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Condition assessments for river lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus* in Welsh marine special areas of conservation

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River lamprey © Mike Hammett (NRW)

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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 lamprai'r afon *Lampetra fluviatilis* a lamprai'r môr *Petromyzon marinus* o fewn ardaloedd cadwraeth arbennig dynodedig (ACA) ledled Cymru. Mae Adran 1 yn rhoi trosolwg o'r broses asesu ac mae Adran 2 yn darparu disgrifiad a lleoliad y nodwedd(ion).

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

Crynodeb o asesiadau cyflwr ar gyfer lamprai'r afon mewn ACAau ledled Cymru

Lleoliad y nodwedd ACA	Asesiad cyflwr	Hyder yn yr asesiad
Bae Ceredigion	Ffafriol	Canolig
Sir Benfro Forol	Anffafriol	Uchel
Bae Caerfyrddin ac Aberoedd	Ffafriol	Canolig

Crynodeb o asesiadau cyflwr ar gyfer lamprai'r môr mewn ACAau ledled Cymru

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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 protected 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 river lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus* within designated special areas of conservation (SACs) across Wales. Cross-border sites are not included in this report but will hopefully be considered in future. Section 1 gives an overview of the assessment process and section 2 provides a description and location of the features.

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

Summary of condition assessments for river lamprey in SACs across Wales.

SAC feature occurs in	Condition assessment	Confidence in assessment
Cardigan Bay	Favourable	Medium
Pembrokeshire Marine	Unfavourable	High
Carmarthen Bay and Estuaries	Favourable	Medium

Summary of condition assessments for sea lamprey in SACs across Wales.

SAC feature occurs in	Condition assessment	Confidence in assessment
Cardigan Bay	Favourable	Medium
Pembrokeshire Marine	Unfavourable	High
Carmarthen Bay and Estuaries	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's marine ecosystems. As MPAs in Wales cover extensive areas of sea and coast, it can be challenging and resource intensive to monitor them. This can make thorough assessments of feature condition difficult. The process used for these condition assessments builds on work undertaken to produce indicative condition assessments published in 2018.

The 2018 indicative assessments used all available data and expert judgement to assess features using a workshop approach with internal NRW specialists. The new full assessment process has been improved by using carefully chosen performance indicators judged to be the most appropriate to assess condition (see section 3). The best available evidence has been used to conduct the assessments. Due to the differences in assessment methods between these full assessments and the indicative condition assessments, the results are not directly comparable. Cross-border sites are not included in the assessment report due to resource limitations, but NRW hopes to take forward cross-border sites condition assessments in the future.

1.1. Assessment process

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

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

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

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

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

Table 1. The main steps of the marine feature

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

2. Feature description

2.1. The river lamprey *Lampetra fluviatilis*

The river lamprey *Lampetra fluviatilis* is found in coastal waters, estuaries and suitable rivers. The species is anadromous (i.e. spawning in freshwater but completing part of its life cycle in the sea), where they typically migrate from freshwater to estuaries and coastal waters as juveniles (Kottelat and Freyhof, 2007). A proportion of the population are freshwater residents (Renaud, 2011), therefore some are likely to remain within rivers and estuaries.

Evidence of migrating river lamprey in the marine environment is limited, and the proportion of the population within the coastal environment is uncertain. The species may spend one to two years mainly in estuaries (Maitland, 2003), then maturing adults cease feeding in autumn and move back upriver to spawn (Kottelat and Freyhof, 2007). However, a proportion of the populations are permanent freshwater residents (Renaud, 2011). River lampreys have been shown to occupy waters of depths up to 50 m (Zanandrea, 1959) and 15 km from the coast. Migration can be impeded by artificial obstacles such as weirs or dams.

The following text is the site selection rationale from the JNCC list of Annex II species for river lamprey.

“Sites that hold healthy populations of river lamprey, with clear water and suitable areas of gravels, silt or sand for spawning, have been selected. The SAC series covers the geographical range of the species and includes a range of high-quality river types in which it occurs. The selected sites are generally extensive river systems, including important tributaries, which provide conservation of the range of habitat features required by the species. Marine sites that are considered important migration routes or feeding grounds for this species have also been selected, usually where they abut a freshwater site. Identification of suitable sites in some parts of the UK has been hampered by the absence of comparative population data, and by difficulties in identifying juvenile lampreys. While the SAC series makes a contribution to securing favourable conservation status for this Annex II species, wider measures are also necessary to support its conservation in the UK.”

2.2. The sea lamprey *Petromyzon marinus*

The sea lamprey *Petromyzon marinus* is the largest of the lampreys found in the UK. They are an anadromous species, once they leave rivers after spawning, they spend a short amount of time feeding in estuaries, then enter the coastal, marine and oceanic waters in search of larger prey. Sea lampreys have been caught >100 km from the shore off the east coast of North America and 230 km off the Irish west coast (Igoe et al., 2004).

The species is semelparous (not a repeat spawner). Sea lampreys require clean gravels in rivers to spawn. Sea lamprey ammocoetes (larvae) inhabit burrows in muddy or sandy substrata for their first 5–6 years before migrating to sea when they become a transformer. They spend their adult life feeding in the sea for 20-36 months (Kottelat and Freyhof, 2007). Sea lampreys do not show homing behaviour to their natal river to spawn, and are believed instead to be attracted by pheromones of other lampreys within rivers to spawn.

Sea lampreys enter the river to spawn in May and June as water temperature increases. Features such as weirs and dams, as well as polluted sections of river, may impede migration to spawning grounds. Evidence of marine movements and behaviour of sea lampreys in the marine environment is limited.

The following text is the site selection rationale from the JNCC list of Annex II species for sea lamprey.

“Sites with reliable records of sea lampreys, and which contain the necessary habitat requirements for spawning and survival of juveniles, have been selected. The SAC series encompasses the geographical range of the species and includes a range of high-quality river types in which it occurs. Rivers with significant barriers to migration have been excluded. Marine sites that are considered important migration routes or feeding grounds for this species have also been selected, usually where they are adjacent to a freshwater site. Identification of suitable sites in some parts of the UK has been hampered by the absence of comparative population data. While the SAC series makes a contribution to securing favourable conservation status for this Annex II species, wider measures are also necessary to support its conservation in the UK.”

3. River lamprey *Lampetra fluviatilis* condition assessments

This section contains condition assessments for the three Welsh only marine ardal cadwraeth arbennig (ACA) / special areas of conservation (SACs) where river lamprey *L. fluviatilis* is a designated feature (Figure 1).

- Bae Ceredigion / Cardigan Bay
- Sir Benfro Forol / Pembrokeshire Marine
- Bae Caerfyrddin ac Aberoedd / Carmarthen Bay and Estuaries

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

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

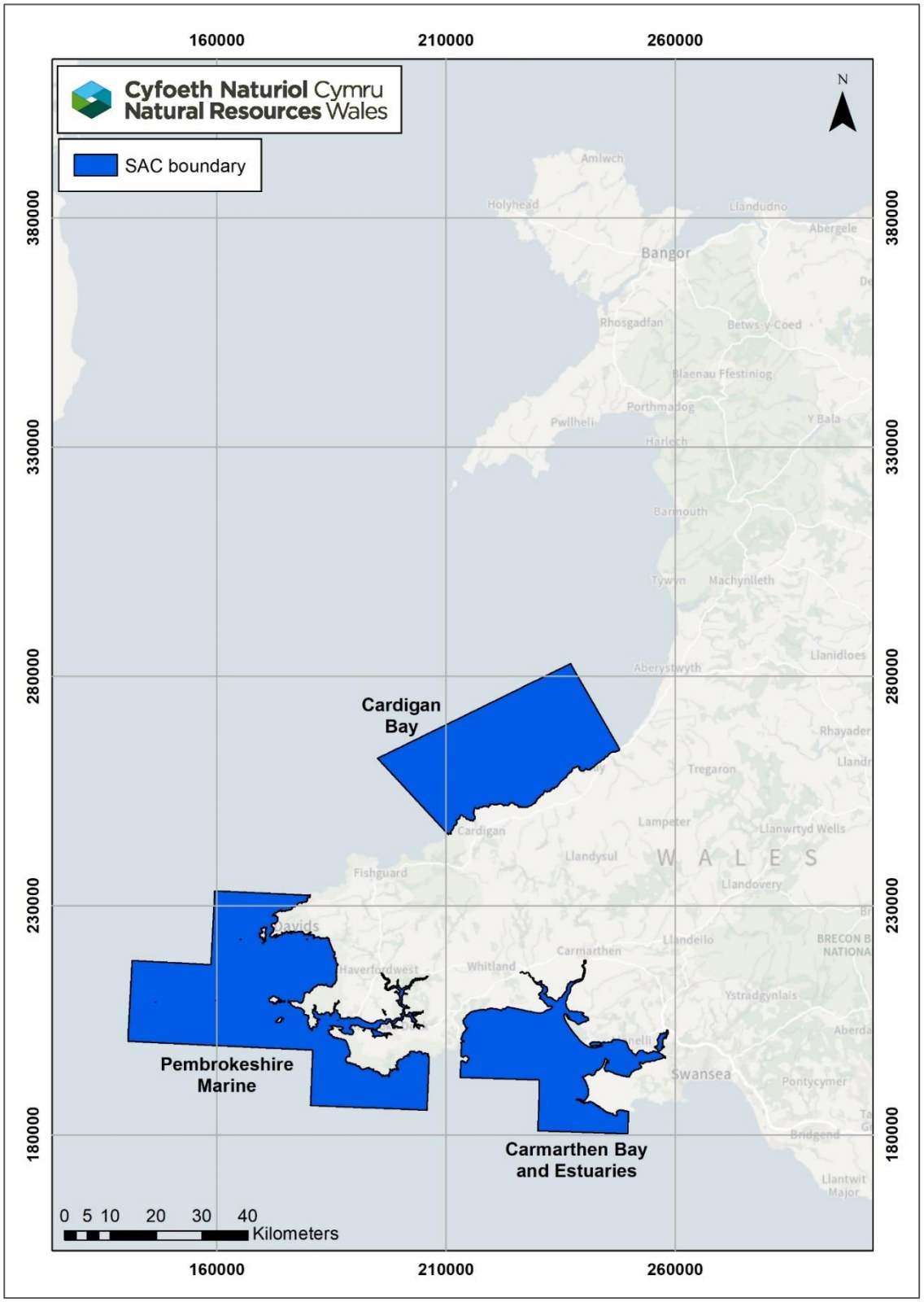
In these condition assessments, the WFD 2024 cycle 3 interim classification was the default information used for water quality, however other earlier cycles were referenced, as follows:

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

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

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

Figure 1. Location of SACs assessed for the river lamprey feature.



3.1. Cardigan Bay SAC condition assessment

River lamprey 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 2. The overall feature condition, a detailed summary of the assessment and threats to condition are discussed in more detail in the sections below.

Table 2. 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 up-to-date specialist knowledge and data.	**Pass**	High
Anthropogenic mortality: bycatch	Bycatch of the species should not adversely affect the viability of the population. (S)	• Bycatch of river lamprey is understood to be low for the SAC population. • Confidence is medium as there are limited data on bycatch.	**Pass**	Medium

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. • 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.	**Pass**	Medium
Water quality: contaminants	Water column contaminants not to exceed the environmental quality standards (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). • 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.	**Fail**	Low

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: dissolved oxygen	The WFD classification achieved for dissolved oxygen should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (P)	• All 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 3). 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 3 with more detail on each performance indicator, and any reasons for failure, provided in the sections below.

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

SAC	Overall Condition Assessment	Indicator failures	Reason for target failure	Threats to condition
Cardigan Bay	**Favourable (medium confidence)**	Water quality: contaminants (S)	• Levels of mercury and PBDE in the Cardigan Bay Central waterbody are failing to meet their relevant environmental quality standards (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 invasive non-native species (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 sea lamprey.

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 GB non-native species secretariat website.

Water quality: contaminants

There is the potential for unregulated contaminants (such as Per- and polyfluoroalkyl substances (PFAS)) to increase. This could affect 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.

3.2. Pembrokeshire Marine SAC condition assessment

River lamprey has been designated as a qualifying feature in Pembrokeshire Marine 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 (Cleddau Rivers SAC). The Cleddau Rivers were therefore considered as the primary upstream spawning locations for the SAC in this assessment. Other rivers that input into the SAC population (Pembroke river) 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 Pembrokeshire Marine SAC can been seen in Table 4. The overall feature condition, a detailed summary of the assessment and threats to condition are discussed in more detail in the sections below.

Table 4. Condition assessment of river lamprey in Pembrokeshire Marine SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see section 1.1).

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Population variables and data	The population of river lamprey relevant to the SAC should be stable or increasing in the long-term. (P)	• There have been no targeted surveys of river lampreys in the Cleddau Rivers SAC and Pembrokeshire Marine SAC. • The indicator could not be assessed due to the lack of available data for the species.	**Unknown**	N/A

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 to marine migration within or into the Pembrokeshire Marine SAC that would limit river lamprey migration through the SAC along the coast. • There are two structures that are currently impeding passage of river lampreys between the marine SAC and the connected spawning rivers (Cleddau Rivers SAC): Canaston and Haverfordwest Town weirs. There are currently fish passes at these weirs but they are not yet suitable for river lampreys. • Barriers to migration are also present on the Pembroke river. • Confidence is high as the barriers present are known to be impeding passage of river lamprey.	**Fail**	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 Pembrokeshire Marine SAC that would affect river lamprey migration. • There are no known issues within the Cleddau Rivers SAC affecting flow to the Milford Haven estuary. • Licenced abstractions on the Cleddau Rivers 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

Indicator	Target	Assessment rationale	Target assessment	Target confidence
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 Pembrokeshire Marine SAC and associated Cleddau Rivers SAC. • Confidence is high due to the availability of long term monitoring data on the species of concern to river lamprey.	**Pass**	High
Anthropogenic mortality: targeted exploitation	There should be no targeted exploitation of the species. (S)	• No targeted exploitation of river lampreys is understood to be occurring in the SAC population. • Confidence is high as the assessment was based on expert judgement and knowledge that there are no fisheries that could capture the species in the SAC.	**Pass**	High
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. • Pembroke Power Station has been identified as not posing a significant impact to river lamprey. • There are no other major operations within the SAC or rivers draining into the SAC known to be causing entrapment of river lamprey. • Confidence is high as all operations go through permitting processes and as the assessment has been based on up-to-date specialist knowledge and data.	**Pass**	High

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Anthropogenic mortality: bycatch	Bycatch of the species should not adversely affect the viability of the population. (S)	• Bycatch of river lamprey is understood to be low for the SAC population. • Confidence is medium as there are limited data on bycatch.	**Pass**	Medium
Fish Community	The WFD Estuarine Fish tool is at least good. (T)	• There is one transitional WFD waterbody within the SAC that has been assessed using the WFD estuarine fish tool. • The Milford Haven Inner waterbody was classified as Good status for the estuarine fish WFD element in the 2024 cycle 3 interim classification. There has been no change from Good status since previous cycles. • The confidence is medium as the assessment only provides a snapshot of the conditions for estuarine fish.	**Pass**	Medium

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: contaminants	Water column contaminants not to exceed the EQS. (S)	• Four of the six WFD waterbodies in the SAC were not classified as the chemicals have not been assessed within the last six years (Pembrokeshire South, Cardigan Bay South, Grassholm Island and the Smalls, and Solfach Estuary). • One WFD waterbody has a pass for chemicals in the 2024 cycle 3 interim classification (Milford Haven Outer). However, some of the chemical classifications were rolled forward from the 2021 cycle 3 classification. This waterbody has improved since previous cycles. • One WFD waterbody has a fail for chemicals (Milford Haven Inner), due to polybrominated diphenyl ethers (PBDE) and polycyclic aromatic hydrocarbons (PAH). • Confidence is low as: the human health standard has been used for PBDE; some waterbodies were not classified for relevant chemicals; and contaminants are not directly monitored in this species.	**Fail**	Low
Water quality: dissolved oxygen	The WFD classification achieved for dissolved oxygen should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (P)	• Five of the six WFD waterbodies in the SAC have been classified as High status for dissolved oxygen in the 2024 cycle 3 interim classification. • All WFD waterbodies that have been assessed overlap with an extensive area within the SAC and are therefore considered to be representative of the area that river lampreys would use in the SAC. • Confidence is low as samples have been taken from the surface of waterbodies.	**Pass**	Low

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: physicochemical properties	Maintain natural physicochemical properties of water subject to natural variation. (T)	• Data from intertidal and subtidal temperature loggers were available. Some temperature loggers in the SAC showed an increase in the number of days with higher temperatures, and potential step change in temperature. • Pembroke Power Station report indicated a localised increase in temperature, which was deemed unlikely to be of wider ecological significance. • This indicator was assessed as unknown due to a lack of understanding of the cause of the temperature patterns, and because there are currently insufficient data on other physicochemical parameters (e.g. salinity and pH).	**Unknown**	N/A

Assessment conclusions

The river lamprey feature in Pembrokeshire Marine SAC has been assessed as being in **unfavourable** condition (high confidence). There were two indicators with failing targets (Table 5). There were limited or absent data for one important indicator to inform on the condition of the feature (see evidence gaps section 5). Further investigation is needed to better understand the failures to be able to identify management options that can bring the feature back into favourable condition.

A summary of the assessment can be seen in Table 5 with more detail on each performance indicator, and any reasons for failure, provided in the sections below.

Table 5. Summary of the condition assessment for river lamprey in Pembrokeshire Marine SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

SAC	Overall Condition Assessment	Indicator failures	Reason for target failure	Threats to condition
Pembrokeshire Marine	**Unfavourable (high confidence)**	Habitat connectivity (P) Water quality: contaminants (S)	• There are barriers within the eastern and western Cleddau Rivers that are affecting lamprey access from the Pembrokeshire Marine SAC into the Cleddau Rivers SAC. • Levels of PBDE and PAH in the Milford Haven Inner waterbody failing are to meet their relevant EQSs.	• Industry • INNS • Water quality: contaminants • Climate change

Detailed assessment information

Population variables

There have been a limited number of recent surveys of river lampreys in the Cleddau Rivers. The acoustic tracking of sea lamprey in the region cannot be used as a proxy for river lampreys as their migration period is different. 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 ammocoetes from NRW monitoring. This may indicate that there is a lot of suitable habitat available for lamprey ammocoetes in the rivers. The indicator linked to population could not be assessed due to the lack of data available for river lamprey. ARIS tracking would be beneficial in the monitoring of river lamprey in rivers for future condition assessments.

Habitat connectivity and freshwater flow

There are no known barriers to marine migration within the Pembrokeshire Marine SAC that would limit river lamprey migration through the SAC and along the coast.

In contrast, there are issues between the upstream spawning rivers and the marine SAC. There are two weirs present within the Cleddau Rivers SAC which are limiting lamprey access between the Cleddau Rivers and the Pembrokeshire Marine SAC. These are the Canaston weir in the eastern Cleddau and the Haverfordwest Town weir in the western Cleddau, both of which are just above the tidal limit and outside of the Pembrokeshire Marine SAC boundary. There has been no acoustic tracking of river lamprey specifically, however during sea lamprey monitoring in the most recent survey in 2023, there were no lampreys found above the Canaston weir (Griffiths, 2023). Both weirs have fish passes, however they are not yet suitable for river lamprey. Improvements or replacement of the fish passes are currently planned or in progress at these two weirs as part of the Four Rivers for LIFE project, with work due to complete in the summer of 2026. Barriers to migration are also present on the Pembroke river which may benefit lampreys if removed or access via a fish pass installed. The habitat connectivity indicator failed to meet the target due to the presence of barriers that are significantly inhibiting passage between the Pembrokeshire Marine SAC and the Cleddau and Pembroke Rivers. Until work has taken place to improve the passage through these structures and the effects have been observed, this indicator will continue to fail with high confidence.

The freshwater flow indicator passed its target as there are no known issues with flow to the Milford Haven estuary or Cleddau Rivers SAC that drains directly into the Pembrokeshire Marine SAC. This conclusion was based on the RoC process (see further information in section 3.1). 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 river lampreys are Chinese mitten crab and Signal crayfish. There have been a small number records of signal crayfish in south Pembrokeshire, but not within the Cleddau Rivers SAC and tributaries. There are no other known records of these species within the Pembrokeshire Marine SAC or the Cleddau

Rivers SAC catchment. The INNS indicator therefore passed its target with a high confidence.

Anthropogenic mortality

There is no known targeted exploitation of river lamprey within Pembrokeshire Marine SAC, therefore this indicator was assessed as passing 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. Pembroke Power Station abstracts water from the SAC. Annual impingement and entrainment monitoring conducted at the power station has not recorded any river lampreys since the commencement of operation (RWE, unpublished data). The power station may pose a threat due to the abstraction and possibility of entrainment or impingement, but monitoring suggests no current impacts to the species. Therefore, it has been identified as not posing a significant impact to river lamprey. There are no other major operations within the Pembrokeshire Marine 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 a 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 Pembrokeshire Marine SAC is understood to be low therefore this indicator passed its target. Confidence in this assessment is reduced to medium as there are limited data on bycatch, especially for unregulated fishing.

Fish community

The WFD estuarine fish tool is used as a proxy for habitat quality for fish in general in estuaries. If this element is classified as Good status it is likely that the conditions for fish, and therefore river lamprey, are favourable. The estuarine fish element is assessed in the transitional WFD waterbodies only. Within the Pembrokeshire Marine SAC there is one relevant transitional WFD waterbody, Milford Haven Inner. This was classified as Good status for the fish estuarine element in the 2024 cycle 3 interim classification, therefore the fish community indicator passed its target. It was assessed as Good status in all previous cycles. 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 six WFD waterbodies within the Pembrokeshire Marine SAC: Pembrokeshire South, Cardigan Bay South, Grassholm Island and the Smalls, Milford Haven Outer, Milford Haven Inner, and Solfach Estuary. The water quality indicator conclusions also apply to sea lamprey.

Contaminants

The Milford Haven Inner waterbody has a fail for chemicals in the 2024 cycle 3 interim classification, where PBDE and PAH failed. PBDE has failed in this waterbody in all previous cycles. 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. River lamprey potentially use the Milford Haven estuary throughout their adult life stages.

The Milford Haven Outer waterbody failed for mercury and TBT in previous cycles. This waterbody now passes for chemicals in the 2024 cycle 3 interim classification, however TBT, which was previously a failing chemical, is no longer assessed. In addition, mercury was not classified in the 2024 cycle 3 interim classification. The other four WFD waterbodies were not classified as the chemicals have not been assessed within the last six years. It is not known how river lampreys use and are distributed in the SAC, and therefore how long they spend in the different waterbodies. However, it is likely that river lampreys will stay mainly within the two Milford Haven waterbodies due to the size of the estuary system compared to the river.

The failure of the Milford Haven Inner waterbody caused the contaminants indicator to fail. The confidence in the fail was reduced to low because the human health standard has been used for PBDE, and due to the unclassified waterbodies for chemicals. In addition, the effect of the chemical failure on the species is uncertain, and the contaminants have not been directly monitored in this species.

Dissolved oxygen

The dissolved oxygen indicator passed its target as five of the six WFD waterbodies in the SAC were classified as High status for the dissolved oxygen element in the 2024 cycle 3 interim classification. These waterbodies overlap with an extensive area in the coastal part of the SAC and are therefore considered to be representative of the areas potentially used by the river lampreys in Pembrokeshire Marine SAC. Confidence in the pass was reduced to low because surface sampling of dissolved oxygen may not detect issues throughout the water column or for more demersal features (see further detail in section 3.1).

Physicochemical properties

Data from seven NRW monitored subtidal temperature loggers and six NRW monitored intertidal monitoring sites at various shore heights (12 temperature loggers in total) were available. Some of the loggers showed an increase in the number of days with higher temperatures, and a potential step change in temperature. This is more apparent in the loggers within the Milford Haven estuary. An external report (Sutton, 2023) found localised increase in temperature near the Pembroke Power Station. However, they concluded that this is unlikely to be of wider ecological significance. While localised, warming water can provide a safe haven for non-native species (NNS), which could then spread further. This will be something to pay close attention to in the next assessment. The physicochemical indicator was assessed as unknown due to a lack of understanding of the cause of the temperature patterns, and as further evidence on the apparent temperature change is needed for a comprehensive assessment. In addition because there are currently insufficient data on other physicochemical parameters (e.g. salinity and pH).

Reasons for target failure

The assessment of river lamprey in Pembrokeshire Marine SAC failed one primary target and one secondary target. This resulted in the river lamprey feature to be assessed as being in **unfavourable** condition. The failing indicators and reasons for failure, if known, are stated below.

Habitat connectivity

This indicator failed due to the two weirs present within the Cleddau Rivers, the Canaston weir in the eastern Cleddau and the Haverfordwest Town weir in the western Cleddau. Monitoring of sea lamprey has been used as a proxy for river lamprey movement through the weirs, as river lampreys have the same access requirements as sea lampreys. This monitoring found no lampreys above the weir, therefore passage at the weir via the current fish passes is likely to be suboptimal. Improvements or replacement of the fish passes are currently planned or in progress at the two weirs in the Cleddau, with work due to complete in the summer of 2026. However, until the effects of these changes have been observed, this indicator will continue to fail.

Water quality: contaminants

This indicator failed to meet its secondary target due to the chemical failure in the Milford Haven Inner waterbody, due to PBDE and PAH. Historically, the main source of PBDE is as flame retardants in a variety of materials (Viñas et al., 2022). PAHs can be produced through natural processes, but also arise from anthropogenic sources, for example during combustion of fossil fuels and organic material (Webster and Fryer, 2022).

The contaminants in the water column may be derived from diffuse sources from contaminated waterbody bed sediments, or point sources from continuous sewage discharge from waste water treatment. However, a WFD investigation of the failure in Milford Haven Inner waterbody is yet to be undertaken. PBDE is being managed in the UK and it is hoped that levels will reduce in time. There is currently no specific management in place for PAH in Wales. The PAH EQS is based on the most sensitive taxa and may not be applicable to the river lamprey feature. The impact of PAH on the river lamprey feature is not fully understood.

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 Pembrokeshire Marine SAC are stated below.

Industry

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

Invasive non-native species

There have been a small number of records of signal crayfish in South Pembrokeshire (not within the Cleddau Rivers SAC). Signal crayfish would predate on eggs and possibly ammocetes of the river lamprey. There are currently no records of Chinese mitten crab in the Pembrokeshire Marine or Cleddau Rivers SACs. There is a threat that these species could be introduced to the area.

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

Water quality: contaminants

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

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

Climate change

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

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

3.3. Carmarthen Bay and Estuaries SAC condition assessment

River lamprey has been designated as a qualifying feature in Carmarthen Bay and Estuaries SAC as it has been considered an important coastal migration route or feeding ground for this species, and as it is adjacent to an important freshwater site for the species (River Tywi SAC). The River Tywi was therefore considered as the primary upstream spawning location for the SAC in this assessment. Other rivers that input into the SAC population (Tâf, Gwendreath and Loughor) have also been considered in the assessment. There may be other relevant smaller rivers that contribute to the SAC population. A summary of the condition assessment for river lamprey in Carmarthen Bay and Estuaries SAC can been seen in Table 6. The overall feature condition, a detailed summary of the assessment and threats to condition are discussed in more detail in the sections below.

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

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

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

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

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

Assessment conclusions

The river lamprey feature in Carmarthen Bay and Estuaries SAC has been assessed as being in **favourable** condition (medium confidence). Overall, river lamprey in the SAC and relevant upstream spawning rivers are thought to be common and widespread, with no known significant barriers to migration present, which has contributed to this favourable assessment outcome. There was one indicator with a failing target (Table 7). Confidence was reduced to medium overall as the data available on river lampreys in the region, and data on water chemistry are limited, and conclusions have been drawn largely using expert judgement.

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

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

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

Detailed assessment information

Population variables

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

Habitat connectivity and freshwater flow

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

The freshwater flow indicator passed its target as there are no known issues with flow to the Three Rivers estuary or River Tywi SAC that drains directly into the Carmarthen Bay and Estuaries SAC. This conclusion was based on the RoC process (see further information in section 3.1). Confidence in the pass is medium as flow data were not used for the assessment.

Invasive non-native species

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

Anthropogenic mortality

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

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

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

Fish community

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

Water quality

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

Contaminants

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

SAC, therefore the chemical failure there has resulted in the failure for the contaminants indicator. The other three WFD waterbodies have a pass for chemicals in the 2024 cycle 3 interim classification. However, in all three waterbodies, some or all of the chemical classifications were rolled forward from previous cycles as they were not assessed in the 2024 cycle 3 interim classification.

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

Dissolved oxygen

The dissolved oxygen indicator passed its target as all four WFD waterbodies in the SAC were classified as High status for the dissolved oxygen element in the 2024 cycle 3 interim classification. These waterbodies overlap with an extensive area in the coastal part of the SAC and are therefore considered to be representative of the areas potentially used by the river lampreys in the Carmarthen Bay and Estuaries SAC. Confidence in the pass was reduced to low because surface sampling of dissolved oxygen may not detect issues throughout the water column or for more demersal features (see further detail in section 3.1).

Physicochemical properties

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

Reasons for target failure

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

Water quality: contaminants

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

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

Threats to condition

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

Invasive non-native species

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

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

Water quality: contaminants

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

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

Climate change

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

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

4. Sea lamprey *Petromyzon marinus* condition assessments

This section contains condition assessments for the three Welsh only marine ACAs / SACs where sea lamprey *P. marinus* is a designated feature (Figure 2).

- Bae Ceredigion / Cardigan Bay
- Sir Benfro Forol / Pembrokeshire Marine
- Bae Caerfyrddin ac Aberoedd / Carmarthen Bay and Estuaries

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

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

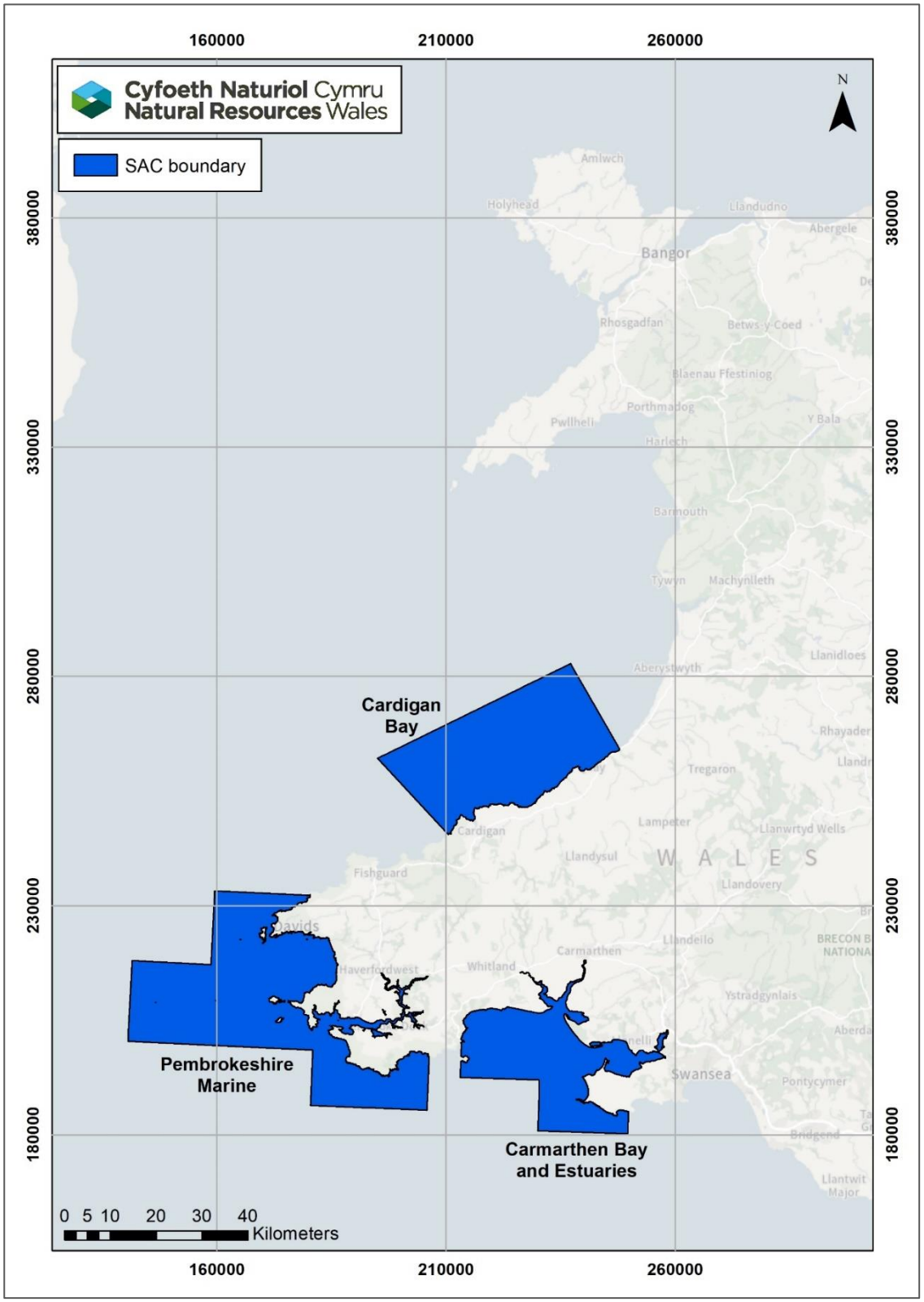
In these condition assessments, the WFD 2024 cycle 3 interim classification was the default information used for water quality, however other earlier cycles were referenced, as follows:

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

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

Figure 2. Location of SACs assessed for the sea lamprey feature.



4.1. Cardigan Bay SAC condition assessment

Sea lamprey 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 8. The overall feature condition, a detailed summary of the assessment and threats to condition are discussed in more detail in the sections below.

Table 8. 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 the long-term. (P)	• 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. • 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.	**Pass**	High

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 up-to-date specialist knowledge and data.	**Pass**	High
Anthropogenic mortality: bycatch	Bycatch of the species should not adversely affect the viability of the population. (S)	• Bycatch of sea lamprey is understood to be low for the SAC population. • Confidence is medium as there are limited data on bycatch.	**Pass**	Medium
Fish Community	The WFD Estuarine Fish tool is at least good. (T)	• There is one transitional WFD waterbody within the SAC that has been assessed using the WFD estuarine fish tool. • 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.	**Pass**	Medium

Indicator	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 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). • 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.	**Fail**	Low
Water quality: dissolved oxygen	The WFD classification achieved for dissolved oxygen should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (P)	• All 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 9). 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 9 with more detail on each performance indicator, and any reasons for failure, provided in the sections below.

Table 9. 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.

SAC	Overall Condition Assessment	Indicator failures	Reason for target failure	Threats to condition
Cardigan Bay	**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 km^2 compared to 997 km^2) (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 lampreys in rivers for future condition assessments. Although this indicator was assessed, there are currently no data available on sea lampreys either in the transitional or coastal areas of the SAC.

Habitat connectivity and freshwater flow

There are no known barriers to marine migration within the 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.

The freshwater flow indicator passed its target as there are no known issues with flow to the Teifi estuary or River Teifi SAC that drains directly into the Cardigan Bay SAC. This conclusion was based on the RoC process (see further information in section 3.1). 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 section 3.1 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 section 3.1 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 GB non-native species secretariat website.

Water quality: contaminants

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

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

Climate change

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

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

4.2. Pembrokeshire Marine SAC condition assessment

Sea lamprey has been designated as a qualifying feature in Pembrokeshire Marine 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 (Cleddau Rivers SAC). The Cleddau Rivers were therefore considered as the primary upstream spawning locations 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 Pembrokeshire Marine SAC can been seen in Table 10. The overall feature condition, a detailed summary of the assessment and threats to condition are discussed in more detail in the sections below.

Table 10. Condition assessment of sea lamprey in Pembrokeshire Marine SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see section 1.1).

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Population variables and data	The population of sea lamprey relevant to the SAC should be stable or increasing in the long-term. (P)	• There has been no evidence of sea lampreys on the eastern Cleddau over the last 10 years, with no redds observed upstream of the Canaston weir. • Acoustic monitoring on the eastern Cleddau in 2023 found no indications of any sea lampreys during the deployment. • Acoustic monitoring on the western Cleddau in 2014 identified a very small number of migrating adult sea lampreys compared to other regions. • There have been no targeted surveys of sea lampreys in the Pembrokeshire Marine SAC. • Confidence is high due to the very low numbers or absence of sea lampreys within the Cleddau.	**Fail**	High

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Habitat connectivity	Maintain safe passage and movement of sea lamprey in the marine environment into, within and away from the SAC, including to and from the connected spawning locations. (P)	• There are no known barriers to marine migration within or into the Pembrokeshire Marine SAC that would limit sea lamprey migration through the SAC and along the coast. • There are two structures that are currently impeding passage of sea lampreys between the marine SAC and the connected spawning rivers (Cleddau Rivers SAC): Canaston and Haverfordwest Town weirs. • There are current fish passes at these weirs but they are not yet suitable for sea lampreys. • Confidence is high as the barriers present are known to be impeding passage of river lamprey.	**Fail**	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 Pembrokeshire Marine SAC that would affect sea lamprey migration. • There are no known issues within the Cleddau Rivers SAC affecting flow to the Milford Haven estuary. • Licenced abstractions on the Cleddau Rivers 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 Pembrokeshire Marine SAC and associated Cleddau Rivers 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. • Pembroke Power Station has recorded entrapment of 25 sea lampreys since 2012, however the effect at the population level is unknown at present, especially as little is known about the population levels within the SAC. This led to an unknown assessment for this indicator. • There are no other major operations within the SAC or rivers draining into the SAC known to be causing entrapment of sea lamprey.	**Unknown**	N/A
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. • The Milford Haven Inner waterbody was classified as Good status for the estuarine fish WFD element in the 2024 cycle 3 interim classification. There has been no change from Good status since previous cycles. • The confidence of the pass is medium as the assessment only provides a snapshot of the conditions for estuarine fish.	**Pass**	Medium
Water quality: contaminants	Water column contaminants not to exceed the EQS. (S)	• Four of the six WFD waterbodies in the SAC were not classified as the chemicals have not been assessed within the last six years (Pembrokeshire South, Cardigan Bay South, Grassholm Island and the Smalls, and Solfach Estuary). • One WFD waterbody has a pass for chemicals in the 2024 cycle 3 interim classification (Milford Haven Outer). However, some of the chemical classifications were rolled forward from the 2021 cycle 3 classification. This waterbody has improved since previous cycles. • One WFD waterbody has a fail for chemicals (Milford Haven Inner), due to PBDE and PAH. • Confidence is low as: the human health standard has been used for PBDE; some waterbodies were not classified for relevant chemicals, and contaminants are not directly monitored in this species.	**Fail**	Low

Indicator	Target	Assessment rationale	Target assessment	Target confidence
Water quality: dissolved oxygen	The WFD classification achieved for dissolved oxygen should be Good or High status in WFD waterbodies that overlap with the feature, and there should be no deterioration between status classes. (P)	• Five of the six WFD waterbodies in the SAC have been classified as High status for dissolved oxygen in the 2024 cycle 3 interim classification. • All WFD waterbodies that have been assessed overlap with an extensive area within the SAC and are therefore considered to be representative of the area that sea lampreys would use in the SAC. • Confidence is low as samples have been taken from the surface of waterbodies.	**Pass**	Low
Water quality: physicochemical properties	Maintain natural physicochemical properties of water subject to natural variation. (T)	• Data from intertidal and subtidal temperature loggers were available. Some temperature loggers in the SAC showed an increase in the number of days with higher temperatures, and potential step change in temperature. • Pembroke Power Station report indicated a localised increase in temperature, which was deemed unlikely to be of wider ecological significance. • This indicator was assessed as unknown due to a lack of understanding of the cause of the temperature patterns, and because there are currently insufficient data on other physicochemical parameters (e.g. salinity and pH).	**Unknown**	N/A

Assessment conclusions

The sea lamprey feature in Pembrokeshire Marine SAC has been assessed as being in **unfavourable** condition (high confidence). There were three indicators with failing targets (Table 11). Further investigation is needed to better understand the failures to be able to identify management options that can bring the feature back into favourable condition.

A summary of the assessment can be seen in Table 11 with more detail on each performance indicator, and any reasons for failure, provided in the sections below.

Table 11. Summary of the condition assessment for sea lamprey in Pembrokeshire Marine SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting.

SAC	Overall Condition Assessment	Indicator failures	Reason for target failure	Threats to condition
Pembrokeshire Marine	**Unfavourable (high confidence)**	Population variables and data (P) Habitat connectivity (P) Water quality: contaminants (S)	• There is an absence of records of sea lampreys within the Cleddau Rivers in recent years. • There are barriers within the eastern and western Cleddau Rivers that are affecting lamprey access from the Pembrokeshire Marine SAC into the Cleddau Rivers SAC. • Levels of PBDE and PAH in the Milford Haven Inner waterbody are failing to meet their relevant EQSs.	• Industry • INNS • Water quality: contaminants • Climate change

Detailed assessment information

Population variables

Sea lampreys were historically present and known to spawn in the Cleddau Rivers. These likely contributed most to the Pembrokeshire Marine SAC population of sea lamprey. There has been no evidence of sea lampreys on the eastern Cleddau in the last 10 years, with no redds observed in the reaches upstream of the Canaston weir (Griffiths, 2023). Acoustic monitoring of sea lampreys has been carried out around the Canaston weir in various years. In 2011, DIDSON (dual frequency identification sonar) was deployed upstream of the weir during sea lamprey spawning season (March to June) (Clabburn and Davies, 2011). An additional DIDSON unit was deployed below the weir for one day in May. During the monitoring period, 12 sea lamprey targets were identified, six were found upstream and six downstream. In comparison, sea lamprey numbers associated with the Carmarthen Bay and Estuaries SAC (River Tywi SAC catchment) in 2011 were the highest in any year since deployment began in 2009 (approximately 12,000), therefore the low numbers found in the eastern Cleddau indicate a localised declining population there compared to other regions. CCTV tracking was used in 2012 in the eastern Cleddau (Davies and Bennett, 2012) from April to June, where no sea lampreys were observed migrating up the fish pass. There was, however, one potential sea lamprey, though it may have been a large eel, observed moving down the pass.

The most recent ARIS (adaptive resolution imagine sonar) in 2023 (Griffiths, 2023) monitored the water column directly upstream of the Canaston weir from April to June. There were no sea lampreys observed during this deployment.

DIDSON monitoring has also been carried out in the western Cleddau above the Haverfordwest Town weir in May to June 2014, where a total of 11 adult sea lampreys were recorded (NRW, 2014). As this deployment was shorter than those in the eastern Cleddau, it is likely that there were more sea lampreys present in the western Cleddau than was indicated in the results. However, compared to other regions these numbers were very low.

Based on the tracking data available, the indictor linked to population failed to meet the set target with high confidence due to the very low numbers or absence of sea lampreys within the Cleddau. ARIS tracking will continue to be important in the monitoring of sea lampreys in rivers for future condition assessments. Although this indicator was assessed, there are currently no data available on sea lampreys either in the transitional or coastal areas of the SAC.

Habitat connectivity and freshwater flow

There are no known barriers to marine migration within the Pembrokeshire Marine SAC that would limit sea lamprey migration through the SAC and along the coast.

In contrast, there are issues between the upstream spawning rivers and the marine SAC. There are two weirs present within the Cleddau Rivers SAC which are limiting sea lamprey access between the Cleddau Rivers and Pembrokeshire Marine SAC. These are the Canaston weir in the eastern Cleddau and the Haverfordwest Town weir in the western

Cleddau, both of which are just above the tidal limit and outside of the Pembrokeshire Marine SAC boundary. ARIS was deployed upstream of the Canaston weir in 2023, in which zero sea lamprey were observed during deployment (Griffiths, 2023). The weir currently has a fish pass. However, the lack of adult migrants or redds upstream of the weir suggests this is ineffective for sea lampreys. Improvements or replacement of the current fish passes are currently planned or in progress at these two weirs as part of the Four Rivers for LIFE project, with work due to complete in the summer of 2026. There have been fewer tracking surveys in the western Cleddau, however a DIDSON survey in 2014 was carried out above the Haverfordwest Town weir (NRW, 2014). A total of 11 adult sea lampreys were recorded (10 upstream and 1 downstream), which was low compared to other regions (Tywi). The habitat connectivity indicator failed to meet the target due to the presence of barriers that are significantly inhibiting sea lamprey migration between the Pembrokeshire Marine SAC and the Cleddau Rivers. Until work has taken place to improve the passage through these structures and the effects have been observed, this indicator will continue to fail with high confidence.

The freshwater flow indicator passed its target as there are no known issues with flow to the Milford Haven estuary or Cleddau Rivers SAC that drains directly into the Pembrokeshire Marine SAC. This conclusion was based on the RoC process (see further information in section 3.1). 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 sea lampreys are Chinese mitten crab and Signal crayfish. There have been a small number records of signal crayfish in south Pembrokeshire, but not within the Cleddau Rivers SAC and tributaries. There are no other known records of these species within the Pembrokeshire Marine SAC or the Cleddau Rivers SAC catchment. The INNS indicator therefore passed the target with a high confidence.

Anthropogenic mortality

There is no known targeted exploitation of sea lamprey within Pembrokeshire Marine 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. Pembroke Power Station abstracts water from the SAC. Annual monitoring at the power station has recorded entrapment of 25 sea lampreys since 2012 (RWE, unpublished data). In addition, the estimated impingement for the period of 2012-2022 was an average of 53 sea lampreys per year. There are limitations to the monitoring data for sea lampreys because it is not specifically designed for this species. The monitoring does not align with the time of year when they are most abundant, and the screen mesh size may be too large to detect sea lamprey transformers and marine juveniles. The effect of entrapment and impingement at the population level is unknown at present as there are currently no population data available. In addition, little is known about the population level within the Pembrokeshire Marine SAC. However, compared with the estimated sea lamprey numbers from data available from run

monitoring on the eastern and western Cleddau, the annual impingement estimates of 53 sea lamprey per year could be significant. The abstraction and entrapment target has been assessed as unknown as the effect at the population level is unknown. There are no other major operations within the Pembrokeshire Marine SAC or rivers draining into the SAC known to be causing entrapment of sea lamprey.

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

Fish community

The WFD estuarine fish tool is used as a proxy for habitat quality for fish in general in estuaries. If this element is classified as Good status it is likely that the conditions for fish, and therefore sea lamprey, are favourable. The estuarine fish element is assessed in the transitional WFD waterbodies only. Within the Pembrokeshire Marine SAC there is one relevant transitional WFD waterbody, the Milford Haven Inner. This was classified as Good status for the estuarine fish element in the 2024 cycle 3 interim classification, therefore the fish community indicator was assessed as passing its target. It was assessed as Good status in all previous cycles. 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 section 3.2 as it also applies to sea lamprey. It is not known how sea lampreys use and are distributed in the SAC, and therefore how long they spend in the different waterbodies. Sea lampreys travel further out to sea compared with river lampreys so it is possible that the contaminants failure in the Milford Haven Inner waterbody has less of an impact. However, as sea lampreys are thought to use the Milford Haven estuary at certain times in their lifecycle, the failure in the Milford Haven Inner waterbody has resulted in a failure for the contaminants indicator.

Temperature is a migratory cue for sea lampreys, where mean daily river temperatures exceeding 12ºC have coincided with peaks of sea lamprey migration on the River Tywi during spawning season (Clabburn and Davies, 2011). During monitoring of sea lampreys on the eastern Cleddau in 2011, temperatures only met this level 53% of the time. This may have been due to compensation releases from the Llys Fran reservoir due to low flows during the spring of 2011 (Clabburn and Davies, 2011). The conditions in spring 2011 were not typical, but they could be repeated during dry summers, and could therefore limit the presence and success of spawning of sea lamprey. The physicochemical properties indicator was still assessed as unknown based on the reasons outlined in the river lamprey water quality section in section 3.2.

Reasons for target failure

The assessment of sea lamprey in Pembrokeshire Marine SAC failed two primary targets and one secondary target. This resulted in the sea lamprey feature to be assessed as being in **unfavourable** condition. The failing indicators and reasons for failure, if known, are stated below.

Population variables and data

The Cleddau Rivers were considered to be the primary upstream spawning locations for the SAC in this assessment. There has been no evidence of sea lampreys on the eastern Cleddau in the last 10 years, with no redds observed in the reaches upstream of Canaston weir. Acoustic tracking in the most recent study in 2023 recorded zero sea lamprey in the eastern Cleddau. Sea lampreys have historically been present in both the eastern and western Cleddau Rivers. Therefore, the absence of records in recent years indicates a poor population present within the upstream spawning rivers that are connected to the Pembrokeshire Marine SAC due to restricted connectivity.

Habitat connectivity

This indicator failed due to the two weirs present within the Cleddau Rivers, the Canaston weir in the eastern Cleddau and the Haverfordwest Town weir in the western Cleddau. Monitoring of sea lamprey at the Canaston weir in 2023 recorded zero sea lamprey. The weir currently has a fish pass, however the lack of redds upstream of the weir suggests this is suboptimal for sea lampreys. Improvements or replacement of the fish passes are currently planned or in progress at the two weirs in the Cleddau, with work due to complete in the summer of 2026. However, until the effects of these have been observed, this indicator will continue to fail.

Water quality: contaminants

See river lamprey reasons for failure in section 3.2 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 Pembrokeshire Marine SAC are stated below.

Industry

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

Invasive non-native species

There have been a small number of records of signal crayfish in South Pembrokeshire (not within the Cleddau Rivers SAC). Signal crayfish would predate on eggs and possibly ammocetes of the sea lamprey. There are currently no records of Chinese mitten crab in the Pembrokeshire Marine or Cleddau Rivers SACs. There is a threat that these species could be introduced to the area.

Further INNS were identified as potential threats to the UK and were listed in the latest horizon scanning exercise (Roy et al., 2019). There is a high likelihood for some of these

species to be found in Wales in the future. This SAC could be at risk since there are a number of possible pathways of introduction. Further information on introduction pathways can be found on the GB non-native species secretariat website.

Water quality: contaminants

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

4.3. Carmarthen Bay and Estuaries SAC condition assessment

Sea lamprey has been designated as a qualifying feature in Carmarthen Bay and Estuaries SAC as it has been considered an important coastal migration route or feeding ground for this species, and as it is adjacent to an important freshwater site for the species (River Tywi SAC). The River Tywi was therefore considered as the primary upstream spawning location for the SAC in this assessment. Other rivers that input into the SAC population (Tâf, Gwendeaeth and Loughor) have also been considered in the assessment. There may be other relevant smaller rivers that contribute to the SAC population. A summary of the condition assessment for sea lamprey in Carmarthen Bay and Estuaries SAC can been seen in Table 12. The overall feature condition, a detailed summary of the assessment and threats to condition are discussed in more detail in the sections below.

Table 12. Condition assessment of sea lamprey in Carmarthen Bay and Estuaries SAC. Each indicator target has a primary (P), secondary (S) or tertiary (T) weighting (see section 1.1).

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

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

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

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

Assessment conclusions

The sea lamprey feature in Cardigan Bay SAC has been assessed as being in **favourable** condition (medium confidence). Overall, sea lamprey numbers in the River Tywi are generally in the thousands, with much of the catchment suitable for spawning and being easily accessible, which has contributed to this favourable assessment outcome. There was one indicator with a failing target (Table 13). 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 13 with more detail on each performance indicator, and any reasons for failure, provided in the sections below.

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

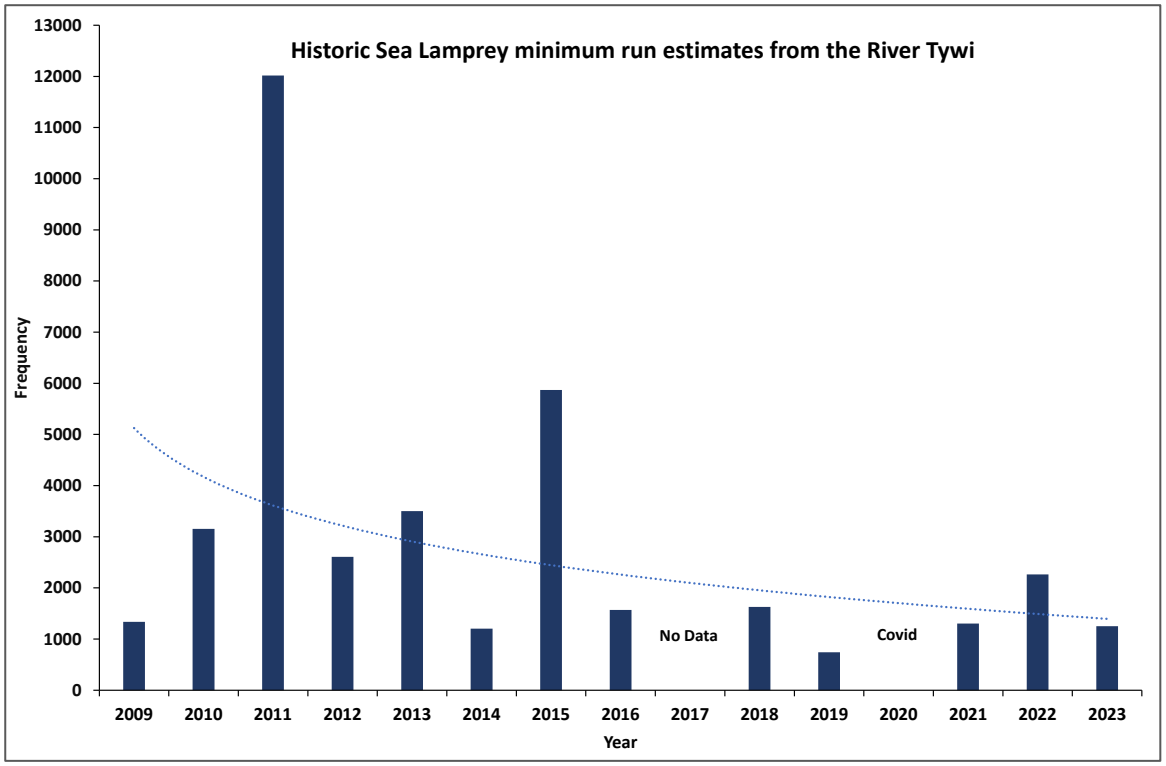
SAC	Overall Condition Assessment	Indicator failures	Reason for target failure	Threats to condition
Carmarthen Bay and Estuaries	**Favourable (medium confidence)**	Water quality: contaminants (S)	• Levels of mercury, PBDE and cypermethrin in the Carmarthen Bay waterbody are failing to meet their relevant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

Detailed assessment information

Population variables

Sea lampreys in the River Tywi SAC catchment are generally in the thousands and all of the catchment is suitable for spawning and easily accessible. Tracking of adult sea lampreys has been carried out in the River Tywi SAC within NRW since 2009 (using DIDSON in earlier years and ARIS in recent years), which has identified high numbers of adults in upstream and downstream areas of the catchment. Sea lamprey numbers were highest in 2011 compared to any other year (Figure 3). Numbers were also high in 2015 (approximately 5,800) (Figure 3). Sea lamprey numbers have been highly variable on the River Tywi throughout the monitoring period, however a general decline in numbers can be observed since the start of deployment in 2009 (Griffiths, in draft) (Figure 3). The most recent provisional sea lamprey counts (2021-2023) range from approximately 1,250 to 2,250 (Figure 3). Further evidence is needed to substantiate any potential decline in estimates. The data from this study showed that run timings may be fluid depending on environmental conditions, therefore the start of the deployment may not coincide with the start of the run time. This may be reducing the accuracy of the estimates. Environmental factors may be causing a shift in the timings of migration, which will need to be investigated in future deployments (Griffiths, in draft). The annual run estimates in the Tywi are strong when compared to data collected in other catchments. As sea lampreys do not show homing behaviour to their natal river for spawning, abundance within a spawning river can fluctuate largely between years.

Figure 3. Historical sea lamprey minimum run estimations from 2009-2023 (Griffiths, in draft).



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

Habitat connectivity and freshwater flow

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

The freshwater flow indicator passed the target as there are no known issues with flow to the Three Rivers estuary or River Tywi SAC that drains directly into the Carmarthen Bay and Estuaries SAC. This conclusion was based on the RoC process (see further information in section 3.1). Confidence in the pass is medium as flow data were not used for the assessment.

Invasive non-native species

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

Anthropogenic mortality

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

In Wales, all licenced abstractions have been assessed through Eel Regulations, Habitats Regulations RoC process, or SAFFA 1975 to ensure that all permitted abstractions are screened to minimise entrainment of fish. There are no major operations such as power stations within the Carmarthen Bay and Estuaries SAC or rivers draining into the SAC

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

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

Fish community

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

Water quality

See river lamprey water quality in section 3.3 as it also applies to sea lamprey.

Reasons for target failure

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

Water quality: contaminants

See river lamprey reasons for failure in section 3.3 as it also applies to sea lamprey.

Threats to condition

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

Industry

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

Invasive non-native species

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

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

Water quality: contaminants

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

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

Climate change

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

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

5. Evidence gaps for the river and sea lamprey features

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

Listed below are current indicators that were either assessed as unknown, not assessed, or assessed with a lower confidence. This was due to either limited data availability, outdated data, or a lack of information. Some indicators are not currently monitored but should be ideally considered in future condition assessments. Not all evidence gaps apply to every SAC, see Table 14 for details.

Table 14. Evidence gaps for the river and sea lamprey features in Welsh SACs. 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)	Unknown / low or 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. • Tracking data on adult sea lampreys in the River Tywi SAC, which is directly upstream of the Carmarthen Bay and Estuaries SAC, shows a potential decline in numbers over the monitoring period. This may be related to the run timings or changes in environmental conditions leading to a shift in the timing of migration periods. Further evidence is needed to substantiate any potential decline in estimates.
Anthropogenic mortality: abstraction and entrapment (S)	Unknown	• Pembroke Power Station has recorded impingement of sea lamprey but better understanding of the structure of the population is required to determine the effect at population level to the sea lamprey in Pembrokeshire Marine SAC. This evidence gap does not apply to river lamprey.

Indicator	Assessed status	Comments
Fish community (S)	Unknown	• The WFD Regulations monitoring of the estuarine fish community element is only carried out in some transitional WFD waterbodies therefore this does not cover the full extent of the SACs (coastal WFD waterbodies). • In the Carmarthen Bay and Estuaries SAC, neither of the transitional WFD waterbodies have been assessed for the estuarine fish element in the 2024 cycle 3 interim classification.
Water quality: physicochemical properties (T)	Not assessed / unknown	• There were no temperature, salinity or pH loggers within the Cardigan Bay and Carmarthen Bay and Estuaries SACs. • Further evidence in temperature changes is required to adequately assess this indicator in the Pembrokeshire Marine SAC. • Some physicochemical parameters such as salinity and pH have not been assessed in any SAC. These could be considered in future as some monitoring data are available. Remote sensing data on temperature, salinity and pH could be used in future.

6. References

Clabburn, P. and Davies, R.N. 2011. Monitoring aduly Sea Lamprey (*Petromyzon marinus*) migration using a DIDSON imaging sonar on the Eastern Cleddau, March – June 2011. Environment Agency report Ref No. FAT/11/07

Davies, R.N. and Bennett, C. 2013. Monitoring adult Sea Lamprey (*Petromyzon marinus*) migration on the Cleddau, 2012. Environment Agency report Ref No. FAT/13/03

Davies, R. 2020. Sonar fish migration monitoring on the river Teifi – 2019. NRW Report Ref No. TM/SE_EAAT/20_07

Environment Agency. 2019. Cypermethrin: Sources, pathways and environmental data.

Griffiths, J. 2023. Use of an ARIS imaging sonar to assess Sea Lamprey migration (*Petromyzon marinus*) through Canaston weir, Eastern Cleddau, Pembrokeshire. NRW Report Ref No. SEEAAT/REP/23/0

Griffiths, G. In draft. Use of an ARIS imaging sonar to assesses long-term population trends of Se Lamprey (*Petromyzon marinus*) in the River Tywi, Nantgaredig, Wales. 2015-2023. NRW Report Ref No. SEEAAT/REP/Tywi/06/24

Igoe, F., Quigley, D.T.G., Marnell, F., Meskell, E., O'Connor, W. and Byrne, C. 2004. The Sea Lamprey Petromyzon marinus (L), River Lamprey Lamperta fluviatalis (L) and Brook Lamprey (Lamperta planeri (Bloch) in Ireland: General Biology, Ecology, Distribution and Status with Recommendations for Conservation.

Khan, B., Burgess, R.M. and Cantwell, M.G. 2023. Occurrence and bioaccumulation patterns of per-and polyfluoroalkyl substances (PFAS) in the marine environment. *American Chemical Society, Environmental Science and Technology: Water,* 3(5), pp.1243-1259.

Kottelat, M. and Freyhof, J. 2007. Handbook of European freshwater fishes. Publications Kottelat, Cornol and Freyhof, Berlin. 646 pp.

Larsen, M. and Hjermann, D. 2022. Status and Trend for Heavy Metals (Mercury, Cadmium and Lead) in Fish, Shellfish and Sediment. In: OSPAR, 2023: The 2023 Quality Status Report for the Northeast Atlantic. OSPAR Commission, London.

Maitland, P. S. 2003. Ecology of the River, Brook and Sea Lamprey. Conserving Natura 2000 Rivers Ecology Series No. 5. English Nature, Peterborough.

NRW. 2014. DIDSON assessment of adult sea lamprey migration on the Western Cleddau. NRW Internal memo Ref No. NFAT 01_15

Renaud, C.B. 2011. Lampreys of the world. An annotated and illustrated catalogue of lamprey species known to date. FAO Species Catalogue for Fishery Purposes. No. 5. Rome, FAO. 109pp.

Roy, H.E., Peyton, J. and Rorke, S. 2019. Horizon-scanning for invasive alien species with the potential to threaten biodiversity and ecosystems, human health and economies in Britain. GB Non-native species secretariat.

Sutton, P. 2023. Analysis of 2020 and 2021 Milford Haven Temperature Monitoring Data Prepared for: Pembroke Power Station. RWE Generation UK plc. Reference number: ENV/713/2023

Viñas, L., Soerensen, A.L. and Fryer, R. 2022. Status and Trends of Polybrominated Diphenyl Ethers (PBDEs) in Biota and Sediment. In: OSPAR, 2023: The 2023 Quality Status Report for the North-East Atlantic. OSPAR Commission, London.

Webster, L. and Fryer, R. 2022. Status and Trends in the Concentrations of Polycyclic Aromatic Hydrocarbons (PAHs) in Shellfish and Sediment. In: OSPAR, 2023: The 2023 Quality Status Report for the North-East Atlantic. OSPAR Commission, London.

Zanandrea, G. 1959. Speciation among lampreys. Nature 184: 380.