Report under The Conservation of Habitats and Species Regulations 2017 (as amended), Regulation 9A

2019-2024

Conservation status assessment for the habitat:

H8330 - Submerged or partially submerged sea caves

Wales

Cyfoeth Naturiol Cymru
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JNCC

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This report was produced by JNCC in collaboration with Natural Resources Wales.

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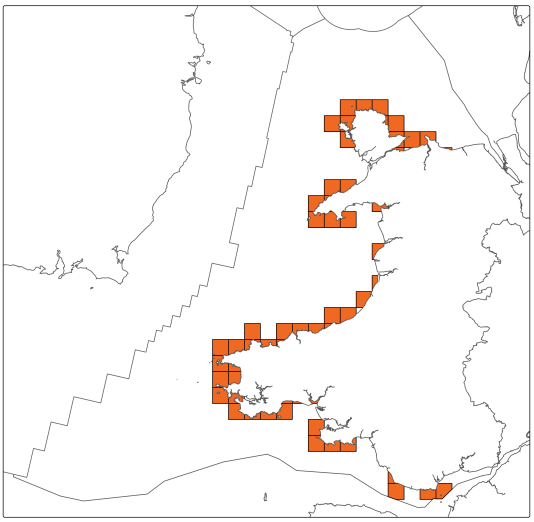
Important note - Please read

- The information in this document represents Wales Report under The Conservation of Habitats and Species Regulations 2017 (as amended), Regulation 9A, for the period 2019-2024.
- It is based on supporting information provided by Natural Resources Wales, which is documented separately.
- The Habitats Regulations reporting 2019-2024 Approach Document provides details on how this supporting information contributed to the UK Report and the fields that were completed for each parameter.
- Maps showing the distribution and range of the habitat are included.
- Explanatory notes (where provided) are included at the end. These provide additional audit trail information to that included within the assessments. Further underpinning explanatory notes are available in the related country reports.
- Some of the reporting fields have been left blank because either: (i) there was insufficient information to complete the field; (ii) completion of the field was not obligatory; and/or (iii) the field was not relevant to this habitat (section 11 National Site Network coverage for Annex I habitats).

Further details on the approach to the Habitats Regulations Reporting 2019-2024 are available on the JNCC website.

Assessment Summary: Submerged or partially submerged sea caves

Distribution Map



Range Map

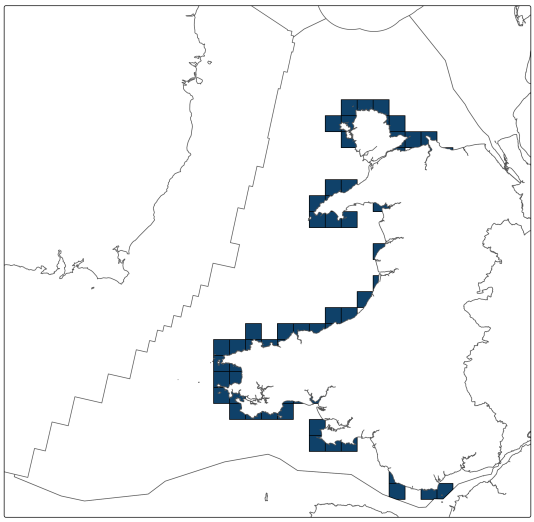


Figure 1: Wales distribution and range map for H8330 - Submerged or partially submerged sea caves. Coastline boundary derived from the Oil and Gas Authority's OGA and Lloyd's Register SNS Regional Geological Maps (Open Source). Open Government Licence v3 (OGL). Contains data © 2017 Oil and Gas Authority. The 10km grid square distribution map is based on available habitat records which are considered to be representative of the distribution within the current reporting period.

Sea caves are physiographic features and so their range is determined primarily by geomorphological and hydrographic processes occurring over long time-scales and is not related to biological communities or processes supported by communities. Therefore, the range was considered equivalent to the distribution and was calculated from the distribution map.

Table 1: Table summarising the conservation status for H8330 - Submerged or partially submerged sea caves. Overall conservation status for habitat is based on assessments of range, area covered by habitat, structure and functions, and future prospects.

Overall Conservation Status (see section 10)

Unfavourable-inadequate (U1)

Breakdown of Overall Conservation Status

Range (see section 4)	**Favourable (FV)**
Area covered by habitat (see section 5)	**Unknown (XX)**
Structure and functions (see section 6)	**Unfavourable-inadequate (U1)**
Future prospects (see section 9)	**Unknown (XX)**

List of Sections

National Level

1. General information

1.1 Country	Wales
1.2 Habitat code	H8330 - Submerged or partially submerged sea caves

2. Maps

2.1 Year or period	1975-2024
2.2 Distribution map	Yes
2.3 Distribution map; Method used	Based mainly on extrapolation from a limited amount of data

2.4 Additional information

No additional information

Biogeographical Level

3. Biogeographical and marine regions

3.1 Biogeographical or marine region where the habitat occurs MATL

3.2 Sources of information

See section 13 References

4. Range

4.1 Surface area (km²)	12,100
4.2 Short-term trend; Period	2013-2024
4.3 Short-term trend; Direction	Stable
4.4 Short-term trend; Magnitude	

a) Estimated minimum	
b) Estimated maximum	
c) Pre-defined range	
d) Unknown	
e) Type of estimate	
f) Rate of decrease	
4.5 Short-term trend; Method used	Based mainly on expert opinion with very limited data
4.6 Long-term trend; Period	2001-2024
4.7 Long-term trend; Direction	Stable
4.8 Long-term trend; Magnitude	
a) Minimum	
b) Maximum	
c) Rate of decrease	
4.9 Long-term trend; Method used	Based mainly on expert opinion with very limited data

4.10 Favourable Reference Range (FRR)

a) Area (km²)	
b) Pre-defined increment	Current range is less than 2% smaller than the FRR
c) Unknown	No
d) Method used	Expert opinion
e) Quality of information	

4.11 Change and reason for change in surface area of range

a) Change	No
b) Genuine change	

c) Improved knowledge or more accurate data	
d) Different method	
e) No information	
f) Other reason	
g) Main reason	

4.12 Additional information

No additional information

5. Area covered by habitat

5.1 Year or period	1975-2024
5.2 Surface area (km²)	
a) Minimum	0.0726
b) Maximum	0.0726
c) Best single value	0.0726
5.3 Type of estimate	Best estimate
5.4 Surface area; Method used	Based mainly on extrapolation from a limited amount of data
5.5 Short-term trend; Period	2013-2024
5.6 Short-term trend; Direction	Stable
5.7 Short-term trend; Magnitude	
a) Estimated minimum	
b) Estimated maximum	
c) Pre-defined range	
d) Unknown	
e) Type of estimate	
f) Rate of decrease	
5.8 Short-term trend; Method used	Based mainly on expert opinion with very limited data

5.9 Long-term trend; Period	2001-2024
5.10 Long-term trend; Direction	Decreasing
5.11 Long-term trend; Magnitude	
a) Minimum	
b) Maximum	
c) Confidence interval	
d) Rate of decrease	Decreasing <=1% (one percent or less) per year on average
5.12 Long-term trend; Method used	Based mainly on expert opinion with very limited data
5.13 Favourable Reference Area (FRA)	
a) Area (km²)	
b) Pre-defined increment	
c) Unknown	Yes
d) Method used	
e) Quality of information	

5.14 Change and reason for change in surface area of range

a) Change	Yes
b) Genuine change	No
c) Improved knowledge or more accurate data	Yes
d) Different method	Yes
e) No information	No
f) Other reason	No
g) Main reason	Use of different method

5.15 Additional information

No additional information

6. Structure and functions

6.1 Condition of habitat (km²)	
Area in good condition	
ai) Minimum	0.0389
aii) Maximum	0.0389
Area not in good condition	
bi) Minimum	0.0337
bii) Maximum	0.0337
Area where condition is unknown	
ci) Minimum	0.0726
cii) Maximum	0.0726
6.2 Condition of habitat; Method used	Based mainly on extrapolation from a limited amount of data
6.3 Short-term trend of habitat area in good condition; Period	
6.4 Short-term trend of habitat area in good condition; Direction	Unknown
6.5 Short-term trend of habitat area in good condition; Method used	Based mainly on expert opinion with very limited data
6.6 Typical species	
Has the list of typical species changed in comparison to the previous reporting period?	No
6.7 Typical species; Method used	

6.8 Additional information

Typical species were not used directly in the assessment of conservation status for habitat structure and function as a comprehensive list of typical species for each habitat

was not available. However, the status of typical species was considered when the condition of individual sites was assessed using Common Standards Monitoring Guidance. Common Standards Monitoring (CSM) data was used to assess the area of habitat in ‘good’ and ‘not good’ condition (field 6.1). Species were a component of the attributes assessed under CSM. Therefore, an assessment of species is considered to have formed part of the reporting under field 6.1 which supported the Habitats Structure and Function assessment (field 10.3).

The Limestone Coast of South West Wales SAC contains significant hibernation sites for Rhinolophus ferrumequinum greater horseshoe bats at sites such as Castle Martin and Bacon Hole. The significance specifically of the sea caves for this species is unclear, due to the inaccessible nature of the caves (Hatton Ellis et al., 2025).

7. Main pressures

7.1 Characterisation of pressures

Table 2: Pressures affecting the habitat, including timing and importance/impact ranking. Pressures are defined as factors acting currently and/or during the reporting period (2019–2024). Rankings are: High (direct/immediate influence and/or large spatial extent) and Medium (moderate direct/immediate influence, mainly indirect and/or regional extent).

Pressure	Timing	Ranking
PK02: Mixed source marine water pollution (marine and coastal)	Ongoing and likely to be in the future	Medium (M)
PA17: Agricultural activities generating pollution to surface or ground waters (including marine)	Ongoing and likely to be in the future	Medium (M)
PF10: Residential, commercial and industrial activities and structures generating marine pollution	Ongoing and likely to be in the future	Medium (M)
PJ01: Temperature changes and extremes due to climate change	Ongoing and likely to be in the future	Medium (M)
PJ13: Change of species distribution (natural newcomers) due to climate change	Ongoing and likely to be in the future	Medium (M)
PJ10: Change of habitat location, size, and / or quality due to climate change	Only in future	Medium (M)
PJ11: Desynchronisation of biological / ecological processes due to climate change	Only in future	Medium (M)

PJ12: Decline or extinction of related species (e.g. food source / prey, predator / parasite, symbiote, etc.) due to climate change	Only in future	Medium (M)
PE01: Roads, paths, railroads and related infrastructure	Only in future	Medium (M)

7.2 Sources of information

See section 13 References

7.3 Additional information

No additional information

8. Conservation measures

8.1: Status of measures

a) Are measures needed?	Yes
b) Indicate the status of measures	Measures identified and taken
8.2 Main purpose of the measures taken	Maintain the current range, surface area or structure and functions of the habitat type
8.3 Location of the measures taken	Both inside and outside National Site Network
8.4 Response to measures	Long-term results (after 2036)

8.5 List of main conservation measures

Table 3: Key conservation measures addressing current pressures and/or anticipated threats during the next two reporting periods (2025–2036). Measures are ranked by importance/impact: High (direct/ immediate influence and/or large spatial extent) and Medium (moderate direct/immediate influence, mainly indirect and/or regional extent).

Conservation measure	Ranking
MK01: Reduce impact of mixed source pollution	High (H)
MF06: Reduce/eliminate marine pollution from industrial, commercial, residential and recreational areas and activities (incl. contamination with litter)	High (H)

MA10: Reduce/eliminate point or diffuse source pollution to surface or ground waters (including marine) from agricultural activities	High (H)
MF10: Other measures related to residential, commercial, industrial and recreational infrastructures, operations and activities	High (H)
ME01: Reduce impact of transport operation and infrastructure	Medium (M)

8.6 Additional information

No additional information

9. Future prospects

9.1a Future trends of parameters

ai) Range	Overall stable
bi) Area	Unknown
ci) Structure and functions	Unknown

9.1b Future prospects of parameters

aii) Range	Good
bii) Area	Unknown
cii) Structure and functions	Unknown

9.2 Additional information

No additional information

10. Conclusions

10.1 Range	Favourable (FV)
10.2 Area	Unknown (XX)
10.3 Specific structure and functions (incl. typical species)	Unfavourable-inadequate (U1)
10.4 Future prospects	Unknown (XX)

10.5 Overall assessment of Conservation Status	Unfavourable-inadequate (U1)
10.6 Overall trend in Conservation Status	Stable

10.7 Change and reason for change in conservation status

This field is not reported as the period 2019-2024 marks the first instance in which conservation status has been assessed at the national level, meaning no comparisons to previous reports can be drawn.

10.7 Change and reason for change in conservation status trend

This field is not reported as the period 2019-2024 marks the first instance in which conservation status has been assessed at the national level, meaning no comparisons to previous reports can be drawn.

10.8 Additional information

No additional information

11. UK National Site Network (pSCIs, SCIs, SACs) coverage for Annex I habitat types

11.1 Surface area of the habitat type inside the pSCIs, SCIs and SACs network (km²)

a) Minimum	
b) Maximum	
c) Best single value	0.0304
11.2 Type of estimate	Best estimate
11.3 Habitat area inside the network; Method used	Based mainly on extrapolation from a limited amount of data
11.4 Short-term trend of habitat area within the network; Direction	Stable

11.5 Short-term trend of habitat area within the network; Method used	Based mainly on expert opinion with very limited data
11.6 Short-term trend of habitat area in good condition within the network; Direction	Unknown
11.7 Short-term trend of habitat area in good condition within the network; Method used	Insufficient or no data available

11.8 Additional information

No additional information

12. Complementary information

12.1 Justification of percentage thresholds for trends

No justification information

12.2 Other relevant information

No other relevant information

13. References

Biogeographical and marine regions

3.2 Sources of information

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Main pressures

7.2 Sources of information

No sources of information

14. Explanatory Notes

Field label	Note
2.1: Year or period	No exhaustive survey of sea caves has ever been undertaken in Wales, and of those that have been identified, very few have been studied in detail. Sections of rocky cliffy coast, where individual caves have been identified, have been assumed to support caves along their entire length. Phase 1 intertidal surveys (Wyn et al., 2006) supplied positions for some caves and some sections of cliffy coastline have been assumed to support sea caves where the high-water mark reaches above the base of the cliff. Neither the point data (mostly Phase 1) nor line data is exhaustive (NRW, 2013b). Some sections of coast that may contain sea caves remain un-surveyed for presence of caves. As natural change in cave distribution is considered unlikely to occur rapidly, all known records for caves have been included (back to at least 1975). However, consideration has been given to the potential for loss of caves through anthropogenic intervention (e.g. closed off during coastal defence works).
4.2: Short-term trend; Period	This assessment is based on very little new data and therefore largely reflects the conclusions of the 2018 report.
4.3: Short-term trend; Direction	No new data or information relating to sea caves has been collected during the short-term trend period (i.e. since the 2018 report). Short-term trend is a best estimate with low confidence and is based on there being no evidence of cave losses during the stated period.
4.5: Short-term trend; Method used	The value given here is the range value derived from 10 km2 squares, provided by JNCC in 2013. No change since then.
4.6: Long-term trend; Period	No new data or information relating to sea caves has been collected since 2015, therefore this assessment reflects the conclusions of the 2018 reporting.

4.7: Long-term trend; Direction	No new data or information relating to sea caves has been collected since 2015. There were some cave losses in the past, prior to 2004 (Brazier, 2017, Burdon & Boyes, 2009). Only a few caves were affected, therefore range at the 10 km2 level is unlikely to have changed since 1989. Long-term trend is a best estimate with low confidence and is based on there being no evidence of cave losses during the stated period.
4.11: Change and reason for change in surface area of range	There has been no change to the Welsh 10 km2 distribution reported here from that submitted in support of the 2018 article 17 report. During the current reporting period (2019-2024), there have not been any reported cases of reduction in cave habitat range.
5.1: Year or period	As natural change in cave extent and distribution is considered unlikely to occur rapidly, all known records for caves have been included (back to at least 1975). However, consideration has been given to the potential for loss of caves through anthropogenic intervention e.g. closed-off or in-filled as a result of coastal defence or infrastructure protection.
5.3: Type of estimate	We have no true value for the surface area of sea caves, nor is it likely that we ever will. No exhaustive survey of sea caves has ever been undertaken in Wales, and of those that have been identified and georeferenced, very few caves have been studied in any detail. The main reasons for this lack of study, is that caves are usually remote and often almost inaccessible, therefore costs in terms of survey time and resources are high. For example, Bunker & Holt (2003) describe intertidal and subtidal sea cave surveys that took place between 2000 and 2002 within Welsh Special Areas of conservation (SACs). These surveys involved 11 people, took 16 days and surveyed a total of 24 sea caves. These surveys included mapping and photographing caves, a detailed inventory of species and biotopes present and the installation of permanent monitoring equipment (Bunker & Holt, 2003). The figures in this section should therefore be treated with

	caution and are of very low confidence. It is likely only a small proportion of sea caves present in Wales have ever been recorded. Using the method described in the 2013 sea cave report (NRW, 2013a, NRW, 2013b), the figure shown above was calculated by giving each known cave a standard area value of 100 m2, which approximates to an 'average cave" of 10 m depth and circular cross-section of 3 meters (diameter). The total number of sea caves (726) situated in Wales (as estimated in the current reporting round), was multiplied by the average cave (100 m2) area to give the overall surface area value presented above. Note, in the current reporting round the total estimate of Welsh sea caves was less than in previous rounds due to a change in how sea caves were identified within GIS. Previously, the number of sea cave biotopes was used as a proxy for the number of sea caves. In the current round, this number was rationalised where an individual sea cave had multiple biotope records. Caves tend to occur along or above the highwater mark of rocky cliff areas. Many marine GIS layers, such as SAC boundaries, use the mean highwater mark as the shoreward edge of the designation. This creates a problem when mapping vertical features such as caves as they often fall outside the boundary layer within the GIS and therefore it is not always clear from the GIS whether a cave is even situated within a SAC.
5.6: Short-term trend; Direction	Although the most recent Special Area of Conservation (SAC) sea cave condition assessment was unknown, indicators relating to feature distribution and extent all passed their targets in all SACs. Additionally, no anthropogenic activities were identified during the current short-term period that might directly impact the sea cave feature condition (Hatton Ellis et al., 2025). The short-term trend in sea cave extent is therefore

	assumed to be stable. However, this trend direction has low confidence as it is based on expert judgment.
5.10: Long-term trend; Direction	Although the short-term trend direction was considered stable (section 5.6), Burdon & Boyes (2009) reported significant localised occurrences of historical cave infilling or modification relating to coastal defences and protection of railway infrastructure. They estimated as of 2004 (the year of the survey), 66% of caves were lost or modified within the 4 km coastal stretch between Friog and Llwyngwril in Gwynedd, north Wales. Although no specific dates were reported, it was estimated the losses had occurred in the few decades prior to 2004 (Burdon & Boyes, 2009). Following a second partial survey of this area in 2015, and subsequent comparison to 2004 data, Brazier (2017) concluded that no further losses to the cave feature had occurred since the 2004 survey, although some existing defences had been maintained. However, Brazier (2017) indicated a potential for further cave losses in this area due to the likely need of future coastal defences along the same stretch of coastline. No evidence of further losses were identified in the current reporting round. Based on this evidence and expert opinion the long-term trend in cave extent was assessed as decreasing. The magnitude of the decrease is likely to be small as there are lots of caves and comparatively few are known to have been filled in or modified. The confidence of this assessment is low based on the lack of cave extent data and the uncertainty of dates of historic cave losses.
6.1: Condition of habitat	We have no true value for the surface area of sea caves, whether good or not-good habitat, nor is it likely that we ever will. No exhaustive survey of sea caves has ever been undertaken in Wales, and of those that have been identified and georeferenced, very few caves have been studied in any detail. Therefore, the figures above should be treated with caution and are of very low confidence. During the most recent Special Areas of Conservation

(SAC) indicative condition assessment (2024), all SACs with sea cave features passed their targets relating to cave distribution and extent. However, targets relating to habitat structure and function were assessed as unknown and each SAC overall, was assessed as unknown (Hatton Ellis et al., 2025). Additionally, no widespread surveys of sea caves have been completed since 2002 (Hatton Ellis et al., 2025) and therefore it is difficult to assess the condition of this habitat in terms of structure and function.

The only addition information available to assess sea caves that are not in 'good' condition is the outcome of the most recent Water Framework Directive (WFD) classification. Using GIS, sea caves within 'High' or 'Good' WFD waterbodies were considered in 'Good' condition, those in 'Moderate' or 'Poor' waterbodies were assigned 'Not Good' condition. The proportions of caves have then been adjusted to an area value using the same method as described in section 5.3 (NRW, 2013a, NRW, 2013b). The 389 caves (54%) located in High and Good WFD waterbodies was multiplied by 100 m2 to provide an area in square metres of 'Good' habitat, this value was divided by a million to convert to km2. The same calculation was applied to the 337 (46%) caves located in Moderate or Poor waterbodies, providing the value for habitat classed as 'Not Good'.

These figures should be treated with caution and are of very low confidence. Only a small proportion of sea caves present have ever been recorded accurately. Additionally, WFD results from a sampling location may not be appropriate for cave features throughout the rest of the waterbody. There has not been the opportunity to verify that a WFD sampling location is appropriate to use for the feature across the spatial extent of the waterbody. For example, extensive tracts of north Cardigan Bay are 'not good' due to mercury levels, but no evaluation has been done to the appropriateness of this outcome, since the

	sampling location is likely to be a long way from some parts of the feature.
7.1: Characterisation of pressures	PK02: Mixed source marine water pollution (marine and coastal) & PA17: Agricultural activities generating pollution to surface or ground waters (including marine). Timing: 3 ongoing and likely to be in the future; Pressure: medium There are multiple sources of pollution to the marine environment that are difficult to quantify and apportion. Open coast areas are relatively unpolluted, but many coastal areas have raised levels of nutrients and contaminants. Within the sea caves SAC network six WFD waterbodies failed due to nutrients or chemicals including mercury, polybrominated diphenyl ethers (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 (Environment Agency. 2019). The application of cypermethrin has been restricted for some uses (sheep dipping and in forestry against the pine weevil). In the most recent WFD cycle 3 interim classification, the following WFD waterbodies failed targets for marine pollution related elements, comprising nutrient levels (DIN - Dissolved Organic Nitrogen) and the specified contaminants (Hatton Ellis et al., 2025): • Anglesey North contains 38% of sea caves within the

Menai Strait and Conwy Bay SAC and failed due to contaminants - mercury and PBDE.

• Cardigan Bay North contains 64% of sea caves within the Pen Llŷn a'r Sarnau SAC and failed due to contaminants - mercury and PBDE.

• Teifi Estuary contains 22% of sea caves within the Cardigan Bay SAC and failed due to nutrients – Dissolved Inorganic Nitrogen (DIN).

• Cardigan Bay Central contains 24% of sea caves within the Cardigan Bay SAC and failed due to contaminants - mercury and PBDE.

• Milford Haven Outer contains 4% of sea caves within the Pembrokeshire Marine SAC and failed due to nutrients – Dissolved Inorganic Nitrogen (DIN).

• Carmarthen Bay contains 28% of sea caves within the Limestone Coast of south-west Wales SAC and failed due to contaminants – mercury, PBDE and cypermethrin.

WFD investigations of the nutrient failures for waterbodies within Cardigan Bay SAC and Pembrokeshire Marine SAC confirm the DIN failures (Jopson, et al., in draft; Lock, 2021). These reports concluded main inputs of nutrients were likely derived from diffuse sources associated with agriculture and rural land management (Jopson, 2022; Jopson, et al., in draft). Point source continuous and intermittent sewage discharge from the water industry were also likely to be a minor source of nutrients linked to the DIN failures (Haines and Edwards, 2016; Caprez, 2020; Lock, 2021; Jopson, 2022; Jopson, et al., in draft).

Low confidence on the levels of pressure and threat, due to the uncertainty of the significance of coastal pollution of the biological communities of sea caves (Hatton Ellis et al., 2025).

PF10: Residential, commercial and industrial activities and structures generating marine pollution.

Timing: 3 ongoing and likely to be in the future; Pressure: medium

Marine macro-pollution (e.g. plastic bags, lost fishing gear and other anthropogenically derived debris) tends to accumulate within sea caves, particularly those with an internal beach. There is a small increasing trend in marine litter on UK beaches (Nelms et al., 2017; NARC, 2015, 2016 & 2022). Grey seals in Wales largely pup within caves and the pups and adults must negotiate this debris and may ingest, entangle or injure themselves in the process. Negative (and some negligible) impacts of ingestion of plastic have been observed on marine species but the research on the impacts of litter in the marine environment is in its infancy and impacts are poorly understood (Bergmann et al., 2015; Gall & Thompson, 2015; Galloway & Lewis, 2016). Further assessment of the impacts is required to aid understanding of the extent and the likely impact of litter on the functioning of animal communities, and recommendations of any appropriate management action.

PJ01 Temperature changes and extremes due to climate change &

PJ13 Change of species distribution (natural newcomers) due to climate change.

Timing: 3 ongoing and likely to be in the future; Pressure: medium

The timing of these pressures are now considered ongoing now and in the future due to evidence to suggest temperature changes and extremes and changes in species distributions due to climate change is already

occurring. Confidence in available evidence has increased from low to medium (Moore & Smale, 2020). Benthic habitats are predicted to face increased temperatures and frequency of heatwaves under climatic projections in the future. Circalittoral rocks are thought to face a strong effect of increased temperatures in the future (Moore & Smale, 2020). Benthic invertebrates and macroalgal species distributions and range shifts of local species, with some increase in warm-water affinity species especially in the South-West.

PJ10: Change of habitat location, size, and / or quality due to climate change &

PJ11: Desynchronisation of biological / ecological processes due to climate change &

PJ12: Decline or extinction of related species (e.g. food source / prey, predator / parasite, symbiote, etc.) due to climate change.

Timing: 4 only in future; Pressure: medium

As a result of warming seas, there is evidence of major declines in plankton abundances in the NE Atlantic (~50% decline in copepod abundance over the last ~60yrs), shifting to a 'microbial food web" driven by picophytoplankton e.g. Synechococcus (Schmidt et al. 2020; Holland et al. 2023). Synechococcus is a poor primary producer due to its small size and lack of essential fatty acids (Lindeque et al. 2015). Changes such as this are likely to affect entire food-webs and a particular at-risk group would be filter-feeders such as those found in partially submerged sea caves.

Climate change and ocean acidification cause direct and indirect pressures which can significantly alter the environmental conditions (e.g. decreases in pH, increases in sea surface temperature) necessary for benthic

ecosystem processes and functions (OSPAR, 2023). Climatic models predict there will be changes to area of suitable habitat in the future depending on the climatic scenario (Moore & Smale, 2020). Other studies suggest ecosystem-level responses could remain stable over long periods of time, depending on the species involved (Moore & Smale, 2020). While confidence in evidence has increased from low to medium, there are still knowledge gaps meaning we are unable to fully assess the scale of benthic species and community responses in relation to climate change (Moore & Smale, 2020).

PE01: Roads, paths, railroads and related infrastructure.

Timing: 4 only in future; Pressure: medium

Historically, sea cave losses or modifications (i.e. caves closed off or partially filled in) appear to have been a result of maintenance or creation of road and rail infrastructure (particularly railways), specifically to prevent or reduce erosion that may adversely affect such infrastructure. Casework, involving Network Rail, has aimed to avoid further cave infilling, such as that which occurred along the coastal stretch between Friog and Llwyngwril in Gwynedd, north Wales (Brazier, 2017, Burdon & Boyes, 2009).

With future sea level rise and continual erosion, it is anticipated that further caves will be in-filled to secure major infrastructure (Railway and roads), resulting in a medium threat.

PF05: Sports, tourism and leisure activities.

Timing: 3 ongoing and likely to be in the future; Pressure: low

Recreational use of intertidal caves resulting in trampling and scouring of cave floor and sides. Although no evidence of direct impacts, concern has been raised due to increases

in activities such as coasteering and climbing in Pembrokeshire and Pen Llyn a'r Sarnau. Although limited in extent, increased recreational use of intertidal caves has the potential to disturb seals during the pupping season and disturb bats at all times of the year.

The Limestone Coast of South West Wales SAC contains significant hibernation sites for Rhinolophus ferrumequinum greater horseshoe bats at sites such as Castle Martin and Bacon Hole. The significance specifically of the sea caves for this species is unclear, due to the inaccessible nature of the caves (Hatton Ellis et al., 2025).

PK03: Mixed source air pollution, air-borne pollutants.

Timing: 3 ongoing and likely to be in the future; Pressure: low

Nitrogen input is particularly cumulative in areas with existing high nitrogen loads such as the Milford Haven, where there are inputs from LNG plants and the power station as well as water borne oxides of nitrogen (Edwards, 2014, Haines & Edwards, 2016). Small amounts of other airborne pollutants are likely to be derived from other industries across Wales.

PI02: Other invasive alien species (other than species of Union concern). Timing: 4 only in future; Pressure: low

Presence of invasive non-native species on inshore reefs including Crepidula fornicata (Bohn, 2014), Magallana (Crassostrea) gigas, Didemnum vexillum and Sargassum muticum. Modification of habitat and associated community is observable in areas of high density. The future threat from highly invasive species such as Didemnum vexillum is high. However, it is unclear if these species would colonise sea caves, therefore the pressure is assessed as in the future and low.

PJ03 Changes in precipitation regimes due to climate change &

PJ04 Sea-level rise due to climate change. Affecting Inshore &

PJ06 Wave exposure changes due to climate change &

PJ07 Cyclones, storms, or tornados due to climate change &

PJ14: Other climate related changes in abiotic conditions.

Timing: 4 only in future; Pressure: low

Climate-change related changes in sea-level and wave exposure have the potential to impact and affect the physical structure and biological communities of sea caves. Increased erosion from rising sea level and wave exposure can provide the opportunity for additional formation of caves, whilst destroying others. Sea level rise projections for Wales to 2099 (~ 1 m increase) suggest intertidal rocky features will be highly vulnerable to sea level rise in the long terms (Oaten et al., 2021).

It is currently unclear how changes in abiotic conditions due to climate change will affect the biotic conditions in sea caves. Oaten et al. (2021) assessed some intertidal reef biotopes as likely to be highly vulnerable to climate driven changes in wave exposure by 2049.

This suit of climate change driven changes were assessed as low and acting in the future as timescales of impacts are predicted to be greater than two reporting cycles away.

PE03: Shipping lanes, ferry lanes and anchorage infrastructure (e.g. canalisation, dredging).

Timing: 4 only in future; Pressure: low

	Sea caves have been, or could potentially be, closed off or filled in to prevent or reduce erosion that may adversely affect port and harbour infrastructure. PF15: Modification of coastline, estuary and coastal conditions for built-up areas. Timing: 3 ongoing and likely to be in the future; Pressure: low Sea caves have been, or could potentially be, closed off or filled in to prevent or reduce erosion that may adversely affect residential, commercial, industrial and recreational infrastructure, or caves near to urban areas that are considered to pose a health and safety risk. This is considered a low threat, due to the distribution of sea caves largely being away from residential, commercial, industrial or recreational infrastructure.
8.5: List of main conservation measures	MK01: Reduce impact of mixed source pollution. High. & MF06: Reduce/eliminate marine pollution from industrial, commercial, residential and recreational areas and activities (incl. contamination with litter). High & MA10: Reduce/eliminate point or diffuse source pollution to surface or ground waters (including marine) from agricultural activities. High Key measures which are in place to mitigate water quality related pressures and threats identified in this assessment are driven by European legislation and cover the wider sea area: The Water Framework Directive (WFD) aims to maintain the 'high and good status" of waters where it exists, prevent any deterioration in the existing status of waters and to restore at least 'good status" in relation to all waters. The mechanism by which this is to be achieved under the WFD is through the adoption and implementation of River Basin Management Plans and Programmes of

Measures for each of the identified River Basin Districts. The Programme of Measures will be incorporated into the delivery plan for updated river basin management plans. Many planned measures aim to deal with issues causing WFD coastal and estuarine waterbody failures for ecological and chemical elements. The Programme of Measures delivers many of the statutory requirements for other directives and associated legislations e.g. Marine Strategy Framework Directive, Urban Waste-Water Directive, Bathing Waters Directive and Eel Regulations.

The UK Marine Strategy identifies marine litter as a descriptor of clean seas (Descriptor 10) and requires UK administrations to ensure that 'properties and quantities of marine litter do not cause harm to the coastal and marine environment' (HM Government 2025). As a Contracting Party to the OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic, UK government in collaboration with devolved governments is also developing and implementing actions under the OSPAR Regional Action Plan for Marine Litter to 'prevent inputs of and significantly reduce marine litter, including microplastics, to reach levels that do not cause adverse effects to the marine and coastal environment with the ultimate aim of eliminating inputs of litter”. The Action Plan has three key themes: actions to reduce land-based sources of marine litter, actions to reduce sea-based sources of marine litter and cross cutting actions.

In Wales, the Welsh National Marine Plan (Welsh Government, 2019) encourages action to reduce litter in the marine environment (ENV_04) and requires developers to consider how to prevent or minimise marine litter in their proposals. The Wales Clean Seas Partnership, part of the United Nations Clean Seas Campaign and Global Partnership on Marine Litter is a multi-stakeholder group which develops and delivers the Marine Litter Action Plan for Wales. Welsh Government funds Keep Wales Tidy and Natural Resources Wales' Fly Tipping Action Wales

Programme, which work to enable proper waste management and prevent fly tipping which can be a source of marine litter. In 2021, Welsh Government published the Beyond Recycling Strategy (Welsh Government, 2021a), to implement a circular economy in Wales. This encourages proper waste management and commits to phase out single-use plastics which could end up as marine litter. In 2023, the Welsh Government launched the Environmental Protection (Single-use Plastic Products) Act (Welsh Government 2023), which bans the sale and supply of selected single use plastic items, such as plastic cutlers and straws, many of which are commonly found as marine litter. Future exemptions are likely to also include wet wipes and single use vapes.

Voluntary organisations undertake litter removal at specific locations. This includes beach cleans (organised by local groups or the marine conservation society) and subtidal litter removal (NARC, 2015; 2016; 2022) based in southwest Wales.

Implementation and enforcement of water quality regulation (both marine and freshwater) is ongoing work and is making gains in improving water quality. Shared multi-agency pollution response plans to deal with major incidences are in place and are regularly updated. Remediation work continues for capturing mine water and removing heavy metal contaminants (Jarvis et al., 2014).

MF10: Other measures related to residential, commercial, industrial and recreational infrastructures, operations and activities. High

This measure covers the HRAs that have been completed for construction projects, to ensure no significant effect on site integrity within marine Natura 2000 sites.

This measure is ranked High due to its importance in reducing impacts on Welsh SAC features from construction

and development projects within SACs

ME01: Reduce impact of transport operation and infrastructure. Medium &

ME06: Habitat restoration of areas impacted by transport. Low

MF02: Habitat restoration of areas impacted by residential, commercial, industrial and recreational infrastructure, operations and activities. Low

General regulatory framework for assessment of environmental impacts prior to development, plans and projects.

The Shoreline Management Plans (SMP) which identify the most sustainable approach to managing the flood and coastal erosion risks to the coastline in the short, medium and long term have been produced for the whole of the Welsh coast, however, these plans have yet to be fully implemented.

The National Habitat Creation Program has been put in place by the Welsh Government to identify and progress opportunities for managed retreat of the coastal line, to mitigate losses of intertidal habitats as a result of man-made constraints where Hold-The-Line policies of the Shoreline Management Plan have been maintained.

MF03: Reduce impact of outdoor sports, leisure and recreational activities (incl. restoration of habitats). Low

Targeted education, awareness raising, and voluntary measures including developing guidance and a code of conduct for good practice relating to climbing, caving and coasteering to reduce impacts from trampling and damaging the fragile biological communities in caves.

MJ01: Implement climate change mitigation measures. Low

The UK, including Wales, has implemented various conservation measures to mitigate climate change impacts, focusing on carbon reduction, habitat restoration, and sustainable resource management.

One major initiative is the UK's net-zero by 2050 target, which Wales supports through its Net Zero Wales plan under the Environment (Wales) Act 2016. This includes decarbonising industries, investing in marine renewables like floating offshore wind farms in the Celtic Sea, and restoring natural carbon sinks (Welsh Government, 2021b). There is growing focus on marine and coastal restoration of habitats such as salt marsh, seagrass and native oyster, all of which are important for blue carbon storage. A number of projects to restore these habitats right across Wales, and a further focus on restoration is supported by WG's Programme for Government commitment to put in place targeted programmes of restoration for sea grass and salt marsh.

Habitat conservation plays a crucial role in climate mitigation. For example, peatland restoration is a key focus in Wales, as peatlands store vast amounts of carbon. The National Peatland Action Programme aims to restore 600-800 hectares of peatland per year, with projects in Eryri (Snowdonia), Bannau Brycheiniog (Brecon Beacons), and the Cambrian Mountains (NRW, 2022). Similarly, the National Forest for Wales is expanding tree planting to improve carbon sequestration and biodiversity.

Wales is also reforming agriculture under the Sustainable Farming Scheme, which rewards farmers for climate-friendly practices like soil conservation and agroforestry.

These conservation efforts, combined with emissions reduction policies, contribute to Wales' climate resilience strategy.

MI03: Management, control or eradication of other invasive alien species. Low

Legislative agreements seek to protect biodiversity, species and habitats, and include provisions requiring measures to prevent the introduction, spread and control of, invasive non-native species (INNS), especially those that threaten native or protected species and habitats.

Through its implementation of the Marine Strategy Framework Directive (MSFD), the UK aims to ensure that INNS introduced by human activities are at levels that do not adversely alter the ecosystems. The UK's Marine Strategy includes targets to reduce the risk of introduction and spread of non-native species through improved management of high-risk pathways and vectors, and for action plans to be developed for key high-risk marine non-indigenous species by 2020. The strategy also sets out indicators for Good Ecological Status (GES) in respect of these INNS targets, and monitoring programmes for measuring progress towards achieving or maintaining GES. In Wales, various statutory and ad-hoc monitoring programmes contribute towards the MSFD INNS evidence baseline. Examples include marine rapid assessment surveys of Welsh marinas carried out in 2011 and 2014 (Sambrook et al., 2014). Contingency plans are currently being developed for priority marine INNS species not yet established in Wales.

The impacts associated with INNS are also recognised as potentially significant anthropogenic pressures through the UK's approach to implementing the Water Framework Directive. Impacts from invasive non-native species are considered as part of the assessment of the ecological status of water bodies and, in general terms, measures are adopted to improve status and address impacts, on a water body by water body basis, where INNS are implicated in a water body failing to achieve its objectives.

	In Wales, anthropogenic activities with the potential to introduce or spread INNS are managed through the implementation of biosecurity risk assessment and management planning under existing regulatory and consenting frameworks. Examples include the marine licensing provisions of the Marine and Coastal Access Act 2009, Habitats Regulations Assessments under the Conservation of Habitats and Species Regulations 2017 and Sites of the Special Scientific Interest (SSSI) consenting procedures under the Wildlife and Countryside Act 1981. Natural Resources Wales and the Welsh Government are standing members of the UK Marine Pathways Group, a coordinated approach to preventing new INNS introductions, early detection and rapid action to prevent the establishment of INNS, and containment and long-term control measures across the UK and Ireland. The Marine Pathways Group, in its earlier project form, produced specific INNS guidance and voluntary best practice for marina operators, boat owners and the aquaculture sector, and led on the identification of locations at high risk of introduction where biosecurity efforts should be focused.
10.1: Range	Conclusion on Range reached because: (i) the short-term trend direction in Range surface area is stable; and (ii) the current Range surface area is approximately equal to the Favourable Reference Range.
10.2: Area	Conclusion on Area reached because:(i) the short-term trend direction in Area is stable; (ii) the Favourable Reference Area is unknown and iii) there has been no significant change in distribution pattern within range.
10.3: Specific structure and functions	Conclusion on Structure and function reached because: i) habitat condition data indicates that less than 75% of the habitat is in favourable (good) condition; ii) short-term trend in area of habitat in good condition is unknown; and iii) expert opinion determines that we have no evidence to support a conclusion of unfavourable-bad.

	Fields within section 5 relating to area were considered stable due to having no evidence or reasons to think caves have been lost within this reporting period. In terms of structure and function, no new data has been collected to inform trends, therefore many fields in section 6 were reported as unknown. For similar reasons to the area conclusion, we have no reason to conclude unfavourable-bad, so have concluded Unfavourable-inadequate.
10.4: Future prospects	Conclusion on Future prospects reached because: (i) the Future prospects for Range are good; (ii) the Future prospects for Area covered by habitat are unknown; and (iii) the Future prospects for Structure and function are unknown.
10.5: Overall assessment of Conservation Status	Overall assessment of Conservation Status is Unfavourable-inadequate because one of the conclusions is Unfavourable-inadequate
10.6: Overall trend in Conservation Status	The overall trend is stable because the short-term trend in range is stable, the short-term trend in area is stable, and the short-term trend in structure & function is unknown.
11.1: Surface area of the habitat type inside the pSCIs, SCIs and SACs network	We have no true value for the surface area of sea caves, nor is it likely that we ever will. No exhaustive survey of sea caves has ever been undertaken in Wales, and of those that have been identified and georeferenced, very few caves have been studied in any detail. The main reasons for this lack of study, is that caves are usually remote and often almost inaccessible, therefore costs in terms of survey time and resources are high. For example, Bunker & Holt (2003) describe intertidal and subtidal sea cave surveys that took place between 2000 and 2002 within Welsh Special Areas of conservation (SACs). These surveys involved 11 people, took 16 days and surveyed a total of 24 sea caves. These surveys included mapping and photographing caves, a detailed inventory of species and biotopes present and the installation of permanent monitoring equipment (Bunker & Holt, 2003). The figures in this section should therefore be treated with

	caution and are of very low confidence. It is likely only a small proportion of sea caves present in Wales have ever been recorded. Using the method described in the 2013 sea cave report (NRW, 2013a, NRW, 2013b), the figure shown above was calculated by giving each known cave a standard area value of 100 m2, which approximates to an 'average cave" of 10 m depth and circular cross-section of 3 meters (diameter). The total number of caves (304) situated in SACs where sea caves are a primary or qualifying reason for site selection (as estimated in the current reporting round), was multiplied by the average cave (100 m2) area to give the overall surface area value presented above. This value represents 42% of the estimated cave resource (total of 726 caves) in Wales (NRW, 2013b). Note, in the current reporting round the total estimate of Welsh sea caves was less than in previous rounds due to a change in how sea caves were identified within GIS. Previously, the number of sea cave biotopes was used as a proxy for the number of sea caves. In the current round, this number was rationalised where an individual sea cave had multiple biotope records. Caves tend to occur along or above the highwater mark of rocky cliff areas. Many marine GIS layers, such as SAC boundaries, use the mean highwater mark as the shoreward edge of the designation. This creates a problem when mapping vertical features such as caves as they often fall outside the boundary layer within the GIS and therefore it is not always clear from the GIS whether a cave is even situated within a SAC.
5.13: Favourable Reference Area (FRA)	The UK-level FRV for surface area was developed by JNCC using an audit trail based on the year the FRV was first established and any changes made in subsequent reporting rounds. The audit may draw from any combination of the 2007, 2013, or 2019 Habitats Directive reports and reflects the full rationale used for the 2019

	Article 17 reporting. This FRV was reviewed by Welsh experts and considered appropriate for use in Wales based on current habitat extent and trends.
4.10: Favourable Reference Range (FRR)	The UK-level FRV for range was developed by JNCC using an audit trail based on the year the FRV was first established and any changes made in subsequent reporting rounds. The audit may draw from any combination of the 2007, 2013, or 2019 Habitats Directive reports and reflects the full rationale used for the 2019 Article 17 reporting. This FRV was reviewed by Welsh experts and considered appropriate for use in Wales based on current distribution and trends.