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:

S1103 - Twaite shad (*Alosa fallax*)

ENGLAND

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.

Report on the main results of the surveillance under Article 11 for Annex II, IV and V species (Annex B)

NATIONAL LEVEL

1. General information

1.1 Member State	**UK (England information only)**
1.2 Species code	**1103**
1.3 Species scientific name	**Alosa fallax**
1.4 Alternative species scientific name	
1.5 Common name (in national language)	Twaite shad

2. Maps

2.1 Sensitive species	No
2.2 Year or period	2013-2018
2.3 Distribution map	Yes
2.4 Distribution map Method used	Based mainly on extrapolation from a limited amount of data
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

Addy, S., Cooksley, S., Dodd, N., Waylen, K., Stockan, J., Byg, A. & Holstead, K. 2016. River restoration and biodiversity: Nature based solutions for restoring rivers in the UK and Republic of Ireland. CREW ref. CRW2014/10
Aprahamian, M.W., Lester, S.M. & Aprahamian, C.D. 1998. Shad Conservation in England and Wales. R&D technical report W110. Environment Agency
Aprahamian, M.W. and Aprahamian, C. D. 2001. The influence of water temperature and flow on year class strength of twaite shad (Alosa fallax fallax) from the River Severn, England. Bulletin Franeais de la Pzche et de la Pisciculture. 362/363: 953-972
Aprahamian, M.W. and Lester, S.M. 2001. Variation in the age at first spawning of female twaite shad (Alosa fallax fallax) from the River Severn, England. Bulletin Franeais de la Pzche et de la Pisciculture. 362/363: 941-951
Aprahamian, M. W., J.-L. Baglinicre, R. Sabatie, P. Alexandrino, and C. D. Aprahamian. 2002. Alosa alosa and Alosa fallax spp.: Literature Review and Bibliography. R&D Technical Report W1-014/TR. Environment Agency, Swindon
Aprahamian, M.W., Baglinicre, J. L., Sabatie, M. R., Alexandrino, P., Thiel, R. and Aprahamian, C. 2003. Biology, status and conservation of the anadromous twaite shad, Alosa fallax fallax. In: K. E. Limburg and J. R. Waldman (eds.) Biodiversity, status, and conservation of the world's shads. American Fisheries Society, Symosium 35, Bethesda, Maryland. Pp. 103-124.
Aprahamian, M. W., Aprahamian, C. D. and Knights, A.M. 2010. Climate change and the green energy paradox: the consequences for twaite shad Alosa fallax from the River Severn, U.K. Journal of Fish Biology 77:1912-1930.
Caswell, P. A., and M. W. Aprahamian. 2001. Use of River Habitat Survey to determine the spawning habitat characteristics of Twaite Shad (Alosa fallax

fallax). Bulletin Francais de la Peche et de la Pisciculture 362/363:919-929.
Common Standards Monitoring Guidance for Freshwater Fauna 2015
Common Standards Monitoring Guidance for Rivers 2014
Cotterell, S.P. & Hillman, R.J. 2016. Monitoring of allis shad and smelt in Tamar estuaries. EC18234. Natural England Evidence Project Report RP02463, York.
Davies, C., Shelley, J., Harding, P., McLean, I., Gardiner, Ross & Peirson, G. 2004. Freshwater Fishes in Britain. The species and their distribution. Harley Books.
Environment Agency fish survey data held on the National Fish Populations Database.
https://ea.sharefile.com/share/view/s5301a91e00c428a8
Findlay, J.D.S. 2013. Impacts of signal crayfish on stream fishes. Durham theses, Durham University.
Findlay, J.D.S., Riley, W.D. & M.C. Lucas. 2014. Signal crayfish (Pacifastacus leniusculus) predation upon Atlantic salmon (Salmo salar) eggs. Aquatic Conservation: Marine and Freshwater Ecosystems. 25. 250-258.
Garrett, H. 2017. River Wye SAC Allis & Twaite shad population condition assessment. Reporting cycle 2013 to 2018. Natural Resources Wales. (Unpublished).
Guan, R-Z. & Wiles, P.R. 1996. Ecological Impact of Introduced Crayfish on Benthic Fishes in a British Lowland River. Conservation Biology, 11
Habitats Regulations Assessment: Site Report for Hinkley Point. EN-6: Revised Draft National Policy Statement for Nuclear Power Generation. 2010. Department of Energy and Climate Change.
Hatton-Ellis, T., Aprahamian, M and Mainstone, C.P. 2012.Accessibility of shad spawning rivers in Wales and England, 1998-2012. Supplementary information for Article 17 reporting.
Hatton-Ellis, T. 2018. Procedure for Estimating Population (including Favourable Reference Population) using 1km Square Resolution Records Data. Interagency freshwater group. (Unpublished).
Henderson, P., Pisces Conservation Ltd. pers. comm. Hinkley Point cooling water shad entrainment figures
Holdich, D.M., James, J., Jackson, C. & Peay, S. 2014. The North American signal crayfish, with particular reference to its success as an invasive species in Great Britain. Ethology, Ecology & Evolution, 26, 232-262.
Hillman, R. 2003. The distribution, biology and ecology of shad in South-West England. Environment Agency R&D technical report W1-047/TR
Hillman, R. J., I. G. Cowx, and J. P. Harvey. 2003. Monitoring Allis & Twaite. Report on the main results of the surveillance under article 11 for annex II, IV and V species (Annex B) Shad.Conserving Natura 2000 Rivers Monitoring Series 3. English Nature, Peterborough.
Hillman, R. J., I. G. Cowx, and J. P. Harvey. 2003. Monitoring Allis & Twaite Shad. Conserving Natura 2000 Rivers Monitoring Series 3. English Nature, Peterborough.
Hillman, R., Environment Agency. Pers. comm
Jolly, M, T., Aprahamian, M. W., Hawkins, S. J., Henderson, P. A., Hillman, R., O'Maoileidigh, N., Maitland. P. S., Piper, R. and Genner, M. J. 2012. Population genetic structure of protected allis shad (Alosa alosa) and twaite shad (Alosa fallax). Marine Biology.
Mainstone, C.P., Dils, R.M. and Withers, P.J.A. 2008. Controlling sediment and phosphorus transfer to receiving waters - A strategic management perspective for England and Wales. Journal of Hydrology, 350, 131-143.
Mainstone, C.P. and Holmes, N.T. 2010. Embedding a strategic approach to river restoration in operational management processes - experiences in England.

Aquatic Conservation: Marine and Freshwater Ecosystems. Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/aqc.1095
Mainstone, C., Hall, R. & Diack, I. 2016. A narrative for conserving freshwater and wetland habitats in England. Natural England Research Reports, Number 064.
Mainstone C.P. 2008. The role of specially designated wildlife sites in freshwater conservation - an English perspective. Freshwater Reviews, 1, 89-98.
Mainstone, C. & Burn, A. 2011. Relationships between ecological objectives and associated decision-making under the Habitats and Water Framework Directives. Discussion paper, Natural England.
Mainstone, C.P. & Wheeldon, J. 2016. The physical restoration of English rivers with special designations for wildlife: from concepts to strategic planning and implementation. Freshwater Reviews. 8. Pg. 1 - 25.
Mainstone, C.P. 2016. Developing a coherent narrative for conserving freshwater and wetland habitats: experiences in the UK. WIRES Water, published Online: Nov 07 2016. DOI: 10.1002/wat2.1189.
Mainstone, C.P. 2018. Article 17 Habitats Pro-forma England H3260 for UK aggregation. Natural England
Mainstone, C.P. 2018. Analysis of Water Framework Directive data for use in Habitats Directive Article 17 reporting on Annex I river habitat (H3260) in England. Supplementary paper for the submission package to Europe, Natural England.
Maitland, P.S. & Campbell, R.N. 1992. Freshwater Fishes of the British Isles. HarperCollins.
Maitland, P., and T. Hatton-Ellis. 2003. Ecology of the Allis and Twaite Shad. Life in UK Rivers Ecology Series No. 3. English Nature, Peterborough.
Maria, I., Bernardo, J.M. & Fernandes, S. 2007. Predation of invasive crayfish on aquatic vertebrates: the effect of Procambarus clarkii on fish assemblages in Mediterranean temporary streams. Biological Invaders in Inland Waters. Gherardi, F. (ed.)
Nachon, D.J., Mota, M., Antunes, C., Servia, M.J. & Cobo, F. 2015. Marine and continental distribution and dynamic of the early spawning migration of twaite shad (Alosa fallax) and allis shad (Alosa alosa) in the north-west of the Iberian Peninsula. Marine and Freshwater Research.
NBN Atlas occurrence download at https://nbnatlas.org accessed on Tue May 15 15:45:14 UTC 2018
Natural England. 2015. River restoration theme plan. Output from the EU Life project 'Improvement Programme for England's Natura 2000 Sites' (IPENS). Natural England Report number IPENSTP023.
Nunn, A.D., Smith, M.A., Harvey, J.P., Noble, R.A.A. & Cowx, I.G. 2015. A desk-based study to consolidate existing data and literature to help inform the conservation status of Annex II features (migratory fish species) within the Severn Estuary river catchment. Natural England. IPENS LIFE11NAT/UK/000384IPENS
Peay, S., Guthrie, N., Spees, J., Nilsson, E. & Bradley, P. 2009. The impact of signal crayfish (Pacifastacus leniusculus) on the recruitment of salmonid fish in a headwater stream in Yorkshire, England. Knowledge and Management of Aquatic Ecosystems.
Reynolds, J.D. 2011. A review of ecological interactions between crayfish and fish, indigenous and introduced. Knowledge and Management of Aquatic Ecosystems. 401, 10
Shad Monitoring Overview Report 2017. Heritage Lottery Fund - Unlocking the Severn development phase. LIFE15 NAT/UK/000291/HG-15-04573
Stewart-Russon, I., Anderson, E & Fraser, D. 2015. A habitat survey for spawning

ground and nursery areas for annex II fish species within the Severn Estuary river catchment. Natural England.
Wheeldon, J. 2018. Progress report on the English river SSSI/SAC physical restoration programme. Paper to the river SSSI restoration project steering group.

5. Range

5.1 Surface area (km²)		
5.2 Short-term trend Period		
5.3 Short-term trend Direction	Stable (0)	
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 c) Unknown d) Method	
5.11 Change and reason for change in surface area of range	No change The change is mainly due to:	
5.12 Additional information		

6. Population

6.1 Year or period	2013-2018	
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	131
6.3 Type of estimate	Minimum	
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	Based mainly on extrapolation from a limited amount of data	
6.7 Short-term trend Period	2007-2018	
6.8 Short-term trend Direction	Uncertain (u)	

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6.9 Short-term trend Magnitude	a) Minimum b) Maximum c) Confidence interval
6.10 Short-term trend Method used	Insufficient or no data available
6.11 Long-term trend Period	
6.12 Long-term trend Direction	
6.13 Long-term trend Magnitude	a) Minimum b) Maximum c) Confidence interval
6.14 Long-term trend Method used	
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	No information on nature of change The change is mainly due to:
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 expert opinion with very limited data	
7.6 Long-term trend Period		
7.7 Long-term trend Direction		
7.8 Long-term trend Method used		
7.9 Additional information		

8. Main pressures and threats

8.1 Characterisation of pressures/threats

Pressure	Ranking
Physical alteration of water bodies (K05)	H
Modification of hydrological flow (K04)	H

Mixed source pollution to surface and ground waters (limnic and terrestrial) (J01)	H
Invasive alien species of Union concern (I01)	M
Marine fish and shellfish harvesting (professional, recreational) activities causing physical loss and disturbance of seafloor habitats (G03)	M
Hydropower (dams, weirs, run-off-the-river), including infrastructure (D02)	M

Threat	Ranking
Physical alteration of water bodies (K05)	H
Modification of hydrological flow (K04)	H
Mixed source pollution to surface and ground waters (limnic and terrestrial) (J01)	H
Invasive alien species of Union concern (I01)	M
Marine fish and shellfish harvesting (professional, recreational) activities causing physical loss and disturbance of seafloor habitats (G03)	M
Other climate related changes in abiotic conditions (N09)	M
Hydropower (dams, weirs, run-off-the-river), including infrastructure (D02)	H
Wind, wave and tidal power, including infrastructure (D01)	H
Abstraction of surface and ground water for energy production (excluding hydropower) (D13)	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: Expand the current range of the species (related to ‘Range’)

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 impact of mixed source pollution (CJ01)
Reduce impact of multi-purpose hydrological changes (CJ02)
Restore habitats impacted by multi-purpose hydrological changes (CJ03)
Management of professional/commercial fishing (including shellfish and seaweed harvesting) (CG01)
Management of hunting, recreational fishing and recreational or commercial harvesting or collection of plants (CG02)
Adopt climate change mitigation measures (CN01)

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Reduce impact of hydropower operation and infrastructure (CC04)

Adapt/manage renewable energy installation, facilities and operation (CC03)

Adapt/manage exploitation of energy resources (CC02)

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	42

12.2 Type of estimate

Minimum

12.3 Population size inside the network Method used

Based mainly on expert opinion with very limited data

12.4 Short-term trend of population size within the network Direction

Stable (0)

12.5 Short-term trend of population size within the network Method used	Based mainly on expert opinion with very limited data
12.6 Additional information	

13. Complementary information

13.1 Justification of % thresholds for trends
13.2 Trans-boundary assessment
13.3 Other relevant Information

Distribution Map

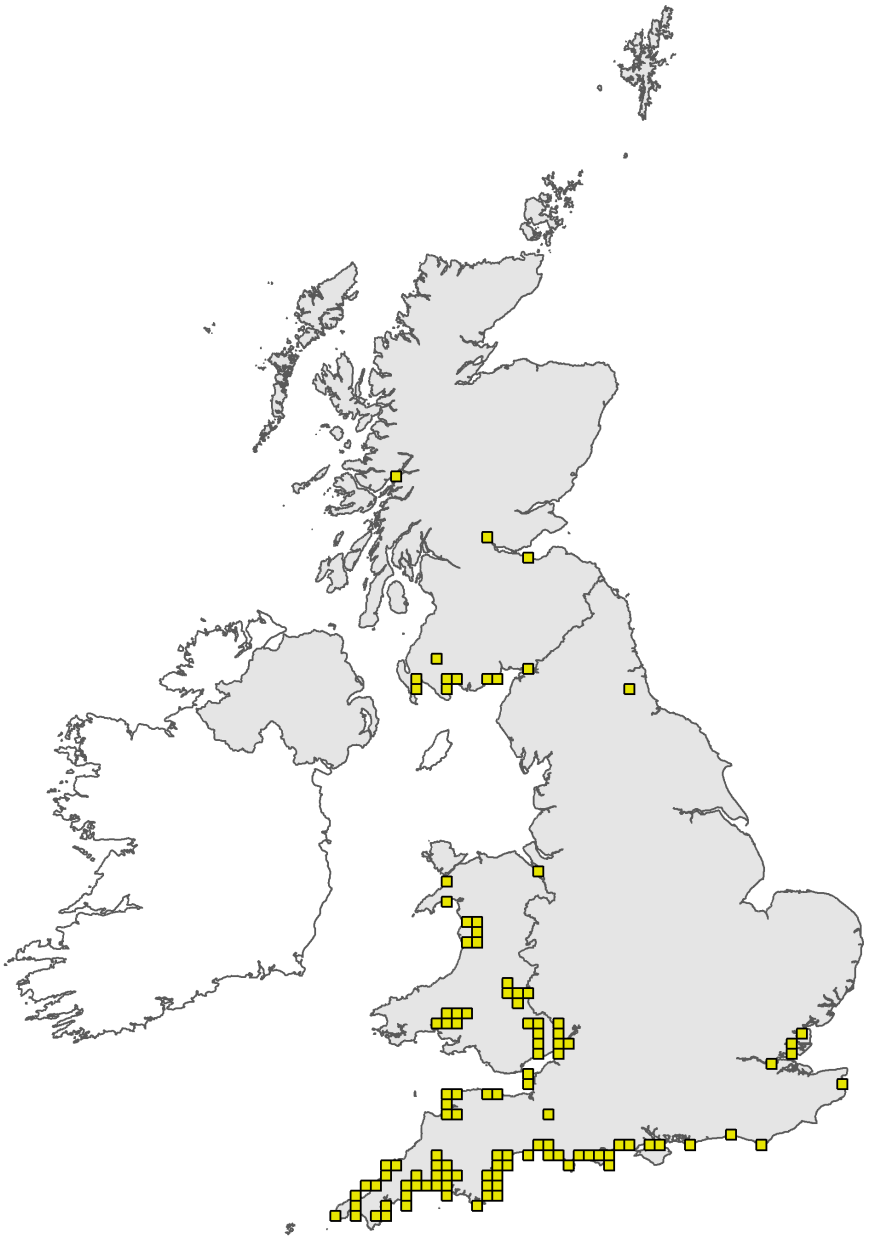

Figure 1: UK distribution map for S1103 - Twaite shad (*Alosa fallax*). Coastline boundary derived from the Oil and Gas Authority's OGA and Lloyd's Register SNS Regional Geological Maps (Open Source). Open Government Licence v3 (OGL). Contains data © 2017 Oil and Gas Authority.

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

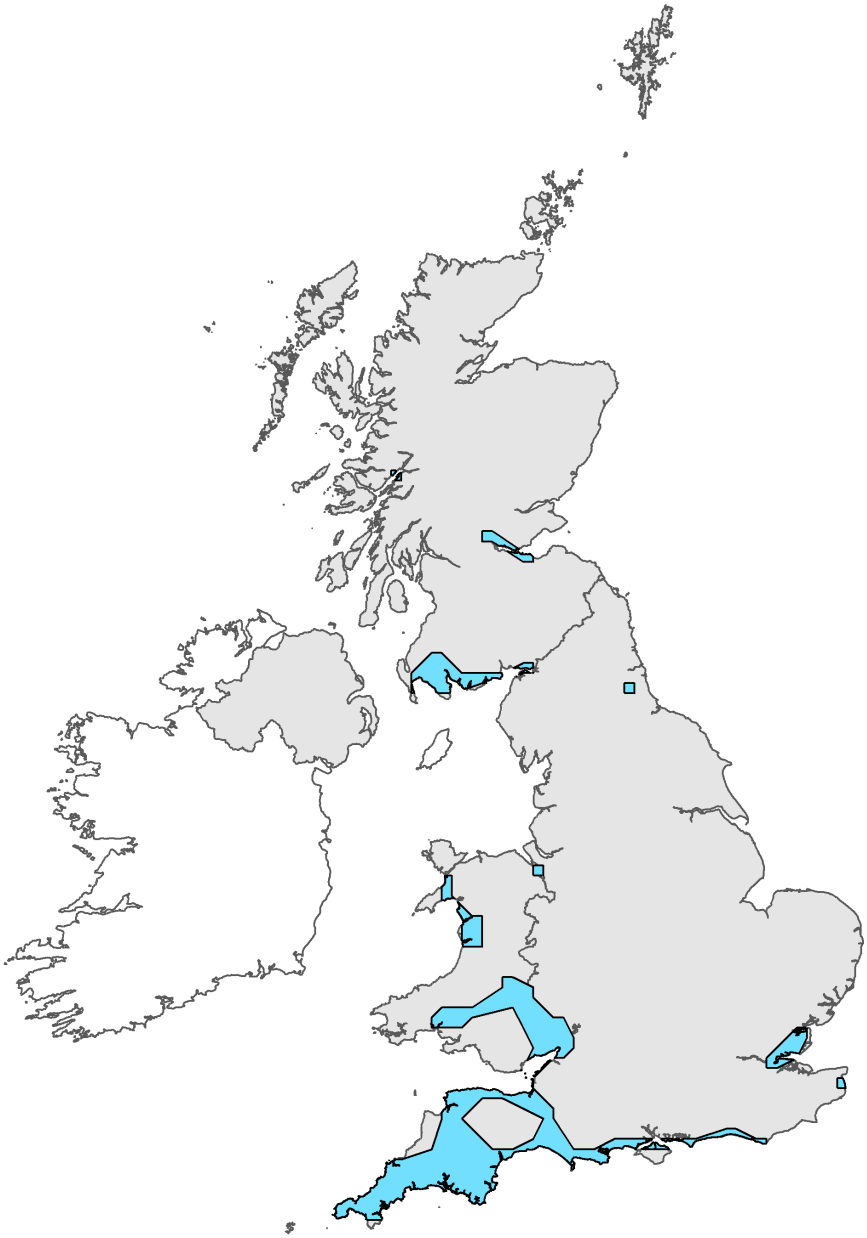

Figure 2: UK range map for S1103 - Twaite shad (*Alosa fallax*). Coastline boundary derived from the Oil and Gas Authority's OGA and Lloyd's Register SNS Regional Geological Maps (Open Source). Open Government Licence v3 (OGL). Contains data © 2017 Oil and Gas Authority.

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: Alosa fallax (1103)

Field label	Note
2.4 Distribution map; Method used	Data contained within the Environment Agency Fish Population Database has been combined with bespoke EA shad records to produce distribution maps for twaite shad. This data has been collated from both routine and ad-hoc Environment Agency fish surveys. Twaite shad distribution is likely to be under-represented in England as they are often not recorded in routine surveys due to their migratory life history. There are uncertainties over the ability to discriminate between twaite and allis shad in the records available for the two species, and the species have the ability to hybridise. Therefore a considerable number of records are reported at genus level only. For this reason the range maps are based on the species records for A. fallax plus all genus records. This may result in an over-estimate for the range of the species.
3.1 Is the species take in the wild/ exploited	Twaite shad are not directly exploited as a quarry species for recreational angling in England. It is possible that they could be captured as bycatch when fishing for other freshwater fish species, however, they have specific protection under Schedule 5 of the wildlife and Countryside Act 1981 and general protections from fishery activity under the Salmon and Freshwater Fisheries Act 1975.
3.2 Which of the measures in Art. 14 have been taken?	Specific protection afforded to twaite shad in England by Schedule 5 of the Wildlife and Countryside Act 1981: (1) Subject to the provisions of this Part, if any person intentionally kills, injures or takes any wild animal included in Schedule 5, he shall be guilty of an offence. (2) Subject to the provisions of this Part, if any person has in his possession or control any live or dead wild animal included in Schedule 5 or any part of, or anything derived from, such an animal, he shall be guilty of an offence. (4) Subject to the provisions of this Part, if any person intentionally- (a) damages or destroys, or obstructs access to, any structure or place which any wild animal included in Schedule 5 uses for shelter or protection ; or (b) disturbs any such animal while it is occupying a structure or place which it uses for that purpose, he shall be guilty of an offence.
3.3 Hunting bag or quantity taken in the wild for Mammals and Acipenseridae (Fish)	No recording unit available due to no national requirement for catch returns to be submitted and specific targeting of twaite shad being illegal.

Species name: Alosa fallax (1103) Region code: ATL

Field label	Note
5.3 Short term trend; Direction	Using comparisons between previous reporting rounds, literature and expert judgement, range appears stable

5.11 Change and reason for change in surface area of range	Data contained within the Environment Agency Fish Population Database has been combined with bespoke EA shad records to produce distribution maps for twaite shad. This data has been collated from both routine and ad-hoc Environment Agency fish surveys. Twaite shad distribution is likely to be under-represented in England as they are often not recorded in routine surveys due to their migratory life history. There are uncertainties over the ability to discriminate between twaite and allis shad in the records available for the two species, and the species have the ability to hybridise. Therefore a considerable number of records are reported at genus level only. For this reason the range maps are based on the species records for A. fallax plus all genus records. This may result in an over-estimate for the range of the species. The species continues to be cut off from much of its historical range due to the presence of artificial barriers to migration. A.fallax and A. alosa are thought to share a similar historical range. In England A. fallax are known to spawn in the R. Severn below Worcester. Recent monitoring on the R. Severn has confirmed that adult shad can successfully pass Upper Lode weir but cannot pass Diglis weir. The majority of the fish also remain below Powick weir on the R.Teme. In the marine phase twaite shad have been recorded at approximately twice the frequency of allis shad, with both species distributed around the south west coast of England and Severn Estuary. However, twaite shad are more common in estuarine and freshwater areas around the Severn Estuary and allis shad more common around the Tamar estuary. There is some evidence that mature twaite shad are present in the Torridge Estuary around spawning time; whether these are attempting to spawn or are just strays from the Severn and South Wales populations is not known (Hillman pers. comm). There are records of mature allis and twaite shad from other south west estuaries around spawning time (May-July), however, many estuarine shad records are immature shad feeding in the estuary.
6.2 Population size	In 2017 detailed studies of shad migrations within the River Severn at Upper Load weir gave a whole run estimate of between 11682 - 20697 fish. This estimate was developed using a combination of direct observation by volunteers, resistivity counter and the collection of footage from a fixed camera on Upper Lode Weir. However it is unknown what proportion of these shad may have been Alosa fallax. It is also unknown what proportion of the overall spawning run did not attempt to pass Upper Lode weir.
6.6 Population size; Method used	A detailed methodology used for population assessment at the 1 km2 resolution and the associated interpolation approach can be found in the Interagency Freshwater Group paper, Procedure for estimating population using 1km square resolution records data.

6.8 Short term trend; Direction	Records for twaite shad are sporadic throughout the short term trend period and survey effort is not consistant across the species range. It is therefore impossible to accurately assess a trend direction. The species is still being recorded across much of what is thought to be its natural coastal / estuarine range and there has been no significant increase in pressures in the freshwater environment, which suggests that the population may be stable. However, A.alosa records collected from Gunnislake fish trap beween 2007 - 2015 demonstrate a potential step change in allis shad numbers within the Tamar between 2011 and 2012 with very low numbers of allis captured in the trap during 2012 and 2013, with a complete absence of allis shad in 2015. Although low flows may have been at least partially responsible for the low numbers of allis captured since 2011 due to difficulties with upstream migration, the data may still represent a genuine reduction in allis numbers. Due to the difficulties of identification for twaite and allis shad and their ability to hybridise, a change in recorded allis shad on the Tamar may also indicate a change in twaite shad numbers. The likelihood of an improving trend seems low because many of the artificial physical barriers to upstream migration that have blocked passage to historical spawning grounds are still in place. Where fish passes have been added, thery are generally unsuitable for twaite shad. However, the water quality of a number of English estuaries and rivers has improved in recent years, and this may have removed chemical barriers for migrating adults and improved juvenile survival. Detailed studies of shad migrations within the River Severn in 2017 at Upper Load weir gave a whole shad (Alosa sp.) run estimate of between 11682 - 20697 fish. However this estimate is for a single year and does not have previous years' data on which a comparison can be made.
6.11 Long term trend; Period	N/A as no quantitative long-term data is available in the required reporting unit.
6.16 Change and reason for change in population size	There is no appreciable change in the population size between periods using the EU standard reporting unit as twaite shad records are still focused on the same locations over time. However, A.alosa records collected from Gunnislake fish trap beween 2007 - 2015 demonstrate a potential step change in allis shad numbers within the Tamar between 2011 and 2012 with very low numbers of allis captured in the trap during 2012 and 2013, with a complete absence of allis shad in 2015. Although low flows may have been at least partially responsible for the low numbers of allis captured since 2011 due to difficulties with upstream migration, the data may still represent a genuine reduction in allis numbers. Due to the difficulties of identification for twaite and allis shad and their ability to hybridise, a change in recorded allis shad numbers on the Tamar may also indicate a change in twaite shad numbers. Fish entraiment CPUE figures for Hinkley point power station, although not statistically analysed at the present time, may indicate a substantial decline in the numbers of shad captured by the cooling water abstraction in recent years. As catch effort has remained consistant these data could signify a reduction in shad numbers in the Bristol Channel. In addition the figures may show a corresponding reduction in the size of individual fish (P. Henderson pers. comm). There has been no significant change in accessibility between 2007 and 2013 for potential twaite shad sites in England. There have been no new in-channel structures in the recent past and measures to address existing key artificial barriers to shad migration are still in the planning phase. This would indicate that any significant and persistant change in allis numbers may represent a genuine change in the population.

7.1 Sufficiency of area and quality of occupied habitat	Twaite shad populations have declined across Europe and are reduced across England when compared with their natural/unimpacted reference condition. This decline is generally attributed to reductions in habitat quality due to poor water quality, which are still on-going, and the introduction of physical barriers which stop twaite shad reaching their spawning grounds and which are only now starting to be addressed . The construction of navigation weirs on the R. Severn in the 19th century severely reduced the access to twaite shad spawning grounds. Diglis weir has been demonstrated to be a total barrier to shad as part of the monitoring undertaken for the Unlocking the Severn project. Access restrictions (due to physical barriers) to historical river habitat is the primary issue for the species. However, water quality is thought to have been responbsible for the loss of shad species from the River Thames, although it is likely that there would be an interaction between polluting inputs to the river and the presence of barriers, such as weirs, which may have compounded the impacts of individual stressors on the species. An example of this would be impoundments behind in-channel structures leading to increased deposition of fine sediment. This reduces the mosaic of habitats which characterise a naturally functioning riverine environment and provide the range of microhabitats utilised by twaite shad at different stages of their lifecycle. The extent to which poor water quality has effected shad populations is uncertain, however, excessive fine sediment may smother spawning gravels and nutrient enrichment may stimulate increased algal growth in these areas. Twaite shad release their eggs into the water column, unlike salmon which bury their eggs in redds deep within the gravel, therefore, twaite shad eggs may be less suceptable to deoygenation effects related to gravel clogging than those of salmonid species. It is likely that the effects of water quality and physical habitat degredation are highly variable across the range of twaite shad. The current barriers to migration are likely to limit access to some areas of habitat which would be of suitable quality to maintain a viable twaite shad population, however, without further improvements in both water quality and habitat quality, there is unlikley to be a sufficient area of currently unoccupied high quality habitat to maintain the species at FCS. Surveys of the R. Severn catchment in 2015 identified no specific shad habitat in the main stem of the R. Severn downstream of Diglis weir as the substrate was deemed unsuitable for spawning and there was a lack of marginal deadwater/backwaters for juvenile nursery habitat. However, the River Teme offered offered both spawning and nursery habitats.
7.2 Sufficiency of area and quality of occupied habitat; Method used	Gunnislake fish trap has demonstrated the inability of many shad to reach the freshwater reach of the River Tamar. In addition, monitoring on the River Severn has highlighted that while many shad successfully pass Upper Lode weir, the numbers that remain below the weir may be much higher. In addition Diglis weir is thought to be a total barrier to shad migration.

7.4 Short term trend; Direction	Twaite shad have complex habitat requirements as they are anadromous and require migratory passage, with relatively low flow velocities and turbulence. In addition, the habitat required during the marine/estuarine phase of their lifecycle is poorly understood. These factors, combined with sporadic survey effort make a detailed assessment of habitat quality trends impossible at the present time. However, progress has been made with reducing nutrient and organic pollution levels in many rivers across England within the short-term trend period, which may have a beneficial effect on the quality of shad habitat. Water quality improvements in a number of rivers and estuaries are also likely to facilitate passage to spawning grounds. However, physical barriers to migration and physical habitat degradation are still significant stressors for shad populations within England. In addition, the increased focus on run of river hydropower schemes may result in man-made barriers to shad migration being perpetuated for the foreseeable future as technical fish passage solutions are often biased towards salmonid species and may still represent a total barrier to shad passage There has been no significant change in accessibility between 2007 and 2013 for the River Severn or other potential twaite shad sites in England, Sush as the R. Tamar. There have been no new in-channel structures in the recent past and measures to address existing key artificial barriers to shad migration are still in the planning phase, therefore, the likely trend may be inferred as stable.

8.1 Characterisation of pressures/ threats	K05 - Physical barriers which prevent twaite shad reaching their spawning grounds have been a pressure on many populations throughout their range. These barriers may also act synergistically with water quality problems such as increased sediment and nutrient load. Impoundments behind structures may lead to increased deposition of fine sediment on gravels and dissolved oxygen sags due to a lack of turbulent flow. In some areas fish passes have been added to barrier structures, however, these tend to be focused on increasing turbulent flows for the passage of salmonid species and are not suited to the passage of shad which generally require lower flow velocities. K04 - Twaite shad require clean, well oxygenated gravels for spawning and slackwater refuge areas for juveniles. Changes to the hydrological regime may increase deposition rates of fine sediment on gravels and increase the resistance of structures to passage by twaite shad. In addition river engineering works may increase spate flows within the catchment which may result in both adult and juvenile shad being washed out of areas of favourable habitat within the river system. If low flows are maintained over long periods of time, elevated water temperatures, deoxygenation, siltation and bed armouring may become evident. Conversely very high flows may scour gravel spawning beds and deposited eggs. J01 - Diffuse agricultural pollution has increased the input of fine sediment, phosphate and nitrate to rivers leading to eutrophication issues such as increased algal production in spawning areas and smothering of spawning gravels. Urbanization and industrialization have resulted in discharges of both raw and treated sewage, industrial effluents and diffuse urban pollution. These discharges may prove acutely toxic to shad or produce lethal effects due to deoxygenation of the water column. A wide variety of other chemicals, including pesticides and endocrine disrupters, have been released into the aquatic environment. These may result in obvious lethal effects, however, a wide variety of sub-lethal effects, such as reduced fertility and may affect the overall fitness of the shad. Due to the diverse array of sources and impacts, the severity and contribution of each individual stressor on the population as a whole is unknown. I01 - Invasive non-native crayfish species such as signal crayfish Pacifastacus leniusculus have the potential to increase predation pressure on shad eggs and change food webs. Invasive non-native crayfish may be more aggressive, more tolerant of poor water quality, better adapted to silty substrates and achieve greater biomasses than the indigenous white clawed crayfish Austropotamobious pallipes which may have co-existed with shad in many areas across its English range. The invasion of habitats by INNS crayfish and the displacement of indigenous crayfish species may therefore have led to an increase in interspecific competition with between crayfish and shad. G03/G06 - English populations of shad may be captured as bycatch during commercial fishing on their marine feeding grounds, in coastal areas during spawning migration, and in their up-river migrations. Fishing pressure includes both commercial net and recreational rod fisheries. However, shad cannot be legally targeted and are therefore only impacted as bycatch. Shad are not considered to be a particularly robust species, therefore, stress related to capture and handling may either kill them or render them less likely to spawn successfully. N09 - Increases in temperature may produce synergistic effects with other environmental stresses such as increased toxicity of pollutants and more rapid deoxygenation. Low flows may reduce the ability of shad to pass barriers and high spate flows may lead to adults, juveniles and eggs being washed out of areas of suitable habitat. D02 - Hydro-electric schemes may form major obstructions as twaite shad populations are denied passage over spillways, through turbines and impoundments. Impounding structures may disrupt sediment movement down river, deepen and stabilise water levels, reduce hydraulic scour and increase siltation behind the structure. They may restrict the free movement of shad up and down the river. Designs may require the abstraction of water out of the channel through an off-line turbine, leaving a depleted reach. Other designs divert water within the channel through the turbine which may create current velocities that attract migrating shad. Bank reinforcements affect riparian habitats, whilst turbine arrangements without suitable screening can entrain shad, generating

injuries and mortalities. Turbine offtakes may attract migratory fish resulting in delays to migration and increased predation. D01 - N/A there are no tidal barrages in place affecting English twaite shad populations D13 Shad migrate up and down the Bristol Channel past Hinkley Point power station. Habitat adjacent to the site is likely to be used by these species as possible nursery and feeding grounds. Effects on shad at Hinkley Point may include direct entrainment in cooling water abstractions or dissolved oxygen fluctuations due to the discharge of artificially warm water from the site. Threats: K05 - Although new barriers are unlikely to be built within river systems used by twaite shad, the modification of existing structures by the addition of fish passes to facilitate the passage of salmonid species ,but unsuitable for shad, may hinder the removal / decommissioning of these structures. Such investment will allow the impacts of these structures on river habitats and associated impacts on shad to be perpetuated. K04 - increased pressure on water supplies for drinking water and agricultural irrigation may lead to increased abstraction and lower flows within the channel. Increased channel engineering and flow modification for flood risk management may continue to degrade the complex habitat mosaic required for shad to complete their lifecycle. J01 - while great improvements have been made in water quality across England, particularly relating to point source inputs of gross organic pollution, diffuse rural sources of nutrients and sediment emanating from agricultural land use are likely to continue to be a stress on the aquatic environment. I01 - Signal crayfish, together with other INNS crayfish species, continue to increase their range and populations in many English river and lake catchments. There are no effective control measures for INNS crayfish and their range is expected to continue to expand in river and lake networks for the foreseeable future. N09 - The potential for climate change to impact on future twaite shad populations is poorly understood. However, future climate change scenarios indicate a shift to a pattern of increasingly extreme events such as more prolonged low flows and higher, more energetic spate flows. This is likely to add further stress to s shad populations by making migratory barriers harder to pass and the ability to utilise high quality in-river habitats more difficult. D02 - the potential for an expansion of hydropower development across England may lead to a continuation of barriers to shad migration. While fish passage must be considered by these developments, pass designs may continue to be targeted at salmonid species and unsuitable for twaite shad. D01 - Plans are being developed for a potential tidal barrage / lagoons within the Severn Estuary. This has the potential to affect shad populations in the estuary and associated river catchments. D13 - Plans have been made for the development of a new power station at Hinkley Point. This has the potential to modify the coastal twaite shad habitat and entrain fish in cooling water intakes.

9.5 List of main conservation measures	CJ01 - Work has continued to reduce discharges to both the Natura and wider river network. Major infrastructure projects to improve sewerage, such as removal or upgrade of combined sewer overflows and improved phosphorus removal from treated sewage effluent, has been funded via the water industry's programme of strategic improvements such as AMP and PR rounds. However, further investigations are needed into the application of new best available technology for phosphorus removal and the increased availability of mains sewerage for rural populations. The England Catchment Sensitive Farming Initiative is continuing to promote a range of best agricultural practices to reduce pollution loads to priority aquatic sites. A combination of Natura 2000, SSSI and Water Framework objectives continues to drive improvements in water quality with diffuse water pollution prevention plans developed for many sites. CJ02/CJ03 - Abstraction management - Improvements have been achieved with limiting abstraction volumes and improving flow regimes by altering compensation flows from water company assets via AMP and PR rounds. However, further improvements are required to naturalise flows at many sites. As part of the on-going abstraction reform process, abstraction licences will become environmental permits and a greater emphasis will be given to environmental considerations. By 2022 all previously exempt abstractions will be permitted. CJ02/CJ03 - Physical habitat restoration - A major programme of physical restoration has been implemented on the designated river network, involving the development of a long-term strategic plan for each river and its programmed implementation. These plans address key issues such as dams and weirs, floodplain reconnection, channel modifications, lack of riparian habitat, lack of riparian trees and lack of woody debris in the channel. Outside of the designated site network, river restoration schemes have focused on addressing channel modifications and the many weirs and dams on the river network in England. A further driver for river restoration has been the increased prominence of natural flood management. If properly implemented, NFM has the potential to enable widespread improvements in many previously degraded riverine habitats. Specifically regarding shad species, the 'Unlocking the Severn' project aims to significantly improve access to the R. Severn and tributaries such as the R. Teme by improving fish passage at a number of navigation weirs. In addition, plans are being developed for improving fish passage for shad at Gunnislake weir and protecting spawning gravels downstream of the weir on the R.Tamar and upper Tamar estuary. CGO1/CG02 - Fisheries in all rivers are subject to exploitation controls. Twaite shad are classified as rare and listed in Appendix III of the Bern Convention and Annexes II and V of the EC Habitats Directive. Annex II requires that Special Areas of Conservation are designated for shad and that Member States should ensure the appropriate management of these and other sites where they are known to occur so that the favourable conservation status of the species can be secured. In addition, twaite shad is protected under Schedule 5 of the Wildlife and Countryside Act (1981) which makes it an offence to intentionally kill or injure and shad are now included in Section 9(4)(a) of the Act, which makes it an offence to intentionally obstruct access to spawning areas, or to damage or destroy gravels used for spawning. Additional fishery specific issues are addressed by the 'Salmon and freshwater fisheries act 1975'. CC04 - In recent years the rapid increase in the installation of run-of-river hydropower schemes has led to concerns over their impacts on migratory fish such as twaite shad. Research has been undertaken on the safety of various turbine designs but this has mainly focused on fish strike by turbine blades and their associated screening requirements. The effects of these installations on fish behaviour and the associated delays to migration, energy costs to fish and increased predation rates are less well understood. Many of the studies have assessed individual installations. While each individual installation may have a relatively low impact on fish, where multiple schemes have been planned on a river, their in-combination effects on shad have not been fully taken into account. In addition, fish passage mitigations at these installations take no account of the loss of geomorphological processes within the river and often lead to the barrier and its associated impoundment being

	perpetuated when opportunities for its complete removal and restoration of river processes may have been available. In the case of strong swimming fish species such as salmon, the requirement for fish passage enhancements associated with these installations has led to increased connectivity between marine feeding grounds and riverine spawning habitat at some sites, however, twaite shad are may be excluded from passes with turbulent flows. It is therefore important to install fish passes which can be utilised by all species which would be considered representative of a location, including twaite shad. CN01 - The rationale behind restoring river habitat in England is the restoration of natural riverine processes, which creates characteristic habitats and provides for individual species to an extent dependent on the natural character of the river. This rationale is also the main adaptation response for combatting climate change. Some aspects of restoring natural function are also seen as climate change mitigation measures, such as the re-establishment of natural tree cover and riparian vegetation which is being implemented as part of many river restoration schemes and agri-environment schemes. These interventions may result in moderated extremes of flow, reductions in water temperature and increased water quality. CC02/CC03 - Detailed assessments must be made of the potential risks to twaite shad stocks due to abstractions, discharges and potential barrier effects from new energy infrastructure. Any developments must be fully assessed and mitigation measures developed pre-construction phase. Continuous post construction monitoring must be undertaken and operational procedures modified if required. The HRA for Hinkley Point has identified screening and operational modifications that could be implemented to avoid entrainment in cooling water abstractions. Tidal lagoon / barrage developments are in their infancy and detailed plans to protect twaite shad stocks will be required as part of the feasibility and development phase.
10.1 Future prospects of parameters	Assumes no major development of estuarine barrages or lagoons in the foreseeable future and the successful delivery of the unlocking the Severn project, combined with improvements in water quality, particularly relating to reductions in fine sediment and nutrients.