

Broads Annual Water Plant Monitoring Report 2019



November 2019

Broads Authority
Yare House
62-64 Thorpe Road
Norwich NR1 1RY

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Cover photo of flowering water crowfoot, taken by Hannah Southon

Executive Summary

The Broads Authority and its contractors have surveyed the water plant communities within the Broads since 1983. The Broads Annual Water Plant Monitoring programme provides information on the diversity of species and a measure of abundance. The programme has consistently surveyed key broads, such as Hickling Broad (a prime navigation site with high recreational value) and Cockshoot Broad (undergone restoration measures), providing long term datasets. Between 1983 and 2013, a transect-based technique was used for the monitoring programme. Due to limitations in the efficiency of the methodology along with the improvements in water plants generally across the Broads, a new point -based technique was developed and implemented. Point sample surveys have been conducted since 2014.

Macrophytes in the Broads are inherently highly variable in both abundance and species richness between years, so limited significance should be attached to variation in these parameters between one individual year and the next.

This report presents and discusses the findings from the annual water plant surveys carried out during 2019, which covered 15 water bodies with a total of 410 survey points.

- Overall this year, 10 out of the 15 broads surveyed saw an increase in species abundance. Section 41 species were found in 9 out of the 15 broads; Holly-leaved naiad being in 8 out of the 9. However, Holly-leaved naiad saw a decrease from 2018 -2019 in Cockshoot Broad and Upton Great Broad. Martham South saw an overall reduction in stoneworts.
- An increase has been observed in vascular plants this year, with many broads seeing an increase in abundance whilst other plant groups have seen reductions.
- Heigham sound recorded an increase in species abundance from last year with Starry stonewort and Baltic stonewort occurring regularly. Only one survey point recorded zero plants this year, in comparison to ten last year. Filamentous algae also decreased slightly.
- Hickling recorded increased occurrences for many species including Section 41 species and with plants at every point this year. Mare's tail and Ivy-leaved duckweed made appearances after not being seen for some time.
- Barton Broad, Ranworth Broad and Hoveton Great Broad all recorded consistently low macrophyte population abundance, however major lake restoration projects have been completed in these broads, so the next few years will be interesting to follow in terms of water plant response.
- Although Martham North and South Broads showed a decrease this year in species abundance they still have some of the highest total abundances of all the broads.

- The number of species in Whitlingham Little Broad increased by over 50% between 2018 -2019 with abundance levels close to 2017 figures, although filamentous algae also increased.
- Stonewort's were represented well in Heigham Sound, Hickling Broad, Martham North and Martham South this year.

Introduction

Background information

The Broads Authority (the Authority hereafter) has monitored aquatic macrophytes (water plants hereafter) annually at numerous broads within its Executive Area since 1983. The water plant monitoring programme has provided data on species richness (number of species) and a measure of abundance of the water plants present in each of the broads surveyed. The surveys have created long-term datasets, provided vital information in monitoring the response of a number of broads to restoration measures such as suction dredging and / or biomanipulation and are contributing to scientific reviews of key broads (http://www.broads-authority.gov.uk/data/assets/pdf_file/0006/549114/Broads-Lake-Review.pdf).

Following increased water plant growth across many of the broads, it was acknowledged that the transect methodology (employed until 2013), was difficult to implement in a robust and consistent manner required for analysis of long-term trends. Following consultation with Natural England, Environment Agency, Dr Nigel Wilby (University of Stirling) and other researchers, a point based survey methodology was developed. Between 2011 and 2013, the point sample survey was conducted alongside the transect surveys. The purposes of the concurrent surveys was to understand if the data gathered was directly comparable and would allow long-term trend analysis. Whilst research undertaken by Dr Nigel Wilby, revealed the data gathered by the two techniques was not directly comparable, the point based technique was adopted as the method for the Broads Annual Water Plant Monitoring programme from 2014 onwards.

Aims & objectives

The main objectives of the annual programme are to monitor key broads with long-term datasets, those that have undergone restoration measures or those that are known to be experiencing a change in their water plant community. Broad that have not received restoration efforts or are stable (with or without water plants) are monitored on a less frequent basis. When resources allow, the monitoring of sites not previously surveyed is an ongoing objective.

The general aim of the monitoring programme is to monitor water plant growth and provide an assessment of the condition, or health, of the broads and waterways within the Broads. The monitoring programme also provides an assessment of Section 41 species, Species “of principal importance for the purpose of conserving biodiversity” covered under section 41 (England) of the NERC Act (2006) and therefore need to be taken into consideration by a public body when performing any of its functions.

Two types of surveys are undertaken as part of the monitoring programme, point sample surveys to assess species diversity and provide a measure of abundance within a broad or stretch of river and hydroacoustic surveys, which use sonar technology to estimate cover and volume of water plants along transects.

The purpose of this report is to present the results of the 2019 survey season.

The data gathered through the water plant and hydroacoustic surveys and presented within these reports are used to:

- Report the status of conservation priority species, e.g. certain stoneworts and Holly-leaved naiad (Section 41 species)
- Assess the condition of designated sites (SSSIs) and WFD waterbodies in partnership with NE and EA respectively.
- Assess the success of restoration measures such as catchment or in-lake projects by managers and research scientists as well as assessing long-term trends
- Assess the impact of and ability to cut water plants to allow the safe passage of boats.

Methodology

Survey design

The point sample survey was designed in consultation with Dr Nigel Wilby using Broad's species accumulation data. The data generated a relationship ($y = 4.6242\ln(x) + 17.149$) between the area of the open water of a broad and the required number of points to be sampled (see Figure 1). Using ArcGIS, the area of open water of each broad to be surveyed was measured in hectares (ha) and the number of sample points calculated. Once the required number of points was calculated, a grid system was applied over an aerial image of the open water areas of each broad. Sample points were set equidistant from each other and the co-ordinates generated (see Figure 2). The maps and sample point co-ordinates were loaded onto a Samsung tablet for the survey teams to use.

Figure 1

The relationship between the area of open water and the required number of points sampled.

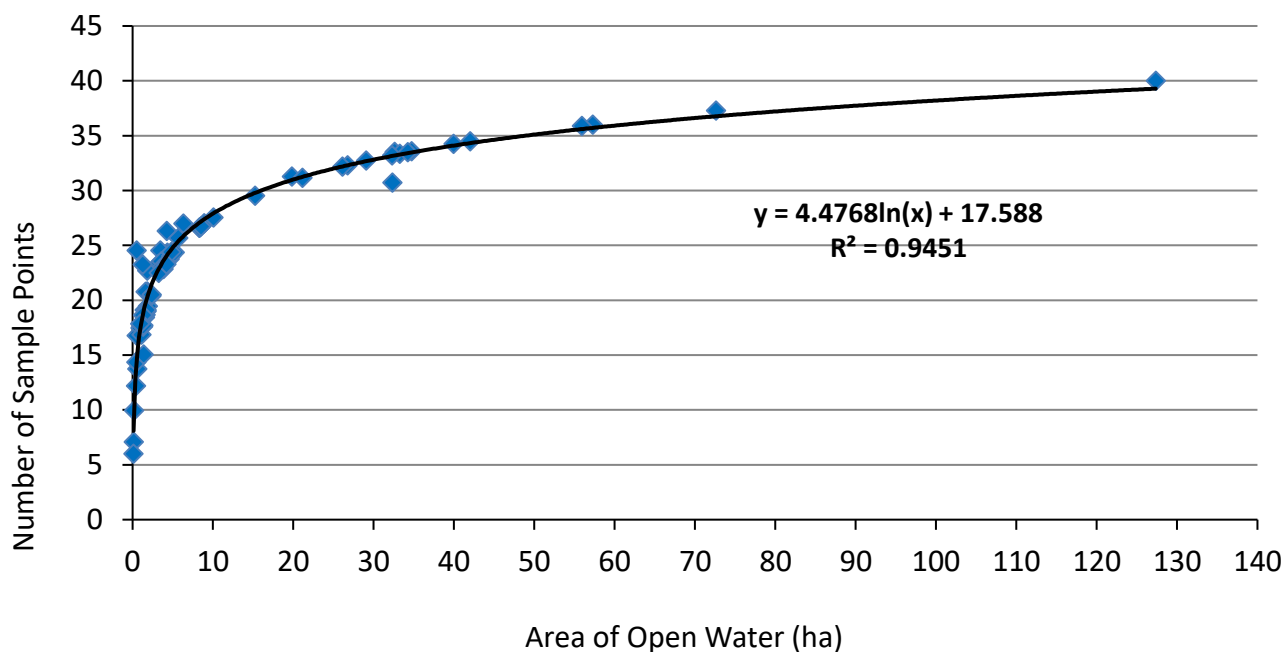
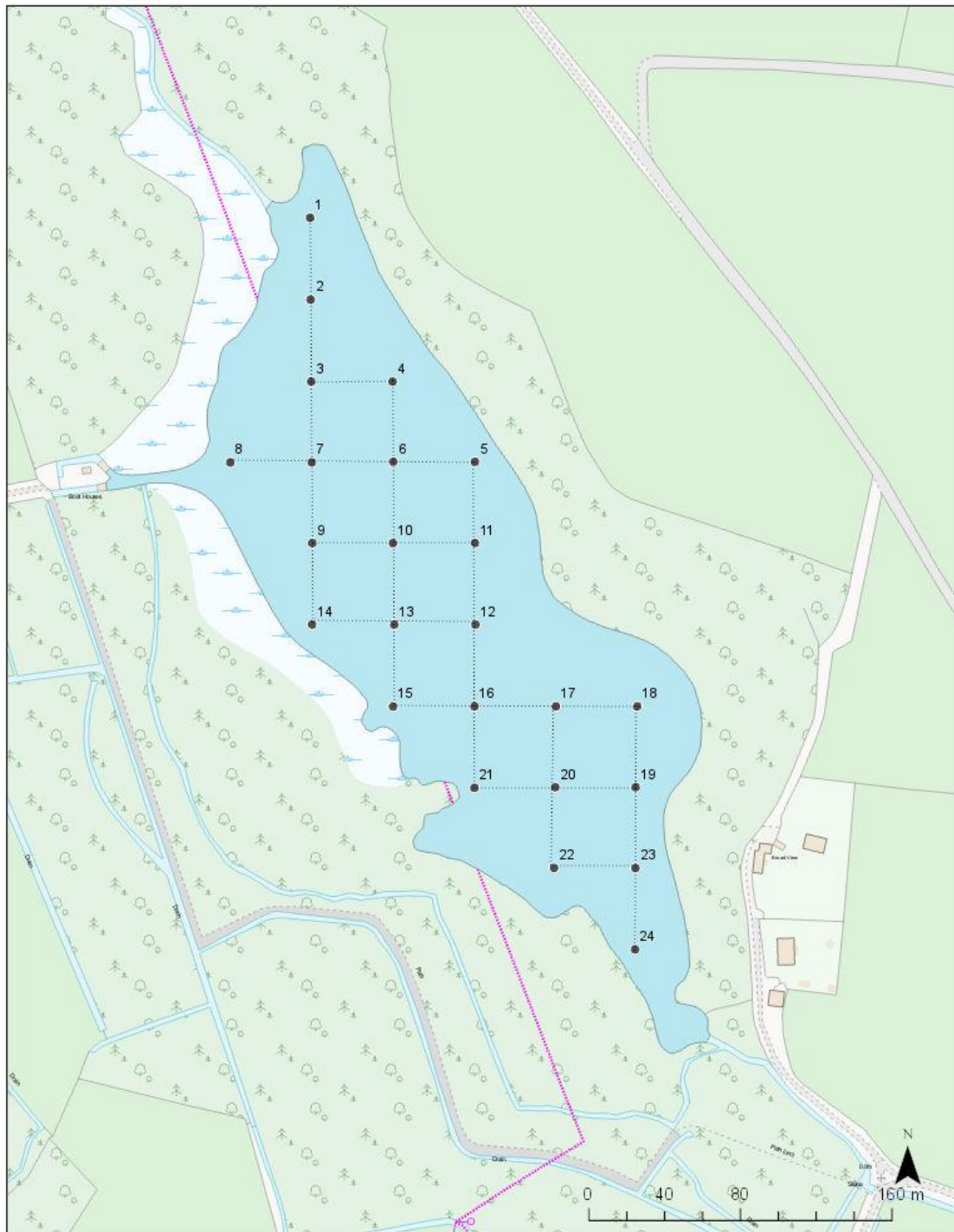


Figure 2

Map showing the sample points of Alderfen Broad



Sample points at Alderfen Broad



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Point sample survey technique

At each broad, the surveyors used the maps and grid references on the Samsung tablet and GPS to navigate by boat to each of the sample points. Once within 5 m of the plotted grid reference, mud weights were deployed to keep the boat in the correct location.

At each sample point, a double headed survey rake was thrown north and south, at each sample point, at 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 back towards the boat. For points that were in known 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.

On retrieval of the 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. 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. Any unidentified plant specimens (or where identification was uncertain) were collected in plastic bags and labelled using the station number reference. 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.

To assign a level of abundance for each species, the total volume of live water plant material was scored based on the maximum trap-ability on the rake. Scores attributed to each species present range from 10% (low abundance) and 100% (the maximum trappable) in increments of 10%. For example, if the maximum plant volume was present on the rake, but split equally between two species then each species would be scored 50%. In addition, scores of 1% were given to trace and very small amounts of identifiable plant material.

The 'trap-ability' of a particular species on the rake, was taken into account so that a score of 100% represents the maximum amount trappable on the rake. For example, a fine leaved species such as Unbranched bur-reed *Sparganium emersum* is not as 'trappable' on the rake as a more structured species such as Spiked water milfoil *Myriophyllum spicatum*. Surveyor experience and judgement is therefore important in scoring the less trappable species based on the likelihood of being retrieved in the rake and possibly other visual indications. 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 duckweeds *Lemna* sp. and water lilies.

The maximum total of all species abundance scores on an individual rake sample cannot really be more than 100%, although $\pm 10\%$ is considered acceptable to account for the varying trap-ability of different species.

The broads that have been sampled between 2014 and 2019 are presented in Table 1. Surveys are conducted during the summer period, July to September.

Table 1

Sites surveyed as part of the monitoring programme between 2014 and 2019.

Broad	2014	2015	2016	2017	2018	2019
Alderfen Broad	X	X	X	X	X	X
Bargate Broad	X			X		
Barnby Broad		X				
Barton Broad	X	X	X	X	X	X
Belaugh Broad				X		
Blackfleet broad			X			
Bridge Broad		X				
Buckenham Broad		X		X		
Burntfen Broad			X			
Calthorpe Broad	X					
Catfield Broad		X				
Cockshoot Broad	X	X	X	X	X	X
Cromes Broad	X	X	X	X	X	X
Decoy Broad	X		X		X	
Hassingham Broad		X		X		
Heigham Sound	X	X	X	X	X	X
Hickling Broad	X	X	X	X	X	X
Horsey Mere	X	X	X	X	X	X
Hoveton Great Broad	X	X	X	X	X	X
Hoveton Little Broad	X			X		
Hudson's Bay		X			X	
Little Broad			X			
Martham Broad North	X	X	X	X	X	X
Martham Broad South	X	X	X	X	X	X
Mautby Decoy			X			
Norton's Broad			X			
Oulton Broad			X			
Pound End		X				
Ranworth Broad	X	X		X		X
Reedham Water						
Rockland Broad	X	X	X	X	X	X
Round Water Broad			X			

Broad	2014	2015	2016	2017	2018	2019
Sotshole Broad			X			
Sprat's Water			X			
Strumpshaw broad		X			X	
Upton Broad	X	X	X	X	X	X
Upton Little Broad	X		X		X	
Wheatfen Broad & Channels		X			X	
Whitlingham Great Broad	X	X	X	X	X	
Whitlingham Little Broad		X	X	X	X	X
Woolner's Carr			X			
Wroxham Broad	X	X	X	X	X	X

Data processing

For each sample point, an abundance score for each species was calculated, derived from the data from the north and south throws;

$$\frac{(\text{Score from north} + \text{Score from south})}{2}$$

2

The abundance score for each species was then totalled to produce an abundance score for each sample point. An overall mean abundance for each species for the whole broad was then calculated by summing the scores from each sample point and dividing by the number of sample points. The overall mean abundance score for each species was then added together to give the overall total abundance score for the broad. Assuming maximum plant abundance on the site, the site abundance score should have a maximum of 100 ($\pm 10\%$).

The water plants present in the surveys were also categorised into groups, such as stoneworts or macro-algae, and abundance scores were calculated for each group in each broad, as described above. The water plant groups and the species within them are presented in Appendix I.

Results

Section 41 Species

Species “of principal importance for the purpose of conserving biodiversity” covered under section 41 (England) of the NERC Act (2006) and therefore need to be taken into consideration by a public body when performing any of its functions.

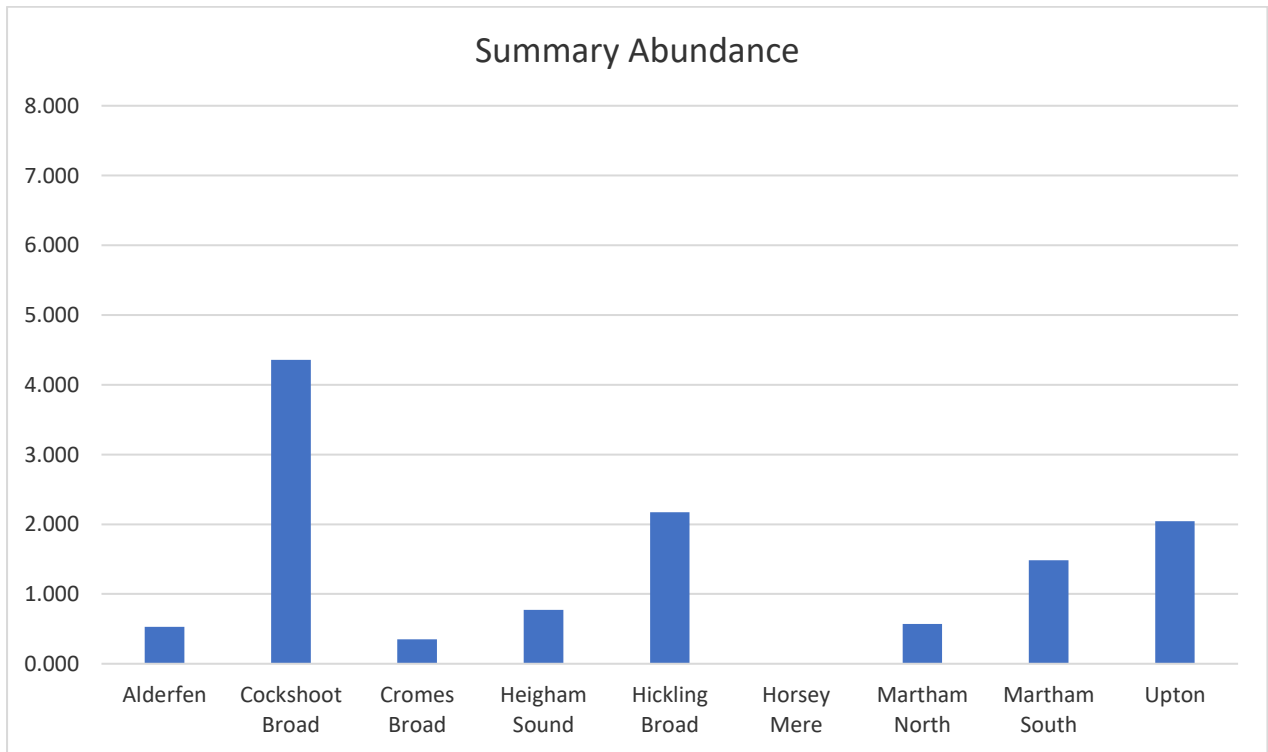
Table 2

Nine Broads were found to have Section 41 species

Species	Broads
<i>Najas marina</i>	Alderfen Broad, Cockshoot Broad, Cromes Broad, Heigham Sound, Hickling Broad, Martham North, Martham South, Upton Broad
<i>Chara baltica</i>	Heigham Sound, Hickling Broad, Martham North, Martham South
<i>Chara intermedia</i>	Heigham Sound, Hickling Broad, Horsey Mere, Martham North, Martham South
<i>Chara connivens</i>	Heigham Sound, Hickling Broad
<i>Nitellopsis obtusa</i>	Heigham Sound, Martham North, Martham South

Graph 1

Broads with Section 41 species and their abundance scores in 2019. See main report for specific abundance levels



Graph 2

Section 41 species Abundance in 2018 & 2019

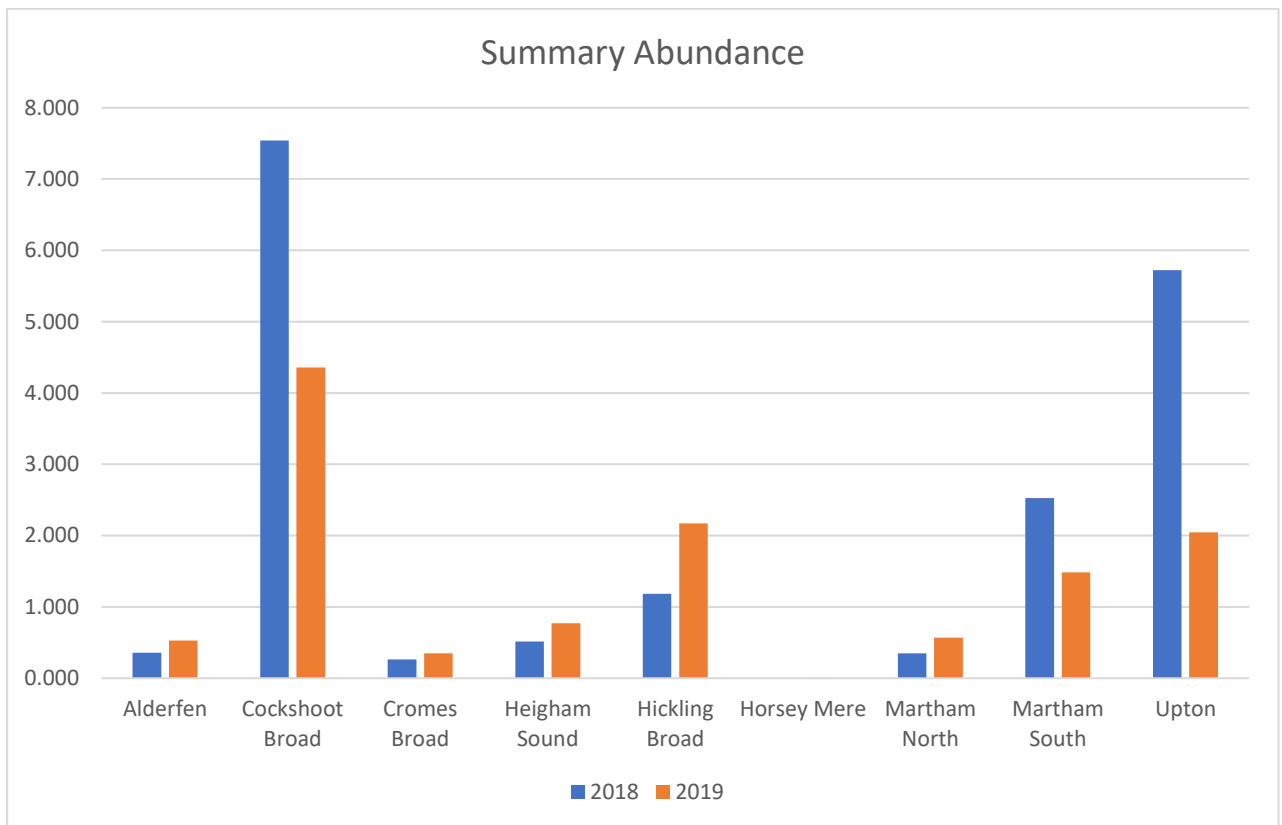


Table 3

Holly-leaved naiad distribution

Broad	Number of Points with Holly-leaved naiad	Summary abundance
Heigham	4/66	0.047
Hickling	21/76	0.279
Martham North	16/52	0.275
Martham South	37/54	0.830
Alderfen	25/48	0.525
Cromes	13/40	0.350
Cockshoot	48/48	4.356
Upton	31/48	2.046

Holly-leaved naiad was present in over 50% of points in four of the broads surveyed, with particularly high summary abundances in Cockshoot and Upton.

Main Survey Results

Each broad that was surveyed in 2019 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 2.2).

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.

Thurne Valley

The broads which are located in the Thurne valley are part of the reason that the Broads are designated as a Special Area of Conservation (SAC) Two Annex I habitats are present. Hard oligo-mesotrophic waters with benthic vegetation of stonewort species (3140), and Natural eutrophic lakes with Magnopotamion or Hydrocharition - type vegetation (3150).

These bodies of water are a sanctuary 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 safe haven 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.

Heigham Sound

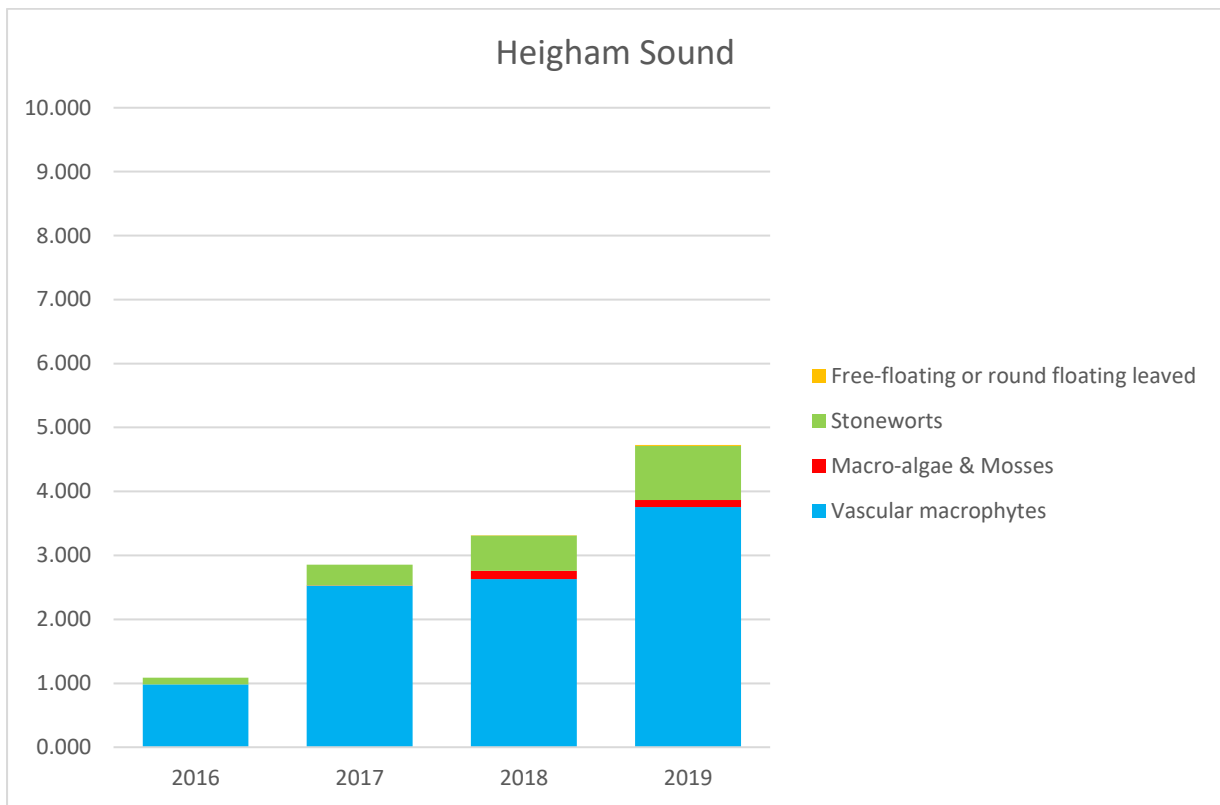
Table 4

Common Name	Scientific Name	Summary Abundance	Occurrences
Mare's tail	<i>Hippuris vulgaris</i>	1.064	30
Fan-leaved water crowfoot	<i>Ranunculus circinatus</i>	0.852	21
Spiked water milfoil	<i>Myriophyllum spicatum</i>	0.792	49
Rigid hornwort	<i>Ceratophyllum demersum</i>	0.345	30
Baltic stonewort	<i>Chara baltica</i>	0.308	10
Curled pondweed	<i>Potamogeton crispus</i>	0.280	23
Starry stonewort	<i>Nitellopsis obtusa</i>	0.218	16
Nuttall's waterweed	<i>Elodea nuttallii</i>	0.217	17
Intermediate stonewort	<i>Chara intermedia</i>	0.183	7
Filamentous algae	<i>Zygnematales</i>	0.106	6
Bristly stonewort	<i>Chara hispida</i>	0.106	4
Canadian waterweed	<i>Elodea canadensis</i>	0.082	9
Lesser pondweed	<i>Potamogeton pusillus</i>	0.079	7
Shining pondweed	<i>Potamogeton lucens</i>	0.061	3
Holly-leaved naiad	<i>Najas marina</i>	0.047	4
Ivy-leaved duckweed	<i>Lemna trisulca</i>	0.017	2
Convergent stonewort	<i>Chara connivens</i>	0.015	1
Fragile/convergent stonewort	<i>Chara globularis/connivens</i>	0.015	1
Starwort species	<i>Callitriche sp</i>	0.015	1
Common water moss	<i>Fontinalis antipyretica</i>	0.002	1
Yellow water lily	<i>Nuphar lutea</i>	0.002	1
Total number of species recorded		21	Total samples taken: 66

This has been a good year for Heigham sound for continued macrophyte recovery in a SSSI site. Duck Broad as well as the whole area recorded an increase in occurrences from 17 species in 2018 to 21. Many of the species have stayed the same or increased in abundance and only one sample point recorded zero plants in 2019, compared to ten in 2018. Filamentous algae, recorded a slight decrease.

Graph 3

Abundance shown in plant groups (see Appendix 1 for more detail)



Hickling Broad

Table 5

Common Name	Scientific Name	Summary Abundance	Occurrences
Intermediate stonewort	<i>Chara intermedia</i>	1.033	52
Baltic stonewort	<i>Chara baltica</i>	0.847	47
Spiked water milfoil	<i>Myriophyllum spicatum</i>	0.804	52
Fennel-leaved pondweed	<i>Potamogeton pectinatus</i>	0.329	25
Holly-leaved naiad	<i>Najas marina</i>	0.279	21
Hedgehog stonewort	<i>Chara aculeolata</i>	0.184	4
Curled pondweed	<i>Potamogeton crispus</i>	0.172	13
Bristly stonewort	<i>Chara hispida</i>	0.118	7
Rough stonewort	<i>Chara aspera</i>	0.067	6
Mare's tail	<i>Hippuris vulgaris</i>	0.053	2
Fragile/convergent stonewort	<i>Chara globularis/connivens</i>	0.043	6
Delicate stonewort	<i>Chara virgata</i>	0.041	4
Rigid hornwort	<i>Ceratophyllum demersum</i>	0.026	2
Convergent stonewort	<i>Chara connivens</i>	0.014	2
Ivy-leaved duckweed	<i>Lemna trisulca</i>	0.013	1
Canadian waterweed	<i>Elodea canadensis</i>	0.001	1
Total number of species recorded		16	Total samples taken: 76

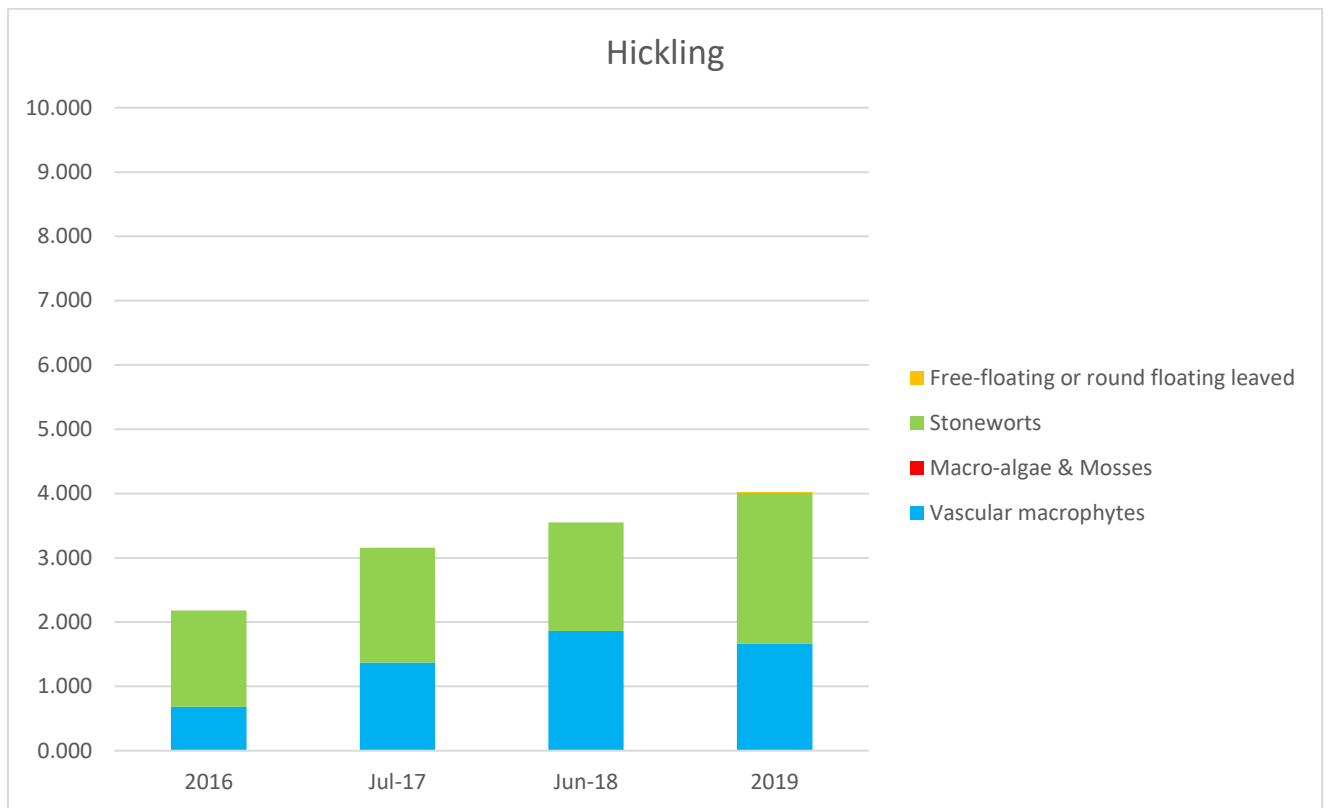
Vascular plants slightly decreased in 2019 although stonewort's recorded an increase. Ivy-leaved duckweed has appeared again after 8 years. Increases were seen in 10 species: Intermediate stonewort, Spiked water milfoil, Fennel-leaved pondweed, Holly-leaved naiad, Curled pondweed, Bristly stonewort, Rough stonewort, Fragile/convergent stonewort, Delicate stonewort and Hedgehog stonewort.

Hedgehog stonewort (*Chara aculeolata* formally *Chara pedunculata*) increased in abundance and in occurrence.

There were plants at every point this year even if the amount of plants may not have been as high.

Graph 4

Abundance shown in plant groups (see Appendix 1 for more detail)



Horsey Mere

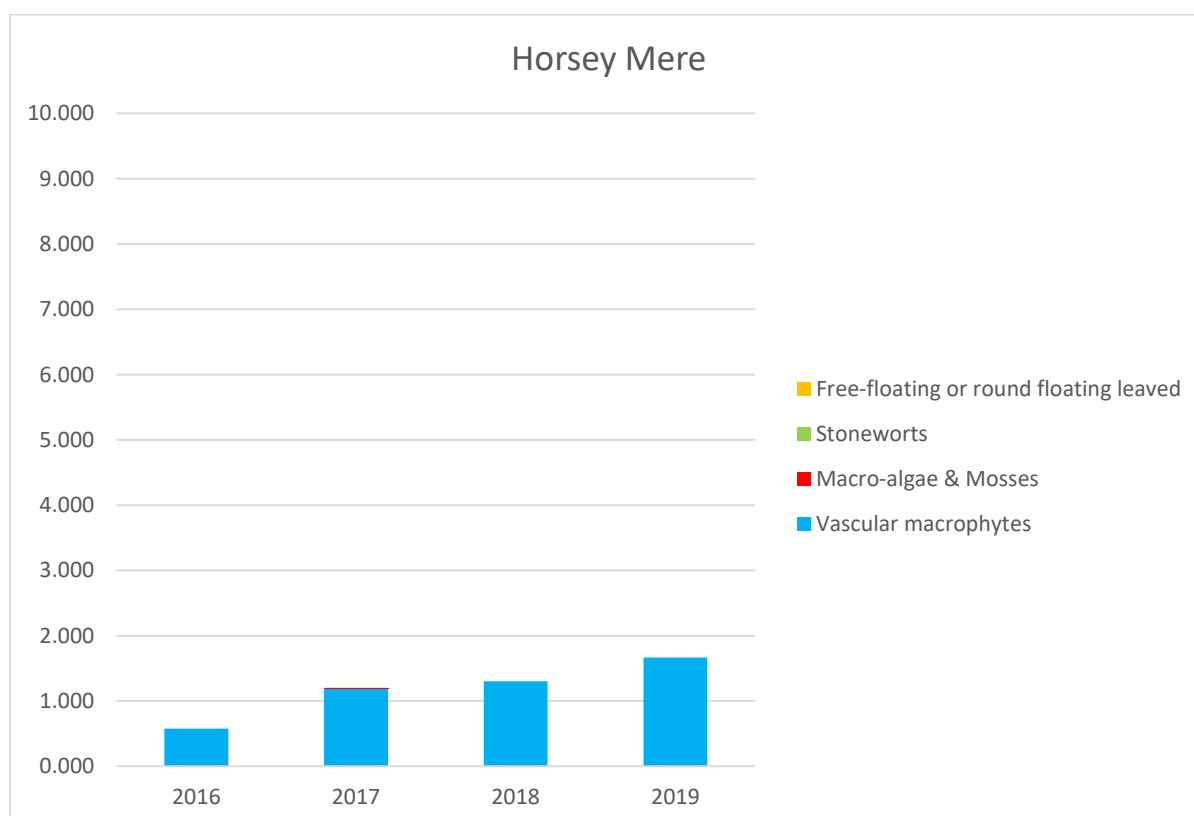
Table 6

Common Name	Scientific Name	Summary Abundance	Occurrences
Mare's tail	<i>Hippuris vulgaris</i>	1.058	19
Spiked water milfoil	<i>Myriophyllum spicatum</i>	0.580	29
Long-stalked Pondweed	<i>Potamogeton praelongus</i>	0.025	1
Intermediate stonewort	<i>Chara intermedia</i>	0.003	1
Opposite stonewort	<i>Chara contraria</i>	0.003	1
Total number of species recorded		5	Total samples taken: 40

Mare's tail had a good year and while Rigid hornwort was not seen this year Intermediate stonewort, Opposite stonewort and Long-stalked Pondweed made an appearance. There is still very little growth in the Mere itself as most of the plants were found around the edges. Summary abundance has increased overall and we had 5 species this year compared with 3 last year. The 'no plant' points have decreased from 18 points to 1.

Graph 5

Abundance shown in plant groups (see Appendix 1 for more detail)



Martham North

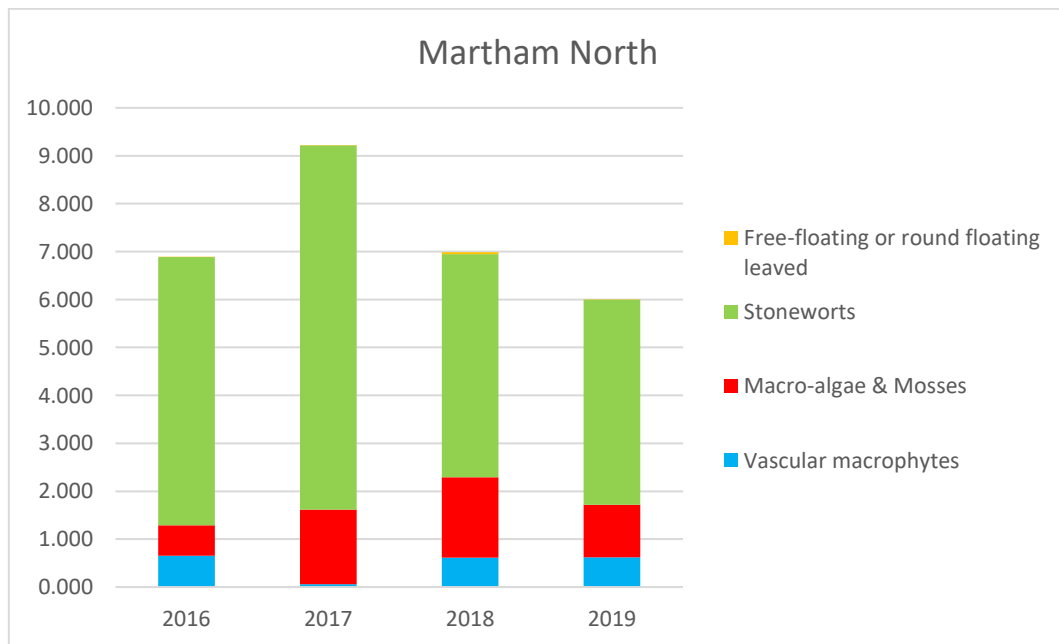
Table 7

Common Name	Scientific Name	Summary Abundance	Occurrences
Bristly stonewort	<i>Chara hispida</i>	3.962	39
Filamentous algae	<i>Zygnematales</i>	1.096	14
Fennel-leaved pondweed	<i>Potamogeton pectinatus</i>	0.327	12
Holly-leaved naiad	<i>Najas marina</i>	0.275	16
Intermediate stonewort	<i>Chara intermedia</i>	0.156	9
Baltic stonewort	<i>Chara baltica</i>	0.119	8
Delicate stonewort	<i>Chara virgata</i>	0.021	2
Mare's tail	<i>Hippuris vulgaris</i>	0.019	1
Starry stonewort	<i>Nitellopsis obtusa</i>	0.019	1
Stonewort (Chara) species	<i>Chara sp</i>	0.006	3
Ivy-leaved duckweed	<i>Lemna trisulca</i>	0.004	2
Total number of species recorded		11	Total samples taken: 52

Vascular plants and Stoneworts are similar to last year, however other plant groups have decreased since 2018. Filamentous algae was found in the same number of locations although a decrease in the quantity was seen. Holly-leaved naiad increased in occurrences. Overall a decline in abundance has been seen since 2017 however once a site gets above 5 on this scale, it is -macrophyte dominated and water quality is driven by the plant biomass. The ecological significance of change between say 6-9 is very limited. Whereas change from 1 to 3 (and vice versa) is massive in terms of ecological functioning.

Graph 6

Abundance shown in plant groups (see Appendix 1 for more detail)



Martham South

Table 8

Common Name	Scientific Name	Summary Abundance	Occurrences
Bristly stonewort	<i>Chara hispida</i>	1.500	38
Fennel-leaved pondweed	<i>Potamogeton pectinatus</i>	0.946	27
Holly-leaved naiad	<i>Najas marina</i>	0.830	37
Intermediate stonewort	<i>Chara intermedia</i>	0.372	13
Starry stonewort	<i>Nitellopsis obtusa</i>	0.150	7
Filamentous algae	<i>Zygnematales</i>	0.111	2
Hedgehog stonewort	<i>Chara aculeolata</i>	0.093	4
Baltic stonewort	<i>Chara baltica</i>	0.076	5
Spiked water milfoil	<i>Myriophyllum spicatum</i>	0.076	5
Common water moss	<i>Fontinalis antipyretica</i>	0.074	4
Mare's tail	<i>Hippuris vulgaris</i>	0.057	4
Convergent stonewort	<i>Chara connivens</i>	0.057	4
Ivy-leaved duckweed	<i>Lemna trisulca</i>	0.039	3
Rough stonewort	<i>Chara aspera</i>	0.039	3
Fragile/convergent stonewort	<i>Chara globularis/connivens</i>	0.039	3
Common stonewort	<i>Chara vulgaris</i>	0.037	2
Enteromorpha	<i>Enteromorpha</i>	0.037	2
Shining pondweed	<i>Potamogeton lucens</i>	0.019	1
Stonewort (Chara) species	<i>Chara sp</i>	0.006	3
Starwort species	<i>Callitriche sp</i>	0.002	1
Nuttall's waterweed	<i>Elodea nuttallii</i>	0.002	1
Stonewort (Nitella) species	<i>Nitella sp.</i>	0.002	1
Total number of species recorded		23	Total samples taken: 54

This year a decrease in abundance was recorded, however there was an increase in vascular plants in part due to Holly-leaved naiad and Fennel-leaved pondweed. Stoneworts still dominated the broad this year with 10 varieties being found. Holly-leaved naiad and

Intermediate stonewort have swapped the number of places where they are found and in their relative abundances. Fresh water sponge was noted in a couple of places as well.

Table 9

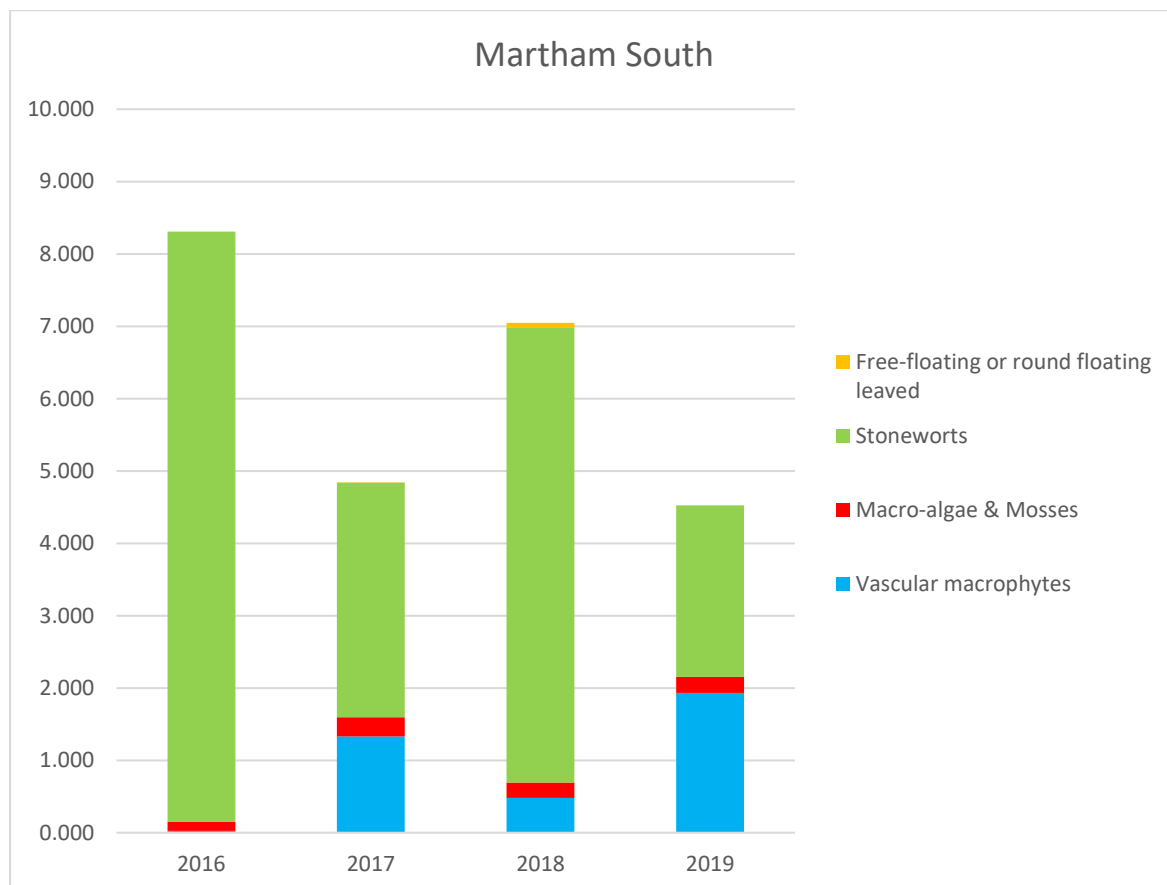
Fennel-leaved pondweed data

Year	Occurrence	Quantity	Number of points	Summary abundance
2014	6	60	4	0.115
2015	4	23	3	0.046
2016	1	10	1	0.021
2017	16	196	12	0.392
2018	3	40	2	0.083
2019	27	511	17	0.946

Fennel-leaved pondweed saw an increase in quantity and occurrence from 2018. It is unclear at the present whether this was a high for 2019 or a more permanent shift in the plant community. The survey in 2020 may reveal more.

Graph 7

Abundance shown in plant groups (see Appendix 1 for more detail)



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.

Alderfen

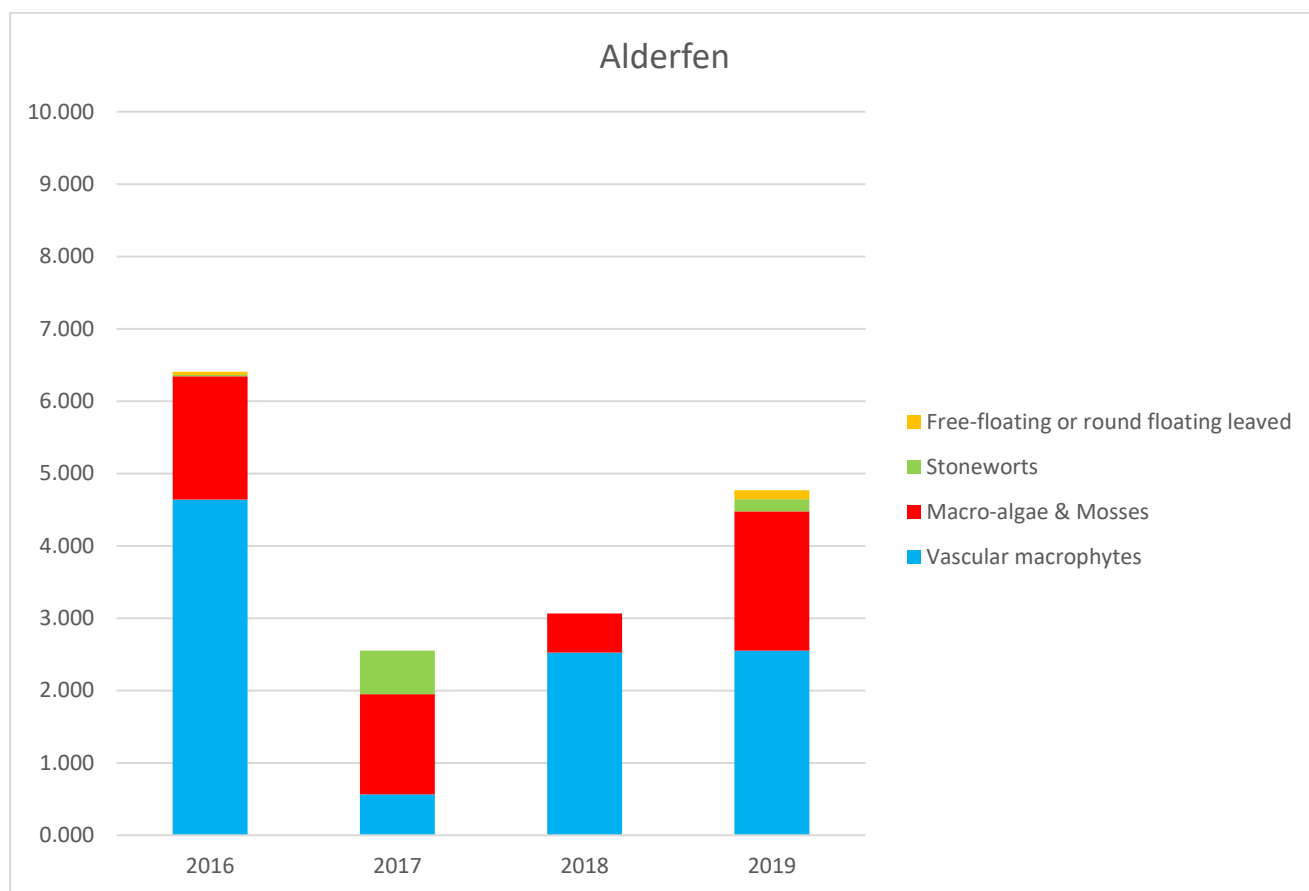
Table 10

Common Name	Scientific Name	Summary Abundance	Occurrences
Rigid hornwort	<i>Ceratophyllum demersum</i>	2.023	47
Filamentous algae	<i>Zygnematales</i>	1.919	34
Holly-leaved naiad	<i>Najas marina</i>	0.527	25
Fragile/convergent stonewort	<i>Chara globularis/connivens</i>	0.167	8
Ivy-leaved duckweed	<i>Lemna trisulca</i>	0.125	2
Water net	<i>Hydrodictyon</i>	0.004	2
Jelly algae	<i>Nostoc</i>	0.004	2
Total number of species recorded		7	Total samples taken: 48

Vascular plant abundance remained similar to last year, however an increase in macro algae and moss was recorded. Stoneworts have made an appearance this year along with the free floating leaved group (Ivy-leaved duckweed). There has been a total increase in plants to last year, approaching levels seen in 2016. Rigid Hornwort increased in occurrences but quantity has decreased slightly. Filamentous algae has increased in abundance but not in the number of sites. Holly-leaved naiad has increased in frequency and abundance and there were plants at every point this year which was not the case in 2018.

Graph 8

Abundance shown in plant groups (see Appendix 1 for more detail)



Barton Broad

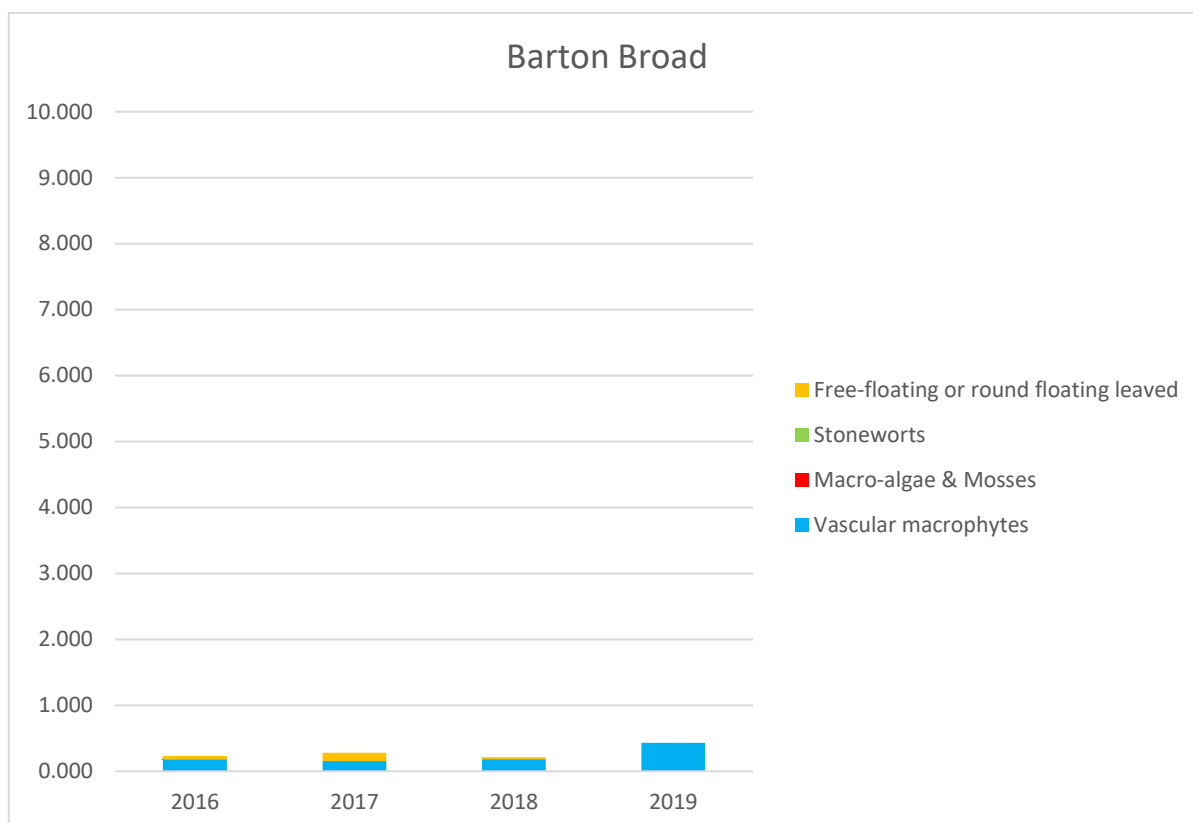
Table 11

Common Name	Scientific Name	Summary Abundance	Occurrences
Fennel-leaved pondweed	<i>Potamogeton pectinatus</i>	0.163	14
Yellow water lily	<i>Nuphar lutea</i>	0.125	5
Rigid hornwort	<i>Ceratophyllum demersum</i>	0.095	7
Nuttall's waterweed	<i>Elodea nuttallii</i>	0.048	4
Total number of species recorded		4	Total samples taken 64

Barton Broad only recorded vascular macrophytes this year. Vascular macrophytes mainly consisted of Fennel-leaved pondweed and Rigid Hornwort. The plants were found in the shallower areas and nearer the edges around the Broad. Yellow water lilies have also remained on the edges and there were numerous freshwater mussels caught in each throw and there were less 'no plant points' recorded.

Graph 9

Abundance shown in plant groups (see Appendix 1 for more detail)



Cromes Broad

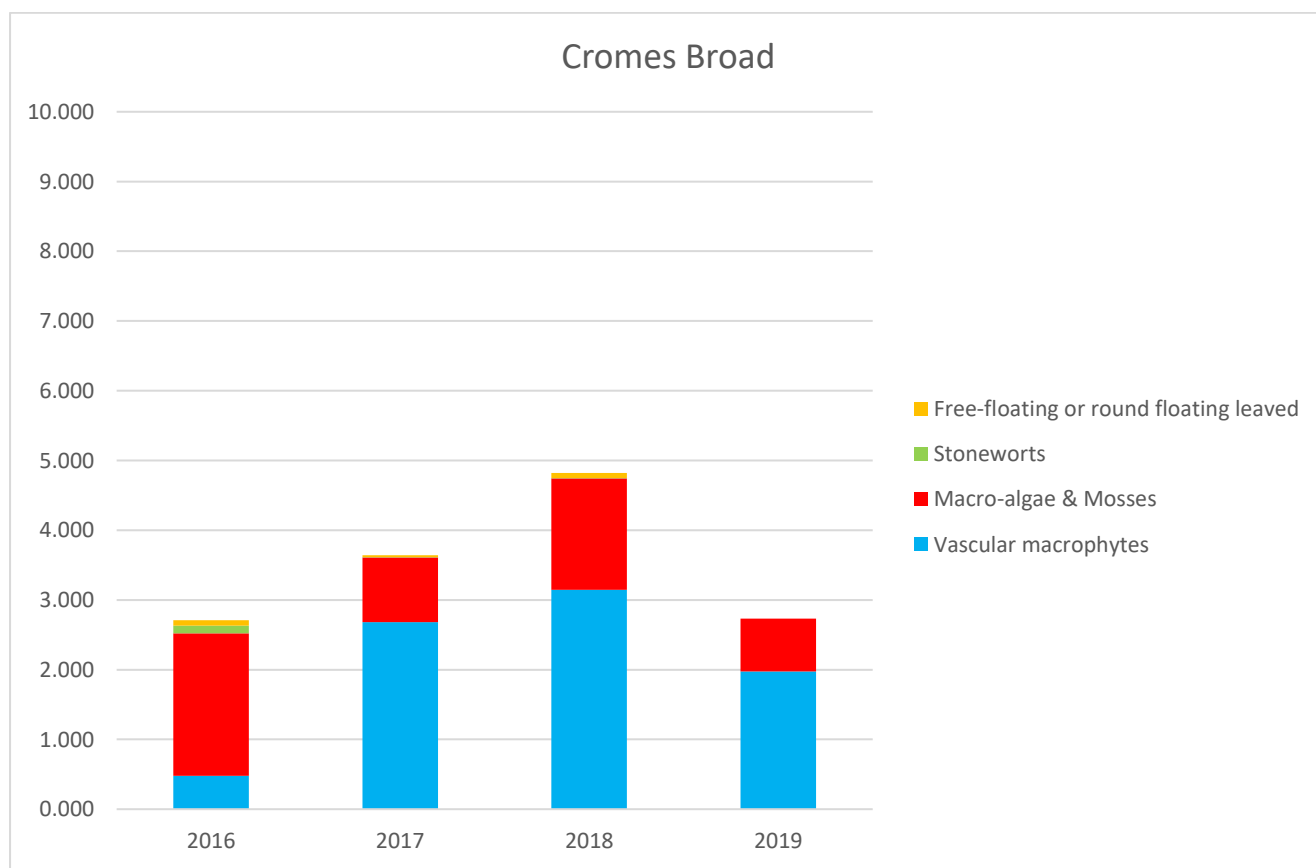
Table 12

Common Name	Scientific Name	Summary Abundance	Occurrences
Rigid hornwort	<i>Ceratophyllum demersum</i>	1.325	21
Filamentous algae	<i>Zygnematales</i>	0.755	30
Holly-leaved naiad	<i>Najas marina</i>	0.350	13
White water lily	<i>Nymphaea alba</i>	0.250	3
Water Soldier	<i>Stratiotes aloides</i>	0.050	2
Jelly algae	<i>Nostoc</i>	0.005	2
Total number of species recorded		6	Total samples taken: 40

Decreases in all sections were seen this year compared with 2018. The variation between 2018 and 2019 is principally due to lower abundance of the dominant species Rigid hornwort and lower abundance of algae. Positively, Filamentous algae decreased and Holly-leaved naiad has increased along with White water lily.

Graph 10

Abundance shown in plant groups (see Appendix 1 for more detail)



Cockshoot

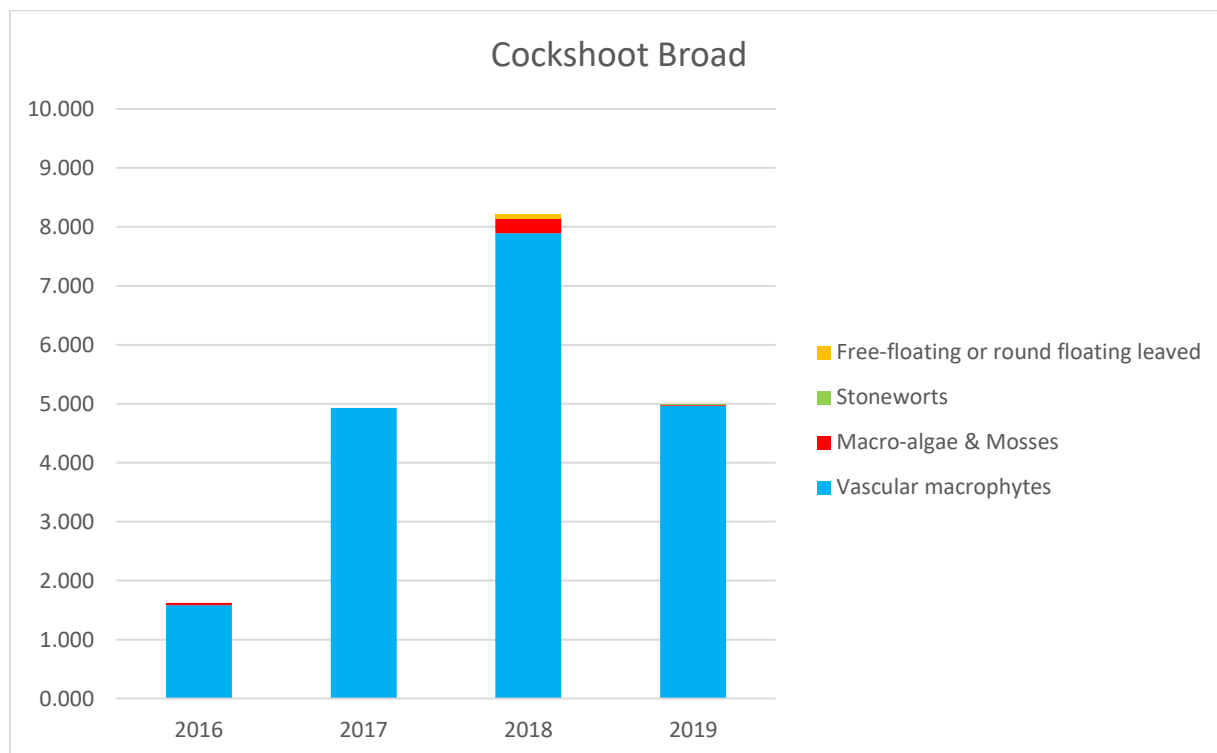
Table 13

Common Name	Scientific Name	Summary Abundance	Occurrences
Holly-leaved naiad	<i>Najas marina</i>	4.356	48
Rigid hornwort	<i>Ceratophyllum demersum</i>	0.383	20
Fennel-leaved pondweed	<i>Potamogeton pectinatus</i>	0.210	11
Filamentous algae	<i>Zygnematales</i>	0.021	1
Canadian waterweed	<i>Elodea canadensis</i>	0.021	1
Fragile/convergent stonewort	<i>Chara globularis/connivens</i>	0.004	2
Total number of species recorded		6	Total samples taken: 48

There was a decrease in vascular plants in 2019 but overall last year's levels were not dissimilar to that recorded in 2017. There has also been a decrease in filamentous algae from being found in 13 samples to only 1 this year. There has been a decrease in Holly-leaved naiad but it is still the dominant plant in the broad. Rigid Hornwort tripled in areas covered but not in quantity and Stonewort's and Canadian waterweed have made an appearance this year.

Graph 11

Abundance shown in plant groups (see Appendix 1 for more detail)



Hoveton Great Broad

Table 14

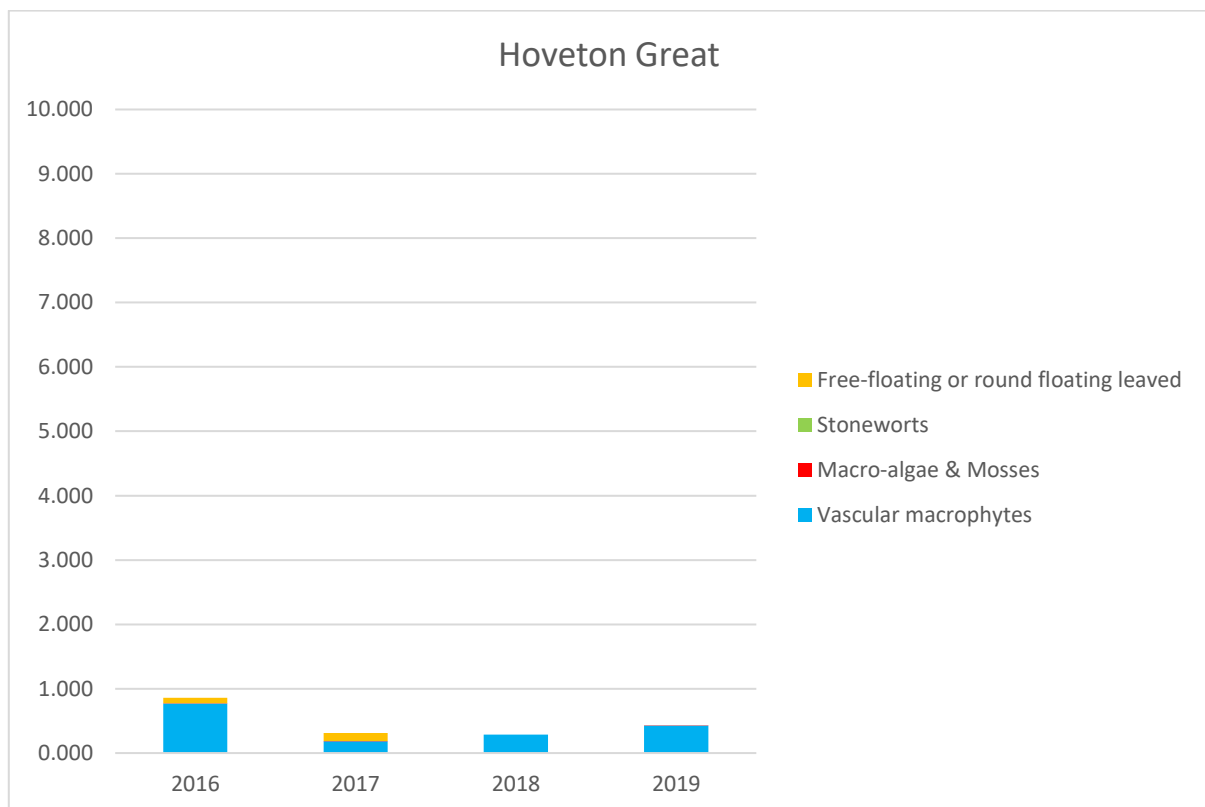
Common Name	Scientific Name	Summary Abundance	Occurrences
Rigid hornwort	<i>Ceratophyllum demersum</i>	0.224	13
Fennel-leaved pondweed	<i>Potamogeton pectinatus</i>	0.130	7
Yellow water lily	<i>Nuphar lutea</i>	0.037	1
Nuttall's waterweed	<i>Elodea nuttallii</i>	0.019	1
Curled pondweed	<i>Potamogeton crispus</i>	0.019	1
Filamentous algae	<i>Zygnematales</i>	0.004	2

Common Name	Scientific Name	Summary Abundance	Occurrences
Total number of species recorded		6	Total samples taken: 54

Vascular plants increased from last year, including Rigid hornwort and filamentous algae was only present at two points. Six species were found this year which is an increase from the 2 found in 2018. There were a few key places around the edge of the broad which were particularly good for plant growth but the vast majority of the broad showed no plant growth.

Graph 12

Abundance shown in plant groups (see Appendix 1 for more detail)



Ranworth

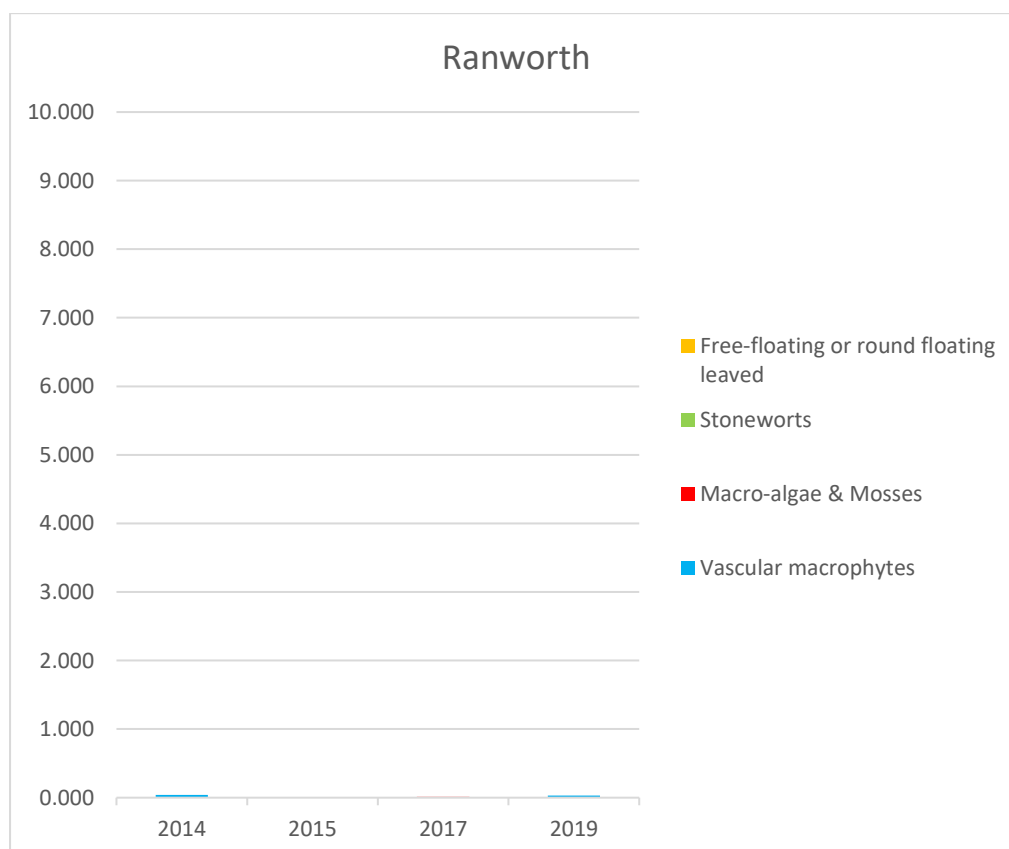
Table 15

Common Name	Scientific Name	Summary Abundance	Occurrences
Fennel-leaved pondweed	<i>Potamogeton pectinatus</i>	0.030	2
Total number of species recorded		1	Total samples taken: 66

Very few plants were found in the broad this year which is a similar pattern to other years. Only two points had any plants out of the 66 taken, both with just Fennel-leaved pondweed present. Very little was found during the survey although freshwater mussels (painters and duck mussels) were recorded. There are fish barriers going in this year to areas of the broad so if successful the next few years may see a greater variety of plants in the broad.

Graph 13

Abundance shown in plant groups (see Appendix 1 for more detail)



Upton Great Broad

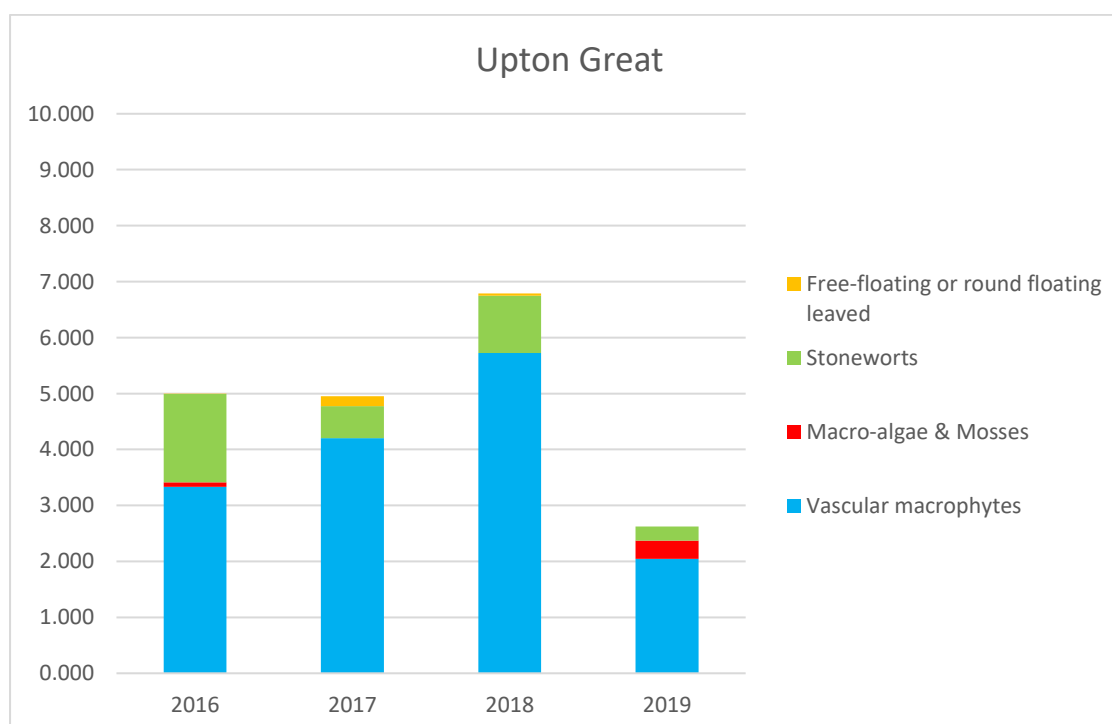
Table 16

Common Name	Scientific Name	Summary Abundance	Occurrences
Holly-leaved naiad	<i>Najas marina</i>	2.046	31
Filamentous algae	<i>Zygnematales</i>	0.323	19
Bristly stonewort	<i>Chara hispida</i>	0.190	5
Opposite stonewort	<i>Chara contraria</i>	0.063	2
Total number of species recorded		4	Total samples taken: 48

This year recorded a significant decrease in abundances from last year, possibly due to an increase in Filamentous algae from not being present in 2018 to being present in 40% of the points sampled in 2019. Holly-leaved naiad was present in the same areas but at a lower abundance. There were fewer 'no plant' points, possibly due to the Filamentous algae increase. The Stoneworts have changed occurrences on the table and their abundances are also reduced.

Graph 14

Abundance shown in plant groups (see Appendix 1 for more detail)



Wroxham

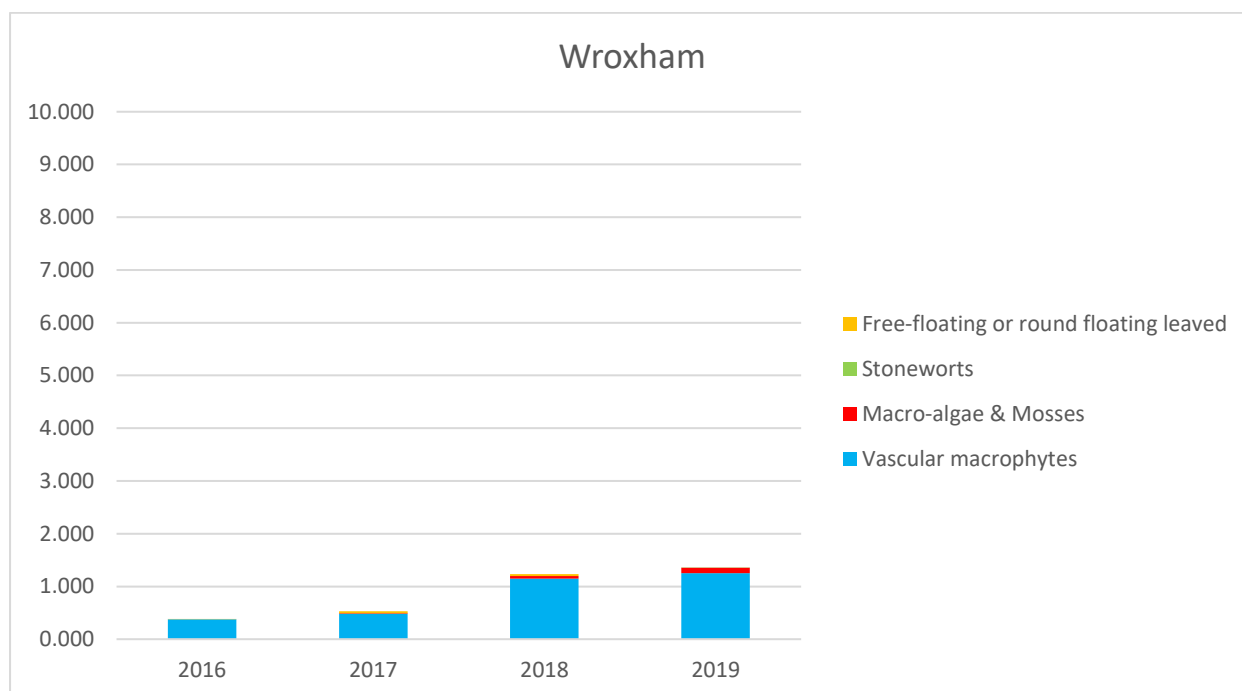
Table 17

Common Name	Scientific Name	Summary Abundance	Occurrences
Rigid hornwort	<i>Ceratophyllum demersum</i>	0.485	29
Fennel-leaved pondweed	<i>Potamogeton pectinatus</i>	0.306	19
Nuttall's waterweed	<i>Elodea nuttallii</i>	0.202	16
Filamentous algae	<i>Zygnematales</i>	0.102	9
Spiked water milfoil	<i>Myriophyllum spicatum</i>	0.098	6
Fan-leaved water crowfoot	<i>Ranunculus circinatus</i>	0.082	6
Yellow water lily	<i>Nuphar lutea</i>	0.065	4
Pondweed species	<i>Potamogeton sp</i>	0.016	1
Translucent stonewort	<i>Nitella translucens</i>	0.002	1
Total number of species recorded		9	Total samples taken: 62

This broad is very well used by the public and boat tours and day boats used it frequently over the summer months. There is not a great amount of plants in this broad but there was a slight increase in vascular and macro algae and mosses this year. Rigid Hornwort was present in nearly 50% of sample points. Another positive is that there were few sites where no plants were found and there were two more species found this year. Three species have increased in abundance this year Fennel-leaved pondweed, Nuttall's waterweed and Yellow water lily.

Graph 15

Abundance shown in plant groups (see Appendix 1 for more detail)



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'.

Rockland Broad

Table 18

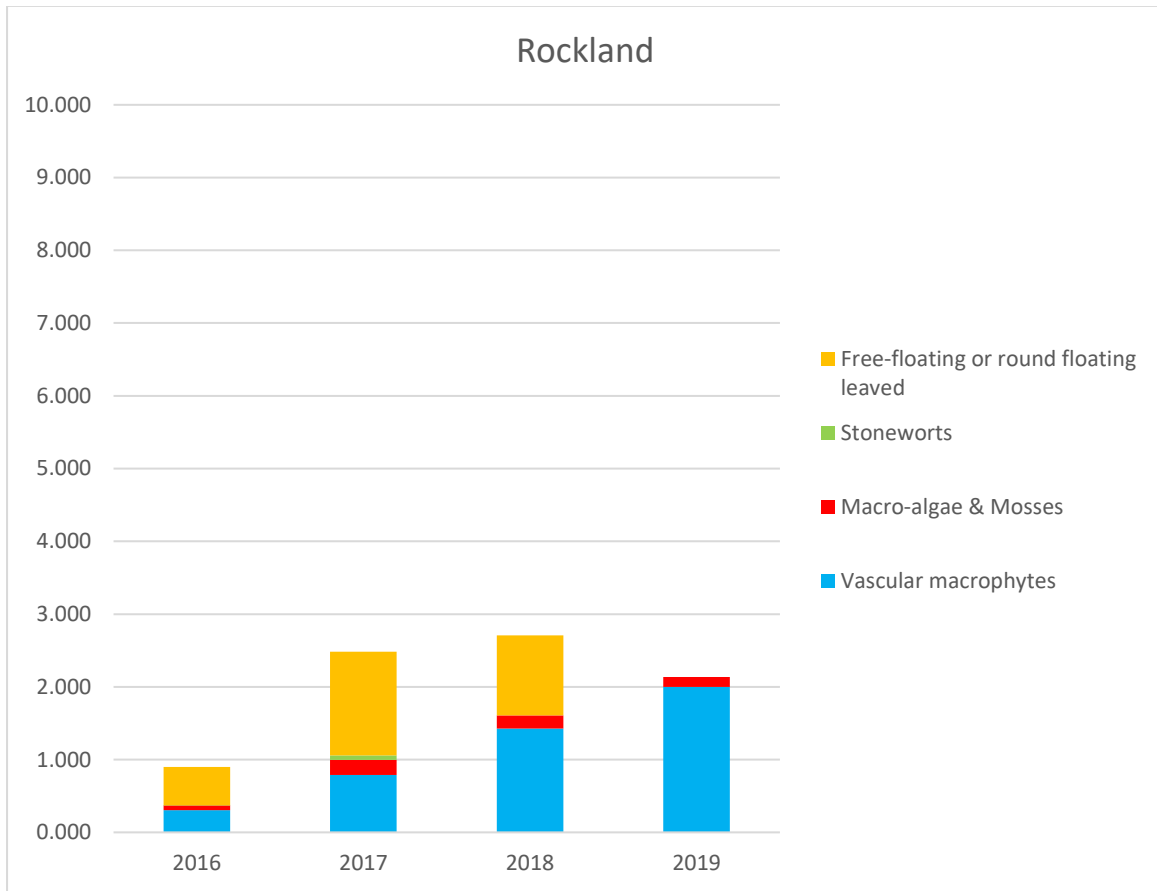
Common Name	Scientific Name	Summary Abundance	Occurrences
Yellow water lily	<i>Nuphar lutea</i>	0.760	19
Unbranched bur-reed	<i>Sparganium emersum</i>	0.424	22
Rigid hornwort	<i>Ceratophyllum demersum</i>	0.347	26
Common water moss	<i>Fontinalis antipyretica</i>	0.135	12
Spiked water milfoil	<i>Myriophyllum spicatum</i>	0.116	9
Nuttall's waterweed	<i>Elodea nuttallii</i>	0.100	8
Fennel-leaved pondweed	<i>Potamogeton pectinatus</i>	0.082	6

Common Name	Scientific Name	Summary Abundance	Occurrences
Whorled water milfoil	<i>Myriophyllum verticillatum</i>	0.066	5
Blunt-leaved pondweed	<i>Potamogeton obtusifolius</i>	0.053	6
Starwort species	<i>Callitriche sp</i>	0.016	1
Crowfoot species	<i>Ranunculus sp.</i>	0.016	1
Branched bur-reed	<i>Sparganium erectum</i>	0.016	1
Pondweed species	<i>Potamogeton sp</i>	0.003	2
Filamentous algae	<i>Zygnematales</i>	0.002	1
Total number of species recorded		14	Total samples taken: 62

Only vascular plants and macro algae or mosses were found this year. Vascular plants have increased, and macro algae and mosses have decreased. The number of points where zero plants were found this year had increased. Rigid hornwort and Unbranched bur-reed have become the dominant in this broad even though Unbranched bur-reed prefers flowing waters. Yellow water lily decreased in abundance and in the number of points where it was found.

Graph 16

Abundance shown in plant groups (see Appendix 1 for more detail)



Whitlingham Little Broad

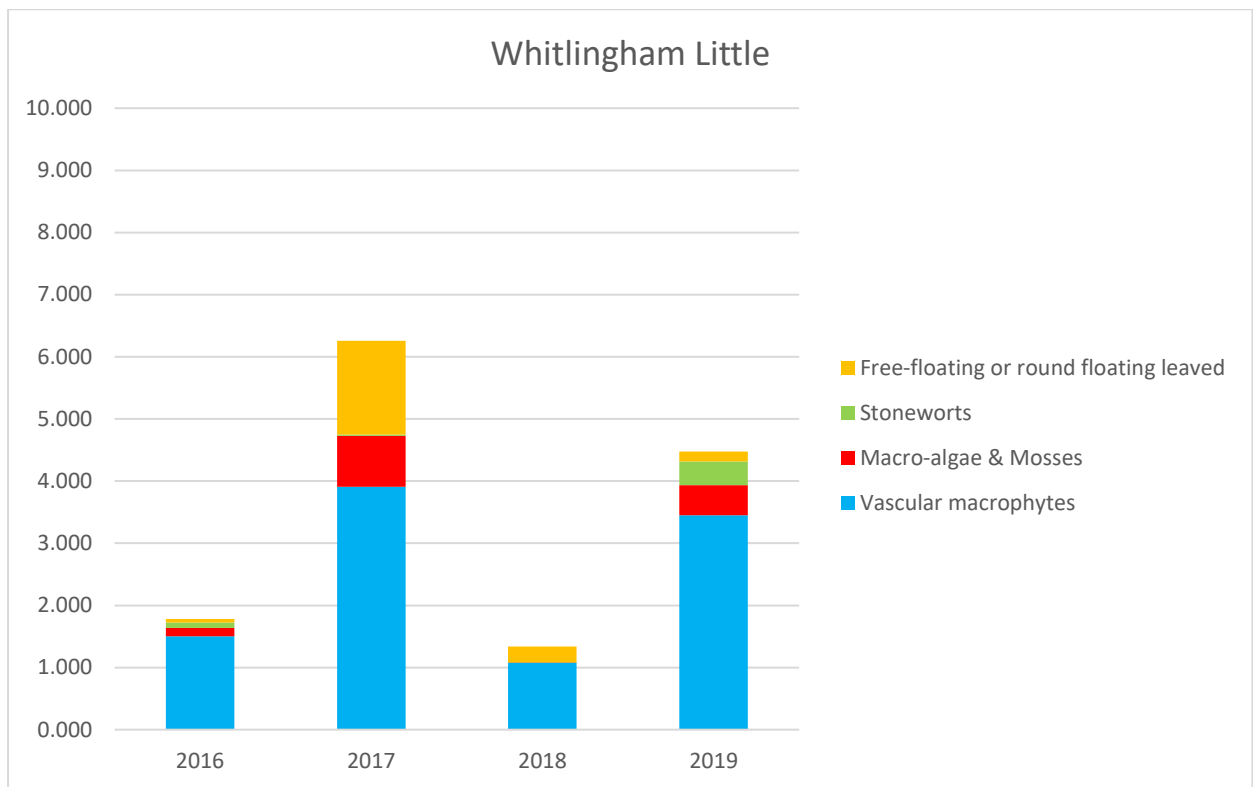
Table 19

Common Name	Scientific Name	Summary Abundance	Occurrences
Nuttall's waterweed	<i>Elodea nuttallii</i>	2.485	30
Filamentous algae	<i>Zygnematales</i>	0.483	20
Common stonewort	<i>Chara vulgaris</i>	0.258	11
Rigid hornwort	<i>Ceratophyllum demersum</i>	0.235	13
Horned pondweed	<i>Zannichellia palustris</i>	0.225	7
Fennel-leaved pondweed	<i>Potamogeton pectinatus</i>	0.200	2
Ivy-leaved duckweed	<i>Lemna trisulca</i>	0.160	9
Flat-stalked pondweed	<i>Potamogeton friesii</i>	0.130	7
Canadian waterweed	<i>Elodea canadensis</i>	0.125	5
Fragile/convergent stonewort	<i>Chara globularis/connivens</i>	0.075	3
Delicate stonewort	<i>Chara virgata</i>	0.050	2
Curled pondweed	<i>Potamogeton crispus</i>	0.050	2
Jelly algae	<i>Nostoc</i>	0.003	1
Total number of species recorded		13	Total samples taken: 40

This year the number of species has increased by 53% from 2018 and abundance by 74% even though filamentous algae has increased. Stoneworts have also made an appearance this year. Nuttall's waterweed has quadrupled this year along with more overall plants at every point.

Graph 17

Abundance shown in plant groups (see Appendix 1 for more detail)



Acknowledgements

The Broads Authority, Hannah Southon would like to thank all those individuals and organisations who assisted during the 2019 survey season by providing their time, boats, identification skills or permissions.

Many thanks must be expressed to the landowners who kindly granted permission to access the privately owned & managed broads: Norfolk Wildlife Trust, Natural England, Blofeld Estate, the Horsey Estate and the National Trust.

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A special thanks to Vicky Short for all the GIS work involved.

Appendix I: Common water plants in the Broads

Table 20

Details of Broads water plants

Group	Scientific name	Common name	Section 41
Stoneworts	<i>Chara aspera</i>	Rough stonewort	
	<i>C. baltica</i>	Baltic stonewort	Y
	<i>C. connivens</i>	Convergent stonewort	Y
	<i>C. contraria</i>	Opposite stonewort	
	<i>C. curta</i>	Lesser bearded stonewort	
	<i>C. globularis</i>	Fragile stonewort	
	<i>C. hispida</i>	Bristly stonewort	
	<i>C. intermedia</i>	Intermediate stonewort	Y
	<i>C. pedunculata</i>	Hedgehog stonewort	
	<i>C. virgata</i>	Delicate stonewort	
	<i>C. vulgaris</i>	Common stonewort	
	<i>Nitella flexilis</i>	Starry stonewort	Y
	<i>N. mucronata</i>	Pointed stonewort	
	<i>N. translucens</i>	Translucent stonewort	
Vascular macrophytes	<i>Acorus calamus</i>	Sweet flag	
	<i>Crassula helmsii</i>	Australian swamp stonecrop	
	<i>Callitriche sp.</i>	Starwort sp.	
	<i>Ceratophyllum demersum</i>	Rigid hornwort	
	<i>Elodea canadensis</i>	Canadian waterweed	
	<i>E. nuttallii</i>	Nuttall's waterweed	
	<i>Eleogiton fluitans</i>	Floating club-rush	
	<i>Glyceria maxima</i>	Reed sweet grass	
	<i>Hippuris vulgaris</i>	Mare's tail	
	<i>Myriophyllum spicatum</i>	Spiked water milfoil	
	<i>M. verticillatum</i>	Whorled water milfoil	
	<i>Najas marina</i>	Holly-leaved naiad	Y
	<i>Persicaria amphibia</i>	Amphibious bistort	
	<i>Potamogeton acutifolius</i>	Sharp-leaved pondweed	
	<i>P. berchtoldii</i>	Small pondweed	
	<i>P. crispus</i>	Curled pondweed	
	<i>P. friesii</i>	Flat-stalked pondweed	
	<i>P. lucens</i>	Shining Pondweed	
	<i>P. natans</i>	Broad-leaved pondweed	
	<i>P. obtusifolius</i>	Blunt-leaved pondweed	
	<i>P. pectinatus</i>	Fennel-leaved pondweed	
	<i>P. perfoliatus</i>	Perfoliate pondweed	
	<i>P. pusillus</i>	Lesser pondweed	
	<i>P. trichoides</i>	Hair like pondweed	
	<i>Potamogeton x Salicifolius</i>	Willow-leaved pondweed	
	<i>Ranunculus circinatus</i>	Fan-leaved water crowfoot	
	<i>Rorippa nasturtium-aquaticum</i>	Water cress	
	<i>Sagittaria sagittifolia</i>	Arrowhead	
	<i>Sparganium erectum</i>	Branched bur-reed	
	<i>S. emersum</i>	Unbranched bur-reed	

	<i>Stratiotes aloides</i>	Water-soldier	
	<i>Utricularia vulgaris</i>	Greater bladderwort	
	<i>Zannichellia palustris</i>	Horned pondweed	
Free-floating or Round floating leaved macrophytes	<i>Hydrocharis morsus-ranae</i>	Frogbit	
	<i>Lemna gibba</i>	Inflated duckweed	
	<i>L. minor</i>	Common duckweed	
	<i>L. minuta</i>	Least duckweed	
	<i>L. trisulca</i>	Ivy-leaved duckweed	
	<i>Nuphar lutea</i>	Yellow water lily	
	<i>Nymphaea alba</i>	White water lily	
	<i>Spirodela polyrhiza</i>	Greater duckweed	
Macro-algae & Mosses	<i>Enteromorpha</i>		
	<i>Fontinalis antipyretica</i>	Common water moss	
	<i>Hydrodictyon</i>	Water net	
	<i>Leptodictyum riparium</i>	Stringy moss	
	<i>Zygnematales</i>	Filamentous algae	