Geo Factsheet

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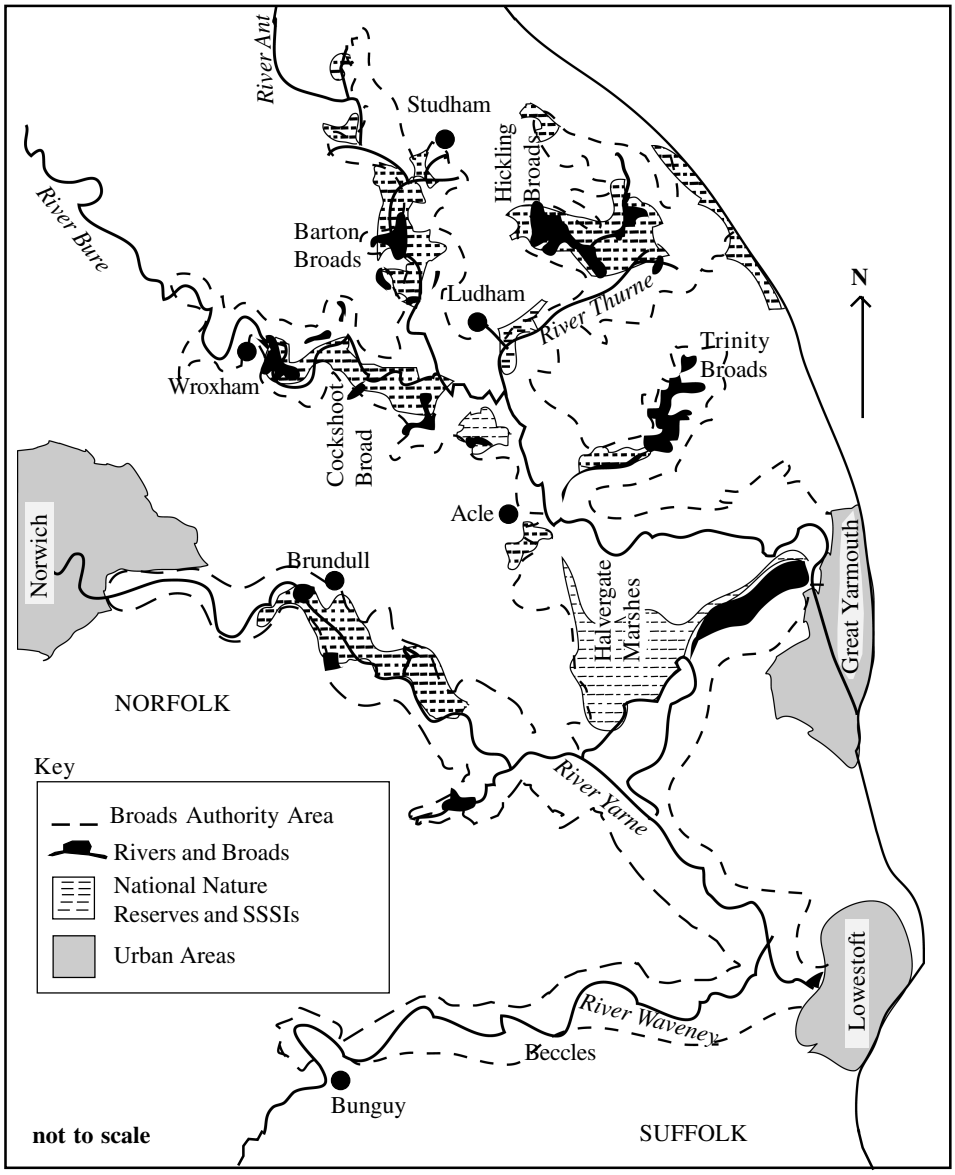
The Broads National Park - a study of Ecological Management

The Broads:

- 301km^2 of marsh, woodland, farmland and open water in Eastern Norfolk and North Suffolk.
- The boundaries of the area closely follow the valleys of 5 main rivers: The Bure, Yare, Thurne, Ant and Waveney.
- 190km of navigable waterways and 63 expanses of open water called Broads.
- Originally considered to be natural the Broads are now known to be the flooded remains of Medieval peat diggings. The peat formed from the compressed remains of swamp like vegetation in the wide river valleys and was dug out, dried and used as fuel. The rivers were used to transport the peat to where it was needed.
- A popular destination for boating holidays. Not all the Broads are however navigable and the Northern Broads contain the highest number of Broads open to boating - for example Wroxham, Salhouse, Blackhorse, Barton and Hickling Broads.
- Some Broads are only open to non-powered craft and are used for sailing and canoeing eg. Decoy Broad and the Trinity Broads of Ormesby, Rollesby and Filby.
- The Trinity Broads are also used as drinking water supply for the surrounding area. Some Broads are cut off from the rivers and are left as havens for wildlife eg. Hoveton Great Broad and Cockshoot Broad (Fig 1 and 3)

Fig 1. The Broads and conservation



The Norfolk rivers drain into Breydon water near Gt.Yarmouth before entering the North Sea , the Waveney flows into the sea through Oulton Broad near Lowestoft. In 1953 the Broads was devastated by a tidal surge which breached sea defences and flooded up the rivers to flood the area with seawater. This as a similar event to the one which created the Broads in the 1300s.

The dominat landuse of the Broadland catchment area is agriculture and the land has been farmed intensively for arable crops although there is cattle farming on the marshes and some pig farming. The largest urban areas in the catchment are Norwich ,with a population of approximately 130, 000 and Gt Yarmouth and Lowestoft at the mouths of the rivers Yare and Waveney respectively.

The Broads attracts 1 million tourists a year and the tourism industry is worth £146.6 million to the area.

The Norfolk Broads was given National Park Status in 1988, and although not widely known as a National Park ,the landscape and wildlife enjoy the same protection as other National Parks.

The Broads Authority is the equivalent to a National Park Administrative body and manages the difficult balance of local communities, tourists, ecology, farming and navigation .

Most of the land and Broads in the area are privately owned (including he National Trust and RSPB) and the Authority must work closely with land owners to ensure that economics, leisure and the environment can coexist amicably.

Ecological Issues

Why are the Broads ecologically important?

- 28 **SSSI**s (Sites of Special Scientific Interest) covering 24% of the area, a third of which are also **National Nature Reserves** . Fig 1 shows that most of the protected areas are located along the main river valleys and often encompass entire Broads.
- **High Biodiversity** : Fenland contains 250 species of plant including the milk parsely, food for Britain's largest butterfly the Swallowtail which is only found on the Broads. It also contains 200 species of invertebrates and is one of the few. One of few remaining habitats of the Bittern (wading bird). 14 out of 21 species of stonewort, some having there only occurrence on the Broads
- 45% of the area is protected Grazing Marsh which is important for waders and wildfowl: Halvergate Marshes is an **ESA (Environmentally Sensitive Area)** and a SSSI. Much of the marshland has been drained for arable agriculture so Halvergate marshes are particularly important.
- **Ramsar Convention Designation** - Wetland of recognised international importance
- **Biodiversity Action Plan** priority habitats number six in total, including Reedbeds and Grazing marshes. Biodiversity Action Plans targeted at 20 species including the Fen Orchid, Natterjack toad, Bittern and Otter.

(a) Hydrosere Succession and Eutrophication

If left unmanaged open water areas of the Broads would eventually disappear as the plants encroached on the water to eventually create areas of woodland. Many Broads have reduced significantly in size or completely disappeared. Fig 2 shows the natural **succession** for an open area of water . Floating and submerged plants contribute humus material to the Broads bed, thereby making the water increasingly shallow. Reeds and rushes, which emerge through the water to the surface, add further organic matter increasing the nutrient content and decreasing the depth of water further. Eventually shrubs and trees can form an Alder Fen Carr woodland which is partly submerged. This eventually gives way to birch and then the **climatic climax** vegetation of oak woodland. Throughout the succession the depth of the water has decreased and the soil dried out until the oak woodland stands well above the waterline on a mass of organic matter. Eventually this succession covers the whole water body and it fills in and disappears.

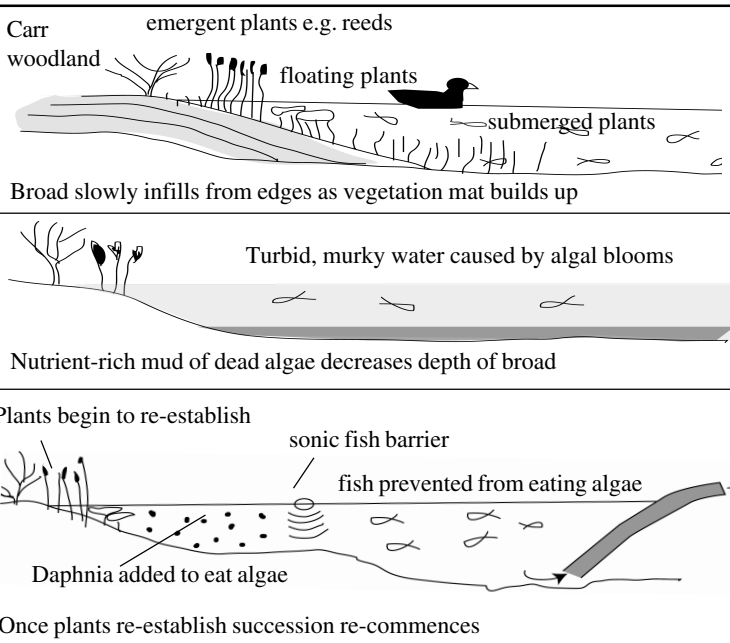
Along the rivers of the present day Broads the water appears murky and brown, a result of **algal blooms** and stirred up sediment. In most of the Broads the water appears the same. This has been caused by **Eutrophication,** or the over-enrichment of the water with nutrients, and has interfered with the natural succession in several ways.

- Firstly, the fringing emergent plants and submerged plants find it difficult to anchor in the algal mud and may disappear. Reeds may become top heavy with growth due to excess nutrients and topple over..
- Secondly, wave wash can remove organic material from the Broad fringes.
- Thirdly the organic remains of the algae cause an overall shallowing of the lake, but reeds, rushes and submerged plants cannot take hold. The Broad may shallow but the process of natural succession has been disturbed and a **subclimax** stage is reached. Where development has occurred, hard quay heading has been installed to allow boats to moor. In some areas where reeds have died away, bank protection has been put in place to prevent erosion. (Fig 2).

(b)The Decline in Water Quality and Biodiversity

Water quality, habitats and **biodiversity** started to significantly decline in the 1960s. A healthy Broadland ecosystem would show a typical lake succession as shown in Fig 2 .

Fig 2. Succession and Biomanipulation



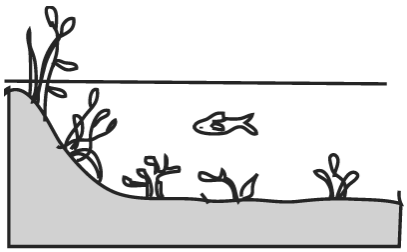
Pre-Eutophicution
Natural succession
- good water clarity
- High Biodiversity

Eutrophic stage
Natural Succession is halted
- poor water clarity
- low Biodiversity

Biomanipulation
- management will lead to improved water clarity & quality
- greater biodiversity

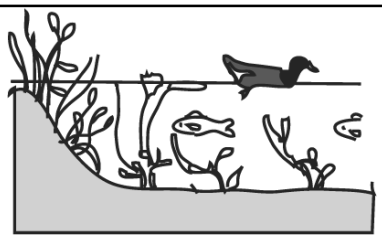
Fig 3 : Stages in decline of Broadland water quality

Phase 1 Pre1880 Oligotrophic
Good quality water is low in nutrients but supports a diverse amount of plants, invertebrates and fish.



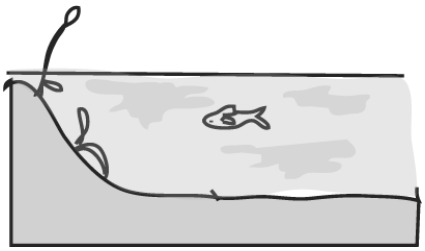
- Crystal clear water
- Waterways fringed with reeds and plants
- Low growing stoneworts in the water.
- Charophyte plants dominate
- Good light penetration
- Very low plant Nutrients
- Phosphate <0.02 mg/l
- Nitrate < 0.5mg/l
- High oxygen levels
- Sedimentation 1mm/year

Phase 2 1880-1940 Mesotrophic
Human activity increases the amount of nutrients in the water. Untreated sewage and farm waste enters the Broads and acts like fertiliser.



- Water maintains clarity
- Significant increase in luxuriant growth of water plants eg. waterweed and waterlillies
- Increasing plant nutrient levels
- Phosphate 0.02-0.1 mg/litre
- Nitrate < 0.5-1.0 mg/l
- High oxygen levels
- Sedimentation 2mm/year

Phase 3 1940 - present Eutrophic Run off from intensively farmed land adds large amounts of fertiliser (nitrates) to the water. Herbicides and pesticides further damage the food chain. Sewage from a growing tourist industry is pumped straight into the water increasing phosphate levels. An increase in population in the Broads catchment increases the amount of sewage and detergent entering the water, increasing phosphate levels.

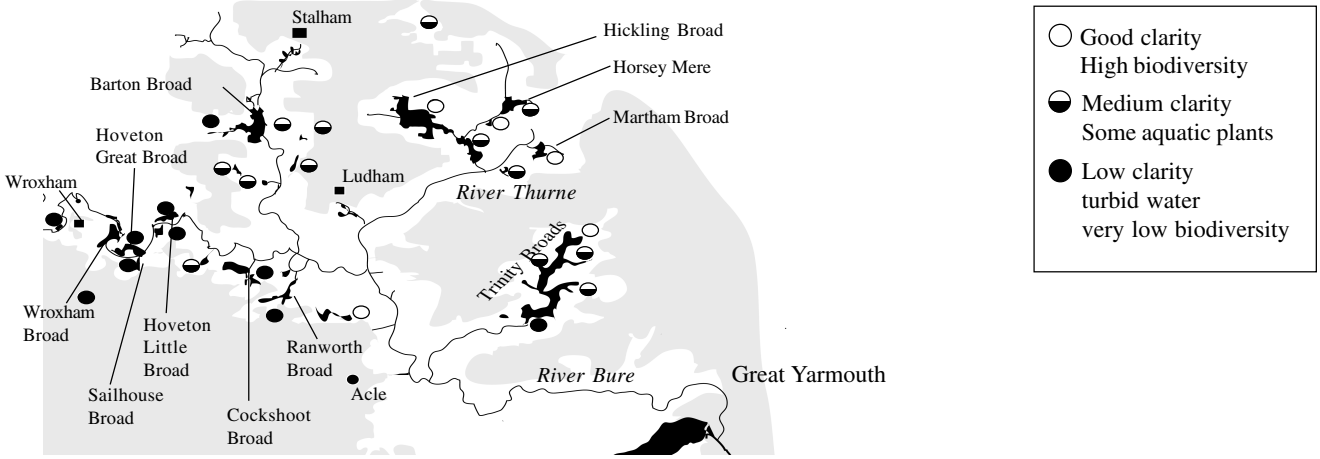


Turbid water often dominated by blue-green algae.
No Plants

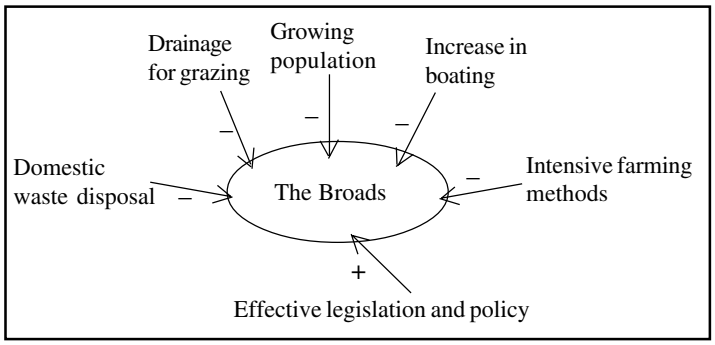
- Water plants rapidly vanish from some Broads
- Bank erosion occurs
- Algal blooms turn the cloudy or turbid and light penetration is drastically reduced.
- Algae uses up the dissolved oxygen
- Bio-diversity drops drastically
- Fish die in large numbers
- Food webs disrupted
- Massive increase in nutrients available in the water leads to EUTROPHICATION
- Phosphate >0.1mg/l
- Nitrates > 1.0 mg/l
- Low oxygen levels
- Sedimentation 10 mm/year
- Increased sedimentation due to algal bodies dying and settling to bottom to form a glutinous nutrient rich mud.
- Boats stir up nutrient rich mud increasing nutrients available, particularly in summer during the tourists season.

Fig 4 shows the extent of the decline in water quality in the Northern Broads. The more isolated Broads tend to have better water quality. The intensity of agriculture, population density, boat usage and quantity of sewage disposal play an important role in the clarity of the water.

Fig 4. Northern rivers water quality



Human Impact and Influences on the Broads



Management (Biomanipulation) of the Broads

The Broads Authority is attempting to reverse the effects of **eutrophication** to improve water quality, improve habitats for organisms throughout the food chain and thereby improve the **biodiversity** and ecological health of the Broads. Relevant legislation includes:

- **EC Directive on the Conservation of Natural Habitats and Wild Fauna 1992.** Established Special Areas of Conservation and Special Protection Areas, both of which require a detailed assessment to be made of any development in the area which is out of keeping with the ecological management of the area. If habitat loss occurs due to human activity it must be recreated elsewhere.
- **EC Water Frameworks Directive 2000**: aims to prevent further deterioration of aquatic water systems by reducing pollution.
- **UK Biodiversity Action Plans 1994**: aims to increase, conserve, protect and enhance biological diversity. The BAPs target particular species and habitats of which there are 5 priority habitats and 19 priority species with in the Broads.
- **Broads Environmentally Sensitive Area scheme**: Farmers are given special payments to manage and conserve the landscape and biodiversity. This would include careful use of fertilisers and pesticides.

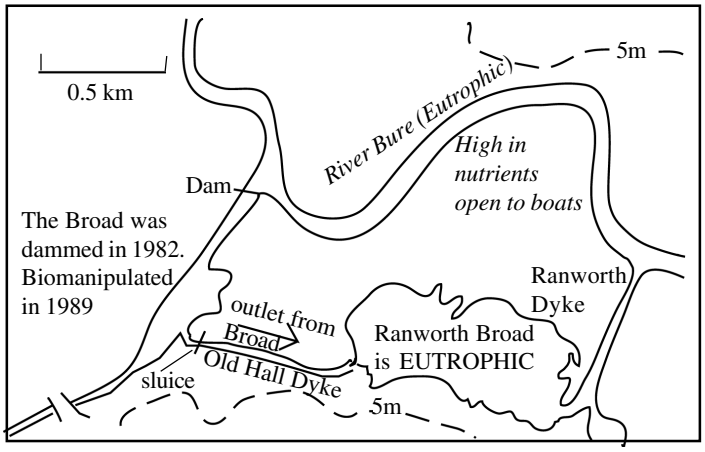
There have been several practical strategies to improve water quality.

- Eliminate raw sewage from boats entering the water directly by storing and pumping out waste from boats
- **Sewage management** : Diversion of effluent to the sea rather than into the watercourses.
- Treat effluent water with iron sulphate to precipitate **phosphates** before the treated water returns to the river.
- Nutrient rich mud and sediment removal
- **Biomamipulation:** Water fleas (daphnia) are added to the water to consume the algae and therefore improve water clarity . Fish have been removed so that the fleas can be predator-free. Plants are re-established.

The Success of Biomanipulation

The long term success of biomanipulation relies on the successful establishment of plants which provide a safe habitat for the **Daphnia (zooplankton).** Water fowl can cause problems for re-establishing the plants by feeding on them. In Biomanipulation the fish are removed to so that the plants can establish themselves and this enables the daphnia to feed and multiply without being preyed on. An enclosed area is needed, either an isolated broad or an area cut off with a sonic fish barrier. As the daphnia eat the algae the water clears and light is available for the plants to grow. If successful fish communities can be reintroduced but if the nutrient supply overload has not been addressed then this may not happen. In all cases on the Broads where biomanipulation has taken place a return to a low nutrient or Oligotrophic state is unlikely. Fig 2 shows how Biomanipulation can change a eutrophic water body.

Cockshoot Broad - managing a wildlife haven



Cockshoot Broad is a small broad (3.3ha) originally connected to the river Bure by a dyke, it had an average depth of 1 metre but only 40cm of water. Increases in sewage disposal, intensification of agriculture and the popularity of the boating industry turned the low nutrient water into a eutrophic soup of algae, mud and nutrients.

Cockshoot Broad was in a unique situation in that boat navigation was not practical or necessary so the Broad was cut off from the main river with a dam. The dam prevented nutrient rich water from the river entering the Broad. Suction mud pumping was carried out to a depth of 1 metre on the Broad and the dyke excavated with a digger.

*Initially the water cleared and large numbers of **Daphnia (water fleas)** appeared, and then shoals of bream (fish) could be seen swimming in the clear water. The dyke exhibited vigorous plant growth but the re-establishment of vegetation in the main basin failed. The Daphnia eventually disappeared because they had been eaten by the fish which were trapped behind the dam. It was decided that to increase the Daphnia population the fish population should be removed, some by **electrofishing**. The water became clear again and Daphnia populations increased.*

Although Cockshoot Broad is now a wildlife haven it is still at risk from tidal flows of saline water which will become an increasing threat as sea levels rises due to global warming. The sediment still contains relict phosphorous and the ecosystem is not expected to return to oligotrophic levels.

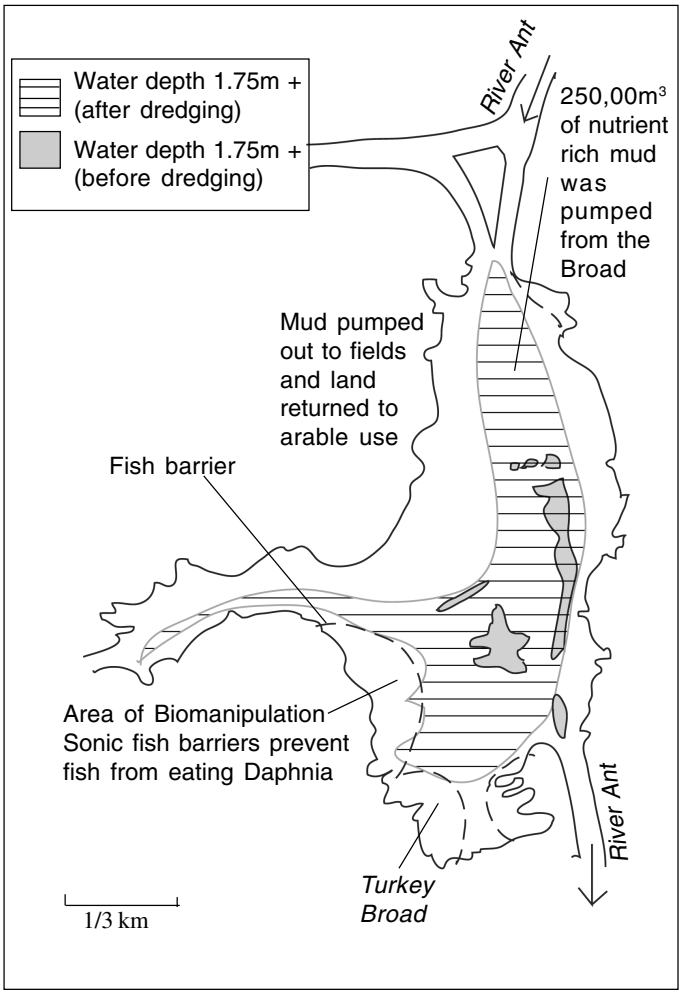
Barton Broad: - a broad in crisis

Barton Broad is the second largest of the Broads and the main course of the river Ant flows through the broad. Nutrients were sourced both internally from dead plant organic matter held in the sediment and from two sewage treatment works. Isolation to reduce nutrient input was not an option because the navigation needed to be maintained. The Broad was becoming very shallow and it was feared would be closed to sailing and boat traffic apart from the main river channel. Phosphate stripping of sewage was installed at Stalham Treatment works and effluent from N.Walsham was diverted to the North Sea and completed by 1981 which reduced phosphate input. However the water remained turbid and plant communities failed to re-establish.

The Clearwater 2000 Project *was established by the Broads Authority to improve the water quality, water depth and plant communities on the Broad. Initially, a corner of the main Broad called Turkey Broad was dredged and a* ***sonic fish barrier*** *enclosed the area. The fish were removed and* ***Daphnia*** *added to graze on the algae. Water could still flow through the sonic barrier but organisms could not. The Daphnia clear the water of algae and allow light to penetrate the water, this in turn provides habitats for the Daphnia and other invertebrates which helps restablish the food chain. Dredging of the entire Broad commenced in 1996 and the nutrient rich mud was pumped to lagoons on the land where it was allowed to dry out. Over 250,000 cubic metres of mud was removed increasing the depth by 50cms. Fig 6 shows the extent of the mud pumping and the areas which have undergone Biomanipulation.*

Clearwater 2000 Focus
- Biomanipulation
- Water Clarity
- Mud pumping
- Ecology
- recreation

Fig 6. Barton Broad and Clearwater 2000



Conclusion

A future for the Broads

Under the umbrella of the Broads Authority, projects aimed at improving water quality and improving the ecology of selected Broads have been relatively successful. The degree of isolation of water bodies, landuse in the catchment area and size of water body are key factors in the success of any restoration. Some Broads which are isolated from the main rivers have catchment areas which are less intensively farmed and which have a low population have maintained clear waters and a high diversity of life eg. Martham Broad. Broads which are closely connected to the main rivers, unless isolated, will continue to receive large supplies of nutrients and experience turbid water due to algal blooms and disturbance of sediment by boat traffic.

Biomanipulation projects will continue to improve water quality in some areas but the task of returning the entire Broads network to even Mesotrophic nutrient levels is unlikely. However The Broads will continue to be a haven for aquatic wildlife and popular holiday destination.

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Acknowledgements; *This Factsheet was researched and written by Lucy Prentrice (Née Newstead) who formerly taught at Diss High School in Norfolk.* ***Curriculum Press, Bank House, 105 King Street, Wellington, Shropshire, TF1 1NU****. Geopress Factsheets may be copied free of charge by teaching staff or students, provided that their school is a registered subscriber.*

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