

**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:

S6965 - Bullhead (*Cottus gobio*)

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 | 6965 |
| 1.3 Species scientific name | Cottus gobio |
| 1.4 Alternative species scientific name | |
| 1.5 Common name (in national language) | Bullhead |

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? | <table> <tr> <td>a) regulations regarding access to property</td><td>No</td></tr> <tr> <td>b) temporary or local prohibition of the taking of specimens in the wild and exploitation</td><td>No</td></tr> <tr> <td>c) regulation of the periods and/or methods of taking specimens</td><td>No</td></tr> <tr> <td>d) application of hunting and fishing rules which take account of the conservation of such populations</td><td>No</td></tr> <tr> <td>e) establishment of a system of licences for taking specimens or of quotas</td><td>No</td></tr> <tr> <td>f) regulation of the purchase, sale, offering for sale, keeping for sale or transport for sale of specimens</td><td>No</td></tr> <tr> <td>g) breeding in captivity of animal species as well as artificial propagation of plant species</td><td>No</td></tr> <tr> <td>h) other measures</td><td>No</td></tr> </table> | 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 |
| 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

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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.

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5. Range

| |
|------------------------------------------------------------|
| 5.1 Surface area (km ²) |
| 5.2 Short-term trend Period |
| 5.3 Short-term trend Direction |
| 5.4 Short-term trend Magnitude |
| 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 |
| 5.9 Long-term trend Method used |
| 5.10 Favourable reference range |
| 5.11 Change and reason for change in surface area of range |
| 5.12 Additional information |

Stable (0)

a) Minimum

b) Maximum

a) Minimum

b) Maximum

a) Area (km²)
b) Operator
c) Unknown
d) Method

No change

The change is mainly due to:

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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 3297 |
| 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 | Stable (0) |
| 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 | Stable (0) |
| 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 |
| 6.16 Change and reason for change in population size | No change The change is mainly due to: |
| 6.17 Additional information | |

7. Habitat for the species

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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)?

Unknown

b) Is there a sufficiently large area of occupied AND unoccupied habitat of suitable quality (to maintain the species at FCS)?

Unknown

7.2 Sufficiency of area and quality of occupied habitat Method used

Insufficient or no data available

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

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 |
| Problematic native species (I04) | M |
| Freshwater fish and shellfish harvesting (recreational) (G06) | 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 |
| Problematic native species (I04) | M |
| Freshwater fish and shellfish harvesting (recreational) (G06) | M |
| Hydropower (dams, weirs, run-off-the-river), including infrastructure (D02) | H |

8.2 Sources of information

8.3 Additional information

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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

Restore the habitat of the species (related to 'Habitat for the species')

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)

Adopt climate change mitigation measures (CN01)

Management, control or eradication of established invasive alien species of Union concern (CI02)

Management of hunting, recreational fishing and recreational or commercial harvesting or collection of plants (CG02)

Reduce impact of hydropower operation and infrastructure (CC04)

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:

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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 | 406 |

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

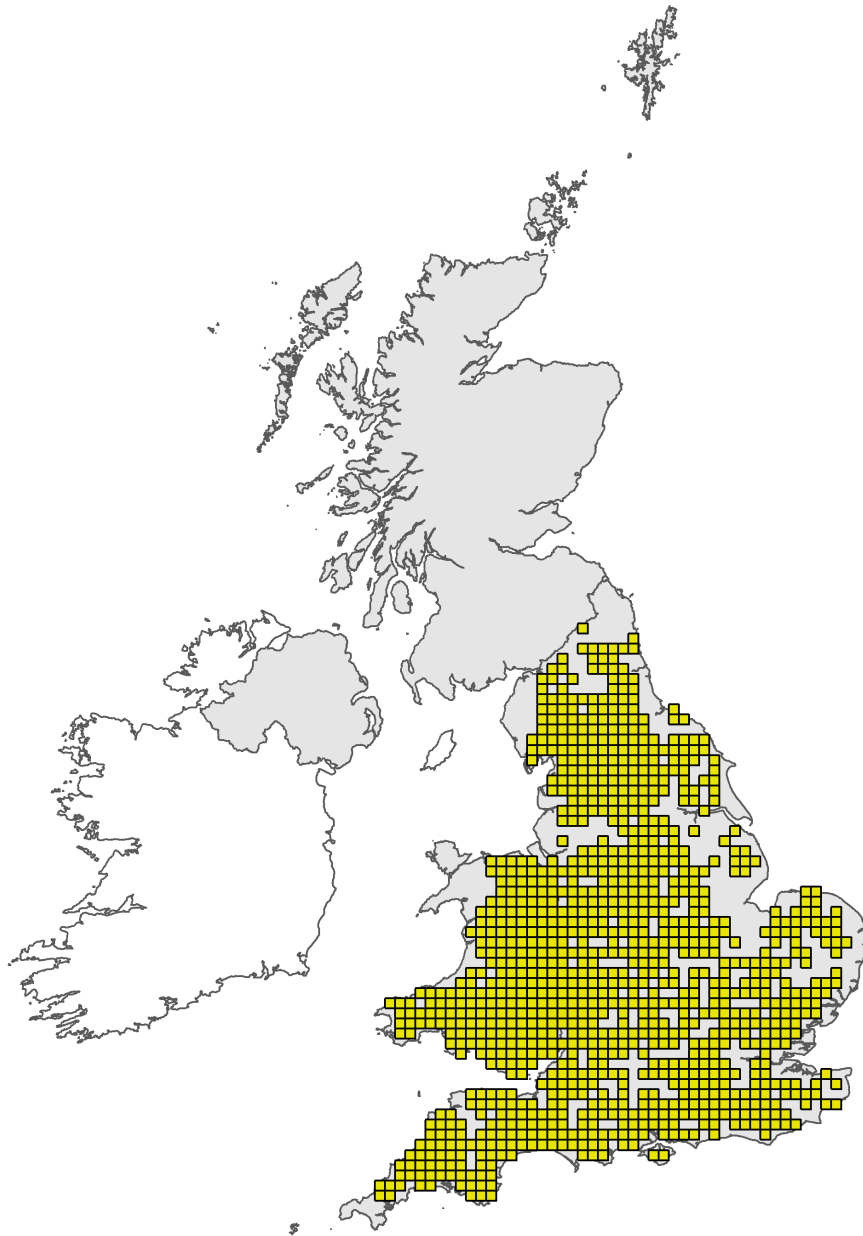


Figure 1: UK distribution map for S6965 - Bullhead (*Cottus gobio*). Coastline boundary derived from the Oil and Gas Authority's OGA and Lloyd's Register SNS Regional Geological Maps (Open Source). Open Government Licence v3 (OGL). Contains data © 2017 Oil and Gas Authority.

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 S6965 - Bullhead (*Cottus gobio*). 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: *Cottus gobio* (6965)

| Field label | Note |
|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2.4 Distribution map; Method used | Data contained within the Environment Agency Fish Population Database has been used to produce distribution maps for bullhead. Adult bullhead are captured during routine electric fishing surveys and benthic kick samples, therefore, recording effort across England is relatively high. However, they may be under recorded in some habitats due to their cryptic nature, habitat preferences, crepuscular behaviour and operational difficulties using electric fishing gear in typical bullhead habitat. The bullhead is a widespread and common species in England. Its present distribution is thought to have been the result of a largely natural expansion of remnant populations in the south east which survived glacial periods. Due to a lack of recreational angling or commercial interest in bullhead, it is unlikely to have been widely introduced to new areas by human intervention. |

Species name: *Cottus gobio* (6965) 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 bullhead. Adult bullhead are captured during routine electric fishing surveys and benthic kick samples, therefore, recording effort across England is relatively high. However, they may be under recorded in some habitats due to their cryptic nature, habitat preferences, crepuscular behaviour and operational difficulties using electric fishing gear in typical bullhead habitat. The bullhead is a widespread and common species in England. Its present distribution is thought to have been the result of a largely natural expansion of remnant populations in the south east which survived glacial periods. Due to a lack of recreational angling or commercial interest in bullhead, it is unlikely to have been widely introduced to new areas by human intervention. |
| 6.6 Population size; Method used | A detailed methodology used for population assessment at the 1 km ² 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 bullhead are common throughout the short term trend period, however, survey effort is not consistent across the species range. In addition, specific surveys targeting bullhead and taking into account their cryptic and crepuscular traits are limited within the data set. It is therefore impossible to accurately assess a trend direction. The species is being 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 and lakes has improved in recent years improving the probability of both adult and juvenile survival, it is likely that the population is stable and possibly increasing. |

| | |
|------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6.12 Long term trend; Direction | <p>Due to varying levels of survey effort throughout the bullhead range it is not possible to accurately assess population trends for this period. 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 at least stable. Water quality has improved markedly in many English rivers, 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 benthic fish species. In addition, fine sediments resulting from poor agricultural practices have continued to be deposited on gravels and coarse substrates in many typical bullhead habitats, potentially reducing successful recruitment.</p> |
| 6.16 Change and reason for change in population size | <p>Although bullhead are captured by both routine fish surveys and benthic kick samples, the lack of a coordinated monitoring programme for bullhead which takes account of their cryptic lifestyle makes it impossible to accurately assess whether the population is recruiting efficiently. The continued presence of adult and juvenile bullhead across their native range within England would indicate that the population has remained viable over time and is recruiting successfully. However, the expansion of non-native crayfish populations within England has the potential to increase mortality rates and reduce egg numbers in benthic fish species such as bullhead and may therefore cause a deviation from the unimpacted condition.</p> |
| 7.1 Sufficiency of area and quality of occupied habitat | <p>Access restrictions to historical river habitat due to poor water quality is thought to have been responsible for the exclusion of bullhead from some areas of English rivers within their natural range. The extent to which poor water quality has effected bullhead populations is uncertain, however, nutrient enrichment and the growth of algae on coarse substrates together with the excessive deposition of fine sediments produce a habitat unsuitable for bullhead. In addition, macrophytes may be lost from water courses due to pollution. This may reduce cover for adults during foraging activity at dawn and dusk. Although adult bullhead are known to favour coarse substrates for refuge during daylight hours, a mosaic of microhabitats may be used for feeding during the more active dawn and dusk periods. Excessive sediment loads due to agricultural sources has the potential to transform this habitat mosaic into a homogenous silted environment which may impact on bullhead. Habitat connectivity is important for bullhead. While they are not considered a migratory species, small scale movements within river systems are important as they allow the colonisation / re-colonisation of newly available habitats. This may be particularly important following catastrophic events such as scouring during spate flows, low flows or pollution events. Upstream movements by bullhead may be blocked by relatively small man-made barriers. Larger barriers may have fish passes added to improve their passability by some fish species, however, many technical fish pass solutions are unsuitable for bullhead and the large expenditure on their construction may delay the ultimate removal of the barrier from the channel. Excessive predation may also impact on bullhead. Due to their small size bullhead are liable to be preyed upon by a number of fish species such as brown or rainbow trout, therefore, additional stocking for recreational angling purposes may increase predation rates. Invasive non-native crayfish species such as signal crayfish <i>Pacifastacus leniusculus</i> also have the potential to increase predation pressure on both bullhead and their eggs and compete for interstitial refuges within the substrate. 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 <i>Austropotamobius pallipes</i> which may have co-existed with bullhead in rivers and lakes 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 bullhead.</p> |

7.4 Short term trend; Direction

Sporadic survey effort and the widespread distribution of bullhead 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 bullhead habitat. However, issues of siltation of gravels/coarse substrates, physical barriers to movement and physical habitat degradation are still significant stressors for bullhead populations within England. In addition, the increased focus on run of river hydropower schemes may result in man-made barriers to bullhead movements being perpetuated for the foreseeable future as technical fish passage solutions are often unsuitable for bullhead. When taking into account the marked improvement in water quality in many English rivers, which may in turn benefit adult and juvenile bullhead survival, it would be reasonable to expect an increasing trend in the available habitat and habitat quality over this period. However, this may be off-set by the continued expansion of INNS crayfish range.

8.1 Characterisation of pressures/ threats

Pressures: K05 - Physical modification of river channels may remove habitat heterogeneity and the mosaic of microhabitats utilised by bullhead. Although bullhead are not thought to undertake large scale migratory activity, upstream movements by bullhead to newly available habitats / territories 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 coarse 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 suited to the passage of bullhead which require lower flow velocities. This problem may become acute in the event of a catastrophic pollution event occurring high in a river catchment. Downstream populations of bullhead which succeeded in finding refuge and survived the passage of the pollutant may then be unable to recolonise upstream areas of the catchment due to physical barriers. K04 - Bullhead require a habitat mosaic of coarse gravels / cobbles for refuge, feeding and egg deposition. Tree roots and leaf litter are also thought to offer important refuge areas. Macrophytes provide cover during the more active periods of dawn and dusk. Changes to the hydrological regime may increase deposition rates of fine sediment on gravels, increase the resistance of structures to passage by bullhead 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 bullhead 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 for adult refuge and 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 bullhead 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. Bullhead may be particularly vulnerable to deposited pollutants due to their benthic existence and use of interstitial spaces within gravels. 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 bullhead. 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 bullhead to pass barriers and reach new habitat. High spate flows may lead to 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 both bullhead and their 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 *Austropotamobius pallipes* which may have co-existed with bullhead 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 bullhead. G06/I04 - Due to their small size bullhead are liable to be preyed upon by a number of fish species such as brown and rainbow trout. Therefore, additional stocking for recreational angling purposes may increase predation rates, particularly if stock densities are increased above the local carrying capacity, larger fish or locally non-native/non-native predatory fish species are introduced. D02 -

Hydro-electric schemes may form major obstructions as bullhead populations are denied upstream passage. Impounding structures may disrupt sediment movement down river, deepen and stabilise water levels, reduce hydraulic scour and increase siltation behind the structure. Designs may require the abstraction of water out of the channel through an off-line turbine, leaving a depleted reach. Bank reinforcements affect marginal habitats. Fish passes may be added to the impoundment structure, however, many technical fish pass solutions are unsuitable for bullhead due to their slow swimming speeds and lack of leaping ability. Even rock ramp solutions must be carefully engineered to avoid the addition of sills which may prevent passage by bullhead. Threats: K05 - Continued channel modification may remove refuges such as coarse substrates, tree roots and woody debris. This may also remove the diversity of flow types, such as riffles and pools, utilised by bullhead. Although new barriers are unlikely to be built within river systems used by bullhead, the modification of existing structures by the addition of fish passes unsuitable for bullhead, may hinder the removal / decommissioning of these structures. This will allow their impacts on geomorphological process and associated impacts on bullhead 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 bullhead 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 bullhead 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 bullhead populations. 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. G06/I04 - Competitive pressure from locally non-native fish species and / or fish species stocked above their natural carrying capacity is likely to remain at or above current levels as there is no suitable method of control for these species and pressure from recreational angling interests for high stock densities is likely to continue. D02 - the potential for an expansion of hydropower development across England may lead to a continuation of barriers to upstream movement by bullhead. While fish passage must be considered by these developments, pass designs may continue to be targeted at salmonid species and unsuitable for bullhead.

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. Efforts are being made to restore natural hydrological regimes to designated lake sites within England as part of a coordinated lake restoration programme. These improvements in lake habitat are likely to be of benefit to bullhead.

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.

CL02 / CG02 - Section 14 of the Wildlife and Countryside Act (WCA) prohibits the introduction into the wild of any animal of a kind which is not ordinarily resident in, and is not a regular visitor to, Great Britain in a wild state, or any species of animal or plant listed in Schedule 9 to the Act. Schedule 9 lists non-native species that are already established in the wild, but which continue to pose a threat to native biodiversity and habitats such that further releases should be regulated. The EU Invasive Alien Species (IAS) Regulation (1143/2014) came into force on 1 January 2015. The Regulation imposes restrictions on species known as 'species of Union concern'. These are species whose potential adverse impacts across the European Union are such that concerted action across Europe is required. Under the Water Framework Directive (WFD) invasive non-native species (INNS) have been classified as high, moderate, low or unknown impact. Their presence prevents a site reaching high ecological status. They may also affect the ability of waterbodies to reach the default objective of good ecological status, or may cause a deterioration of status away from good status. The presence of viable populations of high impact non-native species constitutes a reason for unfavourable condition of SSSIs and SACs notified for their freshwater habitat. The presence of any

non-native species may constitute a reason for unfavourable condition of SSSIs and SACs notified for either their freshwater habitat or particularly freshwater species, depending on the nature of the effect. The Live Fish Movement Scheme (LFMS) enacts the Keeping and Introducing Fish Act 2015 (KIFA). It lists Invasive non-native fish species (Annex 1 species) which cannot be kept in water bodies without a licence, controls the stocking of locally non-native fish species and regulates the stocking of native fish species to the wild. There are a number of strategies in England aimed at limiting the spread of invasive species. Examples include the development of pathway action plans such as the 'angling pathway action plan' and the 'boating pathway action plan' which are required under the IAS regulations, the implementation of the Great Britain Invasive Non-Native Species Strategy and publicity via stakeholders surrounding the importance of biosecurity protocols. CC04 - In recent years the rapid increase in the installation of run-of-river hydropower schemes has led to concerns over their impacts on various fish species. 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 bullhead behaviour and the associated impacts on movements within the channel are less well understood. Many of the studies have assessed individual installations for fish species other than bullhead. While each individual installation may have a relatively low impact on bullhead, where multiple schemes have been planned on a river, their in-combination effects on bullhead may not have 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 possible. 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, bullhead 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 bullhead.

10.2 Additional information

As improvements continue to be made regarding water quality and the re-establishment of natural riverine processes and lake habitat in England the area of freshwater habitat suitable for bullhead 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.