

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

2019-2024

Conservation status assessment for the species:

S6965 - Bullhead

(*Cottus gobio*)

England



For further information please contact:

Natural England, Foss House, Kings Pool, 1-2 Peasholme Green, York, YO1 7PX.
<https://www.gov.uk/government/organisations/natural-england>

JNCC, Quay House, 2 East Station Road, Fletton Quays, Peterborough, PE2 8YY.
<https://jncc.gov.uk>

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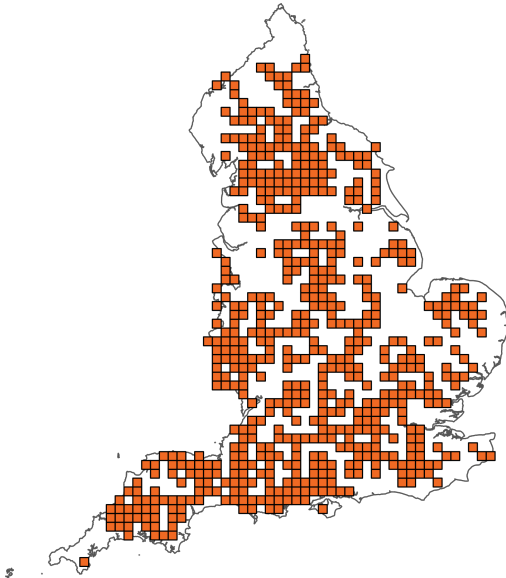
Important note - Please read

- The information in this document represents the England Report under The Conservation of Habitats and Species Regulations 2017 (as amended), Regulation 9A, for the period 2019-2024.
- It is based on supporting information provided by Natural England, which is documented separately.
- The Habitats Regulations reporting 2019-2024 Approach Document provides details on how this supporting information contributed to the UK Report and the fields that were completed for each parameter.
- Maps showing the distribution and range of the species are included.
- Explanatory notes (where provided) are included at the end. These provide additional audit trail information to that included within the assessments. Further underpinning explanatory notes are available in the related country reports.
- Some of the reporting fields have been left blank because either: (i) there was insufficient information to complete the field; (ii) completion of the field was not obligatory; and/or (iii) the field was not relevant to this species (section 12 National Site Network coverage for Annex II species).

Further details on the approach to the Habitats Regulations Reporting 2019-2024 are available on the [JNCC website](#).

Assessment Summary: Bullhead

Distribution Map



Range Map

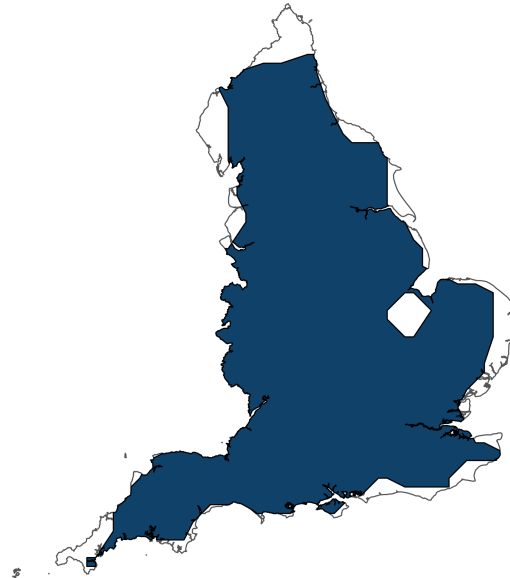


Figure 1: England distribution and range map for S6965 - Bullhead (*Cottus gobio*). Coastline boundary derived from the Oil and Gas Authority's OGA and Lloyd's Register SNS Regional Geological Maps (Open Source). Open Government Licence v3 (OGL). Contains data © 2017 Oil and Gas Authority. The 10km grid square distribution map is based on available species records within the current reporting period.

Table 1: Table summarising the conservation status for S6965 - Bullhead (*Cottus gobio*). Overall conservation status for species is based on assessments of range, population, habitat for the species, and future prospects.

Overall Conservation Status (see section 11)

Favourable (FV)

Breakdown of Overall Conservation Status

Range (see section 5)

Favourable (FV)

Population (see section 6)

Favourable (FV)

Habitat for the species (see section 7)

Favourable (FV)

Future prospects (see section 10)

Unknown (XX)

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National Level

1. General information

1.1 Country	England
1.2 Species code	S6965
1.3 Species scientific name	<i>Cottus gobio</i>
1.4 Alternative species scientific name	
1.5 Common name	Bullhead
Annex(es)	II

2. Maps

2.1 Sensitive species	No
2.2 Year or period	2019-2024
2.3 Distribution map	Yes
2.4 Distribution map; Method used	Based mainly on extrapolation from a limited amount of data

2.5 Additional information

Data contained within the National Biodiversity Network 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 for fisheries management purposes. However, the appearance of bullhead in areas of Wales, Scotland and catchments such as the Yorkshire Esk indicate that anthropogenic range expansion is occurring for bullhead.

3. Information related to Annex V Species

3.1 Is the species taken in the wild / exploited?

3.2 What measures have been taken?

a) Regulations regarding access to property

b) Temporary or local prohibition on the taking of specimens in the wild and exploitation

c) Regulation of the periods and/or methods of taking specimens

d) Application of hunting and fishing rules which take account of the conservation of such populations

e) Establishment of a system of licences for taking specimens or of quotas

f) Regulation of the purchase, sale, offering for sale, keeping for sale, or transport for sale of specimens

g) Breeding in captivity of animal species as well as artificial propagation of plant species

Other measures

Other measures description

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

a) Unit

Table 2: Quantity taken from the wild during the reporting period (see 3.3a for units). For species with defined hunting seasons, Season 1 refers to 2018/2019 (autumn 2018 to spring 2019), and Season 6 to 2023/2024. For species without hunting seasons, data are reported by calendar year: Year 1 is 2019, and Year 6 is 2024.

	Season/ year 1	Season/ year 2	Season/ year 3	Season/ year 4	Season/ year 5	Season/ year 6
b) Minimum	-	-	-	-	-	-

c) Maximum	-	-	-	-	-	-
d) Unknown	-	-	-	-	-	-

3.4: Hunting bag or quantity taken in the wild; Method used

3.5: Additional information

No additional information

Biogeographical Level

4. Biogeographical and marine regions

4.1 Biogeographical or marine region where the species occurs ATL

4.2 Sources of information

See section 14 References

5. Range

5.1 Surface area (km²) 114,211.07

5.2 Short-term trend; Period 2013-2024

5.3 Short-term trend; Direction Stable

5.4 Short-term trend; Magnitude

a) Estimated minimum

b) Estimated maximum

c) Pre-defined range

d) Unknown

e) Type of estimate

f) Rate of decrease	Decreasing <=1% (one percent or less) per year on average
5.5 Short-term trend; Method used	Based mainly on extrapolation from a limited amount of data
5.6 Long-term trend; Period	2000-2024
5.7 Long-term trend; Direction	Stable
5.8 Long-term trend; Magnitude	
a) Minimum	
b) Maximum	
c) Rate of decrease	
5.9 Long-term trend; Method used	Based mainly on extrapolation from a limited amount of data
5.10 Favourable Reference Range (FRR)	
a) Area (km²)	
b) Pre-defined increment	Current range is less than 2% smaller than the FRR
c) Unknown	No
d) Method used	Expert opinion
e) Quality of information	moderate
5.11 Change and reason for change in surface area of range	
a) Change	No
b) Genuine change	
c) Improved knowledge or more accurate data	
d) Different method	
e) No information	
f) Other reason	
g) Main reason	

5.12 Additional information

No additional information

6. Population

6.1 Year or period 2019-2024

6.2 Population size (in reporting unit)

a) Unit number of map 1x1 km grid cells

b) Minimum

c) Maximum

d) Best single value 1,297

6.3 Type of estimate Best estimate

6.4 Quality of extrapolation to reporting unit moderate

6.5 Additional population size (using population unit other than reporting unit)

a) Unit

b) Minimum

c) Maximum

d) Best single value

e) 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 2013-2024

6.8 Short-term trend; Direction Stable

6.9 Short-term trend; Magnitude

a) Estimated minimum

b) Estimated maximum

c) Pre-defined range	
d) Unknown	
e) Type of estimate	
f) Rate of decrease	
6.10 Short-term trend; Method used	Based mainly on extrapolation from a limited amount of data
6.11 Long-term trend; Period	2000-2024
6.12 Long-term trend; Direction	Stable
6.13 Long-term trend; Magnitude	
a) Minimum	
b) Maximum	
c) Confidence interval	
d) Rate of decrease	
6.14 Long-term trend; Method used	Based mainly on extrapolation from a limited amount of data
6.15 Favourable Reference Population (FRP)	
ai) Population size	
aii) Unit	
b) Pre-defined increment	Current population is less than 5% smaller than the FRP
c) Unknown	No
d) Method used	Expert opinion
e) Quality of information	moderate
6.16 Change and reason for change in population size	
a) Change	No
b) Genuine change	

c) Improved knowledge or more accurate data

d) Different method

e) No information

f) Other reason

g) Main reason

6.17 Additional information

No additional information

6.18 Age structure, mortality and reproduction deviation Unknown

7. Habitat for the species

7.1 Sufficiency of area and quality of occupied habitat (for long-term survival)

a) Is area of occupied habitat sufficient? Yes

b) Is quality of occupied habitat sufficient? Yes

c) If No or Unknown, is there a sufficiently large area of unoccupied habitat of suitable quality?

7.2 Sufficiency of area and quality of occupied habitat; Method used

a) Sufficiency of area of occupied habitat; Method used Based mainly on extrapolation from a limited amount of data

b) Sufficiency of quality of occupied habitat; Method used Insufficient or no data available

7.3 Short-term trend; Period 2013-2024

7.4 Short-term trend; Direction Stable

7.5 Short-term trend; Method used	Based mainly on extrapolation from a limited amount of data
7.6 Long-term trend; Period	2000-2024
7.7 Long-term trend; Direction	Stable
7.8 Long-term trend; Method used	

7.9 Additional information

No additional information

8. Main pressures

8.1 Characterisation of pressures

Table 3: Pressures affecting the species, including timing and importance/impact ranking. Pressures are defined as factors acting currently and/or during the reporting period (2019–2024). Rankings are: High (direct/immediate influence and/or large spatial extent) and Medium (moderate direct/immediate influence, mainly indirect and/or regional extent).

Pressure	Timing	Ranking
PK01: Mixed source pollution to surface and ground waters (limnic and terrestrial)	Ongoing and likely to be in the future	High (H)
PI01: Invasive alien species of Union concern	Ongoing and likely to be in the future	High (H)
PL01: Abstraction from groundwater, surface water or mixed water (mixed or unknown drivers)	Ongoing and likely to be in the future	Medium (M)
PA17: Agricultural activities generating pollution to surface or ground waters (including marine)	Ongoing and likely to be in the future	High (H)
PL05: Modification of hydrological flow (mixed or unknown drivers)	Ongoing and likely to be in the future	High (H)
PJ14: Other climate related changes in abiotic conditions	Ongoing and likely to be in the future	High (H)
PL03: Old barriers or other obsolete infrastructures (mixed or unknown drivers)	Ongoing and likely to be in the future	High (H)

PJ03: Changes in precipitation regimes due to climate change	Ongoing and likely to be in the future	High (H)
PL06: Physical alteration of water bodies (mixed or unknown drivers)	Ongoing and likely to be in the future	High (H)
PD02: Hydropower (dams, weirs, run-off-the-river and respective infrastructure)	Ongoing and likely to be in the future	Medium (M)

8.2 Sources of information

See section 14 References

8.3 Additional information

No 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

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

9.3 Location of the measures taken

Both inside and outside National Site Network

9.4 Response to measures

Medium-term results (within the next two reporting periods, 2025–2036)

9.5 List of main conservation measures

Table 4: Key conservation measures addressing current pressures and/or anticipated threats during the next two reporting periods (2025–2036). Measures are ranked by importance/impact: High (direct/immediate influence and/or large spatial extent) and Medium (moderate direct/immediate influence, mainly indirect and/or regional extent).

Conservation measure	Ranking
MK01: Reduce impact of mixed source pollution	High (H)
MA10: Reduce/eliminate point or diffuse source pollution to surface or ground waters (including marine) from agricultural activities	High (H)

MF02: Habitat restoration of areas impacted by residential, commercial, industrial and recreational infrastructure, operations and activities	High (H)
MK03: Restoration of habitats impacted by multi-purpose hydrological changes	High (H)
MF09: Adapt the management of water abstraction for public supply and for industrial and commercial use to reduce negative impacts on habitats and species (incl. restoration of habitats)	Medium (M)
MJ01: Implement climate change mitigation measures	High (H)

9.6 Additional information

Work has continued to reduce point and diffuse discharges to both the national site network 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 Habitats Site, SSSI and Water Framework objectives continues to drive improvements in water quality with diffuse water pollution prevention plans developed for many sites. New Countryside Stewardship payments are being developed to incentivise good agricultural practices.

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.

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 and agri-environment schemes. These interventions may result in moderated extremes of flow, reductions in water temperature and increased water quality.

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. Since 2022 many previously exempt abstractions require a permit.

Detailed assessments are being made of potential risks to bullhead due to abstractions from existing and new water supply infrastructure. Where problems are highlighted mitigation measures such as improved screening or modified operating procedures are being implemented.

10. Future prospects

10.1a Future trends of parameters

ai) Range	Overall stable
bi) Population	Overall stable
ci) Habitat for the species	Overall stable

10.1b Future prospects of parameters

aii) Range	Good
bii) Population	Unknown
cii) Habitat for the species	Unknown

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.

11. Conclusions

11.1 Range	Favourable (FV)
11.2 Population	Favourable (FV)
11.3 Habitat for the species	Favourable (FV)
11.4 Future prospects	Unknown (XX)
11.5 Overall assessment of Conservation Status	Favourable (FV)
11.6 Overall trend in Conservation Status	Stable

11.7 Change and reason for change in conservation status

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

11.7 Change and reason for change in conservation status trend

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

11.8 Additional information

No additional information

12. UK National Site Network (pSCIs, SCIs, SACs) coverage for Annex II species

12.1 Population size inside the pSCIs, SCIs and SACs network

a) Unit	number of map 1x1 km grid cells
b) Minimum	
c) Maximum	

d) Best single value	191
12.2 Type of estimate	Best estimate
12.3 Population size inside the network; Method used	Based mainly on extrapolation from a limited amount of data
12.4 Short-term trend of population size within the network; Direction	Stable
12.5 Short-term trend of population size within the network; Method used	Based mainly on expert opinion with very limited data
12.6 Short-term trend of habitat for the species inside the pSCIs, SCIs and SACs network; Direction	Stable
12.7 Short-term trend of habitat for the species inside the pSCIs, SCIs and SACs network; Method used	Based mainly on expert opinion with very limited data

12.8 Additional information

The situation within the SAC network broadly reflects the general situation within higher quality areas of the river and lake resource outside of the network. As improvements continue to be made regarding water quality and re-establishment of natural riverine and lacustrine processes in England and plans are developed and implemented to improve fish passage for all fish species, including bullhead, in rivers throughout England, the area of freshwater habitat suitable for bullhead may be expected to increase. The rate of improvement may be expected to be greater within the SAC network than outside of it. Set in opposition to this generally positive outlook are the unknowns of climate change effects which may lead to more extreme flow variations and the potential for continued diffuse agricultural pollution resulting in inputs of nutrients and fine sediment. However, it is less likely that future barriers to bullhead movement would be permitted within the SAC site series.

13. Complementary information

13.1 Justification of percentage thresholds for trends

No justification information

13.2 Trans-boundary assessment

No trans-boundary assessment information

13.2 Other relevant information

No other relevant information

14. References

Biogeographical and marine regions

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Wildlife and Countryside Act 1981 (as amended)

Main pressures

8.2 Sources of information

No sources of information

15. Explanatory Notes

Field label	Note
2.5: Additional information	<p>The bullhead is a small fish species which rarely exceeds 15cm in length. It is widely distributed in England and is the only freshwater representative of the Cottidae family found in the UK. Bullhead are adapted to a benthic lifestyle with a dorso-ventrally flattened body, eyes located high on the head, no swim bladder and broad pectoral fins with which to rest on the substrate. They seek secure refuge during daylight hours to avoid predation and are most active at dawn and dusk. Their favoured habitat can be found in both running waters and lake margins. It consists of interstitial spaces between cobbles and large gravel or woody debris, tree roots and leaf litter. Due to their solitary and territorial nature juveniles may be excluded from high quality refuge sites and forced to accept the cover provided by finer substrates, macrophytes and riffle areas. They require high dissolved oxygen concentrations but may be relatively tolerant of nutrient enrichment, provided clean gravels are maintained. Bullheads become more active at night and feed on benthic invertebrates. They spawn from March to April, with the males excavating a nest beneath stones. The male will fiercely defend this nest and eggs hatch after 20-30 days. The young will then be dispersed within the freshwater drift / plankton community.</p> <p>A revision of the <i>Cottus</i> genus concluded that the species in Britain is actually a distinct species, chabot fluviatile <i>C. perifretum</i>, rather than <i>C. gobio</i>. However, this taxonomy has not been widely adopted with the majority of subsequent studies of the species in Britain referring to <i>C. gobio</i>.</p> <p>Morphological, genetic and life history variations have been observed between bullhead in the north of England and Wales, and the south of England, which supports the idea of two separate genetic lineages in the British Isles.</p>

5.7: Long-term trend;
Direction

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 could have been counteracted by the rapid expansion of the invasive, non-native signal crayfish population which has the potential to negatively 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.

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. 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.

6.18: Age structure,
mortality and
reproduction

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.

7.1: Sufficiency of area and quality of occupied habitat

Bullhead have an extensive distribution in England and are highly adaptable to a variety of habitats. They may become highly abundant in suitable habitats. They have capacity to recolonize habitats when accessible and potential for rapid population recovery following local-scale impacts. The extent of suitable habitat available for bullhead is large and widespread, however, it is dependent on the natural functioning of these habitats. Habitat extent and quality for bullhead is therefore threatened by pressures impacting on the functioning of aquatic habitats including channelization, impoundment, dredging, hydrological modifications and water quality.

Habitat connectivity is important for bullhead. While they are not considered a migratory species, small scale movements within aquatic 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 passibility 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 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

Pacifastacus leniusculus 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 *Austropotamobius pallipes* 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 lead to an increase in interspecific competition with between crayfish and bullhead.

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 offset by the continued expansion of INNS crayfish range.

8.1: Characterisation of pressures

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 cobbles. 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. These 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.

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 between crayfish and bullhead.

Bullhead inhabit many English rivers and may frequent areas impacted by water abstraction. Due to their small home range they are particularly susceptible to rapid variations in water level/flow and may also be directly entrained or impinged by abstraction infrastructure.

Bullhead require clean, well oxygenated cobbles and gravels for spawning. 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 eggs and juveniles during

low flows. In addition river engineering works may increase spate flows within the catchment which may result in both adult and juvenile bullhead being washed out of areas of favourable habitat within river systems. 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.

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 high spate flows may lead to adults, juveniles and eggs being washed out of areas of suitable habitat. 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 bullhead populations by making barriers harder to pass and the ability to access and utilise high quality in-river habitats more difficult.

Physical barriers which prevent bullhead accessing upstream habitats have been a pressure on many populations throughout their range, particularly when a population must recolonise an area after being impacted by a catastrophic event such as drying or pollution. 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 / cobbles 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 generally require lower flow velocities. Hydro-electric schemes may form major obstructions as bullhead 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 bullhead 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. Bank reinforcements affect riparian habitats, whilst turbine arrangements without suitable screening can entrain bullhead, generating injuries and mortalities.

10.1: Future trends and prospects of parameters

Assumes widespread species, with a large natural range within England. However, the species may expect to become increasingly distributed and abundant within this range, assuming no further increases in barriers to upstream movement associated with hydropower development and unsuitable fish passage solutions.

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The species may expect to become increasingly distributed and abundant within its natural range, assuming no further increases in altered hydrology, barriers to upstream movements associated hydropower development and unsuitable fish passage solutions. However, the potential impact of increasing range and biomass of non-native crayfish and the particular sensitivities of bullhead to this pressure is unquantified.

10.1: Future trends and prospects of parameters

Assuming that water quality improvements and physical habitat restoration continues and no further increases in altered hydrology, barriers to upstream movements associated hydropower development and unsuitable fish passage solutions. However, the potential impact of increasing range and biomass of non-native crayfish and the particular sensitivities of bullhead to this pressure is unquantified.