

# Updated Hoveton Wetlands Restoration WFD Compliance Assessment

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## Introduction

This assessment is an update to the 'Hoveton Wetlands Restoration WFD Compliance Assessment, March 2014' It replaces the 'Updated Hoveton Wetlands Restoration WFD Compliance Assessment, March 2020' and the 'Addendum to Hoveton Wetlands Restoration Project Water Framework Directive Assessment (WFDA), January 2020' submitted with FRAP application EPR/NB3494JP. It provides a concise update using the most recent WFD condition monitoring and reviews the conclusions of the 2014 assessment. It should be read in conjunction with the 'Hoveton Wetlands Restoration WFD Compliance Assessment, March 2014' (submitted with FRAP application). The sediment removal works associate with the project have been completed. This updated assessment therefore focuses on the WFD impact of the biomanipulation of Hoveton Great Broad and Hudson's Bay, namely:

- The installation of fish barriers on Hoveton Great Broad.
- Biomanipulation - the removal of >75% of the fish biomass from Hoveton Great Broad and Hudson's Bay.
- Releasing the removed fish on the River Bure.

## Hoveton Great Broad Restoration Project update

The project has just completed the process of sediment removal and the establishment of fen vegetation areas. Sediment was dredged from the broad to a depth of 1.1m and used to fill geotextile bags to create new vegetation areas. Additional sediment was then taken to back fill the northern and western sites only. Fen vegetation was taken from Woodbastwick marshes, adjacent to decoy broad, to help establish these new fen areas. Early signs of growth seen on these areas is encouraging.

The next phase of the project is to isolate Hoveton Great Broad from the river Bure and adjacent marsh dykes. This will be achieved with the installation of 3 water permeable barriers within Hoveton Great Broad at Foxborrow Dyke (TG32071581), The Dam (TG32421614), and Hoveton Marshes (TG31891651). These barriers will prevent movement of fish but maintain hydrological connectivity between to the river. In addition two small scale non-permeable barriers have been installed at Gravel Dyke (TG31403159) and Hudson's Marsh Dyke (TG31631687 – also known as Haugh's End Dyke).

Biomanipulation will then involve the removal of >75% of the fish biomass focusing on zooplanktivorous and benthivorous fish species. This should provide conditions for the clear-water state to be recreated and in turn allow macrophytes to re-establish. Once a diverse and abundant macrophyte community has been achieved it is anticipated the broad will maintain a stable clear water, macrophyte dominated state, and the barriers will be removed.

Simultaneously, the project continues to maintain and develop the Hoveton Great Broad Nature Trail, seeing a year on year growth of visitor numbers of around 10% a year. The project also delivers an extensive engagement and community outreach programme which worked with 3000 people last year across 55 events.



## WFD assessment

The following section considers the change in WFD condition since the 2014 assessment and reviews the conclusions of the 2014 assessment considering the most up to date information available. The project will no longer be undertaking the proposed marginal habitat works at Wroxham Broad therefore Wroxham Broad has not been included in this updated analysis. In addition sediment removal and creation of the new fen areas on Hoveton Great Broad has been completed, therefore this update assessment will focus on the isolation of Hoveton Great Broad from the system, via the installation of fish barriers, the removal of fish as part of the biomanipulation, and the introduction of those removed fish in to the River Bure.

## Hoveton Great Broad (waterbody ID: GB30535977)

Key activities to be assessed for Hoveton Great Broad:

- Broad isolation and fish removal

Table 1. Selected WFD data for Hoveton Great Broad waterbody. Quality elements are italicised, statuses are in bold and failing elements are in red and passing elements in green.

<b>Hoveton Great Broad</b>		<b>waterbody ID: GB30535977</b>		
Waterbody size:	0.37km			
Typology:	High Alkalinity, Very Shallow			
Hydromorphology designation:	not designated artificial or heavily modified			
	<b>2014 classification</b>	<b>2016 classification</b>	<b>2019 classification</b>	
<b>Overall Water Body:</b>	<i>Moderate</i>	<i>Poor</i>	<i>Poor</i>	
<b>Biological Status:</b>	<i>Moderate</i>	<i>Poor</i>	<i>Poor</i>	
<i>Macrophytes:</i>	<i>Moderate</i>	<i>Poor</i>	<i>Poor</i>	
<i>Phytoplankton Blooms:</i>	<i>Poor</i>	<i>Poor</i>	<i>Poor</i>	
<i>Fish</i>	Not assessed	Not assessed	Not assessed	
<b>Physio-chemical Status:</b>	<i>Moderate</i>	<i>Moderate</i>	<i>Moderate</i>	
<i>Dissolved Oxygen:</i>	<i>High</i>	<i>High</i>	Not assessed	
<i>Total Phosphorous:</i>	<i>Moderate</i>	<i>Moderate</i>	<i>Moderate</i>	
<i>Total Nitrogen</i>	Not assessed	Not assessed	<i>Poor</i>	
<b>Morphology Status:</b>	<i>Good</i>	<i>Good</i>	<i>Good</i>	
<i>Hydrology:</i>	<i>High</i>	<i>High</i>	<i>High</i>	
<i>Morphology:</i>	<i>Good</i>	<i>Good</i>	<i>Good</i>	
<b>Chemical Status:</b>	Assessment not required	Assessment not required	<i>Fail</i>	



Flouranthene:	Not assessed	Not assessed	Good
Priority Hazardous substances:	Not assessed	Not assessed	Fail

Hoveton Great Broad (HGB) (waterbody ID: GB30535977) consists of HGB itself as well as the smaller broad Hudson's Bay. It is connected to the River Bure (waterbody ID: GB105034050930) at various points where water exchange occurs. Water from the Hoveton Marshes also drains into this waterbody but many of the dykes on the marsh are silted up and the marshes themselves are scrubbing over. At the northern end of Hudson's Bay is an area of marsh/wet woodland with a shallow dyke system which connects to the River Bure.

### Macrophytes – Poor

Since the 2014 assessment macrophytes have deteriorated from moderate to poor despite improvements in the WFD status of macrophytes within the River Bure. This decline occurred before the first round of sediment removal in August 2016 so is due to natural deterioration of the water body. This decline is likely to be a consequence of continued high turbidity within Hoveton Great Broad associated with high algal concentration. Other mechanisms could include sediment suspension through wind action or benthivorous fish feeding, and reduced grazing by zooplankton due to high numbers of zooplanktivores.

The installation of fish barriers and biomanipulation of Hoveton Great Broad and Hudson's Bay will help improve conditions for macrophyte growth and recovery by removing zooplanktivores to reduce predation on zooplankton and therefore increase grazing on phytoplankton, reduce sediment suspension and uprooting of macrophytes by removal of benthivorous fish, and reduce sedimentation from wind action as macrophytes stabilise the sediment. Any localised damage to macrophytes during the installation of the barriers will be minimal and short-term.

There is no change from the conclusion of the 2014 WFD assessment:

*'the central aim of this project is to improve the clarity of the water in the broad which will improve conditions for macrophyte growth. The project is using proven methods to restore the broad back to an ecologically favourable condition of clear water with lush macrophyte growth.'*

Indeed, the proposed works should deliver a significant improvement in the macrophyte WFD element.

### Phytoplankton – Poor

There has been no change in phytoplankton status since the 2014 assessment. The installation of fish barriers is not expected to suspend significant amounts of sediment. However, if some sediment is suspended during installation the conclusion of the original assessment still stands, with improvements expected following biomanipulation:

*'The impact of the works will be of a temporary nature and will not impact the WFD status for phytoplankton blooms. An increase in blooms may occur for a short time after the works but when the lake is monitored for WFD these impacts should no longer be apparent. Phytoplankton is*



*monitored in the summer between July-September. In the long-term the Phytoplankton bloom status should improve as the amount of phosphate in the waterbody will be less as a result of the sediment removal. Also, as part of this project, fish will be removed from the broad and the broad isolated for up to 10 years [permission for 10 years granted]. Removal of fish has been shown to reduce chlorophyll a, a proxy for phytoplankton abundance, in shallow broads (Moss et al., 1996). Fish predation of zooplankton can suppress zooplankton numbers so that they are no longer effectively grazing phytoplankton. This allows phytoplankton abundance to increase thus increasing turbidity and suppressing macrophyte growth. The removal of fish coupled with sediment removal can have an almost immediate positive impact on water clarity and macrophyte growth (Moss et al., 1996).'*

This conclusion is supported by the Broads Authority's 'A review of lake restoration practices and their performance in the Broads National Park' which reports large reduction in chlorophyll *a* and corresponding increase in Secchi depth (often to the lake bed) providing 'gin-clear' conditions appears to be guaranteed in biomanipulated lakes and enclosures in the Broads (Phillips *et al.* 2015).

### **Fish – not assessed**

No tool is currently available to assess the WFD status of the fish communities in lakes, therefore the Environment Agency have not assessed the fish element for HGB. Given concerns about the impact of the proposed works on the fish community an assessment of the likely impact of the project on the WFD status of the fish has been completed by Natural England using the best available evidence and is included in appendix 1 of this assessment. Below provides a brief summary and those looking for further information should consult the appendix

With regards to HGB the assessment concludes that the current fish status is **poor**. Monitoring data shows a fish community within HGB is dominated by roach in number and bream by biomass. Such communities are highly indicative of lakes suffering from eutrophication, and such fish communities help maintain poor ecological condition with turbid waters and low macrophyte diversity and coverage. The EA's Scientific and Evidence Services team highlight bream as a species which can actively increase turbidity, reduce macrophyte abundance, and impact on WFD status when in high numbers (Bentley *et al.* 2014).

Whilst monitoring data indicates that HGB is an important spawning site for bream within the Northern Broads system, the evidence is clear that the current fish community dominated by bream and roach does not represent a fish community in 'Good Ecological status' (GES). Furthermore, a fish community which helps maintain poor ecological status is not compatible with GES under the WFD. Therefore, restoring a more diverse fish community associated with the clear water macrophyte dominated lakes within The Broads cannot be considered a decline in the WFD status of the fish community within Hoveton Great Broad.

The impacts of the displacement of this bream community on the WFD status at other sites within the broads is discussed further in appendix 1 and the relevant assessments below.

### **Dissolved Oxygen – not assessed**

There was no assessment of dissolved oxygen status in the 2019 WFD monitoring data report, and there was no change from the 2014 assessment in the 2016 WFD monitoring data. Installation of fish barriers is not expected to suspend significant amounts of sediment. Monitoring of Dissolved



Oxygen levels during sediment removal did not record any significant declines (i.e. danger to fish), and effects are short-term. In addition, monthly water sampling by the project consistently shows high dissolved oxygen levels within Hoveton Great Broad. There is no change from the conclusion of the 2014 assessment:

*'High status is the top status under WFD and indicates that human activity is having no or limited impact on this element. DO will only be temporarily impacted by the [works] and therefore there will be no deterioration in the WFD status for this element.'*

### **Total Phosphorous – Moderate**

The status of total phosphorous has not changed since the 2014 assessment. Whilst the River Bure has seen improvements in phosphorous levels these improvements have not been seen in Hoveton Great Broad. The high levels of phosphorous in Hoveton Great Broad are attributed to in lake nutrient cycling caused by the presence of nutrient rich sediment. In lake cycling is expected to improve following the sediment removal over the short-term. In addition, stabilisation of the sediment through establishment of macrophytes should further reduce in lake cycling. Increased macrophytes are also likely to reduce phosphorous through direct absorption during growth.

There is no change to the 2014 assessment:

*'Apart from a potential short-term increase in total phosphorous the long-term impact of these works will be to reduce total phosphorous concentrations.'*

### **Hydrology – High**

There has been no change in hydrology element since the 2014 assessment.

The fish barriers being installed on Hoveton Great Broad at Foxborrow Dyke, The Dam, and Hoveton Marshes will be constructed from 2mm screen and permeable to water. The barriers installed at Gravel Dyke and Hudson's Marsh Dyke are not permeable, however their impact on the hydrology of HGB is considered *de minimis*. The barrier at Gravel Dyke was put in as a precaution to ensure that biomanipulation was not undermined by any potential connection to the River Bure. It was installed at the site of an extinct dyke which used to connect to the river but for many years has been silted up and scrubbed over. We have been unable to detect any flow through Gravel Dyke at various states of the tide, but given the investment in the biomanipulation, the relatively low cost of installing this small barrier as a precaution was considered appropriate. The dyke to the north of Hudson's Bay is extremely shallow and flow from this dyke into Hudson's Bay appears minimal. At high water levels flow into or out of Hudson's Bay in this area is primarily across the adjacent marsh, which is not impeded by the low profile barrier in the dyke.

Therefore the conclusion of the 2014 assessment stands:

*'No water level management works are planned for this project nor are any of the other works expected to have an indirect affect on hydrology. No abstraction of water is planned either therefore no deterioration in this element is to be expected.'*



## Morphology – Good

There has been no change in the morphology classification since the 2014 assessment. The installation of fish barriers will not have an impact on the morphology of Hoveton Great Broad, therefore there is no change in the conclusion of the 2014 assessment:

*‘There should be no long-term deterioration of this quality element’.*

## Chemical Status – Fail

Reported in previous WFD status reporting as ‘not requiring assessment’, and therefore not included in the 2014 WFD assessment, the chemical status of Hoveton Great Broad was reported as ‘fail’ in 2019. This was due to levels of Polybrominated diphenyl ethers (PBDE) most likely from diffuse sources and waste water treatment works.

Installation of the fish barriers is not expected to suspend significant amounts of sediment which could be a source of PBDE. In addition, long term stabilisation of the sediment through macrophyte recovery as a result of the project is likely to reduce this potential source of PBDEs within the surface water. Therefore, it can be concluded that there should be no long-term deterioration of this quality element as a result of the works.

## River Bure

The original 2014 assessment used the WFD classifications for River Bure (waterbody ID: GB105034050930). This waterbody has since been divided for WFD reporting and therefore data is no longer available for the river Bure under this waterbody ID. As such, this assessment has used River Bure (Horstead Mill to St Benet's Abbey) (waterbody ID: GB105034050931) which represents the section of the river Bure adjacent to Hoveton Great Broad. The 2014 values in table 2 have been updated accordingly.

Key activities to be assessed for the River Bure:

- Installation of fish barriers on HGB – associated suspended sediment.
- Release of fish removed from HGB during biomanipulation.

*Table 2. Selected WFD data for the River Bure waterbody. Quality elements are italicised, statuses are in bold and failing elements are in red and passing elements in green.*

	Waterbody ID: GB105034050930	Waterbody ID: GB105034050931	
Waterbody size:	54.47km	29.799 km	
Typology:	Low, medium, calcareous	River	
Hydromorphology designation:	Heavily modified	heavily modified	
	<b>2014 classification</b>	<b>2014 classification</b>	<b>2019 classification</b>
<b>Overall water body:</b>	<b>Poor</b>	<b>Good</b>	<b>Moderate</b>
<b>Biological Status:</b>	<b>Poor</b>	<b>Good</b>	<b>Good</b>



Diatoms	<i>Moderate</i>	<i>Not assessed</i>	<i>Not assessed</i>
Macro-invertebrates	<i>Good</i>	<i>Good</i>	<i>Good</i>
Macrophytes	<i>Moderate</i>	<i>High</i>	<i>High</i>
Fish	<i>Poor</i>	<i>Not assessed</i>	<i>Not assessed</i>
<b>Physio-chemical Status:</b>			
<i>pH</i>	<i>High</i>	<i>Good</i>	<i>Moderate</i>
<i>Ammonia</i>	<i>High</i>	<i>High</i>	<i>High</i>
<i>Dissolved Oxygen:</i>	<i>High</i>	<i>Good</i>	<i>Moderate</i>
<i>Phosphate</i>	<i>High</i>	<i>High</i>	<i>High</i>
<b>Morphology Status:</b>			
<i>Hydrology:</i>	<i>Moderate</i>	<i>Good</i>	<i>Good</i>
<i>Morphology</i>	<i>Moderate</i>	<i>Not assessed</i>	<i>Not assessed</i>
<b>Chemical Status:</b>			
	<i>Good</i>	<i>Good</i>	<i>Fail</i>

The following assessment reviews the conclusions of the original WFD assessment (submitted with FRAP application) considering the new WFD waterbody boundaries and their changed condition status.

### Diatoms – not assessed

Diatoms have not been assessed as part of the new waterbody (Waterbody ID: GB105034050931). As per the original assessment diatoms respond to phosphate levels. The only impact on diatoms from the project could be caused by a short-term increase in suspended sediment and available phosphate. It's not anticipated that sediment suspension will be significant during the installation of the barriers. Any small amounts of suspended sediment released will be diluted by the flow of the River Bure and will only be temporary in nature. The mitigation measures proposed in the original assessment and conclusion are still appropriate, as below:

#### *'Mitigation Measures*

*Silt curtains will be placed at points around the exit points around HGB to reduce suspended sediment flushing into the River Bure.*

#### *Conclusion*

*This project will cause no long-term deterioration for this element.'*

### Macrophytes - High

Macrophytes have been assessed as having high status as part of the new waterbody (Waterbody ID: GB105034050931). However, this does not affect the conclusion of the original assessment, as below:





*‘Long-term inputs of phosphate can impact on the macrophyte element. Any inputs of suspended nutrients and thus phosphates into the River Bure from HGB will be small and of a temporary nature, therefore no deterioration in this element is to be expected because of the installation of fish barriers.’*

## **Macroinvertebrates - Good**

There has been no change in the WFD status from the original WFD assessment. The conclusions of the original WFD assessment stand, as below:

*‘The Macroinvertebrates are good indicators of habitat quality, flow dynamics and oxygen levels, as well as being useful indicators of acute and chronic pollution incidents. Sediment is a natural part of a river but a small input of sediment from works on HGB may cause a localised short-term impact on macroinvertebrates. Excessive sediment can alter the macroinvertebrate community as different taxa have varying tolerances to sediment. However, the inputs from these works will be negligible.’*

### *Mitigation Measures*

*Silt curtains will be placed at points around the exit points around HGB to reduce suspended sediment flushing into the River Bure.*

### *Conclusion*

*The small, short-term and localised input of sediment from the sediment removal works will not alter the macroinvertebrate community and will therefore not have a negative impact on this element.’*

## **Fish – not assessed**

Fish have not been assessed as part of the new waterbody (Waterbody ID: GB105034050931). The fish status was previously reported as being in poor ecological status as part of the Water Body GB105034050930 before monitoring boundaries were redrawn.

Natural England has used the best available evidence to assess the impacts of the proposed works on the WFD status of the fish community, this is included in appendix 1 of this assessment. Below provides a brief summary and those looking for further information should consult the appendix.

The broad’s lakes and rivers are a highly interconnected system as shown by the fish tracking PhD data. The condition of the fish communities in the rivers will be heavily linked to the health of the broadland lakes and the fish communities they support. For the river fish communities to be in GES, (defined as slight variation from undisturbed conditions) the attached broads would also need to be healthy with balanced fish communities.

In addition, the bream and roach within HGB currently freely move in to the river Bure and are part of a meta-population that exists within the river, broads, and dykes. As such, the release of the fish removed from HGB during biomanipulation does not represent a change to the number or community of fish already using the river Bure, and it is anticipated the fish will quickly access the other off channel habitats available to them.



Therefore, the proposed works will not cause a deterioration in the fish element of the River Bure. Indeed, in the long term, restoring the natural fish assemblage in HGB will help restore a natural assemblage in the connected river system as it will provide improved refuge and spawning habitat for a range of fish species that use the Bure.

## Physio-chemical – Moderate

The overall physio-chemical status of the River Bure has declined since the 2014 assessment from high to moderate due to a change in dissolved oxygen status:

Dissolved Oxygen *Current status:* **Moderate**

Phosphate *Current status:* **High**

pH *Current status:* **High**

Ammonia *Current status:* **High**

Significant levels of suspended sediment are not anticipated from the installation of the fish barriers and will not be sufficient to impact on dissolved oxygen levels. Use of silt curtains will remove any potential impact further. Conclusion of original assessment stands, as below:

*‘The small potential input of suspended nutrients as a result of the [installation of the barriers] may lead to a short-term increase in phosphate levels but this will only be temporary and will not be sufficient to affect this element. The River Bure is a calcareous river and pH will not be impacted by these works.*

### Mitigation Measures

*Silt curtains will be placed at points around the exit points around Hoveton Great Broad to reduce suspended sediment flushing into the River Bure*

### Conclusion

*None of the physio-chemical elements will deteriorate as a result of this restoration project.’*

## Hydrology – Good

The hydrology status has changed to good since the 2014 assessment as part of the new waterbody (Waterbody ID: GB105034050931). No water level management works are planned for this project and the installed fish barriers will be permeable with regular maintenance to ensure permeability is maintained. No abstraction of water is planned either. Conclusion of original assessment still valid, as below:

The barriers installed at Gravel Dyke and Hudson’s Marsh Dyke are not permeable, however their impact on the hydrology of HGB is considered *de minimis*. The barrier at Gravel Dyke was put in as a precaution to ensure that biomanipulation was not undermined by a potential connection to the River Bure. It was installed at the site of an extinct dyke which used to connect to the river but for many years has been silted up and scrubbed over. We have been unable to detect any flow through Gravel Dyke at various states of the tide, but given the investment in the biomanipulation, the relatively low cost of this barrier as a precaution was considered appropriate.



The dyke to the north of Hudson’s Bay is extremely shallow and flow from this dyke into Hudson’s Bay appears minimal. At high water levels flow into or out of Hudson’s Bay in this area is primarily across the adjacent marsh, which is not impeded by the low profile barrier in the dyke.

*‘no deterioration in this element is to be expected.’*

### Morphology - Not assessed

Works are limited to Hoveton Great Broad and will not impact the morphology of the River Bure.

### Chemical - Fail

The Chemical status of the River Bure has been assessed as failing in the most recent monitoring due to levels of Polybrominated diphenyl ethers (PBDE) and Perfluorooctane sulphonate (PFOS), most likely from diffuse sources and waste water treatment works.

Installation of the fish barriers is not expected to suspend significant amounts of sediment which could be a source of PBDE and PFOS. Therefore, it can be concluded that there should be no long-term deterioration of this quality element as a result of the works.

Good practice by contractors throughout the project, such as limiting any oil or petrol spills from machinery, should ensure that no deterioration in this element occurs.

### Other broadland lakes

The following section summarises the WFD status of other key broads in order to:

- Put the condition of Hoveton Great Broad in to context
- Highlight the WFD improvements which will be delivered by the work

Table 4. Selected WFD data for key broads. With poor elements in red, moderate in orange, and good/passing elements in green.

	Overall	Ecological	Chemical	Phytoplankton	Macrophytes	Total P	Ammonia
<b>Wroxham Broad</b>	Moderate	Moderate	Fail	Moderate	Moderate	Moderate	High
<b>Decoy Broad</b>	Poor	Poor	Fail	Moderate	Poor	Moderate	Not assessed
<b>Cockshoot Broad</b>	Moderate	Moderate	Fail	Good	Moderate	High	Not assessed
<b>Ranworth Broad</b>	Poor	Poor	Fail	Poor	Poor	Moderate	High
<b>Barton Broad</b>	Poor	Poor	Fail	Poor	Poor	Moderate	High

### WFD status of broadland lakes

The fish communities of the middle Bure broads are dominated by roach in number and bream by biomass. Such communities are highly indicative of lakes suffering from eutrophication, and such fish communities help maintain poor ecological condition with turbid waters and low macrophyte diversity and coverage.



A fish community which helps maintain poor ecological status is not compatible with GES under the WFD. Therefore restoring the fish community to one not dominated by bream and roach even if that means a decline (but not loss) of bream and roach associated with the installation of fish barriers at HGB cannot be considered a decline in the WFD status of the fish community, either within the individual broads or the rivers.

A redistribution of bream within the wider Broads system as a result of proposed works driving a decline in WFD status in less impacted waterbodies is considered very low, in part due to the already highly impacted condition of The Broads as well as the reasons given above.

No native fish species are being removed from The Broads system as part of the proposed biomanipulation. The fish within HGB and HB currently move freely between the river and other broads and therefore already utilise these broads. The redistribution of the fish following removal from HGB and HB is not likely to greatly increase the impact on the surrounding broads given the amount of connected habitat available within The Broads.

Therefore, no deterioration in WFD status in any broadland lakes is expected as a result of the proposed works.

## References

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Phillips, G., Bennion, H., Perrow, M.R., Sayer, C.D., Spears, B.M., Willby, N. (2015) A review of lake restoration practices and their performance in the Broads National Park, 1980-2013. Report for Broads Authority, Norwich and Natural England.

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## Appendix 1

### Introduction

The Water Framework Directive Assessment (WFDA) for the Hoveton Wetlands Restoration project was published in June 2014. Since then, project plans have developed and further surveys have been carried out, including updated Water Framework Directive (WFD) monitoring. The Environment Agency has therefore asked that the WFDA be updated considering improved evidence.

This section of the WFDA relates specifically to the impact of proposed works on the WFD fish status of Hoveton Great Broad, the River Bure, and connected Broads. It reviews the new data on how fish are using Hoveton Great Broad (HGB) and Hudson's Bay (HB) (WFD unit GB30535977), and whether this changes the conclusions of the original WFDA. It replaces the 'Addendum to Hoveton Wetlands Restoration Project Water Framework Directive Assessment (WFDA), January 2020' submitted with FRAP application EPR/NB3494JP.

### New fish data available

Since the 2014 WFDA was published baseline fish surveys of Hoveton Great Broad and adjacent upper Bure Broads have been conducted. In addition, the results of the fish tracking PhD funded by the project has been published.

It should be noted that this monitoring was not commissioned for the purpose of assessing the WFD status of the fish community. Indeed, this monitoring was commissioned to understand the role of HGB and HB in the wider fishery in response to concerns raised by anglers. Therefore it's focus relates to the fish community as it relates to its amenity as a fishery, and provides useful information for managing and understanding the fishery going forward, and how we can maintain its amenity value whilst achieving a fish community appropriate for Broads habitats in good ecological condition and which is considered as in GES under the WFD. This is particularly true of the fish tracking study which predominately has a single species (bream) focus.

It is therefore important to understand the distinction between a fish community considered as in good ecological status under WFD, and one which is consider of high amenity value as a fishery under current angling behaviours. The purpose of this document is to consider the ecological status of the fish community as defined by the WFD. Therefore, the impact of the proposal on the amenity value of this fish community is not a consideration under this document.



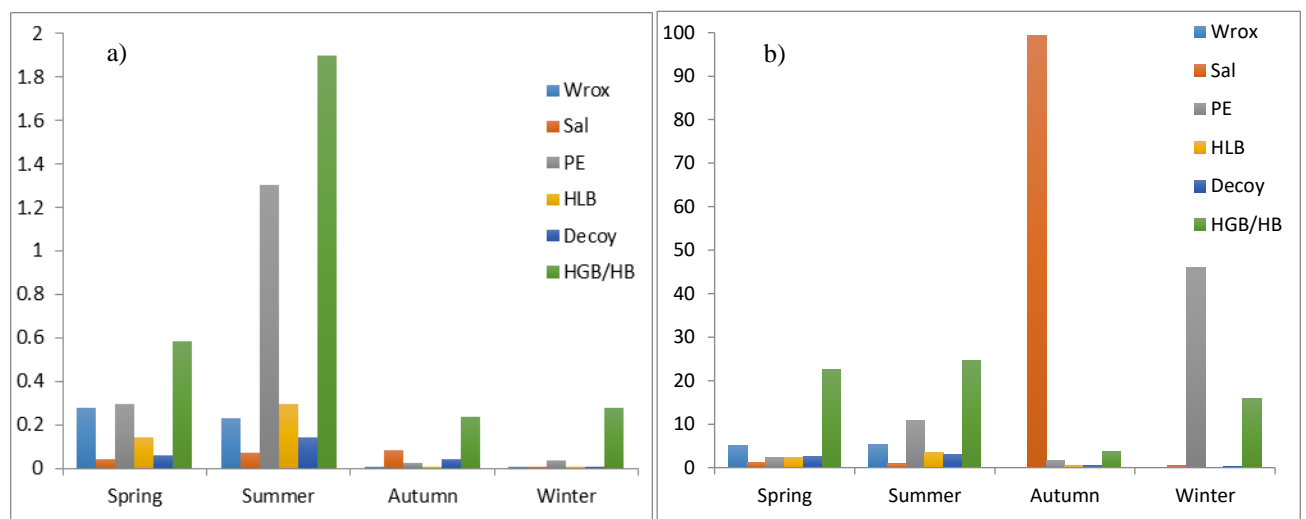
These caveats accepted, the monitoring data has still improved our understanding of the fish communities in HGB, HB, and the upper Bure broads, and how they use the wider Broads system. In combination with current scientific understanding of eutrophication and the role of fish communities, it provides a robust and scientifically informed assessment of the WFD condition status of the fish community.

### Summary of the project's fish monitoring data

The project commissioned Fishtrack to undertake Point Abundance Sampling by Electrofishing (PASE) and Mobile High-Resolution Sonar Survey (MHRSA) in 2016-17 to build on Environment Agency monitoring in 2013-15. These surveys covered Hoveton Great Broad and Hudson's Bay (HGB/HB), Wroxham Broad (Wrox), Salhouse Broad (Sal), Pound End (PE), Hoveton Little Broad (HLB), and Decoy Broad (Decoy).

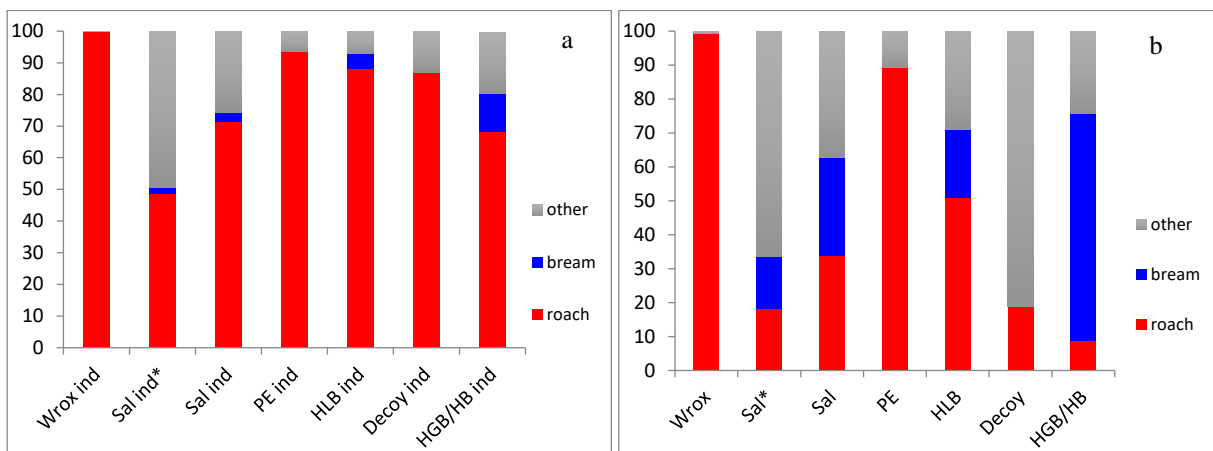
The results from this monitoring show that in comparison to other middle bure broads, HGB and HB support a large proportion of fish (predominately bream and roach) and therefore may have significant importance for the wider Bure fishery. In particular, the broad seems an important spawning site for adult bream. The data is summarised below with figure 1 showing the relative number and biomass in the Upper Bure broads surveyed throughout the seasons. Figure 2 shows the proportions of the fish community made up of roach and bream, with roach typically dominating by number and bream by biomass, particularly in Spring and Summer. The domination of the fish community by bream and roach appears to be particularly strong within HGB/HB.

**Figure 1.** Overall, whole broad density (a) (ind. m<sup>-2</sup>) and biomass (b) (g m<sup>-2</sup>) estimates by season. All broads 2016-2017 (Hindes 2017).

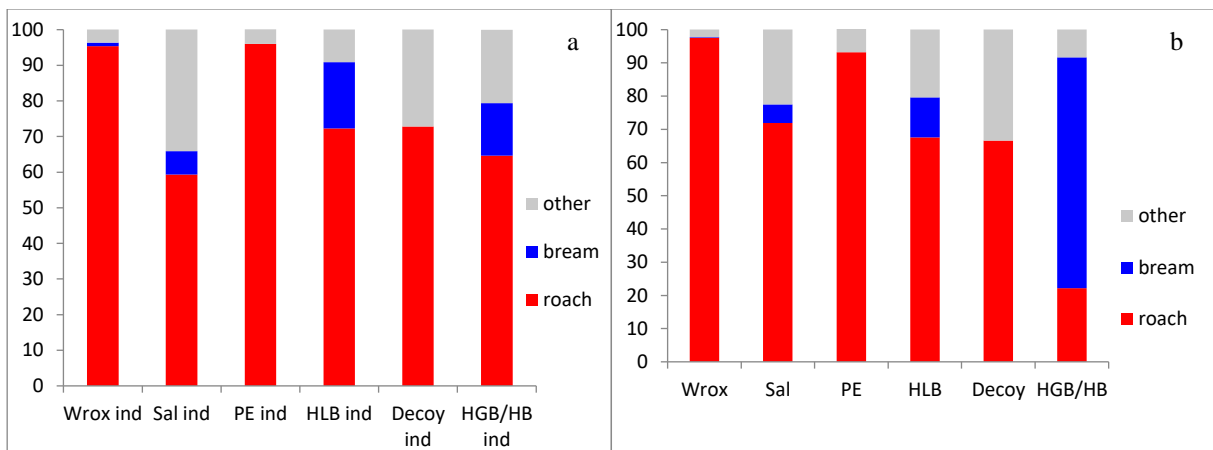


**Figure 2.** Relative (%) overall density (a) and biomass (b) of roach, bream and all 'other' species category. All broads.

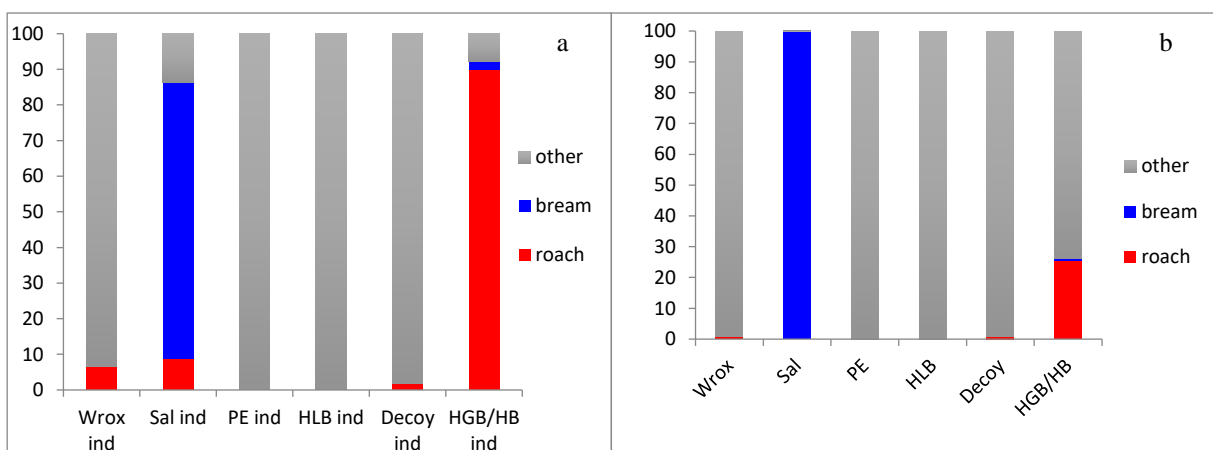
**Spring 2016**



**Summer 2016**



**Autumn 2016**



Winter 2016

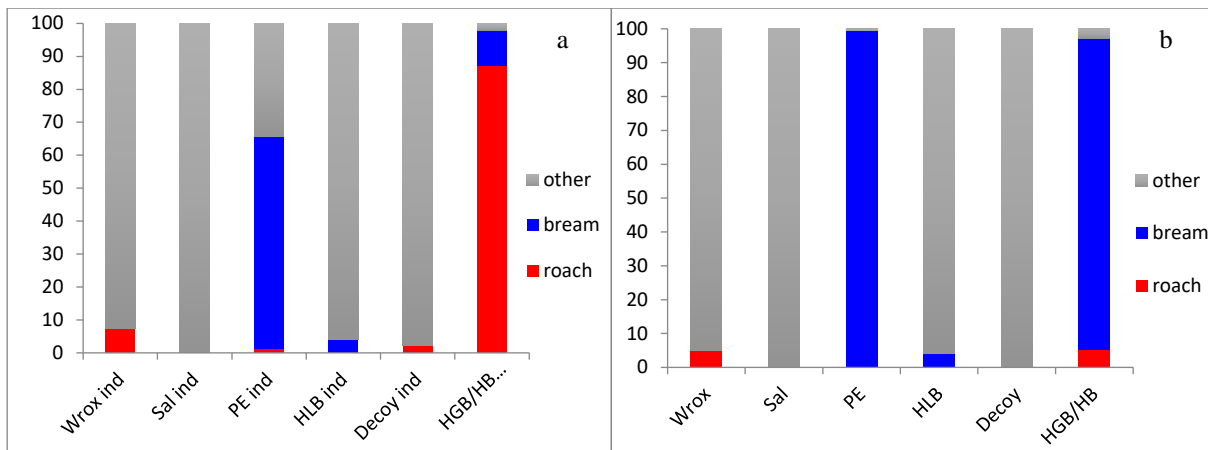
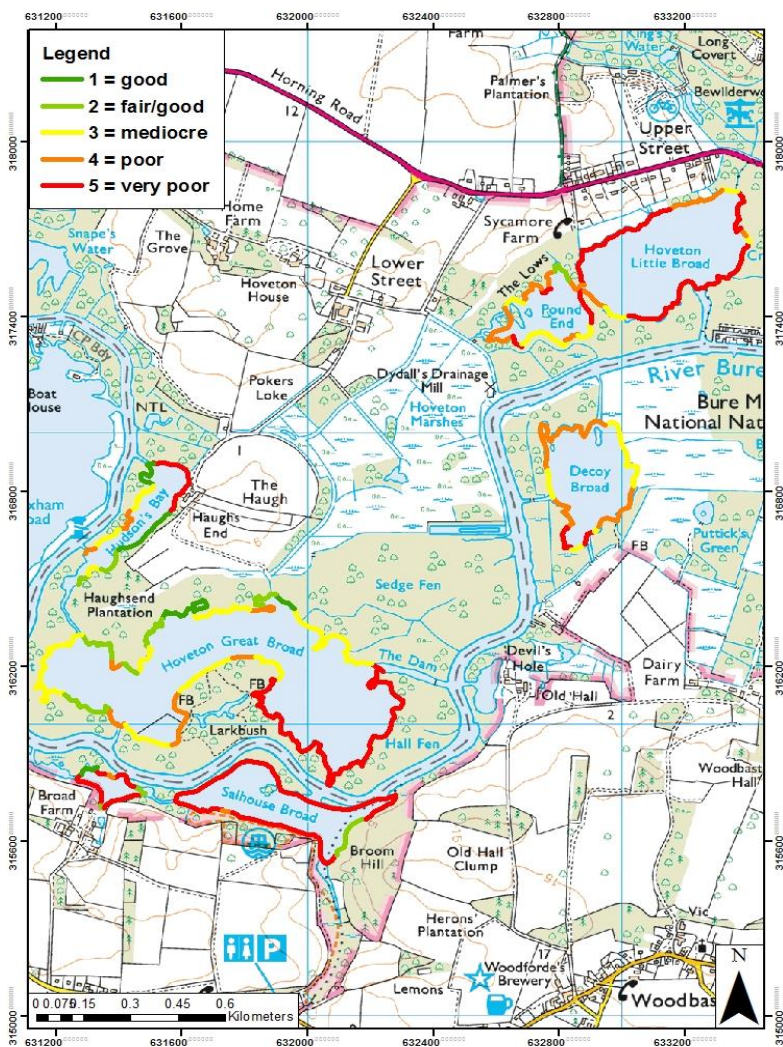


Figure 3. Map of Bream spawning habitat quality assessment and distribution, 2018. Fishtrack Ltd.





Fishtrack were also commissioned to undertake an assessment of spawning habitat quality and availability within the Upper Bure, as shown in figure 5.

The fish tracking PhD funded by the project has now concluded and the thesis analysing the associated data has been published. The project plans to carry out further fish tracking following installation of the barriers to understand how the proposed biomanipulation of HGB and HB influences bream movement within the broads. The following is a summary of relevant sections of the PhD thesis (see Winter 2020 for full details)

In total 181 bream were tagged from the Upper Bure, Lower Bure, Thurne, and Ant, between November 2017 and September 2018 (details in table 1). These fish were monitored between November 2017 and February 2020 using a network of 56 acoustic receivers deployed across the Rivers Bure, Thurne, and Ant (see figure 4).

**Table 1:** Details of common bream sampling locations, tagging dates and acoustic tracking duration by group in the River Bure study system. Length and tracking duration are represented by the range of values, with mean  $\pm$  SD in parentheses.

Group Name	Sampling location	Tagging date(s)	Length (mm)	Tracking duration (days)	N
UB-1	Upper Bure	6 Nov 2017 – 8 Nov 2017	374 – 491 (435 $\pm$ 28)	0 – 725 (217 $\pm$ 198)	26
LB-1	Lower Bure	8 Nov 2017 – 9 Nov 2017	286 – 471 (362 $\pm$ 70)	25 – 524 (181 $\pm$ 173)	8
TH	Thurne	14 Jan 2018	341 – 471 (394 $\pm$ 32)	40 – 371 (132 $\pm$ 80)	17
AN	Ant	27 Jan 2018 – 29 Jan 2018	362 – 502 (406 $\pm$ 34)	28 – 645 (286 $\pm$ 235)	25
UB-2	Upper Bure	20 Apr 2018 – 23 Apr 2018	313 – 527 (413 $\pm$ 44)	18 – 562 (414 $\pm$ 217)	62
LB-2	Lower Bure	15 Sep 2018 – 18 Sep 2018	290 – 503 (389 $\pm$ 54)	2 – 414 (177 $\pm$ 147)	43

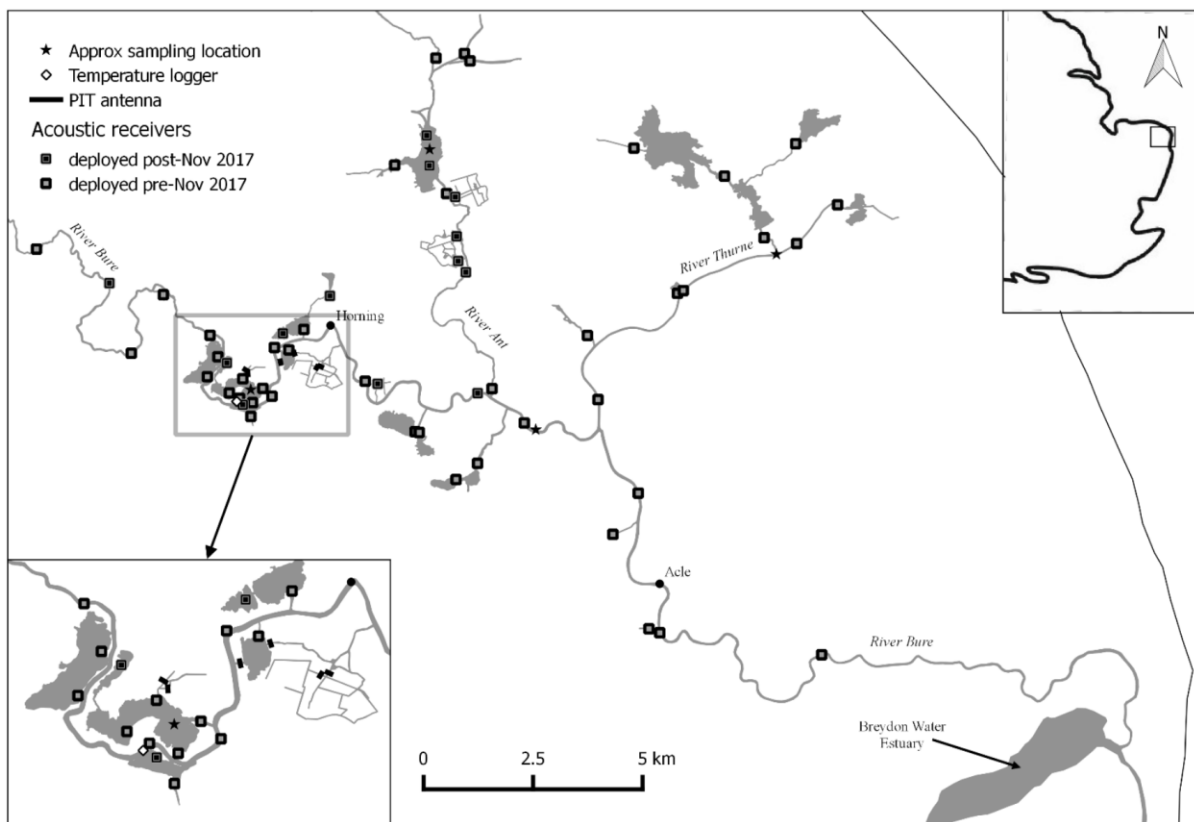
Within the tagged bream their appeared to be different sub-populations adopting different movement behaviours with some populations largely resident, others undertaking partial migrations, and some making repeated ~25km migrations during the spawning season (see figure 5). This probably plays an important role in maintaining resilience within the population outside of the breeding season i.e. food availability.

The fish tracking data showed HGB and HB are a significant spawning site for sub-populations of bream within the Upper Bure, Lower Bure, and Thurne. HGB and HB do not appear to play any role in spawning for bream using the Ant. There also appear to be populations of bream not visiting the Upper Bure during the spawning season, with these bream primarily visiting Ranworth/Malthouse Broad and Barton Broad during spawning season (see figure 6).

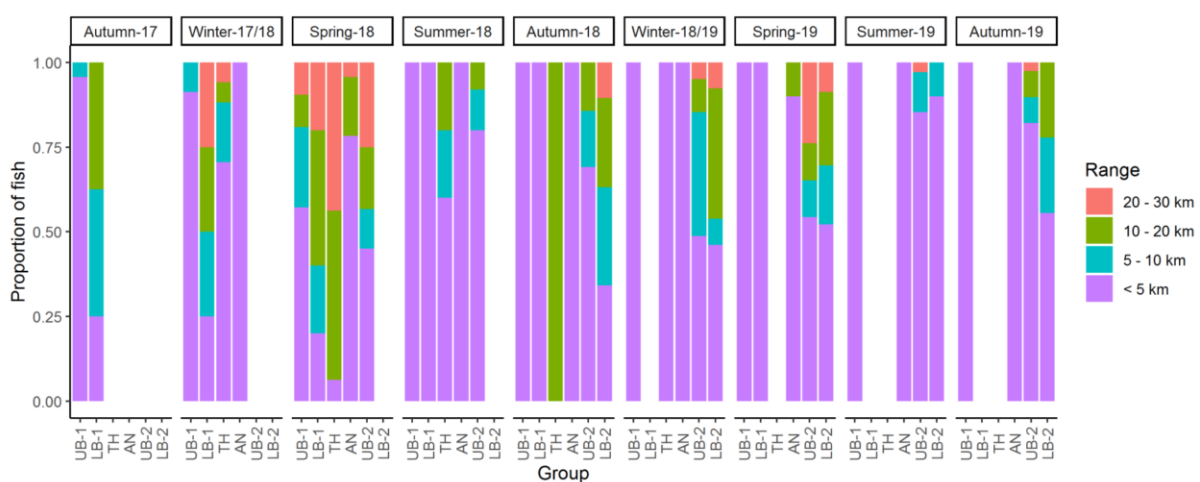
Individual movement was highly consistent between years suggesting high levels of site fidelity, with mixing of different movement phenotypes during spawning, suggesting that different movement phenotypes comprised a single metapopulation that converged at particular off-channel sites to reproduce on an annual basis.

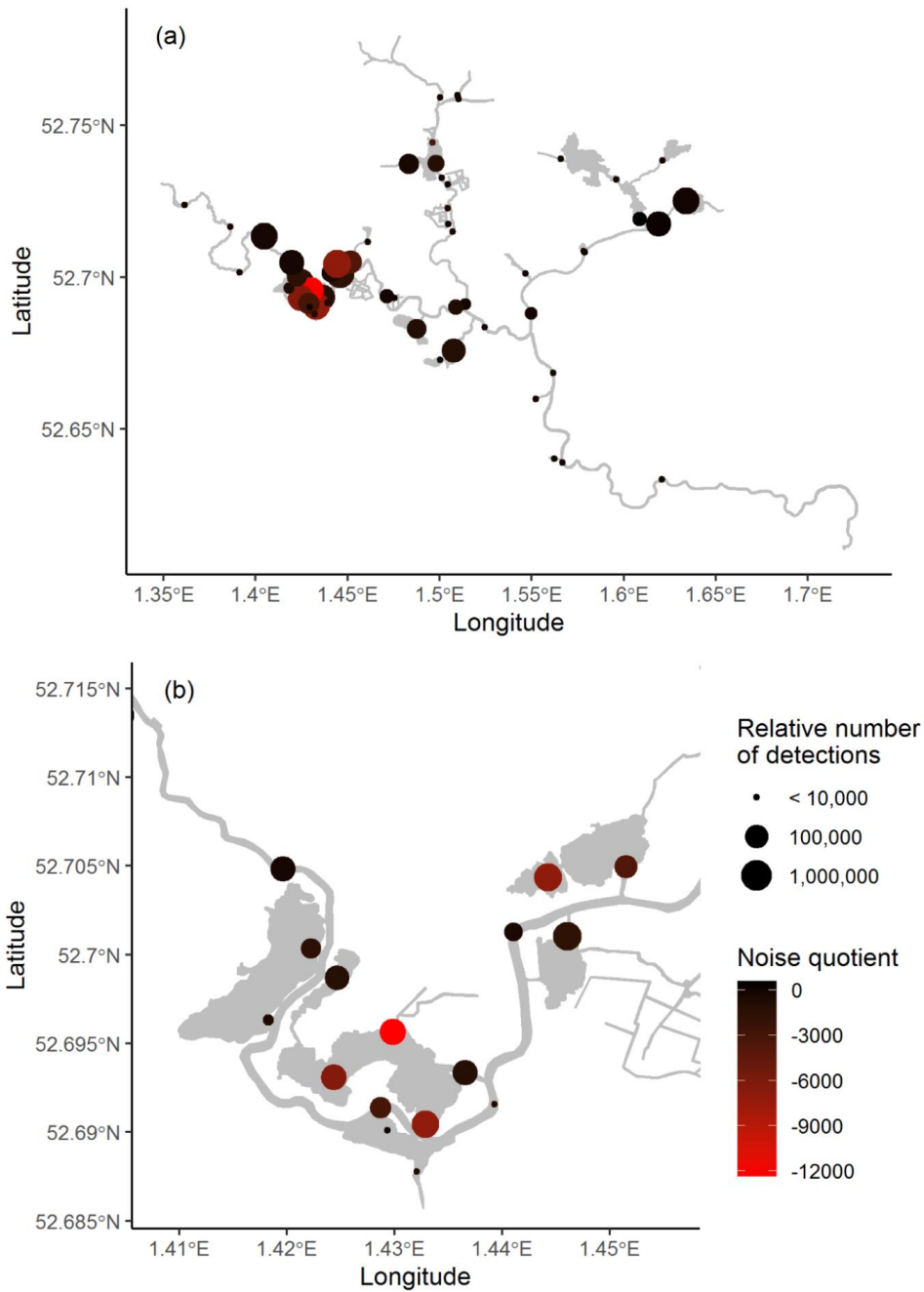


**Figure 4:** Map of the River Bure study system, eastern England, showing locations of sampling locations, acoustic receivers, PIT antennae and temperature logger. Channel width not to scale.



**Figure 5:** Total seasonal range of common bream in the River Bure study system, expressed as the proportion of fish in each group and season for each set of values.





**Figure 6.** Total number of detections at each acoustic receiver during the 2019 spawning period (a) across the entire study area and (b) in the Wroxham-Horning section of the Upper Bure reach. Detections are scaled relative to the detection area of each receiver when detection range = 200 m. Points are coloured according to the mean daily noise quotient, with values < 0 indicating interference by tag collisions. Detections for fish classified ‘resident’, ‘migrant’, or other.

Spawning surveys carried out in 2019 by EA and Fishtrack observed aggregations of bream in HGB and HB as well as spawning behaviour and egg deposit within HB. No significant aggregations of bream were recorded elsewhere within the Bure, Ant, Thurne system although some egg deposit was observed on the Ant.

### **Assessing WFD status of fish element**

There is currently no tool for assessing the condition of the fish assemblage of shallow lakes under WFD. Therefore the EA have not assessed the ecological status of the fish community within HGB or any of the other lakes within The Broads. The status of a tool for assessing the condition of fish assemblages in rivers is less clear, but there has been no WFD assessment of the fish assemblage of the Bure (Horstead Mill to St Benet's Abbey), Ant, or Thurne.

However, the lack of a classification of the fish community under WFD does not remove the requirement to assess if the project will cause a deterioration of the fish community. Therefore this report reviews the best available evidence to assess the condition of the current fish community and whether the proposed installation of fish barriers will cause a deterioration in the fish element both within HGB/HB and the wider system.

### **WFD status of fish community within HGB & HB**

Good ecological status (GES) under the WFD is defined as slight variation from undisturbed conditions. Sediment sampling from HGB and HB has shown that these broads were once dominated by macrophytes (including charophytes) (Goldsmith *et al.* 2014). Indeed, Hoveton Great Broad and Hudsosn Bay are designated as protected sites for H3140 Hard oligo-mesotrophic waters with benthic veg of Chara spp and H3150 Natural eutrophic lakes with Magnopotamion or Hydrocharition. These habitats and their associated communities, including fish, therefore represent the undisturbed condition from which WFD status is assessed. With regards to the WFD status of the fish assemblage this section aims to ascertain:

- What is the undisturbed fish assemblage for these habitats, and is a fish assemblage heavily dominated by two species, roach by number and bream by biomass, a slight variation from undisturbed conditions?

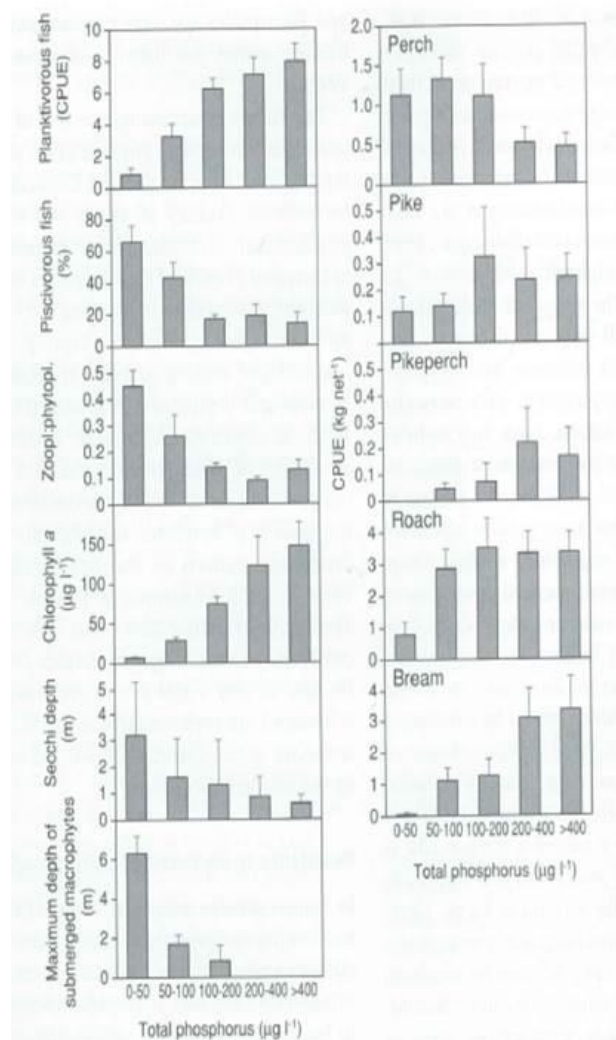
The response of fish communities to eutrophication is well documented with roach, bream and carp eventually dominating the fish community (e.g. Jeppesen *et al.*, 2000; Moss, 2010), see figure 6. Surveys in the Broads have led to the same conclusions. Where habitat complexity provided by macrophytes remains, the piscivores (pike and perch) dominate by biomass. Tench, eels and rudd are also found in greater abundance in these habitats. Conversely, under turbid, algal



dominated conditions roach and bream are more abundant and there are fewer pike, perch, tench, rudd and eel (refer to figure 7, Kelly 2008).

The dominance of roach and bream under eutrophic conditions is not just a symptom of eutrophication, these species play a critical role in the food web, which reinforces the turbid, algal dominated state. In effect, they act as a forward switch, maintain the stability of the algal dominated turbid state and make it harder to switch the lake back to a macrophyte dominated state, even if nutrient concentrations reduce (Bernes *et al.*, 2015, Phillips *et al.*, 2015). Large numbers of small roach significantly alter the zooplankton community in lakes, which reduces their ability to control the phytoplankton through grazing, allowing algal dominated water to persist. Bream also play an important role as benthic feeders re-suspending the sediment, increasing turbidity and uprooting macrophytes. They also promote nutrient release and cycling from the sediment. This also reinforces the algal dominated state (Breukelaar *et al.*, 1994). The role of bream in increasing water turbidity and decreasing macrophyte cover, and therefore their potential to impact on WFD status is acknowledged by the EA's Scientific and Evidence Services team in a report on Aquatic and riparian plant management (Bentley *et al.* 2014).

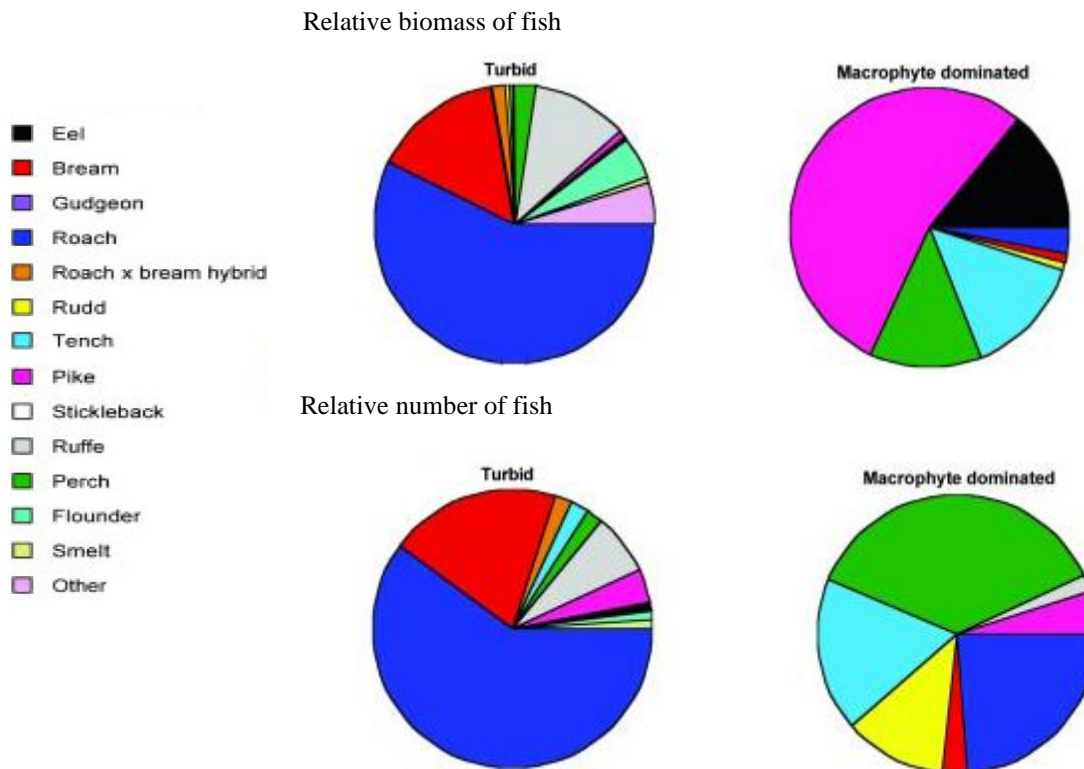
**Figure 6.** Response of fish communities to increase phosphorus (Jeppesen & Sammalkorpi 2002)



Moss et al (1996), in their Guide to the restoration of nutrient-enriched shallow lakes, provides a summary of the characteristics of the most common fish species in lowland Britain in respect to their compatibility with shallow lakes restored to diverse plant communities (see figure 8). The more negative the score the more incompatible they are with lake restoration. It clearly shows that a fish community so heavily dominated by bream and roach as that in Hoveton Great Broad and Hudson's Bay is not compatible with restoring shallow lakes, i.e. to WFD good status

and SSSI favourable status targets. It is of note that bream can coexist with a vegetated state as part of a diverse fish community, but in such conditions they don't dominate the fish community, whereas in eutrophic conditions they do, and help reinforce the algal dominated state (Moss *et al*, 1996).

**Figure 7.** Relative biomass and number of fish in the Broads in macrophyte dominated and turbid conditions. Presented in Kelly (2008). Data from selected Environment Agency (National Rivers Authority) fisheries surveys and surveys conducted for the Broads Authority.



The fish surveys of HGB & HB (detailed above) reveal roach and bream populations which are likely to be having an impact on the condition of HGB and HB.

Perrow *et al.* (1999) reported that in open water with no refuges,  $>0.2 \text{ ind. m}^{-2}$  of zooplanktivorous fish, such as roach, may exert a negative effect on zooplankton, although where there were submerged plants, the density may have to be much higher ( $> 1 \text{ ind.m}^{-2}$ ) to exert the same effect. Hindes (2017) reported finding more than 5 roach individuals per  $\text{m}^{-2}$  in Hoveton Broad in spring, although this later decreased it remained above  $0.2 \text{ m}^{-2}$  throughout the rest of the year. As Hoveton has extremely sparse macrophytes this level of roach abundance has the capacity to detrimentally affect the lake.

Although the exact boundaries of any relationship between fish biomass and macrophyte cover remain difficult to define, a general rule of thumb appears to be



that a broad is unlikely to support good populations of plants with more than around 100 kg ha<sup>-1</sup> of benthivorous fish (Kelly, 2008). At Hoveton in spring, a mean bream biomass of over 250 kg ha<sup>-1</sup> was recorded, this declined to nearer 150 kg ha<sup>-1</sup> in summer and declined further in autumn, but it rose to over 100 kg ha<sup>-1</sup> again in winter (Hindes, 2017). The presence of such a high biomass of bream, particularly at the start of the growing season, has the capacity to detrimentally affect Hoveton Broad.

**Figure 8.** Summary of the characteristics of the most common fish species in lowland Britain in respect of their compatibility with shallow lakes restored to diverse plant communities (from Moss et al 1996).

	Bream	Common carp	Crucian carp	Dace	Eel	Roach	Rudd	Perch	Pike	Tench	Brown trout
Native/Introduced	N	I	(N) <sup>1</sup>	(N) <sup>1</sup>	N	N	N	N	N	N	N
Breeds prolifically	+	-	±	+	++	++	++	++	++	+	+
Disturbs bottom	++	++	+	-	-	-	-	-	-	++	-
Pelagial zooplanktivore <sup>3</sup>	++	+	±	-	-	++	+	++	-	-	-
Weed-bed zooplanktivore <sup>3</sup>	-	-	+	-	-	-	+	+	-	-	-
Piscivorous <sup>3</sup>	-	-	-	-	+	-	-	+	++	-	+
Intrusive angling	++	++	-	-	-	-	-	-	-	-	-
Usually abundant	+	++	±	±	++	++	+	++	++	+	±
Destroys plants	-	++	±	-	-	?+	-	-	-	?+ <sup>2</sup>	-
<b>Total score*</b>	<b>-7</b>	<b>-23</b>	<b>-2</b>	<b>+20</b>	<b>+28</b>	<b>-3</b>	<b>+1</b>	<b>+5</b>	<b>25</b>	<b>-4</b>	<b>+33</b>

Scoring system  
 Origin N=5, (N)=0, I=-5; for breeding, --5, ±=3, +=0, ++=-5; for bottom disturbance, +++=-5, +=0, -=5; for zooplanktivory, -=5, ±=-1, +=-3, +++=-5; for piscivory, +++=5, +=3, --=-5; for angling intrusion, -=5, +=-3, +++=-5; for abundance, ±=0, +=-3, +++=-5; for plant destruction, -=5, ±=-1, +=-3, +++=-5.

<sup>1</sup> Introduced from Southern England. <sup>2</sup> Because of predation on epiphyte eating snails. <sup>3</sup> Post-larval. Pelagial means open water, middle of the lake.

Therefore the current fish assemblage inhibits WFD GES (Good Ecological Status) being achieved for macrophytes, phytoplankton, and macro-invertebrates. Given the aim of WFD is to achieve GES in open waters and rivers, a fish population which prevents overall GES being achieved cannot be considered to be in 'Good Status'. As GES is defined as slight variation from undisturbed conditions and we know that in the past when the broads were not subject to nutrient enrichment and it supported macrophytes associated with clear water conditions, this is what GES would look like. GES for the fish assemblage would therefore be one that is compatible with such conditions, so it is likely to contain bream and roach but they would not dominate the assemblage, which would be more diverse and dominated by piscivores. We know the Broad was once dominated by macrophytes pre-eutrophication as evidenced from sediment core studies (Goldsmith *et al.* 2014) and the scientific literature described above shows that this is not compatible with a fish community dominated by bream and roach. This is also evidenced by the more



diverse balanced fish communities observed in broads with clear water macrophyte dominated conditions (refer to figure 7). There is no doubt that bream and roach will form a part of a more undisturbed broadland community, but not to the numeric extent currently observed.

There is no evidence to suggest that any reduction in the dominance of bream would be considered as a deterioration in WFD ecological status on the contrary it would be considered an improvement. To test this assumption in the absence of a UK shallow lake classification tool the EA trialled the use of a shallow lake fish classification tool from Holland. This model comes with very many caveats as it is not Broadland specific, but it does consider high bream biomass as a percentage of community biomass as an indication of eutrophication and is detrimental to the WFD status of a lake (figure 9). Therefore, reducing bream number would generally result in an improvement in WFD fish status.

There is also a proposed new standard approved for consultation by UK admins based on an eDNA fish tool for use in the UK. This supports the findings from the Dutch classification as this sees the presence of bream and roach as negative indicators in eutrophic lakes so that a decrease in number would improve the lake classification. Together these two tools support the view that the current fish assemblage would not be considered to be at GES and reducing bream and roach would result in an improvement not a deterioration in the fish community WFD class.

**Figure 9.** Class boundary information for fish from Dutch fish classification tool.

**M 14, M 27 - Type-specific class boundaries for shallow lakes**

Indicator	Weight	Bad	Poor	Moderate	GES	HES (max)
% W <i>Abramis brama</i>	0.25	50-100	25-50	8-25	2-8	0,5-2 (0)
% W (roach+perch)/euryt.	0.25	0-10	10-20	20-30	30-35	35-40 (100)
% W phytophilic	0.25	0-8	8-20	20-40	40-65	65-80 (100)
% W low oxygen tolerant	0.25	0-1	1-3	3-10	10-20	20-30 (100)
EQR		0-0.2	0.2-0.4	0.4-0.6	0.6-0.8	0.8-1.0

**WFD status of fish community within the wider Broads system**

The fish tracking data has provided new evidence on the role HGB/HB plays within the wider Bure/Ant/Thurne system, and highlights the potential for bream numbers to reduce in the wider system if they fail to spawn elsewhere or less successfully when the fish barriers are installed on HGB. Therefore, there is a requirement to consider if installing fish barriers at HGB will impact the WFD fish class of the waterbodies that make up the wider Broads system.





As with lakes the objective for WFD in rivers is for the ecology to be in good condition with the highest status most akin to reference condition, where the ecology is unimpacted. Consequently, the highest ecological status class for fish in rivers would be similar to a fish assemblage unimpacted by human influence. Such a fish assemblage would not be reliant on elevated bream and roach numbers in HB or HGB, which are a symptom of anthropogenic eutrophication, as this reflects very impacted conditions. Restoring the natural fish assemblage in HGB and HB will help restore the natural assemblage in the connected river system as it will provide a refuge, and spawning habitat for a range of fish species that use the Bure and potentially provide a source for recruitment.

The broad's lakes and rivers are a highly interconnected system as shown by our fish tracking data. The condition of the fish communities in the rivers will be heavily linked to the health of the broadland lakes and the fish communities they support. For the river fish communities to be considered to be in GES, (defined as slight variation from undisturbed conditions) the attached broads would also need to be healthy with balanced lake fish communities associated with clear water and macrophytes to not cause variation from undisturbed conditions. The river fish community cannot to be considered to be at GES if it is being influenced by bream and roach dominated communities which are a consequence of eutrophication as observed in the middle Bure broads. Therefore, a decline in bream that results in a more natural fish community in the connected broads cannot be considered to be a decline in the WFD status of the river fish community.

PASE surveys of the upper Bure broads indicate that they also support fish communities which is largely dominated by bream and roach, not a more diverse community dominated by piscivores which might be expected in unimpacted conditions as discussed above. As reported in the 2019 WFD condition monitoring these broads are failing to achieve GES for phytoplankton and macrophytes and therefore a reduction in bream and roach numbers, if observed as a result of the proposed fish barriers at HGB and HB, would be considered an improvement in WFD fish status not a decline.

Data from the fish tracking shows the bream populations in the Ant are largely independent of the sub-populations spawning on HGB and HB, therefore there will be no impact on the WFD status on the Ant if bream numbers decline.

The fish tracking data gathered as part of the PhD indicates that bream from the Thurne undertake annual migrations of up to ~25km to spawn in HGB and HB. Such migrations indicate the value of the Thurne as a feeding habitat outside of spawning season and there is no evidence to suggest bream would stop utilising this resource when barriers are installed on HGB. Therefore, these populations of bream would



only be impacted if they fail to spawn elsewhere or if spawning success was significantly reduced when the fish barriers are installed on HGB.

Such a decline in spawning success is not anticipated as a result of the project. Bream are a very common species across England (and indeed northern Europe), found in a wide variety of waters from ponds and canals to large lakes and slow-to-moderate flowing rivers (Maitland, 1972). This suggests they are able to spawn successfully in a broad range of environments. Indeed, locally bream will attempt to spawn on a wide variety of substrates including lilies, sedge roots and tree roots. It is therefore highly unlikely that within the wider broadland catchment that HGB offers the only suitable spawning habitat for bream. It is also very unlikely – given that bream have already been recorded covering large distances and wide areas - that bream would not be able to access such suitable spawning / feeding / loafing habitat elsewhere in the highly connected Broads system, even if it does not occur locally to HGB.

It is bream's tolerance to a wide range of conditions, their ability to successfully colonise and maintain strong populations in a range of different habitats across the UK, which has been the key to their success. In the literature bream are described as favouring rich, muddy and weedy lakes where their sticky eggs are deposited onto submerged macrophytes. However, many fully enclosed lake sites maintain strong populations of bream with a macrophyte assemblage which is largely limited to an emergent fringe and effectively devoid of submerged forms – like many of the broads, including Hoveton. The highly fecund nature of bream and their ability to persist in environments in which their favoured spawning habitat is absent indicates a strong competitive advantage over other species with more restricted spawning habitat requirements.

Each female may spawn several times over a week or so until all eggs are laid. The number of eggs laid depends on the size of the female but can range from 90,000 – 340,000 (Maitland & Campbell 1992). Adámek *et al.* (2002) recorded the average number of eggs obtained by stripping 1 kg of female bream biomass from the river Sow and Trent to be in the range of  $93,642 \pm 20,896$  and  $151,179 \pm 25,123$ , respectively. Given the reproductive potential of the species, spawning success does not have to be frequent to sustain a population.

So in summary, whilst a number of bream might preferentially choose HGB and HB due to habitat quality and the low disturbance levels, it is likely they will use lower quality habitats if HGB and HB were unavailable. Fish tracking data indicates that indeed there are populations of bream that do not utilise HGB and HB for spawning.

Given that we expect bream to find alternative spawning sites following the installation of fish barriers at HGB, a more likely mechanism for WFD decline in the



wider system is increased numbers of bream in currently less impacted broads, as identified by the PhD study:

*‘as bream are ecological engineers, and their presence can be linked to increased turbidity and eutrophication in shallow lakes...population disturbance in one area could drive the evolution of a new behavioural strategy, with unpredictable consequences for aquatic ecology in neighbouring reaches’ (Winter 2020)*

This risk is considered de minimis given the heavily degraded nature of The Broads with the majority of waterbodies classified as Poor or Moderate for phytoplankton and macrophytes. However, as outlined in the project monitoring plan (HWRP Monitoring Plan addendum\_27.10.20) the project will be funding a 3 year continuation of the fish tracking undertaken by the PhD, which will highlight if significant proportions of bream are observed at sites not previously utilised (as indicated by the original fish tracking). This will allow assessments of the potential impacts of the bream should such a pattern occur. In addition, the formation of the Hoveton Fisheries Advisory Group (as detailed in ‘HWRP Fisheries Advisory Group. January 2021’) provides a mechanism for highlighting and delivering any further monitoring or management needs identified.

## Summary

- The fish communities of the middle Bure broads are dominated by roach in number and bream by biomass. Such communities are highly indicative of lakes suffering from eutrophication, and such fish communities help maintain poor ecological condition with turbid waters and low macrophyte diversity and coverage.
- A fish community which helps maintain poor ecological status is not compatible with GES under the WFD and should be considered as in poor status. Therefore restoring the fish community to one not dominated by bream and roach even if that means a decline (but not loss) of bream and roach associated with the installation of fish barriers at HGB cannot be considered a decline in the WFD status of the fish community, either within the individual broads or the rivers.
- Bream and roach will form a part of a more undisturbed broadland fish community, but not to the numeric extent currently observed.
- A large scale decline in bream associated with the temporary closure of HGB and HB is unlikely due to the adaptability and fecundity of bream, as demonstrated by their success throughout UK waters.



- A redistribution of bream within the wider Broads as a result of proposed works driving a decline in WFD status in less impacted waterbodies is considered very low, in part due to the already highly impacted condition of The Broads. However, mechanisms are in place within the projects monitoring programme and the formation of the 'Hoveton Fisheries Advisory Group' to monitor and if required mitigate such an event.

Overall the project is still expected to provide long-term benefits through significant improvements in habitat quality, food availability and improved spawning structure. The diversity of fish in the broad is expected to improve, with a higher proportion of typical Broadland fish – tench, perch, rudd – expected to be present once the broad is established in a clear-water, plant dominated state.

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