

## Appendix 5. History of lake restoration

Broad	Past restoration and success	Current restoration and success (See Action Plan for full details)
Alderfen	<b>Isolation</b> – (1979) reduction in nutrient entering from catchment. 1982-83 macrophytes dominate. 1985 phytoplankton dominate. High nutrients due to internal release and lack of flushing. 1994 - 2007 TP <50ug/l, internal phosphorus release less important.	Remains isolated as phosphorus load in diverted inflow stream remains too high to risk reconnection.
	<b>Sediment Removal</b> – (1992-93) increased water depth, removal of most of soft silt, however rapid decomposition of exposed peat was thought to cause internal loading from dredged sediment immediately after dredging (Pitt & Kelly, 1997)	
	<b>Iron injection</b> – (1995) sediment injected with iron to lock up phosphorus in the silt, within the mobile sediment the iron was rapidly lost and technique was not success at binding phosphorus within the sediment.	
	<b>Biomanipulation, fish removal</b> – (1990) natural fish kill. (1993) division and partial biomanipulation, perch removed at this time. Occurrence of rudd and roach indicate it is not fully isolated.	No plans to remove fish unless zooplanktivorous fish dominate resulting in a deterioration in water clarity.
	<b>Biomanipulation, perch stocking</b> – (1999) Most introduced perch did not survive due to hot temperatures during introduction	
	<b>Refugia</b> (May 2000) – cobweb brushes provide excellent habitat for invertebrates in initial stages of restoration after 2-3 years brushes become encrusted with sponges. Cobweb brushes and all structures removed in 2007.	
	<b>Littoral margin scrub removal</b> – (ongoing) 10-30m margin, good for some species but there has been little overall re-growth of emergent plants into water up to 10 years since clearance. Clearance of the inflow dyke was done in 2006 to provide connected dyke habitat and to prepare for connection with the inflow stream once water quality has improved.	Ongoing
	<b>Macrophyte re-introduction</b> – to improve species diversity. Water soldier, from dyke clearance operations, added. None survived.	
	<b>Extend open water</b> - Restore and connect adjacent dyke habitats to extend open water habitat into adjacent dykes	
	<b>Bird enclosure</b> - (1993) removed in 2000.	
Barnby	<b>Sediment Removal</b> – (1990) southern half mudpumped, (2007) northern half mud pumped	
Barton	<b>Siltex treatment</b> – (1988) applied at c. 1tonne/ha in an attempt to consolidate sediment, unsuccessful.	
	<b>Phosphorus stripping at major STWs and industry</b> – 1980-1996 reduced P loading by 90% since late seventies	
	<b>Sediment Removal</b> – 1996-2001 increased water depth by mean of 43cm, 60% lower P loading from dredged sediment in late summer, lake net P retention	
	<b>Biomanipulation, fish removal</b> – (2000-date) in isolated bays, effective if repeated as required. Integrity of barrier essential to success in early stages of the project before macrophytes are established. Once water quality and macrophytes improved barrier integrity appears less important, large barriers reduce blue greens. Biomanipulation review will assess overall success.	Ongoing - see detail of barrier maintenance, removal and replacement in biomanipulation review
	<b>Refugia</b> – (2001) (£12,000) 14,000 cobweb brushes provide excellent habitat for invertebrates in initial stages and 70ha or surface area for periphyton growth thus significant P uptake and less blue green algae. Good technique for initial stages of biomanipulation where no natural habitat structure available. Sponges have colonised the brushes. In larger enclosures with general water quality and macrophyte improvements the success of this technique is doubtful.	Refugia removal 2008
	<b>Island re-creation</b> – (2003) pleasure island secured and rebuilt with piles and backfill. Piles do not provide favorable habitat for aquatic life, this was purely a landscape project.	
	<b>Installing floating island</b> – (2003) (£50,000) 0.3ha interlocking free-floating pre-planted pallets abutted to pleasure island and protected by grazing protection 'goose guard'. Success in year 1 included good plant growth and increased fish numbers around the structure. After year 3, despite a replanting (£10,000) the structure has few remaining plants. Seeking to relocate the island to a sheltered site.	Relocated to Bridge broad
	<b>Littoral margin scrub removal</b> – (ongoing) 20m margin, good for some species but there has been little overall re-growth of emergent plants into water up to five-years since clearance	<b>Littoral margin scrub removal</b> - ongoing reeds swamp regrowing in some areas where rooted into the lake bed, and protected from boat and wind generated waves. Hover reeds swamp remains in decline
	<b>Macrophyte re-introduction</b> – (1984/5) mesh enclosure (365m long) stocked with macrophytes and refuge unsuccessful in long term	
	<b>Water Space Management plan (2006-11)</b> - developed with stakeholders to ensure sustainable future use of broad for all.	<b>Water Space Management Plan</b> - Action Plan - implement annual action plan (2006 - 11)
	<b>First Time Rural Sewerage (2006)</b> - Neatishead	
Belaugh	<b>Phosphorus stripping at major STWs</b> – 1986-reduced P loading by around 90% since late seventies	
	<b>Sediment Removal</b> – (1987) increased water depth for macrophyte regrowth. Regrowth of a low number of species on occasional years.	
	<b>Macrophyte re-introduction</b> – (1988) water lilies generally and variety of species into bird protection cages	
	<b>Bird grazing protection</b> – (1988) installing mesh cages to protect macrophytes from grazing birds	Cages removed in 2007
Bridge	<b>Phosphorus stripping at major STWs</b> – 1986-reduced P loading by around 90% since late seventies	
	<b>Installing floating island</b> – (2007) 0.2ha interlocking free-floating pre-planted pallets in sheltered area and protected by grazing protection 'goose guard'.	
Burntfen	<b>Macrophyte harvesting</b> – (ongoing) removal of <i>N.lutea</i> to keep open water for boating and swimming (not for ecological restoration)	ongoing
		Feasibility for restoration being considered in 2008
Brundall	<b>Sediment Removal</b> – (1975)	
Buckenham	<b>Sediment Removal</b> – (1980)	
Calthorpe	<b>Chalk application</b> – (1977/8 plus other times) attempt to reduce acidity	Feasibility for restoration/sediment removal being considered in 2008
	<b>Isolation</b> – (between late 1960s to 1970) following extensive drainage in the catchment for agriculture, water control structures were installed to prevent complete drainage of the broad itself, resulting in a perched water table. The structures also acted to prevent input of acid and ochreous water to the Broad, which was produced as a results of the deep drainage on the surrounding peat soils.	
	<b>Bark chips</b> – (late 90s) to precipitate the ochre from the water in adjoining dykes	
Cockshoot	<b>Phosphorus stripping at major STWs</b> – reduced P loading by % since late seventies	
	<b>Emergent macrophyte re-introduction</b> – (2002/3) coir pallets planted with emergent vegetation ( <i>T. latifolia</i> , <i>S. lactustris</i> ) laid over shallow mud to form hover, protected by coir goose protection nets. Success in years 1 and 2, low water and high temperatures resulted in failure of most plants.	
	<b>Submerged macrophyte re-introduction</b> – (2000-03) coir pallets with plugs of rooted broad and fine-leaved macrophyte species introduced to areas around the lake. Failure to colonise due to smothering with filamentous algae.	
	<b>Sediment Removal</b> – (1982) increased water depth	

	<b>Isolation</b> – (1981) damn built to isolate the lake from the nutrient rich R. Bure	Isolation structures checked and maintained annually
	<b>Biomanipulation, fish removal</b> – (1989-date) Effective if repeated as required	<b>Biomanipulation, fish removal</b> – (ongoing)
	<b>Scrub clearance</b> – (1982) scrub removed along dyke and parts of the lake, some which have been ongoing. (2002) scrub removed along dyke and parts of the lake	
<b>Cromes</b>	<b>Siltex treatment</b> – (1988) applied at c. 1 tonne/ha in an attempt to consolidate sediment, unsuccessful	
	<b>Isolation</b> – (1992) reduction in nutrient entering from main catchment	
	<b>Sediment Removal</b> – (1988) south broad, (2005 north broad) increased water depth and allowed regrowth of macrophytes. Successful.	
<b>Decoy</b>	<b>Scrub Clearance</b> - adjacent to broad in 2001-02, then some more in 2004	
	<b>Phosphorus stripping at major STWs</b> – reduced P loading by % since late seventies	
<b>Filby</b>	<b>Scrub clearance</b> – scrub removed along shore	Ongoing
	<b>Sediment Removal</b> - feasibility study for removal of some sediment from south west corner complete, in need of updating with changes to Waste Management Regulations.	
<b>Hickling</b>	<b>Macrophyte cutting</b> – (up until 1997) to lower the height of <i>M.spicatum</i> for boats (for navigation driver)	<b>Water Space Management Plan</b> - Action Plan - implement annual action plan (2006 - 11)
	<b>Macrophyte cutting</b> – (2000, 2003) experimental approach to investigate impact of lowering height for <i>C. intermedia</i> for boats (for navigation purposes)	
	<b>Channel dredging</b> – (1968 and 74) main channel, (2002) Catfield channel (both for navigation purposes) little benefit for conservation. Some loss of <i>C.intermedia</i> due to uprooting as a result of barge movements.	
	<b>Goose grazing protection</b> – (2000-03) Heigham Sound 2km of floating fences and bundles of brushwood faggots installed. Both effective at minimizing grazing from feral geese, but require maintenance.	
<b>Horsey</b>	<b>Channel dredging</b> – (mid-1960) channel to Waxham cut (for navigation purposes)	
<b>Hoveton Great</b>	<b>Biomanipulation, fish removal</b> – (1990) ridged structure, 1.5 ha enclosure, tidal scour undercut structure, fish gained access within first year, unsuccessful. Structure removed in 2003	
	<b>Biomanipulation, fish removal</b> – (2001-date) in isolated bays, effective if repeated as required. Integrity of barrier essential to success	
	<b>Littoral margin scrub removal</b> – (ongoing) 20m margin, good for some species but there has been little overall re-growth of emergent plants into water up to five-years since clearance	
	<b>Bird enclosures</b> - (1993) Removed in 2003	
<b>Hoveton Little</b>	<b>Sediment Removal</b> – (1989-90) nutrient rich surface mud removed, no noticeable improvement in macrophyte growth or P levels	
<b>Lady</b>	<b>Scrub clearance</b> – scrub removed along shore	
<b>Martham North and South</b>	<b>IDB pump outflow</b> – Somerton North Pump installed (TG 4572 2080) to divert flow of polluted water from Somerton South Pump (TG 4657 2022) which discharges directly to the broads	
	<b>Goose grazing protection</b> – (1990s) alder poles and wire mesh installed. Effective at minimizing grazing from feral geese	
	<b>Goose grazing protection</b> – (2006) fencing replaced, faggots and coir roll installed as erosion protection. Effective at minimizing grazing from feral geese and locally protecting unhealthy reedswamp.	
<b>Ormesby</b>	<b>Biomanipulation, fish removal</b> – (1995) in isolated bays, effective if repeated as required. Integrity of barrier essential to success	Ongoing fish survey and spawn removal
	<b>Scrub clearance</b> – scrub removed along shore	Ongoing
<b>Ormesby Little</b>	<b>Scrub clearance</b> – scrub removed along shore	Ongoing
<b>Pound End</b>	<b>Biomanipulation, fish removal</b> – (1990) effective if repeated as required. Integrity of barrier essential to success	
	<b>Sediment Removal</b> – (1990) nutrient rich surface mud removed, no noticeable improvement in macrophyte growth or P levels	
	<b>Bird enclosures</b> - (1993) removed in 2007	
<b>Ranworth</b>	<b>Iron dosing</b> – (March 1992) 1 ha of sediment dosed with ferric chloride to lock up phosphorus in the silt, within the mobile sediment the iron was rapidly lost and technique was not success at binding phosphorus within the sediment.	
	<b>Bird enclosures</b> - (1993)	
<b>Round Water</b>	<b>Sediment Removal</b> – (1985) nutrient rich surface mud removed, no noticeable improvement in macrophyte growth or P levels	
<b>Strumpshaw</b>	<b>Sediment Removal</b> – (1983) nutrient rich surface mud removed, no noticeable improvement in macrophyte growth or P levels	
<b>Wheatfen</b>	<b>Sediment Removal</b> – (1995) nutrient rich surface mud removed, no noticeable improvement in macrophyte growth or P levels	
	<b>Sediment Removal</b> – (2002) nutrient rich surface mud suction dredged from Mystery Pool and adjoining dyke network	