



Broads Annual Water Plant Monitoring Report 2009

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1 EXECUTIVE SUMMARY

This report presents and discusses the findings from the annual water plant surveys carried out during 2009, which covered 30 waterbodies and seven river reaches. The methodology, data gathering and analysis employed in the annual water plant surveys undertaken by the Broads Authority is detailed in "Broads Annual Water Plant Monitoring Methods." This publication should be read alongside this report.

Key results from the 2009 survey can be summarised as: -

- Hickling and Horsey Mere continue to have a very low number of species present and low abundance. Those plants collected appeared to be in poor condition. The holly leaved naiad record from Hickling was only a small single plant.
- Heigham Sound's plant community, although poor, has remained relatively stable over the last 5 years predominately found off the main navigation channels.
- Wroxham Broad showed no indication of continuing to improve or maintain the surprising increase in species numbers found in the 2008 survey. Species numbers and abundance dropped in 2009, in a similar manner to Barton Broad, which may have been a result of wet summer weather.
- Ranworth appears to show little change in plant community. However, those plants present tended to cover a wider proportion of the broad unlike the patchy presence found previously.
- All six river reaches previously surveyed were re-visited in 2009 along with a new survey site, the Waxham Cut. The river surveys reveal a generally rich assemblage of marginal and submerged species. In comparison to the other river sites Waxham Cut had the fewest number of species (n=7) but species present included two stoneworts and two pondweeds.
- The Trinity Broads continue to have thriving plant communities overall. Rollesby and Lily are now similar to the historically rich Ormesby in diversity. Ormesby Little continues to improve. Filby was not surveyed in 2009 but is known to continue to have low species numbers and abundances.
- Martham North and South continue to have good plant diversity, stable in terms of long term abundance and richness. However the patches of bare sediment in Martham South require close monitoring to detect any negative changes.
- Barnby broad, mud pumped over the winter of 2006/2007, has experienced significant gains in plant richness and abundance since then. The water was clear to the bottom of the broad with a marked reduction in the amount of filamentous algae present. As a consequence five new species, all stoneworts were identified, growing in large beds across the broad.
- Little Broad and Mautby Decoy both mud pumped in the last two years show improved plant communities, with Little Broad containing the carnivorous Greater Bladderwort.
- Three infrequently surveyed sites, Irstead Holmes, Reedham and Catfield Broad were surveyed in 2009. Since the last survey in 2004 there appears to have been little change in the plant communities found at the three sites, all continue to low diversity.
- Water soldier was recorded in Barton Broad in 2009 for the first time since the annual plant survey started in 1983. It is thought to have colonised from Barton Staithe where it has been present for 3 to 4 years. Plant abundance in Barton fell in 2009 suggesting the improvement seen from 2004 to 2008 is not a stable state.

- Whitlingham Great and Whitlingham Little have good species richness and abundance. The very high abundance levels were mainly due to the huge volume of Canadian and Nuttall's waterweed found in the Great broad.
- The holly leaved naiad (a Biodiversity Action Plan (BAP) species) was found to be present in eleven of the broads surveyed in 2009, the same as 2008.

As a classification and assessment tool the water plant surveys inform ways in which lake restoration works can be targeted and the outcome of management interventions assessed. The water plant monitoring also provides an early means to identify possible sites of deterioration. The results of the water plant surveys also contribute to the classification and monitoring of SSSI waterbodies in partnership with Natural England. The detection of invasive, non-native plant species within the Broads is also important function of the annual survey if the risks posed by these plants are to be effectively managed.

Following several months of hard work by volunteer Oliver Hewitt all water plant survey data (1983 to present) has now been imported into a custom designed Access database developed by Oliver. In conjunction with the 'Water Plant Database' there is also the 'Water Quality Database'. The combination of the two datasets into one Access database makes it possible to now undertake rapid, accurate data queries and analysis. Both datasets will be continually updated as new data is collected e.g. water quality from broads where water plant surveys are undertaken and there is normally no routine water quality sampling.

Steady progress is clearly being made through the Lake Restoration Strategy. Broads where mud pumping has been completed show a marked switch back to diverse plant communities. However much work remains to be done across the Broads to bring degraded broads back to health, in line with national and EU drivers and to increase and subsequently maintain the diversity of those broads lacking in species richness. The annual water plant survey therefore continues to be an important part of targeting and measuring the success of such efforts.

2 AIMS AND OBJECTIVES

The aim of the Broads annual survey is to monitor water plants within specified broads, along previously defined transects between late July and early September, using the methodology outlined by Kennison *et al* (1998). Where broads have historically been sampled around a particular date, it is aimed that the survey takes place as near as possible to that date.

The main objectives in the annual programme are to monitor key broads with long-term datasets, those that have had restoration measures put in place or those that are known to be experiencing a change in their macrophyte community. Other broads that are not receiving restoration efforts or are stable and/or are generally without plants, are monitored on a less frequent basis. When resources allow, a rolling program of monitoring sites not previously surveyed is also an ongoing aim.

This report aims to collate the data collected since the last survey report in 2008 and will refer to the long-term data from 1983 to 2009 (Table 1).

Table 1. Sites surveyed for water plants from 1983 to 2009.

	# of years	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09
Alderfen	27																											
Bargate	2																											
Barnby	5																											
Barton	27																											
Belaugh	18																											
Blackfleet	3																											
Bridge	12																											
Buckenham	6																											
Burntfen	3																											
Catfield	2																											
Cockshoot	27																											
Cockshoot Dyke	26																											
Cromes South	26																											
Cromes North	26																											
Decoy	8																											
Filby	21																											
Flixton Decoy	2																											
Fritton Lake	1																											
Hassingham	6																											
Heigham Sound	19																											
Hickling	27																											
Horsey Mere	23																											
Hopton 1 (Lound)	1																											
Hopton 2 (Lound)	1																											
Hopton 3 (Lound)	1																											
Hopton 4 (Lound)	1																											
Hoveton Great	27																											
Hoveton Little	13																											
Hudson's Bay	7																											
Irstead	2																											
Lily	22																											
Little	3																											
Malthouse	6																											
Martham North	26																											
Martham South	25																											
Mautby Decoy	3																											
Mill Water (Lound)	1																											
Norton	2																											
Ormesby	24																											
Ormesby Little	24																											
Pound End	14																											
Ranworth	25																											
Reedham Water	2																											
Rockland	20																											
Rollesby	23																											
Round water	1																											
Salhouse Great	12																											
Salhouse Little	6																											
Spratts Water	2																											
Strumpshaw	5																											
Upton Great	27																											
Upton Little	4																											
Wheatfen	4																											
Whitlingham Great	7																											
Whitlingham Little	5																											
Wroxham	27																											
# per year		21	20	21	21	22	13	22	20	21	21	15	12	24	26	24	28	20	24	17	21	19	35	33	38	40	30	31

Table 2 Sampling dates and transect lengths (metres) (2006-2008).

Broad	Date Sampled			Total Transect Length (m)		
	2007	2008	2009	2007	2008	2009
Alderfen	15-Aug	15-Aug	19-Aug	866	850	850
Barnby	05-Sep	-	14-Aug	-	-	360
Barton	25-Jul	06-Aug	12-Aug	5458	5234	4942
Belaugh	07-Aug	-	-	332	-	-
Bridge Broad	07-Aug	23-Jul	-	383	430	-
Buckenham Broad	24-Jul	22-Jul	28-Aug	276	331	270
Cockshoot Broad	17-Aug	14-Aug	03-Sep	938	1125	938
Catfield	-	-	03-Sep	-	-	345
Crome's	15-Aug	13-Aug	19-Aug	956	1049	964
Decoy Broad	09-Aug	29-Jul	05-Aug	1582	1512	1567
Filby	29-Aug	-	-	2909	-	-
Flixton Decoy	03-Aug	-	-	903	-	-
Hassingham Broad	24-Jul	22-Jul	28-Jul	259	232	254
Heigham Sound	31-Jul	07-Aug	07-Aug	2620	2684	2180
Hickling	01-Aug	07-Aug	13-Aug	8714	8964	8423
Hopton 1	04-Sep	-	-	283	-	-
Hopton 2	04-Sep	-	-	741	-	-
Hopton 3	04-Sep	-	-	458	-	-
Hopton 4	04-Sep	-	-	271	-	-
Horsey Mere	02-Aug	08-Aug	07-Aug	3637	2999	3520
Hoveton Great	08-Aug	30-Jul	06-Aug	3040	3237	3039
Hoveton Little	09-Aug	29-Jul	-	2429	2421	-
Hudson Bay	08-Aug	-	-	322	-	-
Lily	23-Aug	-	26-Aug	1258	-	1149
Irstead	-	-	04-Aug	-	-	165
Little Broad	-	12-Sep	09-Sep	-	231	216
Martham Broad North	26-Jul	28-Jul	30-Jul	942	833	814
Martham Broad South	26-Jul	28-Jul	30-Jul	716	752	772
Mautby Decoy	30-Aug	02-Sep	09-Sep	455	462	498
Mill Water	04-Sep	-	-	261	-	-
Nortons	-	-	29-Jul	-	-	242
Ormesby	22-Aug	19-Aug	24-Aug	4916	4641	4267
Ormesby Little	23-Aug	22-Aug	10-Sep	3803	3699	2480
Pound End	09-Aug	29-Jul	-	589	710	-
Ranworth	13-Aug	12-Aug	21-Aug	4597	4416	4399
Rockland	28-Aug	09-Sep	-	1631	1518	-
Reedham	-	-	04-Aug	-	-	421
Rollsby	23-Aug	21-Aug	26-Aug	2430	2391	2537
Round Water	-	10-Sep	-	-	33	-
Spratt's Water	-	10-Sep	-	-	83	-
Strumpshaw	24-Jul	22-Jul	-	338	447	-
Upton Great	13-Aug	12-Aug	18-Aug	917	977	986
Upton Little	13-Aug	-	18-Aug	174	-	173
Wheatfen	28-Aug	-	-	760	-	-
Whitlingham Great	27-Jul	14-Aug	28-Aug	3111	4884	2990
Whitlingham Little	27-Jul	14-Aug	28-Aug	705	689	672
Wroxham	07-Aug	23-Jul	04-Aug	1786	1913	1933

3 BROADS MACROPHYTE RESULTS.

Each broad that was surveyed in 2009 will be reviewed in terms of species richness and abundance. Species recorded in 2007 and 2008 are listed to enable recent trends to be readily seen. Where data or key events are relevant to the current status of the broad they will be highlighted. The broads are grouped by the river catchment in which they are situated.

Appendix 1 classifies the plants into group of similar form/structure. Appendix 3 lists the common and Latin names for all plants found to date during river and broads surveys.

3.1 Thurne Valley

These broads contain the richest population of stoneworts in the UK. Several of which are on the list of high conservation importance plants and have Biodiversity Action Plans attached to them. Stoneworts are recorded in some broads outside of the Thurne catchment but in lower abundances. Species present in the Thurne broads that are included in the Joint Nature Conservation Committee (JNCC) Red Data Book included, three 'Vulnerable' species: Baltic stonewort, Convergent stonewort, Starry stonewort, one 'Rare': Intermediate stonewort (Stewart and Church, 1992). The Thurne broads also provide a stronghold for the rare BAP species holly-leaved naiad, as well as more common vascular plants such as spiked water milfoil and mare's tail.

3.1.1 Hickling

	2007	2008	2009
Common water moss			
Curled pondweed			
Fennel-leaved pondweed	*	*	*
Holly-leaved naiad	*	*	*
Lesser pondweed			
Mare's tail	*		*
Rigid hornwort			*
Rough stonewort			
Spiked water milfoil	*	*	*
Starry stonewort			

Since peaking in the late 1990s/early 2000s, macrophyte diversity in Hickling Broad has been declining. However, the over last four survey years species richness has dramatically decreased from 11 species in 2005 to just three in 2008. The 2009 survey recorded five species but abundance was low. A single small fragment of holly-leaved naiad was found in 2009.

3.1.2 Horsey Mere

	2007	2008	2009
Fennel-leaved pondweed	*		*

Mares tail	*	*	*
Perfoliate pondweed	*		
Spiked water milfoil	*	*	*

There has been a gradual decline in macrophyte species richness and abundance since 2002. The abundance of spiked water milfoil has remained relatively constant over the last 5 years. Stonewort species were last present in Horsey Mere in 2005, showing a similar decline to that of Hickling Broad.

Martham North and South

For many years, the Martham Broads have been characterised by sustained clear water conditions, resulting from the plentiful supply of good quality freshwater draining from the northeast of the broads. These conditions continue and are reflected in the high diversity of the plant communities found in the most recent surveys.

3.1.3 Martham North

	2007	2008	2009
Baltic stonewort	*	*	*
Blunt-leaved pondweed	*		
Bristly stonewort	*	*	*
Common stonewort	*		*
Convergent stonewort	*	*	
Fan-leaved water crowfoot			
Fennel-leaved pondweed	*		
Filamentous algae	*		*
Fragile/Convergent stonewort	*		
Holly-leaved naiad	*	*	*
Horned pondweed	*	*	*
Intermediate stonewort	*		*
Ivy-leaved duckweed	*		
Lesser pondweed		*	
Mare's tail		*	*
Nuttall's waterweed	*		*
Perfoliate pondweed	*	*	
Pointed stonewort		*	*
Rough stonewort	*		
Spiked water milfoil	*	*	*
Starwort sp.			*
Starry stonewort	*	*	*
Yellow water lily		*	

Recent surveys have recorded a dominance of stonewort compared to vascular plants, comprised primarily of Bristly stonewort and Starry stonewort, the latter species classified as a vulnerable Red Data Book species. Fewer pondweeds were recorded in 2009, however species diversity remains very high. There continues to be plant volume (or biomass) variations that are poorly detected by the rake method, especially in broads with generally high macrophyte abundance.

3.1.4 Martham South

	2007	2008	2009
Baltic stonewort	*	*	*
Bristly stonewort	*	*	*
Canadian waterweed		*	*
Common water moss		*	
Convergent stonewort	*	*	
Crowfoot sp.			*
<i>Enteromorpha</i>		*	*
Fan-leaved water crowfoot	*	*	*
Fennel-leaved Pondweed	*	*	*
Filamentous algae	*	*	*
Hedgehog Stonewort	*	*	*
Holly-leaved naiad	*	*	*
Horned pondweed	*	*	*
Intermediate stonewort	*	*	*
Lesser pondweed	*	*	
Mare's tail	*	*	*
Perfoliate pondweed		*	*
Rigid hornwort		*	*
Rough stonewort	*	*	*
Spiked water milfoil	*	*	*
Starry stonewort	*	*	*
Starwort sp.	*	*	*
Whorled water milfoil		*	
Willow-leaved Pondweed		*	
Yellow water lily			*

Surveys show that bristly stonewort, holly-leaved naiad, starry stonewort and mare's tail remain abundant across the broad. Areas of clear sediment within *Chara* beds were seen in 2009. These phenomenon have been noted in previous years and at other sites. The cause is not yet understood. To accurately record the location and extent of the bare patches within the *Chara* beds Martham North and South will be surveyed with the hydroacoustic equipment.

3.1.5 Heigham Sound

	2007	2008	2009
Curled pondweed		*	*
Holly-leaved naiad		*	
Mare's tail	*	*	*
Rigid hornwort		*	*
Spiked water milfoil	*	*	*
Whorled water milfoil			*
Yellow water lily	*		

There has been a decrease in the number of macrophyte species from 10 in 2005 to five in both 2008 and 2009. The BAP species holly-leaved naiad was not present in 2009 however those plants present were growing to the surface in some areas.

Muck Fleet Valley - Trinity Broads

The Trinity Broads are a series of five lakes draining into the River Bure via the Muck Fleet. Ormesby Broad has the most abundant and diverse population of aquatic plants with stoneworts being present, the lake having benefited from the recent restoration programme. During the last three years of surveying, the plant communities in the Trinity Broads have either remained stable or have increased in both richness and abundance.

3.1.6 Ormesby

	2007	2008	2009
Canadian waterweed	*	*	*
Common duckweed		*	*
Common stonewort		*	*
Common water moss			*
Curled pondweed	*		*
Delicate stonewort			*
<i>Enteromorpha</i>	*	*	*
Fennel-leaved pondweed	*	*	*
Filamentous algae	*	*	*
Flat-stalked pondweed	*	*	*
Fragile/Convergent stonewort	*	*	*
Holly-leaved naiad		*	*
Horned pondweed	*	*	*
Ivy-leaved duckweed	*	*	*
Least duckweed	*		*
Lesser pondweed	*	*	*
Nuttall's waterweed	*	*	*
Opposite stonewort			*
Rigid hornwort	*	*	*
Water net	*	*	*
Yellow water lily	*	*	*

From 1995 to the present there has been a continued increase in abundance of fine-leaved pondweeds e.g. fennel-leaved pondweed and flat-stalked pondweed, as well as other fine-leaved species such as rigid hornwort. This period of improved macrophyte growth coincided with the biomanipulation work, which started in 1995 and has been ongoing.

Since 2006 the macrophyte community in Ormesby has been very stable. The east arm of Ormesby has typically been less diverse compared to the rest of the broad. It is expected that following the completion of the mud pumping of the east arm of Ormesby Broad that the excellent plant community found in the rest of the broad will extend into the east arm.

3.1.7 Rollesby

	2007	2008	2009
Canadian waterweed	*	*	*
Common stonewort		*	*
Delicate stonewort			*
<i>Enteromorpha</i>	*	*	
Fan-leaved water crowfoot		*	*
Fennel-leaved pondweed		*	*
Filamentous algae	*	*	*
Flat-stalked pondweed	*	*	*
Fragile/Convergent stonewort	*	*	*
Horned pondweed	*	*	*
Ivy-leaved duckweed	*	*	*
Lesser pondweed	*	*	*
Nuttall's waterweed	*	*	*
Rigid hornwort	*	*	*
Starwort sp.	*		
Water net	*	*	
Yellow water lily	*	*	*

Although there was a decline in macrophyte abundance between 1997 and 2006, the last three years of surveys have shown a reversal in this trend. Species richness remains very good with minimal presence of filamentous algae in 2009. The abundance of macrophytes was very high in 2009, with pondweed growing to the surface over most of the broad.

3.1.8 Ormesby Little

	2007	2008	2009
Canadian waterweed	*	*	*
Common stonewort	*		*
Curled pondweed	*	*	
<i>Enteromorpha</i>	*	*	*
Fennel-leaved pondweed	*	*	*
Filamentous algae	*	*	*
Flat-stalked pondweed	*	*	
Fragile/Convergent stonewort	*	*	*
Horned pondweed	*	*	
Ivy-leaved duckweed	*	*	*
Least duckweed	*		
Lesser pondweed	*	*	
Nuttall's waterweed	*	*	*
Rigid hornwort	*	*	*
Water net	*	*	
White water lily		*	
Yellow water lily	*	*	*

Similar to Rollesby, Ormesby Little has also shown an increase in species diversity since 2006, with the addition of a number pondweed species. In 2009 surveying conditions were not ideal and the southern transects were not surveyed. Thus the apparent loss of the curled and lesser pondweeds may have been a result of sampling rather than actual loss of the species from the broad.

3.1.9 Filby

	2006	2007
Canadian waterweed		*
<i>Enteromorpha</i>	*	*
Filamentous algae		*
Flat-stalked pondweed		*
Fragile/Convergent stonewort	*	*
Horned pondweed		*
Ivy-leaved duckweed		*
Lesser pondweed		*
Water net		*

Filby has generally been species poor compared to the rest of the Trinity system. However a marked change in richness was observed in 2007, with seven additional species found. No surveys were conducted in 2008 and 2009 but the broad will be surveyed in 2010.

3.1.10 Lily

	2006	2007	2009
Canadian waterweed	*	*	*
Common duckweed	*		
Curled pondweed		*	*
<i>Enteromorpha</i>	*	*	*
Fennel-leaved pondweed	*	*	
Filamentous algae	*	*	*
Flat stalked pondweed			*
Holy leaved naiad			*
Horned pondweed	*	*	
Ivy-leaved duckweed	*	*	*
Least duckweed		*	
Lesser pondweed	*	*	*
Nuttall's waterweed			*
Rigid hornwort	*	*	*
White water lily		*	*
Yellow water lily	*	*	*

Species richness remains high, but individual species abundances at the time of sampling was relatively low, with the exception of Canadian waterweed and filamentous algae, which continue to be widespread.

3.1.11 Little Broad

	2005	2008	2009
Greater bladderwort		*	*
Bristly stonewort		*	*
Common stonewort			*
<i>Enteromorpha</i>		*	
Filamentous algae	*	*	*
Horned pondweed	*	*	

This broad was sampled for the first time in 2005. During winter of 2007/08 restorative suction dredging was carried out to deepen the lake and remove the upper layers of nutrient

rich sediment. Approximately nine months later, the broad was surveyed for the second time and found to have clear water and quantities of stonewort and pondweed. The 2009 survey showed continued clear water and the continued presence of the stoneworts.

Ant Valley

In the Ant Valley, Alderfen, Crome's and Barton have been regularly surveyed. These water bodies have been subject to extensive restoration effort over the last 25 years and all have improved water quality and macrophyte populations as a result. Alderfen and Crome's have good populations of rigid hornwort. Aquatic plants are numerous within the clear water areas of Barton Broad, which have been created through zooplanktivorous fish removal behind temporary barriers. The success of these restoration areas has now reached out into the main broad itself, with several macrophyte species being commonly recorded (primarily rigid hornwort and Nuttall's waterweed, particularly along the western side in the shallower margins and along the Neatishead Arm).

Three infrequently surveyed SSSI open water sites, Irstead Holmes, Reedham Water and Catfield Broad were surveyed in 2004 and again in 2009.

3.1.12 Barton

	2007	2008	2009
Arrowhead		*	
Bulrush	*	*	
Canadian waterweed	*		
Common duckweed	*	*	
Curled pondweed	*	*	
Delicate stonwort	*		
Fan-leaved water crowfoot	*		
Fennel-leaved pondweed	*	*	*
Filamentous algae		*	*
Greater duckweed	*	*	
Hair like pondweed	*		
Horned pondweed	*		
Lesser pondweed	*		
Nuttall's waterweed	*	*	*
Rigid hornwort	*	*	*
Stonewort species	*		
Unbranched bur-reed	*	*	
Water soldier			*
White water lily			*
Yellow water lily	*	*	*

Barton Broad historically had a very low abundance and occasional complete absence of recorded aquatic macrophytes. Between 2003 and 2008 more than 10 macrophyte species have been recorded each summer, with steadily increasing abundance and richness. However, in 2009 abundances were relatively low and only seven species were recorded, suggesting the improvement seen from 2004 to 2008 is not a stable state. Where there were plants in significant amounts they tended to be near the fish exclusion barriers and off the navigation channels. Water soldier was recorded in Barton Broad in 2009 for the first time since the annual plant survey started in 1983. It is thought to have colonised from Barton Staithe where it has been present for 3 to 4 years.

3.1.13 Alderfen

	2007	2008	2009
<i>Enteromorpha</i>			*
Filamentous algae		*	*
Holly-leaved naiad	*	*	*
Rigid hornwort	*	*	*

The abundance of macrophytes in Alderfen appears to be cyclical with years of near absence of plants followed by several years where rigid hornwort, macro-algae and sometimes duckweeds occur, such as was found in 2009. Holly-leaved naiad first recorded 2006 and has remained present albeit in relatively small patches.

3.1.14 Crome's

	2007	2008	2009
Canadian waterweed	*	*	*
Common duckweed	*		*
Delicate stonewort		*	*
<i>Enteromorpha</i>	*		*
Filamentous algae	*	*	*
Fragile/Convergent stonewort	*	*	*
Ivy-leaved duckweed			*
Nuttall's waterweed		*	*
Rigid hornwort	*	*	*
Water-soldier	*		
White water lily	*	*	*

Crome's Broad is divided into north and south basins by a reed strip on top of an old peat baulk. Both the basins have been dredged/mud pumped in the past. The positive effects of increased water depth from the mud pumping continues in the South basin, reflected in good species richness. The North basin continues to be less diverse compared to the South basin. The aquatic plant richness in the whole of Crome's Broad has generally been low, but since 2006 macrophyte diversity has remained stable. In 2009 no water soldier was collected but this could be an effect of sampling methods rather than the loss of the species from the broads.

3.1.15 Catfield Broad

	2004	2009
Blunt leaved pondweed	*	
Canadian waterweed	*	*
Common duckweed	*	*
Filamentous algae	*	*
Fragile stonewort		*
Frogbit	*	
Ivy leaved duckweed	*	*

Least duckweed	*	
Mare's tail		*
Rigid hornwort	*	*
Whorled water milfoil	*	

The overwhelmingly dominant plant in main part of Catfield broad was filamentous algae with rigid hornwort dominating the eastern limb. The sample of fragile stonewort was a single fragment, without roots floating near the water surface. This casts an element of doubt over the idea that it is actually growing in the broad. Rather it is suspected that the fragment was trans-located from another nearby water body, possible through bird movements. The plant community in the broad, the water quality and lack of water clarity do not suggest a waterbody suitable for stoneworts. Blunt leaved pondweed, present in 2004 was not found in the main broad in 2009 but was seen in the dyke leading into broad by the boat house.

3.1.16 Irstead

	2004	2009
Bladderwort	*	*
<i>Enteromorpha</i>	*	*
Filamentous algae	*	*
Frogbit	*	*
Rigid hornwort	*	*
Spiked water milfoil		*

Irstead is a very shallow broad with clear water and very fine soft sediment. Since the last survey five years ago it has gained another species, spiked water milfoil. All plants were found at low abundances with the most common being the bladderwort.

3.1.17 Reedham

	2004	2009
<i>Enteromorpha</i>	*	*
Filamentous algae	*	*
Lesser pondweed		*
Rigid hornwort	*	*

Unlike Irstead this shallow water body had very bad water clarity and those plants found were not abundant or of good quality. Heavy use by water birds probably explains the poor water quality and the minimal amount of plants. The single sample of lesser pondweed almost certainly was introduced by birds and it is uncertain if it will continue to colonise the water body.

Bure Valley

The hydrological connection to the River and the position of the Bure Valley broads within the catchment affects both ecological condition and restoration potential of these waterbodies. In recent years Upton and Cockshoot Broads, both isolated from the river, have had the highest populations of aquatic plants present in the Bure Broads. Upton Broad is a stronghold for the rare holly-leaved naiad. Those broads connected to the river, such as Nortons and Ranworth, have minimal plant diversity.

3.1.18 Cockshoot

	2007	2008	2009
Canadian waterweed	*	*	*
Common duckweed	*		
Common stonewort	*		*
<i>Enteromorpha</i>	*	*	*
Filamentous algae	*	*	*
Fragile/Convergent stonewort	*		
Frogbit	*		
Holly-leaved naiad	*	*	*
Horned pondweed	*		*
Ivy-leaved duckweed			
Least duckweed	*		
Lesser pondweed			*
Rigid hornwort	*	*	*
Small pondweed	*		
Water net		*	
White water lily	*		*
Yellow water lily	*		

In 2000 and 2003 ten species of submerged rooted aquatic plants (pondweed and stonewort species) were planted into weighted coir pallets. However, the plantings were unsuccessful due to bird grazing or being smothered by filamentous algae. Subsequently 11 species were found in 2005 and 2006, with 2006 being a good year for the holly-leaved naiad. Species richness continued to increase into 2007, but declined to five species in 2008. Although species numbers in 2009 were not at the same level as found in 2006 there was a sufficient increase to record the plant richness as high. Holly-leaved naiad remains the dominant species in Cockshoot, with very high abundance covering virtually the entire waterbody in 2009. The large volume of filamentous algae in Cockshoot dyke prevented boat access down the dyke in 2009.

3.1.19 Hoveton Great

	2007	2008	2009
Curled pondweed	*	*	
<i>Enteromorpha</i>	*		
Fennel-leaved pondweed	*	*	*
Filamentous algae	*	*	*
Holy leaved naiad			*
Horned pondweed	*		

Rigid hornwort	*	*	*
Starwort		*	
White water lily	*		*
Yellow water lily	*	*	*

Hoveton Great Broad generally has low macrophyte abundance with remnant patches of water lilies in sheltered bays. The species richness of this broad continues to be stable, at a low level, with only slight changes in species composition over the years. Disused fish barriers provide increased shelter from the strong wind-induced waves that can disturb the bottom sediments in this broad.

3.1.20 Mautby Decoy

	2007	2008	2009
Common duckweed		*	
<i>Enteromorpha</i>	*	*	
Filamentous algae	*	*	*
Fragile/Convergent stonewort	*	*	*
Holly-leaved naiad		*	
Horned pondweed	*		
Ivy-leaved duckweed		*	*
Least duckweed	*	*	*
Lesser pondweed		*	
Rigid hornwort	*	*	*
Small pondweed	*		

Mautby Decoy was surveyed in 2007 and 2008 prior to and in preparation for suction dredging, which was carried out during the winter of 2008/09. Although the eastern end of the broad was of adequate depth, the western end was no more than 20 cm deep in parts. As a result, the distribution of macrophytes was largely confined to the deeper eastern end. The 2009 survey showed a gradual colonisation of plants at the western end. Three pondweeds found in 2008 were not recorded in 2009. This is probably a temporary loss due to the disturbance of the mud pumping.

3.1.21 Ranworth

	2007	2008	2009
Curled pondweed			*
Fennel-leaved pondweed	*	*	*
Filamentous algae			*
Nuttall's waterweed	*	*	
Rigid hornwort	*	*	*

The plants in Ranworth Broad have nearly always been limited to a few sickly-looking individuals on some of the transects. There appears to be little change in plant community. However, those plants present in 2009 tended to cover a wider proportion of the broad area, unlike the patchy presence found previously.

3.1.22 Upton Great

	2007	2008	2009
Convergent stonewort	*	*	*

Filamentous algae		*	
Holly-leaved naiad	*	*	*
Horned pondweed			
Opposite stonewort		*	*
Yellow water lily	*		*

Upton Broad has been a stable stronghold for holly-leaved naiad, where it occupies much of the water column and area of the lake. The stonewort population fluctuates throughout the survey period, but is generally restricted to the shallower, marginal areas rather than the deeper, central basin where holly-leaved naiad dominates.

3.1.23 Upton Little

	2006	2007	2009
Common stonewort			*
Fennel-leaved pondweed		*	
Filamentous algae		*	*
Holly-leaved naiad	*	*	*
Opposite stonewort	*		*

Holly-leaved naiad has been the most abundant species over the three years of surveys, although with less vigorous growth than in the neighbouring Upton Great. Water depth, particularly on the western side of the broad is very shallow, with bare mud exposed during periods of low rainfall. Macrophytes are limited to the deeper areas, which are no more than 70 cm depth at any point.

3.1.24 Wroxham

	2007	2008	2009
Fennel-leaved pondweed	*	*	*
Filamentous algae		*	*
Nuttall's waterweed		*	*
Pointed stonewort		*	
Rigid hornwort		*	
Yellow water lily		*	*

Despite improvement in water quality (both lower nutrient and improved water clarity) since the early nineties there has been no development of the aquatic plant community. Wroxham Broad showed no indication of continuing to improve or maintain the surprising increase in species numbers found in the 2008 survey. Species numbers and abundance dropped in 2009.

3.1.25 Decoy

	2007	2008	2009
Canadian waterweed	*		
Filamentous algae	*	*	
Holly-leaved naiad	*		*
Rigid hornwort	*	*	*
Yellow water lily	*	*	*

Prior to 2004 Decoy broad has only been sampled twice before, in 1986 and 1998, and has always had extremely low submerged plant abundance. There are some persistent patches of yellow water lily and rigid hornwort; however the species communities appear unstable. A single fragment of holly-leaved naiad was recorded in 2009.

3.1.26 Nortons

	2009
Filamentous algae	*
Starwort sp.	*

Nortons was suction dredged late summer 2008. Water depth was significantly increased with the encroaching alder carr pushed back. The survey in 2009 showed minimal plant colonisation a year later. It is possible that Nortons will follow the same re-colonisation pattern as Belagh and plant communities will be return over a number of years.

Yare Valley

Waterbodies surveyed in the Yare Valley are generally of good condition in terms of their submerged macrophyte populations. Despite high nutrient concentrations, submerged plants are frequent in Rockland and Wheatfen Broads. Whitlingham Great and Little Broads originated from gravel extraction and despite their 'youth' have abundant submerged plant growth and a diverse species assemblage.

3.1.27 Whitlingham Great

	2007	2008	2009
Amphibious bistort	*	*	*
Canadian waterweed		*	*
Common stonewort	*	*	*
<i>Enteromorpha</i>			*
Fan-leaved water crowfoot		*	
Filamentous algae	*	*	*
Fragile stonewort	*	*	
Ivy-leaved duckweed	*		*
Lesser pondweed		*	
Nuttall's waterweed	*	*	*
Pointed stonewort		*	*
Smooth stonewort	*	*	
Water net			*

Species richness and abundance are high in the shallow margins. In 2006 there were localised areas where sediment-laden water was pumped into the broad from the gravel transport process. This apparently reduced plant growth, but this has now ceased operation.

The apparent loss of two stonewort species in Whitlingham Great in 2009 might be as a result of difficult weather conditions on the survey day resulting in less than optimal rake trawls in the area known to have significant stonewort beds. Canadian and Nuttall's waterweeds were the overwhelmingly dominant plants in 2009 being found in huge abundances across the broad.

3.1.28 Whitlingham Little

	2007	2008	2009
Amphibious bistort	*		
Canadian waterweed	*		
Common stonewort	*		*
Delicate stonewort	*		
<i>Enteromorpha</i>			*
Fan-leaved water crowfoot		*	
Fennel leaved pondweed			*
Filamentous algae	*	*	*
Fragile/Convergent stonewort		*	*
Horned pondweed	*		
Ivy-leaved duckweed	*	*	*
Lesser pondweed	*		
Nuttall's waterweed	*	*	
Rigid hornwort	*	*	*
Swamp Stonecrop	*		

Species richness rose in 2009 however the most dominant plants were filamentous algae and *Enteromorpha*.

3.1.29 Buckenham

	2007	2008	2009
Canadian waterweed			
Common duckweed		*	
Curled pondweed	*		*
<i>Enteromorpha</i>			*
Horned pondweed			*
Fennel-leaved pondweed			*
Filamentous algae	*	*	*
Fragile/Convergent stonewort	*	*	*
Fan leaved water crowfoot			*
Ivy-leaved duckweed	*	*	*
Nuttall's waterweed			*
Rigid hornwort	*	*	*
Whorled water milfoil	*		*
Yellow water lily			

Buckenham was surveyed for the first time in 2004. Species richness has declined steadily between 2004 and 2008. However, 2009 showed a significant increase in species richness with pondweeds, stonewort and crowfoot being recorded in relatively good abundances.

3.1.30 Hassingham Broad

	2007	2008	2009
Bristly stonewort	*	*	
Common duckweed		*	
Curled pondweed	*	*	
<i>Enteromorpha</i>			
Fennel-leaved pondweed			
Filamentous algae	*	*	*
Fragile stonewort			*
Fragile/Convergent stonewort	*	*	*
Ivy-leaved duckweed	*	*	*
Nuttall's waterweed	*		
Rigid hornwort	*	*	*

Hassingham Broad was surveyed for the first time in 2004. Water clarity continues to be generally good resulting in abundant stonewort populations. Species composition is possibly less stable than previously thought with the loss of two pondweed species and a stonewort for 2009.

Waveney Valley

There are six broads along the Waveney valley that lay within the Broads Authority executive area. These are Barnby, Spratt's Water, Woolner's Carr, Round Water, Flixton Decoy and Oulton Broad. Surveying and monitoring of these broads has been limited in the past, however restoration programmes are now being developed at some of these sites.

3.1.31 Barnby

	2006	2007	2009
Bristly stonewort			*
Delicate stonewort			*
Filamentous algae		*	*
Fragile stonewort			*
Fragile/convergent stonewort			*
Opposite stonewort			*
Rigid hornwort	*	*	*
Yellow water lily		*	*

Following mud pumping in winter 2006/07, the previously dominant Rigid Hornwort that was restricted to the deeper southern half of the Broad, had in the 2007 survey extended to all parts of the site. As has been observed previously at freshly mud pumped sites, filamentous algae was also frequent. However, the 2009 survey showed the clear deep water providing the conditions necessary for stoneworts to thrive in huge abundance pushing the species richness of the broad to eight species and significantly improving plant diversity.

3.2 Summary of the lakes surveys.

The number of broads sampled has increased from an average of 20 broads per year between 1983 and 2003, to over 30 per year from 2004 onwards, with previously un-surveyed broads now included.

Figure 1 shows the broads ranked according to their average species richness for 2006, 2007 & 2008. They were also categorised into low and high according to their species richness, following the baseline methodology used in the Rivers and Broads Strategy.

The division between high and low species number is based on whether a broad has an average of eight or more species over the period.

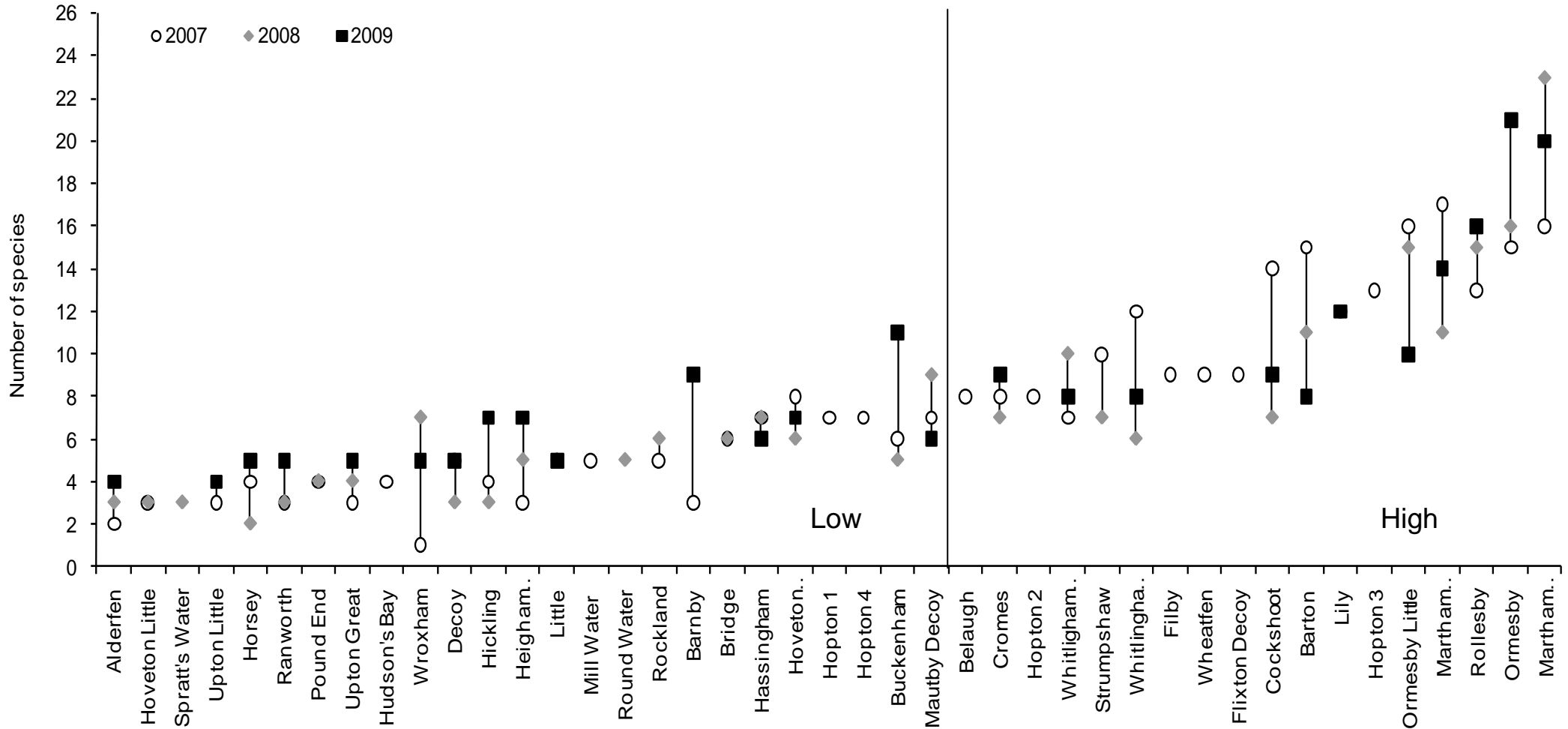
However within the same time frame Hickling and Cockshoot Broad have suffered a significant loss of richness with Hickling being reclassified from 'high' in 2006 to 'low' richness in 2008. Declines in species recorded at Cockshoot Broad in the last two years have been due to the vigorous growth of holly-leaved naiad, which has become dominant. Buckenham Broad has also suffered an annual decline in the number of species recorded.

The broads with a low number of plant species remain the most numerous group. These broads are sometimes dominated by one or two vigorous species such as rigid hornwort or Nuttall's waterweed. Alderfen, Hickling, Upton Great and Upton Little are generally species poor, with only two to three species recorded in recent years. Broads with low species number can have periods of relative stability in the water plant community and clear water, such as at Upton Great, which is dominated by holly-leaved naiad. More often than not, the clear water periods are linked to the total plant abundance rather than the actual number of species.

Figure 1. Species richness by broad and year.

The broads are ranked based on their average species richness for 2007, 2008 & 2009 into low and high categories.

The division of high and low species number is based on whether a broad has an average eight or more species over the period.



4 RIVER SURVEY MACROPHYTE RESULTS

Background

River macrophytes were previously surveyed in 1992, with the following stretches sampled; Dilham Canal (Honing Lock to Tonnage Bridge); River Waveney (Outney Common to Dunburgh Hill); River Wensum in Norwich (New Mills to Foundry Bridge); and the West Somerton channel (village staithe to first bend) (Kennison 1992). River surveys have again been repeated annually from 2005 to 2009 with slightly different stretches sampled to the 1992 surveys (Table 3). A seventh survey stretch on the Waxham New Cut was included in the 2009 river surveys.

A rake-trawl method was used, similar to that used in the broads and abundances of individual species were recorded. For the individual river plant lists all the years that have been surveyed are listed.

Table 3 River stretches and dates sampled

River	Start point	End point	2005	2006	2007	2008	2009
Ant	Honing Lock	Wayford Bridge	13-Sept	31-Aug	8-Sep	-	8-Sep
Bure	Horstead canal	Wroxham Bridge	-	6-Sept	7-Sep	28-Aug	13-Sept
Thurne	West Somerton staithe	Dungeon corner	9-Aug	7-Sept	6-Sep	4-Sep	6-Sept
Waxham Cut	Bridge Farm	Brograve Mill					6-Sept
Waveney	Geldeston Lock	Beccles New Bridge	14-Sept	-	12-Sep	5-Sep	28-Aug
Wensum	New Mills	Foundry Bridge	9-Aug	-	-	8-Sep	19-Sept
Yare	Carrow Bridge	Thorpe Rail Bridge	9-Oct	-	-	5-Sep	26-Sept

4.1.1 River Ant

	2005	2006	2007	2009
Amphibious bistort		*		
Arrowhead	*	*	*	*
Bladderwort		*		
Canadian waterweed	*	*	*	*
Common duckweed	*	*	*	*
<i>Enteromorpha</i>		*		*
Fan-leaved water crowfoot	*	*		*
Filamentous algae	*	*	*	
Flowering rush		*		
Frogbit	*	*	*	*
Ivy-leaved duckweed	*	*	*	*
Lesser pondweed	*			
Nuttall's waterweed	*	*	*	*
Rigid hornwort		*		
Starwort sp.	*	*	*	*
Unbranched bur-reed	*	*	*	*
Water-soldier	*	*	*	*
Yellow water lily	*	*	*	*

4.1.2 River Bure

	2006	2007	2008	2009
Arrowhead	*	*	*	*
Canadian waterweed			*	*
Common duckweed	*	*	*	*
Fan-leaved water crowfoot	*		*	
Filamentous algae			*	*
Flowering rush	*			
Ivy-leaved duckweed	*	*	*	*
Nuttall's waterweed	*	*	*	*
Perfoliate pondweed	*	*	*	
Pointed stonewort	*	*	*	
Starwort sp.	*	*	*	*
Unbranched bur-reed	*	*	*	*
White water lily	*			
Yellow water lily	*	*	*	

4.1.3 River Thurne

	2005	2006	2007	2008	2009
Arrowhead	*	*	*	*	*
Canadian waterweed	*	*	*	*	*
<i>Cladophora</i>		*			
Clustered stonewort	*				
Common stonewort	*	*		*	*
Common water moss	*	*	*	*	*
Curled pondweed	*	*		*	*
<i>Enteromorpha</i>			*		
Fan-leaved water crowfoot	*	*	*	*	*
Fennel-leaved pondweed	*	*	*	*	
Filamentous algae	*		*	*	*
Fragile stonewort				*	
Frogbit					*
Holly-leaved naiad	*	*	*	*	
Ivy-leaved duckweed	*	*	*	*	*
Mare's tail	*	*	*	*	*
Opposite stonewort	*				
Perfoliate pondweed	*	*	*	*	*
Rigid hornwort				*	
Spiked water milfoil	*	*	*	*	*
Starry stonewort	*	*	*	*	*
Starwort sp.	*	*	*	*	*
Unbranched bur-reed	*	*	*	*	*
White water lily	*	*	*	*	*
Whorled water milfoil	*		*	*	*
Willow-leaved pondweed	*	*	*	*	*
Yellow water lily	*	*	*	*	*

4.1.4 River Waveney

	2005	2007	2008	2009
Amphibious bistort		*	*	*
Arrowhead	*	*	*	*
Bulrush	*			
Common duckweed	*	*	*	*
Common water moss	*	*	*	
Filamentous algae			*	*
Frogbit		*		
Greater duckweed	*		*	*
Inflated duckweed			*	*
Nuttall's waterweed	*	*	*	*
Perfoliate pondweed			*	*
Pointed stonewort			*	*
Rigid hornwort	*	*	*	*
Smooth stonewort	*			
Spiked water milfoil			*	*
Starwort sp.			*	*
Unbranched bur-reed	*	*	*	*
Water Fern	*			
Whorled water milfoil	*	*	*	*
Yellow water lily	*	*	*	*

4.1.5 River Wensum

	2005	2008	2009
Arrowhead	*	*	*
Canadian waterweed	*		
Common duckweed	*	*	*
Common water moss	*	*	*
Fennel-leaved pondweed	*		*
Nuttall's waterweed		*	*
Perfoliate pondweed	*		*
Pointed stonewort			*
Spiked water milfoil			*
Starwort sp.	*		*
Unbranched bur-reed	*	*	*
Water fern	*		*
Yellow water lily	*	*	*

4.1.6 River Yare

	2005	2008	2009
Arrowhead	*	*	*
Common duckweed	*	*	*
Common water moss	*		*
Fennel-leaved pondweed	*		*
Nuttall's waterweed	*	*	*
Pointed stonewort		*	*

Starwort sp.	*	*	*
Unbranched bur-reed	*	*	*
Water fern			*
Yellow water lily	*	*	*

4.1.7 Waxham Cut

	2009
Baltic stonewort	*
Bristly stonewort	*
Fennel-leaved pondweed	*
Filamentous algae	*
Mare's tail	*
Perfoliate pondweed	*
Spiked water milfoil	*

4.2 River Survey results

Overall the diversity of water plants in the reaches surveyed are good. In some reaches there is an apparent lack of stability in the plant richness e.g. River Wensum. However, sampling conditions one year to the next varies with visibility being a problem on occasions, possibly leading to under recording.

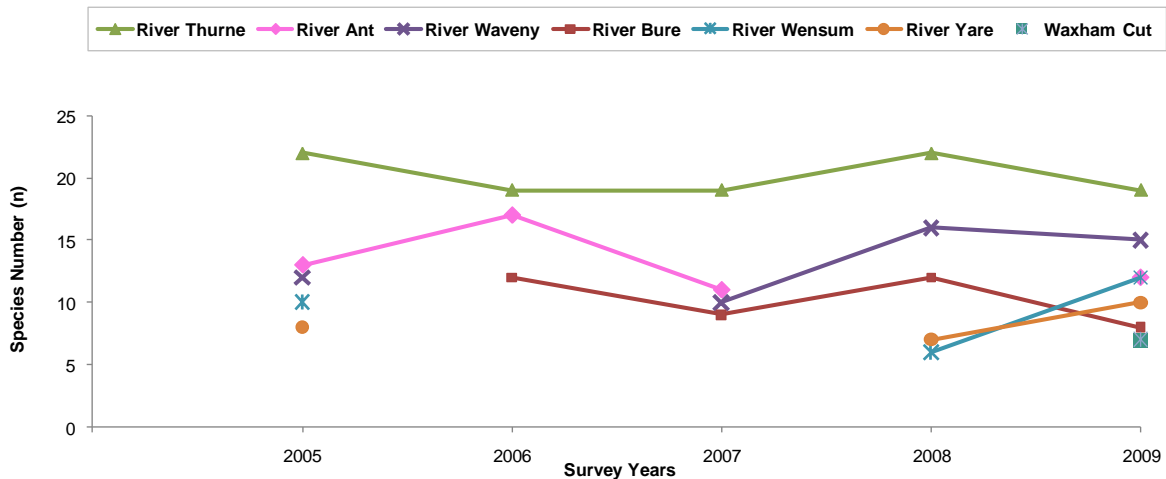


Figure 2. Species number for each year for all river reaches that have been surveyed.

The surveys have provided good characterisation of macrophyte communities in these stretches. The upper River Thurne channel is the most species rich river stretch sampled reflecting the good water quality. Although Waxham Cut had the fewest

number of species (n=7) those species present included two stoneworts and two pondweeds. The amount of plants found at each of the sites was, on the whole high, leading to diverse water plant communities in the river reaches.

5 GENERAL DISCUSSION

The Broad's annual macrophyte survey is the longest time series and most complete macrophyte data set for a series of shallow lakes in the UK. The methodology used is simple, low tech and easy to replicate both spatially and temporally. The results clearly show changes in plant species richness and abundance and it is a rapid way of assessing the ecological status of lakes. It is important that this data set is maintained through regular monitoring to inform the managers and scientists of ecological health and restoration progress or necessity thereof.

It is planned that the key broads remain surveyed on an annual basis, with a rolling programme of sampling other sites to gain maximum coverage. The survey outputs are used to:

- Inform the impact of restoration efforts
- Continue the long-term change data set
- Monitor macrophyte recovery
- Inform waterspace management plans
- Inform the Water Framework Directive target setting at a National and European level

The Rivers and Broad's Strategy (RaBS) database incorporates scores for the status of broads based on their macrophyte populations. These scores combine the abundance and richness of macrophytes. This scoring system classifies the broads into four groups (Table 6). Lakes with high macrophyte abundance (plant cover) and richness score 4 and those with low abundances and low richness score 1. The cut-off value between low and high abundance is based on whether the broad scores greater or less than 0.5 for the sum of all species mean % cover. The cut-off for high and low diversity is arbitrary, but the mid-point of 7.5 is usually greater than the average number of species per broad.

Table 6 Water plant classification for broads based on abundance and number of species

Score	Total transect score abundance	Number of species
1	High abundance	> 7.5 species
2	High abundance	< 7.5 species
3	Low abundance	> 7.5 species
4	Low abundance	< 7.5 species

In both abundance and species richness scores macro-algae (Filamentous Algae and *Enteromorpha*) are not included for the classification of broads in Table 7. Although indicative of a favourable underwater light climate, 100% cover of filamentous algae may not be seen as an ecologically desirable water plant population. Examples of lakes that had high scores for filamentous algae are Whitlingham Little and Nortons.

Table 7. Water plant classification for broads sampled in 2009 excluding all records of Filamentous algae and *Enteromorpha* algae.

<u>High Abundance</u>		<u>Low Abundance</u>	
High Richness	Low Richness	High Richness	Low Richness
1	2	3	4
Buckenham Broad Lily Martham Broad North Martham Broad South Ormesby Broad Ormesby Little Broad Rollesby Broad	Alderfen Barnby Catfield Cockshoot Cromes South Hassingham Broad Little Broad Mautby Decoy Whitlingham Great		Barton Cromes North Decoy Broad Heigham Sound Hickling Horsey Mere Hoveton Great Broad Iinstead Nortons Ranworth Broad Reedham Upton Grt Broad Upton Little Broad Wroxham Broad Whitlingham Little

As it can be seen

Trends of abundance in macrophyte populations over the last five years within the most regularly surveyed broads are summarised in Table 8.

Table 8 Trends in abundance of macrophytes over last 5 years for the most frequently surveyed broads. Abundances are listed as either stable (S) or Fluctuating (F).

Improving	With abundant macrophytes	Without abundant macrophytes	Declining
Belaugh Filby Ormesby Little	Alderfen (F) Cockshoot (S) Crome's (F) Martham North (S) Martham South (S) Rollesby (F) Ormesby (F) Upton Great (S)	Hoveton Great (S) Pound End (S) Ranworth (S) Rockland (S) Wroxham (S)	Barton Hickling Horsey

It is evident from this report that much more restoration work is required to improve the condition of the shallow lakes in Broadland to a more favourable ecological status. Where lake restoration efforts such as sediment removal and biomanipulation have been undertaken, lake ecological condition has steadily improved. There are also early signs that continued phosphorus reduction from sewage treatment works discharges has benefited macrophytes, especially in the more upstream broads, like Belaugh and Barton. This positive response demonstrates the measurable benefit of lake restoration and management.

Some of the permanent water bodies in Broadland have not been surveyed for macrophytes. It is hoped that future extension of the monitoring programme to all water bodies will enable assessment of the status of the open water in the Broads. This, in turn, will inform the integrated management of the total open water resource in Broadland.

6 ACKNOWLEDGEMENTS

The Broads Authority wishes to thank all those individuals and organisations who assisted during the 2009 survey season by providing their time, boats identification or permissions. In no particular order they were: Jane Harris, George Taylor, Mr. & Mrs. R. Starling, Jennifer Johnson, Tim Strudwick, Alasdair Fraser, John Blackburn, Derek Pye, Hoveton Hall estate, Mrs. Cooper, Rick Southwood, Elaine Green, Seaton Rowley, Jo Cullum, Mr. & Mrs J. Nickerson, the many Broads Authority staff and volunteers, Edward Knowles, Tobi Baker, Stephen Prowse, John Buxton, Michael Trafford, David Nobbs, David Griffin, How Hill Trust and staff from the Trinity Broads and Fritton Lake Partnership. The survey would not have been conducted without the assistance from these people and their respective organisations which include: Norfolk Wildlife Trust, Natural England, National Trust, RSPB, Fleggburgh & Billockby Poor's Trust, Horsey Estate, F. & A. George Ltd, Whitlingham Charitable Trust, Environment Agency, the Somerleyton Estate, the Ted Ellis Trust, Essex & Suffolk Water and Suffolk Wildlife Trust.

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8 APPENDICIES.

Appendix 1. Macrophyte groupings based on physical form.

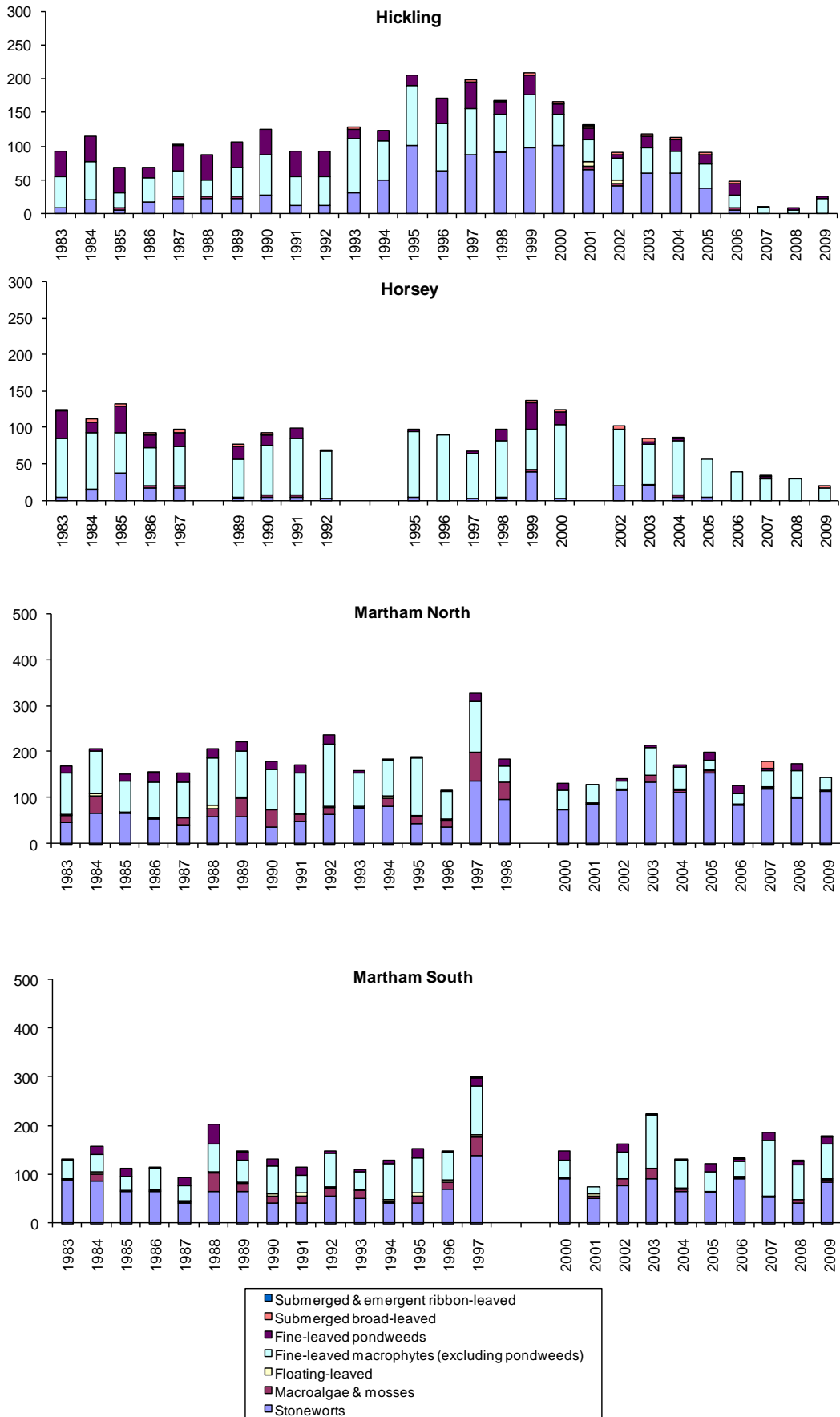
Appendix 2. Long term macrophyte abundance trends (1983 – 2008)

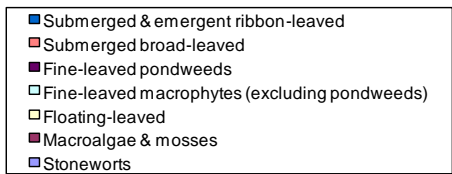
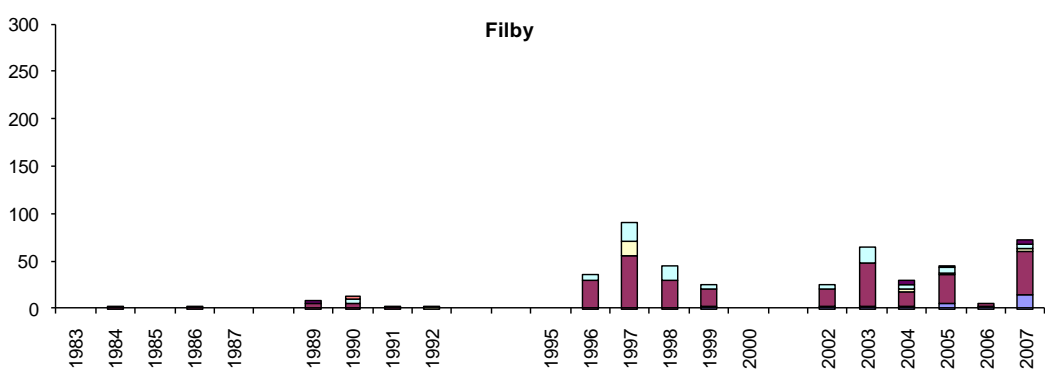
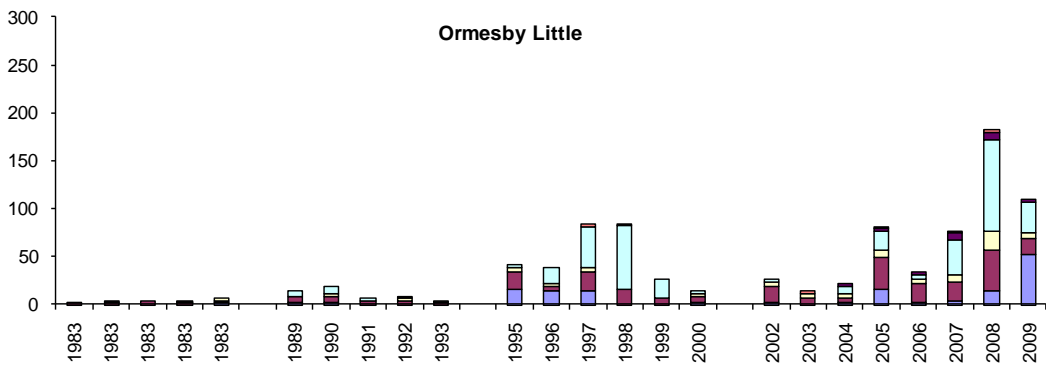
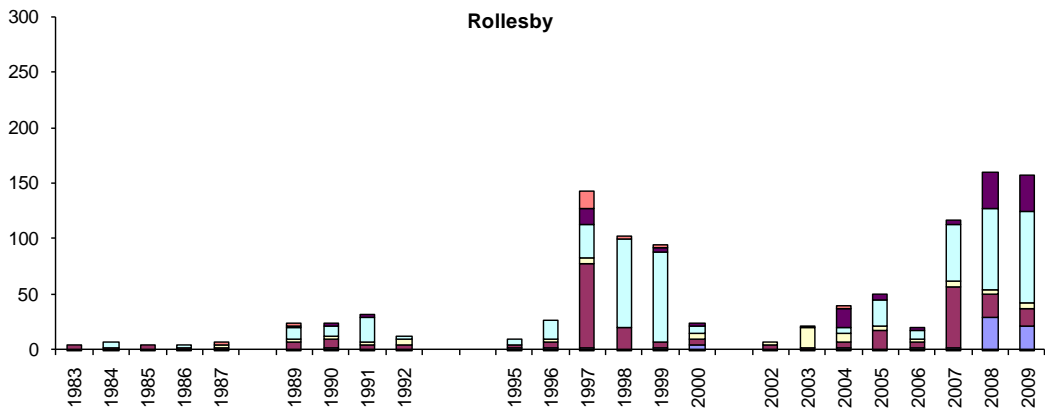
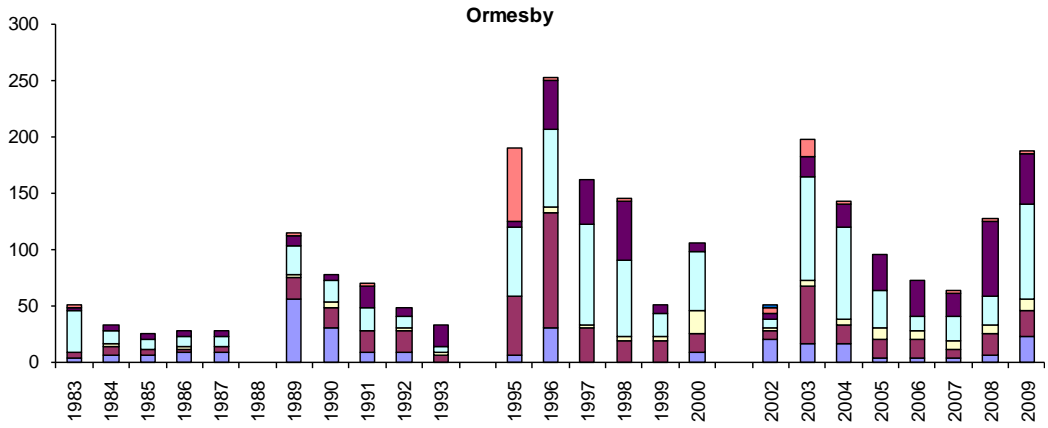
Appendix 3a & b. Plant common and Latin names.

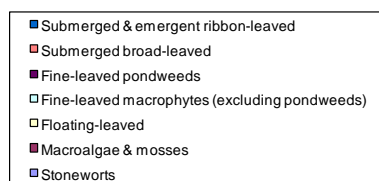
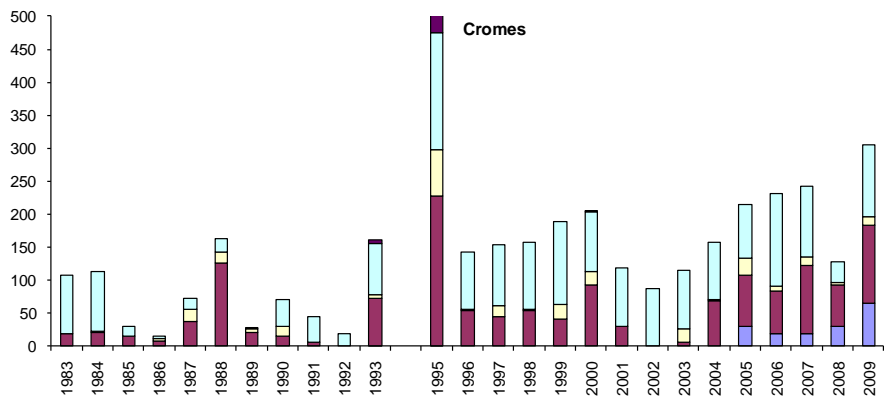
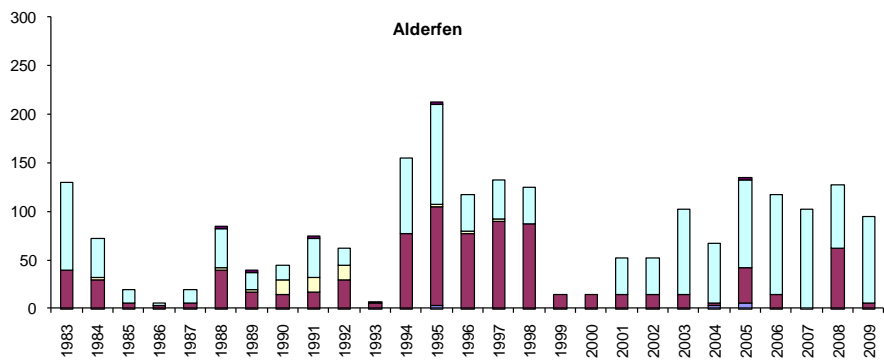
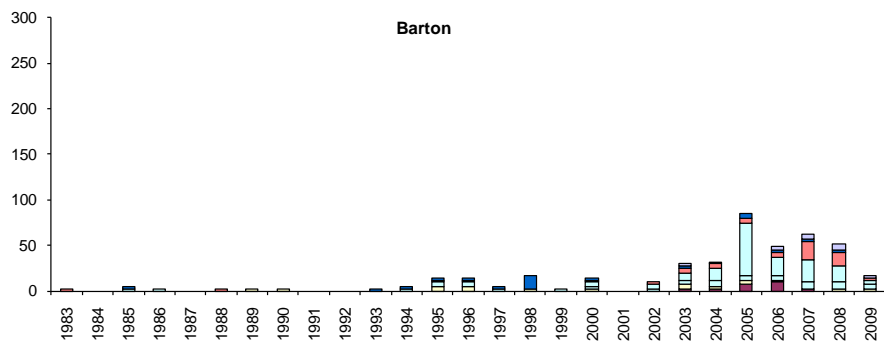
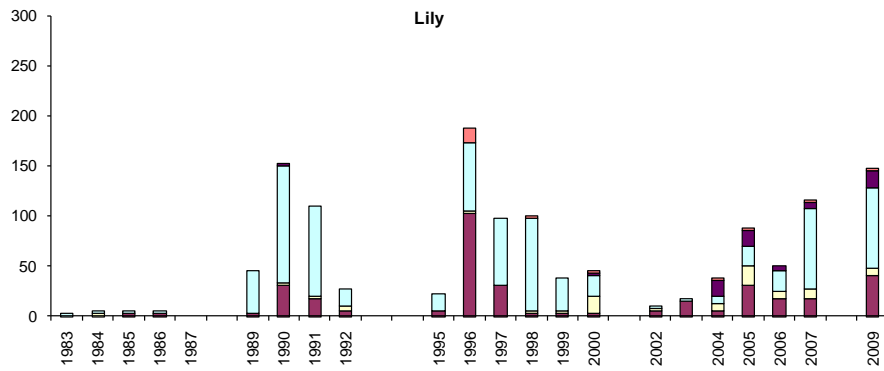
8.1 Appendix 1. Macrophyte groupings based on form

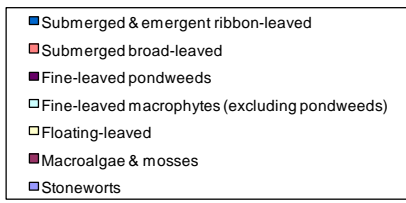
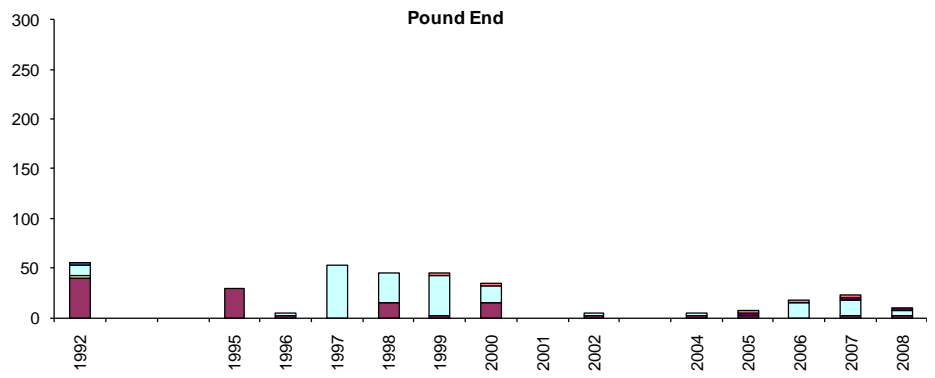
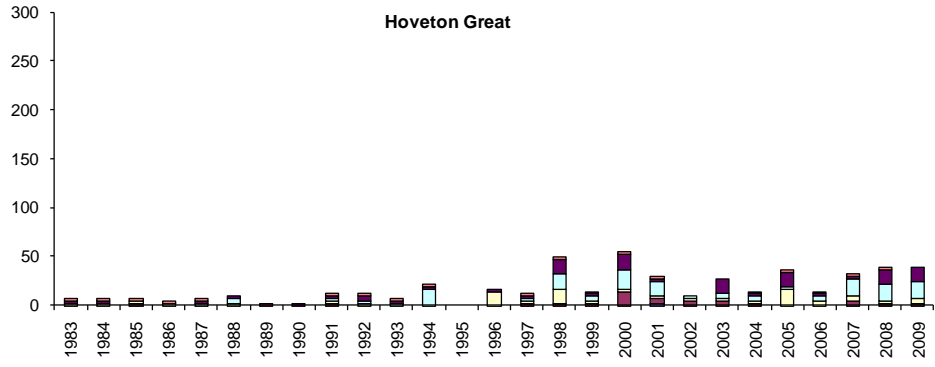
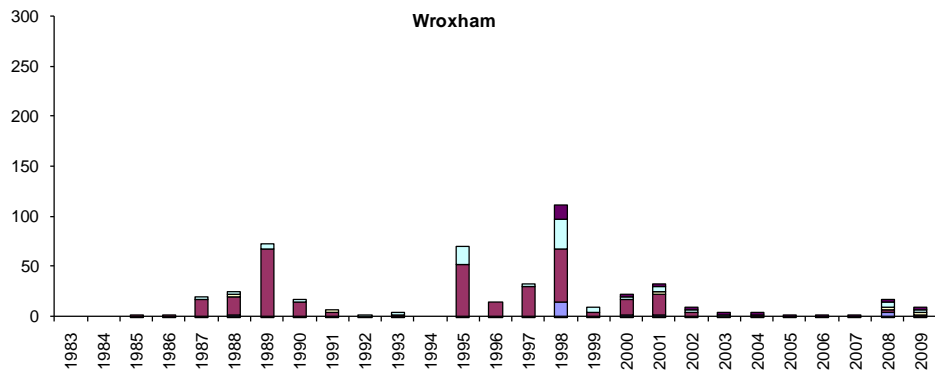
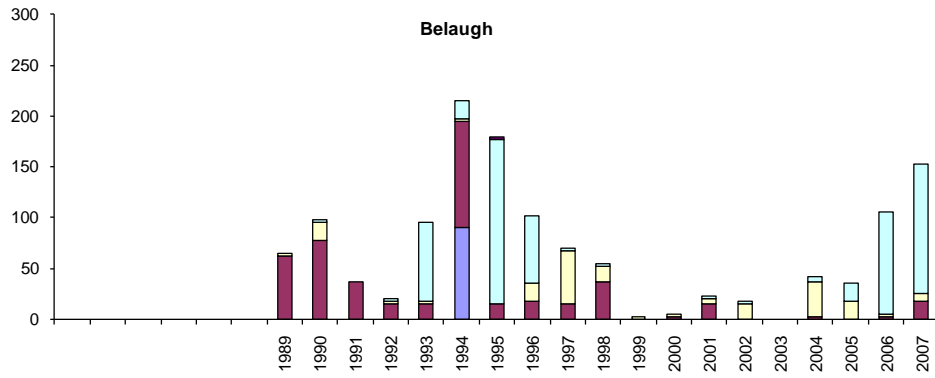
Submerged fine-leaved pondweeds	Free-floating or round floating-leaved	Submerged fine-leaved macrophytes (excluding pondweeds)	Stoneworts	Long submerged, emergent, floating ribbon leaves
Blunt-leaved pondweed Fennel-leaved pondweed Flat-stalked pondweed Hair like pondweed Horned pondweed Lesser pondweed Sharp-leaved pondweed Small pondweed	Amphibious bistort Common duckweed Frogbit Greater duckweed Inflated duckweed Ivy-leaved duckweed Least duckweed White water lily Yellow water lily	Greater bladderwort Canadian waterweed Crowfoot sp. Fan-leaved water crowfoot Floating club-rush Holly-leaved naiad Mare's tail Nuttall's waterweed Rigid hornwort Spiked water milfoil Starwort sp. Australian swamp stonecrop Whorled water milfoil	Baltic stonewort Bristly stonewort Common stonewort Convergent stonewort Delicate stonewort Fragile stonewort Hedgehog stonewort Intermediate stonewort Lesser bearded stonewort Opposite stonewort Pointed stonewort Rough stonewort Smooth stonewort Starry stonewort Translucent stonewort	Arrowhead Branched bur-reed Bulrush Common reed Greater reedmace Lesser reedmace Reed sweet grass Sweet flag Unbranched bur-reed Water cress Water-soldier
Submerged broad-leaved pondweeds	Macro-algae and mosses			
Broad –leaved pondweed Curled pondweed Perfoliate pondweed Shining Pondweed Willow-leaved pondweed	<i>Enteromorpha</i> Common water moss Filamentous algae Stringy moss Water net			

8.2 Appendix 2. Macrophyte abundance trends (1983 – 2009)









8.3 Appendix 3a. Latin to Common plant names.

Latin	Common	Latin	Common
<i>Acorus calamus</i>	Sweet flag	<i>Potamogeton pectinatus</i>	Fennel-leaved pondweed
<i>Alisma plantago-aquatica</i>	Common water-plantain	<i>Potamogeton perfoliatus</i>	Perfoliate pondweed
<i>Chara aculeolata</i>	Hedgehog stonewort	<i>Potamogeton pusillus</i>	Lesser pondweed
<i>Callitriche stagnalis</i>	Intermediate water-starwort	<i>Potamogeton x salicifolius</i>	Willow-leaved pondweed
<i>Callitriche sp.</i>	Starwort sp.	<i>Potamogeton sp.</i>	Pondweed sp.
<i>Ceratophyllum demersum</i>	Rigid hornwort	<i>Potamogeton trichoides</i>	Hair like pondweed
<i>Chara pedunculata</i>	Hedgehog stonewort	<i>Phragmites australis</i>	Common reed
<i>Chara aspera</i>	Rough stonewort	<i>Ranunculus circinatus</i>	Fan-leaved water crowfoot
<i>Chara baltica</i>	Baltic stonewort	<i>Ranunculus fluitans</i>	River water crowfoot
<i>Chara connivens</i>	Convergent stonewort	<i>Ranunculus sp.</i>	Crowfoot sp.
<i>Chara contraria</i>	Opposite stonewort	<i>Rorippa nasturtium-aquaticum</i>	Water cress
<i>Chara curta</i>	Lesser bearded stonewort	<i>Sagittaria sagittifolia</i>	Arrowhead
<i>Chara globularis/connivens</i>	Fragile/convergent stonewort	<i>Schoenoplectus lacustris</i>	Bulrush
<i>Chara globularis</i>	Fragile stonewort	<i>Sparganium emersum</i>	Unbranched bur-reed
<i>Chara hispida</i>	Bristly stonewort	<i>Sparganium erectum</i>	Branched bur-reed
<i>Chara intermedia</i>	Intermediate stonewort	<i>Spirodela polyrhiza</i>	Greater duckweed
<i>Chara sp.</i>	Stonewort (<i>Chara</i>) species	<i>Stratiotes aloides</i>	Water-soldier
<i>Chara virgata</i>	Delicate stonewort	<i>Typha angustifolia</i>	Lesser reedmace
<i>Chara vulgaris</i>	Common stonewort	<i>Typha latifolia</i>	Greater reedmace
<i>Crassula helmsii</i>	Swamp stonecrop	<i>Utricularia vulgaris</i>	Bladderwort
<i>Elodea canadensis</i>	Canadian waterweed	<i>Veronica catenata</i>	Pink water speedwell
<i>Eleogiton fluitans</i>	Floating club-rush	<i>Zanichellia palustris</i>	Horned pondweed
<i>Elodea nuttalli</i>	Nuttall's waterweed		
<i>Enteromorpha</i>	<i>Enteromorpha</i>		
<i>Filamentous algae</i>	Filamentous algae		
<i>Fontinalis antipyretica</i>	Common water moss		
<i>Glyceria maxima</i>	Reed sweet grass		
<i>Hippuris vulgaris</i>	Mare's tail		
<i>Hydrocharis morsus-ranae</i>	Frogbit		
<i>Hydrodictyon</i>	Water net		
<i>Lemna gibba</i>	Inflated duckweed		
<i>Lemna minor</i>	Common duckweed		
<i>Lemna minuta</i>	Least duckweed		
<i>Lemna trisulca</i>	Ivy-leaved duckweed		
<i>Leptodictyum riparium</i>	Stringy moss		
<i>Myriophyllum spicatum</i>	Spiked water milfoil		
<i>Myriophyllum verticillatum</i>	Whorled water milfoil		
<i>Najas marina</i>	Holly-leaved naiad		
<i>Nitella flexilis</i>	Smooth stonewort		
<i>Nitella mucronata</i>	Pointed stonewort		
<i>Nitellopsis obtusa</i>	Starry stonewort		
<i>Nitella translucens</i>	Translucent stonewort		
<i>Nitella sp.</i>	Stonewort (<i>Nitella</i>) species		
<i>Nuphar lutea</i>	Yellow water lily		
<i>Nymphaea alba</i>	White water lily		
<i>Persicaria amphibia</i>	Amphibious bistort		
<i>Potamogeton acutifolius</i>	Sharp-leaved pondweed		
<i>Potamogeton berchtoldii</i>	Small pondweed		
<i>Potamogeton crispus</i>	Curled pondweed		
<i>Potamogeton friesii</i>	Flat-stalked pondweed		
<i>Potamogeton lucens</i>	Shining pondweed		
<i>Potamogeton natans</i>	Broad-leaved pondweed		
<i>Potamogeton obtusifolius</i>	Blunt-leaved pondweed		

8.4 Appendix 3b. Common to Latin plant names.

Common	Latin		
Amphibious bistort	<i>Persicaria amphibia</i>	Rough stonewort	<i>Chara aspera</i>
Arrowhead	<i>Sagittaria sagittifolia</i>	Sharp-leaved pondweed	<i>Potamogeton acutifolius</i>
Baltic stonewort	<i>Chara baltica</i>	Shining pondweed	<i>Potamogeton lucens</i>
Bladderwort	<i>Utricularia vulgaris</i>	Small pondweed	<i>Potamogeton berchtoldii</i>
Blunt-leaved pondweed	<i>Potamogeton obtusifolius</i>	Smooth stonewort	<i>Nitella flexilis</i>
Branched bur-reed	<i>Sparganium erectum</i>	Spiked water milfoil	<i>Myriophyllum spicatum</i>
Bristly stonewort	<i>Chara hispida</i>	Starry stonewort	<i>Nitellopsis obtusa</i>
Broad –leaved pondweed	<i>Potamogeton natans</i>	Starwort sp.	<i>Callitriche sp.</i>
Bulrush	<i>Schoenoplectus lacustris</i>	Stonewort (<i>Chara</i>) species	<i>Chara sp.</i>
Canadian waterweed	<i>Elodea canadensis</i>	Stonewort (<i>Nitella</i>) species	<i>Nitella sp.</i>
Common duckweed	<i>Lemna minor</i>	Stringy moss	<i>Leptodictyum riparium</i>
Common reed	<i>Phragmites australis</i>	Swamp stonecrop	<i>Crassula helmsii</i>
Common stonewort	<i>Chara vulgaris</i>	Sweet flag	<i>Acorus calamus</i>
Common water moss	<i>Fontinalis antipyretica</i>	Translucent stonewort	<i>Nitella translucens</i>
Common water-plantain	<i>Alisma plantago-aquatica</i>	Unbranched bur-reed	<i>Sparganium emersum</i>
Convergent stonewort	<i>Chara connivens</i>	Water cress	<i>Rorippa nasturtium-aquaticum</i>
Crowfoot sp.	<i>Ranunculus sp.</i>	Water net	<i>Hydrodictyon</i>
Curled pondweed	<i>Potamogeton crispus</i>	Water-soldier	<i>Stratiotes aloides</i>
Delicate stonewort	<i>Chara virgata</i>	White water lily	<i>Nymphaea alba</i>
<i>Enteromorpha</i>	<i>Enteromorpha</i>	Whorled water milfoil	<i>Myriophyllum verticillatum</i>
Fan-leaved water crowfoot	<i>Ranunculus circinatus</i>	Willow-leaved pondweed	<i>Potamogeton x salicifolius</i>
Fennel-leaved pondweed	<i>Potamogeton pectinatus</i>	Yellow water lily	<i>Nuphar lutea</i>
Filamentous algae	<i>Filamentous algae</i>		
Flat-stalked pondweed	<i>Potamogeton friesii</i>		
Floating club-rush	<i>Eleogiton fluitans</i>		
Fragile stonewort	<i>Chara globularis</i>		
Fragile/convergent stonewort	<i>Chara globularis/connivens</i>		
Frogbit	<i>Hydrocharis morsus-ranae</i>		
Greater duckweed	<i>Spirodela polyrhiza</i>		
Greater reedmace	<i>Typha latifolia</i>		
Hair like pondweed	<i>Potamogeton trichoides</i>		
Hedgehog stonewort	<i>Chara aculeolata/pedunculata</i>		
Holly-leaved naiad	<i>Najas marina</i>		
Horned pondweed	<i>Zanichellia palustris</i>		
Inflated duckweed	<i>Lemna gibba</i>		
Intermediate stonewort	<i>Chara intermedia</i>		
Intermediate water-starwort	<i>Callitriche stagnalis</i>		
Ivy-leaved duckweed	<i>Lemna trisulca</i>		
Least duckweed	<i>Lemna minuta</i>		
Lesser bearded stonewort	<i>Chara curta</i>		
Lesser pondweed	<i>Potamogeton pusillus</i>		
Lesser reedmace	<i>Typha angustifolia</i>		
Mare's tail	<i>Hippuris vulgaris</i>		
Nuttall's waterweed	<i>Elodea nutalli</i>		
Opposite stonewort	<i>Chara contraria</i>		
Perfoliate pondweed	<i>Potamogeton perfoliatus</i>		
Pink water speedwell	<i>Veronica catenata</i>		
Pointed stonewort	<i>Nitella mucronata</i>		
Pondweed sp.	<i>Potamogeton sp.</i>		
Reed sweet grass	<i>Glyceria maxima</i>		
Common	Latin		
Rigid hornwort	<i>Ceratophyllum demersum</i>		
River water crowfoot	<i>Ranunculus fluitans</i>		