolved oxygen should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (S)	 All three WFD waterbodies that overlap with subtidal reefs 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. 	Pass	Medium

Indicators	Target	Assessment rationale	Target assessment	Target confidence
Water quality: contaminants	Water column contaminants not to exceed the EQS. (S)	• One of the three WFD waterbodies was not classified in the 2024 cycle 3 interim classification as the chemicals have not been assessed within the last six years (Cardigan Bay South). This waterbody overlaps with 7% of subtidal reefs.	Fail	Medium
		• One WFD waterbody has a pass for chemicals, however the chemical classifications were rolled forward from the 2018 cycle 2 interim classification (Teifi Estuary). This waterbody overlaps with 1% of subtidal reefs.		
		• The WFD other waterbody has a fail for chemicals in the 2024 cycle 3 interim classification (Cardigan Bay Central). This waterbody failed for mercury and PBDE and overlaps with 17% of subtidal reefs.		
		• Confidence is medium as the human health standard has been used for PBDE, and due to unclassified waterbodies or rolled forward classifications.		
Water quality: turbidity	Maintain expected levels of turbidity, allowing for natural change and variation. (S)	• There are limited data on turbidity for the reefs feature in the Cardigan Bay SAC, therefore this target was assessed as unknown.	Unknown	N/A
Invasive non- native species (INNS)	Spread and impact of INNS caused by human activities should not adversely	 There is limited evidence to suggest that INNS (e.g. Sargassum muticum) are currently impacting the condition of subtidal reefs in the SAC. Confidence is low as the spread and impacts of the INNS 	Pass	Low
	the feature. (P)	present within the feature are not well understood.		

Indicators	Target	Assessment rationale	Target assessment	Target confidence
Non-native species (INNS)	No increase in the number of introduced NNS by human activities. (T)	 No new NNS were identified within the last six years within the reefs feature of Cardigan Bay SAC. <i>S. muticum</i> has been previously identify in low abundance in the SAC. Confidence is low as there have been no targeted INNS surveys in the SAC. 	Pass	Low

Assessment conclusions

The reefs feature in Cardigan Bay SAC has been assessed as being in **unfavourable** condition (low confidence). There were two failing targets, which were both related to water quality in specific parts of the SAC (Table 8). There were no failures of primary targets. There were limited or no data available for several key indicators to inform on the condition of the feature, especially for subtidal reefs (see <u>evidence gaps</u>). This has contributed to the reduced confidence in the overall conclusion to low. 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 nutrients failure was localised, it has been mapped to help focus management effort (Figure 5). A summary of the assessment can be seen in Table 8 with more detail on each performance indicator, and any reasons for failure, provided in the sections below.

Table 8. Summary of the condition assessment for reefs in Cardigan Bay SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

Feature	Overall Condition Assessment	Indicator failures	Reason for indicator failure	Threats to condition
Reefs	Unfavourable (low confidence)	Water quality: nutrients (DIN only) (S) Water quality: contaminants (S)	 High nutrient levels have been recorded in the Teifi Estuary waterbody. This failure is relevant to intertidal reefs only. Levels of mercury and PBDE in the Cardigan Bay Central waterbody are failing to meet their relevant EQSs. 	 Unconsented infrastructure INNS Water quality: contaminants Management of coastal defences Climate change



Figure 5. Map of the localised failure in the intertidal reefs in Cardigan Bay SAC.

Detailed assessment information

Extent and distribution

The extent, distribution of the feature, and the distribution and extent of habitats and communities indicators in the Cardigan Bay SAC passed their targets as there are currently no known anthropogenic impacts that would negatively affect the reefs feature. This applies to both intertidal and subtidal reefs. Mapping has not been used to assess the extent and expert judgment was used to assess these indicators in the absence of recent data. This has reduced the confidence to medium.

Sediment and topography

The sediment quality indicators are relevant to subtidal reefs only. There were no data available on sediment quality within the SAC therefore these indicators were not assessed.

The topography, bathymetry, hydrodynamic and sediment transport processes are not well researched for reefs. 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 intertidal and subtidal reefs. Photo monitoring at New Quay confirms no excessive shell fishery waste in the intertidal.

Water quality

It has been estimated that approximately 79% of intertidal reefs and 25% of subtidal reefs within the SAC falls within three WFD waterbodies. These are therefore likely to be a good reflection of the overall effect of water quality on the feature. The Cardigan Central waterbody overlaps with a large proportion of intertidal and subtidal reefs in the SAC (Table 9). The Cardigan Bay South and Teifi Estuary waterbodies overlap with a smaller proportion of intertidal and subtidal reefs (Table 9).

WFD waterbody	Degree of overlap with intertidal reefs (%)	Degree of overlap with subtidal reefs (%)
Cardigan Bay Central	56.10	17.40
Cardigan Bay South	13.60	6.70
Teifi Estuary	8.70	1.00
All waterbodies combined	78.4	25.1

Table 9. WFD waterbodies that overlap with intertidal and subtidal reefs within the Cardigan Bay SAC.

Nutrients (Dissolved Inorganic Nitrogen - DIN only), phytoplankton and opportunistic macroalgae

The nutrients indicator failed to meet its target for intertidal reefs as one of the overlapping WFD waterbodies, the Teifi Estuary, was classified as Poor status for the DIN element in the 2024 cycle 3 interim classification. The Teifi Estuary WFD investigation report confirms Page **47** of **122**

the continued failure in DIN (Jopson, Newman and Moore, 2025). This waterbody overlaps with a small proportion of intertidal reefs (Table 9), therefore the confidence in the fail was low. This waterbody overlaps with a very small proportion of subtidal reefs (Table 9), therefore this indicator did not fail for subtidal reefs, but confidence in the pass was low. The other two WFD waterbodies (Cardigan Bay Central and Cardigan Bay South), were classified with a High status for DIN.

The phytoplankton indicator met its target as two WFD waterbodies which combined overlap with 65% of intertidal reefs and 18% of subtidal reefs, were classified with a High status for this element in the 2024 cycle 3 interim classification. The classification for one of these waterbodies, the Teifi Estuary waterbody, was rolled forward from the 2021 cycle 3 classification. This waterbody overlaps with 9% of intertidal reefs and 1% of subtidal reefs. The WFD investigation report for this waterbody states that the phytoplankton WFD element for the 2018 cycle 2 interim and 2021 cycle 3 classifications were not a true representation of the phytoplankton in the Teifi Estuary waterbody, but were instead more representative of the Cardigan Bay South waterbody (Jopson, Newman and Moore, 2025). The confidence in the pass was reduced to low for intertidal reefs to reflect this, and because one WFD waterbody was not classified for this element. For subtidal reefs, confidence is medium due to the unclassified waterbody. Classification of some WFD waterbodies are not suitable or possible for this element due to WFD classification methodology, or due to the nature of the waterbodies (e.g. turbidity levels).

The opportunistic macroalgae indicator met the target as one of the three overlapping WFD waterbodies, the Teifi Estuary, was classified with a Good status for opportunistic macroalgae in the 2024 cycle 3 interim classification. This waterbody overlaps with 9% of intertidal reefs. The confidence of this classification was uncertain due to outdated available intertidal habitat layers (Jopson, Newman and Moore, 2025). It was therefore concluded that it is possible that a biological response of high nutrient levels has occurred as a result of excess DIN, but it has not been identified through the classification (Jopson, Newman and Moore, 2025). This reduced the confidence in the pass. The other two WFD waterbodies were not classified for the opportunistic macroalgae element in the 2024 cycle 3 interim classification. Some WFD waterbodies are not assessed for opportunistic macroalgae as they don't have suitable substratum (i.e. areas of intertidal habitat for opportunistic macroalgal growth). The confidence is low as a large proportion of intertidal reefs are in unclassified waterbodies, and due to the uncertainty in the Teifi Estuary waterbody classification. This indicator is not relevant to subtidal reefs.

Dissolved oxygen

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

Contaminants

The Cardigan Bay Central waterbody has a fail for chemicals in the 2024 cycle 3 interim classification, where mercury and PBDE failed. This waterbody overlaps with the largest proportion of both intertidal and subtidal reefs. This caused the contaminants indicator to fail in both intertidal and subtidal reefs. 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 reefs are not fully understood.

One WFD waterbody was not classified as the chemicals have not been assessed within the last six years. One WFD waterbody has a pass for chemicals, however the chemical classifications were rolled forward from the 2018 cycle 2 interim classification. Combined, these waterbodies overlap with 22% of intertidal reefs and 8% of subtidal reefs. Overall, the confidence in the failure was reduced to medium to reflect that the PBDE failure uses a protection goal which may be over precautionary, and due to the unclassified waterbody and rolled forward classification. In addition, the impact of the failing contaminants on the feature are not fully understood.

Turbidity and physicochemical properties

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

Species and communities

All species and communities indicators could not be assessed for subtidal reefs in the SAC as there is an absence of data.

Assessment of the species community indicators for intertidal reefs in Cardigan Bay SAC used data from various monitoring sites. This includes monitoring of the rockpools at Aberporth and Cei Bach, the *Sabellaria alveolata* reefs at Aberporth and Cei Bach and the turf algae communities at Aberporth from 2007 to 2022.

Species composition analysis indicated that communities associated with rockpools at Aberporth and Cei Bach varied across the monitoring period in a cyclical manner. Rockpool species are known to fluctuate, and since there are no anthropogenic activities known to date that could impact the reef, the variations observed were deemed to be natural. Analysis also showed that whilst communities associated with turf algae at Aberporth were extremely variable, this was considered within the bounds of natural variation.

The cover of *S. alveolata* has fluctuated substantially across the monitoring period, with a noticeable low percentage cover in 2022 (Moore, 2022a). The cover of live *S. alveolata* has been relatively low since 2017 especially at Cei Bach site, however this reestablished in 2023 and 2024. *S. alveolata* cover tends to fluctuate greatly at these sites, with no known reason for the intermittent decline. The distribution of *S. alveolata* reef was

assessed by using extent information measured by GPS tracking along the *S. alveolata* reef edge. There was evidence of small changes across the monitoring period with no apparent trend (Moore, 2022a). A gradual progressive change over the course of the monitoring programme was observed for the *S. alveolata* reef communities at Aberaeron and Cei Bach sites and this appeared to be due to small changes in multiple species. These notable changes and trends are considered natural (Moore, 2022a). There was a notable increase in the abundance of green algae (primarily *Ulva spp.*) since 2011 at Cei Bach site (Moore, 2022a). *Ulva* spp. have the capacity to rapidly expand and can smother the reefs.

Mytilus edulis abundance was recorded at one location at the Aberporth rockpools between 2007 and 2022. *M. edulis* abundance varied through time, with an increase in abundance to up to 50% cover in 2022 in some places following a low percentage cover observed in 2021 (Moore, 2022b; P. Brazier, pers. comm). Such variations are often observed in *M. edulis* and form part of a natural cycle where fast recovery are often observed after storm events (P. Brazier, pers. comm). The abundance of *Fucus serratus* has been recorded in Aberporth rockpools and in *S. alveolata* reefs at Cei Bach and Aberaeron sites between 2017 and 2019. *F. serratus* increased in 2017, and by 2019 was abundant in lower platform rockpools in Aberporth (Moore, 2022b). Similarly, abundance of *F. serratus* has increased at Cei Bach *S. alveolata* reef since 2015, with an increase to more than a third of quadrats (Moore, 2022a).

Overall, the abundance, distribution and species composition of communities indicator met its target. The occurrence of green algae on Cei Bach *S. alveolata* reef was not deemed to be a large enough impact to fail the target, however it reduced the confidence in the assessment to medium, and will be something to pay close attention to in the next assessment.

The average number of taxa per rockpool has fluctuated with, an overall increasing trend, especially in total number of taxa, which is possibly linked with surveyor skills improvement. There was, however, no clear temporal trend in species richness and diversity at Aberporth and Cei Bach rockpools. Similarly, no clear temporal trend was detected in species richness and diversity for the turf algae sites and *S. alveolata* reef communities. Some increase in the average number of taxa at the *S. alveolata* reef community in Aberaeron was detected but not at Cei Bach site, which is known to be less stable. In addition, the wide-scale survey on *S. alveolata* reefs did not reveal any concerns or highlight any known anthropogenic impacts. The lack of a clear temporal trend and the natural fluctuations observed in species richness and diversity resulted in the target indicator to pass with high confidence.

Invasive non-native species

There have been no new records of non-native species (NNS) in the reefs feature in Cardigan Bay SAC within the last six years. This resulted in a pass for the tertiary target of the NNS indicator. The confidence was reduced to low as there have not been any targeted surveys for INNS within the SAC.

There were two records of the American slipper limpet *Crepidula fornicata* in 2021 and 2023 from this general area, however, neither were inside the SAC boundary. A small number of records of the wireweed *Sargassum muticum* have been previously identified

within the SAC. The spread and extent of the impacts this species may have on the condition of the reef feature is currently unknown, however there is limited evidence that this NNS is adversely impacting the condition of the feature yet. 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 NNS present within the feature are not well understood.

Reasons for target failure

The assessment of the reefs feature in the Cardigan Bay SAC failed two secondary targets. This resulted in the feature to be assessed as being in **unfavourable** condition. The failures are linked with water quality only, and are limited to the Teifi Estuary waterbody for nutrients, and the coastal Cardigan Bay Central waterbody for contaminants. The failing indicators and reasons for failure, if known, are stated below.

Water quality: nutrients (DIN only)

This indicator target has a secondary weighting. High levels of DIN have been recorded in the Teifi Estuary waterbody, which was classified as Poor status for the DIN element in the 2024 cycle 3 interim classification. As this waterbody overlaps with 9% of intertidal reefs, this caused the indicator to fail. Management should be focused on the Teifi Estuary waterbody for this feature. It did not lead to a failure for subtidal reefs due to the small spatial overlap (1%). The WFD investigation report in this waterbody confirms the DIN failure (Jopson, Newman and Moore, 2025). In this report, the likely sources of the nutrients were identified from source apportionment. It found that major input of nutrients is likely to be derived from diffuse sources associated with agriculture and rural land management in the River Teifi catchment (Jopson, 2022; Jopson, Newman and Moore, 2025). Point source continuous and intermittent sewage discharge from the water industry is also likely to be a minor source of nutrients linked to the DIN failure (Jopson, 2022; Jopson, Newman and Moore, 2025). This is a localised issue that is not causing an impact on the rest of the reefs feature.

There has been no biological failure in the phytoplankton or opportunistic macroalgae elements in the Teifi Estuary waterbody. However, due to the issues with the phytoplankton and opportunistic macroalgae classifications (see further detail in <u>water quality section</u>), it is possible that a biological response of high nutrient levels has occurred as a result of excess DIN but it has not been identified through the classification (Jopson, Newman and Moore, 2025).

Water quality: contaminants

This indicator target has a secondary weighting. The Cardigan Bay Central waterbody failed due to mercury and PBDE. 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 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, a WFD investigation of the failure in the

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

Activities that go through licencing and permission process e.g. offshore wind and marine cabling, whereby the impact of the activity on the feature would be assessed have not been included. The threats to the condition of the reefs feature in the Cardigan 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

At high density, *C. fornicata* could cause an impact on the feature as it and 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). The spread and full impact of *C. fornicata* on the reefs is not fully understood.

The various other NNS recorded in the SACs pose a threat but the spread and future impacts on the reefs feature are not understood.

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

Water quality: contaminants

There is the potential for unregulated contaminants (such as PFAS) to increase. This could affect some of the biota of the reefs 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 <u>State of the UK Climate 2023 Report</u> 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). <u>Shoreline Management Plans</u> 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 (<u>Oaten et al, 2024</u>).

Climate change

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

- Sea level rise, leading to coastal squeeze and loss of extent for some SACs.
- Changes in air and sea temperature.
- Changes in ocean acidification.
- Changes to wave climate, especially storm frequency and intensity.
- Changes in species distribution.
- Potential range expansion in NNS (e.g. grey triggerfish *Balistes capriscus* and *Magallana gigas*).

Evidence gaps

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

Listed below (Table 10) are current indicators that were either assessed as unknown, not assessed, or assessed with a lower confidence. This was due to either limited data availability, outdated data, or a lack of information. Some indicators are not currently monitored but should be ideally considered in future condition assessments.

Table 10. Evidence gaps for the reefs feature in Cardigan Bay SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Assessed status	Comments
Feature extent (P); distribution of the feature (P); distribution and extent of habitats and communities (P); topography of the feature (S); bathymetry of the feature (P); hydrodynamic and sediment transport processes (P)	Medium confidence (proxy data used)	 There are currently no temporal data available to assess changes for these indicators for intertidal and subtidal reefs across all SACs, and assessment was based on expert judgment.
Distribution and extent of the naturally present reef types (P)	Not assessed	 There are currently no temporal data on reef types for this SAC.
Abundance, distribution and species composition of communities (P)	Not assessed	• There are no current data available to assess this indicator for the subtidal reefs within the SAC.
Invasive non- native species (P)	Low confidence (limited data)	• The spread and impact of the NNS currently present within the SAC on the reefs feature is not fully understood. More targeted surveys and investigation on the impact of NNS on reefs are needed.
Sediment: composition and distribution (S); availability (S); depth (S)	Not assessed	• There is no current monitoring of the sediment composition, availability and depth over reefs within all SACs.
Water quality: opportunistic macroalgae (S)	Low confidence	• Some of the WFD waterbodies that overlap with the feature in the SAC were not classified for the opportunistic macroalgae WFD element in the 2024 cycle 3 interim classification. Some WFD waterbodies are not assessed for opportunistic macroalgae as they do not have suitable substratum.

Indicator	Assessed status	Comments
Water quality: turbidity (S)	Unknown	• Turbidity is measured in WFD sampling. As this is limited to only a few samples per year it cannot be used to adequately assess the turbidity.
		 Investigation of the use of remote sensing data to assess turbidity could be carried out in the future. External data from other organisations could also be used.
Water quality: physicochemical properties (S)	Not assessed	 There were no temperature, salinity or pH loggers within the Cardigan Bay SAC. Remote sensing data on temperature, salinity and pH could be used in future.
Species richness and diversity (S)	Not assessed	• There are no current data available to assess this indicator for the subtidal reefs within the Cardigan Bay SAC.
Taxonomic spread of species (S)	Not assessed	• There are currently no data on the taxonomic distinctness for intertidal and subtidal reefs in the Cardigan Bay SAC.
Sediment quality: contaminants (T)	Not assessed	Currently, there is no sediment monitoring within the Cardigan Bay SAC.

3.3. Sea caves condition assessment

The sea caves feature in the Cardigan Bay SAC comprises a number of submerged and partially submerged sea caves (Figure 6). There is currently no NRW Habitats Regulation monitoring programme for the sea caves within the Cardigan Bay SAC, therefore some indicators could not be assessed. The summary of the assessment outcome for sea caves is provided in Table 11. The outcome and reasons for failure are discussed in more detail in the sections below.



Figure 6. Location map of the sea caves feature in the Cardigan Bay SAC.

Table 11. Condition assessment of sea caves in Cardigan Bay SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicators	Target	Assessment rationale	Target assessment	Target confidence
Extent	No significant decrease in the extent of natural reef within the SAC, allowing for natural change and variation. (P)	 There are currently no anthropogenic impacts known to be significantly affecting the extent of sea caves in the Cardigan Bay SAC. Confidence is medium as the assessment has not been based on comparison mapping of the feature and expert judgment was used. 	Pass	Medium
Distribution of the feature	Maintain distribution of intertidal reef, allowing for natural change. (P)	 There are currently no anthropogenic impacts known to be significantly affecting the distribution of sea caves in the Cardigan Bay SAC. Confidence is medium as the assessment has been based on expert judgment. 	Pass	Medium
Distribution and extent of habitats and communities	Maintain the distribution and extent of reef 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 sea caves in the Cardigan Bay SAC. Confidence was reduced as expert judgement has been used to assess this indicator in the absence of any recent data from within sea caves. 	Pass	Low
Bathymetry of the feature	Maintain bathymetry of the reef(s), allowing for natural change and variation. (P)	 There are currently no anthropogenic impacts known to significantly affect the bathymetry of the sea caves at this SAC. Confidence was reduced as expert judgement has been used to assess this indicator in the absence of any recent data from within sea caves. 	Pass	Low

Indicators	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 significantly affect the hydrodynamic and sediment transport processes of the sea caves at this SAC. Confidence is medium as expert judgement has been used to assess this indicator in the absence of recent data. 	Pass	Medium
Water quality: nutrients (DIN only)	The WFD classification achieved for winter DIN should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (T)	 Two of the three WFD waterbodies that overlap with the sea caves feature in the SAC were classified with a High status for DIN in the 2024 cycle 3 interim classification (Cardigan Bay Central and Cardigan Bay South). Combined, these waterbodies overlap with 78% of the mapped sea caves. The other WFD waterbody was classified with a Poor status for DIN (Teifi Estuary). It overlaps with 22% of the mapped sea caves. Confidence is low as a large proportion of the feature overlap with waterbodies classified as High status and as ecological relationships between DIN and sea caves are not fully understood. 	Fail	Low

Indicators	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. (T)	 One of the three WFD waterbodies was not classified for phytoplankton in the 2024 cycle 3 interim classification (Cardigan Bay South). This waterbody overlaps with 55% of mapped sea caves feature. The other two WFD waterbodies were classified with High status for phytoplankton (Cardigan Bay Central and Teifi Estuary). Combined, these waterbodies overlap with 45% of the mapped sea caves. The Teifi Estuary waterbody classification was rolled forward from the 2021 cycle 3 classification. Confidence is low due to the unclassified waterbody, rolled forward classification, and as ecological relationships between phytoplankton and reefs are not fully understood. 	Pass	Low
Water quality: dissolved oxygen	The WFD classification achieved for dissolved oxygen should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (S)	 All three WFD waterbodies that overlap with the sea caves feature were classified with a High status for dissolved oxygen in the 2024 cycle 3 interim classification. Confidence is high as sea caves are high energy environments so likely to have high oxygen levels in general. 	Pass	High

Indicators	Target	Assessment rationale	Target assessment	Target confidence
Water quality: contaminants	Water column contaminants not to exceed the EQS. (T)	 One of the three WFD waterbodies was not classified in the 2024 cycle 3 interim classification as the chemicals have not been assessed within the last six years (Cardigan Bay South). This waterbody overlaps with 55% of the mapped sea caves. One WFD waterbody has a pass for chemicals, however the chemical classifications were rolled forward from the 2018 cycle 2 interim classification (Teifi Estuary). This waterbody overlaps with 22% of the mapped sea caves. The other WFD waterbody has a fail for chemicals in the 2024 cycle 3 interim classification (Cardigan Bay Central). This waterbody failed for mercury and PBDE and overlaps with 24% of the sea caves. Confidence is low as the human health standard has been used for PBDE; some waterbodies are unclassified or had rolled forward alagaifigational and the impact of the case. 	Fail	Low
		rolled forward classifications; and the impact of these contaminants on sea caves is unknown.		
Water quality: turbidity	Maintain expected levels of turbidity, allowing for natural change and variation. (S)	 There are limited data on turbidity for the sea caves feature in Cardigan Bay SAC, therefore this target was assessed as unknown. 	Unknown	N/A

Indicators	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 information on sea cave communities has been collected for this SAC since 2000-2002. Intertidal reefs at this SAC passed for this indicator which may give an indication of how sea caves might be doing in the SAC. Intertidal reef was not used as a proxy so this indicator has been assessed as unknown. 	Unknown	N/A
Species richness and diversity	Maintain the expected richness and diversity of reef species, allowing for natural change and variation. (S)	 No information on sea cave communities has been collected for this SAC since 2000-2002. Intertidal reefs at this SAC passed for this indicator which may give an indication of how sea caves might be doing in the SAC. Intertidal reef was not used as a proxy so this indicator has been assessed as unknown. 	Unknown	N/A
Invasive non- native species (INNS)	Spread and impact of INNS caused by human activities should not adversely affect the condition of the feature. (P)	 No information on sea cave communities has been collected for this SAC since 2000-2002. There is also little information on the impact of any INNS present on the condition of sea caves. 	Unknown	N/A
Non-native species (INNS)	No increase in the number of introduced NNS by human activities. (T)	 No information on sea cave communities has been collected for this SAC since 2000-2002. 	Unknown	N/A

Assessment conclusions

The sea caves feature in Cardigan Bay SAC has been assessed as being in **unknown** condition (confidence N/A). This was due to the fact that there were very important indicators that could not be assessed as the data were over twenty years old. Two of these indicators were on species composition and species richness (see <u>evidence gaps</u>). There were two tertiary failing indicators (Table 12). A summary of the assessment can be seen in Table 12 with more detail on each performance indicator, and any reasons for failure, provided in the sections below.

For features where an unknown result is recorded a simple assessment was undertaken to see what level of risk the feature might currently be experiencing that could cause it to be in unfavourable condition, if a full assessment were possible.

This simple assessment for sea caves looked at:

- Other indicators assessed in the condition assessment e.g. extent.
- What pressures are present on the SAC or adjacent to the SAC.
- Any other relevant data e.g. other relevant condition assessments.

Seven indicators were assessed as passing in the assessment of condition for sea caves in the Cardigan Bay SAC including extent and distribution. These can be seen in Table 11. The assessment of pressures which might affect the condition of sea caves in the SAC was based on expert judgement.

The following was discussed: there are no major anthropogenic pressures on the SAC that might cause the feature to be unfavourable. However, there were concerns about the accumulation of marine litter, especially in south-west facing caves, but due to the lack of sea cave surveys the scale of this could not be verified. There were also concerns expressed about the eroding coastline in this SAC. The condition assessment results for intertidal reefs feature at the same SAC was also discussed. On the balance of knowledge of anthropogenic activities in the area and the fact that intertidal reefs in the same SAC passed their species and communities targets it was decided that the sea caves on this SAC were unlikely to be in unfavourable condition.

The sea caves were assessed as being at low likelihood of being in unfavourable condition. The risk assessment was based solely on expert judgment so the confidence was judged to be low (Table 12).

Table 12. Summary of the condition assessment for sea caves in Cardigan Bay SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

Feature	Overall Condition Assessment	Likelihood of unfavourable condition	Indicator failures	Reason for indicator failure	Threats to condition
Sea caves	Unknown (confidence not applicable)	Low (low confidence)	Water quality: nutrients (DIN only) (T) Water quality: contaminants (T)	 High nutrient levels have been recorded in the Teifi Estuary waterbody. Levels of mercury and PBDE in the Cardigan Bay Central waterbody are failing to meet their relevant EQSs. 	 Marine Litter INNS Recreation Climate change Management of coastal defences

Detailed assessment information

Extent and distribution

The extent, distribution of the feature, and the distribution and extent of habitats and communities indicators in the Cardigan Bay SAC passed their targets as there are currently no known anthropogenic impacts that would negatively affect the sea caves feature. It should be noted that not all sea caves in this SAC have been mapped. Comparison mapping has not been used to assess the extent and expert judgment was used to assess these indicators in the absence of recent data. This has reduced the confidence to medium.

Bathymetry and hydrodynamic processes

The bathymetry and hydrodynamic and sediment transport processes are not well researched for sea caves. 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 sea caves within this SAC.

Water quality

The assessment has considered the sea caves which have been mapped within the SAC however there may be a large number of sea caves which have not been mapped. This affects the WFD waterbodies which have been included, and the proportion of sea caves within those waterbodies, and therefore lowers the confidence in the water quality assessment for this feature. For the mapped sea caves, it has been estimated that all of them fall within three WFD waterbodies where 55% overlap with the Cardigan Bay South waterbody, 24% with the Cardigan Bay Central waterbody and 22% with the Teifi Estuary waterbody.

Nutrients (DIN only) and phytoplankton

The nutrients indicator failed to meet its target as one of the overlapping WFD waterbodies, the Teifi Estuary, was classified as Poor status for the DIN element in the 2024 cycle 3 interim classification. The draft WFD investigation report for the Teifi Estuary waterbody confirms that the waterbody is at least Moderate or worse status for DIN (Jopson et al., in draft). This waterbody overlaps with approximately 22% of the mapped sea caves. The other two WFD waterbodies, Cardigan Bay Central and Cardigan Bay South, were classified with a High status for DIN. The confidence in the pass was reduced to low as a large proportion of the feature overlap with waterbodies that were classified with a High status for DIN and as the relationship between DIN and sea caves is poorly understood.

There are limited direct impacts of high nutrients in sea caves as they are largely dark environments with limited opportunities for plant growth. There is, however, some potential from indirect effects of increased nutrients. If there is algal growth in waters close to the sea cave environments, this may enter caves and start to decay, resulting in debris collecting in the caves. As the sea caves have not been surveyed, it is unknown whether this is occurring or has occurred. The phytoplankton indicator met its target as two of the overlapping WFD waterbodies were classified with a High status for this element in the 2024 cycle 3 interim classification. These are the Cardigan Bay Central and Teifi Estuary waterbodies, which combined overlap with 45% of the mapped sea caves. The confidence in the pass was low because one waterbody was not classified for this element, and because the High classification in the Teifi Estuary waterbody was rolled forward from the 2021 cycle 3 classification. Classification of some WFD waterbodies are not suitable or possible for this element due to WFD classification methodology, or due to the nature of the waterbodies (e.g. turbidity levels). In addition, the ecological relationships between phytoplankton and the sea caves feature across all SACs are not fully understood.

Dissolved oxygen

The dissolved oxygen indicator also met its target as all of the relevant WFD waterbodies were classified with a High status for the dissolved oxygen element in the 2024 cycle 3 interim classification. Confidence in the pass was high as sea caves are high energy environments so likely to have high oxygen levels in general.

Contaminants

The Cardigan Bay Central waterbody has a fail for chemicals in the 2024 cycle 3 interim classification, where mercury and PBDE failed. This waterbody overlaps with 24% of the mapped sea caves. This 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 sea caves are not fully understood. One WFD waterbody, Cardigan Bay South, was not classified as the chemicals have not been assessed within the last six years. One WFD waterbody, Teifi Estuary, has a pass for chemicals, however the chemical classifications were rolled forward from the 2018 cycle 2 interim classification. Combined, these waterbodies overlap with 77% of the mapped sea caves. Overall, the confidence in the failure was reduced to low to reflect that the PBDE failure uses a protection goal which may be over precautionary and due to the unclassified waterbody and rolled forward classification. 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

No information on sea cave communities has been collected for this SAC since 2000-2002. Stable boulders and bedrock on the lower shore portions of the cave floors in the Cardigan area were colonised by *Sabellaria alveolata*. Although not found in the large hummocks of honeycomb-like tubes found on the open coast in this area, the fresh growth of tubes in several of the caves reflected the turbid and sand-scoured conditions not found in caves in the other SACs in Wales (Bunker and Holt, 2003).

Above the low water mark deep inside the caves the walls support little other than biotic films grazed by small molluscs such as *Otina ovata* and small *Patella vulgaris*. This apparently barren zone of bedrock continues along the walls out towards the entrance of the caves just above the mobile boulder floor. Spirorbid worms and barnacles with patchy thin crusts of sponge including *Halichondria panicea*, *Myxilla incrustans* and other yellow encrusting sponge species and sparse anemones *Actinia equina* cover the less scoured intertidal parts of the cave walls towards the backs of the caves. Barnacles, anemones and limpets are more common towards the cave entrance (Bunker and Holt, 2003).

Where cave walls have a lower shore and shallow subtidal section, for example in caves on the south-west side of Cardigan Island and the east side of Cemaes Head, the seasquirt *Dendrodoa grossularia is* occasionally found at high densities, mixed with smaller patches of the white lace sponge *Clathrina coriacea* – both highly characteristic of wavesurge conditions. The most species-rich sections of the cave on the south-west side of Cardigan Island occurred just below chart datum between 10 and 30 m back into the cave. Patches of bright yellow sponge *Aplysilla sulfurea* and red *A. rosea* and *Ophlitaspongia seriata* are found on the walls, interspersed with colonial ascidians *Botrylloides leachii* and encrusting bryozoans such as *Flustrellidra hispida*. Towards the entrance of the cave, these short faunal turfs become more species-rich with other hydroids, ascidians and bryozoans (Bunker and Holt, 2003).

Intertidal reefs at this SAC passed for this indicator which may give an indication of how sea caves might be doing in the SAC. However, intertidal reef was not used as a proxy so this indicator has been assessed as unknown.

Invasive non-native species

There is no information available on the establishment or impact of non-native species (NNS) in sea caves in this SAC as there have been no surveys within the sea caves since 2000-2002. For this reason the INNS and NNS targets were assessed an unknown. It is not fully understood how any NNS present in the SAC could impact the sea cave biota and any potential effects on the species diversity and composition are unknown.

Reasons for target failure

The assessment of the sea caves feature in Cardigan Bay SAC failed two tertiary targets. There were also five targets that were assessed as unknown. Overall the feature was assessed to be in unknown condition. The failing indicators and reasons for failure, if known, are stated below.

Water quality: nutrients (DIN only)

This indicator target has a tertiary weighting. High levels of DIN have been recorded in the Teifi Estuary waterbody, which was classified as Poor status for the DIN element in the 2024 cycle 3 interim classification. As this waterbody overlaps with 22% of the sea caves, this caused the indicator to fail. A WFD investigation of the nutrient failure in this waterbody is currently underway, but the draft report confirms the DIN failure (Jopson, et al., in draft). In this draft report it is concluded that major input of nutrients is likely to be derived from diffuse sources associated with agriculture and rural land management (Jopson, 2022; Jopson et al., in draft). Point source continuous and intermittent sewage

discharge from the water industry is also likely to be a minor source of nutrients linked to the DIN failure (Jopson, 2022; Jopson et al., in draft).

There has been no biological failure in the phytoplankton or opportunistic macroalgae elements, however sampling for these elements in the Teifi Estuary waterbody was suspended in earlier years. There is some evidence of phytoplankton blooms which may indicate a localised issue in the estuary. It is possible that the lack of biological response observed could be due to dilution of water. The sources likely to be responsible for increased nutrient loading have been identified from source apportionment. A significant contribution of nitrogen loading is from diffuse sources in the catchment. In addition, a major source of the loading is likely from landward sources which is suggestive that the nutrient input may be from freshwater inputs. There may also be minor point-source inputs from continuous and intermittent sewage discharges from the water industry, and from unsewered domestic discharges by the general public.

Water quality: contaminants

This indicator target has a tertiary weighting. The Cardigan Bay Central waterbody failed due to mercury and PBDE. 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 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, a WFD investigation of the failure in the Cardigan Bay Central 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 sea caves. A threat is defined as an activity that is currently not impacting condition but has the potential to do so over the next reporting cycle, if activity levels increase or are unmanaged. It is important to identify these threats to be able to put pre-emptive management in place to prevent declines in condition.

Activities that go through licencing and permission process e.g. offshore wind and marine cabling, whereby the impact of the activity on the feature would be assessed have not been included. The threats to the sea caves feature condition in the Cardigan Bay SAC are stated below.

Recreational access and collection

Access for recreational activities particularly coasteering can have a trampling effect on intertidal sea caves. This could have detrimental impact on the sea cave communities.

Invasive non-native species

Invasive non-native species are a threat to most of the features in the Welsh SACs. The impact of INNS on the sea caves feature is not well understood, and as they are mostly shady environments many of the invasive seaweeds are unlikely to be an issue.

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. The SACs could be at risk since there are a number of possible pathways of introduction. Further information on introduction pathways can be found on the <u>GB non-native species secretariat website</u>.

Management of coastal defences

The <u>State of the UK Climate 2023 Report</u> 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). <u>Shoreline Management Plans</u> 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.

Climate change

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

- Sea level rise, leading to coastal squeeze and loss of extent for some SACs.
- Changes in air and sea temperature,
- Changes in ocean acidification,
- Changes to wave climate, especially storm frequency and intensity.

Marine litter

Caves especially south-west facing caves are known to accumulate marine litter. This litter can breakdown and cause smothering and leaching effects on sea cave communities. The scale of the issue in the SAC is unknown but is definitely a threat.

Evidence gaps

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

Listed below (Table 13) are current indicators that were either assessed as unknown, not assessed, or assessed with a lower confidence. This was due to either limited data availability, outdated data, or a lack of information. Some indicators are not currently monitored but should be ideally considered in future condition assessments.

Table 13. Evidence gaps for sea caves in Cardigan Bay SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Assessed status	Comments
Distribution and extent of habitats and communities (P)	Low confidence (proxy data used)	• There are currently no data available to assess changes for this indicator from within sea caves across all SACs. Assessment was based on expert judgment.
Abundance, distribution and species composition of communities (P); species richness and diversity (P)	Unknown	There are no current data available to assess this indicator for sea caves across all SACs.
Invasive non- native species (P); Non-native species (T)	Unknown	 Investigations into the impact of the recorded NNS on sea caves is required. There have been no targeted surveys for NNS in sea caves across all SACs.
Water quality: turbidity (S)	Unknown	 Turbidity is measured in WFD sampling, but this is limited to only a few samples per year. Therefore, this cannot be used to adequately assess the turbidity. Investigation of the use of remote sensing data to assess turbidity could be carried out in the
		future. External data from other organisations could also be used.
Water quality: physicochemical	Not assessed	 There were no temperature, salinity or pH loggers within the Cardigan Bay SAC.
properties (S)		 Remote sensing data on temperature, salinity and pH could be used in future.

3.4. Grey seal condition assessment

The grey seal *Halichoerus grypus* population in Cardigan Bay SAC has no active monitoring so the assessment has been carried out using information from surrounding SACs as proxy data. A summary of the condition assessment for grey seal in the Cardigan Bay SAC can be seen in Table 14. Due to the lack of monitoring in Cardigan Bay SAC the indicator 'colony pup production' could not be assessed. The overall feature condition, a detailed summary of the assessment and threats to condition can be found in the assessment conclusions.

Table 14. Condition assessment of grey seal in Cardigan 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
Seal population size relevant to	The wider seal population relevant to the SAC is stable or increasing. (P)	The population relevant to the SAC encompasses all of Wales and the wider Irish and Celtic seas.	Pass	Medium
the SAC		 A census of grey seals in south-west Britain (including the entire coast of Wales) was done via aerial survey in August 2023. 		
		• The population of grey seals in Wales was estimated to be 5,284 seals at the time of the survey. This is a minimum estimate due to cryptic haul outs (e.g. caves).		
		 Pup production models estimate the adult (1 year +) population of Wales to be approximately 5,300. 		
		 The population relevant to the SAC was judged to be doing well and assumed to be increasing. 		
		• Confidence is medium as updated methods and survey areas in the latest aerial survey make comparisons to previous surveys difficult. The lack of systematic monitoring of seals at the all-Wales scale also lowered the confidence.		

Indicator	Target	Assessment rationale	Target assessment	Target confidence
SAC pup production	A stable or increasing pup production within the SAC that continues to support the population, allowing for natural change and variation. (S)	 While there are no recent pup production data for the SAC there is proxy information available to assess this indicator, the increasing pup production trends in the SACs to the north and south, the UK wide increasing population, no knowledge of impacts to seals in the SAC. The use of expert judgement along with the proxy data mean it can be concluded that the same pattern of increasing pup production seen in Pembrokeshire Marine SAC and Pen Llyn a'r Sarnau SAC is likely to be occurring in Cardigan Bay SAC. Confidence is low due to the use of proxy data, expert judgement and lack of pupping data from seals inside the SAC. 	Pass	Low
Distribution of grey seal pupping sites within the SAC	The distribution and extent of pupping sites in the SAC is stable or increasing and continues to support pupping, allowing for natural change and variation. (P)	 There is no seal monitoring in Cardigan Bay SAC. However, given the increasing pup production trends and increase of pupping seen in the other neighbouring SACs it is assumed Cardigan Bay is following the same pattern. There is currently no evidence of activities occurring that would constrain seal pupping. Confidence in the pass is low as there is no monitoring of seals in the SAC. Expert judgement and proxy data have been used. 	Pass	Low

Indicator	Target	Assessment rationale	Target assessment	Target confidence	
Accessibility to habitat used by seals	No evidence of significant constraints on grey seal access to habitat within or associated with the	• There is currently no knowledge of 'barriers' that would be a concern.	Pass	Low	
		 Seal numbers are thought to have remained stable or increased across the SAC, based on proxy information from neighbouring SACs. 			
	SAC. (F)	 This suggests no significant constraints on seals' access to habitat required to support them. 			
		 Confidence is low as there is no monitoring of seals in the SAC and proxy data had to be used. 			
Anthropogenic disturbance	No significant anthropogenic disturbance affecting the grey seal population associated with the SAC. (P)	 There is currently no evidence of anthropogenic disturbance likely to be impacting the seal population associated with the SAC. 	Pass	Low	
		• The confidence in the pass is low as there is no activity monitoring in the SAC and numbers in the SAC are based on proxy data and a single aerial survey.			
Prey availability	Maintain the quality, abundance and diversity of prey species needed to support the grey seal population. (S)	• There is no reason to believe grey seals are prey limited, or prey availability is limiting the grey seal population, or there has been a reduction in diversity of available prey species.	Pass	Medium	
		• Grey seal population is expanding in Wales which strongly suggests prey is abundant enough to support the population.			
		 Confidence in the pass is medium as the assessment is based on proxy data (seal numbers and fisheries data). 			
Indicator	Target	Assessment rationale	Target assessment	Target confidence	
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Water, sediment and prey contaminants	Ensure water, sediment and prey contaminants are at levels not detrimental	• One of the three WFD waterbodies within the SAC was not classified in the 2024 cycle 3 interim classification as the chemicals have not been assessed within the last six years (Cardigan Bay South).	Pass	Low	
	to the grey seal population. (S)	 One WFD waterbody has a pass for chemicals, however the chemical classifications were rolled forward from the 2018 cycle 2 interim classification (Teifi Estuary). 			
		•	 The other WFD waterbody has a fail for chemicals in the 2024 cycle 3 interim classification (Cardigan Bay Central). This waterbody failed for mercury and PBDE. 		
		 OSPAR report mercury and lead are above ecological guidelines in the North East Atlantic region, as is one congener of PCB. 			
		 OSPAR report the PCB range in 2010-2020 was lower than the 1980s but still above marine mammal toxicity thresholds. 			
		• A study of marine mammals from around the UK found grey seals had the lowest mean concentrations of persistent organic pollutants of all 11 species studied, with only 17% above toxicity thresholds. However, the sample size was small.			
		• Contaminants are deemed not to be having a detrimental impact on seals at present, but confidence is low due to lack of sampling in seals and lack of understanding of the impact contaminants have at the population level.			

Assessment conclusions

The condition of the grey seal feature in the Cardigan Bay SAC has been assessed as being in **favourable condition** (low confidence). All performance indicators met their targets (Table 15). The wider population and pup production data in adjacent SACs to the north and south suggest grey seal numbers have been increasing in recent years. There is no evidence to suggest this is not the case in Cardigan Bay. While contaminants are present they are not thought to be impacting grey seals at a population level at present. There is significant bycatch of grey seals in net fisheries in the Celtic Seas of the south-west UK and Ireland (SCOS 2022; Taylor et al., 2022). While seal bycatch is likely to be minimal inside Cardigan Bay SAC, bycatch outside of the SAC affects the wider population, of which the SAC is part. For further information see the <u>threats</u> section.

 Table 15.
 Summary of the condition assessment for grey seal in the Cardigan Bay SAC.

Feature	Overall Condition Assessment	Indicator failures	Reason for indicator failure	Threats to condition
Grey seal Halichoerus grypus	Favourable (low confidence)	None	None	DisturbanceContaminantsFisheries bycatch

Detailed assessment information

Grey seal population

Based on pup production, it is estimated that approximately 3-4% of the UK's grey seal population resides in Wales (SCOS, 2022). An estimated 2,250 pups are born per year in Wales (Russell and Morris, 2020). However, there is uncertainty around this estimate given the age and sporadic nature of most of its underlying data (e.g. Baines et al., 1995; Westcott 2002; Westcott and Stringell 2003). Pup production at regularly monitored sites in Wales has increased markedly since monitoring began (Bull et al., 2017; Morgan et al., 2018; Strong et al., 2015; Robinson et al., 2023).

While grey seals show fidelity to their chosen breeding sites (Pomeroy et al., 2000; Langley et al., 2020), they have been shown to range widely within Wales, southwest England, and Ireland as demonstrated by satellite tracking studies (SCOS, 2013; Thompson, 2011; Russell et al., 2017) and photographic identification (photo ID) (Langley et al., 2020; Pomeroy, et al., 2014; 2015). Females have been shown to range between Skomer in the south and Bardsey in the north within the 8–10-week breeding season. This suggests some females are moving away from breeding sites after pups are reared (approx. 20 days), or that non-breeding females are coming in and out of the breeding areas from around Wales (Langley et al., 2020).

Outside of the breeding season, satellite telemetry has shown that animals (weaned pups/yearlings and adults) also move large distances and seals tagged in Wales have been tracked hauling out around the Irish and Celtic Seas (see Carter et al., 2022 for synopsis).

For these reasons, the population of seals relevant to the Cardigan Bay SAC can be said to be part of the wider seal population inhabiting the UK, particularly within the Irish and Celtic Seas region. Within this area there are several Seal Monitoring Units (SMUs) (SCOS, 2022), of which SMU 12 is the whole of Wales.

An aerial survey in August 2023 counted 1,313 grey seals across Wales. As approximately only 25% of the population are hauled out and visible at any one time, this equates to a population estimate of around 5,284 individuals (95% confidence intervals 4571- 6195) (Thompson, in prep). This represents a minimum estimate due to the use of cryptic haul outs not visible to aerial photography e.g. in caves (Stringell et al., 2014). Ground counts of some haul out sites taken at the same time as aerial surveys, were higher than aerial counts, suggesting a further 10% could also be added to the estimate (Thompson, in prep).

The aerial survey estimated a 64% increase in the number of hauled-out seals, based on the difference since the last summer composite estimate of 800 hauled-out seals that represented data from 2002-2020 (Thompson, in prep). This increase is likely due to more extensive coverage of mainland and offshore island sites in the aerial survey which were not included in the previous estimate (probably a large under estimation) and the apparent increase in numbers of hauled-out seals at previously included sites (Thompson, in prep). Seals hauled-out at cryptic coastal sites, e.g. caves and overhanging cliffs, however, were not counted by the aerial survey and represent an unknown but possibly large bias. Due to the differences in the way these estimates were produced it is hard to tell how large the

increase has been with certainty. The fact that a similar 65% increase is estimated at directly comparable North Wales sites from surveys in August 2002, supports the suggestion of a population increase in Wales (Thompson, in prep).

Pup production is typically used to estimate the size of the overall population (Russell et al., 2019; Thomas et al., 2019). The most recent Welsh pup production estimate, based on pup production between 2016-2019 from sites across Wales, is 2,250 pups (Russell and Morris, 2020). This pup production estimate is used to give an estimate of total population size (1+ year old). Pup production is multiplied by a scaling factor of 2.31, which represents a ratio of pups to adults from systematically monitored pup colonies in Scotland and east England. Based on pup production, the Welsh population is estimated to be approximately 5,200, which is, perhaps coincidentally, very close to the total population estimated from hauled-out seals in summer (Thompson, in prep).

The population of grey seals relevant to the SAC was judged to be doing well and assumed to be increasing, meeting the indicator target. The confidence in the pass was reduced to medium, however, to reflect the caveats on the aerial survey results, the conservative estimates of pup production and the fact that comparisons between the latest aerial survey of summer population and previous ground-based survey results are challenging and potentially unreliable. This makes it harder to say with certainty that the estimated increase is a true increase, but our judgement is that an increase has occurred.

Pup production and distribution

Due to the lack of monitoring in Cardigan Bay SAC the indicator 'colony pup production' could not be assessed. While there are certainly established breeding sites in Cardigan Bay there is no recent information on the pup production at these sites.

The monitored colonies in Pembrokeshire Marine and Pen Llŷn a'r Sarnau SACs have continued to do well since 2005 and have seen a continued upward trend in pup production. There has also been a trend across the UK for increases in the grey seal populations in most regions. The seal population in the UK has increased steadily since the 1960s, though this increase is now slowing (1.4% per year over the last survey interval) (SCOS, 2022). There is also no evidence on activities occurring that would impact seal pupping in the SAC.

For these reasons, it is assumed that pup production across Cardigan Bay SAC is likely to have followed the same pattern as Pembrokeshire Marine and Pen Llŷn a'r Sarnau SACs and is stable or increasing. Confidence in this pass is low as the indicator assessment is based on proxy data and expert judgement.

The distribution of breeding across the SAC can reflect factors impacting on seals, both positive and negative. Monitoring seal pupping distribution can identify areas that are important to breeding seals (JNCC, 2005). These areas can then be managed for anthropogenic impacts. If the distribution of breeding seals changed across the SAC it could be indicative of disturbance or reduction in habitat quality. While there is no monitoring of seals in the SAC, we can look to what is happening in the SACs to the north and south. Pembrokeshire Marine was assessed as having increased pupping distribution in some areas with stable pupping distribution in Skomer MCZ. The North Wales region, which includes the Pen Llŷn a'r Sarnau SAC, has seen an increase of 145% in pupping

sites between 2004 to 2017, though some of this increase may be attributed to increased survey effort (Robinson et al., 2023).

As there is no evidence of activities currently occurring that would impact seal distribution, it is assumed Cardigan Bay is following the same pattern as the other two SACs and distribution is at least stable and possibly increasing, leading to the indicator passing. Confidence in this pass, however, is low as the indicator assessment is based on proxy data and expert judgement.

Habitat accessibility and disturbance

Grey seals require suitable coastal habitat with which to haul out onto to rest after foraging, to give birth and rear their pups and to moult. In general haul out and breeding sites are undisturbed areas of rock, sandbank or beach with good access to the open sea (JNCC, 2005). In Wales, seals show a strong preference for breeding in sea caves (Baines et al., 1995; Stringell et al., 2014). Seals also require suitable foraging habitat that supports sufficient prey to maintain the population. There is a lack of understanding of the availability of suitable habitat in Cardigan Bay SAC. However, the number of grey seals and number of pupping sites in the sites adjacent to the SAC have been increasing (Robinson et al., 2023). Further to this, the wider population is assumed stable or increasing (SCOS, 2022), and there is no evidence of constraints to their movements. For these reasons, it is assumed that grey seals have access to the habitats needed to support them and the indicator passed with low confidence. Confidence was lowered due to the use of proxy data since there is no regular seal monitoring in the SAC.

Disturbance on land mainly comes in the form of recreational disturbance (e.g. dog walkers, kayakers, coasteering, wildlife watching boats, drones etc) or from airborne noise such as from construction, military exercises and recreation e.g. fireworks. Disturbance can lead to seals escaping into the water to avoid the perceived threat. This can stress seals and comes with an energetic cost. It is also a danger to new pups and can result in pup death through physical harm as adults flee to the water or starvation as the mother abandons the breeding site and pup altogether (SCOS, 2013). Changes in the distribution of breeding seals could be indicative of disturbance.

Disturbance to seals at sea comes largely from underwater noise associated with construction of industrial developments e.g. windfarms. There is concern that loud underwater noise can lead to hearing damage, cause animals to flee from or avoid their natural habitat, reduce foraging, and cause physiological stress (Southall et al., 2019; Hastie et al., 2015; Russell et al., 2016; Whyte et al., 2020). Behavioural changes have energetic and fitness costs and may have consequences on populations (e.g. Chudzinska et al., 2024).

It is vital that seals have unconstrained access to sufficient suitable habitat both on land and at sea. There is no evidence of significant disturbance to seals in the SAC so the indicator passed. Confidence in the pass is low due to a lack of regular seal monitoring in the SAC, no activity monitoring across the SAC and no data on disturbance of seals outside monitored colonies in the SAC.

Prey availability

Grey seals are generalist predators and their diet varies depending on their location and the time of year, taking whatever food source is locally abundant (Bowen et al., 2006; Brown et al., 2012; Hammond and Prime, 1990). A study on grey seal diet in Pembrokeshire between 1992 and 1994 found seals ate a wide range of fish species, most of which are not commercially fished, reflecting their opportunistic feeding behaviours. Gadoids and flatfish dominated seal diet (70%) over 3 years in Pembrokeshire (Strong, 1996). Similar results were seen from a more recent comprehensive study of grey seal diet in Wexford Harbour, Southeast Ireland (Gosch et al., 2019) and in small seal diet study on Skomer Island (Lofthouse, 2017). Some commercial species are potentially depleted in the Irish / Celtic Seas (cod, whiting, seabass, herring and plaice which made up 33% of seal diet by weight in the Strong (1996) Pembrokeshire study). However, other commercial species like sole remain abundant, and herring and seabass appear to be making slow recoveries following cessation or restrictions on fishing.

There is no reason to believe that prey is limited or has reduced diversity in the areas of Cardigan Bay that grey seals are using to forage, therefore the indicator passed. Confidence was medium as there is no targeted surveying of prey abundance or recent seal diet studies.

Contaminants

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

The coastal Cardigan Bay Central waterbody has a fail for chemicals in the 2024 cycle 3 interim classification, where mercury and PBDE failed. The human health protection goal that is used for PBDE may be considered as over precautionary as the effect of contaminants on grey seals are not fully understood. The EQS for mercury is based on the secondary poisoning protection goal (for wildlife), which may be more relevant to grey seals and is sampled from biota they may eat. Of the other two relevant WFD waterbodies within the SAC, one was not classified as the chemicals have not been assessed within the last six years. The other WFD waterbody has a pass for chemicals, however the chemical classifications were rolled forward from the 2018 cycle 2 interim classification.

The Convention for the Protection of the Marine Environment of the North-East Atlantic or OSPAR, assess the state of the seas in the region. The latest quality report published in 2023 states that hazardous substances are still a cause for concern across the region, including the Irish Sea. Both mercury and lead are above ecological guidelines in the North-East Atlantic region, as is the most toxic congener (CB118) of PCB when measured in sediments and biota (fish, shellfish, birds and mammals) (Larsen and Hjermann, 2022; Webster and Fryer, 2022). Overall, PCBs in 2010-2020 were lower than the 1980s, but concentrations in some areas are still at levels that may cause adverse effect to marine life (Webster and Fryer, 2022).

While concentrations of POPs in marine mammals have declined over the last 30 years a recent study found a substantial proportion of individuals across 11 species sampled around the UK had POPs above toxicity thresholds (Williams et al., 2023). It should be noted that grey seals had the lowest mean concentrations of all 11 species studied and only 17% of studied grey seals (21 individuals) were above the threshold for PCBs and DDTs (0% above PBDEs), though the sample size was very small (Williams et al., 2023).

Marine litter is also a concern for seals in the waters around Wales. Litter impacts on seals are monitored at the Skomer MCZ every year. The most obvious marine litter impacts are consistently from monofilament line and netting from fishing activity. In 2023, 29 individual seals were photographed with obvious signs of damage from entanglement with fishing nets. The most common injury is a deep scar on the neck, often with the net still embedded (Lock et al., 2024). Microplastics have also been found in seal stomachs and scat (Hernandez-Milian et al., 2019; Lofthouse, 2017). It is not clear if the microplastics are ingested directly or are present inside their prey (Lofthouse, 2019). Marine litter and microplastics are not currently having an impact on seals at population level but are a threat to future condition if they were to increase significantly.

Contaminants are still a threat to all marine mammals around Wales, not just grey seals. Despite bans and strict controls on mercury, PBDE, and PCBs, there is still a risk of historical deposits being released into the environment from sediments. However, at the time of this assessment, contaminants are not considered to be having a detrimental impact on grey seal at the population level, given the long-term increase in seal pupping in the SAC and increasing UK population. Therefore the water, sediment and prey contaminants indicator met its target. The confidence in the pass was low because there is a lack of monitoring of contaminants in grey seals and a lack of understanding around the impacts contaminants have at a population level.

Reasons for target failure

The grey seal feature in the Cardigan Bay SAC has been assessed as being in **favourable** condition as none of the targets failed.

Threats to condition

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

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

Disturbance

While there is some evidence that seals can tolerate human presence in areas close to easily accessible coast, they are still vulnerable to disturbance, especially for seals that haul out in remote places where they are less likely to encounter regular anthropogenic

activity. Increases in recreation to more remote areas via watercraft, the use of drones, noise or physical barriers from industrial development and increases in ongoing military activity in the area all have the potential to significantly disturb seals.

Contaminants

At the time of the assessment, grey seals are thought not to be adversely impacted by contaminants at the population level. However, the high levels of some contaminants within the SAC are cause for concern. While some contaminants like mercury and PBDE are being managed and it is hoped that these levels will reduce in time, there is the potential for unregulated contaminants (such as PFAS and pharmaceuticals) to potentially increase in the future. This could affect grey seals as PFAS has been shown to bioaccumulate in marine species, increasing up the trophic levels (Khan et al., 2023). Even though mercury levels are decreasing and the 2024 WFD classification passes for mercury in Milford Haven Outer waterbody, this classification was based on concentrations of mercury in mussels. Due to the bioaccumulation potential of mercury, the levels in top predators such as seals, may still be of some concern. Many contaminants have been shown to have a detrimental impact on reproductive success and can be passed to pups through their mother's milk (Hammond et al., 2005; Nyman et al., 2003; Robinson et al., 2018). Some persistent chemicals are not measured in every WFD waterbody, and some of the relevant waterbodies have not been classified for any chemicals.

Fisheries bycatch

There is significant bycatch of grey seals in net fisheries in the Celtic Seas of the southwest UK and Ireland (SCOS, 2022; Taylor et al., 2022). The estimated total annual bycatch of grey seals in the Celtic Sea Assessment Unit was 1632 in 2020 (Taylor et al., 2022). Despite this, the population of grey seals is thought to be growing and models suggest the amount of bycatch is below the threshold the population in the wider Celtic Seas can support. While seal bycatch is likely to be minimal inside the SACs, bycatch outside of the SACs affects the wider population, of which the SACs are part.

Evidence gaps

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

Listed below (Table 16) are current indicators that were either assessed as unknown, not assessed, or assessed with a lower confidence. This was due to either limited data availability, outdated data, or a lack of information. Some indicators are not currently monitored but should be ideally considered in future condition assessments.

Table 16. Evidence gaps for grey seal in Cardigan Bay SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Assessed status	Comment
Seal population size relevant to the SAC (P)	Medium confidence (proxy data in some cases)	 Regular systematic monitoring at the scale of the SAC and/or regions is needed to inform the condition assessment. Both pupping and haul out counts are needed across the region to establish whether those sites regularly monitored (e.g. Skomer) are sufficient index sites for the population. Continued funding for monitoring at key sites (e.g. Skomer) is critical to our understanding of seal status. Only a single systematic survey of hauled out seals has been conducted (in summer 2023) in Wales and should be repeated at regular intervals (e.g. 2-5 years).
Colony pup production (P)	Not assessed	This indicator was not assessed as there is no monitoring of pup production at specific colonies in Cardigan Bay.
SAC pup production (S)	Not assessed	 There is no monitoring of pup production across the Cardigan Bay SAC. Monitoring in the SAC would remove the need to use adjacent SACs as proxies and increase confidence in future assessments.
Habitat quality and function (S)	Not assessed	• There is a lack of understanding of what is quality habitat for seals and how much is sufficient to support the population using the SAC.
Anthropogenic disturbance (S)	Low confidence (limited data)	 There is a lack of information on levels of recreational activity in the SAC, their impact on seals and if codes of conduct are being followed. There is limited information on bycatch in net fisheries in Wales. Some studies are underway to estimate the likely bycatch in parts of Wales, but further work is required to provide robust estimates.
Water, sediment and prey contaminants (S)	Low confidence (limited data)	 There are very little data on the level of contaminants in grey seals. Dead seals are rarely autopsied and sampled for contaminants.

3.5. Sandbanks condition assessment

The sandbanks feature in Cardigan Bay SAC comprises a number of sandbanks (Figure 7). The NRW Habitats Regulations monitoring has focussed on one unnamed sandbank within the SAC. This sandbank has been assessed against the performance indicators and an overall condition was assigned for the feature.



Figure 7. Map of the sandbanks feature in Cardigan Bay SAC.

The summary of the assessment outcome is provided in Table 17. These outcomes and reasons of failure are discussed in more detail in the sections below.

Table 17. Condition assessment of sandbanks in Cardigan Bay SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Target	Assessment rationale		Target confidence
Extent	No significant decrease in the extent of sandbanks within the SAC, allowing for natural change and variation. (P)	 There are currently no anthropogenic impacts known to be significantly affecting the extent of sandbanks in the Cardigan Bay SAC. Confidence is medium as the assessment has not been based on comparison mapping of the feature and expert judgment was used. 	Pass	Medium
Distribution of the feature	Maintain sandbank distribution within the SAC, allowing for natural change and variation. (S)	 There are currently no anthropogenic impacts known to be significantly affecting the distribution of sandbanks in the Cardigan Bay SAC. Confidence is medium as the assessment has been based on expert judgment. 	Pass	Medium
Sediment composition and distribution	Maintain composition of sediment granulometry across the sandbanks, allowing for natural change and variation. (P)	 Granulometric analysis for the monitored sandbank showed some changes in sediment composition with mixed sediment type but this is likely to be natural. Confidence is high due to the availability of long term monitoring data and lack of concerning patterns. 	Pass	High
Topography of the feature	No significant anthropogenic impacts to the small or large scale topography of the sandbanks. (P)	 There are currently no anthropogenic impacts known to be significantly affecting the topography of sandbanks in the Cardigan Bay SAC. Confidence is medium as the assessment has been based on expert judgment. 	Pass	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Hydrodynamic and sediment transport processes	Maintain hydrodynamic and sediment transport processes, including connectivity, allowing for natural variation and change. (P)	 There are currently no anthropogenic impacts known to be significantly affecting the hydrodynamic and sediment transport processes of the sandbanks in the Cardigan Bay SAC. 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. (S)	 The sandbanks feature is offshore and does not overlap with any WFD waterbodies. The adjacent Cardigan Bay Central waterbody was used for the assessment. This waterbody was classified as High status for DIN in the 2024 cycle 3 interim classification. Confidence in the pass is medium as there is no direct overlap with the feature. 	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. (T)	 The sandbanks feature is offshore and does not overlap with any WFD waterbodies. The adjacent Cardigan Bay Central waterbody was used for the assessment. This waterbody was classified as High status for phytoplankton in the 2024 cycle 3 interim classification. Confidence in the pass is medium as there is no direct overlap with the feature. 	Pass	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. (S)	 The sandbanks feature is offshore and does not overlap with any WFD waterbodies. The adjacent Cardigan Bay Central waterbody was used for the assessment. This waterbody was classified as High status for dissolved oxygen in the 2024 cycle 3 interim classification. Confidence is low as there is no direct overlap with the feature and as samples were taken from the surface of the waterbody. 	Pass	Low
Water quality: contaminants	Water column contaminants not to exceed the EQS. (S)	 The sandbanks feature is offshore and does not overlap with any WFD waterbodies. The adjacent Cardigan Bay Central waterbody was used for the assessment. This waterbody has a fail for chemicals in the 2024 cycle 3 interim classification due to mercury and PBDE. Confidence is low as there is no direct overlap with the feature; the sandbanks are further offshore; and the human health standard has been used for PBDE. 	Fail	Low
Water quality: turbidity	Maintain expected levels of turbidity, allowing for natural change and variation. (S)	• There are limited data on turbidity for the sandbanks feature in the Cardigan Bay 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	Maintain the abundance, distribution, and diversity of species within communities and component habitats, allowing for	 The adjacent Cardigan Bay Central waterbody was classified as Good status for the Infaunal Quality Index (IQI) WFD element in the 2024 cycle 3 interim classification. 	Pass	High
		 Analysis of macrobentnic infaunal communities for the monitored sandbank showed variations across the sampling period but within limits of natural variation. 		
variation. (P)	variation. (P)	 Confidence is high due to the availability of long term monitoring data and lack of concerning patterns. 		
Species richness and	Maintain the expected richness and diversity	• Analysis of monitoring data has shown an increase of taxa and diversity in recent years.	Pass	High
diversity	of sandbank species, allowing for natural	• There was an unexplained decrease of taxa and diversity in 2014 but these recovered in subsequent years.		
	(S)	 Confidence is high due to the availability of long term monitoring data and lack of concerning patterns in the most recent years. 		
Taxonomic spread of species	Maintain the expected taxonomic spread of sandbank species, allowing for natural change and variation. (S)	 Overall, the average distinctness of infaunal community of the monitored sandbank remained stable and was within the expected values over the monitoring period. Confidence is high due to the availability of high quality. 	Pass	High
		monitoring data and lack of concerning patterns.		

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Invasive non- native species (INNS)	Spread and impact of INNS caused by human activities should not adversely affect the condition of the feature. (P)	 There is limited evidence to suggest that INNS are currently impacting the condition of sandbanks in the SAC. Confidence is medium as whilst there have been no new records of NNS in the last six years, there have been no targeted surveys of NNS and the spread and impacts of any INNS present within the feature are not well understood. 	Pass	Medium
Non-native species (NNS)	No increase in the number of introduced NNS by human activities. (T)	• There were no new NNS records across the monitored sandbank within the last six years.	Pass	Medium
		 Confidence is medium because there have been no targeted surveys of NNS on sandbanks. 		

Assessment conclusions

The sandbanks feature in Cardigan Bay SAC has been assessed as being in **favourable** condition (medium confidence). Overall, the lack of any significant anthropogenic impact on this feature in terms of extent, hydrodynamic processes, topography, sediment composition and its associated community, have contributed to this favourable assessment outcome. There was a failure for one secondary target (Table 18) and there were limited or absent data for one key indicator to inform on the condition of the feature (see <u>evidence gaps</u>). This reduced the confidence in the assessment.

A summary of the assessment can be seen in Table 18 with more detail on each performance indicator, and any reasons for failure, provided in the sections below.

Table 18. Summary of the condition assessment for sandbanks in Cardigan Bay SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

Feature	Overall Condition Assessment	Indicator failures	Reason for indicator failure	Threats to condition
Sandbanks	Favourable (medium confidence)	Water quality: contaminants (S)	 Levels of mercury and PBDE in the Cardigan Bay Central waterbody are failing to meet their relevant EQSs. 	 INNS Water quality: contaminants Climate change

Detailed assessment information

The unnamed sandbank, which is part of the sandbanks feature in the Cardigan Bay SAC, has been monitored in 2001, 2017 and 2021 using grab sampling surveys.

Extent and distribution

The indicators for extent and distribution of the sandbanks feature in Cardigan Bay SAC pass their targets as there are currently no known anthropogenic impacts that would significantly affect the sandbanks feature. However, there is a lower confidence in the accuracy of the delineation of these mapped features. During the mapping exercise, the feature was generalised (corners rounded). Along with a lack of available repeat data, these issues mean that it is not currently possible to compare extents over time in order to calculate change in extent. This has reduced the confidence in both indicators to medium. More resources are needed to accurately and regularly map sandbanks using bathymetry techniques.

Sediment, topography and hydrodynamics

The sediment composition varied over the monitoring period with mixed sediments. The macrofaunal abundance was positively correlated to the sediment composition for both sandbanks, indicating that communities are to some extent determined by sediment characteristics. There are no evidence of anthropogenic impacts that would significantly affect the sediment of these sandbanks. Scallop dredging occurs in the bay and while this activity could be modifying sediment composition, this is unlikely as the fishing vessels are not operating on sandbanks. For this reason, the changes seen in sediment composition were assessed to be natural and the sediment composition and distribution indicator therefore met its target. Confidence in the pass is high due to the availability of long term monitoring data and lack of concerning patterns or changes in sediment composition.

The topography and hydrodynamic and sediment transport processes are not well researched for sandbanks. These indicator targets were met with a medium confidence based on the knowledge that there are currently no anthropogenic activities that are known to have a significant impact on the sandbanks feature in the Cardigan Bay SAC.

Water quality

None of the WFD waterbodies intersect with the sandbanks feature within the SAC. The adjacent Cardigan Bay Central waterbody has been used for the water quality assessment, therefore it may not be a good reflection of the overall effect of water quality on feature, this was considered in the confidence of the water quality assessment. As the sandbanks within the SAC are located further offshore, they are less likely to be impacted by water quality issues derived from the land.

Nutrients (DIN only) and phytoplankton

The targets were met for the nutrients (DIN only) and phytoplankton indicators as the adjacent Cardigan Bay Central waterbody was classified with a High status for both the DIN and the phytoplankton elements in the 2024 cycle 3 interim classification. The confidences were reduced to medium as there was no direct overlap between the Cardigan Bay Central waterbody and the sandbanks feature. In addition, the ecological relationships between phytoplankton and the sandbanks feature are not well understood.

Dissolved oxygen

The dissolved oxygen indicator met its target as the adjacent Cardigan Bay Central waterbody was classified with a High status for the dissolved oxygen element in the 2024 cycle 3 interim classification. The dissolved oxygen samples were taken at the water's surface. By the time oxygen depletion at the surface is recorded, oxygen throughout the water column could have been depleted for some time, especially as hypoxia or low oxygen levels, when present, typically occur in bottom water and sediments. Therefore, surface sampling of dissolved oxygen may not detect issues for more demersal features. This, and as there is no direct overlap with the feature, reduced the confidence in the pass to low.

Contaminants

The Cardigan Bay Central waterbody has a fail for chemicals in the 2024 cycle 3 interim classification, where mercury and PBDE failed. This 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 sandbanks are not fully understood. Low confidence was attributed to the fail to reflect this. The waterbody used in the assessment does not overlap with the sandbanks feature and the sandbanks are further offshore and less likely to be impacted by water quality issues derived from the land. 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 adjacent Cardigan Bay Central waterbody was classified as Good status for the Infaunal Quality Index (IQI) element in the 2024 cycle 3 interim classification.

The sandbank complex in Cardigan Bay SAC is diverse. All species indicators met their targets based on the infaunal analysis. Natural variations in community composition were observed. There was an increase of taxa richness and diversity over time with an

unexplained decline in taxa and diversity in 2014. This was not deemed to be a concern since these recovered quickly thereafter. The average taxonomic distinctness of infaunal community remained stable and within the expected values with high number of taxa but comparatively low number of phyla. A high confidence was attributed to the pass for all species indicators due to the availability of long term monitoring data and lack of concerning patterns in recent years.

Invasive non-native species

The polychaete *Goniadella gracilis,* a low impact species, was first recorded within the sampling stations in the monitored sandbank in the Cardigan Bay SAC in 2001, and has since declined to its lowest recorded abundance in 2021. No new non-native species (NNS) were found within the last six years in the sandbanks feature, resulting in the NNS indicator to meet its tertiary target. Confidence in the pass was reduced to medium as there have been no targeted surveys of NNS on sandbanks.

It is not fully understood how this species may impact the condition of the sandbanks feature within the SAC, and effects on the species diversity and composition have not yet been observed. As there is no current impact from any INNS present the primary target of the INNS indicator passed. Confidence was reduced to medium as whilst there have been no new records of NNS in the last six years, there have been no targeted surveys of NNS, and the spread and impacts of any INNS present within the feature are not well understood.

Reasons for target failure

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

Water quality: contaminants

This indicator target has a secondary weighting. The Cardigan Bay Central waterbody failed due to mercury and PBDE. 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 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, a WFD investigation of the failure in the Cardigan Bay Central 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 sandbanks. A threat is defined as an activity that is currently not impacting condition but has the potential to do so over the next reporting cycle, if activity levels increase or are unmanaged. It is

important to identify these threats to be able to put pre-emptive management in place to prevent declines in condition.

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

Invasive non-native species

INNS are not currently an issue but high numbers in the future may have an impact on the sandbanks 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 <u>GB non-native species secretariat website</u>.

Water quality: contaminants

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

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

Climate change

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

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

Evidence gaps

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

Listed below (Table 19) are current indicators that were either assessed as unknown, not assessed, or assessed with a lower confidence. This was due to either limited data availability, outdated data, or a lack of information. Some indicators are not currently monitored but should be ideally considered in future condition assessments.

Table 19. Evidence gaps for the sandbanks feature in Cardigan Bay SAC. Each indicatortarget has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

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

3.6. River lamprey condition assessment

River lamprey *Lampetra fluviatilis* has been designated as a qualifying feature in Cardigan Bay SAC as it has been considered an important coastal migration route or feeding ground for this species, and as it is adjacent to an important freshwater site for the species (River Teifi SAC). The River Teifi was therefore considered as the primary upstream spawning location for the SAC in this assessment. Other rivers that input into the SAC population (Aeron, Rheidol / Ystwyth and Nevern) have also been considered in the assessment. There may be other relevant smaller rivers that contribute to the SAC population. A summary of the condition assessment for river lamprey in Cardigan Bay SAC can been seen in Table 20. The overall feature condition, a detailed summary of the assessment and threats to condition are discussed in more detail in the sections below.

Table 20. Condition assessment of river lamprey in Cardigan 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
Population variables and data	The population of river lamprey relevant to the SAC should be stable or increasing in the long-term. (P)	 There are a limited amount of high-quality data on river lamprey but there have been confirmed records of river lampreys in the Cardigan Bay SAC and relevant spawning rivers. Based on expert judgement, river lampreys in the Cardigan Bay SAC are common and widespread within the relevant upstream spawning rivers. Confidence is medium as the assessment was based largely on expert judgement. There have been no targeted surveys of river lampreys in the Cardigan Bay SAC. 	Pass	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Habitat connectivity	Maintain safe passage and movement of river lamprey in the marine environment into, within and away from the SAC, including to and from the connected spawning locations. (P)	 There are no known barriers within or into the Cardigan Bay SAC that would limit river lamprey migration between spawning rivers and along the coast. Some man-made barriers have been identified in the River Teifi but these are not known to present significant obstacles to migration of river lamprey. Confidence is high as in depth site knowledge was used. 	Pass	High
Freshwater flow	Maintain freshwater flow to the estuary / estuaries within the SAC. Regulated rivers meet their minimum flow targets. (P)	 There are no known issues affecting the freshwater flow to the Cardigan Bay SAC that would affect river lamprey migration. There are no known issues within the River Teifi SAC affecting freshwater flow to the Teifi estuary. Licenced abstractions on the River Teifi SAC have gone through the Review of Consents (RoC) process to ensure designated features are adequately protected. Flow data were not analysed for this assessment therefore confidence is medium. 	Pass	Medium
Invasive non- native species (INNS)	Spread and impact of INNS caused by human activities is not having a detrimental impact at the population level. (P)	 There are no known records of INNS which would adversely affect the condition of the river lamprey feature within Cardigan Bay SAC and associated River Teifi SAC. Confidence is high due to the availability of long term monitoring data on the species of concern to river lamprey. 	Pass	High

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Anthropogenic mortality: targeted exploitation	There should be no targeted exploitation of the species. (S)	 No targeted exploitation of river lampreys is understood to be occurring in the SAC population. Confidence is high as the assessment was based on expert judgement and knowledge that there are no fisheries that could capture the species in the SAC. 	Pass	High
Anthropogenic mortality: abstraction and entrapment	Abstraction and entrapment should not adversely affect the viability of the population. (S)	 All licenced abstractions have previously been assessed through the Habitats Regulations RoC process, Eel Regulations, or Salmon and Freshwater Fisheries Act (SAFFA) 1975. All new abstractions are required to go through permitting processes to comply with screening requirements for fish. There are no major operations within the SAC or rivers draining into the SAC known to be causing entrapment of river lamprey. Confidence is high as all operations go through permitting processes and as the assessment has been based on upto-date specialist knowledge and data. 	Pass	High
Anthropogenic mortality: bycatch	Bycatch of the species should not adversely affect the viability of the population. (S)	 Bycatch of river lamprey is understood to be low for the SAC population. Confidence is medium as there are limited data on bycatch. 	Pass	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Fish Community	The WFD Estuarine Fish tool is at least good. (T)	• There is one transitional WFD waterbody within the SAC that has been assessed using the WFD estuarine fish tool.	Pass	Medium
		• The Teifi Estuary waterbody was classified as Good status for the estuarine fish WFD element in the 2024 cycle 3 interim classification.		
		• The confidence of the pass is medium as the assessment only provides a snapshot of the conditions for estuarine fish.		
Water quality: contaminants	Water column contaminants not to exceed the EQS. (S)	• One of the three WFD waterbodies within the SAC was not classified in the 2024 cycle 3 interim classification as the chemicals have not been assessed within the last six years (Cardigan Bay South).	Fail	Low
		• One WFD waterbody has a pass for chemicals, however the chemical classifications were rolled forward from the 2018 cycle 2 interim classification (Teifi Estuary).		
		• The other WFD waterbody has a fail for chemicals in the 2024 cycle 3 interim classification (Cardigan Bay Central). This waterbody failed for mercury and PBDE.		
		• Confidence is low as contaminants are not directly monitored in this species; the human health protection goal has been used for PBDE; and some waterbodies were not classified for relevant chemicals or had rolled forward classifications.		

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 within the SAC have been classified as High status for dissolved oxygen in the 2024 cycle 3 interim classification. All WFD waterbodies that have been assessed overlap with an extensive area within the SAC and are therefore considered to be representative of the area that river lampreys would use in the SAC. Confidence is low as samples have been taken from the surface of waterbodies. 	Pass	Low

Assessment conclusions

The river lamprey feature in Cardigan Bay SAC has been assessed as being in **favourable** condition (medium confidence). Overall, river lamprey in the SAC and relevant upstream spawning rivers are thought to be common and widespread, with no known significant barriers to migration present, which has contributed to this favourable assessment outcome. There was one indicator with a failing target (Table 21). Confidence was reduced to medium overall as the data available on river lamprey in the region, and data on water chemistry are limited, and conclusions have been drawn largely using expert judgement.

A summary of the assessment can be seen in Table 21 with more detail on each performance indicator, and any reasons for failure, provided in the sections below.

Table 21. Summary of the condition assessment for river lamprey in Cardigan Bay SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

Feature	Overall Condition Assessment	Indicator failures	Reason for target failure	Threats to condition
River lamprey <i>Lampetra</i> <i>fluviatilis</i>	Favourable (medium confidence)	Water quality: contaminants (S)	 Levels of mercury and PBDE in the Cardigan Bay Central waterbody are failing to meet their relevant EQS. 	 INNS Water quality: contaminants Climate change

Detailed assessment information

Population variables

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

Habitat connectivity and freshwater flow

There are no known barriers to marine migration within the Cardigan Bay SAC that would limit river lamprey migration between spawning rivers and along the coast. Some barriers have been identified within the River Teifi SAC, however they are not known to be significant obstacles to migration of river lamprey as the species has been recorded up to the natural barrier at Cenarth waterfall. The habitat connectivity indicator therefore passed its target with high confidence. There are other contributing rivers to the marine SAC river lamprey population (Aeron, Rheidol / Ystwyth and Nevern), however the River Teifi was considered as the principal contributor to the SAC.

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

Invasive non-native species

The INNS that could significantly impact the river lamprey population in the river and estuary are Chinese mitten crab and signal crayfish. However, there are no known records of these species within the Cardigan Bay SAC or the River Teifi SAC catchment. The INNS indicator therefore passed its target with a high confidence.

Anthropogenic mortality

There is no known targeted exploitation of river lamprey within Cardigan Bay SAC therefore this indicator passed its target. High confidence was attributed to the indicator

pass as it was based on expert judgement and knowledge that there are no fisheries that could capture the species in the SAC.

In Wales, all licenced abstractions have been assessed through Eel Regulations, Habitats Regulations RoC process, or Salmon and Freshwater Fisheries Act (SAFFA) 1975 to ensure that all permitted abstractions are screened to minimise entrainment of fish. There are no major operations such as power stations within the Cardigan Bay SAC or rivers draining into the SAC known to be causing entrapment of river lamprey. The abstraction and entrapment target was therefore assessed as passing with high confidence as all operations go through regulated screening permitting processes and as the assessment has been based on up-to-date specialist knowledge and data.

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

Fish community

The WFD estuarine fish tool is as a proxy for habitat quality for fish in general in estuaries. If this element is classified as Good status it is likely that the conditions for fish, and therefore river lamprey, are favourable. The estuarine fish element is assessed in the transitional WFD waterbodies only. Within the Cardigan Bay SAC there is one transitional WFD waterbody, the Teifi Estuary. This waterbody was assessed as Good status for the estuarine fish element in the 2024 cycle 3 interim classification, therefore the fish community indicator passed its target. It was previously assessed as Good status in the 2015 cycle 2 and 2018 cycle 2 interim classifications and High status in the 2009 cycle 1 classification. The methodology used in the WFD fish classification has changed since the 2009 cycle 1 classification. As the 2009 cycle 1 classification is not comparable to the current methodology, it has not be used. The confidence of the pass was medium as whilst it covers the main estuary that river lampreys transition through, the tool only provides a snapshot of the suitability of conditions for fish.

Water quality

There are three WFD waterbodies within the Cardigan Bay SAC: Cardigan Bay Central, Cardigan Bay South, and the Teifi Estuary. The water quality indicator conclusions also apply to <u>sea lamprey</u>.

Contaminants

The Cardigan Bay Central waterbody has a fail for chemicals in the 2024 cycle 3 interim classification, where mercury and PBDE failed. River lampreys are coastal species so may be using the areas where the chemical failures were recorded in the coastal Cardigan Bay Central waterbody. The failure in the Cardigan Bay Central waterbody has therefore resulted in a failure for the contaminants indicator. 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 river lampreys are not fully understood. One WFD waterbody was not classified as the chemicals have not been assessed within the last six years. One WFD waterbody has a

pass for chemicals, however the chemical classifications were rolled forward from the 2018 cycle 2 interim classification.

Overall, the confidence in the failure was reduced to low to reflect that the PBDE failure uses a protection goal which may be over precautionary, and due to the unclassified waterbody and rolled forward classification. In addition, the effect of the chemical on the species is uncertain, and the contaminants have not been directly monitored in this species.

Dissolved oxygen

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

Physicochemical properties

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

Reasons for target failure

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

Water quality: contaminants

This indicator target has a secondary weighting. The Cardigan Bay Central waterbody failed due to mercury and PBDE. 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 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, a WFD investigation of the failure in the Cardigan Bay Central waterbody is yet to be undertaken. Mercury and PBDE are being managed in the UK and it is hoped that these levels will reduce in time.

Threats to condition

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

Invasive non-native species

There are currently no records of signal crayfish or Chinese mitten crab in the Cardigan Bay or River Teifi SACs. There is a threat that these species could be introduced to the area.

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

Water quality: contaminants

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

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

Climate change

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

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

Evidence gaps

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

Listed below (Table 22) are current indicators that were either assessed as unknown, not assessed, or assessed with a lower confidence. This was due to either limited data

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

Table 22. Evidence gaps for the river lamprey feature in Cardigan Bay SAC. Each
indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1)

Indicator	Assessed status	Comments
Population variables and data (P)	Medium confidence (limited data)	• Data on river lampreys are very limited and there have been no targeted surveys on the species in any of the marine SACs. There is currently no agreed method of assessment of river lamprey in marine environments.
Water quality: physicochemical	Not assessed	There were no temperature, salinity or pH loggers within the Cardigan Bay SAC.
		 Remote sensing data on temperature, salinity and pH could be used in future.

3.7. Sea lamprey condition assessment

Sea lamprey *Petromyzon marinus* has been designated as a qualifying feature in Cardigan Bay SAC as it has been considered an important migration coastal route or feeding ground for this species, and as it is adjacent to an important freshwater site for the species (River Teifi SAC). The River Teifi was therefore considered as the primary upstream spawning location for the SAC in this assessment. There may be other relevant smaller rivers that contribute to the SAC population. A summary of the condition assessment for sea lamprey in Cardigan Bay SAC can been seen in Table 23. The overall feature condition, a detailed summary of the assessment and threats to condition are discussed in more detail in the sections below.

Table 23. Condition assessment of sea lamprey in Cardigan 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
Population variables and data	The population of sea lamprey relevant to the SAC should be stable or increasing in	• A survey to determine sea lamprey presence within the River Teifi SAC in 2019 estimated that there was a net upstream movement of 133 sea lampreys between April and June.	Pass	High
	the long-term. (P)	• This run estimate compares favourably to the Tywi as the accessible catchment area is significantly smaller than in the Tywi due to the partial natural barrier in the Teifi (Cenarth waterfall).		
		• Monitoring in the River Teifi has continued after 2019, and in 2023 a net upstream movement of 244 sea lampreys were recorded from April to June.		
		 There have been no targeted surveys of sea lampreys in the Cardigan Bay SAC. 		
		 Confidence is high due to the availability of recent targeted monitoring data. 		

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

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Anthropogenic mortality: targeted exploitation	There should be no targeted exploitation of the species. (S)	 No targeted exploitation of sea lamprey is understood to be occurring in the SAC population. Confidence is high as the assessment was based on expert judgement and knowledge that there are no fisheries that could capture the species in the SAC. 	Pass	High
Anthropogenic mortality: abstraction and entrapment	Abstraction and entrapment should not adversely affect the viability of the population. (S)	 All licenced abstractions have previously been assessed through the Habitats Regulations RoC process, Eel Regulations, or SAFFA 1975. All new abstractions are required to go through permitting processes to comply with screening requirements for fish. There are no major operations within the SAC or rivers draining into the SAC known to be causing entrapment of sea lamprey. Confidence is high as all operations go through permitting processes and as the assessment has been based on upto-date specialist knowledge and data. 	Pass	High
Anthropogenic mortality: bycatch	Bycatch of the species should not adversely affect the viability of the population. (S)	 Bycatch of sea lamprey is understood to be low for the SAC population. Confidence is medium as there are limited data on bycatch. 	Pass	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Fish Community	The WFD Estuarine Fish tool is at least good. (T)	• There is one transitional WFD waterbody within the SAC that has been assessed using the WFD estuarine fish tool.	Pass	Medium
		• The Teifi Estuary waterbody was classified as Good status for the estuarine fish WFD element in the 2024 cycle 3 interim classification.		
		 The confidence is medium as the assessment only provides a snapshot of the conditions for estuarine fish. 		
Water quality: contaminants	Water column contaminants not to exceed the EQS. (S)	• One of the three WFD waterbodies within the SAC was not classified in the 2024 cycle 3 interim classification as the chemicals have not been assessed within the last six years (Cardigan Bay South).	Fail	Low
		 One WFD waterbody has a pass for chemicals, however the chemical classifications were rolled forward from the 2018 cycle 2 interim classification (Teifi Estuary). 		
		 The other WFD waterbody has a fail for chemicals in the 2024 cycle 3 interim classification (Cardigan Bay Central). This waterbody failed for mercury and PBDE. 		
		• Confidence is low as: contaminants are not directly monitored in this species; the human health protection goal has been used for PBDE; and some waterbodies were not classified or had rolled forward classifications.		
Indicator	Target	Assessment rationale	Target assessment	Target confidence
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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 within the SAC have been classified as High status for dissolved oxygen in the 2024 cycle 3 interim classification. All WFD waterbodies that have been assessed overlap with an extensive area within the SAC and are therefore considered to be representative of the area that sea lampreys would use in the SAC. Confidence is low as samples have been taken from the surface of waterbodies. 	Pass	Low

Assessment conclusions

The sea lamprey feature in Cardigan Bay SAC has been assessed as being in **favourable** condition (medium confidence). Overall, sea lamprey numbers in the River Teifi are considered to be favourable, with no known significant barriers to migration present, which has contributed to this favourable assessment outcome. There was one indicator with a failing target (Table 24). Confidence was reduced to medium overall as the data available on sea lampreys in the region, and data on water chemistry are limited, and conclusions have been drawn largely using expert judgement.

A summary of the assessment can be seen in Table 24 with more detail on each performance indicator, and any reasons for failure, provided in the sections below.

Table 24. Summary of the condition assessment for sea lamprey in Cardigan Bay SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

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

Detailed assessment information

Population variables

ARIS tracking has been used to monitor migratory fish in the River Teifi in various years. The ARIS unit is installed at Llechryd, about 2.5 km above the tidal limit. In 2019, ARIS was used to determine the presence of sea lampreys in the River Teifi (Davies, 2020). The ARIS unit was deployed between April and June 2019 and it recorded a net upstream movement of 133 sea lampreys past the counter. The Cenarth waterfall is upstream of the ARIS monitoring site and is thought to form a partial natural barrier to sea lamprey migration. This denotes that only 10.7% of the total catchment above the ARIS unit was easily accessible to sea lampreys. When this is considered, although the run estimate of 133 is considerably lower than the estimate of sea lampreys in the River Tywi, the Teifi run estimate compares favourably to the Tywi as the accessible catchment area is significantly smaller than in the Tywi (approx. 108 km² compared to 997 km²) (Davies, 2020). Monitoring has continued after 2019, and in 2023 a net upstream movement of 244 sea lampreys were recorded from April to June. Based on the monitoring data available, the indicator linked to population and data indicator passed the set target with high confidence. ARIS tracking will continue to be important in the monitoring of sea lamprevs in rivers for future condition assessments. Although this indicator was assessed, there are currently no data available on sea lampreys either in the transitional or coastal areas of the SAC.

Habitat connectivity and freshwater flow

There are no known barriers to marine migration within the Cardigan Bay SAC that would limit sea lamprey migration between spawning rivers and along the coast. Some barriers have been identified within the River Teifi SAC catchment, however they are not known to be significant obstacles to migration of sea lamprey, as the species has been recorded up to the natural barrier at Cenarth waterfall. The habitat connectivity indicator was therefore assessed as passing its target with high confidence. There are other contributing rivers to the marine SAC sea lamprey population, however the river Teifi was considered as the principal contributor to the SAC.

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

Invasive non-native species

The INNS that could significantly impact the sea lamprey population in the river and estuary are Chinese mitten crab and signal crayfish. However, there are no known records of these species within the Cardigan Bay SAC or River Teifi SAC catchment. The INNS indicator therefore met the target with a high confidence.

Anthropogenic mortality

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

In Wales, all licenced abstractions have been assessed through Eel Regulations, Habitats Regulations RoC process, or SAFFA 1975 to ensure that all permitted abstractions are screened to minimise entrainment of fish. There are no major operations such as power stations within the Cardigan Bay SAC or rivers draining into the SAC known to be causing entrapment of sea lamprey. The abstraction and entrapment target was therefore assessed as passing with high confidence as all operations go through regulated screening permitting processes and as the assessment has been based on up-to-date specialist knowledge and data.

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

Fish community

The WFD estuarine fish tool is as a proxy for habitat quality for fish in general in estuaries. If this element is classified as Good status it is likely that the conditions for fish, and therefore sea lamprey, are favourable. The estuarine fish element is assessed in the transitional WFD waterbodies only. Within the Cardigan Bay SAC there is one transitional WFD waterbody, the Teifi Estuary. This waterbody was assessed as Good status for the estuarine fish element in the 2024 cycle 3 interim classification, therefore the fish community indicator passed its target. It was previously assessed as Good status in the 2015 cycle 2 and 2018 cycle 2 interim classifications and High status in the 2009 cycle 1 classification. The methodology used in the WFD fish classification has changed since the 2009 cycle 1 classification. As the 2009 cycle 1 classification is not comparable to the current methodology, it has not be used. The confidence of the pass was medium as whilst it covers the main estuary that sea lampreys transition through, the tool only provides a snapshot of the suitability of conditions for fish.

Water quality

See river lamprey water quality in <u>Section 3.6</u> as it also applies to sea lamprey. Sea lampreys typically swim straight out to the open sea so are less likely to spend long periods of time in coastal regions like the Cardigan Bay Central waterbody. Therefore, the impact of the chemical failures in this waterbody on the sea lamprey feature are unknown. However, the contaminants indicator was still assessed as failing based on the failure of this waterbody.

Reasons for target failure

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

Water quality: contaminants

See river lamprey reasons for failure in <u>section 3.6</u> as it also applies to sea lamprey.

Threats to condition

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

Invasive non-native Species

There are currently no records of signal crayfish or Chinese mitten crab in the Cardigan Bay or River Teifi SACs. There is a threat that these species could be introduced to the area.

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

Water quality: contaminants

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

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

Climate change

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

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

• Changes to prey availability and abundance.

Evidence gaps

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

Listed below (Table 25) are current indicators that were either assessed as unknown, not assessed, or assessed with a lower confidence. This was due to either limited data availability, outdated data, or a lack of information. Some indicators are not currently monitored but should be ideally considered in future condition assessments.

Table 25. Evidence gaps for the sea lamprey feature in Cardigan Bay SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see Section 1.1).

Indicator	Assessed status	Comments
Water quality: physicochemical properties (T)	Not assessed	 There were no temperature, salinity or pH loggers within the Cardigan Bay SAC. Remote sensing data on temperature, salinity and pH could be used in future.

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