The Broads Annual Water Plant Monitoring Report 2017

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2017

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1 Executive Summary

This report presents and discusses the findings from the annual water plant surveys carried out during 2017, which covered 22 waterbodies. This is a long running survey which in many ways began in 1977 by Michael J. Jackson & Peter Wright at the Nature Conservancy Council who developed the transect method within the Broads (Jackson, 1978). This method was used to complete surveys on a wide set of broads every year since 1983. 2014 saw a switch from a transect based method, to a point based method which had been in development since 2011.

Key Results for 2017 can be summarised as:

- Good results were obtained for Heigham Sound with excellent species richness and abundance. Shining pondweed, a new species of note was recorded, appearing amongst the areas of Mare's tail.
- Hickling was productive; the final count was three more species than 2016. Two surveys were conducted this year in June and July, with the later survey indicating how much the plant life within the broad can increase within one month. It also showed how the dominant or most abundant species can change not only from year to year but from month to month. Baltic stonewort was dominant in June with Spiked water milfoil taking over in July.
- Martham North had an increased overall abundance score this year, the main cause of this was a productive season for Bristly stonewort although it also had a decrease in vascular macrophytes by over 90%. Whereas Martham South had a drop in its overall abundance score (by 39%), this is due to a more than 50% decrease in stoneworts which showed considerable signs of grazing. Conversely, vascular plants such as Holly-leaved naiad and Fennel-leaved pondweed fared much better; their collective abundance score increased from 0.002 to 1.392 which is an increase of over 99%. Independent accounts report sightings of vast flocks of Greylag geese residing on the broad during their moult period.
- Alderfen had a decrease in overall abundance compared to 2016, particularly Rigid hornwort and to a lesser degree Holly-leaved naiad, however stoneworts abundance improved albeit with a reduced diversity.
- Cromes broad demonstrated good results for vascular plants (plants with well-developed vascular tissues consisting of phloem and xylem to transport nutrients water and minerals), mainly Rigid hornwort. This broad is still home to species of conservation concern such as Water-soldier and Holly-leaved naiad.
- Cockshoot continues to be dominated by Holly-leaved naiad, with only one other species recorded during the survey.
- Ranworth was very poor this year with very few plants found. Trace amounts of plants were recorded at four points out of 33. Filamentous algae which is a generalist and can be a good indicator of nutrient enrichment was only recorded at one of these locations.
- Bargate was surveyed this year; the last time was in 2014. It is a quiet hidden broad with an interesting plant community; Common water moss grows within the flow from where the dyke enters the broad to where it exits and returns to the river. Unbranched bur-reed was also found which is more typical of flowing waters, although species of

standing waters are also present. Generally plant abundance had decreased along with species diversity since it was last surveyed in 2014.

- Buckenham and Hassingham, which are connected by dykes, have had a worrying decrease in plant abundance since last surveyed by the Broads Authority in 2015. Buckenham has experienced a 97.7% drop in overall abundance; from a collective abundance score of almost 7 to less than 0.2, which means that only a few fragments of plants were found. The incidental observations noted that waters here were very turbid suggesting a change in water quality or another dynamic within the ecosystem. Coincident with the decline in plants, independent reports suggest that a contributing factor may be a change in the wildfowl feeding regime along with inadvertently attracting opportunistic feral geese, which also feed on the stubble fields in the surrounding area. The water runoff from the surrounding catchment is a possible vector for these subsequent nutrients.
- Good results were recorded at Whitlingham Little Broad, with Ivy-leaved duckweed found throughout and Nuttall's waterweed found at 35 of the 44 points. There is still a considerable amount of Filamentous algae which will hopefully reduce with time and with the support of the public to not feed water birds.
- Oulton Broad was officially surveyed for the first time this year, and even though this is a heavily used broad with active dredging, water plants were still found. The species include: Canadian waterweed, Common water moss, Rigid hornwort, Spiked water milfoil and the *Chara,* Pointed stonewort, all of which were found on the mid to western half of the broad.

2 Aims & Objectives

The aim of the Broads Annual Survey is to monitor the water plant growth of the broads and waterways within the Broads. The resident water plants are used as an indicator, from which data is produced. These results can then be used over the longer term to assess the condition, or health, of the waterbody.

As such our objectives are to use different types of surveys to gain the best information we can while also covering as much of the Broads as possible during the growing season.

Three types of survey are included in this report:

- Broads water plant survey. This survey manually assesses the species abundance and diversity of the water plants within a selected number of Broads.
- River water plant survey. This survey is similar to the Broads survey but slightly adapted for navigable channels and river stretches within the Broads.
- Hydro-acoustic survey. This survey uses a form of sonar to assess the density of the water plant growth within specific larger waterbodies.

3 Broads Water Plant Survey

3.1 Introduction

The aim of the Broads annual survey in 2017 was to continue to monitor water plant growth within specified broads, but using the point based method across all selected sites. Following the analysis of data recorded in 2011 and 2013 whereby surveys were repeated on the same broads using both the historical transect method and the proposed point based method, Dr. Nigel Wilby, University of Stirling, has been advising the Broads Authority on the requirements of a point based method. A revised scoring mechanism has been implemented, to allow continuation of the comparison of long term trends despite changes to the survey methodology used.

Where broads have historically been sampled around a particular date, the aim is to undertake repeat surveys as near as possible to the original 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 water plant community. Broads that have not received restoration efforts or are stable and/or 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.

3.2 Survey Methodology

3.2.1 Survey point selection

a. The area of open water of each broad to be surveyed was measured using GIS mapping.

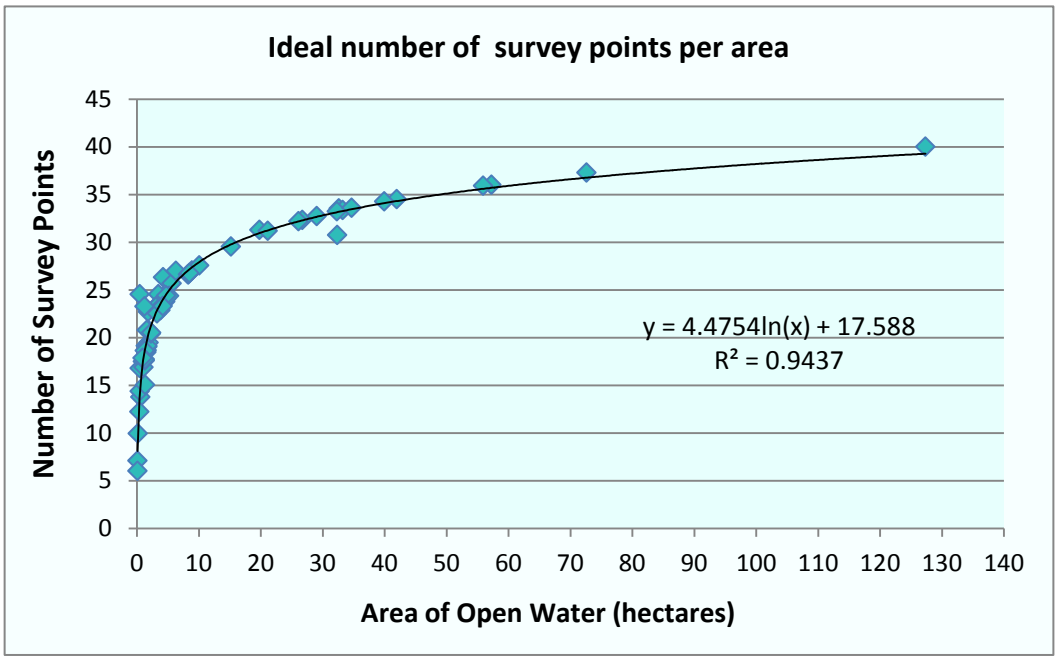


Figure 1. Chart depicting the implementation of survey point in relation to area of open water.

b. The equation y = 4.6242ln(x) + 17.149 was used to calculate the ideal number of survey points, where y = the area of open water in a site. This relationship was generated by Dr Nigel Wilby, based on Broad's species accumulation data. Once this number was calculated, a grid system was applied and a set of points plotted on to the open water areas of each broad. Points were spaced equidistantly.

c. An aerial photograph of each broad was produced on which each of the numbered survey points was marked. Grid references for each numbered point were also included.

3.2.2 Field method

a. In the field, surveyors used the grid references of each plotted point to identify the point's location. The boat was navigated to each point using a handheld GPS device. Once within 5 m of the plotted grid reference, mud weights were deployed to keep the boat in the correct location.

b. At each point, a 5 m rake throw was completed to the north and to the south. Each sample (either north or south) was recorded separately, for subsequent analysis. Two samples at each point has been previously been found to be a suitable representative number.

c. A double headed survey rake was thrown a distance of 5 m from the boat edge. The rake was left for 10 seconds to sink to the bottom after which the rake was pulled slowly and steadily along the bed of the broad, back towards the boat. For points that were in

deeper water, additional rope was thrown to allow the rake to sink and rest on the bed of the 'lake' at a distance of 5m from the edge of the boat.

d. On retrieval of each rake, the plants attached to the rake head were collected in a white survey tray. If necessary, plants were washed to remove excess sediment to aid identification.

e. All the live plant material was identified to species level wherever possible. For example, some particularly difficult groups e.g. any non-fruiting starworts *Callitriche sp.*, were only identified to genus level.

f. Any plant specimens where identification in the field was uncertain were collected in plastic bags, labelled using the station number reference and the direction of the throw. These samples were then taken for subsequent observation using a high powered microscope, or sent for expert identification. Wherever possible, voucher specimens were pressed and dried using standard herbarium techniques.

g. To assign a level of abundance for each species, the total volume of live plant material, was ascribed a value, based on the maximum trap-ability on the rake. Therefore the maximum possible score would be given to a retrieved rake that couldn't possibly hold any more plant material. To make the scoring simpler in the field, the values ascribed to each species ranged between 1 and 10, with 10 being the maximum trappable. If the maximum plant volume was present on the rake, but split equally between two species for example, then each species would be scored 5. Scores of 0.1 were given to trace and very small amounts of identifiable plant material.

h. The score assigned to each species should take into account the trap-ability of that particular species on the rake, so that a score of 10 (91 to 100%) represents the maximum amount trappable on the rake. As such, a fine leaved species such as unbranched bur-reed would not be as trappable on the rake as a more structured species such as spiked water milfoil. The scoring for less trappable species then requires a little bit of surveyor experience and judgement to ascribe a suitable score that reflects the likelihood of being retrieved in the rake, and possibly other visual indications as to how much of the species is actually present. The risk being that high abundances of less trappable species are routinely under-scored compared to more easily retrieved species. Other less trappable water plant families include the duckweeds and water lilies.

Table 1. Species scoring definitions

0.1 = <1%	
1 = 1 to 10%	**6 = 51 to 60%**
2 = 11 to 20%	**7 = 61 to 70%**
3 = 21 to 30%	**8 = 71 to 80%**
4 = 31 to 40%	**9 = 81 to 90%**
5 = 41 to 50%	**10 = 91 to 100%**

i. The maximum total of all species abundance scores on an individual rake sample cannot really be more than 100%; plus or minus 10% is an acceptable tolerance to account for the varying trap-ability of different species.

3.2.3 Data processing

a. For each sample, species abundance scores can be totalled, to produce the total abundance score for each sample. Sum of all sample abundance scores produces the site total abundance. Assuming maximum plant abundance on the site, the site abundance score should have a maximum of 10 (± 10%).

b. For data comparison, the results have been calculated to show the species richness (number of species recorded) and the species abundance scores. Species abundance is calculated by summing all the abundance scores for a particular species at each site and dividing by the number of samples, which were surveyed for that site. Within each sites results table, the species abundances have been displayed in descending order so that the most abundant species in 2017 are listed at the top of each site table.

Table 2. Sites surveyed for water plants from 1983 to 2017, sites that the Norfolk Wildlife Trust now survey are in orange

Broad	Times sampled	Year Sampled																																				
		1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Alderfen	35																																			
Bargate	5																																			
Barnby	7																																			
Barton	35																																			
Belaugh	21																																			
Blackfleet	4																																			
Bridge	15																																			
Buckenham	11																																			
Burntfen	7																																			
Calthorpe	7																																			
Catfield	3																																			
Cockshoot	35																																			
Cromes South	34																																			
Cromes North	32																																			
Decoy	12																																			
Filby	30																																			1
Flixton Decoy	3																																			
Fritton Lake	1																																			
Hassingham	11																																			
Heigham Sound	27																																			
Hickling	35																																			
Horsey Mere	31																																			
Hoveton Great	35																																			
Hoveton Little / Blackhorse	16																																			
Hudson's Bay	9																																			
Irstead	2																																			
Lily	30																																			1
Little	6																																			
Malthouse	7																																			
Martham North	34																																			

Broad	Times sampled	Year Sampled																																				
		1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Martham South	33	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Mautby Decoy	5																									■	■	■	■						■	
Norton	5																						■					■	■	■						■	
Ormesby	32	■	■	■	■	■		■	■	■	■	■		■	■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Ormesby Little	32	■	■	■	■	■		■	■	■	■	■		■	■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Oulton	1																																				■
Pound End	16										■			■	■	■	■	■	■	■	■		■	■	■	■	■					■		■		
Ranworth	33	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■		■	■	■	■	■	■	■	■	■	■	■	■		■
Reedham Water	3																						■					■					■				
Rockland	27	■	■	■	■	■	■	■	■	■	■			■			■	■	■			■	■	■	■	■	■		■	■	■		■	■	■	■
Rollesby	31	■	■	■	■	■		■	■	■	■			■	■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■					
Round Water	3																										■			■					■	
Salhouse Great	13				■	■								■	■	■	■	■	■	■			■	■	■						■					
Salhouse Little	6					■				■				■	■	■	■																			
Sotshole	1																																	■		
Spratts Water	4																						■				■			■					■	
Strumpshaw	10									■							■							■	■	■	■		■	■	■	■		■		
Upton Great	35	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Upton Little	11																							■	■	■	■	■	■	■	■	■	■		■	
Wheatfen	7																■						■		■	■		■			■			■		
Whitlingham Great	14																					■	■	■	■	■	■	■		■	■	■	■	■	■	■	■
Whitlingham Little	13																							■	■	■	■	■	■	■	■	■	■	■	■	■	■
Woolner's Carr	2																													■					■	
Wroxham	35	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Total no. broads sampled per year		23	22	23	23	24	15	24	22	23	23	17	13	27	27	26	32	21	26	19	22	22	37	35	41	42	35	33	36	34	32	26	24	28	32	27

Table 3. Survey dates (2009-2016).

Broad	Survey Date								
	2009	2010	2011	2012	2013	2014	2015	2016	2017
Alderfen	19-Aug	03-Aug	09-Aug	14-Aug	14-Aug	14-Aug	30-Jul	26-Jul	13-Jul
Bargate	-	-	-	31-Aug	-	03-Sep	-	-	25-Aug
Barnby	14-Aug	-	-	19-Jul	-	-	04-Aug	-	-
Barton	12-Aug	21-Jul	04-Aug	06-Aug	09-Aug	07-Aug	07-Aug	17-Aug	03-Aug
Belaugh	-	05-Aug	11-Aug	-	-	-	-	-	10-Aug
Blackfleet	-	-	-	-	-	-	-	31-Aug	-
Bridge	-	-	-	03-Aug	-	-	14-Aug	-	-
Buckenham	-	30-Jul	20-Jul	-	26-Jul	-	28-Jul	-	21-Jul
Burntfen	-	12-Aug	01-Sep	-	20-Aug	-	-	18-Aug	-
Calthorpe	-	03-Sep	17-Aug	11-Sep	-	02-Sep	-	-	-
Cockshoot	03-Sep	01-Sep	18-Aug	29-Aug	05-Sep	27-Aug	20-Aug	04-Aug	27-Jul
Catfield	03-Sep	-	-	-	-	-	21-Aug	-	-
Crome's	19-Aug	03-Aug	08-Aug	14-Aug	08-Aug	06-Aug	29-Jul 07-Aug	27-Jul	26-Jul
Decoy	05-Aug	-	-	-	23-Aug	01-Sep	-	24-Aug	-
Flixton Decoy	-	06-Aug	-	-	-	-	-	-	-
Hassingham	28-Aug	30-Jul	20-Jul	-	26-Jul	-	24-Jul	-	20-Jul
Heigham Sound	07-Aug	23-Aug	29-Jul	26-Jul	02-Aug	22-Jul	14-Jul	12-Jul	11-Jul
Hickling	13-Aug	23-Jul	05-Aug	25-Jul	31-Jul	23-Jul	15-Jul	13-Jul	12-Jul
Horsey Mere	07-Aug	28-Jul	29-Jul	31-Jul	30-Jul	24-Jul	16-Jul	14-Jul	06-Jul
Hoveton Great	06-Aug	05-Aug	03-Aug	06-Sep	13-Aug	12-Aug	05-Aug	02-Aug	01-Aug
Hoveton Little / Blackhorse	-	-	-	-	15-Aug	13-Aug	-	-	22-Aug
Hudsons Bay	-	-	-	06-Sep	-	-	06-Aug	-	-
Irstead Holmes	04-Aug	-	-	-	-	-	-	-	-
Little Broad	09-Sep	02-Sep	-	-	20-Aug	-	-	11-Aug	-
Malthouse	-	17-Aug	-	-	-	-	-	-	-
Martham North	30-Jul	29-Jul	25-Jul	24-Jul	25-Jul	29-Jul	21-Jul	21-Jul	18-Jul
Martham South	30-Jul	29-Jul	26-Jul	24-Jul	24-Jul	30-Jul	22-Jul	19-Jul	19-Jul
Mautby Decoy	09-Sep	02-Sep	-	-	-	-	-	07-Jul	-
Mill Water	-	-	-	-	-	-	-	-	-
Nortons	29-Jul	05-Aug	11-Aug	-	-	-	-	03-Aug	-
Oulton	-	-	-	-	-	-	-	-	16-Aug
Pound End	-	-	-	-	23-Aug	-	06-Aug	-	-
Ranworth	21-Aug	31-Aug	16-Aug	02-Aug	28-Aug	02-Sep	31-Jul	-	02-Aug
Rockland	-	30-Aug	25-Aug	30-Aug	-	28-Aug	11-Aug	16-Aug	08-Aug
Reedham	04-Aug	-	-	-	-	31-Jul	-	-	-
Round Water	-	-	23-Aug	-	-	-	-	23-Aug	-
Salhouse Great	-	-	-	08-Aug	-	-	-	-	-
Salhouse Little	-	-	-	08-Aug	-	-	-	-	-
Sotshole	-	-	-	-	-	-	04-Aug	-	-
Spratt's Water	-	-	23-Aug	-	-	-	-	23-Aug	-
Strumpshaw	-	30-Jul	20-Jul	27-Jul	01-Aug	-	13-Aug	-	-
Upton Great	18-Aug	13-Aug	10-Aug	22-Aug	21-Aug	19-Aug	18-Aug	09-Aug	09-Aug
Upton Little	18-Aug	13-Aug	-	22-Aug	22-Aug	20-Aug	-	09-Aug	-
Wheatfen	-	-	-	30-Aug	-	-	12-Aug	-	-
Whitlingham Great	28-Aug	-	19-Jul	18-Jul	17-Jul	17-Jul	08-Jul	05-Jul	04-Jul
Whitlingham Little	28-Aug	30-Aug	19-Jul	18-Jul	17-Jul	17-Jul	08-Jul	06-Jul	05-Jul
Woolner's Carr	-	-	23-Aug	-	-	-	-	23-Aug	-
Wroxham	04-Aug	04-Aug	21-Jul	03-Aug	06-Aug	05-Aug	23-Jul	17-Aug	07-Jul

3.3 Results.

Each broad that was surveyed in 2017 is reviewed in terms of species richness (the number of species recorded) and abundance (the amounts of each species recorded) according to the point survey and scoring method (outlined in Section 3.2). Some analysis of recent trends of plant abundance has been made. With the four year consecutive run of comparable data general impressions can be made, however the significance of observed trends is limited.

The results tables also illustrate the number of points at which each species was recorded, giving an indication of the frequency of occurrence.

Appendix 1 lists the common and Latin names for all plants found to date during broads surveys.

3.3.1 Thurne Valley

The broads which are located in the Thurne valley contain one of the most diverse populations of stoneworts in the UK.

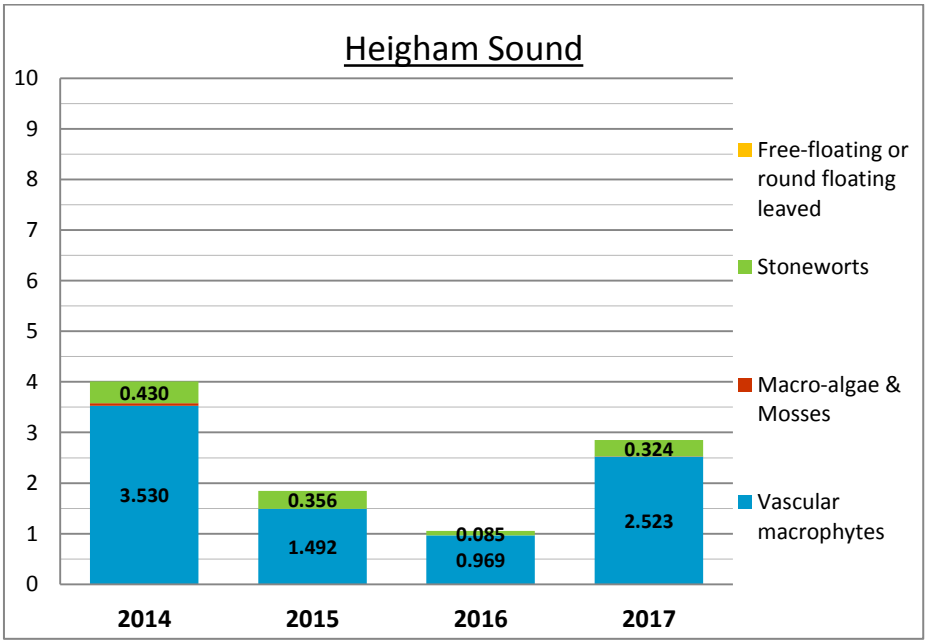
These bodies of water are a haven for vulnerable and rare species which are stated in the Joint Nature Conservation Committee (JNCC) Red Data Book, they include; three 'Vulnerable' species: Baltic stonewort, Convergent stonewort and Starry stonewort, and one 'rare' species: Intermediate stonewort (Stewart and Church, 1992). They also provide a stronghold for the rare Holly-leaved naiad, which is a UK Biodiversity Action Plan priority species (BAP), as well as more common vascular plants such as Spiked water milfoil and Mare's tail.

a. Heigham Sound

Common Name	Scientific Name	Summary Abundance	Occurrences
Mare's tail	*Hippuris vulgaris*	0.894	22
Spiked water milfoil	*Myriophyllum spicatum*	0.802	35
Curled pondweed	*Potamogeton crispus*	0.340	29
Opposite stonewort	*Chara contraria*	0.177	2
Rigid hornwort	*Ceratophyllum demersum*	0.169	32
Fan-leaved water crowfoot	*Ranunculus circinatus*	0.116	16
Shining pondweed	*Potamogeton lucens*	0.113	3
Stonewort (Chara) species	*Chara sp.*	0.081	1
Smooth stonewort	*Nitella flexilis*	0.065	2
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.034	3
Canadian waterweed	*Elodea canadensis*	0.023	5
Holly-leaved naiad	*Najas marina*	0.019	3
Filamentous algae	*Zygnematales*	0.006	4
Nuttall's waterweed	*Elodea nuttallii*	0.005	3
Pondweed species	*Potamogeton sp.*	0.005	3
Baltic stonewort	*Chara baltica*	0.002	1
Flat-stalked pondweed	*Potamogeton friesii*	0.002	1
Starwort species	*Callitriche sp.*	0.002	1
Total number of species recorded		**18**	**Total samples taken 62**

A better year for Heigham Sound with more species recorded this year since adopting point based survey. Spiked water milfoil has remained relatively stable whereas there has been a good increase in Mare's tail and Curled pondweed. A new edition this year was Shining pondweed which was found at three points; it is distinctive with its broad translucent yellowish green leaves.

Observations: Yellow water lily was seen on the broad but sadly was not picked up during the survey.



b. Hickling

Hickling was surveyed twice this year to observe the rate of growth between early and mid-season

June			
Common Name	**Scientific Name**	**Summary Abundance**	**Occurrences**
Baltic stonewort	*Chara baltica*	0.760	25
Spiked water milfoil	*Myriophyllum spicatum*	0.611	64
Intermediate stonewort	*Chara intermedia*	0.529	30
Hedgehog stonewort	*Chara pedunculata*	0.205	2
Bristly stonewort	*Chara hispida*	0.028	4
Holly-leaved naiad	*Najas marina*	0.026	11
Mare's tail	*Hippuris vulgaris*	0.026	1
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.018	5
Opposite stonewort	*Chara contraria*	0.018	5
Fragile/convergent stonewort	*Chara globularis/connivens*	0.017	4
Curled pondweed	*Potamogeton crispus*	0.004	3
Stonewort (*Chara*) species	*Chara sp.*	0.003	2
Stonewort (*Nitella*) species	*Nitella sp.*	0.001	1
Total number of species recorded		**13**	**Total samples taken 78**

July			
Common Name	**Scientific Name**	**Summary Abundance**	**Occurrences**
Spiked water milfoil	*Myriophyllum spicatum*	1.145	64
Intermediate stonewort	*Chara intermedia*	1.109	38
Baltic stonewort	*Chara baltica*	0.394	29
Hedgehog stonewort	*Chara pedunculata*	0.179	4
Holly-leaved naiad	*Najas marina*	0.087	13
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.068	8
Rough stonewort	*Chara aspera*	0.054	6
Bristly stonewort	*Chara hispida*	0.042	4
Curled pondweed	*Potamogeton crispus*	0.041	5
Mare's tail	*Hippuris vulgaris*	0.026	1
Fragile/convergent stonewort	*Chara globularis/connivens*	0.005	4
Opposite stonewort	*Chara contraria*	0.003	2
Canadian waterweed	*Elodea canadensis*	0.001	1
Convergent stonewort	*Chara connivens*	0.001	1
Pondweed species	*Potamogeton sp.*	0.001	1
Total number of species recorded		**15**	**Total samples taken 78**

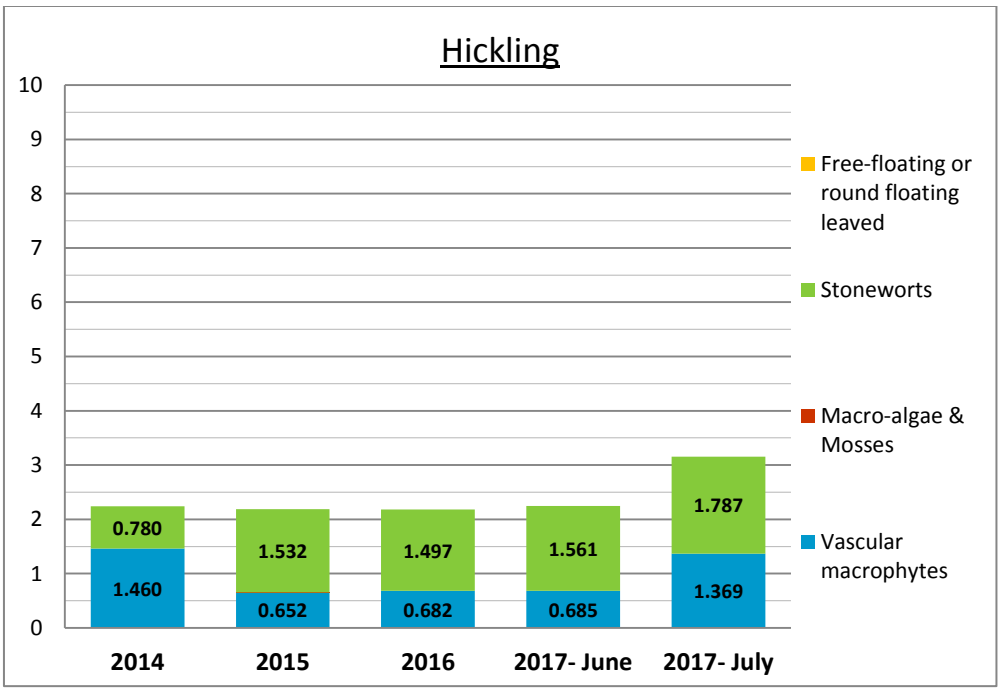
The perceived biannual cycle of the dominance of Spiked water milfoil is apparent in the July survey, which somewhat coincides with casual observations from other users of the broad.

Intermediate stonewort abundance has increased from last year, reaching a similar score to 2015 when it was the dominant species; this shows how much of an increase has occurred.

The change between June and July at Hickling this year appears to show an almost double increase of Spiked water milfoil, a more than double increase of Intermediate stonewort and a decrease in Baltic stonewort.

There was only a slight difference in the composition of species within the broad between the two surveys. In the June survey a small trace of *Nitella* stonewort was found which was absent in July. In the July survey Rough stonewort, Canadian waterweed and a trace of an unidentified pondweed species were found, along with a definite sample of Convergent stonewort which is usually grouped with Fragile stonewort as they are very difficult to separate.

Observations: Fennel- leaved pondweed was seen when travelling between points but not always caught on the survey rake. Mare's tail is often seen in the bays and alcoves within the reed bed edge.

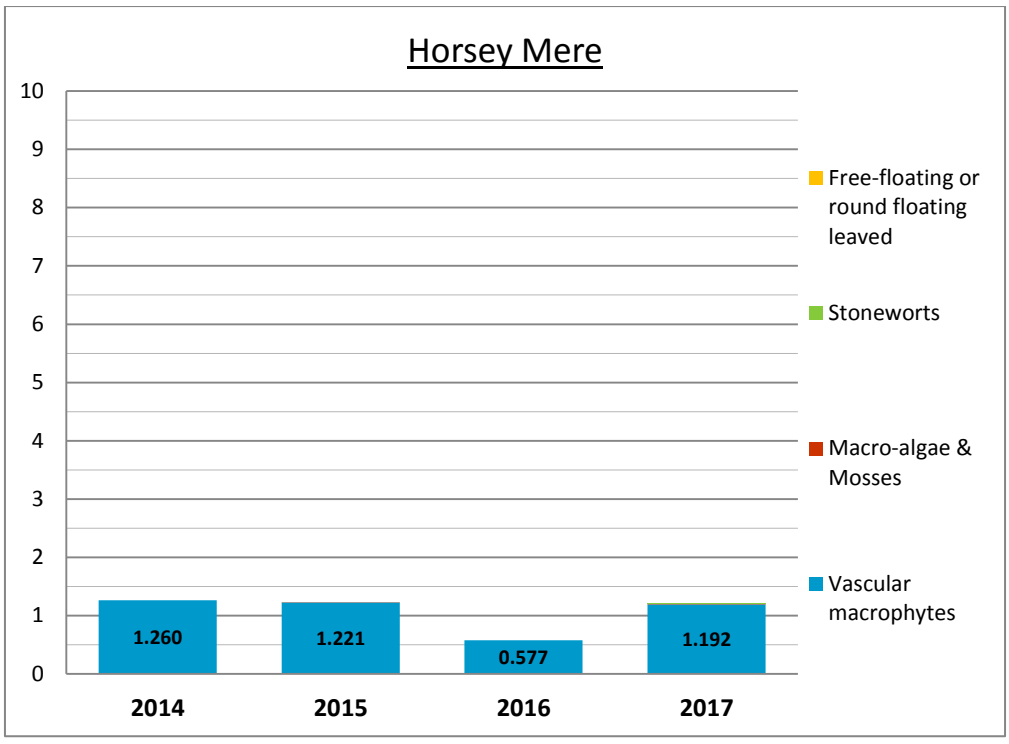


c. Horsey Mere

Common Name	Scientific Name	Summary Abundance	Occurrences
Spiked water milfoil	*Myriophyllum spicatum*	0.624	34
Mare's tail	*Hippuris vulgaris*	0.562	15
Filamentous algae	*Zygnematales*	0.008	5
Perfoliate pondweed	*Potamogeton perfoliatus*	0.003	2
Common stonewort	*Chara vulgaris*	0.002	1
Nuttall's waterweed	*Elodea nuttallii*	0.002	1
Rigid hornwort	*Ceratophyllum demersum*	0.002	1
Total number of species recorded		**7**	**Total samples taken 66**

Somewhat mirroring Hickling broad, Spiked water milfoil has become the abundant species at Horsey Mere; the term dominant could not be used in this case as there is not sufficient quantity of plant material within the broad. Mare's tail remains at a level similar to last year with milfoil abundance increasing by 82% between 2016 and 2017. Fragments of Perfoliate pondweed were found again this year.

Observations: The southern bays within this broad appear to be quite sheltered and are where more varieties of species are usually found.

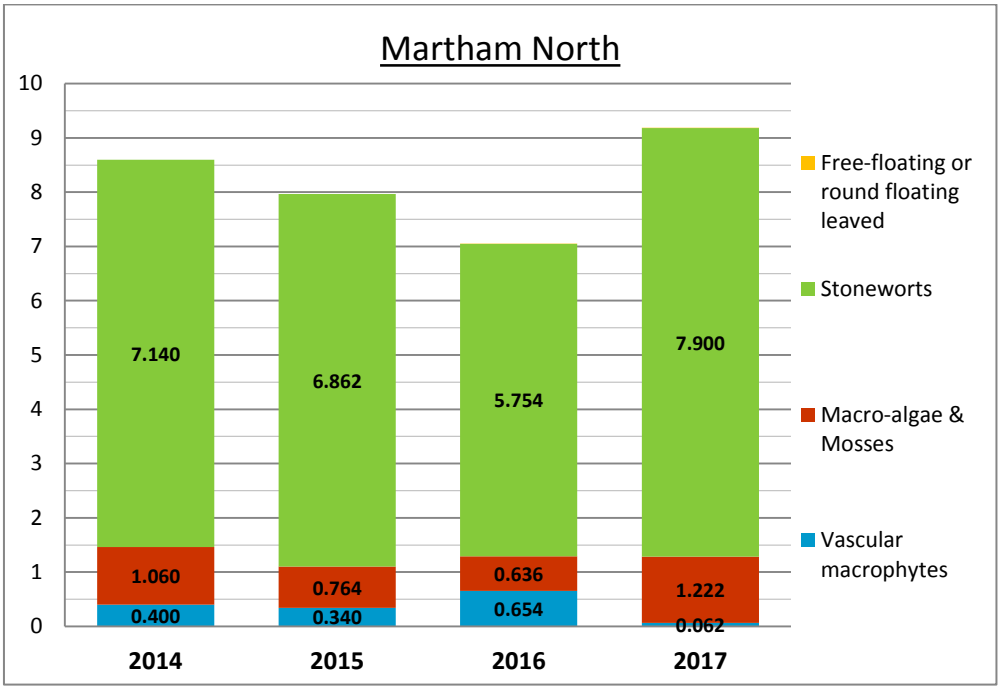


d. Martham North

Common Name	Scientific Name	Summary Abundance	Occurrences
Bristly stonewort	*Chara hispida*	7.358	47
Filamentous algae	*Zygnematales*	1.175	22
Mare's tail	*Hippuris vulgaris*	0.038	1
Rough stonewort	*Chara aspera*	0.038	1
Holly-leaved naiad	*Najas marina*	0.019	1
Starry stonewort	*Nitellopsis obtusa*	0.006	3
Ivy-leaved duckweed	*Lemna trisulca*	0.004	2
Intermediate stonewort	*Chara intermedia*	0.002	1
Shining pondweed	*Potamogeton lucens*	0.002	1
Total number of species recorded		**9**	**Total samples taken 52**

Martham North has the highest abundance score on our survey list this year with an increase on last year's overall abundance score. Bristly stonewort has increased although conversely other stonewort species have decreased along with Holly-leaved naiad. Filamentous algae has also increased in abundance and in the number of locations where it is found; this is more worrying. Pondweeds such as Fennel-leaved, Horned and Lesser were not found this year, although the distinctive yellowish green translucent leaves of Shining pondweed were found. Vascular macrophytes on the whole have decreased by over 90%.

Observations: This broad, in most areas, has plants up to the surface. Fennel-leaved pondweed was seen in the broad but was not picked up during the survey.



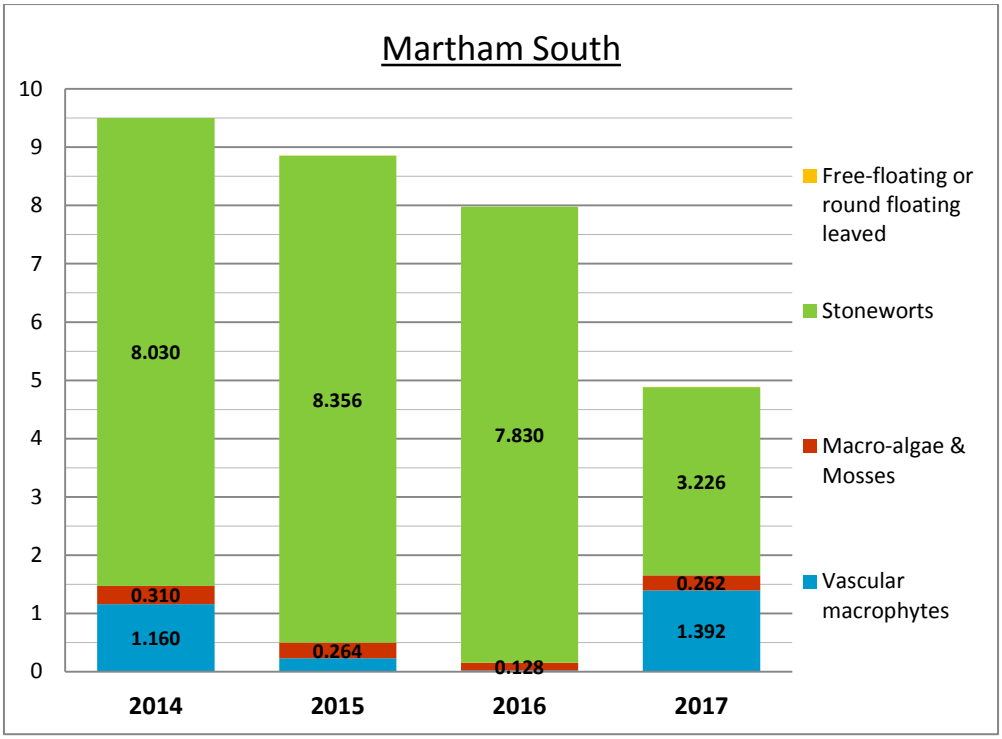
e. Martham South

Common Name	Scientific Name	Summary Abundance	Occurrences
Bristly stonewort	*Chara hispida*	2.268	41
Holly-leaved naiad	*Najas marina*	0.878	35
Starry stonewort	*Nitellopsis obtusa*	0.442	12
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.392	16
Intermediate stonewort	*Chara intermedia*	0.386	12
Filamentous algae	*Zygnematales*	0.220	2
Mare's tail	*Hippuris vulgaris*	0.102	2
Hedgehog stonewort	*Chara pedunculata*	0.084	4
Enteromorpha	*Enteromorpha*	0.042	3
Convergent stonewort	*Chara connivens*	0.040	2
Curled pondweed	*Potamogeton crispus*	0.020	1
Rough stonewort	*Chara aspera*	0.004	2
Fragile/convergent stonewort	*Chara globularis/connivens*	0.002	1
Ivy-leaved duckweed	*Lemna trisulca*	0.002	1
Total number of species recorded		**14**	**Total samples taken 50**

This year there was a big decrease in the Martham South abundance score, the majority of this comes from the considerable drop (>50%) in the amount of Bristly and Intermediate stonewort found within the broad. Bristly stonewort is still the most abundant species, although unlike Martham North the stonewort beds are not touching the surface of the water. Large areas of these stonewort beds displayed signs of being heavily grazed, indepentant reports of vast flocks of Greylag geese on the broad are a probable factor.

On an optimistic note, Holly-leaved naiad has become the second most abundant species and Starry stonewort also scored favourably; on the whole the collective abundance of vacular macrophytes has increased by over 99%.

Observations: Yellow water lily was seen but not picked up in the survey


Martham South
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8.030
0.310
1.160
8.356
0.264
7.830
0.128
3.226
0.262
1.392
2014
2015
2016
2017
Free-floating or round floating leaved
Stoneworts
Macro-algae & Mosses
Vascular macrophytes

3.3.2 Ant Valley

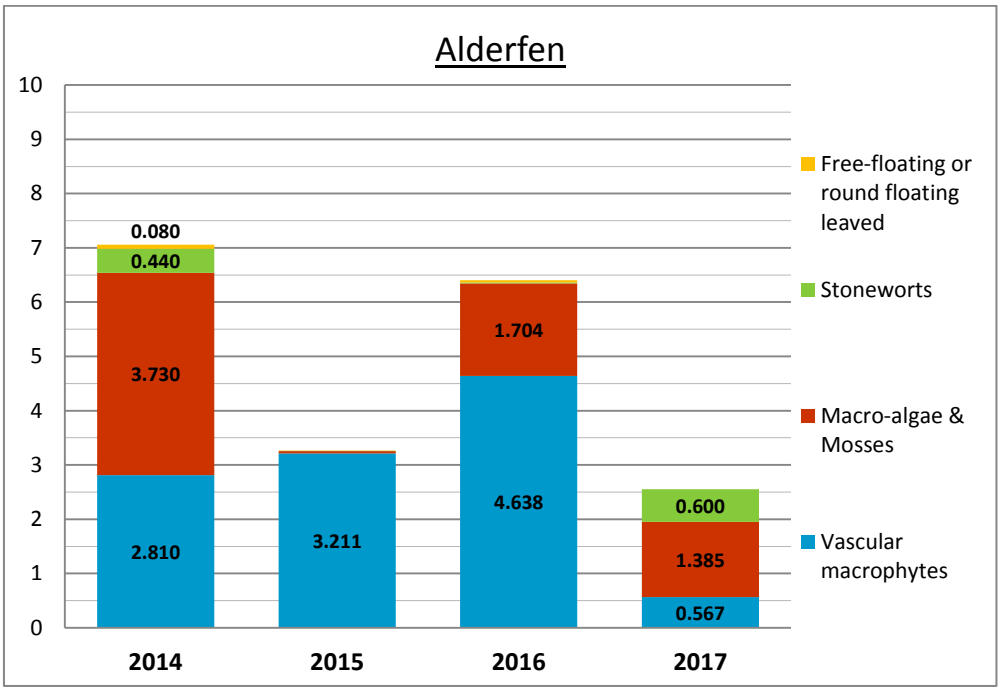
In the Ant Valley, Alderfen, Cromes and Barton broad were some of the first broads surveyed in 1983 and have been regularly surveyed since. These water bodies have been subject to extensive restoration effort over the last 25 years, and all have experienced improved water quality.

f. Alderfen

Common Name	Scientific Name	Summary Abundance	Number of samples where recorded
Filamentous algae	*Zygnematales*	1.385	40
Fragile/convergent stonewort	*Chara globularis/connivens*	0.552	27
Rigid hornwort	*Ceratophyllum demersum*	0.515	41
Holly-leaved naiad	*Najas marina*	0.052	7
Delicate stonewort	*Chara virgata*	0.048	5
Total number of species recorded		**5**	**Total samples taken 48**

Rigid Hornwort has been the most abundant species on this broad for the past two years, however this year it has decreased considerably. Filamentous algae has not taken over but has stayed at a consistent level, which may indicate that it is not a nutrient enrichment issue. The collective Fragile/Convergent stonewort has increased to a level last seen in 2014.

Observations: Ivy-leaved duckweed was seen at a single point in the north east of the broad. A green jelly micro-algae, possibly of the genus Nostoc was found attached to a plant stem.

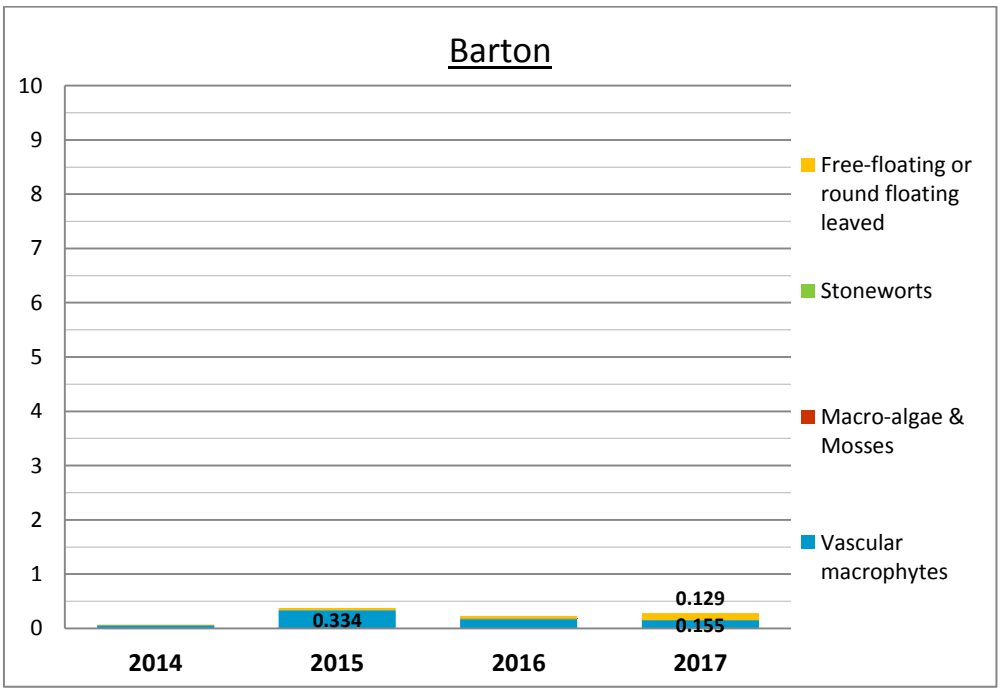


g. Barton

Common Name	Scientific Name	Summary Abundance	Occurrences
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.115	15
Yellow water lily	*Nuphar lutea*	0.113	3
Rigid hornwort	*Ceratophyllum demersum*	0.023	5
Nuttall's waterweed	*Elodea nuttallii*	0.018	2
White water lily	*Nymphaea alba*	0.016	1
Total number of species recorded		**5**	**Total samples taken 62**

Barton continues to have low abundance levels with Fennel-leaved pondweed being the most abundant. It was nice to get a recording of White waterlily this year which was in the north of the broad.

Observations: Yellow and white water lily and Rigid hornwort at point 1, entrance to Hall dyke.

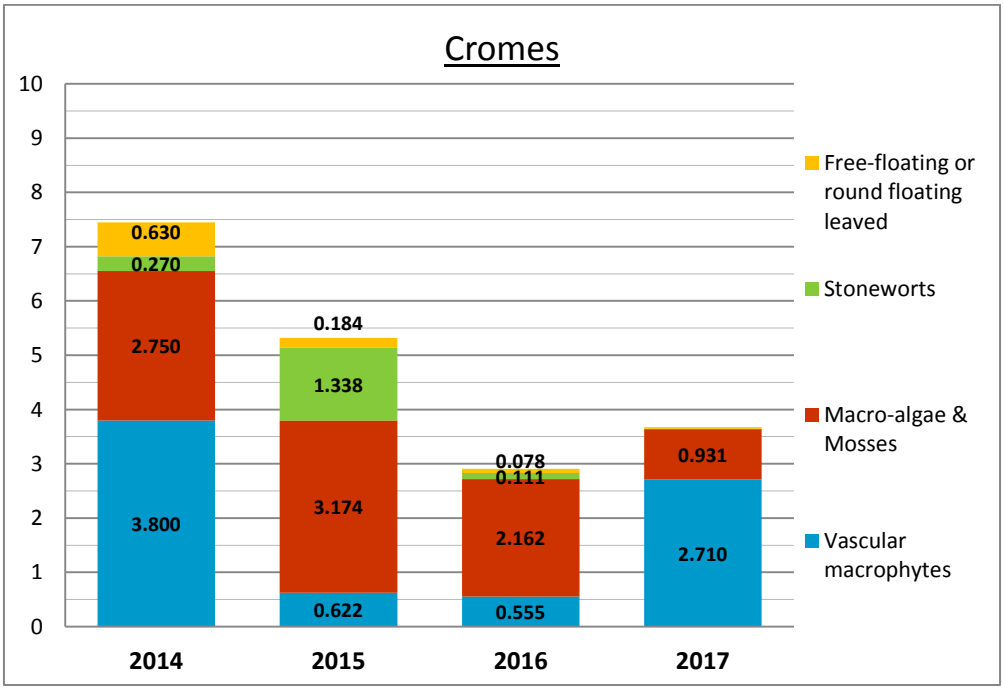


h. Cromes Broad

Common Name	Scientific Name	Summary Abundance	Occurrences
Rigid hornwort	*Ceratophyllum demersum*	2.288	18
Filamentous algae	*Zygnematales*	0.931	33
Bladderwort	*Utricularia vulgaris*	0.321	13
Water-soldier	*Stratiotes aloides*	0.098	3
White water lily	*Nymphaea alba*	0.029	3
Fragile/convergent stonewort	*Chara globularis/connivens*	0.002	1
Holly-leaved naiad	*Najas marina*	0.002	1
Total number of species recorded		**8**	**Total samples taken 42**

An interesting year for Cromes broad with Filamentous algae, which was the most abundant last year, showing a decrease by more than half. Rigid hornwort's abundance has increased significantly to become the most abundant.

Observations: A green jelly algae, possibly of the genus *Nostoc,* was found in the southeast corner of the broad.



3.3.3 Bure Valley

In recent years Upton and Cockshoot Broads, both isolated from the river, have been a stronghold for the rare Holly-leaved naiad. Those broads directly connected to the river, such as Wroxham and Hoveton Great tend to have minimal plant diversity. The survey programme for this valley in 2017 also included Belaugh, Hoveton Little/Blackhorse broad and Ranworth, all of which are surveyed at a different timescale.

i. Belaugh

Common Name	Scientific Name	Summary Abundance	Occurrences
Filamentous algae	*Zygnematales*	0.619	33
Rigid hornwort	*Ceratophyllum demersum*	0.344	22
Yellow water lily	*Nuphar lutea*	0.314	10
White water lily	*Nymphaea alba*	0.169	4
Frogbit	*Hydrocharis morsus-ranae*	0.083	3
Common duckweed	*Lemna minor*	0.031	2
Nuttall's waterweed	*Elodea nuttallii*	0.006	2
Total number of species recorded		**7**	**Total samples taken 36**

This broad although connected to the river is gated, thus restricting boat access. As such, the surface of this broad does not experience the quantity of turbulence of other waterbodies in the Bure. In 2011 three species recorded: Rigid hornwort, Nuttall's and Canadian waterweed respectively. This year Filamentous algae was the most abundant, but more species were found this season which is encouraging.

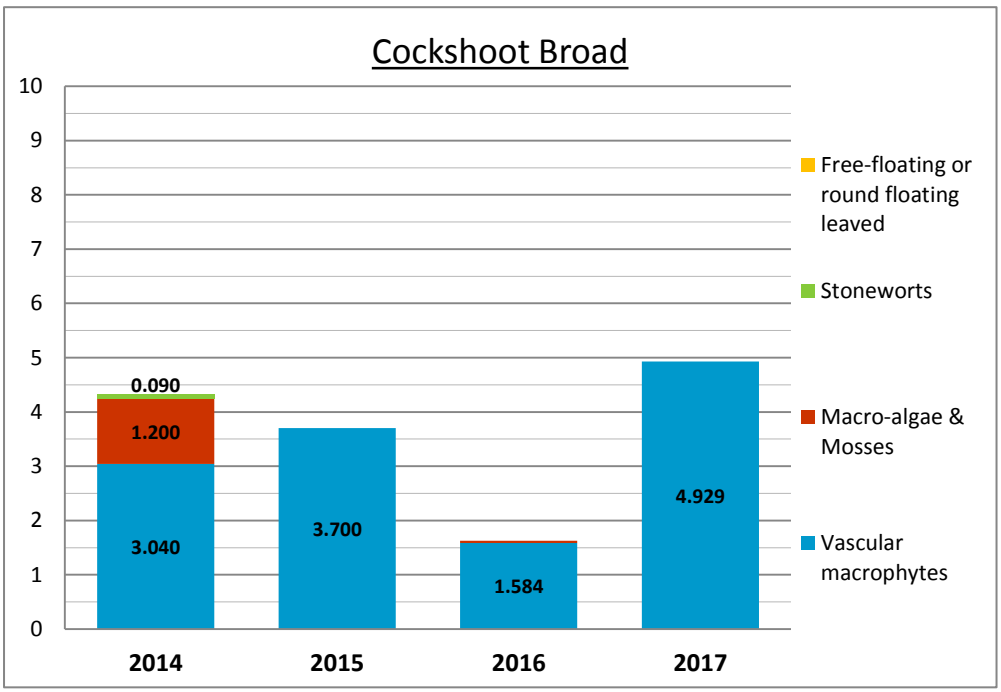
Observations: This broad has extensive rafts of yellow and white water lily, which are not always picked up in the survey. Frogbit was also prevalent closer to the banks and occasional plumes were found further into the open water

j. Cockshoot

Common Name	Scientific Name	Summary Abundance	Occurrences
Holly-leaved naiad	*Najas marina*	4.738	38
Rigid hornwort	*Ceratophyllum demersum*	0.192	16
Total number of species recorded		2	Total samples taken 48

A very interesting broad, the species richness at Cockshoot has decreased from 12 species in 2013 to two this year. However, what has been observed is the emerging dominance of Holly-leaved naiad which in itself is a very rare species. This year the naiad has had an excellent growing season and has more than doubled its abundance, Rigid hornwort has decreased slightly and there were no records of filamentous algae.

Observations: Yellow and white water lily were seen in one of the northeast bays and white water lily at the entrance to Cockshoot dyke.

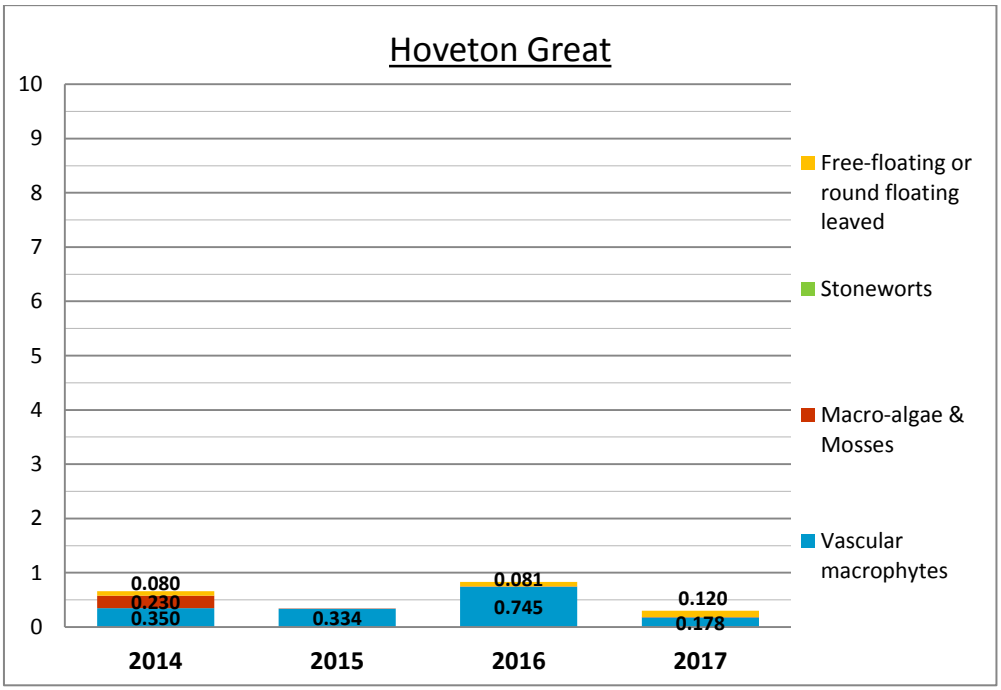


k. Hoveton Great

Common Name	Scientific Name	Summary Abundance	Occurrences
Rigid hornwort	*Ceratophyllum demersum*	0.150	36
Yellow water lily	*Nuphar lutea*	0.120	4
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.028	8
Filamentous algae	*Zygnematales*	0.003	2
Total number of species recorded		**4**	**Total samples taken 60**

The abundance score for Hoveton Great has fallen slightly this year; this is mostly down to the reduction in the amount of Rigid hornwort. Unfortunately the distinctive Curled pondweed was not found this survey season.

Observations: White water lily was observed close to one of the old fish barriers in the western half of the broad.



l. Hoveton Little / Blackhorse

Common Name	Scientific Name	Summary Abundance	Occurrences
Rigid hornwort	*Ceratophyllum demersum*	0.042	7
Yellow water lily	*Nuphar lutea*	0.018	2
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.007	4
Pondweed species	*Potamogeton sp.*	0.003	2
Total number of species recorded		**4**	**Total samples taken 60**

This broad has had a history of low species diversity with only two species (Ridged hornwort and Fennel-leaved pondweed) found in 2014 when it was last surveyed. This number has increased to three for definitely identified species but the abundance score has diminished.

Observations: Swirls of Blue-green algae were seen along the southern and eastern edge of the broad.

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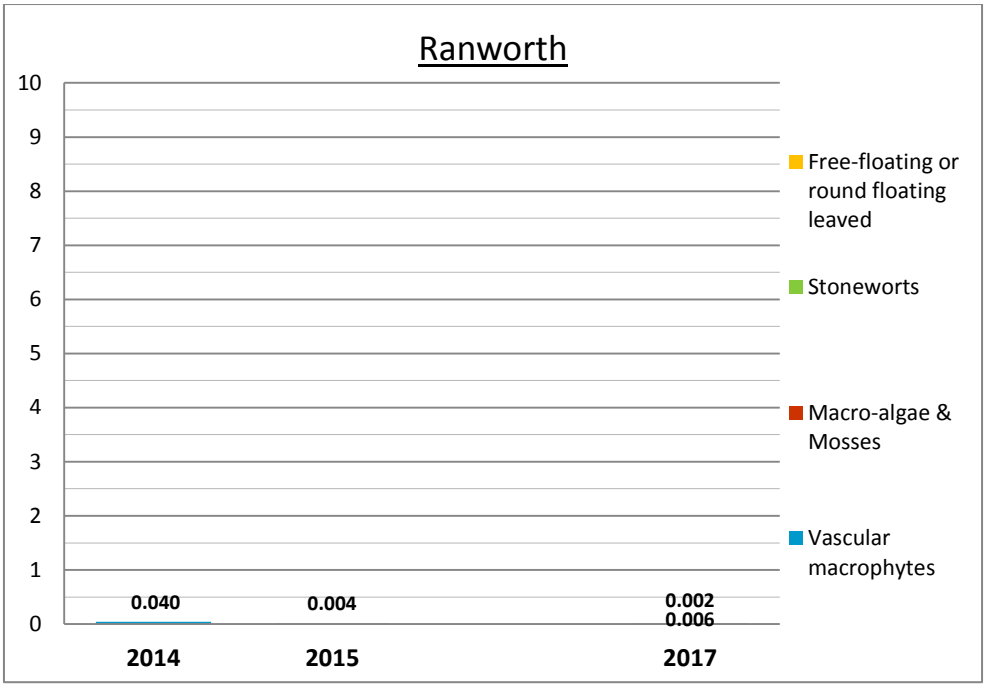
m. Ranworth

Common Name	Scientific Name	Summary Abundance	Occurrences
Rigid hornwort	*Ceratophyllum demersum*	0.005	3
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.001	1
Filamentous algae	*Zygnematales*	0.002	1
Total number of species recorded		**3**	**Total samples taken 66**

It is very difficult to find water plants in this broad; out of 33 points plants were only found at four, and what was found was only in trace amounts. Filamentous algae which is a generalist and can be a good indicator of nutrient enrichment was only recorded at one of these locations.

Observations: Patches of blue-green algae was observed in areas close to the banks but not in the main body of the broad. The water clarity was also poor, even in the biomanipulation ring, which had been compromised since the broad was last surveyed.


Ranworth
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0.040
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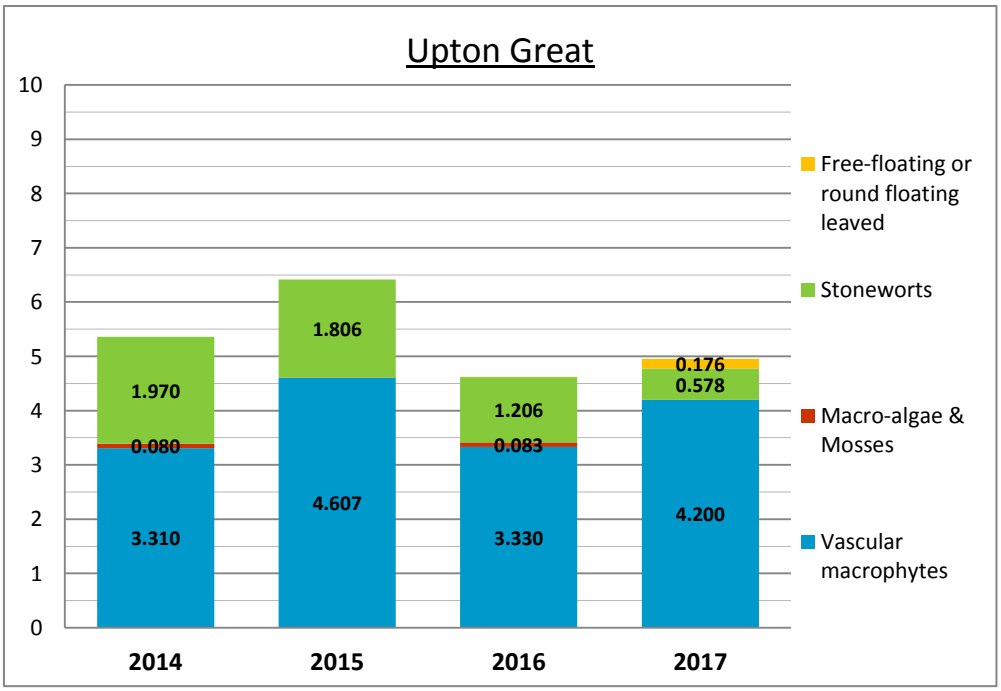
0.006
2014
2015
2017
Free-floating or round floating leaved
Stoneworts
Macro-algae & Mosses
Vascular macrophytes

n. Upton Great

Common Name	Scientific Name	Summary Abundance	Occurrences
Holly-leaved naiad	*Najas marina*	4.178	30
Bristly stonewort	*Chara hispida*	0.393	3
Ivy-leaved duckweed	*Lemna trisulca*	0.176	7
Common stonewort	*Chara vulgaris*	0.109	2
Opposite stonewort	*Chara contraria*	0.067	2
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.022	1
Stonewort (Chara) species	*Chara sp.*	0.004	2
Delicate stonewort	*Chara virgata*	0.002	1
Fragile/convergent stonewort	*Chara globularis/connivens*	0.002	1
Total number of species recorded		**9**	**Total samples taken 46**

Holly-leaved naiad continues to be the most abundant species in this broad. Opposite stonewort was last year's second most abundant species being found on 12 points; this has reduced to two points and has been somewhat usurped by Bristly stonewort, which was only found at two points.

Observations: A jelly algae, possibly of the genus *Nostoc*, was found in this broad usually clinging to the stems of the Holly-leaved naiad. There was a patch of Bristly stonewort on the eastern side which had been heavily grazed, a problem which has been observed and becoming more prevalent on other broads.

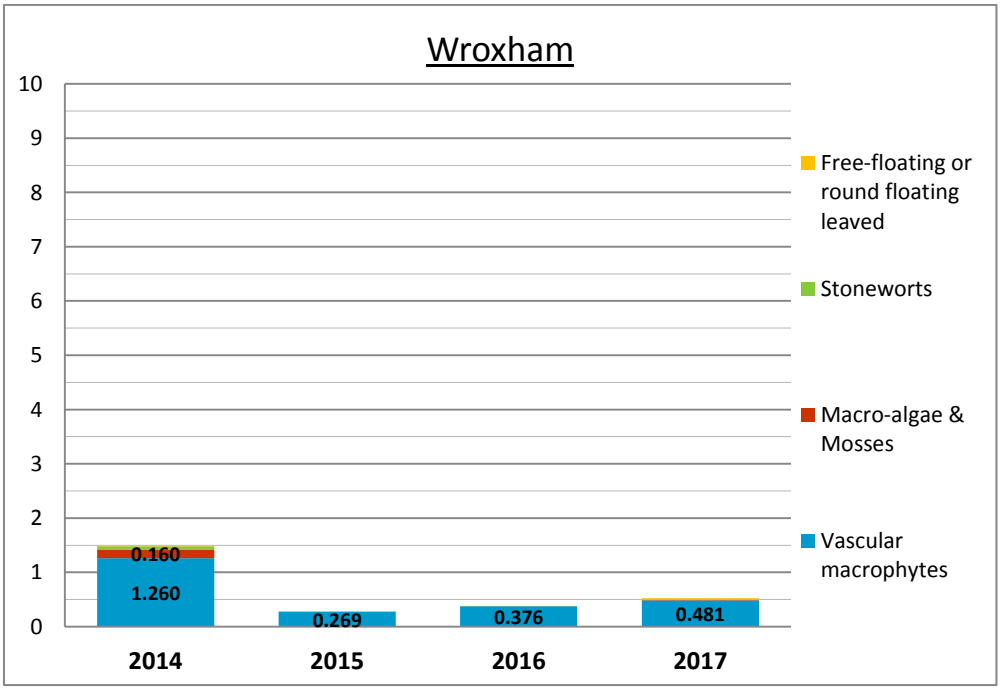


o. Wroxham

Common Name	Scientific Name	Summary Abundance	Occurrences
Rigid hornwort	*Ceratophyllum demersum*	0.384	25
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.089	21
Yellow water lily	*Nuphar lutea*	0.031	1
Filamentous algae	*Zygnematales*	0.013	8
Nuttall's waterweed	*Elodea nuttallii*	0.003	2
Starwort species	*Callitriche sp.*	0.003	2
Canadian waterweed	*Elodea canadensis*	0.002	1
Stonewort (*Nitella*) species	*Nitella sp.*	0.002	1
Total number of species recorded		**8**	**Total samples taken 64**

A fragment of a stonewort from the *Nitella* family was found on Wroxham broad this year. Unfortunately the sample was not sufficient or in good enough condition to narrow it down to species level. In general Wroxham broad's abundance levels are quite low, although there are small pockets in the northern and southern bays which are more hospitable.

Observations: Common duckweed and Yellow water lily were seen in the sheltered northern area. A freshwater sponge was found attached to some hornwort within the broad.



3.3.4 Yare Valley

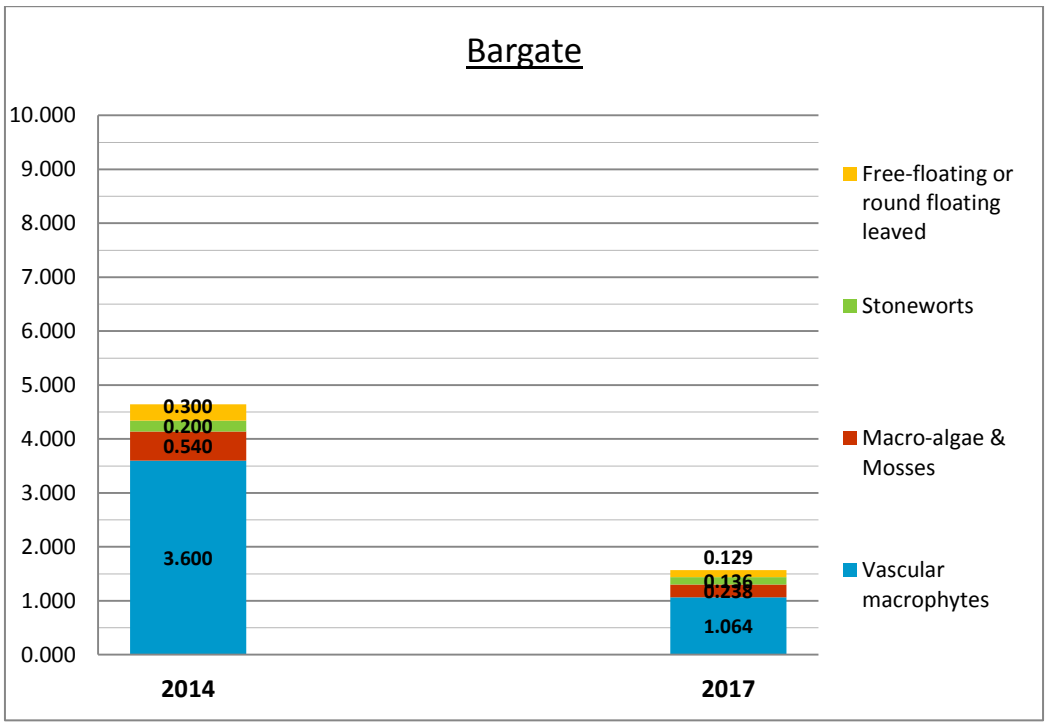
The majority of the broads within the Yare valley are isolated from the main river, with only Bargate, Rockland and Wheatfen having a direct hydrological connection. The Yare valley survey also includes two water bodies which are not a true 'broad' or 'decoy', a manmade lake created from flooded peat diggings or a lake created for wildfowl shooting respectively. Whitlingham Great and Little are created from gravel extraction and are quite young compared to other 'broads'.

p. Bargate

Common Name	Scientific Name	Summary Abundance	Occurrences
Unbranched bur-reed	*Sparganium emersum*	0.4976	23
Common water moss	*Fontinalis antipyretica*	0.2381	13
Nuttall's waterweed	*Elodea nuttallii*	0.2190	16
Rigid hornwort	*Ceratophyllum demersum*	0.1476	17
Pointed stonewort	*Nitella mucronata*	0.1357	12
Starwort species	*Callitriche sp.*	0.1286	18
Yellow water lily	*Nuphar lutea*	0.1286	8
Whorled water milfoil	*Myriophyllum verticillatum*	0.0548	5
Spiked water milfoil	*Myriophyllum spicatum*	0.0167	7
Total number of species recorded		**9**	**Total samples taken 42**

This gem of a broad is a nice peaceful hideaway on the river Yare and is connected to the river at two points. The rivers flow is evident not only in the rippling of the water on one side of the broad but also by the different plant communities therein. The long strap-like leaves of Unbranched bur-reed were the most abundant albeit in reduced quantities than the 2014 survey. Generally plant abundance had decreased along with species diversity, although on a positive note, Pointed stonewort was found at 12 locations within the broad.

Observations: Yellow water lily was seen in two bays on the western side of the broad. In addition an eel was accidently caught in a rake full of water moss, it was returned to the broad with no ill effects.


Bargate
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0.300
0.200
0.540
3.600
0.129
0.136
0.238
1.064
2014
2017
Free-floating or round floating leaved
Stoneworts
Macro-algae & Mosses
Vascular macrophytes

q. Buckenham

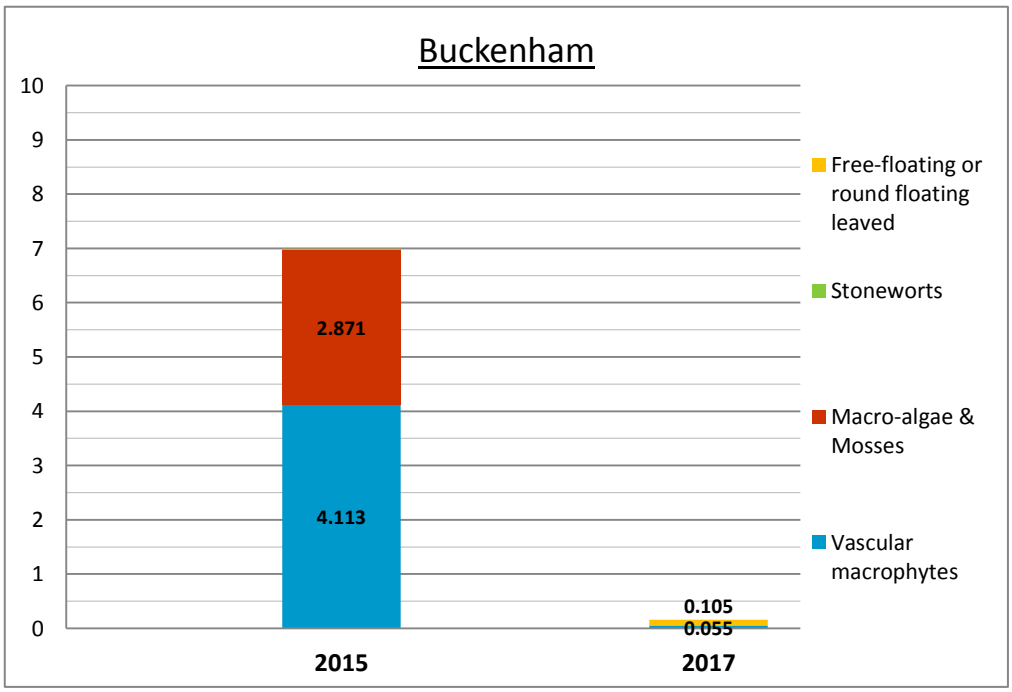
Common Name	Scientific Name	Summary Abundance	Occurrences
Yellow water lily	Nuphar lutea	0.105	1
Fennel-leaved pondweed	Potamogeton pectinatus	0.055	3
Total number of species recorded		2	Total samples taken 38

This broad, along with Hassingham broad is connected to Fleet Dyke and was last surveyed in 2015. Buckenham broad is on the western side of Fleet Dyke and the first broad you access from the estate. Back in 2015 the most abundant species was Rigid hornwort; it was also difficult to move around the broad due to the drifts of Filamentous algae.

This year it was a very different scenario, the overall abundance score dropped from 7.023 in 2015 to 0.16, this is a decrease of 97.7%. In addition only two species were found this year and in very low quantities; this is a considerable drop compared to the 2015 and 2013 surveys which recorded six and nine species respectively. In addition, no traces of Filamentous algae were recorded or observed within the broad.

Incidental observations also noted that the clarity of the water was very poor. Independent reports have mentioned a change in the wildfowl feeding regime which may have also inadvertently attracted feral geese to the estate from the surrounding stubble fields, this could be a contributing factor.

Observations: A fresh water sponge was found attached to a yellow water lily stem in the northern half of the broad close to the estates access dyke.



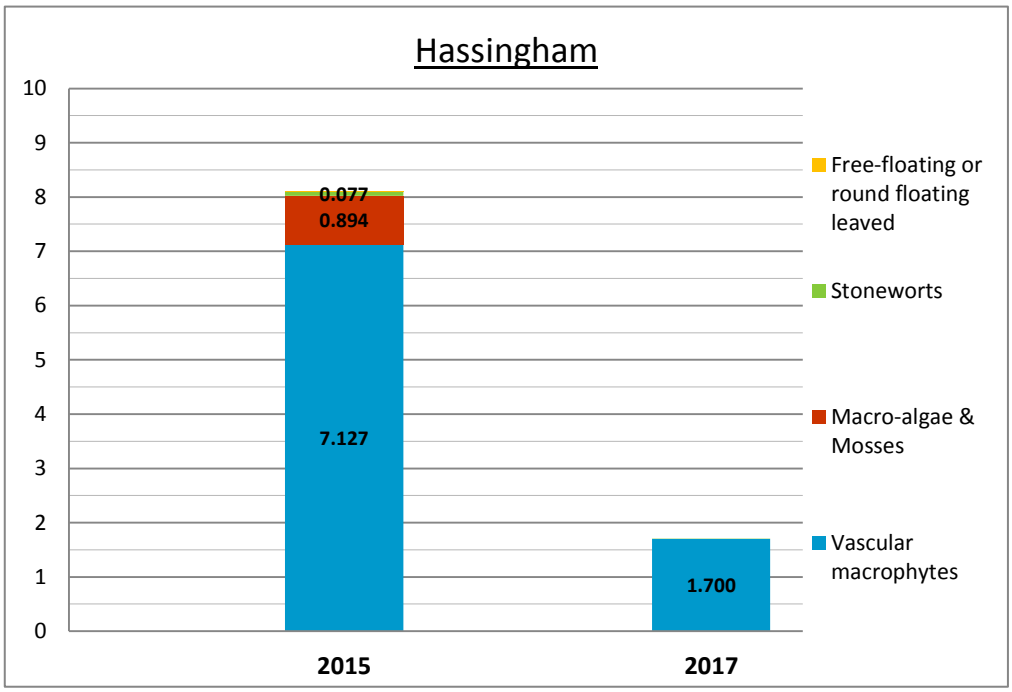
r. Hassingham

Common Name	Scientific Name	Summary Abundance	Occurrences
Rigid hornwort	*Ceratophyllum demersum*	1.268	29
Holly-leaved naiad	*Najas marina*	0.429	13
Fragile/convergent stonewort	*Chara globularis/connivens*	0.006	2
Curled pondweed	*Potamogeton crispus*	0.003	1
Total number of species recorded		**4**	**Total samples taken 34**

Hassingham much like Buckenham's plant abundance score has decreased sharply, albeit not to the same depths. The number of species found has halved and all but one of those species found has decreased by over 80%. Filamentous algae which was the second most abundant species in 2015 was not found this year. Holly-leaved naiad decreased by about 28%, which in itself is not a good result, but is better than the reduction in other resident plant species.

Due to the proximity and connection through a dyke network of Hassingham and Buckenham broad, the factors that have contributed to latter broads decline would also affect Hassingham broad.

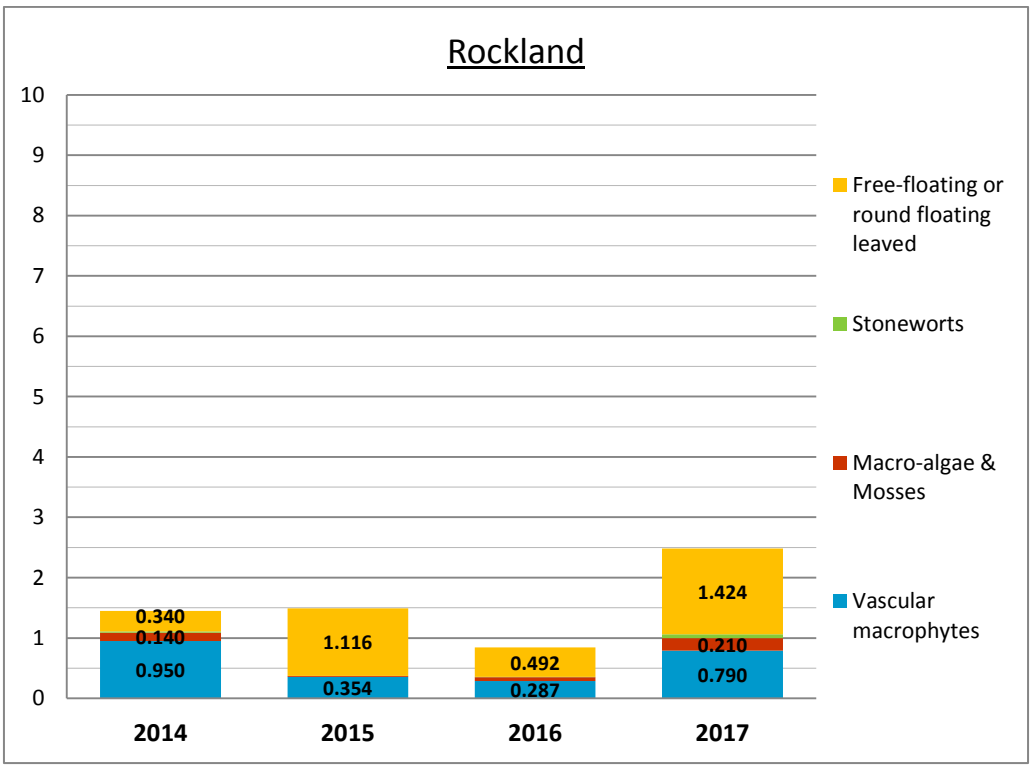
Observations: The water clarity here was much better than its sister broad Buckenham, but had still deteriorated compared to when it was surveyed in 2015.



s. Rockland

Common Name	Scientific Name	Summary Abundance	Occurrences
Yellow water lily	*Nuphar lutea*	1.424	20
Rigid hornwort	*Ceratophyllum demersum*	0.461	37
Common water moss	*Fontinalis antipyretica*	0.169	12
Arrowhead	*Saggitaria sagittifolia*	0.166	7
Horned pondweed	*Zannichellia palustris*	0.058	9
Pointed stonewort	*Nitella mucronata*	0.058	9
Starwort species	*Callitriche sp.*	0.042	8
Filamentous algae	*Zygnematales*	0.040	7
Whorled water milfoil	*Myriophyllum verticillatum*	0.037	5
Nuttall's waterweed	*Elodea nuttallii*	0.019	3
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.003	2
Crowfoot species	*Ranunculus sp.*	0.002	1
Fan-leaved water crowfoot	*Ranunculus circinatus*	0.002	1
Stonewort (*Nitella*) species	*Nitella sp.*	0.002	1
Total number of species recorded		**14**	**Total samples taken 62**

Yellow water lily is still the dominant species on Rockland broad, sheltered within its shallow tidal bays. The water lily had a very productive year, as did Rigid hornwort with a considerable increase in abundance score (390%), making it the second most abundant species in the broad. Pointed stonewort was found at nine different points this year. Spiked water milfoil and Holly-leaved naiad were not found.

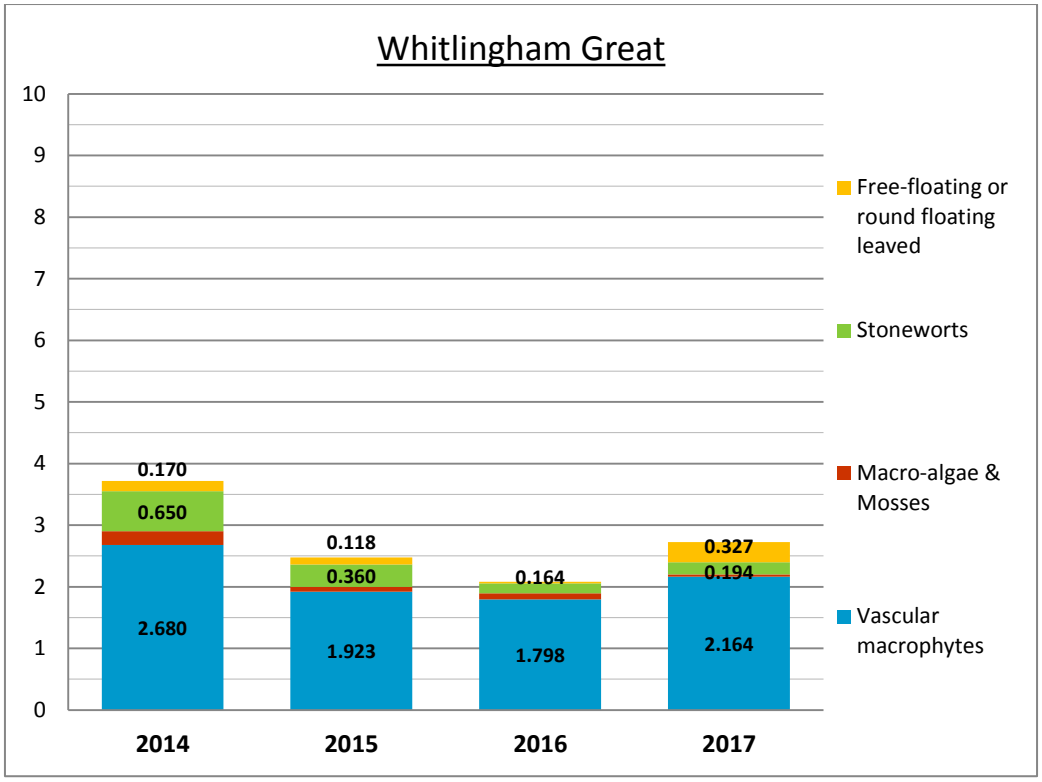


t. Whitlingham Great

Common Name	Scientific Name	Summary Abundance	Occurrences
Flat-stalked pondweed	*Potamogeton friesii*	1.155	25
Nuttall's waterweed	*Elodea nuttallii*	0.961	33
Ivy-leaved duckweed	*Lemna trisulca*	0.325	17
Common stonewort	*Chara vulgaris*	0.191	5
Filamentous algae	*Zygnematales*	0.039	7
Rigid hornwort	*Ceratophyllum demersum*	0.028	9
Canadian waterweed	*Elodea canadensis*	0.016	1
Fan-leaved water crowfoot	*Ranunculus circinatus*	0.003	2
Stonewort (Nitella) species	*Nitella sp.*	0.003	2
Common duckweed	*Lemna minor*	0.002	1
Curled pondweed	*Potamogeton crispus*	0.002	1
Total number of species recorded		**11**	**Total samples taken 64**

Flat-stalked pondweed had a very good season and was the most abundant species in the broad this year. In comparison, back in 2014 only trace amounts were found; since then it has slowly increased its foothold within the broad. Common stonewort also made an appearance after an absence in 2016. Nuttall's waterweed which has been the most abundant for the past few years is now second in the abundance list. Other pondweeds such as Fennel-leaved, Small and Lesser which have been previously recorded in decent quantities were not found this year. Similarly this year stonewort species were only represented by Common stonewort whereas last year there were three; Common, Rough and Delicate.

Observations: The water clarity within the broad this year was not good even in the sheltered area north of Whitlingham's largest island; this is part of the conservation area and has had a different plant community than other parts of the broad.

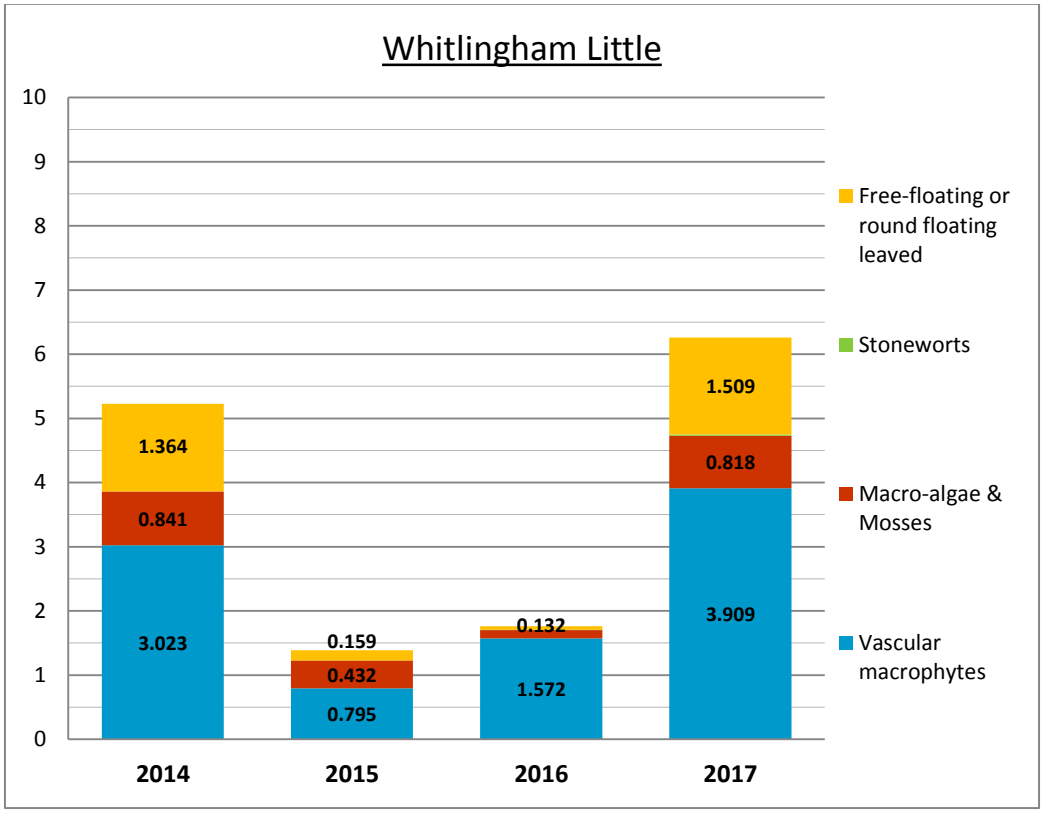

Whitlingham Great
10
9
8
7
6
5
4
3
2
1
0
0.170
0.650
2.680
0.118
0.360
1.923
0.164
1.798
0.327
0.194
2.164
2014
2015
2016
2017
Free-floating or round floating leaved
Stoneworts
Macro-algae & Mosses
Vascular macrophytes

u. Whitlingham Little

Common Name	Scientific Name	Summary Abundance	Occurrences
Nuttall's waterweed	*Elodea nuttallii*	3.552	35
Ivy-leaved duckweed	*Lemna trisulca*	1.509	30
Filamentous algae	*Zygnematales*	0.818	30
Rigid hornwort	*Ceratophyllum demersum*	0.173	9
Canadian waterweed	*Elodea canadensis*	0.093	2
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.091	2
Fragile/convergent stonewort	*Chara globularis/connivens*	0.023	1
Total number of species recorded		7	Total samples taken 44

Unlike Whitlingham Great broad, Nuttall's waterweed has had a very productive season within this broad as has Ivy-leaved duckweed, both of which have returned to a level similar to that of 2014. Unfortunately there was a decrease in the variety of species found within the broad; twelve different species were found in 2016 compared to this year's seven. Curled pondweed was one of the species which was not found; Filamentous algae was also quite productive this season.

Observations: A green jelly micro algae, possibly of the genus *Nostoc* was found attached to plant stems at a few points in the southern half of the broad.



3.3.5 Waveney Valley

There are six broads along the Waveney valley which are within the Broads Authority executive area, these are; Barnby, Spratt's Water, Woolner's Carr, Round Water, Flixton Decoy and Oulton Broad. The surveying of these broads has been focused on monitoring the progress of the broads following restoration programmes. Oulton broad was surveyed this year and is the first time it has been included in the water plant report. This broad is heavily used and during the summer months is subject to activities which other broads in the system do not experience, in particular power-boat racing.

v. Oulton

Common Name	Scientific Name	Summery Abundance	Occurrences
Common water moss	*Fontinalis antipyretica*	0.050	1
Rigid hornwort	*Ceratophyllum demersum*	0.013	8
Spiked water milfoil	*Myriophyllum spicatum*	0.007	4
Canadian waterweed	*Elodea canadensis*	0.002	1
Pointed stonewort	*Nitella mucronata*	0.002	1
Total number of species recorded		**5**	**Total samples taken 60**

This broad is heavily used and has recently been dredged; even so plant species were recorded. Common water-moss was found here, it is a species that appears to like a flow of water instead of slow to stagnant conditions. The other species are quite common within the system, apart from Pointed stonewort, and were all found in the mid to western half of the broad.

3.4 Conclusions

- Good results were obtained for Heigham Sound with excellent species richness and abundance. Shining pondweed, a new species of note was recorded, appearing amongst the areas of Mare's tail.
- Hickling was productive; the final count was three more species than 2016. Two surveys were conducted this year in June and July, with the later survey indicating how much the plant life within the broad can increase within one month. It also showed how the dominant or most abundant species can change not only from year to year but from month to month. Baltic stonewort was dominant in June with Spiked water milfoil taking over in July.
- Martham North had an increased overall abundance score this year, the main cause of this was a productive season for Bristly stonewort although it also had a decrease in vascular macrophytes by over 90%. Whereas Martham South had a drop in its overall abundance score (39%), this is due to a more than 50% decrease in stoneworts which showed considerable signs of grazing. Conversely, vascular plants such as Holly-leaved naiad and Fennel-leaved pondweed fared much better, with their collective abundance score increasing from 0.002 to 1.392 (>99%). Independent accounts report sightings of vast flocks of Greylag geese residing on the broad during their moult period.
- Alderfen had a decrease in overall abundance compared to 2016, particularly Rigid hornwort and to a lesser degree Holly-leaved naiad, however stoneworts abundance improved albeit with a reduced diversity.
- Cromes broad demonstrated good results for vascular plants (plants with a well-developed vascular tissues consisting of phloem and xylem to transport to transport nutrients water and minerals), mainly Rigid hornwort. This broad is still home to species of conservation concern such as Water-soldier and Holly-leaved naiad.
- Cockshoot continues to be dominated by Holly-leaved naiad, with only one other species recorded during the survey.
- Ranworth was very poor this year with very few plants found. Trace amounts of plants were recorded at four points out of 33. Filamentous algae which is a generalist and can be a good indicator of nutrient enrichment was only recorded at one of these locations.
- Bargate was surveyed this year; the last time was in 2014. It is a quiet hidden broad with an interesting plant community; Common water moss grows within the flow from where the dyke enters the broad to where it exits and returns to the river. Unbranched bur-reed was also found which is more typical of flowing waters, although species of standing waters were also present. Generally plant abundance had decreased along with species diversity since it was last surveyed in 2014
- Buckenham and Hassingham, which are connected by dykes, have had a worrying decrease in plant abundance since last surveyed by the Broads Authority in 2015. Buckenham has experienced a 97.7% drop in overall abundance; from a collective abundance score of almost 7 to less than 0.2, which means that only a few fragments of plants were found. The incidental observations noted that waters here were very turbid suggesting a change in water quality or another dynamic within the ecosystem. Coincident with the decline in plants, independent reports suggest that a contributing

factor may be a change in the wildfowl feeding regime along with inadvertently attracting opportunistic feral geese, which also feed on the stubble fields in the surrounding area. The water runoff from the surrounding catchment is a possible vector for these subsequent nutrients.

- Good results were recorded at Whitlingham Little Broad with Ivy-leaved duckweed found throughout and Nuttall's waterweed found at 35 of the 44 points. There is still a considerable amount of Filamentous algae which will hopefully reduce with time and with the support of the public to not feed water birds.
- Oulton Broad was officially surveyed for the first time this year, and even though this is a heavily used broad with active dredging water plants were still found. The species include: Canadian waterweed, Common water moss, Rigid hornwort, Spiked water milfoil and the Chara, Pointed stonewort all of which were found on the mid to western half of the broad.

4 River Plant Survey

4.1 Introduction

The aim of the river plant survey is similar to the Broads water plant survey, which is to monitor water plants within specified lengths of river or man-made watercourse, along previously defined sections. This is undertaken between early June and late July, using the methodology outlined in section 4.2 below. Ideally the river plant survey should be completed, before the commencement of the Broads water plant survey in July.

The river plant survey is a point based system similar to the broad's plant survey. The results are used to inform maintenance work which is carried out within these waterways, such as weedcutting.

4.2 Survey Methodology

4.2.1 Selection

a. The waterways surveyed need to meet a few criteria in order to be selected:

   - The section must be within the Broads executive area
   - The section must be publically navigable thus excluding private dykes or cuts

b. Once the sections are identified, the same algorithm used for the broads water plant survey is used to calculate the number of survey points or in this case sectors which would fully represent the river or dyke.

c. Sectors are then evenly plotted along the length of the river or dyke.

d. Each sector will contain three points where the sampling is conducted; these comprise the centre of the water course, the true left and the true right.

e. An aerial photograph of each selected site was produced on which each of the sectors was marked. Grid references were also included for each numbered sector.

4.2.2 Field method

a. In the field, surveyors used the grid references of each plotted point to identify the point's location. The survey boat navigated to each point using a handheld GPS device.

b. Once within 5 m of the plotted grid reference mud weights were deployed to keep the boat in the correct location at each of the cross section of points.

c. A double headed survey rake was thrown downstream a distance of 5m from the boat edge. The rake was left for 10 seconds to sink to the bottom after which the rake was pulled slowly and steadily along the bed of the broad, back towards the boat. For points

that were in deeper water, additional rope was thrown to allow the rake to sink and rest on the bed of the river or dyke at a distance of 5m from the edge of the boat. Each sample was recorded separately, for subsequent analysis.

d. On retrieval of each rake, the plants attached to the rake head were collected in a white survey tray. If necessary, plants were washed to remove excess sediment to aid identification.

e. All the live plant material was identified to species level wherever possible. For example, some particularly difficult groups e.g. any non-fruiting starworts were only identified to genus level 'Starwort species'.

f. Any plant specimens where identification in the field was uncertain were collected in plastic bags, labelled using the station number reference and the direction of the throw. These samples were then taken for subsequent observation using a high powered microscope, or sent for expert identification. Wherever possible, voucher specimens were pressed and dried using standard herbarium techniques.

g. To assign a level of abundance, the same methodology as per the Broads point survey was used.

4.2.3 Data processing

a. For each sample, species abundance scores can be totalled, to produce the total abundance score. The sum of all sample abundance scores produces the total abundance for the site . Assuming maximum plant abundance on the site, the total site abundance score should be a maximum of 10 (± 10%).

b. For data comparison, the results have been calculated to show the species richness (number of species recorded) and the species abundance scores. Species abundance is calculated by combining all abundance scores for a particular species at each site and dividing by the number of samples which were surveyed for that site. Within each sites results table, the species abundances have been displayed in descending order so that the most abundant species in 2017 are listed at the top.

4.3 Results

4.3.1 River Bure

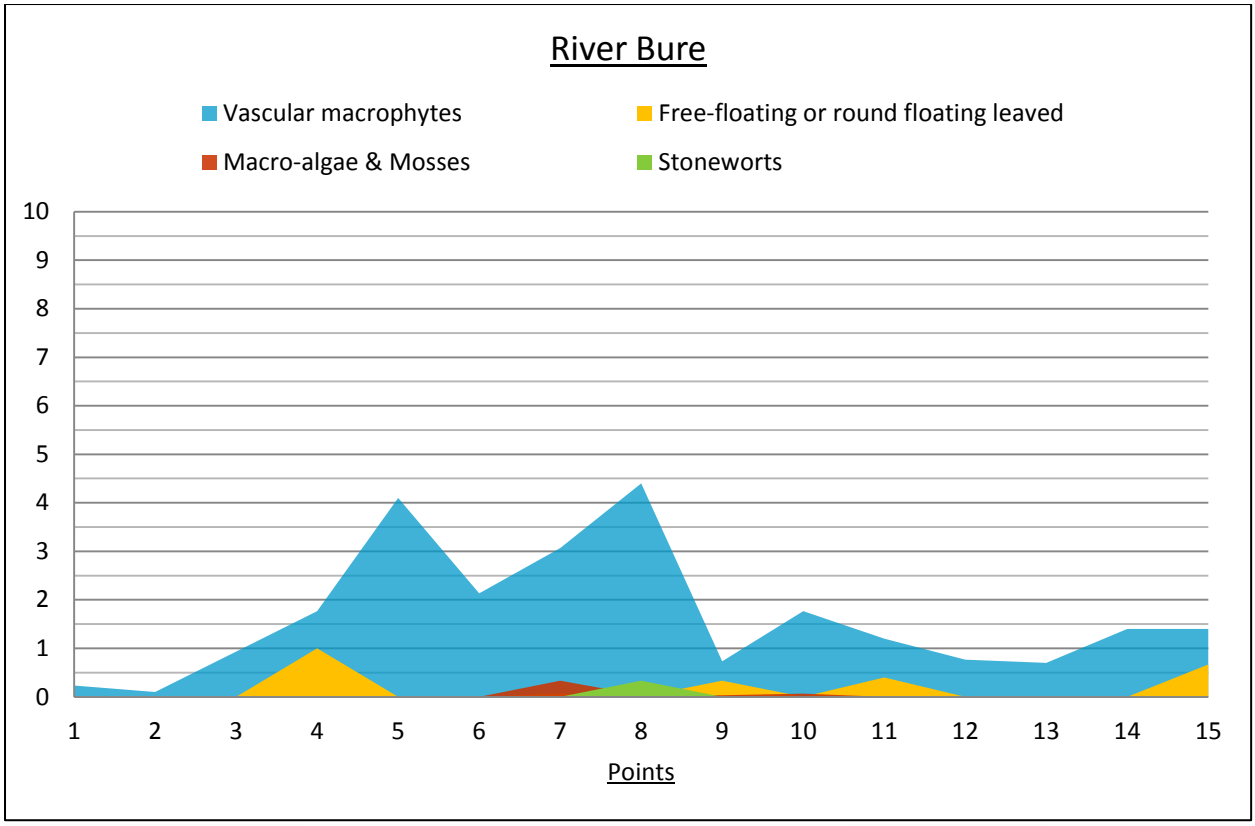
The River Bure survey began at Horstead Mill, in the pool below the dam which marks the end of the navigation. It continued downstream to just after the public mooring at Belaugh; this incorporated 15 stops each with three survey points, True Left, True Right and Centre, to fully represent a cross section of the river. The water plants within this area of the river are regularly cut during the summer season.

This stretch of the river slowly meanders and is quite quiet; it is typified by stretches of Carr woodland, fields, amenity grassland, and residential gardens with areas for boats. There are a few public and smaller private mooring at Belaugh, Coltishall and Horstead.

Common Name	Scientific Name	Summary Abundance 2016	Occurrences
Unbranched bur-reed	*Sparganium emersum*	1.260	43
Nuttall's waterweed	*Elodea nuttallii*	0.890	27
Yellow water lily	*Nuphar lutea*	0.247	8
Starwort species	*Callitriche sp.*	0.180	17
Branched bur-reed	*Sparganium erectum*	0.107	4
Filamentous algae	*Zygnematales*	0.043	4
Pointed stonewort	*Nitella mucronata*	0.033	1
Ivy-leaved duckweed	*Lemna trisulca*	0.003	1
Pondweed species	*Potamogeton sp.*	0.003	1
Total number of species recorded		**9**	**Total samples taken 45**

Unbranched bur-reed is on average the most abundant species on this stretch of river and its long trailing leaves are a regular feature seen rippling within the current. Other species appear in sheltered corners of a bend or bays such as Yellow water lily and Ivy-leaved duck weed. A species of note is the Pointed stonewort which was found at point eight mid-way through the survey area.

Observations: Common duckweed was seen along most of the stretch of river along the banks and caught in eddies, although it was not picked up during the survey. Yellow water lily was also seen along the river, but quite close to the banks and not obtained frequently on the survey rake.


River Bure
Vascular macrophytes
Free-floating or round floating leaved
Macro-algae & Mosses
Stoneworts
10
9
8
7
6
5
4
3
2
1
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Points


River Bure Macrophyte Survey Points
1
2
3
4
5
6
7
8
9
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12
13
14
15
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4.3.2 Old River Yare & Wensum

This river survey incorporated two rivers and the confluence which combines them into one. The survey began on the Wensum in Norwich city at New Mills Yard which marks the end of navigation in that section. It continued downstream to Trowse Eye where it meets and becomes the River Yare. The Yare survey began just upstream before the confluence and then continued following the path of the Old River Yare which runs north of Thorpe. The survey ends just after the moorings before the Old River Yare and the New Cut combine again. The whole survey incorporated 16 stops, each with three survey points, True Left, True Right and Centre, to fully represent a cross section of the river. The water plants within this area of the river are regularly cut during the summer season.

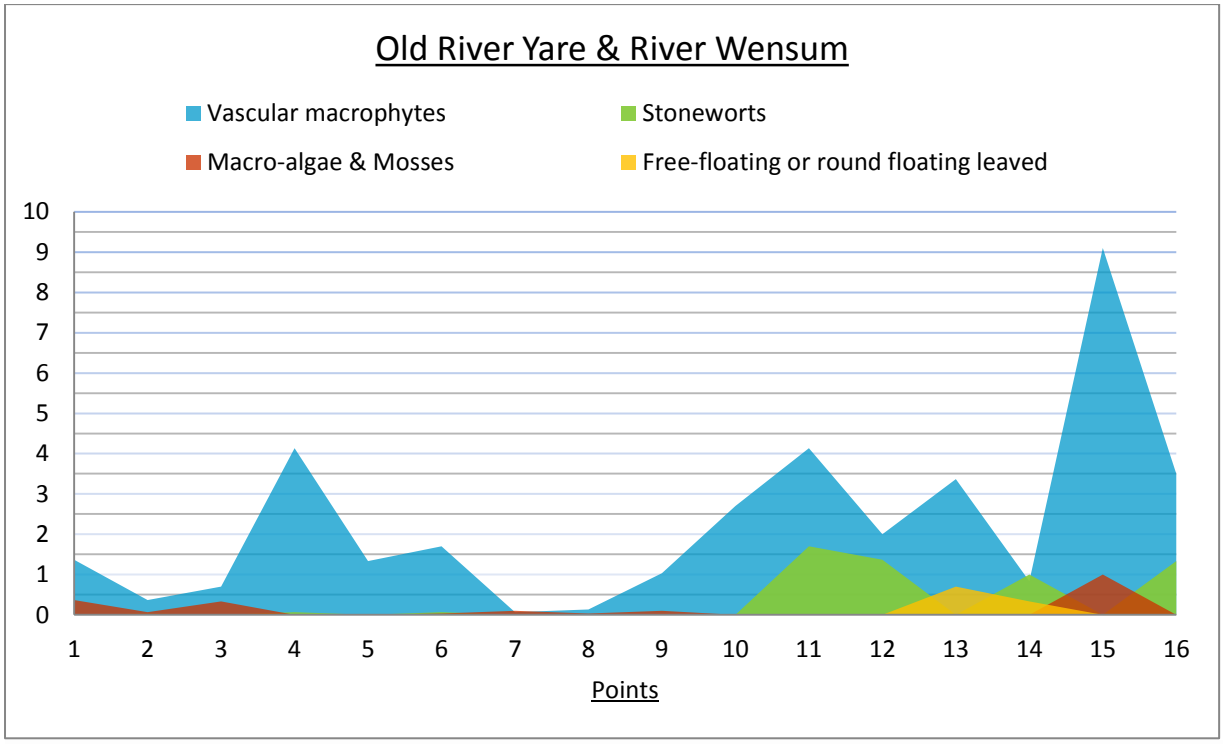
The Wensum stretch of the river is quite wide and runs through the city which as you would expect is typified by concrete and brickwork banks, piling and old industrial complexes which in most cases are now apartments. As the Wensum comes to an end at Trowse Eye and the Yare takes over, a more natural landscape becomes more prevalent, albeit including urban parkland and railway sidings.

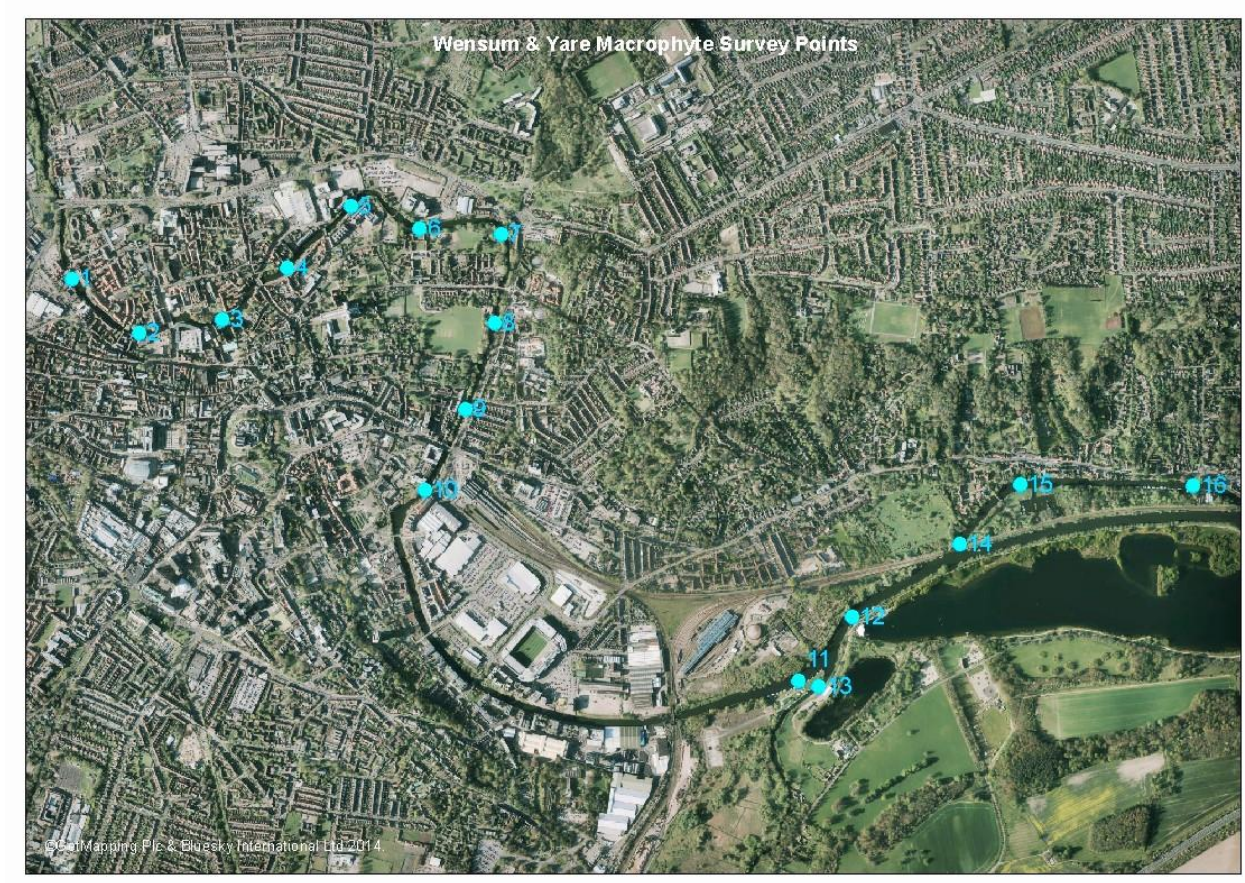
Common Name	Scientific Name	Summary Abundance 2016	Occurrences
Unbranched bur-reed	*Sparganium emersum*	4.717	39
Nuttall's waterweed	*Elodea nuttallii*	2.893	16
Stonewort (*Nitella*) species	*Nitella sp.*	1.217	14
Filamentous algae	*Zygnematales*	0.350	13
Yellow water lily	*Nuphar lutea*	0.258	3
Long-stalked Pondweed	*Potamogeton praelongus*	0.150	2
Rigid hornwort	*Ceratophyllum demersum*	0.092	8
Pondweed species	*Potamogeton sp.*	0.083	1
Smooth stonewort	*Nitella flexilis*	0.083	1
Common water moss	*Fontinalis antipyretica*	0.055	2
Starwort species	*Callitriche sp*	0.038	5
Spiked water milfoil	*Myriophyllum spicatum*	0.018	3
Branched bur-reed	*Sparganium erectum*	0.005	1
Total number of species recorded		**13**	**Total samples taken 48**

Surprisingly this urban survey has recorded more species than the rural survey on the River Bure with thirteen compared to nine. The river specialist, Unbranched bur-reed, is the most abundant, located at over 80% of the points. Long-stalked pondweed was found within the pool below New Mills Yard. All plant species numbers dipped at points 7 and 8 and those that were found were at trace quantities. The Wensum section is not as diverse and contains strands of Filamentous algae; this algae had only one occurrence on the Yare at point fifteen. The river really improves just after point 10 where it leaves the build-up city-scape. At point 13 before the Yare and Wensum join, is not a busy section and is notably narrower. Yellow water lily is abundant here which indicates that there is not a great deal of river traffic, besides rowing boats and kayaks.

Stoneworts were seen in trace amounts intermittently along the survey until point 11 when larger quantities were found and could be identified as Smooth stonewort.

Observations: Common duckweed was seen in small quantities along the stretch of rivers, although it was not picked up during the survey. Greater duckweed was seen in the New Mills Yard pool and Yellow water lilies in quiet bays and bends.





4.4 Conclusions

The results were not fully as expected; the urban River Yare/Wensum contained more species and a higher overall abundance than the more rural River Bure, however many factors influence the plant communities found within each river. For instance the River Bure will have a slower flow than the Yare and is not as influenced by the tide. The Yare/Wensum will have a greater flow of water, wider channel and is not as shaded by trees. The River Yare/Wensum survey also takes in to account the slower meandering original River Yare thus adding another habitat which otherwise wouldn't occur within the survey area.

As such, the two cannot truly be compared and further monitoring of the rivers is required so as to assess the condition of the river accurately against its previous set of results, thus moving away from circumstantial evidence of the rivers health.

Moving forward, it would be sensible to include all the main rivers in the 2018 survey should resources allow.

5 Hydroacoustic Surveys

5.1 Introduction

Hydroacoustic survey equipment, utilising sonar technology, is commonly used for detection, assessment, and monitoring of underwater physical and biological objects. Boat-mounted hydroacoustic equipment can be utilised to detect the depth of a water body (bathymetry), as well as the presence or absence, distribution and size of underwater plants.

Such survey equipment measures the range to an object and its relative size by producing a pulse of sound and measuring the time it takes for an echo to return from the object and the amplitude of the returned echo. The range is calculated as a function of the speed of sound and the time it takes for the echo to return.

5.2 Method

5.2.1 Survey technique

The hydroacoustic survey involves navigating a survey boat along set transect routes within a broad, to provide an insight into the vegetative growth over the bed. The transects are located on the same grid based point survey used for the water plant survey (grid spacing is 178m), thus enabling some level of validation and comparison between the surveys.

In response to the continued expansion of water plant growth in Hickling, additional hydroacoustic transects were added in 2017 to increase the frequency and data gathered. These were increased to every 60m in the Western section of the broad, with a higher concentration of transects (every 4m) over the 2017 experimental plant cutting areas for both Chara and common plant species. Results for the plant cutting trials will be reported separately.

The equipment used in this survey includes a BioSonics DT-X, single beam (10°), 420 KHz transducer, with an on-board control unit and operating laptop. All data recorded whilst mobile on the waterbody was geo-referenced through connection to an external GPS receiver. This allowed subsequent quantitative analysis of the data using Sonar5-Pro post-processing software, developed specifically with a vegetation analysis component.

To assist with data processing and ground-truthing the bathymetric measurements, notes were made about the distribution of plants within each transect e.g. where plants were seen at the surface of the water, or the species observed.

5.2.2 Data Analysis

Using the Sonar5-Pro software, the sediment surface of each transect file was identified, as well as the less intense return derived from the upper surface of the water plants. Each transect was divided into 5 m sections for ease of analysis and to provide workable units within which to generate values for the bathymetric and water plant parameters recorded. However at Hickling each transect was divided into 1m sections to improve the data analysis.

Data analysis produced the following results: water depth (to sediment surface), plant height, area of lake bed covered by plants (PAI), and percent volume of lake inhabited by plants (PVI). All water depth data was corrected for variation through reference to local water level datums.

For Barton Broad, features taller than 8 cm above the inferred sediment surface were recorded as water plants during the data processing, to reduce the likelihood of recording false positive results.

This cut-off figure was calculated by selecting a transect with negligible plant growth, and adjusting the height threshold to determine the optimal (lowest) figure that minimised false reporting. For Hickling Broad features taller than 15cm above the inferred sediment surface were recorded. This was selected following the production of anomalous recordings using the 8cm threshold, possibly owing to a higher percentage of plants covering the bed of the broad than in previous year leading to the analysis programme being unable to make a clear differential between the bed and plant growth. (Table 1).

Table 1 Percent plant coverage of bed, based on different height thresholds for Hickling Broad

Height threshold (m)	% of bed covered in plants
0.05	30.45
0.06	30.45
0.07	30.45
0.08	18.08
0.09	18.08
0.10	18.08
0.11	18.08
0.12	18.08
0.13	18.08
0.14	18.08
0.15	13.42
0.16	13.42

5.3 Barton Broad

As in 2016, there was plant growth in June along the western edge of the broad near the swing moorings, in the narrow western section of the broad leading to Limekiln Dyke and the southern edge of the broad. Figure 1 shows the location of transects used on Barton Broad in 2017.

5.3.1 Results

Overall, Barton Broad had negligible plant growth across the greater part of the broad. Only three transects gave positive results of any significance with a percentage volume of plants (PVI) between than 10% - 20%; these were recorded along transects E3, E8 and N1. Of the remaining transects, sixteen of them had an average PVI of below 10%. Transects N7 to N11 had an average PVI value of below 3.15%

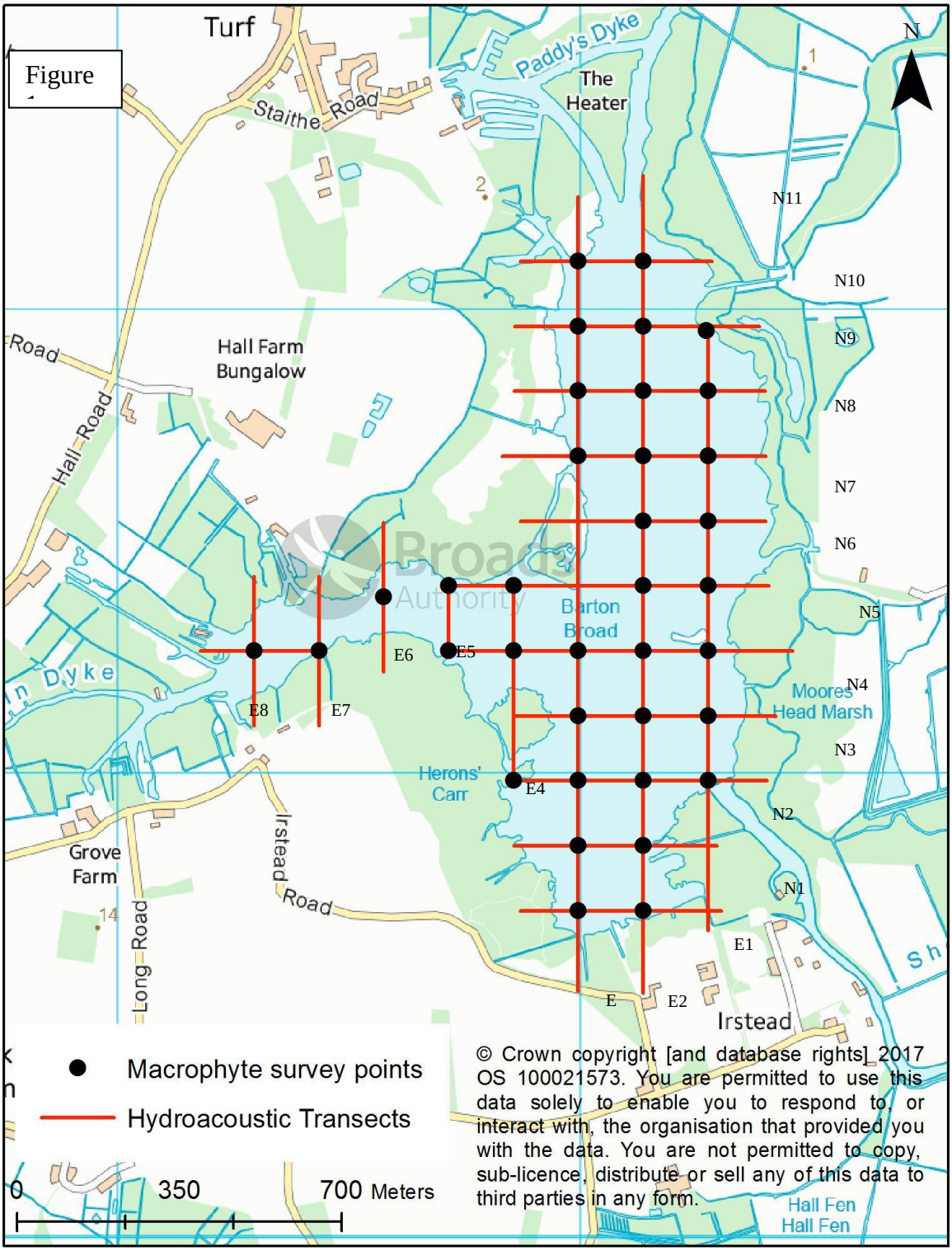


Figure 1 Distribution of grid lines for hydroacoustic survey in Barton Broad

Table 2 Hydroacoustic survey results from Barton Broad, June2016

Barton Broad	June 2016
Mean Water base depth (m)	0.53
Max Water Depth In Meter (m)	2.15
Mean plant height (m)	0.11
Max plant height (m)	1.64
Bed covered by plants (%)	11.38
Plants as a percentage of water column (PVI) (%)	3.45

Table 2 shows the figures for the whole broad with average plant height at 0.11m. Maximum plant height recorded was 1.64 m. Despite the few locations with significant water plant growth, the main body of the broad had no observed water plants, which resulted in an average PVI of 3.09%.

5.3.2 Conclusion

The hydroacoustic survey has shown that water plant growth in Barton Broad is very localised and overall Barton has a relatively low amount of growth for a typical shallow lake. This general low abundance of water plants with limited distribution across the broad was also reflected in the rake based water plant survey. The current Natural England assessment of the SSSI unit that encompasses the open water of Barton Broad is 'unfavourable – recovering', indicating that some recovery is evident, but not yet reaching expected targets. Similarly, the Environment Agency Water body classification in 2015 was described as 'overall – poor' mainly based on paucity of water plants and abundance of phytoplankton (green algae). The Environment Agency's prediction for 2027 is that the direction of travel is not improving, and that 'poor' ecological quality will still be present at this time, based on the currently available evidence and measures in place to improve conditions.

Overall, the transect grid layout has given an overview of plant abundance across the broad and has highlighted the western edges of the broad having the areas of particular abundant growth in comparison to the rest of the broad.

5.4 Hickling

Compared to the low abundance of plants in Barton Broad, Hickling has had periods of intense plant growth with a plethora of different species.

Figure 2 is a typical screenshot of the post processing information, which shows transect G1 running west-east (left to right). The black line marks the sediment surface, and the red line the height of the aquatic macrophytes. The area between the red and black lines is the volume occupied by water plants.

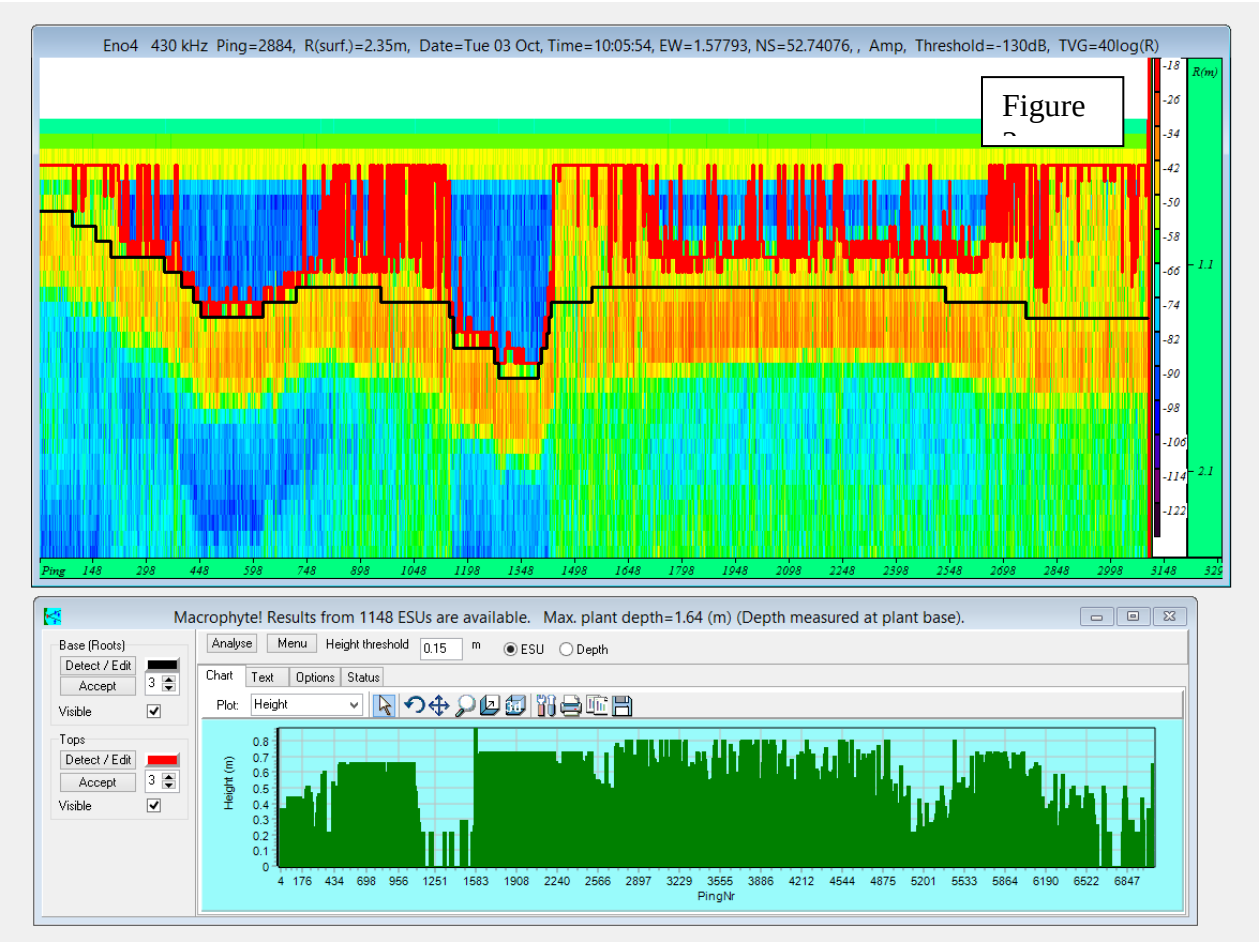


Figure 2 Screenshot of the post-processing visual output of data from Transect G1.

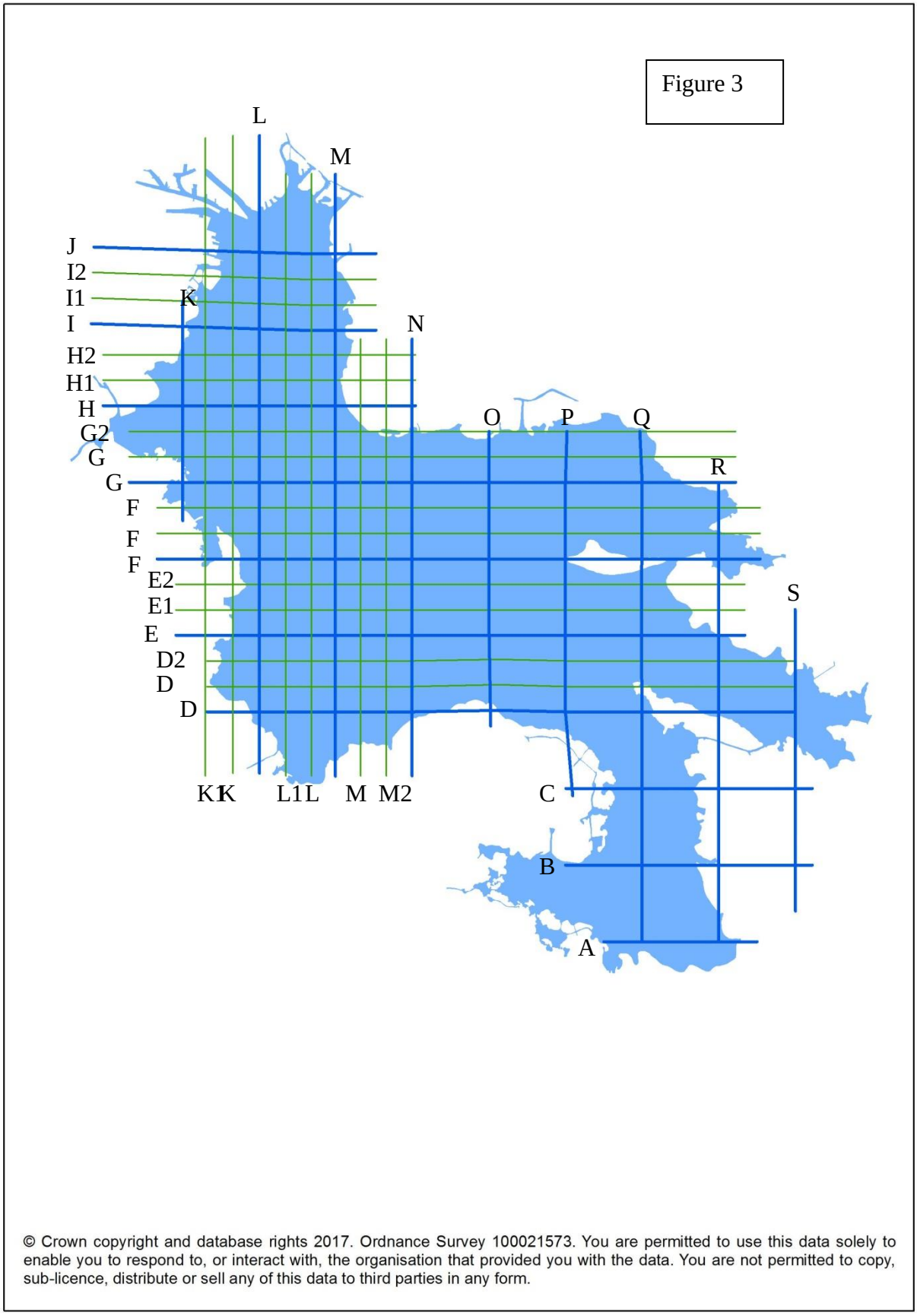


Figure 3 Distribution of grid lines for hydroacoustic survey in Hickling Broad

5.4.1 Results

Four whole-Broad hydroacoustic surveys were undertaken at Hickling in 2017. This increased survey effort was in response to the expansion of water plants in 2016, with the aim of monitoring the growth of plants closely over the course of the 2017 growing season.

During August at the height of growing season in Hickling broad, the areas of most intense plant growth were situated in the bay north of Pleasure Island, the south west corner of the broad and the northwest corner of the broad. Figure 4 shows this distribution as a contoured map of available water depth above the plant growth, which the Authority produced for users of the broad. The information was produced in this way to guide local users as to the location of plants and their height in the water column.

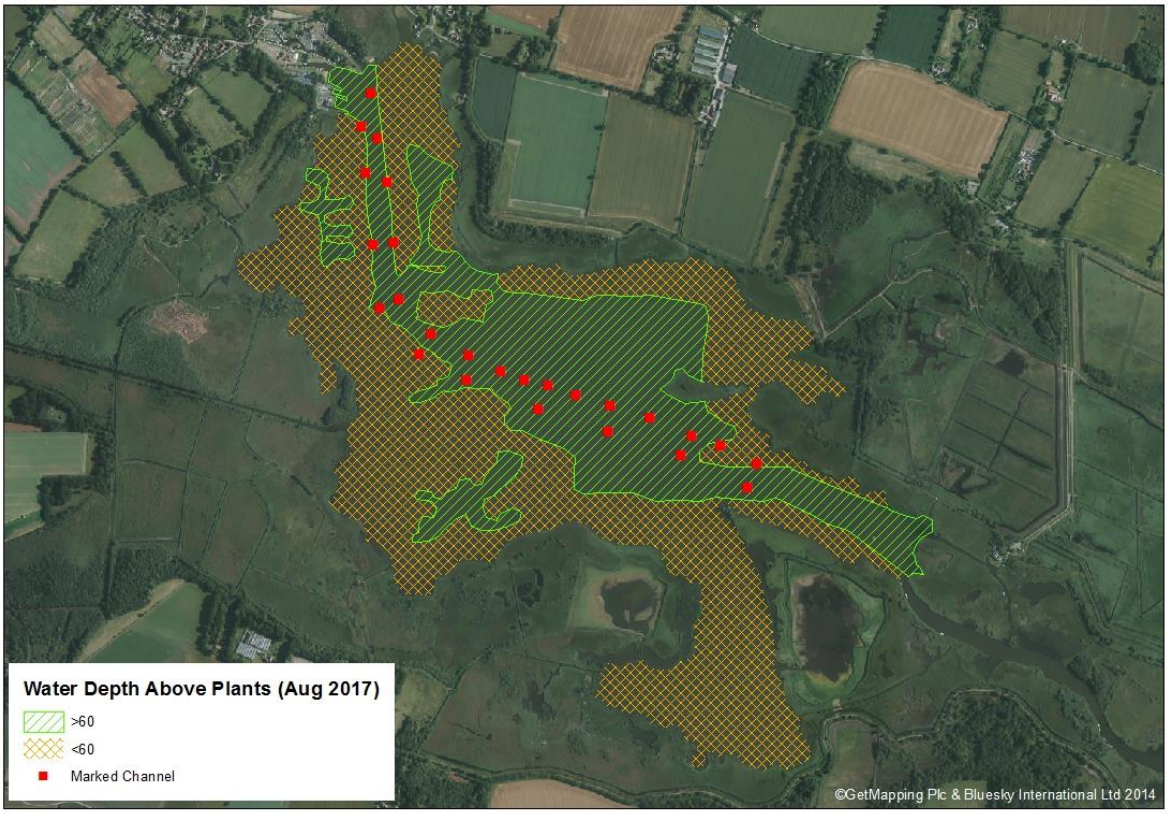


Figure 4 Contoured map of water depth above plant growth in Hickling Broad, August 2017

The survey was unable to proceed to the north east of Pleasure Island due to the density of the plant beds; this area had recorded an average PVI of 60% in 2016 so it is likely that this has increased, thus preventing access for the survey. The southwest of the broad from transects D to F2 had PVI from 30% to 41% this included M1, M2 and N. The transects A,B,C, Q and section D which are located in the south east bay had PVI of 30% to 37%. This is in comparison to transects R and S that only had PVI between 2 and 11%. The remaining seven transects which are located in the east half of the broad which occur at a lower frequency range from 15% - 19% with the majority at 17% PVI.

Table 3 Hydroacoustic survey results from Hickling Broad, 2017

Hickling Broad	May 2017	June 2017	August 2017	October 2017
Mean Water depth (m)	0.52	0.98	1.04	0.99
Max Water Depth In Meter (m)	1.97	1.84	2.78	1.93
Mean plant height (m)	0.21	0.34	0.42	0.39
Max plant height (m)	0.8	0.89	2.19	1.03
Bed covered by plants (%)	35.45	51.64	65.69	65.55
Plants as a percentage of the water column (PVI) (%)	15.54	19.36	27.66	27.14

Table 3 shows the average figures for the whole broad for May, June, August and a late season survey in October. By August, the plant beds had thickened up considerably, with a higher percentage of plants reaching the water surface in comparison to May. The average plant height figures are useful for comparison between surveys, but give little indication of the typical height of visible plants.

The percentage of the bed of the Broad covered in plants had also increased significantly by August with a 30% rise in plants covering the bed. To qualify as having the bed covered by plants, as discussed in the methodology section, these plants could have only been as tall as 15 cm. The most useful figures for direct comparison of the amount of total plant abundance in the waterbody are the PVI%. As this measure represents the percentage volume inhabited, it gives the proportional volume occupied by water plants within the waterbody. The increase from 15.54% to 27.66% between May and August represents a 12% increase; this is considerable and shows how rapidly water plants can respond to optimal growing conditions.

In terms of methodological limitations, as the surveys are based on a grid system, there will inevitably be areas not surveyed. With an even distribution of the grid lines and sufficient total transect length, the overall effort is seen as appropriate to give a robust overview. This year with the increased density of transects on the west side of the broad, this will have enhanced the accuracies of the resulting data.

In August, the results showed that transects D and E had the highest PVI, both just above 40%, with a high density of plant growth to the surface. Overall the results indicated that the navigation channel and middle of the broad had very limited plant growth, in stark contrast to the vigorous growth to the surface north of Pleasure Island, South western side of the Broad (PVI 30-40%) which is then followed by north bay (PVI 20-30%). In October there was a slight decline in the PVI and percentage bed covered by plants; this suggests the start of the expected decline in plants over the winter.

The current Natural England assessment (last carried out in 2013) of the SSSI unit that encompasses the open water of Hickling Broad is 'unfavourable – declining', indicating that overall the site is moving away from target conditions. This assessment was based on a failure to meet characteristic species targets and poor water quality. Similarly, the Environment Agency Water body classification in 2015 was described as 'overall – poor' mainly based on the abundance of phytoplankton (green algae). However, the Environment Agency's prediction for 2021 is that the direction of travel is improving, given the range of remedial measures in place, and the objective of 'good' ecological quality will be met by that time.

5.4.2 Conclusion

It is important to note that the methodology changed this year for Hickling Broad, leading to a substantially larger area being surveyed. This has resulted in an increase in the amount of data collected, improving accuracy and to the ability to further refine the picture of aquatic macrophyte distribution in Hickling.

The number of transects surveyed has risen from 15 to 33 and the number of transects dissecting the navigation channel have increased from 14 to 27. The total length surveyed has more the doubled from just under 18,000m in 2016 to just under 40,000 in 2017, and the number of surveys has increased from 2 to 4 . In addition, the data analysis has also been increased to every 1m along the transect (previously every 10m). These methodological changes have resulted in an improved dataset at a time when the aquatic plants within Hickling are currently demonstrating an upward trend in terms of abundance and distribution.

6 Conclusions

Now that there is a four year data set for the point based survey method, recent trends can be looked at more easily. However this data set is still small and caution is once again advised in inferring longer term patterns from the sometimes high variability in growth of particular species between years.

The comparison of plant abundance between sites has been facilitated through adopting the point based sampling methodology. The graphs presented in the broads section of the main report highlight for example the relatively poor growth of water plants in Barton Broad, Horsey Mere and Ranworth, which are some way from meeting their SSSI and SAC conservation targets. At the other end of the scale, Martham South and North broads both had very strong stonewort populations over the majority of their beds, as is expected for shallow lakes or broad sites with good water quality.

The forward plan to rotationally survey a minimum of two river sites each year is an important aim for these surveys. There has been increasing demand on the weed harvester operation and continued reports on increased water plant growth having an impact on navigational access in specific areas. The key sites include the River Bure (Coltishall Lock to Belaugh), River Thurne (West Somerton to Martham Ferry; Waxham Cut & Catfield Dyke), River Ant (Tyler's Cut), River Wensum/Yare (New Mills to Whitlingham Broad), and the River Waveney (Geldeston Lock to Beccles). Observing the trends and species present at these sites will assist the sustainable management of these areas and strike a good balance between navigational access and ecological functioning. As water quality continues to improve and water plant growth responds accordingly, the challenge of managing appropriate water depth and safe navigation also continues.

The combination of rake based surveys and hydroacoustic surveys continue to be a very powerful tool for guiding site management, such as prioritisation of areas for restoration and ecological enhancement, e.g. Churchill's Bay at Hickling Broad. Water plant growth has been raised as an impact on navigational access, particularly sailing in Hickling Broad. The analysis of plant growth over the whole site is critical in establishing any likely impacts on this European Protected site and the conservation interest features at Hickling, before considering the possibility of managing the height of plant growth outside of the marked channel.

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Appendix 1. Macrophyte groupings based on form

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

Appendix 2a. Latin to Common plant names.

Latin	Common
Acorus calamus	Sweet flag
Alisma plantago-aquatica	Common water-plantain
Chara pedunculata	Hedgehog stonewort
Callitriche stagnalis	Intermediate water-starwort
Callitriche sp	Starwort sp.
Ceratophyllum demersum	Rigid hornwort
Chara pedunculata	Hedgehog stonewort
Chara aspera	Rough stonewort
Chara baltica	Baltic stonewort
Chara connivens	Convergent stonewort
Chara contraria	Opposite stonewort
Chara curta	Lesser bearded stonewort
Chara globularis/connivens	Fragile/convergent stonewort
Chara globularis	Fragile stonewort
Chara hispida	Bristly stonewort
Chara intermedia	Intermediate stonewort
Chara sp.	Stonewort *(Chara)* species
Chara virgata	Delicate stonewort
Chara vulgaris	Common stonewort
Crassula helmsii	Swamp stonecrop
Elodea canadensis	Canadian waterweed
Eleogiton fluitans	Floating club-rush
Elodea nuttallii	Nuttall's waterweed
Enteromorpha	*Enteromorpha*
Filamentous algae	Filamentous algae
Fontinalis antipyretica	Common water moss
Glyceria maxima	Reed sweet grass
Hippuris vulgaris	Mare's tail
Hydrocharis morsus-ranae	Frogbit
Hydrodictyon	Water net
Lemna gibba	Inflated duckweed
Lemna minor	Common duckweed
Lemna minuta	Least duckweed
Lemna trisulca	Ivy-leaved duckweed
Leptodictyum riparium	Stringy moss
Myriophyllum spicatum	Spiked water milfoil
Myriophyllum verticillatum	Whorled water milfoil

Latin	Common
Najas marina	Holly-leaved naiad
Nitella flexilis	Smooth stonewort
Nitella mucronata	Pointed stonewort
Nitellopsis obtusa	Starry stonewort
Nitella translucens	Translucent stonewort
Nitella sp.	Stonewort *(Nitella)* species
Nuphar lutea	Yellow water lily
Nymphaea alba	White water lily
Persicaria amphibia	Amphibious bistort
Potamogeton acutifolius	Sharp-leaved pondweed
Potamogeton berchtoldii	Small pondweed
Potamogeton crispus	Curled pondweed
Potamogeton friesii	Flat-stalked pondweed
Potamogeton lucens	Shining pondweed
Potamogeton natans	Broad –leaved pondweed
Potamogeton obtusifolius	Blunt-leaved pondweed
Potamogeton pectinatus	Fennel-leaved pondweed
Potamogeton perfoliatus	Perfoliate pondweed
Potamogeton pusillus	Lesser pondweed
Potamogeton x salicifolius	Willow-leaved pondweed
Potamogeton sp.	Pondweed sp.
Potamogeton trichoides	Hair like pondweed
Phragmites australis	Common reed
Ranunculus circinatus	Fan-leaved water crowfoot
Ranunculus fluitans	River water crowfoot
Ranunculus sp.	Crowfoot sp.
Rorippa nasturtium-aquaticum	Water cress
Saggitaria sagittifolia	Arrowhead
Schoenoplectus lacustris	Bulrush
Sparganium emersum	Unbranched bur-reed
Sparganium erectum	Branched bur-reed
Spirodela polyrhiza	Greater duckweed
Stratiotes aloides	Water-soldier
Typha angustifolia	Lesser reedmace
Typha latifollia	Greater reedmace
Utricularia vulgaris	Greater bladderwort
Veronica catenata	Pink water speedwell
Zannichellia palustris	Horned pondweed

Appendix 2b. Common to Latin plant names.

Common	*Latin*
Amphibious bistort	*Persicaria amphibia*
Arrowhead	*Saggitaria sagittifolia*
ltic stonewort	*Chara baltica*
Greater bladderwort	*Utricularia vulgaris*
Blunt-leaved pondweed	*Potamogeton obtusifolius*
Branched bur-reed	*Sparganium erectum*
Bristly stonewort	*Chara hispida*
Broad –leaved pondweed	*Potamogeton natans*
Bulrush	*Schoenoplectus lacustris*
Canadian waterweed	*Elodea canadensis*
Common duckweed	*Lemna minor*
Common reed	*Phragmites australis*
Common stonewort	*Chara vulgaris*
Common water moss	*Fontinalis antipyretica*
Common water-plantain	*Alisma plantago-aquatica*
Convergent stonewort	*Chara connivens*
Crowfoot sp.	*Ranunculus sp.*
Curled pondweed	*Potamogeton crispus*
Delicate stonewort	*Chara virgata*
Enteromorpha	*Enteromorpha*
Fan-leaved water crowfoot	*Ranunculus circinatus*
Fennel-leaved pondweed	*Potamogeton pectinatus*
Filamentous algae	*Filamentous algae*
Flat-stalked pondweed	*Potamogeton friesii*
Floating club-rush	*Eleogiton fluitans*
Fragile stonewort	*Chara globularis*
Fragile/convergent stonewort	*Chara globularis/connivens*
Frogbit	*Hydrocharis morsus-ranae*
Greater duckweed	*Spirodela polyrhiza*
Greater reedmace	*Typha latifollia*
Hair like pondweed	*Potamogeton trichoides*
Hedgehog stonewort	*Chara pedunculata/pedunculata*
Holly-leaved naiad	*Najas marina*
Horned pondweed	*Zannichellia palustris*
Inflated duckweed	*Lemna gibba*
Intermediate stonewort	*Chara intermedia*
Intermediate water-starwort	*Callitriche stagnalis*

Common	*Latin*
Ivy-leaved duckweed	*Lemna trisulca*
Least duckweed	*Lemna minuta*
Lesser bearded stonewort	*Chara curta*
Lesser pondweed	*Potamogeton pusillus*
Lesser reedmace	*Typha angustifolia*
Mare's tail	*Hippuris vulgaris*
Nuttall's waterweed	*Elodea nuttallii*
Opposite stonewort	*Chara contraria*
Perfoliate pondweed	*Potamogeton perfoliatus*
Pink water speedwell	*Veronica catenata*
Pointed stonewort	*Nitella mucronata*
Pondweed sp.	*Potamogeton sp.*
Reed sweet grass	*Glyceria maxima*
Rigid hornwort	*Ceratophyllum demersum*
River water crowfoot	*Ranunculus fluitans*
Rough stonewort	*Chara aspera*
Sharp-leaved pondweed	*Potamogeton acutifolius*
Shining pondweed	*Potamogeton lucens*
Small pondweed	*Potamogeton berchtoldii*
Smooth stonewort	*Nitella flexilis*
Spiked water milfoil	*Myriophyllum spicatum*
Starry stonewort	*Nitellopsis obtusa*
Starwort sp.	*Callitriche sp*
Stonewort *(Chara)* species	*Chara sp.*
Stonewort *(Nitella)* species	*Nitella sp.*
Stringy moss	*Leptodictyum riparium*
Swamp stonecrop	*Crassula helmsii*
Sweet flag	*Acorus calamus*
Translucent stonewort	*Nitella translucens*
Unbranched bur-reed	*Sparganium emersum*
Water cress	*Rorippa nasturtium-aquaticum*
Water net	*Hydrodictyon*
Water-soldier	*Stratiotes aloides*
White water lily	*Nymphaea alba*
Whorled water milfoil	*Myriophyllum verticillatum*
Willow-leaved pondweed	*Potamogeton x salicifolius*
Yellow water lily	*Nuphar lutea*