European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC)

Fourth Report by the United Kingdom under Article 17

on the implementation of the Directive
from January 2013 to December 2018

Supporting documentation for the conservation status assessment for the species:

S1029 - Freshwater pearl mussel (*Margaritifera margaritifera*)

WALES

IMPORTANT NOTE - PLEASE READ

- The information in this document is a country-level contribution to the UK Report on the conservation status of this species, submitted to the European Commission as part of the 2019 UK Reporting under Article 17 of the EU Habitats Directive.
- The 2019 Article 17 UK Approach document provides details on how this supporting information was used to produce the UK Report.
- The UK Report on the conservation status of this species is provided in a separate document.
- The reporting fields and options used are aligned to those set out in the European Commission guidance.
- Explanatory notes (where provided) by the country are included at the end. These provide an audit trail of relevant supporting information.
- 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; (iii) the field was not relevant to this species (section 12 Natura 2000 coverage for Annex II species) and/or (iv) the field was only relevant at UK-level (sections 9 Future prospects and 10 Conclusions).
- For technical reasons, the country-level future trends for Range, Population and Habitat for the species are only available in a separate spreadsheet that contains all the country-level supporting information.
- The country-level reporting information for all habitats and species is also available in spreadsheet format.

Visit the JNCC website, https://jncc.gov.uk/article17, for further information on UK Article 17 reporting.

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NATIONAL LEVEL

1. General information

1.1 Member State	**UK (Wales information only)**
1.2 Species code	**1029**
1.3 Species scientific name	**Margaritifera margaritifera**
1.4 Alternative species scientific name	
1.5 Common name (in national language)	Freshwater pearl mussel

2. Maps

2.1 Sensitive species	No
2.2 Year or period	2007-2018
2.3 Distribution map	Yes
2.4 Distribution map Method used	Complete survey or a statistically robust estimate
2.5 Additional maps	No

3. Information related to Annex V Species (Art. 14)

3.1 Is the species taken in the wild/exploited?	No	
3.2 Which of the measures in Art. 14 have been taken?	a) regulations regarding access to property	No
	b) temporary or local prohibition of the taking of specimens in the wild and exploitation	No
	c) regulation of the periods and/or methods of taking specimens	No
	d) application of hunting and fishing rules which take account of the conservation of such populations	No
	e) establishment of a system of licences for taking specimens or of quotas	No
	f) regulation of the purchase, sale, offering for sale, keeping for sale or transport for sale of specimens	No
	g) breeding in captivity of animal species as well as artificial propagation of plant species	No
	h) other measures	No

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3.3 Hunting bag or quantity taken in the wild for Mammals and Acipenseridae (Fish)

a) Unit

b) Statistics/ quantity taken	Provide statistics/quantity per hunting season or per year (where season is not used) over the reporting period					
	Season/ year 1	Season/ year 2	Season/ year 3	Season/ year 4	Season/ year 5	Season/ year 6
Min. (raw, ie. not rounded)						
Max. (raw, ie. not rounded)						
Unknown	No	No	No	No	No	No

3.4. Hunting bag or quantity taken in the wild Method used

3.5. Additional information

BIOGEOGRAPHICAL LEVEL

4. Biogeographical and marine regions

4.1 Biogeographical or marine region where the species occurs

Atlantic (ATL)

4.2 Sources of information

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5. Range

5.1 Surface area (km²)		
5.2 Short-term trend Period		
5.3 Short-term trend Direction	Decreasing (-)	
5.4 Short-term trend Magnitude	a) Minimum	b) Maximum
5.5 Short-term trend Method used		
5.6 Long-term trend Period		
5.7 Long-term trend Direction		
5.8 Long-term trend Magnitude	a) Minimum	b) Maximum
5.9 Long-term trend Method used		
5.10 Favourable reference range	a) Area (km²) b) Operator	

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	c) Unknown	
	d) Method	
5.11 Change and reason for change in surface area of range	Genuine change Use of different method	
	The change is mainly due to:	Genuine change
5.12 Additional information		

6. Population

6.1 Year or period	2007-2018	
6.2 Population size (in reporting unit)	a) Unit	number of map 1x1 km grid cells (grids1x1)
	b) Minimum	
	c) Maximum	
	d) Best single value	76
6.3 Type of estimate	Best estimate	
6.4 Additional population size (using population unit other than reporting unit)	a) Unit	
	b) Minimum	
	c) Maximum	
	d) Best single value	
6.5 Type of estimate		
6.6 Population size Method used	Complete survey or a statistically robust estimate	
6.7 Short-term trend Period	2007-2018	
6.8 Short-term trend Direction	Decreasing (-)	
6.9 Short-term trend Magnitude	a) Minimum	0.1
	b) Maximum	0.3
	c) Confidence interval	
6.10 Short-term trend Method used	Based mainly on extrapolation from a limited amount of data	
6.11 Long-term trend Period	1989-2018	
6.12 Long-term trend Direction	Decreasing (-)	
6.13 Long-term trend Magnitude	a) Minimum	
	b) Maximum	
	c) Confidence interval	
6.14 Long-term trend Method used	Complete survey or a statistically robust estimate	
6.15 Favourable reference population (using the unit in 6.2 or 6.4)	a) Population size	
	b) Operator	
	c) Unknown	
	d) Method	
6.16 Change and reason for change in population size	Genuine change Use of different method	

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The change is mainly due to:	Genuine change

6.17 Additional information	

7. Habitat for the species

7.1 Sufficiency of area and quality of occupied habitat	a) Are area and quality of occupied habitat sufficient (to maintain the species at FCS)?	No
	b) Is there a sufficiently large area of occupied AND unoccupied habitat of suitable quality (to maintain the species at FCS)?	No
7.2 Sufficiency of area and quality of occupied habitat Method used	Based mainly on extrapolation from a limited amount of data	
7.3 Short-term trend Period	2007-2018	
7.4 Short-term trend Direction	Stable (0)	
7.5 Short-term trend Method used	Based mainly on extrapolation from a limited amount of data	
7.6 Long-term trend Period	1950-2018	
7.7 Long-term trend Direction	Decreasing (-)	
7.8 Long-term trend Method used		
7.9 Additional information		

8. Main pressures and threats

8.1 Characterisation of pressures/threats

Pressure	Ranking
Agricultural activities generating point source pollution to surface or ground waters (A25)	H
Agricultural activities generating diffuse pollution to surface or ground waters (A26)	H
Modification of hydrological flow or physical alteration of water bodies for agriculture (excluding development and operation of dams) (A33)	M
Forestry activities generating pollution to surface or ground waters (B23)	M
Modification of hydrological conditions, or physical alteration of water bodies and drainage for forestry (including dams) (B27)	M
Hydropower (dams, weirs, run-off-the-river), including infrastructure (D02)	M
Mixed source pollution to surface and ground waters (limnic and terrestrial) (J01)	H
Drainage (K02)	H
Physical alteration of water bodies (K05)	H
Change of habitat location, size, and / or quality due to climate change (N05)	M

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Threat	Ranking
Agricultural activities generating point source pollution to surface or ground waters (A25)	H
Agricultural activities generating diffuse pollution to surface or ground waters (A26)	H
Modification of hydrological flow or physical alteration of water bodies for agriculture (excluding development and operation of dams) (A33)	M
Hydropower (dams, weirs, run-off-the-river), including infrastructure (D02)	M
Mixed source pollution to surface and ground waters (limnic and terrestrial) (J01)	H
Drainage (K02)	H
Physical alteration of water bodies (K05)	H
Change of habitat location, size, and / or quality due to climate change (N05)	M

8.2 Sources of information

8.3 Additional information

9. Conservation measures

9.1 Status of measures

a) Are measures needed? Yes

b) Indicate the status of measures Measures identified and taken

9.2 Main purpose of the measures taken

Increase the population size and/or improve population dynamics (improve reproduction success, reduce mortality, improve age/sex structure) (related to 'Population')

9.3 Location of the measures taken

Both inside and outside Natura 2000

9.4 Response to the measures

Medium-term results (within the next two reporting periods, 2019-2030)

9.5 List of main conservation measures

Reduce/eliminate point pollution to surface or ground waters from agricultural activities (CA10)
Reduce diffuse pollution to surface or ground waters from agricultural activities (CA11)
Manage drainage and irrigation operations and infrastructures in agriculture (CA15)
Reduce impact of mixed source pollution (CJ01)
Restore habitats impacted by multi-purpose hydrological changes (CJ03)
Other measures related to mixed source pollution and multi-purpose human-induced changes in hydraulic conditions (CJ04)
Implement climate change adaptation measures (CN02)
Reinforce populations of species from the directives (CS01)
Reintroduce species from the directives (CS02)
Improvement of habitat of species from the directives (CS03)

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9.6 Additional information

10. Future prospects

10.1 Future prospects of parameters	a) Range b) Population c) Habitat of the species
10.2 Additional information	

11. Conclusions

11.1. Range	
11.2. Population	
11.3. Habitat for the species	
11.4. Future prospects	
11.5 Overall assessment of Conservation Status	
11.6 Overall trend in Conservation Status	
11.7 Change and reasons for change in conservation status and conservation status trend	a) Overall assessment of conservation status No change The change is mainly due to: b) Overall trend in conservation status No change The change is mainly due to:
11.8 Additional information	

12. Natura 2000 (pSCIs, SCIs and SACs) coverage for Annex II species

12.1 Population size inside the pSCIs, SCIs and SACs network (on the biogeographical/marine level including all sites where the species is present)	a) Unit	number of map 1x1 km grid cells (grids1x1)
	b) Minimum	
	c) Maximum	
	d) Best single value	5
12.2 Type of estimate	Best estimate	
12.3 Population size inside the network Method used	Complete survey or a statistically robust estimate	
12.4 Short-term trend of population size within the network Direction	Decreasing (-)	
12.5 Short-term trend of population size within the network Method used	Complete survey or a statistically robust estimate	
12.6 Additional information		

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13. Complementary information

13.1 Justification of % thresholds for trends

13.2 Trans-boundary assessment

13.3 Other relevant Information

Distribution Map

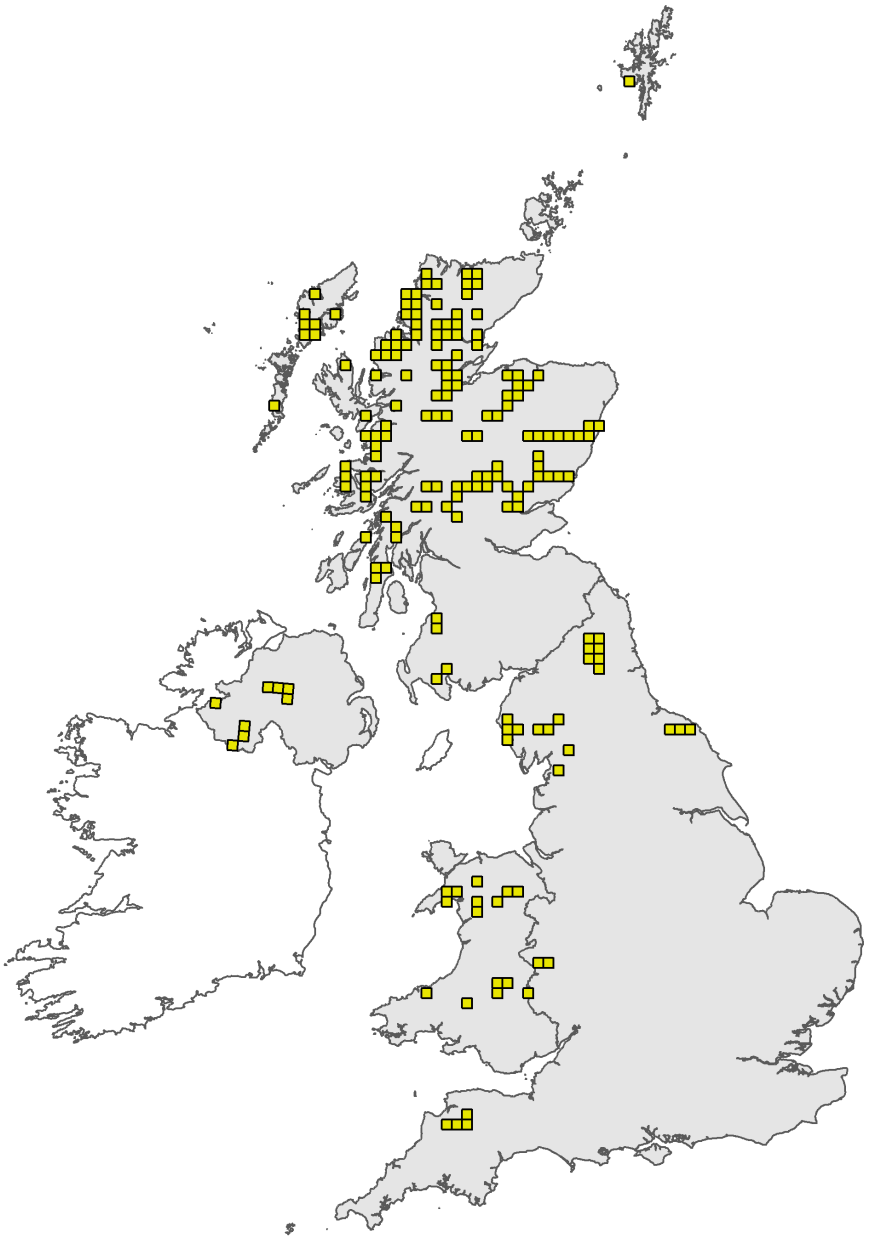

Figure 1: UK distribution map for S1029 - Freshwater pearl mussel (*Margaritifera margaritifera*). Coastline boundary derived from the Oil and Gas Authority's OGA and Lloyd's Register SNS Regional Geological Maps (Open Source). Open Government Licence v3 (OGL). Contains data © 2017 Oil and Gas Authority.

The 10km grid square distribution map is based on available species records within the current reporting period. For further details see the 2019 Article 17 UK Approach document.

Range Map

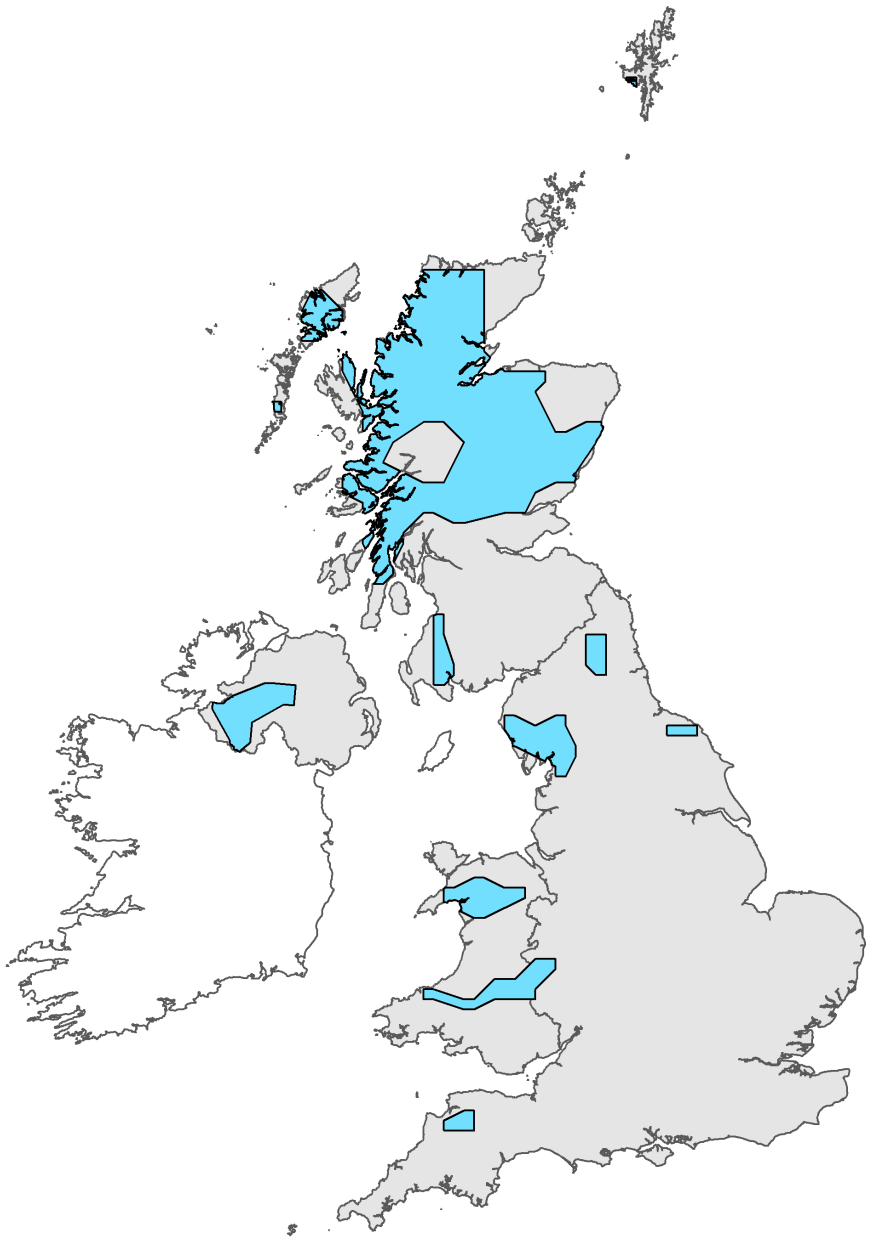

Figure 2: UK range map for S1029 - Freshwater pearl mussel (*Margaritifera margaritifera*). Coastline boundary derived from the Oil and Gas Authority's OGA and Lloyd's Register SNS Regional Geological Maps (Open Source). Open Government Licence v3 (OGL). Contains data © 2017 Oil and Gas Authority.

The range map has been produced by applying a bespoke range mapping tool for Article 17 reporting (produced by JNCC) to the 10km grid square distribution map presented in Figure 1. The alpha value for this species was 25km. For further details see the 2019 Article 17 UK Approach document.

Explanatory Notes

Species name: Margaritifera margaritifera (1029)

Field label	Note
2.1 Sensitive species	Yes. Freshwater pearl mussel is vulnerable to illegal pearl fishing.
2.4 Distribution map; Method used	The distribution of pearl mussel in Wales is considered to be well known. Although it is possible that a few small unknown populations may exist, this is unlikely to significantly affect the range calculation.
3.1 Is the species take in the wild/ exploited	Taking or killing this species is forbidden under the Wildlife & Countryside Act 1981 (as amended).

Species name: Margaritifera margaritifera (1029) Region code: ATL

Field label	Note
5.11 Change and reason for change in surface area of range	Maps of species range are provided in Figure 2.1. Freshwater pearl mussel has been recorded or is expected to have occurred in at least 62 10km squares across Wales (Figure 2.1b). There has been a further reduction in species range, from 18 10km squares in the last reporting period to 14 10km squares in the current cycle (Figure 2.1a). Freshwater pearl mussel is extinct in most of its range in South and Mid Wales, and occurs in 38% of its former squares in North Wales. Overall, this species is estimated to occur in only 23% of its former squares. In most of these, populations are tiny and further loss of range is likely in the near future. A summary of status by river system is provided in Appendix 1.
6.2 Population size	(d) 76 (48 confirmed, 28 interpolated - Figure 6.1) Remaining populations are small, low density and fragmented. Although there are no formal population data, it is likely that there are fewer than 2000 individuals remaining in the wild in Wales. The number of occupied 1km squares is 13% of the FRV and is not considered to be viable at present.
6.4 Additional population size	The previous UK population unit was number of viable populations, but this approach has been abandoned because (i) determining viability requires assessment of mussel age structure, which is invasive and resource intensive; (ii) small juvenile mussels cannot be counted, preventing accurate assessment of recovering populations; (iii) records data cannot be used in this assessment, preventing accurate assessment of past status and decline; (iv) it promotes a culture of failure whereby populations perceived as non-viable are ignored and allowed to go extinct and (v) population results do not tally with the range assessment.
6.5 Type of estimate	Not applicable.
6.6 Population size; Method used	Current data are considered reasonably comprehensive.
6.8 Short term trend; Direction	The nature of the evidence base and the longevity of pearl mussels makes it difficult to reliably assign a trend over a short timescale. However, mussel counts in the larger populations indicate that there have been declines in numbers over this period (Hearn and Garrett 2017; Garrett in prep; J. Taylor unpublished data). No attempt has been made to use the 1km2 method used for population reporting, because demonstrating loss from any square at a given period is not possible. The entire populations of several streams were removed to Mawddach hatchery for captive breeding (Killeen 2007). All of these mussels subsequently died. As a result, captive breeding practice and techniques have been modified, and adult mussels are no longer kept for extended periods in the hatchery. The captive rearing effort has also been relocated the the Cynrig Hatchery near Abergavenny, where water quality is better and greater resources can be allocated to mussel rearing. See Section 9 for further details.

6.9 Short term trend; Magnitude	Detailed counts are only available for two rivers (Hearn & Garrett 2017, J. Taylor unpublished data), so the minimum and maximum magnitudes of decline are indicative only. 6.9.1 UK additional question: Rate of decrease of Population over short-term period (at country-level) >1% per year (on average) during the period indicated in the field 6.7 Due to the relative rarity of this species, any measurable decline would exceed 1% per year.
6.12 Long term trend; Direction	Decreasing There is very clear evidence of a decrease in pearl mussel populations over the longer term including the extinction of a number of populations (Killeen 2007 - see Annexe 1 for a summary). Since 1989 populations have been lost from the Taf, Western Cleddau, Eastern Cleddau, Nyfer and Aeron, the Gwyrfai and Welsh Severn populations are probably extinct, and populations on the Teifi, Tywi, Dee and Conwy are critically endangered.
6.13 Long term trend; Magnitude	The population decrease exceeds 1% per year.
6.15 Favourable reference population	570 1km squares (222 confirmed, 348 interpolated). An FRV population using the 1km squares measure has been calculated for Wales based on available records and literature reviews (Killeen et al. 1999, 2003; Killeen & Moorkens 1999, 2003; Killeen & Oliver 1997, 1998; Oliver et al. 1993). Mussels found are invariably older individuals of 80+ years in age and for this reason all records have been included in the FRV estimate, irrespective of the date of the record, because any newly discovered mussel populations would also have been present in 1994. Due to the relative paucity, and spatial and temporal imprecision of older records for pearl mussel, a certain amount of expert judgment has been required. However, available data clearly indicate that freshwater pearl mussels were formerly widespread and reasonably common in Welsh rivers.
6.17 Additional information	THE FOLLOWING INFORMATION RELATES TO 6.18: Yes, strongly deviating. All surveys of Welsh pearl mussels indicate that populations consist predominantly or entirely of old individuals, often 80+ years in age. Lack of recruitment has already resulted in the extinction of several populations and without urgent conservation action, both in-river and across catchments, this species is expected to be extinct in Wales within 20 years.

7.1 Sufficiency of area and quality of occupied habitat	a) Are area and quality of occupied habitat sufficient (to maintain the species at FCS)? YES/NO/Unknown - area = NO - quality = NO Overall = NO b) If NO, is there a sufficiently large area of occupied & unoccupied habitat of suitable quality (to maintain the species at FCS)? YES/NO/Unknown sufficient occupied = NO sufficient unoccupied = Unknown Overall = NO Decline in pearl mussel populations is due to a combination of habitat extent and quality, accidental mortality during in-river works (e.g. dredging) and pearl fishing. There are no recent cases of pearl fishing recorded from Welsh rivers, reflecting the very low abundance of mussels here. Lack of population recovery therefore reflects a habitat damage and destruction at a reach and a subcatchment scale. Reach scale damage is mainly geomorphological, in particular removal of large material such as boulders and large woody debris that create the variable flow conditions and stable riverbed conditions pearl mussels need (Degerman et al. 2009). The remaining gravels tend to be much more mobile and are therefore insufficient to support juvenile mussels over the c. 5 year period they live buried in gravels. Catchment scale impacts include drainage and intensification of land use that increases clogging and deoxygenation of remaining river gravels and sands. Redox measurements of river gravels predominantly indicate levels of deoxygenation insufficient to support juvenile mussels (Killeen 2012, 2013, 2014, 2015). Thus, river gravels in Wales are either too unstable or too poorly oxygenated for successful mussel recruitment. Only one of the seven transects on the Afon Eden SAC passed the Conservation Objective targets (Garrett & Thomas 2012) in 2011. Evidence of excessive siltation was found throughout the transects. Conditions were similar on the Adon Ddu and Dwyfach (Killeen 2013). Redox on the Eden improved following LIFE project work (Killeen, 2014, 2015). NRW are repeating this redox sampling in the 2018 season in the Afon Eden and the Afon Ddu and this will provide more information on interstitial substrate quality.
7.2 Sufficiency of area and quality of occupied habitat; Method used	Habitat quality has only been assessed in detail on the Afon Eden SAC (Killeen 2004, 2014, 2015, Garrett & Thomas 2012, NRW unpublished data). The river is divided into identifiable sections and transects record the number of sample points that meet defined criteria of suitability: - A substrate comprising a size range from coarse (1mm) to small cobble (100mm), but principally of stable gravel in riffles and runs - No filamentous algae in potential mussel beds. - No obvious siltation in the surface layers of gravels in potential mussel areas. Other rivers have had more limited surveys with little or no repeat data.
7.4 Short term trend; Direction	Killeen (2004) recorded that none of the transects had suitable habitat in 2003 and indicated that less than 15% of the riverbed in the core area supported a suitable substrate. Although one transect was assessed as containing suitable habitat in 2011, there is no evidence to suggest that the habitat has significantly improved in the Afon Eden since 2003 (Garrett & Thomas 2012). The recent Pearls in Peril LIFE project carried out numerous catchment and in-stream interventions (see 9.5) aimed at reducing sediment input and improving habitat quality in the Afon Eden (RESTORE 2018). Redox monitoring carried out as part of the project suggested an improvement in quality of the stream bed substrate between 2013 and 2015 and monitoring of the settlement ponds showed that they are effective at trapping sediment and preventing it entering the river (Marples 2017). However there are known to be significant lag times between catchment improvements and in-stream response (Geist 2010) and ongoing monitoring of the riverbed substrate is required. Restoration work has also been carried out on the Irfon and Ddu, but there are insufficient monitoring data to demonstrate improvements to pearl mussel habitat on either river. On the Irfon, initial data showed increases in fish numbers attributable to improvements in habitat quality. Existing habitat quality is in general insufficient to support viable pearl mussel populations, regardless of trend.
7.5 Short term trend; Method used	Although there may have been limited short-term improvements in habitat quality over the reporting period, these are in response to specific remediation measures that are not necessarily representative of the wider environment. Further data are required to establish wider trends.

7.9 Additional information	The long-term decline of pearl mussels in Welsh rivers is rooted in changes in river management that occurred during the mid to late 20th Century
8.1 Characterisation of pressures/ threats	Pressures: The most important impacts on pearl mussel populations are morphological changes to rivers as a result of dredging work, and associated land drainage (K02, K05, A33, B27, B02). These have resulted in destabilisation of river substrates and banks, increased siltation, higher flows and clogging of gravels and sands with fine material. These activities also help transport pollutants from agriculture, forestry and other activities (A25, A26, B23, J01). Forestry can have a significant effect on pearl mussel populations through water pollution (B23), drainage and hydromorphology (B27) (Degerman et al. 2009; Cosgrove et al. 2017). The extent of forestry in pearl mussel catchments in Wales is localised, and its water pollution and hydromorphological effects are therefore considered moderate. Increased storminess due to climate change (N05) is likely to result in greater flooding, causing washout of adult and juvenile mussels and the eggs of their salmonid hosts. These impacts have or are expected to further destabilise rivers.Threats: Threats are broadly the same as pressures. It is expected that forestry impacts (B23, B27) will reduce as forestry is removed and habitats restored in pearl mussel catchments, hence the threat from forestry impacts has been downgraded to low. Climate change risks (N05) are expected to increase over the coming decades and the risk of impacts therefore increases from medium to high. There have been no reported cases of illegal pearl fishing (G11) in Wales hence current impact is assessed as zero, but there is a residual threat assessed as Low.
9.2 Main purpose of the measures taken	c) Increase the population size and/or improve population dynamics (improve reproduction success, reduce mortality, improve age/sex structure) (related to 'Population') or d) Restore the habitat of the species (related to 'Habitat for the species') Due to the highly endangered status of this species, both c) and d) are required, and in all likelihood all of a)-d) apply.
9.3 Location of the measures taken	Due to the very small extent of Natura 2000 sites designated for pearl mussel in Wales, a high proportion of works are required outside Natura 2000 sites.

9.5 List of main conservation measures	Habitat restoration and catchment management Key to the long-term sustainable future of freshwater pearl mussel in Wales will be the establishment of river reaches where habitat conditions are suitable for mussel recruitment in the long-term. This requires a combination of actions to reverse or mitigate past habitat damage including drainage (CA15, CB14), hydropower scheme management (CC04), general morphological damage such as removal of boulders and channel straightening (CJ03, CJ04) and management of short-term impacts on and risks to water quality (CA10, CA11, CB10, CJ01). Integrated catchment management is essential alongside this habitat works and will predominantly need to be carried out in partnership with the agricultural and forestry sectors. A LIFE project, Pearls in Peril, took place between 2012 and 2016 and included action in Afon Eden, the only Welsh SAC designated for pearl mussel. This included various measures including fencing, sediment traps (CB14), ditch blocking (CB14) and replacement of boulders to the river (CS03). Redox measurements show some evidence of improvements as a result (NRW, unpublished), but further data collection is required to confirm this. Further actions are planned in the catchment in a Welsh Government funded project led by Snowdonia National Park. NRW is currently in discussions with the operator regarding measures to reduce the impact of a hydropower scheme that abstracts water from the Afon Eden (CC04). The Welsh agrienvironment scheme (Glastir) prioritises actions to improve water and river habitat quality in catchments where pearl mussels are present. Due to the way in which the scheme is administered, it is difficult to link actions specifically to individual species. However, a number of farms in pearl mussel catchments have entered into Glastir agreements that will benefit the mussels (CA10, CA11, CA15, CS03). Conservation management works as part of the project included removal of 54ha of conifer plantation in an adjacent forestry block, blocking of 430 grips and creation of 11 settlement ponds within the forestry block (CB10), 2km of ditch fencing and installation of downstream defenders to remove heavy metals from nearby road run-off. In-river works included 2.4km of stream restoration (gravel introduction and boulder placement)(CS03) and 4.5km of river corridor fencing. In the Afon Ddu, works since 2005 with 640 metres of river fenced out to stop cattle and livestock access (CA11) and another 820 metres restored through replacement of boulders and re-introduction of gravel (CS03). In addition three fish barriers have been ameliorated (CJ03). There has been a large amount of restoration works carried out in the Irfon catchment as part of the ISAC project (WUF 2018b) in which 32km of SAC designated sections of the Cledan, South Dulas, Cammdwr, Cammarch, Cynffiad, Garth Dulas and Chwefru were restored. Work included double bank fencing (CA11), erosion repair (CS03), coppicing and introducing instream features (CS03) and water gates (CA11). In the forested parts of the upper catchment, coniferous trees were removed, drainage reduced and forest design plans altered (CB10). A further LIFE project is being developed for the River Dee that will include actions targeted at pearl mussel (CS01, CS02, CS03), and plans are also under way to conserve the Irfon population using a combination of catchment based measures and captive breeding (CS01, CS02). NRW is also planning monitoring and survey work to identify measures that can conserve other pearl mussel populations elsewhere in Wales. Measures to ensure populations of salmonid hosts are sufficient to support mussel recruitment (CS04) may be needed in some circumstances. Captive Rearing Remaining pearl mussel poulations in Wales are unlikely to be viable (see Bergengren et al 2004; Degerman et al 2009) due to very low mussel numbers. Therefore, we cannot rely only on habitat measures alone to ensure the survival of pearl mussels in Wales (Hatton-Ellis et al. 2017) and a programme of captive rearing for the purpose of population reinforcement (CS01) and reintroduction (CS02) is under way to ensure short and medium term persistence and improve the long-term prospects for recovery. Population reinforcement will also improve survival chances of remaining populations, as there is evidence that pearl mussel recruitment improves at higher densities (Arvidsson et al. 2012). Previous captive rearing programmes in Wales were unsuccessful for various technical and logistical reasons. Mussels reproduced in

	captivity and produced viable juveniles, but survival post 12 months has been virtually non-existant. However, recent developments in pearl mussel culture in Europe have been adopted by NRW's Cynrig Hatchery and initial results of have been encouraging with survival and growth up to 14 months much improved (J. Taylor pers comm). We are currently seeking funding to reopen a hatchery specifically for pearl mussel rearing where these activities can be carried out on a larger scale. There is also a project underway to captive rear pearl mussels from the Afon Irfon using the Freshwater Biological Association facilities with the intention that knowledge can be shared between the FBA and NRW's Cynrig hatchery.
10.1 Future prospects of parameters	Future trend in range is dependant on the success and nature of conservation measures. However, due to the fragmented distribution and small size of many populations, further losses of range are likely in the short term at least.Future trend in population is dependant on the success and nature of conservation measures. However, due to the fragmented distribution and small size of many populations, further losses of population are likely in the short term at least. The key focus at present is preventing extinction in Wales.At present, habitat quality and probably extent are insufficient to maintain freshwater pearl mussel populations in Wales. Although there is no particular reason to expect further decline, the status quo will inevitably result in extinction of pearl mussel from Wales. A key priority must be the restoration of natural geomorphology on pearl mussel rivers alongside integrated catchment management in order to recreate habitat conditions where populations can thrive.
12.1 Population size inside the pSCIs, SCIs and SACs network	Afon Eden still contains the highest densities of pearl mussels in Wales. However, the population there is very small by global standards and the habitat is not in favourable condition.