Broads Annual Water Plant Monitoring Report 2020

November 2019

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Contents

Cover photos of flowering white water lilies and Hedgehog stonewort, 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 2020, which covered 21 Broads with a total of 568 survey points.

- Overall in 2020, 17 out of the 21 broads surveyed saw an increase in species abundance when scores are compared to those recorded in 2019.

- Section 41 species (conservation priority species) were found in 10 out of the 21 broads surveyed; Holly-leaved naiad being in 9 out of the 10. Holly-leaved naiad saw an increase in 2020 in Alderfen Broad, Cromes Broad, Cockshoot Broad, Pound End, and Upton Great Broad.

- An increase has been observed in abundance in vascular plants again this year in Barton Broad, Bridge Broad, Cromes Broad, Cockshoot Broad, Heigham Sound, Hudson's Bay, Hoveton Little Broad, Pound End, Rockland Broad, Upton Great Broad and Wroxham Broad.

- Stonewort's were dominant in Hickling Broad, Martham North and Martham South this year. There were also higher abundances recorded in Alderfen Broad, Bargate Broad, Cockshoot Broad, Heigham Sound and Rockland Broad compared to 2019.

- This year 13 of the broads surveyed showed the highest macrophyte abundance levels seen since the new survey method started in 2014. They are Bargate Broad, Barton Broad, Bridge Broad, Cockshoot Broad, Decoy Broad, Heigham Sound, Hickling Broad, Hoveton Great Broad, Hoveton Little Broad, Hudson's Bay, Pound End, Rockland Broad and Wroxham Broad.

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. Broads 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 2020 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 priority 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 = 4.6242ln(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.

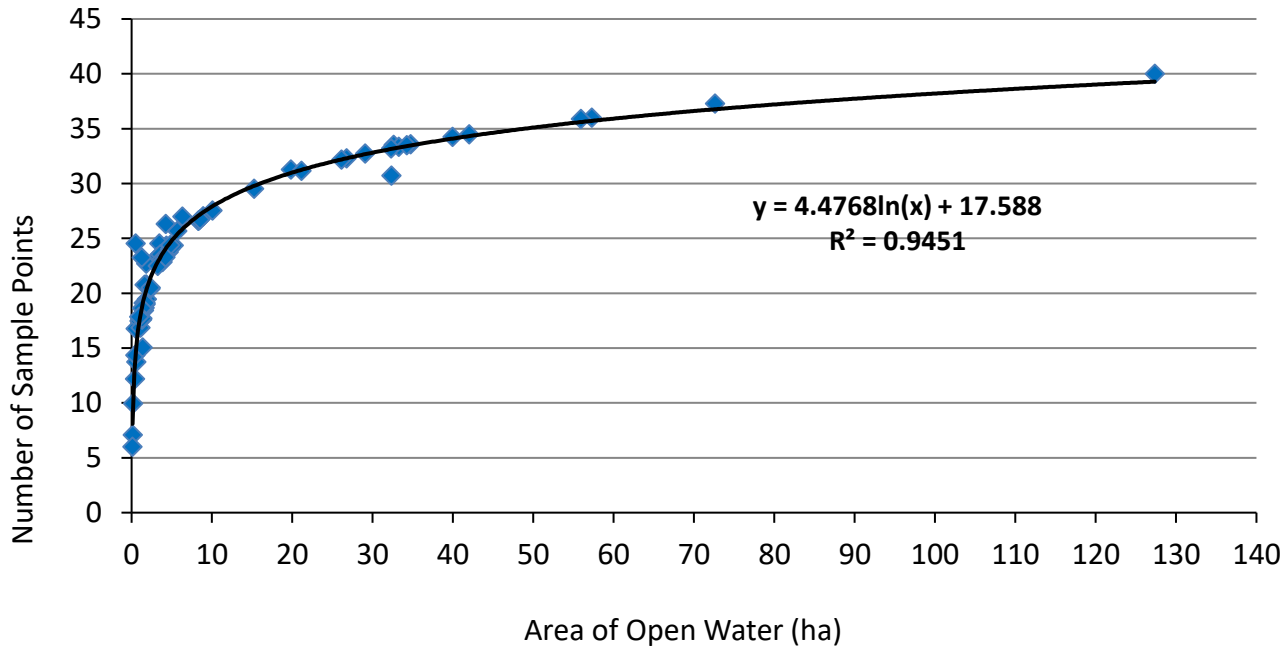
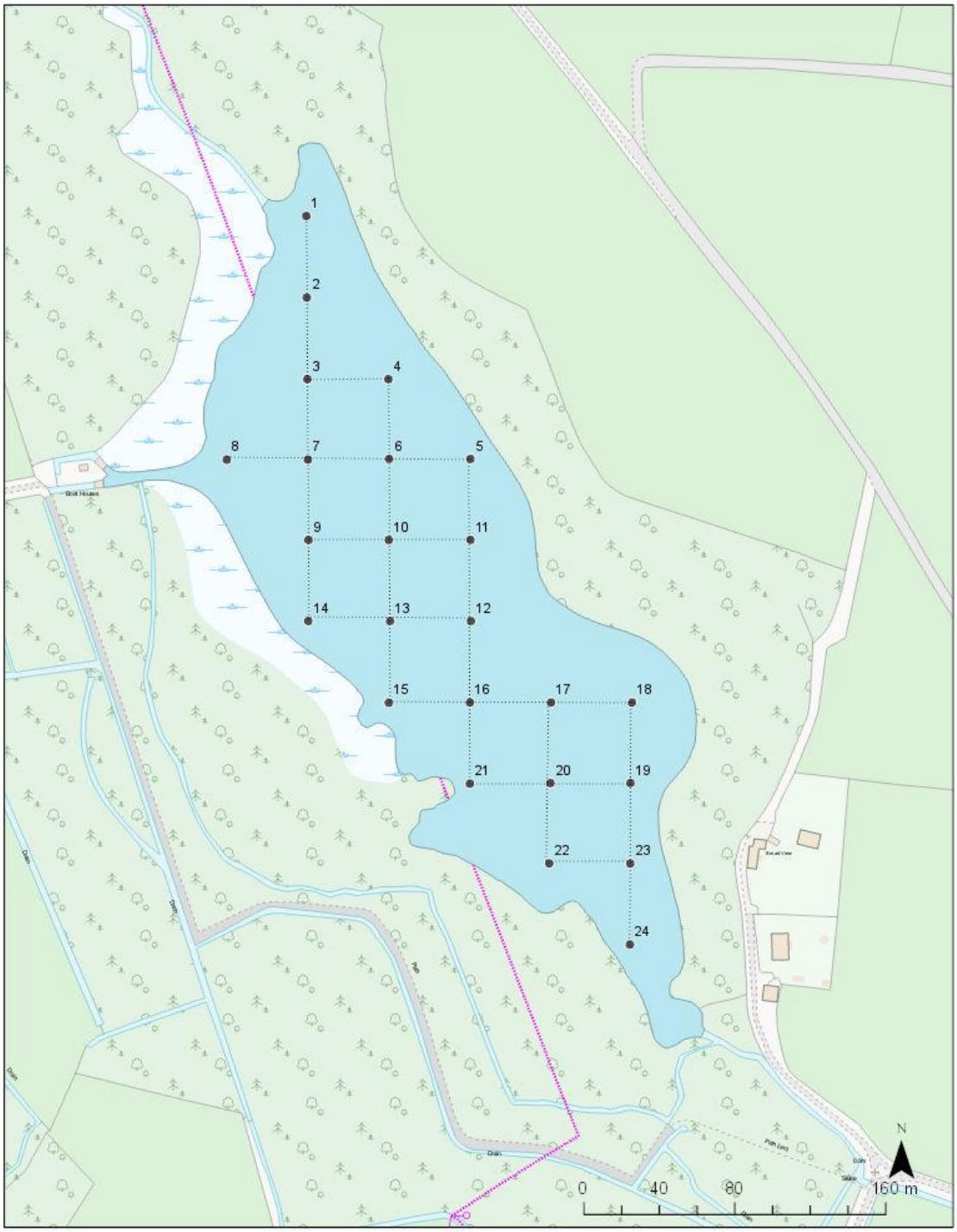


Figure 2

Map showing the sample points of Alderfen Broad



Sample points at Alderfen Broad

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 ± 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	2020
Alderfen Broad	X	X	X	X	X	X	X
Bargate Broad	X			X			X
Barnby Broad		X					
Barton Broad	X	X	X	X	X	X	X
Belaugh Broad				X			
Blackfleet broad			X				
Bridge Broad		X					X
Buckenham Broad		X		X			
Burntfen Broad			X				
Calthorpe Broad	X						
Catfield Broad		X					
Cockshoot Broad	X	X	X	X	X	X	X
Cromes Broad	X	X	X	X	X	X	X
Decoy Broad	X		X		X		X
Hassingham Broad		X		X			
Heigham Sound	X	X	X	X	X	X	X
Hickling Broad	X	X	X	X	X	X	X
Horsey Mere	X	X	X	X	X	X	X
Hoveton Great Broad	X	X	X	X	X	X	X
Hoveton Little Broad	X			X			X
Hudson's Bay		X			X		X
Little Broad			X				
Malthouse Broad							X
Martham Broad North	X	X	X	X	X	X	X
Martham Broad South	X	X	X	X	X	X	X
Mautby Decoy			X				
Norton's Broad			X				
Oulton Broad			X				
Pound End		X					X
Ranworth Broad	X	X		X		X	X
Reedham Water							
Rockland Broad	X	X	X	X	X	X	X

Broad	2014	2015	2016	2017	2018	2019	2020
Round Water Broad			X				
Sotshole Broad			X				
Sprat's Water			X				
Strumpshaw broad		X			X		
Upton Broad	X	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	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;

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

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 (± 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

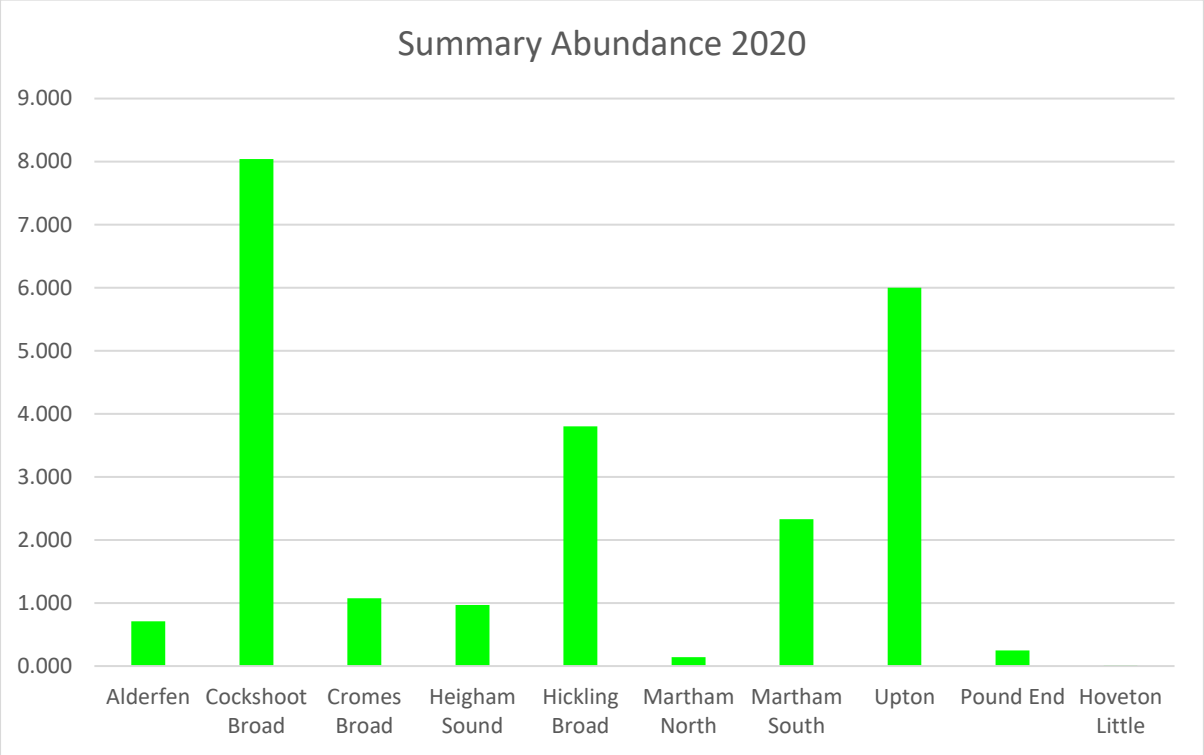
Ten Broads were found to have Section 41 species

Species	**Broads**
Holly-leaved naiad- *Najas marina*	Alderfen Broad, Cockshoot Broad, Cromes Broad, Heigham Sound, Hickling Broad, Martham South, Upton Broad, Pound End, Hoveton Little Broad
Baltic stonewort - *Chara baltica*	Heigham Sound, Hickling Broad, Martham North, Martham South
Intermediate stonewort - *Chara intermedia*	Heigham Sound, Hickling Broad, Martham North, Martham South
Convergent stonewort - Chara connivens	Heigham Sound, Hickling Broad, Martham South
Starry stonewort *Nitellopsis obtusa*	Heigham Sound, Hickling Broad, Martham South

As can be seen from this table the broads in the Thurne are an important site for section 41 species.
In this survey, the Ant Broads were a particular stronghold for Holly-leaved naiad.

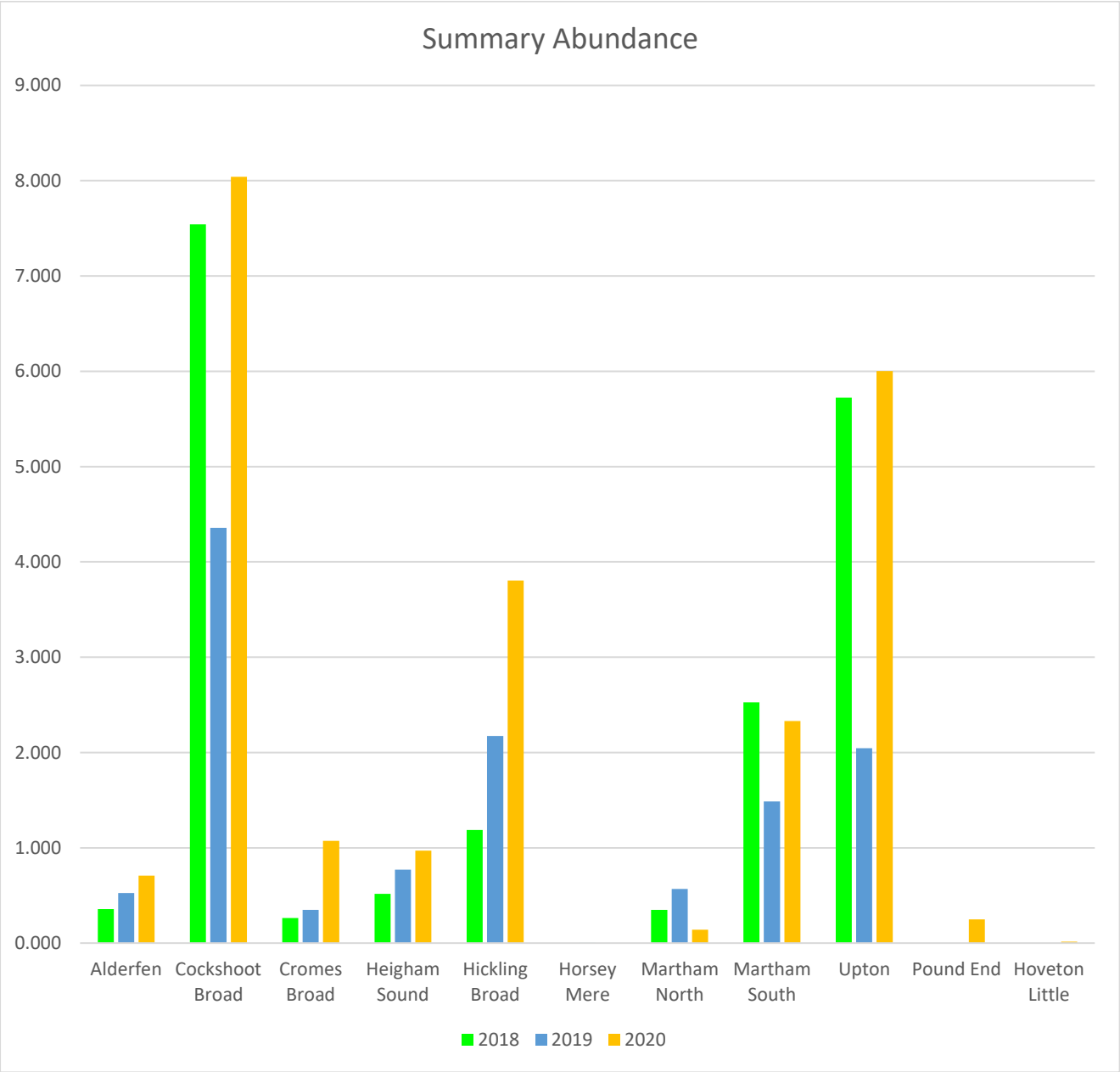
Graph 1

Broads with Section 41 species and their abundance scores in 2020. See main report for specific abundance levels



Graph 2

Section 41 species abundance between 2018 - 2020.



This year saw two broads join the list of Broads with section 41 species, Pound End and Hoveton Little. Horsey Mere recorded one occurrence in 2019 (which the summary abundance is too low to see on the graph) but not in the other two years shown. Hoveton Little recorded one point in 2020 but the summary abundance is too low to see on this graph. See main results for more details.

Table 3
Holly-leaved naiad distribution

Broad	Number of Points with Holly-leaved naiad	Summary abundance
Heigham	2/66	0.045
Hickling	11/80	0.213
Martham South	17/54	0.356
Alderfen	30/48	0.708
Cromes	31/40	1.074
Cockshoot	47/48	7.958
Upton	44/48	6.002
Pound End	11/44	0.250
Hoveton Little	1/60	0.017

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 again this year. Martham North is not on the table this year but was very dominated by Bristly stonewort, *Chara hispida*.

Main Survey Results

The data collected from each broad is presented as 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 water plant surveys in the Broads.

Thurne Valley

The Thurne valley broads contain two Annex I habitats and form a key part of the Broads Special Area of Conservation (SAC) designation. (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 section 41 priority species, as well as more common vascular plants such as Spiked water milfoil and Mare's tail.

2020 Summary

This year there has been a general increase in abundance from 2019. All broads except Horsey Mere showed an increase from 2019 with Heigham Sound and Hickling Broad recording the highest levels since the new method started. The Broads at Martham both have recorded abundance levels up from the previous year and similar to levels seen in prior to 2019. The high variability of plant abundance between years highlights the importance of surveys carried out frequently and looking across multiple years to establish trends. Horsey Mere continues to show low macrophyte levels compared to the other broads in the Thurne Valley.

Heigham Sound

Table 4

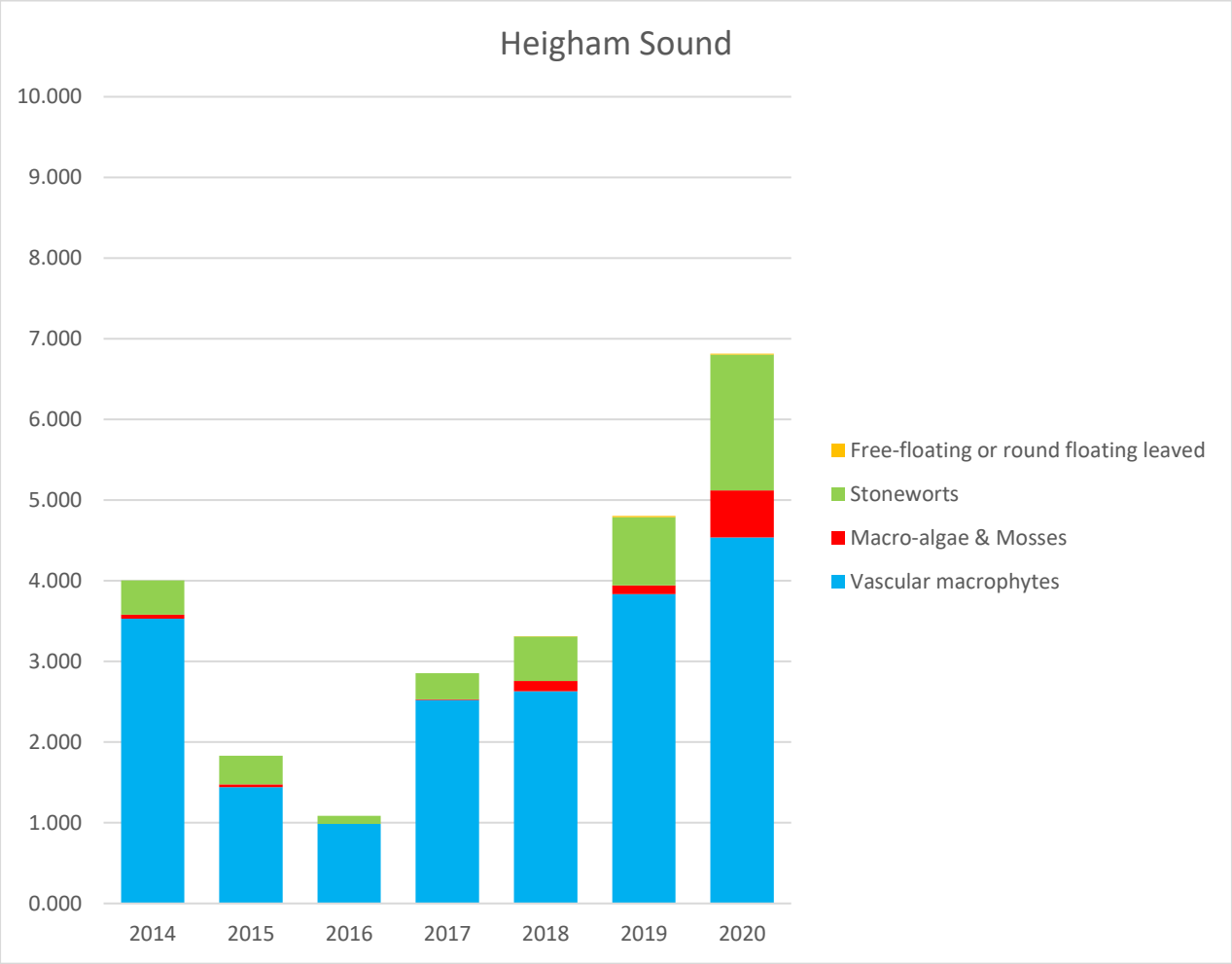
Common Name	Scientific Name	Summary Abundance	Occurrences
Mare's tail	*Hippuris vulgaris*	0.909	23
Fan-leaved water crowfoot	*Ranunculus circinatus*	0.909	26
Rigid hornwort	*Ceratophyllum demersum*	0.714	37
Bristly stonewort	*Chara hispida*	0.682	11
Spiked water milfoil	*Myriophyllum spicatum*	0.653	32
Filamentous algae	*Zygnematales*	0.583	19
Nuttall's waterweed	*Elodea nuttallii*	0.380	21
Starry stonewort	*Nitellopsis obtusa*	0.364	17
Canadian waterweed	*Elodea canadensis*	0.273	15
Curled pondweed	*Potamogeton crispus*	0.242	16
Intermediate stonewort	*Chara intermedia*	0.212	6
Convergent stonewort	*Chara connivens*	0.197	3
Baltic stonewort	*Chara baltica*	0.152	6
Starwort species	*Callitriche sp*	0.123	8
Whorled water milfoil	*Myriophyllum verticillatum*	0.106	5
Shining pondweed	*Potamogeton lucens*	0.106	3
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.061	1
Common stonewort	*Chara vulgaris*	0.061	2
Holly-leaved naiad	*Najas marina*	0.045	2
Fragile/convergent stonewort	*Chara globularis/connivens*	0.015	1
Yellow water lily	*Nuphar lutea*	0.015	1
Lesser pondweed	*Potamogeton pusillus*	0.015	1
Total number of species recorded		**22**	**Total samples taken: 66**

This has been a good year for Heigham sound with continued macrophyte recovery. 2020 recorded the highest summary abundance since the new point sampling method was introduced in 2014, with an increase of two points (in summary abundance score). Whorled

water milfoil was recorded which had been absent since 2016. Bristly stonewort continued to show an increase in abundance.

Graph 3

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



Hickling Broad

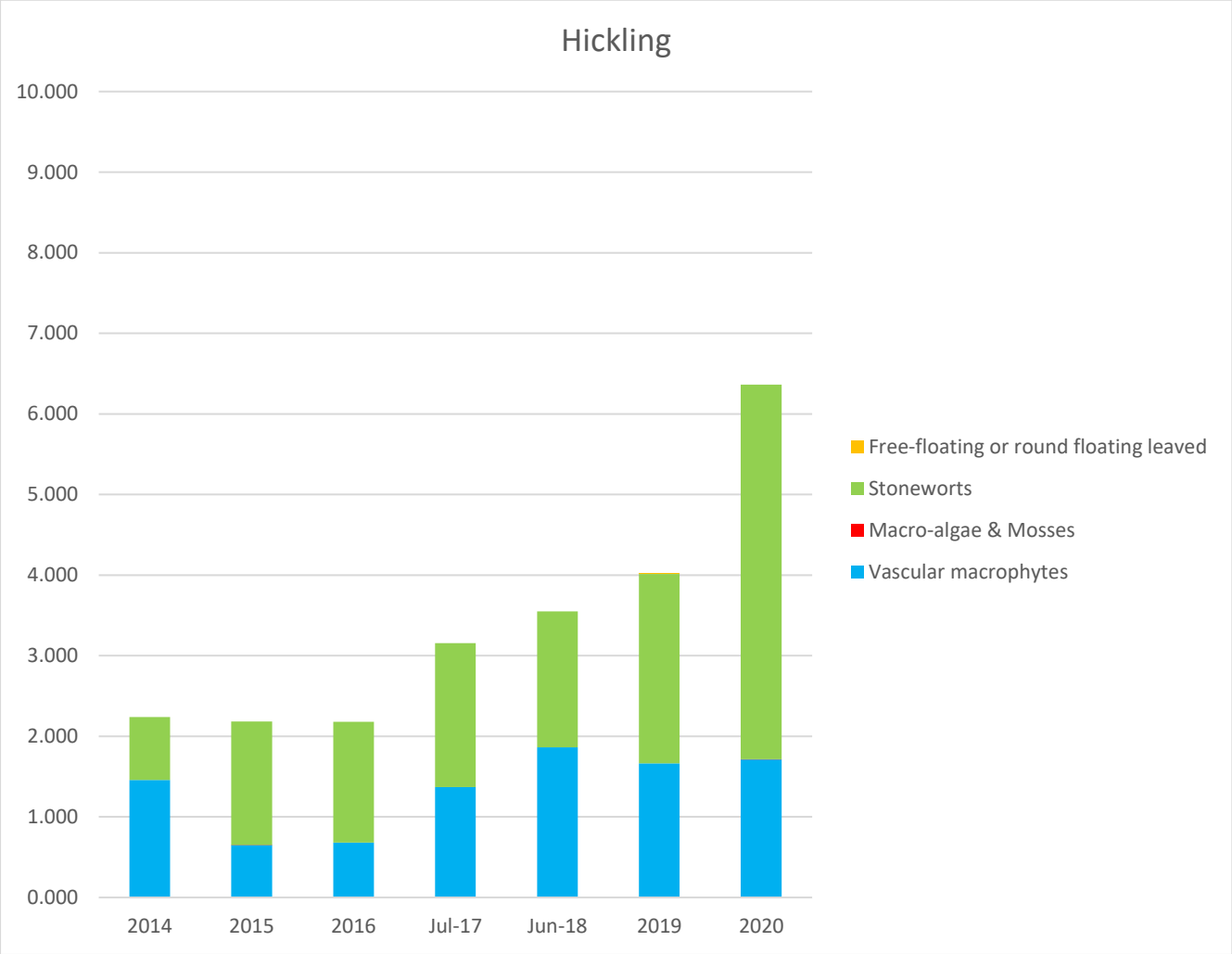
Table 5

Common Name	Scientific Name	Summary Abundance	Occurrences
Intermediate stonewort	*Chara intermedia*	2.325	53
Baltic stonewort	*Chara baltica*	1.191	45
Spiked water milfoil	*Myriophyllum spicatum*	0.886	49
Bristly stonewort	*Chara hispida*	0.689	18
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.390	26
Hedgehog stonewort	*Chara aculeolata*	0.275	4
Holly-leaved naiad	*Najas marina*	0.213	11
Curled pondweed	*Potamogeton crispus*	0.125	10
Mare's tail	*Hippuris vulgaris*	0.088	2
Convergent stonewort	*Chara connivens*	0.063	5
Lesser bearded stonewort	*Chara curta*	0.039	3
Rough stonewort	*Chara aspera*	0.038	3
Stonewort (Chara) species	*Chara species*	0.018	5
Starry stonewort	*Nitellopsis obtusa*	0.013	1
Rigid hornwort	*Ceratophyllum demersum*	0.013	1
Filamentous algae	*Zygnematales*	0.003	2
Total number of species recorded		**16**	**Total samples taken: 80**

In 2020 the survey recorded similar vascular plant abundance and a large increase in stonewort's compared to 2019 . Increases were recorded in Intermediate, Baltic, Bristly, Hedgehog and Convergent stoneworts. There were plants at every point this year which has not always been the case in past years surveys. Holly-leaved naiad had a similar abundance to 2019 but the occurrences were less than seen in 2019 (2019 recorded 21 occurrences whereas 2020 recorded 11).

Graph 4

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



Horsey Mere

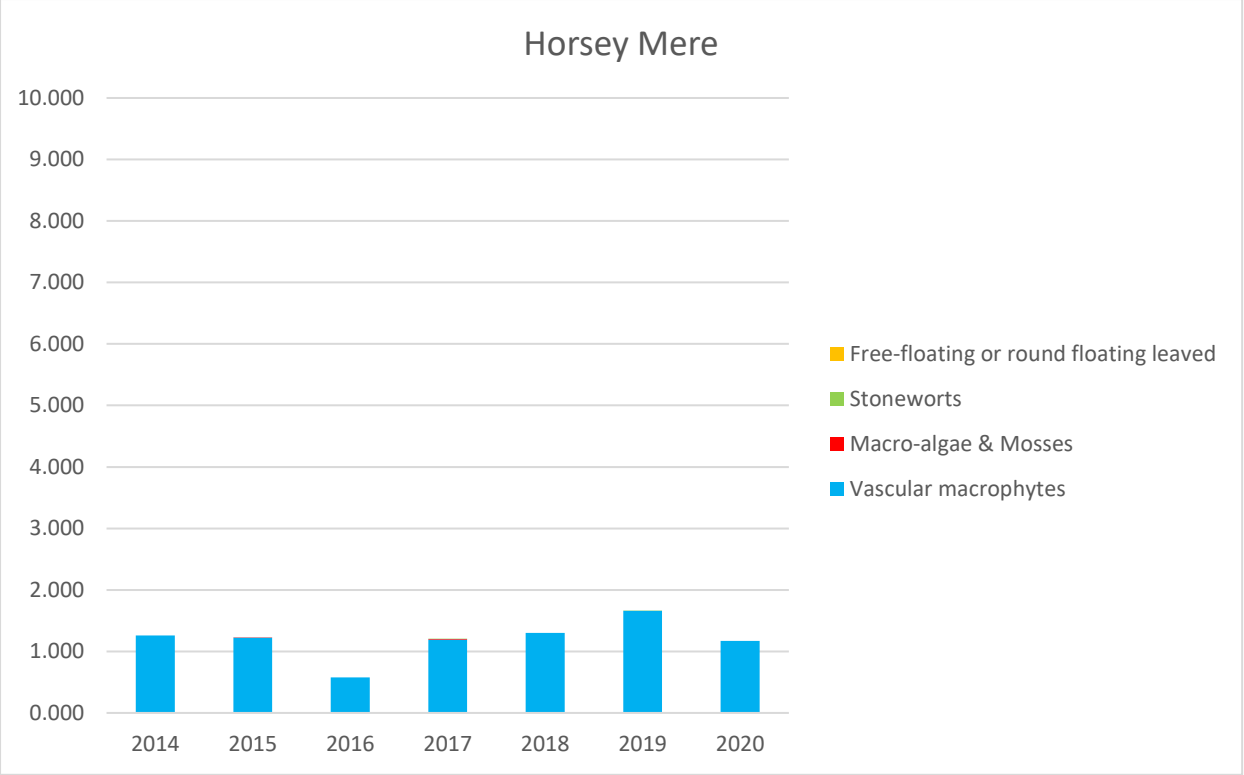
Table 6

Common Name	Scientific Name	Summary Abundance	Occurrences
Mare's tail	*Hippuris vulgaris*	0.667	13
Spiked water milfoil	*Myriophyllum spicatum*	0.505	35
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.002	1
Total number of species recorded		**3**	**Total samples taken: 66**

Mare's tail had a good year along with spiked water milfoil. There is still very little growth in the Mere itself as most of the plants were found around the edges. Summary abundance has decreased overall this year and only three species were recorded compared with five in 2019. The 'no plant' points in 2020 was quite high at 29 compared with one in 2019.

Graph 5

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



Martham North

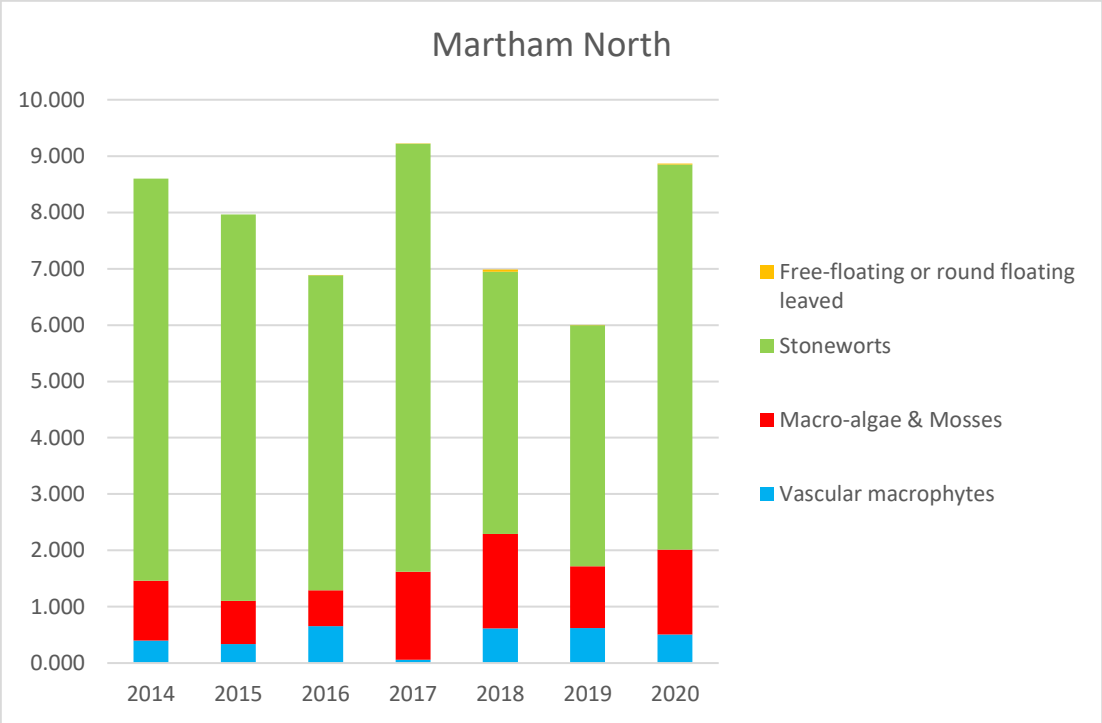
Table 7

Common Name	***Scientific Name***	**Summary Abundance**	**Occurrences**
Bristly stonewort	*Chara hispida*	6.694	39
Filamentous algae	*Zygnematales*	1.446	17
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.310	13
Ivy-leaved duckweed	*Lemna trisulca*	0.138	7
Baltic stonewort	*Chara baltica*	0.102	7
Common water moss	*Fontinalis antipyretica*	0.058	3
Intermediate stonewort	*Chara intermedia*	0.038	2
Mare's tail	*Hippuris vulgaris*	0.038	2
Fresh water sponge	*Spongillidae*	0.038	2
White water lily	*Nymphaea alba*	0.019	1
Willow-leaved pondweed	*Potamogeton x salicifolius*	0.019	1
Starwort species	*Callitriche sp*	0.002	1
Spiked water milfoil	*Myriophyllum spicatum*	0.002	1
Total number of species recorded		**13**	**Total samples taken: 52**

Vascular and macro algae & mosses are similar to 2019, however stoneworts have increased to levels last seen in 2017. This is shown in the summary abundance going up nearly three points this year. Bristly stonewort has doubled in abundance from 2019 whereas Baltic stonewort is very similar to 2019. Filamentous algae recorded levels seen in 2018 therefore no drastic increase even though reports have indicated Filamentous algae being more prevalent this year. There was no Holly-leaved naiad found this year.

Graph 6

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



Martham South

Table 8

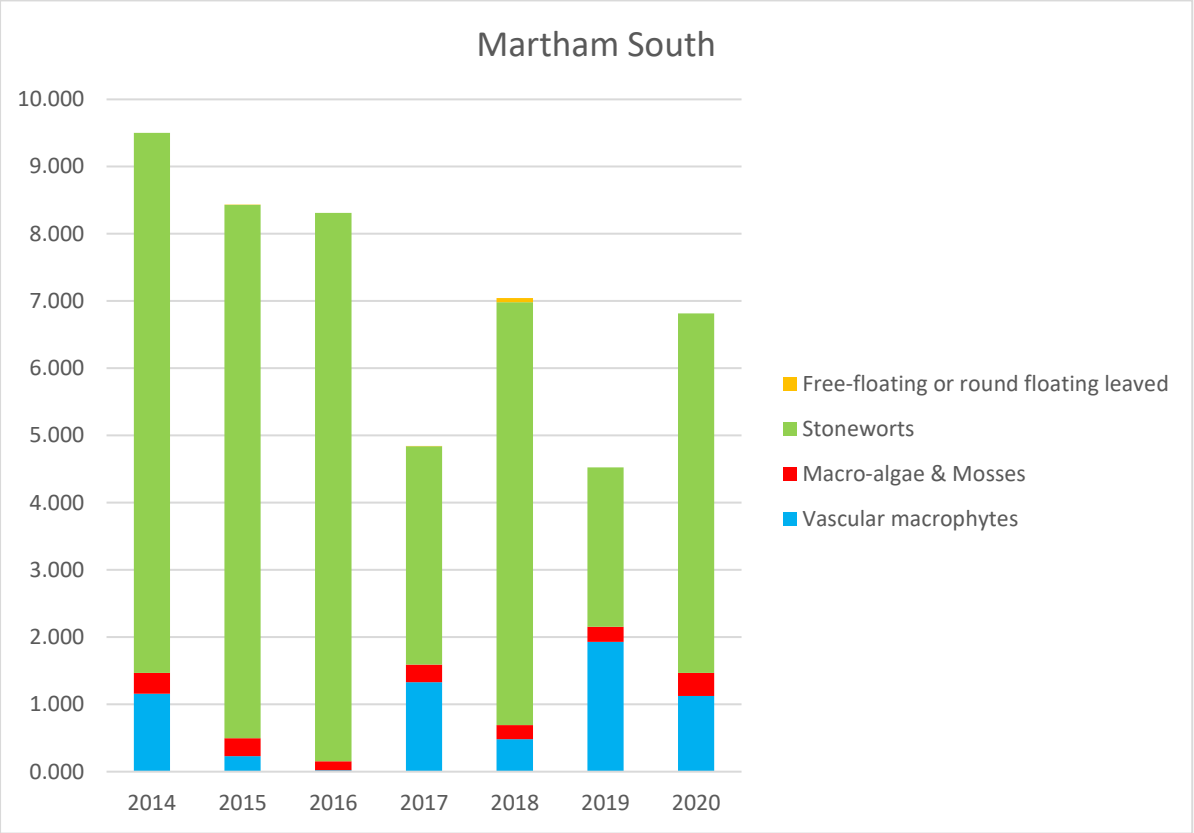
Common Name	Scientific Name	Summary Abundance	Occurrences
Bristly stonewort	*Chara hispida*	3.246	40
Baltic stonewort	*Chara baltica*	0.963	27
Starry stonewort	*Nitellopsis obtusa*	0.578	18
Holly-leaved naiad	*Najas marina*	0.356	17
Intermediate stonewort	*Chara intermedia*	0.300	16
Filamentous algae	*Zygnematales*	0.281	11
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.261	13
Mare's tail	*Hippuris vulgaris*	0.243	5
Spiked water milfoil	*Myriophyllum spicatum*	0.154	9
Convergent stonewort	*Chara connivens*	0.133	8
Horned pondweed	*Zannichellia palustris*	0.076	5
Fresh water sponge	*Spongillidae*	0.074	4
Common water moss	*Fontinalis antipyretica*	0.057	4
Fragile/convergent stonewort	*Chara globularis/connivens*	0.056	3
Ivy-leaved duckweed	*Lemna trisulca*	0.039	3
Delicate stonewort	*Chara virgata*	0.037	1
Rough stonewort	*Chara aspera*	0.037	2
Total number of species recorded		**17**	**Total samples taken: 54**

This year an increase in overall abundance was recorded compared to 2019, however there was a decrease in vascular plants. Stoneworts still dominated the broad this year with eight varieties being found and an increase in abundance seen for Bristly, Baltic, Starry and Convergent stoneworts. Holly-leaved naiad saw a decrease this year by about 50% for both abundance and occurrence. Fresh water sponge was also noted at 4 points and Jelly algae at one point.

Fennel-leaved pondweed saw a decrease in points from 2019. Graph 7 shows there does not seem to be a year on year decline in the plant community as possibly inferred from the 2019 data.

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 to be surveyed, starting 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.

2020 Summary

2020 has seen a general increase in abundance in the Broads surveyed. Eleven out of the fourteen surveyed showed an increase in abundance levels this year with three recording levels seen in previous years. Nine of the Broads also recorded their highest abundances levels since the new method began.

Alderfen

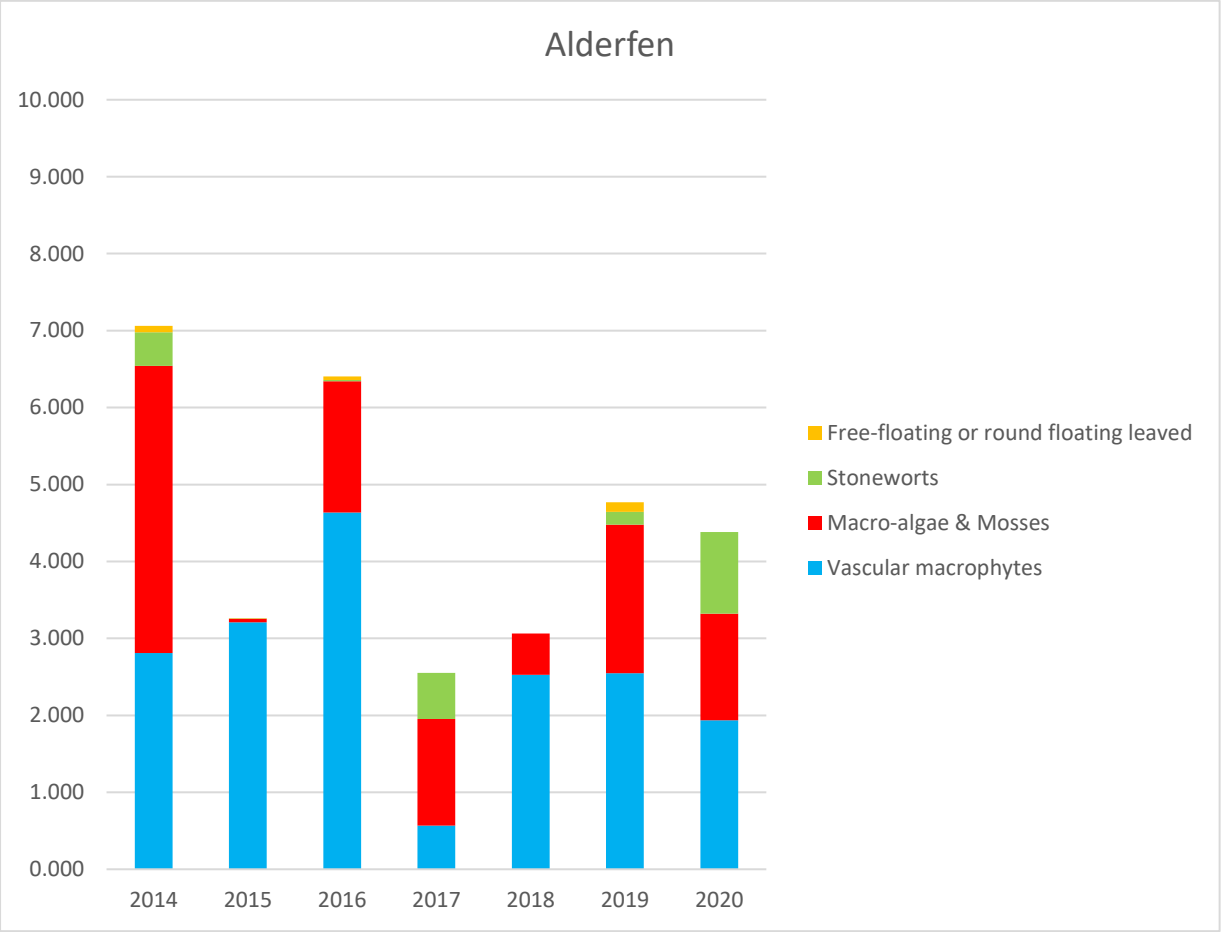
Table 9

Common Name	Scientific Name	Summary Abundance	Occurrences
Rigid hornwort	*Ceratophyllum demersum*	1.229	38
Fragile/convergent stonewort	*Chara globularis/connivens*	1.063	23
Filamentous algae	*Zygnematales*	1.042	32
Holly-leaved naiad	*Najas marina*	0.708	30
Water net	*Hydrodictyon*	0.083	4
Total number of species recorded		**5**	**Total samples taken: 48**

Vascular plant abundance remained similar to 2019, however an increase in stoneworts was also recorded. As in previous years, plants were recorded at every point in the broad. Fragile/convergent stonewort went from eight points recorded in 2019 to 23 in 2020, with abundance levels going from 0.167 to 1.063. Filamentous algae was found in a similar amount of points this year but abundance levels have dropped from 2019. Holly-leaved naiad increased this year being seen in over 60% of points surveyed. Jelly algae was also recorded at 15 points

Graph 8

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



Barton Broad

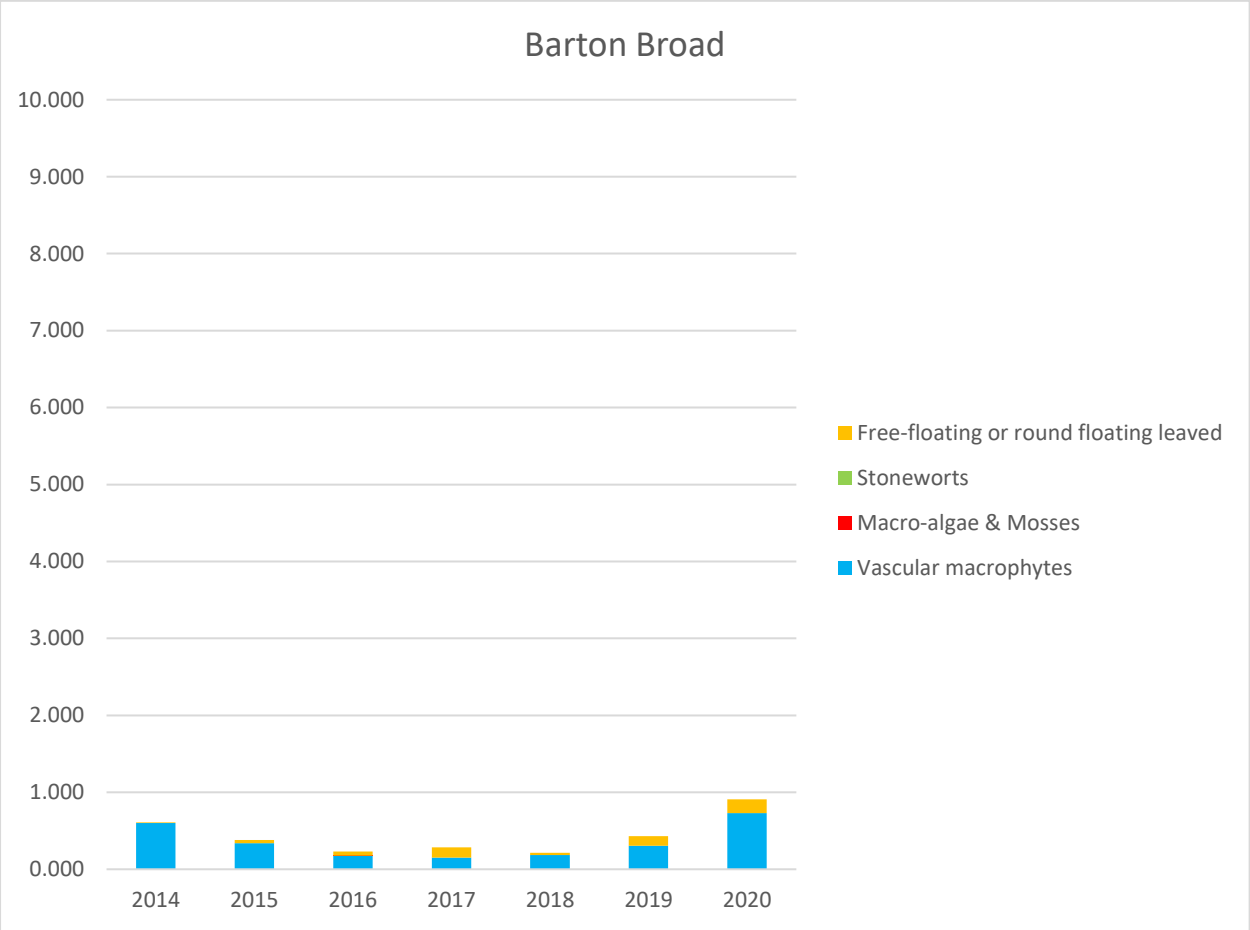
Table 10

Common Name	Scientific Name	Summary Abundance	Occurrences
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.416	17
Rigid hornwort	*Ceratophyllum demersum*	0.216	13
Yellow water lily	*Nuphar lutea*	0.146	5
Nuttall's waterweed	*Elodea nuttallii*	0.071	5
White water lily	*Nymphaea alba*	0.029	1
Canadian waterweed	*Elodea canadensis*	0.014	1
Fan-leaved water crowfoot	*Ranunculus circinatus*	0.014	1
Water-soldier	*Stratiotes aloides*	0.014	1
Inflated duckweed	*Lemna gibba*	0.001	1
Total number of species recorded		**9**	**Total samples taken 70**

Barton Broad recorded vascular macrophytes and free floating or round floating leaved plants this year. Vascular macrophytes mainly consisted of Fennel-leaved pondweed and Rigid Hornwort with yellow water lily making up the floating leaved plants. The top four species are the same from 2019 but there were only four species in 2019 whereas this year nine species were found. The plants were found in the shallower areas and nearer the edges around the Broad. There were numerous freshwater mussels caught in each rake throw. The species abundance level is the highest seen since the new method started.

Graph 9

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



Cromes Broad

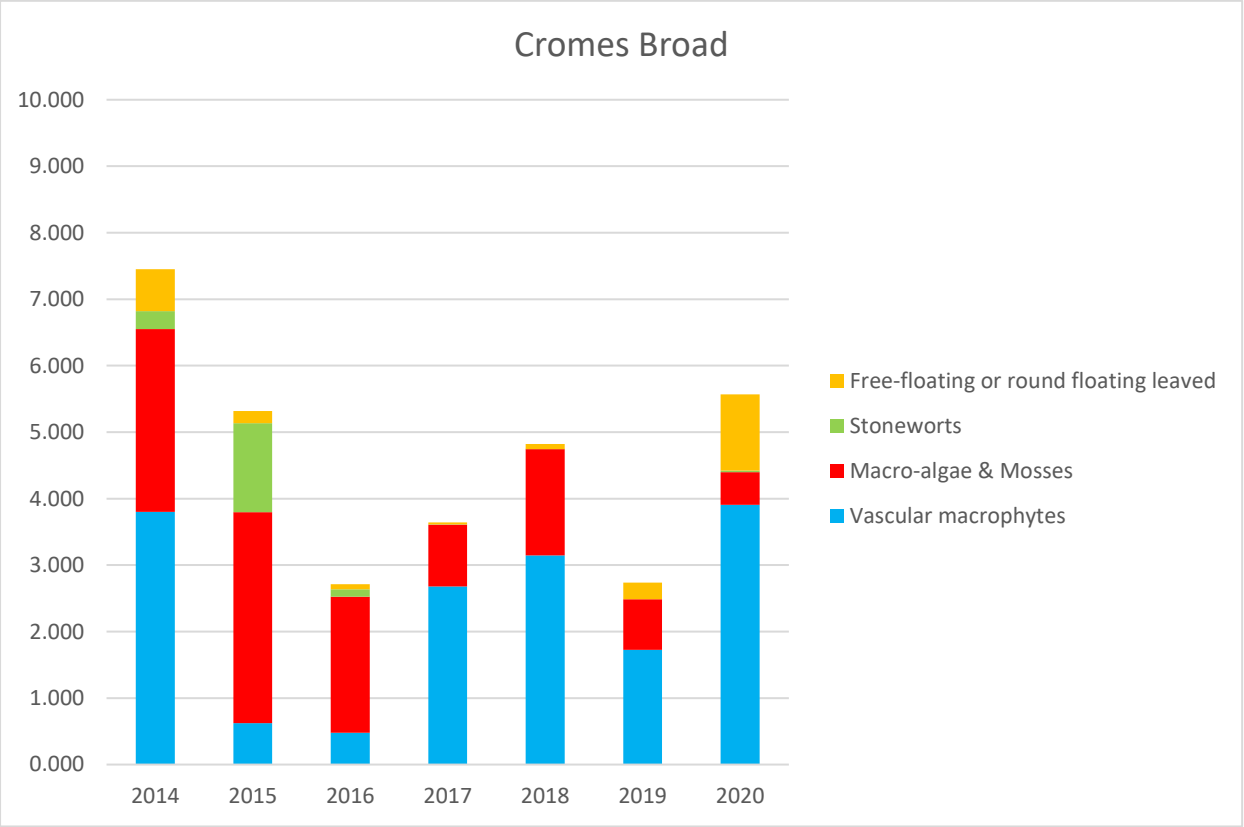
Table 11

Common Name	Scientific Name	Summary Abundance	Occurrences
Rigid hornwort	*Ceratophyllum demersum*	2.764	27
White water lily	*Nymphaea alba*	1.145	6
Holly-leaved naiad	*Najas marina*	1.074	31
Filamentous algae	*Zygnematales*	0.479	17
Bladderwort	*Utricularia vulgaris*	0.071	1
Fragile/convergent stonewort	*Chara globularis/connivens*	0.026	2
Total number of species recorded		**6**	**Total samples taken: 42**

A small increase in vascular and free floating species was recorded this year compared with 2019. This increase results in overall abundance levels similar to those recorded in 2015 data. Filamentous algae has dropped to 4th place in the table this year which has not been recorded since the new method started. White water lilies have increased in abundance and occurrences this year. Bladderwort made an appearance this year and although only found in one spot this year was easily seen in the southern end of the broad from the surface and was quite prevalent there. Holly-leaved naiad has increased from thirteen occurrences to thirty one. Stoneworts also have made an appearance this year and Jelly algae was found at four points.

Graph 10

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



Cockshoot

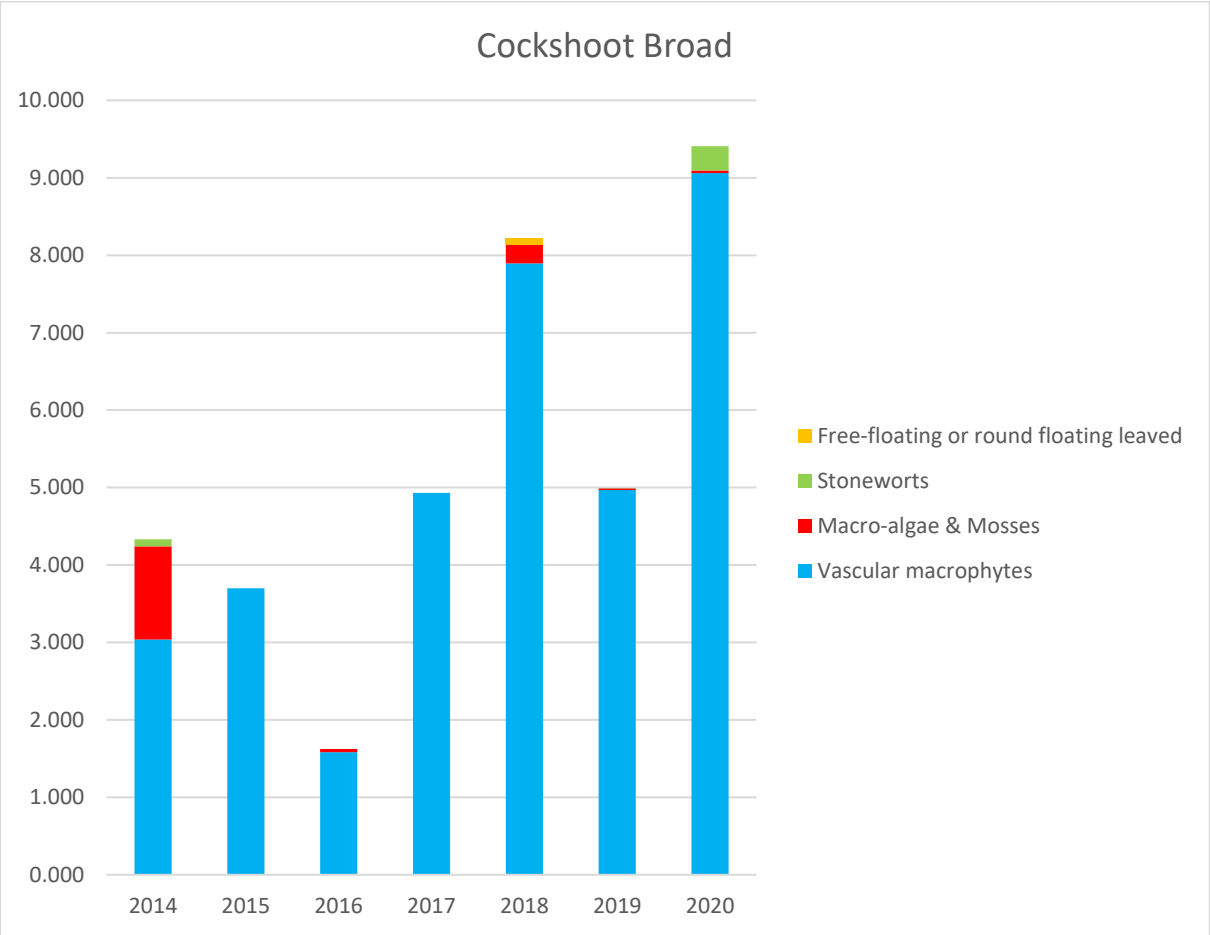
Table 12

Common Name	Scientific Name	Summary Abundance	Occurrences
Holly-leaved naiad	*Najas marina*	7.958	47
Horned pondweed	*Zannichellia palustris*	0.521	22
Rigid hornwort	*Ceratophyllum demersum*	0.500	22
Fragile/convergent stonewort	*Chara globularis/connivens*	0.167	8
Opposite stonewort	*Chara contraria*	0.083	3
Canadian waterweed	*Elodea canadensis*	0.083	2
Common stonewort	*Chara vulgaris*	0.063	3
Filamentous algae	*Zygnematales*	0.033	7
Total number of species recorded		**8**	**Total samples taken: 48**

Vascular plants increased in 2020 with levels now at the highest point since the new sampling method began in 2014. Holly-leaved naiad has increased significantly from 4.356 to 7.958 with stoneworts also increasing this year. Rigid Hornwort increased in abundance but not in points and Horned pondweed made an appearance this year which was last seen in 2014. Opposite stonewort made and appearance which has not been identified since 2014. Species numbers went from six to eight this year was well.

Graph 11

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



Hoveton Little

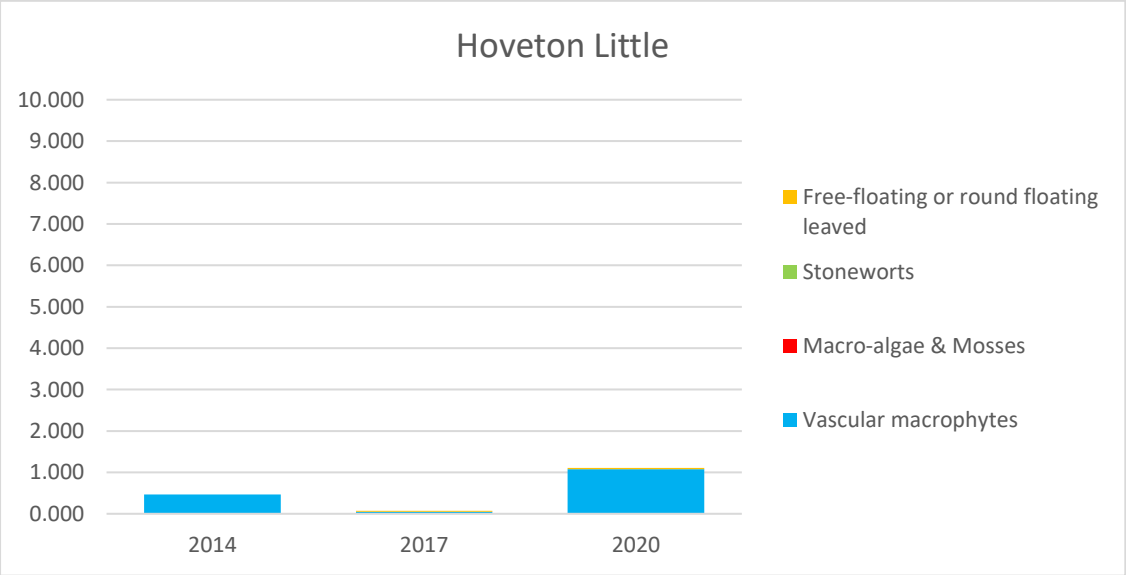
Table 13

Common Name	Scientific Name	Summary Abundance	Occurrences
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.652	36
Rigid hornwort	*Ceratophyllum demersum*	0.388	21
Yellow water lily	*Nuphar lutea*	0.033	2
Holly-leaved naiad	*Najas marina*	0.017	1
Curled pondweed	*Potamogeton crispus*	0.017	1
Total number of species recorded		5	Total samples taken: 60

There were more vascular macrophytes seen this year compared with the last two surveys with fennel-leaved pond weed and rigid hornwort making up the most of the score. There were also fewer 'no plant' occurrences this year.

Graph 12

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



Pound End

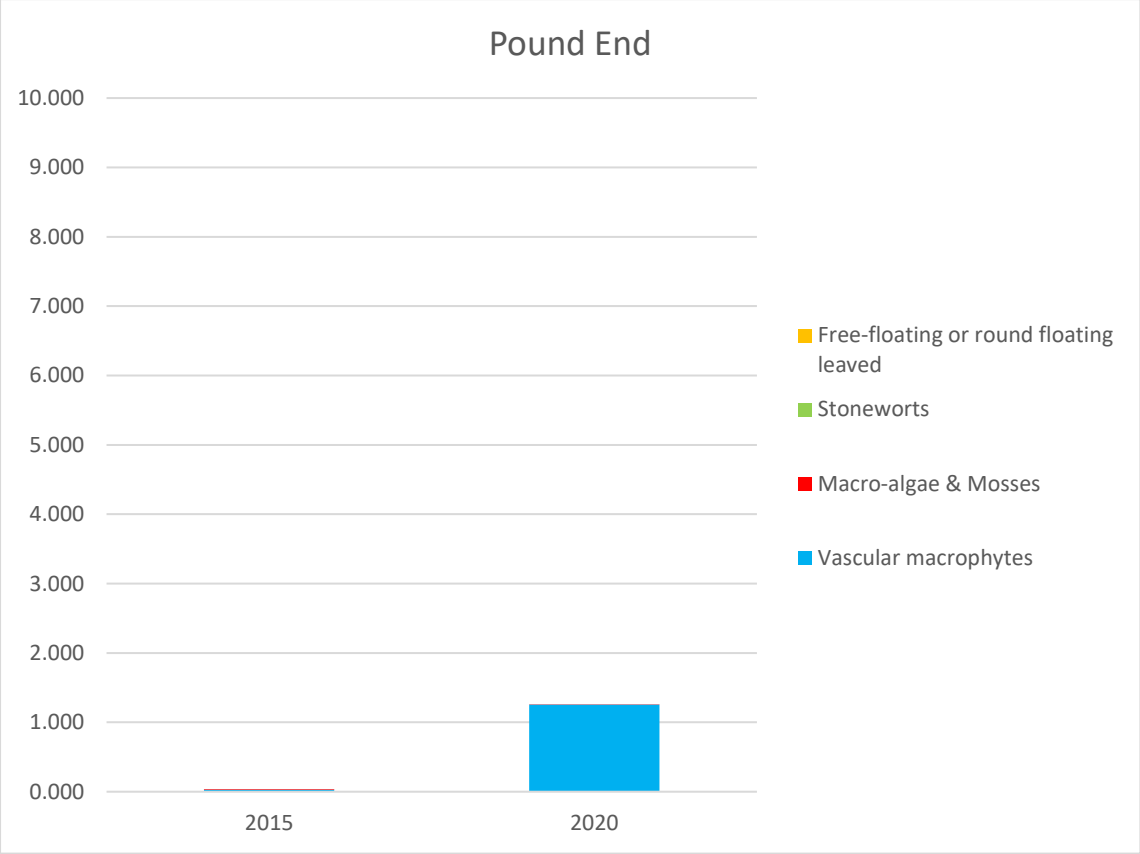
Table 14

Common Name	Scientific Name	Summary Abundance	Occurrences
Rigid hornwort	*Ceratophyllum demersum*	0.666	28
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.341	15
Holly-leaved naiad	*Najas marina*	0.250	11
Filamentous algae	Zygnematales	0.002	1
Common water moss	*Fontinalis antipyretica*	0.002	1
Total number of species recorded		5	Total samples taken: 44

Fennel-leaved pondweed, Rigid hornwort and Holly-leaved naiad make up largest part of the vascular macrophyte increase seen this year. There were also fewer 'no plant' points this year.

Graph 13

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



Decoy Broad

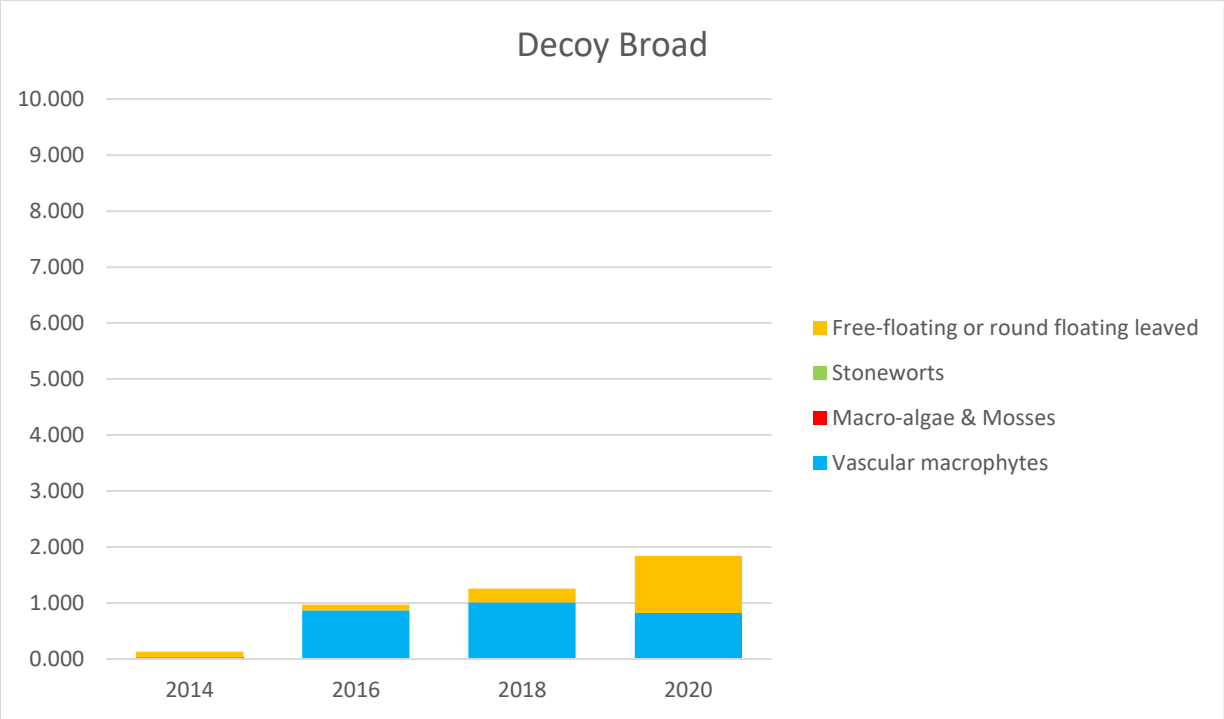
Table 15

Common Name	Scientific Name	Summary Abundance	Occurrences
Yellow water lily	*Nuphar lutea*	1.020	17
Rigid hornwort	*Ceratophyllum demersum*	0.783	25
Nuttall's waterweed	*Elodea nuttallii*	0.037	2
Total number of species recorded		3	Total samples taken: 54

This year has seen an increase in free floating or round floating leaved plants due to the increase in Yellow water lily. Rigid hornwort and Nuttall's waterweed although found in more places than the lily were less abundant. The species list has reduced this year from six in 2018 to three this year.

Graph 14

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



Hoveton Great Broad

Table 16

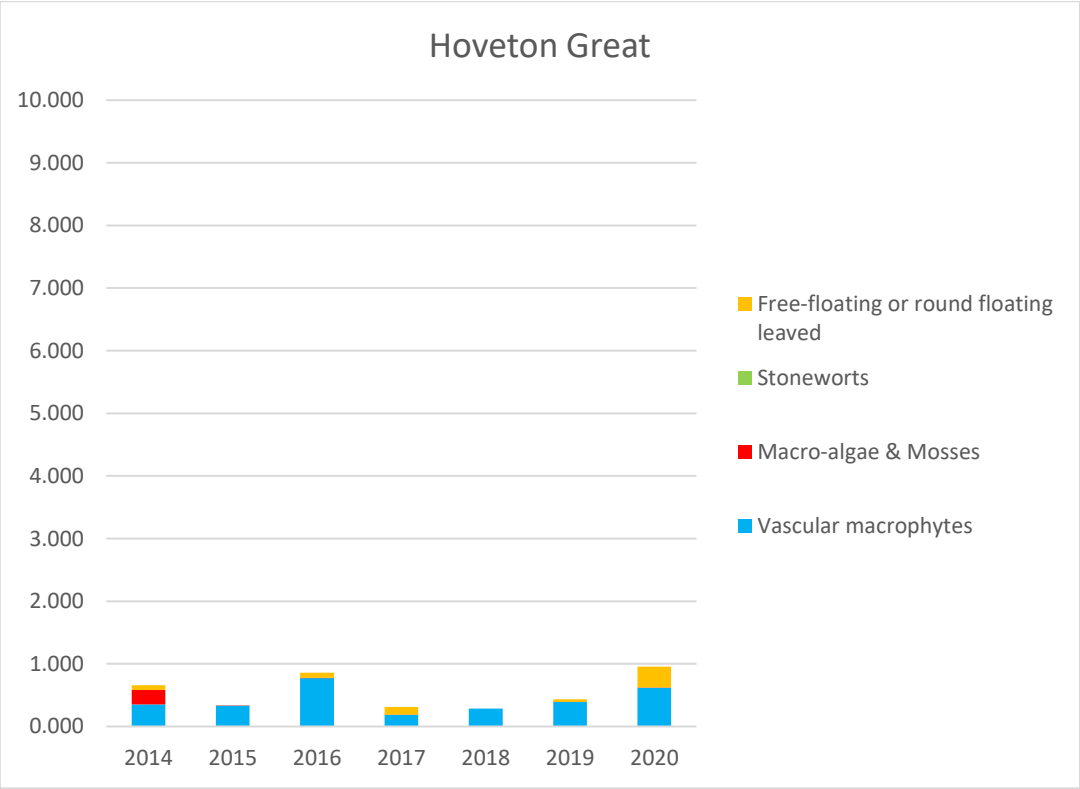
Common Name	Scientific Name	Summary Abundance	Occurrences
Yellow water lily	*Nuphar lutea*	0.333	3
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.317	17
Rigid hornwort	*Ceratophyllum demersum*	0.252	14
Nuttall's waterweed	*Elodea nuttallii*	0.050	3
Filamentous algae	*Zygnematales*	0.005	3
Total number of species recorded		5	Total samples taken: 60

An increase in diversity of vascular plants was recorded this year although a similar amount of species were found this year to last. 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 recorded no plants. This year Yellow water lily has become more abundant but still only appears in a few places. There were fewer 'no plant' occurrences which is a trend seen over the last three years.

Graph 15

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



Hudson's Bay

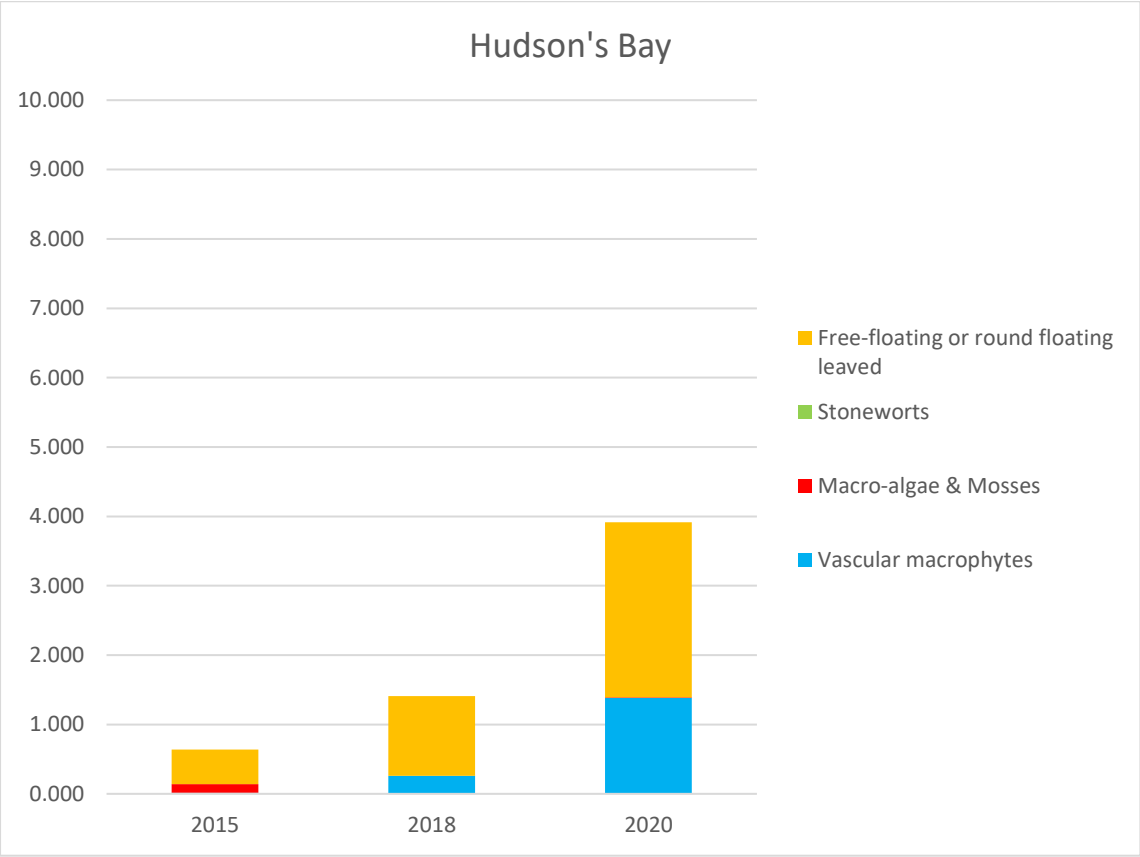
Table 17

Common Name	Scientific Name	Summary Abundance	Occurrences
Yellow water lily	*Nuphar lutea*	2.325	18
Rigid hornwort	*Ceratophyllum demersum*	1.333	25
White water lily	*Nymphaea alba*	0.200	3
Canadian waterweed	*Elodea canadensis*	0.050	2
Filamentous algae	*Zygnematales*	0.008	3
Total number of species recorded		5	Total samples taken:40

Hudsons Bay has recorded a marked difference in 2020 with an increase in summary abundance from just above one in to just below four this year. Yellow water lily and rigid hornwort are the notable species for 2020

Graph 16

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



Ranworth

Table 18

Common Name	*Scientific Name*	Summary Abundance	Occurrences
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.024	1
Total number of species recorded		**1**	**Total samples taken: 42**

Only one sample point recorded plants out of the 42 taken, with just Fennel-leaved pondweed present. There are fish barriers now present in the broad, but due to social distancing measures it was not possible to survey the areas in question; this has resulted in fewer sample points this year.

Malthouse

The survey resulted in no plants being found in 2020, this being consistent with casual observations at the site, and past surveys.

Upton Great Broad

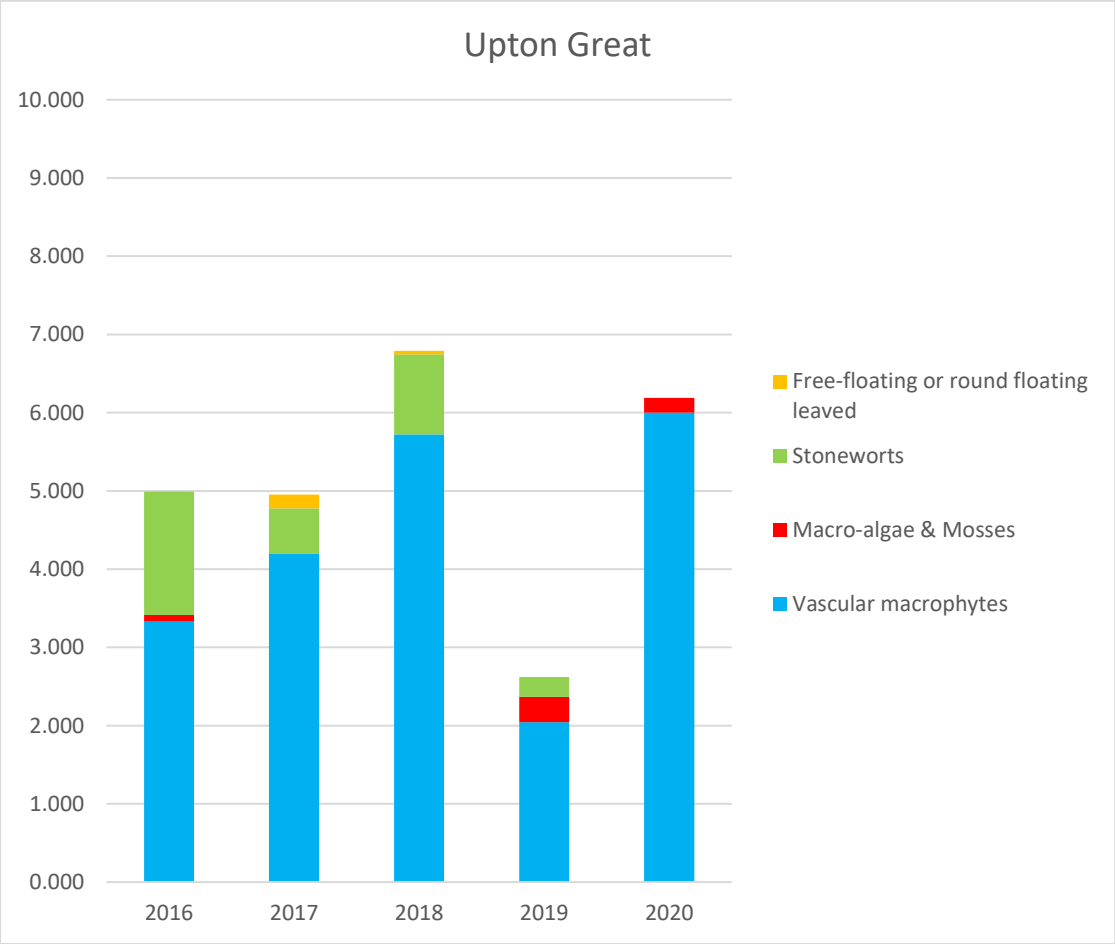
Table 19

Common Name	Scientific Name	Summary Abundance	Occurrences
Holly-leaved naiad	*Najas marina*	6.002	44
Filamentous algae	*Zygnematales*	0.188	9
Total number of species recorded		**2**	**Total samples taken: 48**

In 2020 only two species were found to be present in the broad. Holly-leaved naiad has gone from an abundance of 2 to 6; this is back to levels seen in 2018. Filamentous algae has reduced since 2019 but no stoneworts were recorded this year. Stoneworts have been present since the new recording method started in 2014 so next year's survey will be important to see if there is a more permanent shift in species present in the Broad or just an annual fluctuation.

Graph 17

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



Wroxham

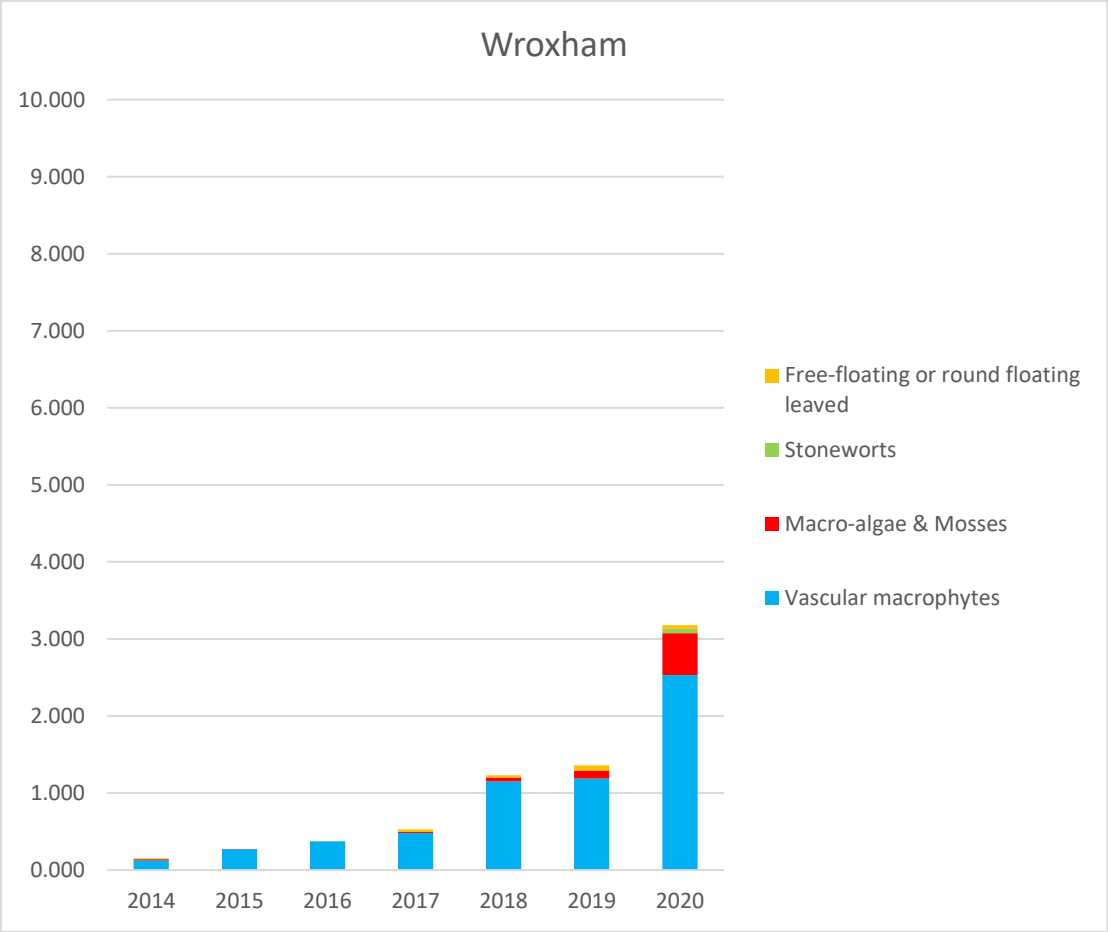
Table 19

Common Name	Scientific Name	Summary Abundance	Occurrences
Nuttall's waterweed	*Elodea nuttallii*	0.985	39
Rigid hornwort	*Ceratophyllum demersum*	0.765	40
Filamentous algae	*Zygnematales*	0.544	25
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.531	31
Stonewort (Nitella) species	*Nitella sp.*	0.059	4
Spiked water milfoil	*Myriophyllum spicatum*	0.059	4
Fan-leaved water crowfoot	*Ranunculus circinatus*	0.059	4
Unbranched bur-reed	*Sparganium emersum*	0.059	3
Yellow water lily	*Nuphar lutea*	0.046	3
Starwort species	*Callitriche sp*	0.029	2
Canadian waterweed	*Elodea canadensis*	0.029	2
Whorled water milfoil	*Myriophyllum verticillatum*	0.015	1
Total number of species recorded		**12**	**Total samples taken:68**

Although this broad is very well used by boats, particularly between the months of June and August this year, the results are the best recorded for 6 years. The top four species this year have all increased from 2019 and the number of points where no plants were recorded has decreased from 22 to 14. The water was clear around the south west edge which has a gravel substrate. Nuttall's waterweed has overtaken Rigid hornwort with the highest abundance for the first time since the new method started.

Graph 18

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



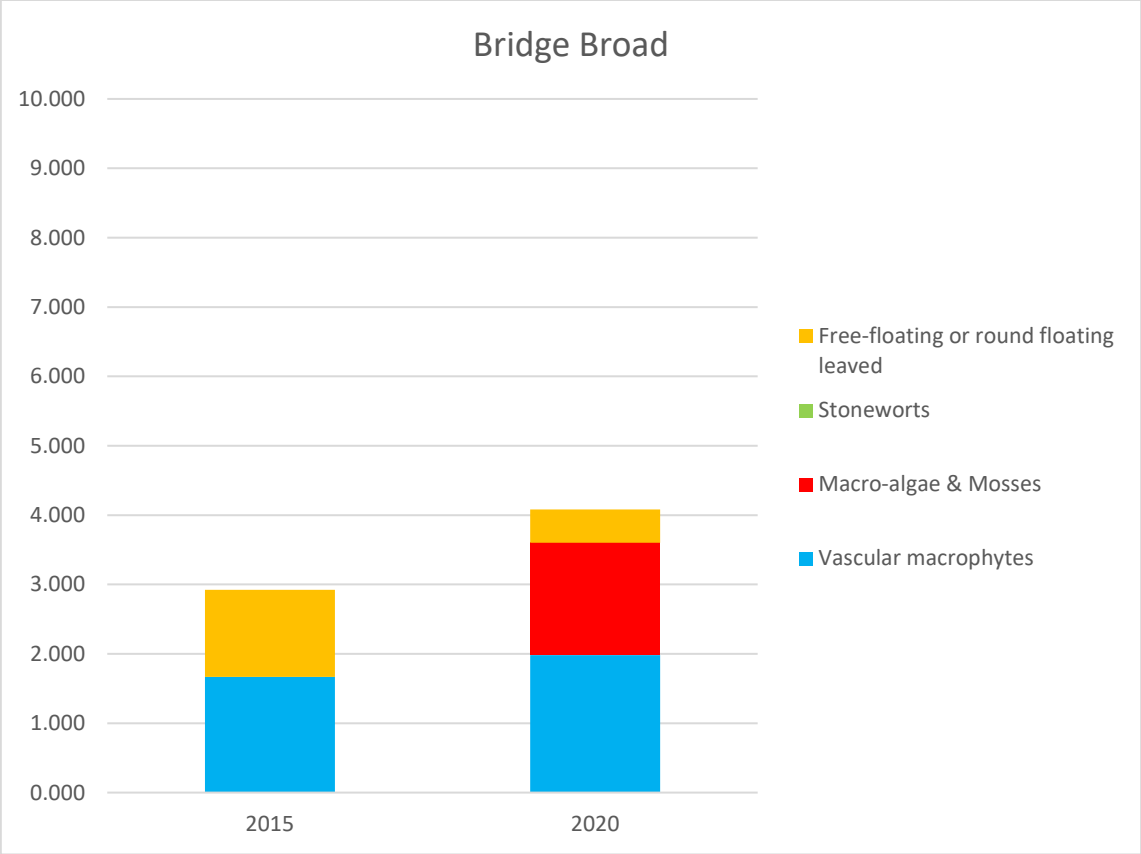
Bridge Broad

Table 20

Common Name	Scientific Name	Summary Abundance	Occurrences
Filamentous algae	*Zygnematales*	1.529	24
Unbranched bur-reed	*Sparganium emersum*	0.676	16
Nuttall's waterweed	*Elodea nuttallii*	0.629	19
Yellow water lily	*Nuphar lutea*	0.394	13
Rigid hornwort	*Ceratophyllum demersum*	0.294	9
Starwort species	*Callitriche sp*	0.176	5
Shining pondweed	*Potamogeton lucens*	0.176	5
Ivy-leaved duckweed	*Lemna trisulca*	0.029	1
Frogbit	*Hydrocharis morsus-ranae*	0.029	1
Common duckweed	*Lemna minor*	0.029	1
Arrowhead	*Saggitaria sagittifolia*	0.029	1
Total number of species recorded		**11**	**Total samples taken: 34**

Bridge Broad is surveyed every five years and the main difference since 2015 is the notable increase in Filamentous algae. There is a decrease in free floating or round floating leaved plants with vascular plants showing similar levels to 2015. Arrowhead made an appearance this year which is nice to see and Jelly algae was recorded at three points.

Graph 19


Bridge Broad
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
2015
2020
Free-floating or round floating leaved
Stoneworts
Macro-algae & Mosses
Vascular macrophytes

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'.

2020 Summary

The two Broads surveyed this year recorded increases in abundance levels from previous years.

Rockland Broad

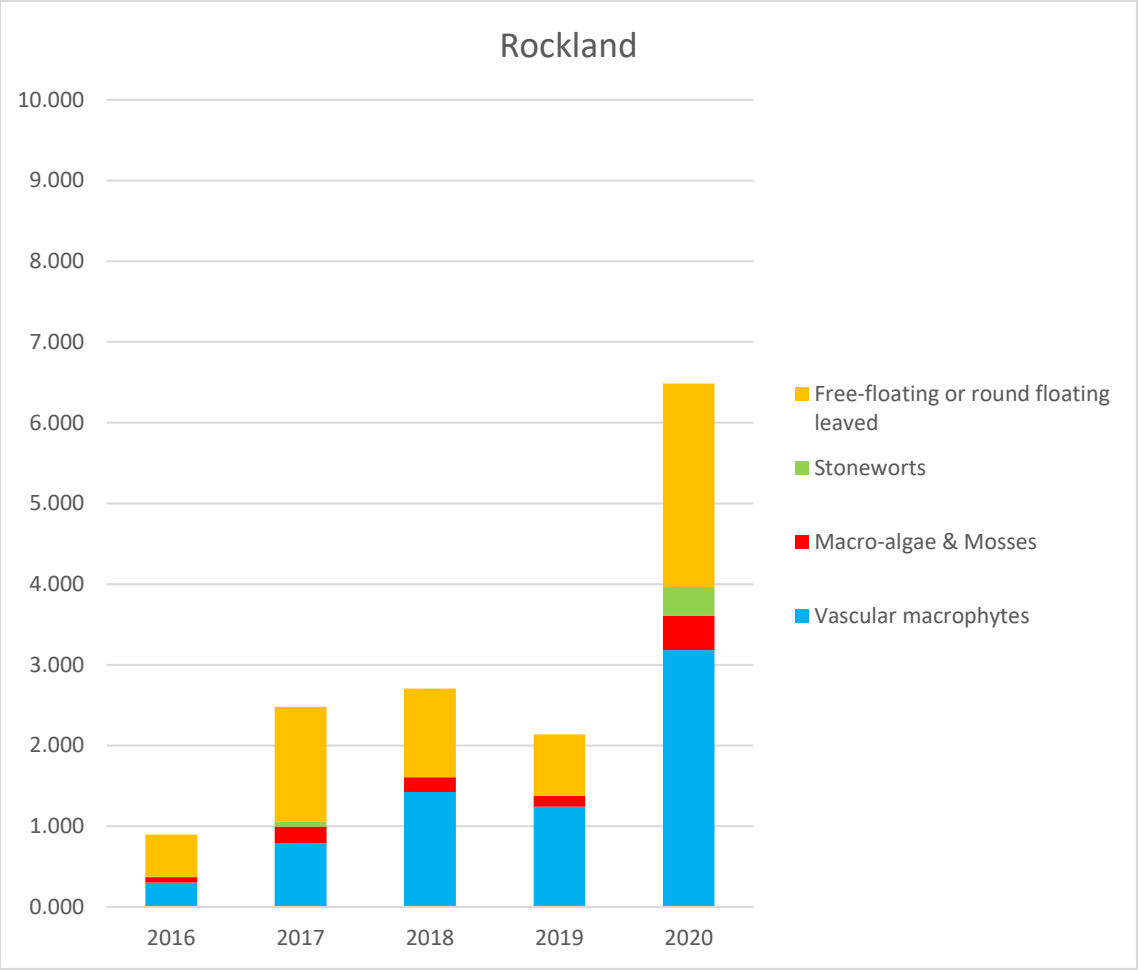
Table 21

Common Name	Scientific Name	Summary Abundance	Occurrences
Yellow water lily	*Nuphar lutea*	2.518	31
Rigid hornwort	*Ceratophyllum demersum*	0.645	38
Starwort species	*Callitriche sp*	0.597	37
Spiked water milfoil	*Myriophyllum spicatum*	0.534	25
Unbranched bur-reed	*Sparganium emersum*	0.485	21
Nuttall's waterweed	*Elodea nuttallii*	0.452	28
Stonewort (Nitella) species	*Nitella sp.*	0.355	20
Filamentous algae	Zygnematales	0.298	18
Whorled water milfoil	*Myriophyllum verticillatum*	0.177	10
Horned pondweed	*Zannichellia palustris*	0.115	8
Common water moss	*Fontinalis antipyretica*	0.097	5
Arrowhead	*Saggitaria sagittifolia*	0.081	3
Fan-leaved water crowfoot	*Ranunculus circinatus*	0.065	4
Fennel-leaved pondweed	*Potamogeton pectinatus*	0.032	2
Ivy-leaved duckweed	*Lemna trisulca*	0.002	1
Total number of species recorded		**15**	**Total samples taken: 62**

Yellow water lily has increased from 1.097 to 2.518, with Starwort species, Rigid hornwort and Spiked water milfoil showing large increases as well. It was a lot harder to get across the broad due to the increase in the water lilies and nice to see stonewort back after a 2 year absence. The summary abundance has gone up from 2.137 to 6.484. Jelly algae was also recorded at two points.

Graph 20

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



Bargate Broad

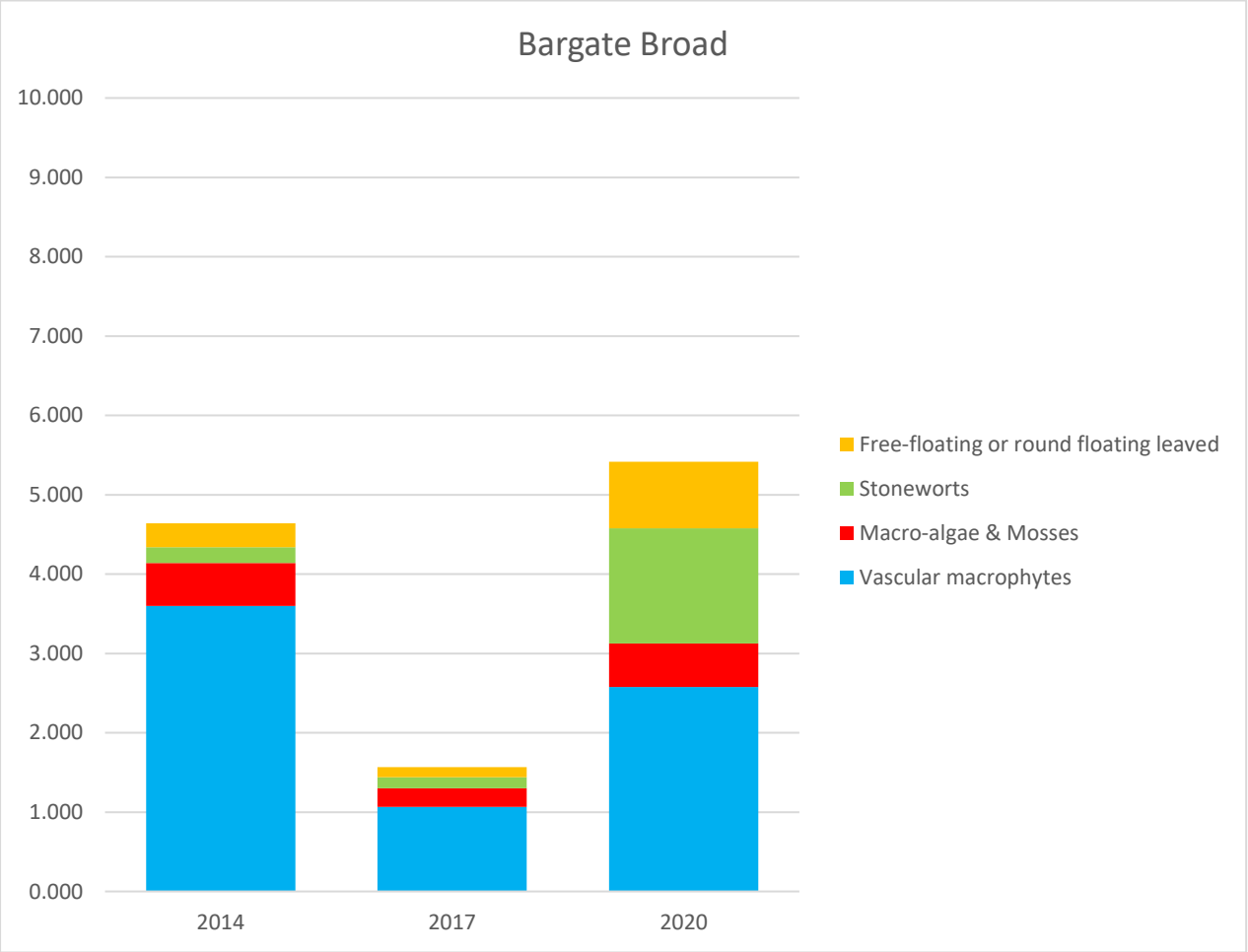
Table 22

Common Name	Scientific Name	Summary Abundance	Occurrences
Pointed stonewort	*Nitella mucronata*	1.452	26
Nuttall's waterweed	*Elodea nuttallii*	1.002	30
Unbranched bur-reed	*Sparganium emersum*	0.952	26
Yellow water lily	*Nuphar lutea*	0.836	14
Starwort species	*Callitriche sp*	0.310	12
Common water moss	*Fontinalis antipyretica*	0.286	10
Filamentous algae	*Zygnematales*	0.264	12
Arrowhead	*Saggitaria sagittifolia*	0.214	7
Rigid hornwort	*Ceratophyllum demersum*	0.071	3
Whorled water milfoil	*Myriophyllum verticillatum*	0.024	1
Spiked water milfoil	*Myriophyllum spicatum*	0.002	1
Total number of species recorded		**11**	**Total samples taken: 42**

A drop in abundance of vascular plants was recorded this year, however, stoneworts have increased with the most seen on record since the new sampling method began in 2014 and the greatest abundance to date this year. Nuttall's waterweed, Unbranched bur-reed and Yellow water lily also showed good abundance scores this year. Freshwater sponge was recorded along with Arrowhead.

Graph 21

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



Acknowledgements

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

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Most of all many thanks all those who gave up their time to collect and assist with analysing the water plant data; Erin Barber, Sue Stephenson, Dan Hoare, David Norton, Erica Murray, Elaine Green, Karen Tyrrell and Andrea Kelly.

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

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