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

Conservation status assessment for the species:

S5085 - Barbel (*Barbus barbus*)

UNITED KINGDOM

IMPORTANT NOTE - PLEASE READ

- The information in this document represents 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.
- It is based on supporting information provided by the geographically-relevant Statutory Nature Conservation Bodies, which is documented separately.
- The 2019 Article 17 UK Approach document provides details on how this supporting information contributed to the UK Report and the fields that were completed for each parameter.
- The reporting fields and options used are aligned to those set out in the European Commission guidance.
- Maps showing the distribution and range of the species are included (where available).
- Explanatory notes (where provided) are included at the end. These provide additional audit trail information to that included within the UK assessments. Further underpinning explanatory notes are available in the related country-level 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 species (section 12 Natura 2000 coverage for Annex II species).
- The UK-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**
1.2 Species code	**5085**
1.3 Species scientific name	**Barbus barbus**
1.4 Alternative species scientific name	
1.5 Common name (in national language)	Barbel

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

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5. Range

5.1 Surface area (km²)	28197.14	
5.2 Short-term trend Period	2013-2018	
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	Based mainly on extrapolation from a limited amount of data	
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	Approximately equal to (≈)

	c) Unknown	
	d) Method	The FRR has changed since 2013. An FRR operator has been used because it has not been possible to calculate the exact FRR value. The FRR is considered to be sufficient to maintain a viable population and is no less that when the Habitats Directive came into force in the UK. For further details see the 2019 Article 17 UK Approach document.
5.11 Change and reason for change in surface area of range	Use of different method	
	The change is mainly due to:	Use of different method
5.12 Additional information	The current range surface area calculation does not represent the real range surface area. Change in availability of underpinning mapping data has resulted in an apparent decrease in range area compared to 2013, but this is not due to genuine change. Expert opinion considers the trend in range to be stable. The real range surface area is considered to be the range in 2013 - 35,236km2, which is the same as the FRR in 2013. The FRR has been changed to an operator 'approximately equal to current' for this reporting period. For further information see the 2019 Article 17 UK Approach document.	

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	215
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	Increasing (+)	
6.9 Short-term trend Magnitude	a) Minimum	
	b) Maximum	
	c) Confidence interval	
6.10 Short-term trend Method used	Based mainly on expert opinion with very limited data	
6.11 Long-term trend Period	1994-2018	
6.12 Long-term trend Direction	Increasing (+)	

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6.13 Long-term trend Magnitude	a) Minimum b) Maximum c) Confidence interval	
6.14 Long-term trend Method used	Based mainly on expert opinion with very limited data	
6.15 Favourable reference population (using the unit in 6.2 or 6.4)	a) Population size b) Operator c) Unknown d) Method	 Approximately equal to (≈) The FRP has changed since 2013. An FRP operator has been used because it has not been possible to calculate the exact FRP. The FRP is considered to be large enough to maintain a viable population and is no less that when the Habitats Directive came into force in the UK. The FRP was Unknown in 2013. For further details see the 2019 Article 17 UK Approach document.
6.16 Change and reason for change in population size	Use of different method The change is mainly due to:	 Use of different method
6.17 Additional information	Due to varying levels of survey effort throughout the natural range of barbel and during different time periods, it is not possible to accurately assess population variations between reporting periods. However, as the species has been consistently recorded across much of its natural range and pressures have not increased, the species is considered to be maintaining a self-sustaining, viable population. Barbel have expanded outside their natural range in the UK due to 'successful' stocking programmes, indicating that the habitat will support expanding populations. For further information see the 2019 Article 17 UK Approach document.	

7. Habitat for the species

7.1 Sufficiency of area and quality of occupied habitat	a) Are area and quality of occupied habitat sufficient (for long-term survival)? b) Is there a sufficiently large area of unoccupied habitat of suitable quality (for long-term survival)?	Yes
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		
7.7 Long-term trend Direction		
7.8 Long-term trend Method used		
7.9 Additional information		

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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)	M
Mixed source pollution to surface and ground waters (limnic and terrestrial) (J01)	H
Invasive alien species of Union concern (I01)	M
Management of fishing stocks and game (G08)	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
Other climate related changes in abiotic conditions (N09)	M
Invasive alien species of Union concern (I01)	M
Management of fishing stocks and game (G08)	M
Hydropower (dams, weirs, run-off-the-river), including infrastructure (D02)	H

8.2 Sources of information

8.3 Additional information

9. Conservation measures

9.1 Status of measures

a) Are measures needed? No

b) Indicate the status of measures

9.2 Main purpose of the measures taken

9.3 Location of the measures taken

9.4 Response to the measures

9.5 List of main conservation measures

9.6 Additional information

10. Future prospects

10.1 Future prospects of parameters

a) Range Good

b) Population Good

c) Habitat of the species Good

10.2 Additional information

Future trend of Range is Positive - increasing <=1% (one percent or less) per year

on average; Future trend of Population is Positive - increasing <=1% (one percent or less) per year on average; and Future trend of Habitat for the species is Positive - slight/moderate improvement. For further information on how future trends inform the Future Prospects conclusion see the 2019 Article 17 UK Approach document.

11. Conclusions

11.1. Range	Favourable (FV)
11.2. Population	Favourable (FV)
11.3. Habitat for the species	Favourable (FV)
11.4. Future prospects	Favourable (FV)
11.5 Overall assessment of Conservation Status	Favourable (FV)
11.6 Overall trend in Conservation Status	Improving (+)
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	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. Conclusion on Population reached because: (i) the short-term trend direction in Population size is increasing; and (ii) the current Population size is approximately equal to the Favourable Reference Population. Conclusion on Habitat for the species reached because: (i) the area of occupied habitat is sufficiently large and (ii) the habitat quality is suitable for the long-term survival of the species; and (iii) and the short-term trend in both area and quality of habitat is stable. Conclusion on Future prospects reached because: (i) the Future prospects for Range are good; (ii) the Future prospects for Population are good; and (iii) the Future prospects for Habitat for the species are good. Overall assessment of Conservation Status is Favourable because all of the conclusions are Favourable. Overall trend in Conservation Status is based on the combination of the short-term trends for Range – stable, Population – increasing, and Habitat for the species – stable. Overall assessment of Conservation Status has not changed since 2013.

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Overall trend in conservation status was not recorded for this species in 2013, but it is likely it would have been either stable or increasing.

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 b) Minimum c) Maximum d) Best single value
12.2 Type of estimate	
12.3 Population size inside the network Method used	
12.4 Short-term trend of population size within the network Direction	
12.5 Short-term trend of population size within the network Method used	
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

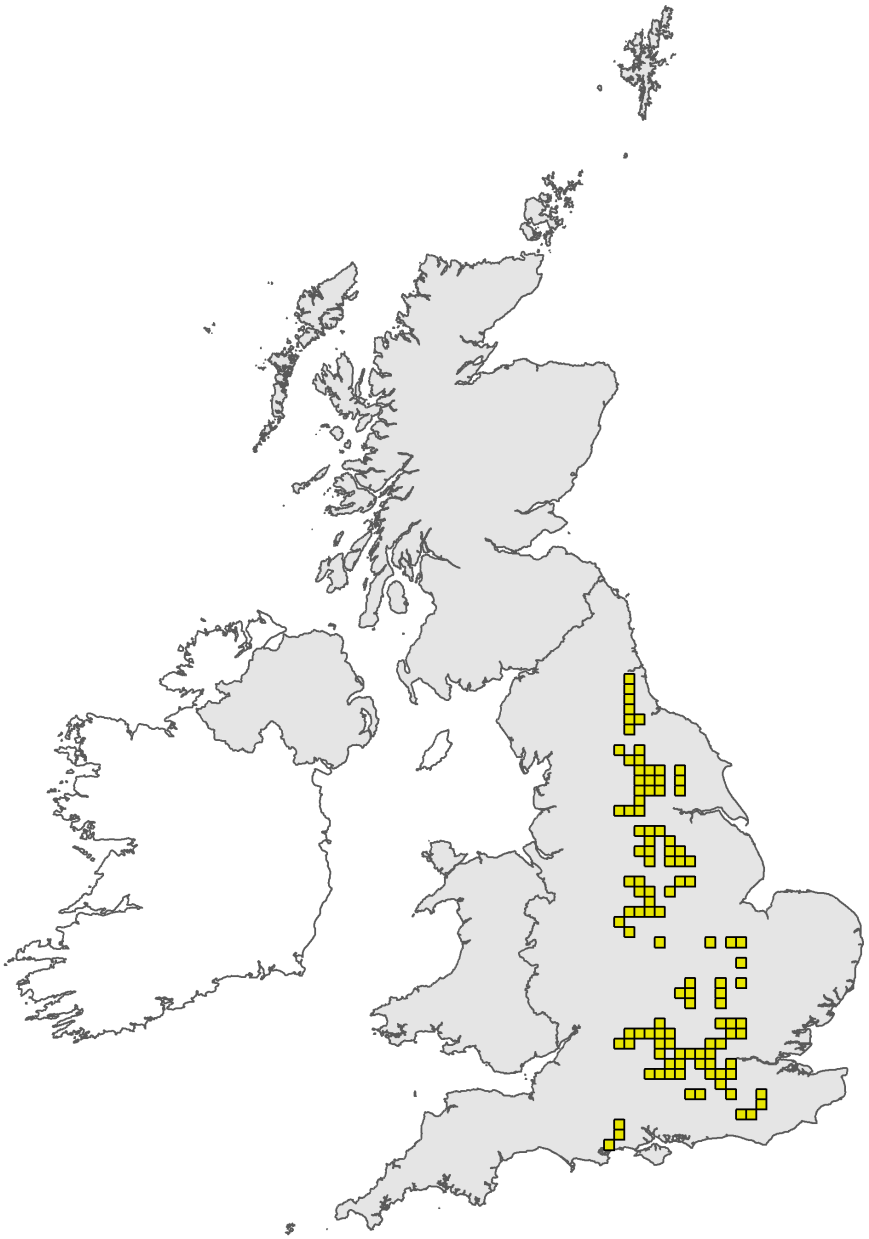

Figure 1: UK distribution map for S5085 - Barbel (*Barbus barbus*). Coastline boundary derived from the Oil and Gas Authority's OGA and Lloyd's Register SNS Regional Geological Maps (Open Source). Open Government Licence v3 (OGL). Contains data © 2017 Oil and Gas Authority.

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

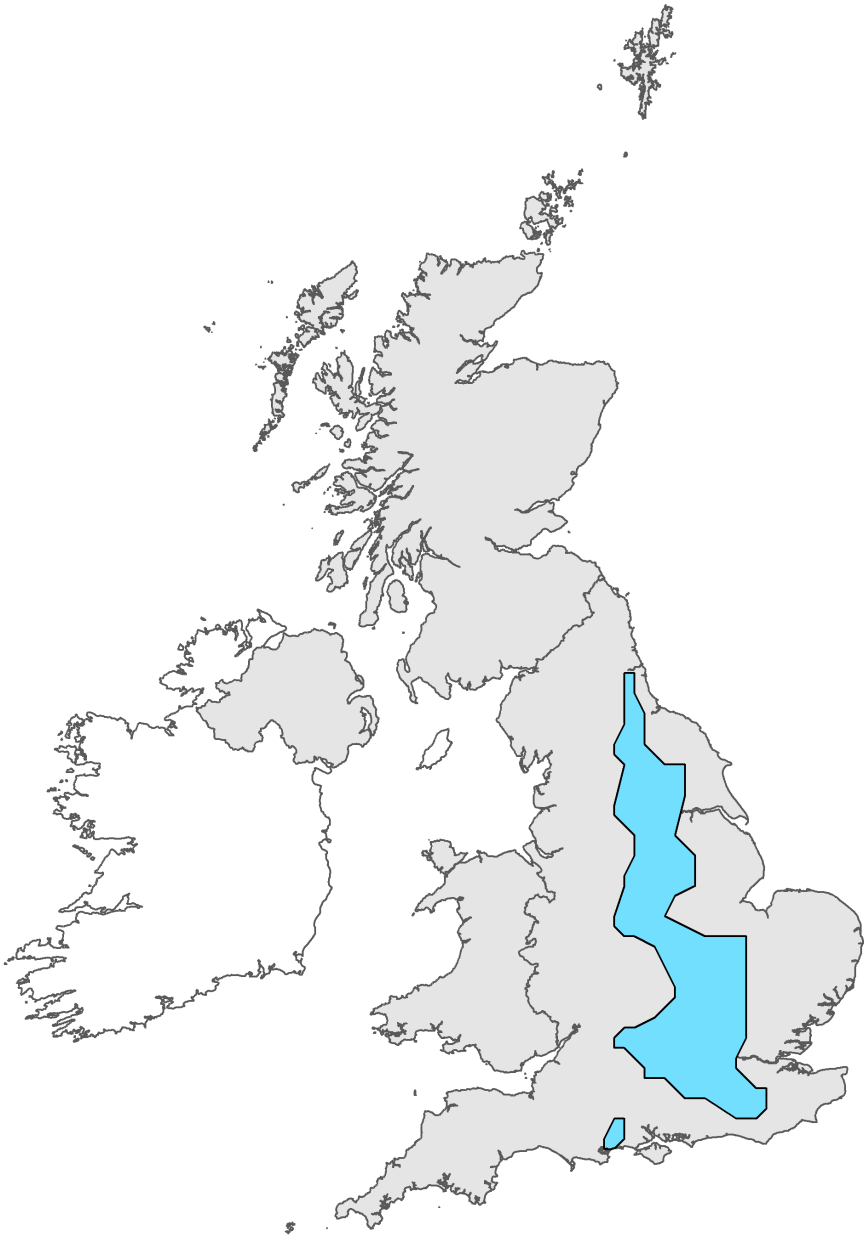

Figure 2: UK range map for S5085 - Barbel (*Barbus barbus*). Coastline boundary derived from the Oil and Gas Authority's OGA and Lloyd's Register SNS Regional Geological Maps (Open Source). Open Government Licence v3 (OGL). Contains data © 2017 Oil and Gas Authority.

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: Barbus barbus (5085)

Field label	Note
2.3 Distribution map	Data contained within the Environment Agency Fish Population Database has been used to produce distribution maps for barbel. Adult and juvenile barbel are captured during routine electric fishing surveys, therefore, recording effort across England is relatively high. However, they may be under recorded due to the difficulty of surveying barbel habitats with electric fishing gear caused by strong flows, shallow or deep water, abundant submerged macrophytes and bankside cover. In addition, these surveys do not account of the behaviour of the barbel and its tendency to take refuge during daylight hours and to venture into open water during darkness. The barbel is a widespread and common species in England. The species' natural distribution is limited to rivers in the east of England that during the periglacial period formed part of the catchment of the Proto-Rhine, along with rivers of north western Europe such as the Schelde that now run into the North Sea and/or English Channel. However, the natural range has been artificially increased due to fish movements associated with recreational angling, the River Severn catchment being a notable example. Records related to artificial expansions of range due to stocking for recreational angling have been excluded from the distribution map as they are outside of the natural range of the species and solely a result of human intervention.
3.1 Is the species take in the wild/ exploited	Barbel are highly valued as a quarry species for recreational anglers as they are a relatively large, powerful fish. They are subject to catch and release in England and are not removed from the population, however, angler capture may lead to mortality in a small number of individuals and a reduction in fitness or spawning success for others.
3.2 Which of the measures in Art. 14 have been taken?	Barbel in all English rivers are subject to controls on angling activity. The primary legislation for the regulation of angling is the 'Salmon and Freshwater Fishery Act 1975'. Under this legislation the Environment Agency has powers to licence recreational angling. Fishery byelaws regulate when, where and how angling can take place. The licencing approach records the number of licenced individuals and regulates the gear and effort used. As part of this managed exploitation, pressure on the population can be controlled and data can be collected on barbel stocks. In addition to the Salmon and Freshwater Fishery Act, the stocking of fish to freshwaters is regulated by 'The Keeping and Introduction of Fish (England and River Esk Catchment Area) Regulations 2015'.
3.3 Hunting bag or quantity taken in the wild for Mammals and Acipenseridae (Fish)	No recording unit available due to catch and release with no national requirement for catch returns to be submitted
3.4 Hunting bag or quantity take in the wild; Method used	Barbel are subject to catch and release in England and are not removed from the population. There is no national requirement for catch returns to be submitted

Species name: Barbus barbus (5085) Region code: ATL

Field label	Note

5.12 Additional information	Data contained within the Environment Agency Fish Population Database has been used to produce distribution maps for barbel. Adult and juvenile barbel are captured during routine electric fishing surveys, therefore, recording effort across England is relatively high. However, they may be under recorded due to the difficulty of surveying barbel habitats with electric fishing gear caused by strong flows, shallow or deep water, abundant submerged macrophytes and bankside cover. In addition, these surveys do not account of the behaviour of the barbel and its tendency to take refuge during daylight hours and to venture into open water during darkness. The barbel is a widespread and common species in England. The species' natural distribution is limited to rivers in the east of England that during the periglacial period formed part of the catchment of the Proto-Rhine, along with rivers of north western Europe such as the Schelde that now run into the North Sea and/or English Channel. However, the natural range has been artificially increased due to fish movements associated with recreational angling, the River Severn catchment being a notable example. Records related to artificial expansions of range due to stocking for recreational angling have been excluded from the distribution map as they are outside of the natural range of the species and solely a result of human intervention.
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 (Hatton-Ellis 2018).
6.8 Short term trend; Direction	Records for barbel are common throughout the short term trend period, however, survey effort is not consistent across the species natural range. In addition, surveys may underestimate barbel numbers due to the difficulties of carrying out detailed surveys within typical barbel habitat. It is therefore impossible to accurately assess a trend direction. The species is regularly recorded across its natural range and there has been no significant increase in pressures suggesting that the population is at least stable. The water quality of many English rivers has improved in recent years improving the probability of adult and juvenile survival. This is set against a perception that barbel populations may be declining in rivers within their natural range while increasing in rivers outside of their natural range. The validity of this statement is unknown due to a lack of detailed survey effort and natural fluctuations in barbel populations.
6.12 Long term trend; Direction	Due to varying levels of survey effort throughout the natural range of barbel it is not possible to accurately assess population trends for this period. However, as the species has been consistantly recorded across much of its natural range and pressures have not increased, the species is considered to be at least stable. Water quality in many English rivers has improved markedly over the period, which may in turn benefit adult and juvenile survival. This may have led to an increasing trend in the population over this period, however, this may have been counteracted by the rapid expansion of the invasive, non-native signal crayfish population which has the potential to impact on rheophilous fish species. In addition, fine sediments resulting from poor agricultural practices have continued to be deposited on spawning gravels in many typical barbel rivers, potentially reducing successful recruitment.
6.16 Change and reason for change in population size	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.

6.17 Additional information	Records for barbel are common throughout the short term trend period, however, survey effort is not consistent across the species natural range. In addition, surveys may underestimate barbel numbers due to the difficulties of carrying out detailed surveys within typical barbel habitat. It is therefore impossible to accurately assess a trend direction. The species is regularly recorded across its natural range and there has been no significant increase in pressures suggesting that the population is at least stable. The water quality of many English rivers has improved in recent years improving the probability of adult and juvenile survival. This is set against a perception that barbel populations may be declining in rivers within their natural range while increasing in rivers outside of their natural range. The validity of this statement is unknown due to a lack of detailed survey effort and natural fluctuations in barbel populations.
7.1 Sufficiency of area and quality of occupied habitat	Access restrictions to historical river habitat due to poor water quality is thought to have been responsible for the exclusion of barbel from some areas of English rivers within their natural range. The extent to which poor water quality has effected barbel populations and continues to do so is uncertain, however, the excessive deposition of fine sediments on gravels used for egg deposition may reduce recruitment success. In addition, macrophytes may be lost from water courses due to pollution. A lack of abundant submerged macrophytes will reduce cover for adults during daylight. Barbel are associated with rivers of moderate gradient, width and flow. This type of environment has been greatly altered by man made channel modifications, often for flood risk management. Channel reprofiling and riparian management has resulted in a degraded barbel habitat due to removal of features such as overhanging vegetation. These habitats may be used for refuge and/or feeding and their loss may reduce the probability of a barbel successfully completing its lifecycle. Habitat connectivity is important for barbel. Where suitable optimal habitat exists, barbel may remain within a small home range. However, where suitable spawning habitat is not present in a section of river barbel may undergo large scale movements within a river system to find suitable spawning gravels. Upstream movements by barbel may be blocked by man-made barriers such as weirs, although it has been demonstrated that barbel can often successfully pass smaller obstructions. Larger barriers may have fish passes added to improve their passibility by some fish species, however, while barbel have been recorded as successfully navigating technical fish passes intended for salmonid species, the passage efficiency for barbel is low and movements within the river will be greatly impeded when compared with a natural river channel. In addition, the large expenditure on technical pass construction may delay the ultimate removal of the barrier from the channel. Additional stocking of other rheophylic species such as chub at high biomasses for recreational angling purposes may increase interspecific competition, however, effective resource partitioning between barbel and chub has been demonstrated. Invasive non-native crayfish species such as signal crayfish Pacifastacus leniusculus also have the potential to increase predation pressure on barbel eggs. 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 barbel in rivers across England. 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 barbel. The current physical and chemical barriers to barbel movements within river channels are likely to limit access to some areas of habitat ,within the native range, which would be of suitable quality to maintain a viable barbel 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.

7.4 Short term trend; Direction	Sporadic survey effort and the widespread distribution of barbel within England, 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 spawning substrates. Water quality improvements in a number of rivers are also likely to facilitate passage to spawning grounds. However, issues of siltation of spawning gravels, physical barriers to movement and physical habitat degradation are still significant stressors for barbel populations within England. In addition, the increased focus on run of river hydropower schemes may result in man-made barriers to barbel movements being perpetuated for the foreseeable future as technical fish passage solutions are often biased towards salmonid species and may still represent a significant obstacle to barbel passage. When taking into account the marked improvement in water quality in many English rivers such as the River Trent, which may in turn benefit adult and juvenile barbel survival, it would be reasonable to expect an increasing trend in the available habitat and habitat quality within the native range of barbel over this period. However, this may be off-set by the continued expansion of INNS crayfish range and new hydropower infrastructure.

8.1 Characterisation of pressures/ threats	Pressures: K05 - Physical modification of river channels may remove habitat heterogeneity and the mosaic of habitats utilised by barbel. Although barbel will occupy a relatively small home range if optimal habitats are present, if suitable spawning gravels are not present they will undertake large scale movements to source them. Upstream migrations by barbel may be blocked by man-made in-stream barriers such as weirs. 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 gravel substrates 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 ideally suited to the efficient passage of barbel which generally require lower flow velocities. K04 - Barbel require a habitat mosaic of gravels, macrophytes, riparian cover and flow types for refuge, feeding and egg deposition. Changes to the hydrological regime may increase deposition rates of fine sediment on gravels, increase the resistance of structures to passage by barbel and lead to stranding of fish or desiccation of eggs during low flows. In addition river engineering works may increase spate flow velocities within the catchment which may result in juvenile barbel 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 substrates used for egg deposition. 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 and changes in the macrophyte community. Urbanization and industrialization have resulted in discharges of both raw and treated sewage effluent, industrial effluents and diffuse urban pollution. These discharges may prove acutely toxic to barbel or produce lethal effects due to deoxygenation. A wide variety of other chemicals, including pesticides and endocrine disrupters, have been released into the aquatic environment. Pollutants may result in obvious lethal effects, however, a wide variety of sub-lethal effects, such as reduced fertility may affect the overall fitness of barbel. 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. 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 barbel to pass barriers and reach new habitat. High spate flows may lead to juvenile fish and eggs being washed out of areas of suitable habitat. I01 - Invasive non-native crayfish species such as signal crayfish Pacifastacus leniusculus have the potential to increase predation pressure on barbel eggs. 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 barbel in many areas across its native 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 barbel. G06/G08 - Additional stocking for recreational angling purposes may increase interspecific competition, particularly if stock densities are increased above the local carrying capacity. Although barbel are only subject to catch and release angling in England, capture by rod and line methods will still impart a certain level of stress on the fish, may result in mortality or reduce spawning success. D02 - Hydro-electric schemes may form major obstructions as barbel 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 barbel 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 barbel. Bank reinforcements affect riparian habitats, whilst turbine arrangements without suitable screening can entrain barbel, generating injuries and mortalities. Turbine offtakes may attract barbel resulting in delays to spawning migration and increased predation. Threats: K05 - Continued channel modification may remove refuges such as gravel substrates and riparian vegetation. This may also remove the diversity of flow types, such as riffles and pools, utilised by barbel. Although new barriers are unlikely to be built within river systems used by barbel, the modification of existing structures by the addition of fish passes unsuitable or inefficient for barbel, may hinder the removal / decommissioning of these structures. This will allow their impacts on geomorphological process and associated impacts on barbel 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 barbel 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. N09 - The potential for climate change to impact on future barbel 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 on barbel populations. However, a small increase in water temperatures may also allow colonisation of new areas, leading to an expansion of the range occupied by barbel. I01 - Signal crayfish, together with other INNS crayfish species, continue to increase their range and populations in many English river catchments. There are no effective control measures for INNS crayfish and their range is expected to continue to expand in river networks for the foreseeable future. G06 - Competitive pressure from fish species stocked above their natural carrying capacity is likely to remain at current levels due to pressure from recreational angling interests for high stock densities. This pressure is likely to continue. D02 - the potential for an expansion of hydropower development across England may lead to a continuation of barriers to barbel movements within a river system. While fish passage must be considered by these developments, pass designs may continue to be targeted at salmonid species and inefficient for barbel.
10.2 Additional information	As improvements continue to be made regarding water quality and the re-establishment of natural riverine processes in England the area of freshwater habitat suitable for barbel may be expected to increase. Set in opposition to this generally positive outlook are the unknowns of climate change effects which may lead to more extreme flow variations, the potential for continued diffuse agricultural pollution resulting in inputs of nutrients and fine sediment, the increase and expansion of non-native crayfish populations and the possibility of increases in energy production infrastructure associated with run of river hydropower.